

Initial Environmental Examination

January 2019

India: Chhattisgarh Road Connectivity Project

Lambar-Bodesara-Birkol-Singhora Road

Prepared by Public Works Department, Government of Chhattisgarh for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 31 December 2018)

Currency unit	=	Indian rupee/s (Re/Rs)
Re1.00	=	\$0.01408
\$1.00	=	Rs71.0008

ABBREVIATION

AADT	-	Annual Average Daily Traffic
AAQM	-	Ambient air quality monitoring
ADB	-	Asian Development Bank
ASI	-	Archaeological Survey of India
BDL	-	Below detectable limit
BGL	-	Below ground level
BOD	-	Biochemical oxygen demand
BOQ	-	Bill of quantity
CGWA	-	Central Ground Water Authority
CO	-	Carbon monoxide
COD	-	Chemical oxygen demand
CPCB	-	Central Pollution Control Board
CSC	-	Construction Supervision Consultant
DFO	-	Divisional Forest Officer
DG	-	Diesel generating set
DO	-	Dissolved oxygen
DPR	-	Detailed project report
E&S	-	Environment and social
EA	-	Executing agency
EAC	-	Expert Appraisal Committee
EFP	-	Environmental Focal Person
EHS	-	Environment Health and Safety
EIA	-	Environmental impact assessment
EMOP	-	Environmental monitoring plan
EMP	-	Environmental management plan
ESCAP	-	United Nations Economic and Social Commission for Asia and Pacific
GHG	-	Greenhouse gas
GIS	-	Geographical information system
GOI	-	Government of India
GRC	-	Grievance redress committee
GRM	-	Grievance redress mechanism
HFL	-	Highest flood level
IA	-	Implementing Agency
IEE	-	Initial Environmental Examination
IMD	-	Indian Meteorological Department
IRC	-	Indian Road Congress
IUCN	-	International Union for Conservation of Nature
LHS	-	Left hand side

LPG	-	Liquefied petroleum gas
MOEFCC	-	Ministry of Environment, Forests and Climate Change
MORSTH/MORTH	-	Ministry of Road Surface Transport and Highways
MPRSD	-	Master Plan Road Sector Development
N, S, E, W, NE, SW, NW	-	Wind Directions (North, South, East, West or combination of Two directions like South West, North West)
NGO	-	Non-governmental organization
NH	-	National Highway
NOC	-	No Objection Certificate
NOx	-	Oxides of nitrogen
PAH	-	Project Affected Household
PAP	-	Project Affected Persons
PAAs	-	Protected Areas
PCR	-	Public Community Resources
PCU	-	Passenger Car Units
PD	-	Project Director
PM	-	Particulate Matter
PIU	-	Project Implementation Unit
PPE	-	Personal protective equipment
PPT	-	Parts per trillion
PPTA	-	Project Preparedness Technical Assistance
PUC	-	Pollution Under Control
PWD	-	Public Works Department
R & R	-	Rehabilitation and Resettlement
RHS	-	Right hand side
ROB	-	Road Over Bridge
ROW	-	Right of way
RSPM	-	Respiratory suspended particulate matter
SAARC	-	South Asian Association for Regional Corporation
SC	-	Scheduled Cast – Name of a community in India
SEIAA	-	State Environmental Impact Assessment Authority
SEMU	-	Social and Environmental Management Unit
SH	-	State highway
SO ₂	-	Sulphur Dioxide
SOI	-	Survey of India
SPCB	-	State Pollution Control Board
SPL	-	Sound Pressure Level
SPM	-	Suspended Particulate Matter
SPS	-	ADB Safeguard Policy Statement, 2009
ST	-	Scheduled Tribes
TA	-	Technical assistance
TDS	-	Total dissolved solids
TSS	-	Total Suspended Solids
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
USEPA	-	United States Environmental Protection Agency
UT	-	Union Territories
ZSI	-	Zoological survey of India

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
ha	–	hectare
km	–	kilometre
µg	–	microgram
m	–	meter
MW (megawatt)	–	megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10 micron size

NOTE

In this report, "\$" refers to US dollars.

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CONTENTS

EXECUTIVE SUMMARY	i
I. INTRODUCTION	1
A. Project Background and Rationale	1
B. Nature, Size and Location of Subproject Road	3
C. Objective and Scope of the Study	5
D. Methodology Adopted for IEE Study	6
E. Structure of the Report	8
II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK	9
A. National (India) Environmental Policies and Regulatory Framework	9
B. International Treaties and Relevance to the Project	12
C. ADB Safeguard Policy Statement Requirements	12
D. Category of the Project as per SPS 2009	13
III. PROJECT DESCRIPTION	13
A. Type of Project	13
B. Location and Features of the Project Road	14
C. Engineering Surveys and Investigations	15
D. Current and Projected Daily Traffic	15
E. Design Standards	16
F. Proposed Improvement	23
G. Construction Camps	29
H. Project Cost	29
I. Construction Packaging and Implementation Schedule	29
J. Project Benefits	29
IV. DESCRIPTION OF THE ENVIRONMENT	30
A. Introduction	30
B. Physical Environment	30
C. Biological Environment	39
D. Socio-economic Environment	43
V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	48
A. Introduction	48
B. Positive Environmental Impacts due to improvement of project road section	49
C. Adverse Environmental Impacts due to improvement of project road section	49
D. Impacts Related to Project Location, Preliminary Planning and Design	50
E. Environmental Impacts - Construction Stage	53
F. Environmental Impacts - Operation Phase	68
G. Cumulative and Induced Environmental Impacts	70
H. Potential Environmental Enhancement/ Protection Measures	71
VI. CLIMATE CHANGE IMPACTS AND RISKS	71
A. Climate Change Mitigation	71
VII. CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE	79
A. Objectives of the Consultations	79
B. Methodology for Consultations	80
C. Interaction with NGOs	83
D. Public Disclosure	83
VIII. GRIEVANCE REDRESS MECHANISM	84
IX. ENVIRONMENTAL MANAGEMENT PLAN	85
A. Introduction	85
B. Objectives of Environmental Management Plan	86
C. Impacts and Mitigation Measures	86
D. Environmental Monitoring and Reporting Program	88

E. Environmental Reporting System.....	89
F. Institutional Requirements.....	91
G. Environmental Management Budget.....	95
X. CONCLUSIONS AND RECOMMENDATIONS	97
APPENDICES.....	99
Appendix 1: ADB's Rapid Environmental Assessment (REA) Checklist	99
Appendix 2: List of Proposed Road Sections and Packages	103
Appendix 3: Comparison of World Bank and GoI Ambient Air Quality Standards	105
Appendix 4: Comparison of WB EHS and GoI Ambient Noise Level Standards	107
Appendix 5: Indian Standard Drinking Water Specification: IS 10500:1991	108
Appendix 6: Record Of Public Consultations.....	109
Appendix 7: GRM Information Sheet.....	111
Appendix 8: Environmental Management and Monitoring Plan (Contract Package No. 6).....	116
Appendix 9: Guidelines for Tree Plantation and Management.....	134
Appendix 10: Guidelines for Borrow Area Management.....	136
Appendix 11: Guidelines for Emergency Management System.....	138
Appendix 12: Guidelines for Waste Disposal and Management	141
Appendix 13: Outline of an Environmental Monitoring Report	143
Appendix 14: Air Modeling Details	146

LIST OF TABLES

Table 1: Details of Packages Under Group A, Group B and Group C	3
Table 2: Details of Group A Subprojects	3
Table 3: Lambar-Bodesara-Birkol-Singhora Road.....	3
Table 4: Primary and Secondary Information Sources	6
Table 5: Summary of Relevant Environmental Legislation	9
Table 6: Applicable Permits and Clearances Required for the Subproject.....	11
Table 7: Summary Road Components and Design Standard	13
Table 8: Existing conditions and Landuse along the Subproject Road	15
Table 9: Average Traffic on road section.....	16
Table 10: Design Speed	17
Table 11: Radius for Horizontal Curves.....	18
Table 12: Sight Distance.....	20
Table 13: Radius for Horizontal Curves.....	20
Table 14: Cross-sectional Element	20
Table 15: Details of proposed improvement carriageway and shoulders.....	24
Table 16: Major and Minor Intersections	27
Table 17: Cost of Civil Works and Maintenance Components of project road	29
Table 18: Soil sampling locations along subproject alignment.....	32
Table 19: Soil Quality along the Project road	33
Table 20: Water source/bodies along the Project Road	34
Table 21: Water sample location along the project alignment	35
Table 22: Water Quality Characteristics along the Project Road	35
Table 23: Details of Ambient Air Quality Monitoring Locations	37
Table 24: Techniques Used for Ambient Air Quality Monitoring	37
Table 25: Summary of AAQM Results along the project Road Section (Average Values)	38
Table 26: Details of Noise Level Monitoring Locations.....	39
Table 27: Ambient Noise Level in decibel (A) along the Project Road.....	39
Table 28: Details of Project Road Section In Forest Area	41

Table 29: Detail of Trees existing within the Proposed ROW of the Project Road	42
Table 30: Demographic Features of State as per 2011 census.....	44
Table 31: Area under Different Landuses in the State.....	45
Table 32: Physical /Sensitive Features along the project road	47
Table 33: Activity-Impact Identification Matrix	48
Table 34: Detail of Trees to be impacted in corridor of impact.....	50
Table 35: Measures for environmental issues mitigation	52
Table 36: Clearances and Permits Required for the Subprojects	54
Table 37: Impact on Air Quality during Construction Stage	57
Table 38: Construction Noise / Distance Relationship.....	58
Table 39: Likely Impact on Noise Quality in the Vicinity of Project Area	59
Table 40: Typical noise levels of principal construction equipments.....	59
Table 41: Potential Effects on Topography by the Proposed Road Sections Upgrading.....	62
Table 42: Air Modeling Results (Predicted Conc. of CO).....	68
Table 43: Baseline pollutant concentration ($\mu\text{g}/\text{m}^3$) at different locations.....	69
Table 44: CO ₂ Emission Factors	72
Table 45:Emission Standards of Fleet (%)	72
Table 46: Estimated Total CO ₂ Emissions during Road Construction.....	73
Table 47: Section-wise Project CO ₂ Emissions Intensity Indicators	73
Table 48. Summary of Climate Change Trends	74
Table 49. Possible Climate Events, Risks and Adaptation Measures and Costs	77
Table 50: Subproject wise details of the Public consultation	80
Table 51: Summary of Issues Discussed and Measures Taken	81
Table 52: Peoples' Perception about Environmental Scenario	83
Table 53: Details of Trees to be affected due to subproject	87
Table 55: Stage-wise Reporting System of PIU	90
Table 56: Environmental Management Cost Estimate *	96

LIST OF FIGURES

Figure 1: Location of project Road Alignment on State Map.....	4
Figure 2: Alignment route Lambar-Bodesara-Birkol-Singhora Road.....	14
Figure 3: Typical Cross Sections	25
Figure 4: Geological Map of Chhattisgarh	32
Figure 5: Seismic Zoning Map showing Project Road Location (Source: IS 1893 - Part I: 2002).....	34
Figure 6: Forest Map of Chhattisgarh State	41
Figure 7: Protected Area Map of Chhattisgarh State	42
Figure 8: Conceptual Drawing of the Noise Barrier	61
Figure 9: Grievance Redress Mechanism	85

EXECUTIVE SUMMARY

A. Introduction

1. This report summarizes the findings and results of the Initial Environmental Examination (IEE) carried out for Lambar Bodesara Birkol Singhora Road (subproject) included in the ADB's Proposed Chhattisgarh Road Connectivity Project (the Project). The project aims to improve road connectivity in the state of Chhattisgarh by rehabilitating and upgrading 25 state highways and major district roads (MDRs) individually called as subproject. The Project constitutes (i) rehabilitating and upgrading of about 870 km of state road network, (ii) improving road maintenance and asset management and (iii) developing an efficient accident response system. These 25 road sections are packaged into 25 civil works contract packages and three construction supervision consultancy packages.

2. The subproject road is located in Chhattisgarh State of India. The report also briefly describes the subproject details, existing environmental conditions in the subproject areas, anticipated environmental impacts and corresponding mitigation measures, public consultation process, the environmental management plan (EMP) and its monitoring plan. The subproject is categorized as environment Category B as per Safeguard Policy Statement (SPS) 2009 categorization criteria. The Rapid Environment Assessment (REA) checklist for the subproject road is attached as Appendix 1. The IEE for the proposed subproject has been carried out as part of project preparation and in compliance with ADB's Safeguard Policy Statement (SPS) 2009 requirements. Since the improvement work involved upgrading of existing state roads, therefore this work does not fall in the purview of the EIA Notification 2006 of Government of India (GOI). Hence environmental assessment and environmental clearance is not required for the proposed road as per GOI regulatory requirements.

B. Description of the Subproject

3. The subproject road is located in Chhattisgarh State covering Mahasamund District with a the length of 39.99 km. The proposed road section is part of the major district road network on Chhattisgarh State. The existing carriageway is Intermediate lane having flexible pavement, with widths varying between 3.30 m to 5.50 m along the entire length of project road. The existing road has both paved and unpaved shoulder of varying lengths on either sides of the project road. Entire length of the project road runs through plain and rolling terrain and land use is mostly agricultural, patches of ofrest land intermittently. The pavement is bituminous asphalt in the road section and overall riding quality is fair to poor. The condition of shoulders is also poor which are now mostly covered with vegetation. There is no formal drainage system along the road. Major traffic on the road section is of passenger vehicles. The current and projected average daily traffic on the project road is relatively low, averaging about 2244 PCU each day.

4. It is proposed to improve the selected MDR road section to two lane with paved shoulders configuration with 7m rigid pavement carriageway and 1.5m shoulders on both side. While in section proposed for four lane with paved shoulders configuration with 15 m rigid pavement carriageway and 1.0m shoulders on both side. In urban areas the improvement will be restricted to the existing ROW. Adequate cross drainage structures have been proposed in the subproject.

C. Description of Environment

5. **Physical Environment:** The subproject areas experience typical tropical climate. The topography of the subproject areas is passing plain and rolling terrain. Land use is predominantly agriculture followed by protected class of forest, open areas and residential areas. Subproject is situated in Mahanadi basin, which is characterized as having very deep soils with texture ranging from sandy loam to clay in the surface and clay loam texture. The soil type in the areas is mainly shallow to medium black. Soil is mostly found as sandy clay loam soil in the sampling locations and it is loaded with sand, percentage ranges from 53 to 57 %. Nitrogen content ranges from 60 mg/1000g and is poor in organic carbon content.

6. The water quality parameters is not a problem in the project area as all parameters are well within permissible limits of drinking water. Overall the ground water quality in the project areas is good. Ambient air quality parameters are well within the NAAQ standards of prescribed by MoEFCC for residential areas. Maximum concentration of PM₁₀ is 75 µg/m³ found at Potapara (km 4+600), whereas maximum concentration of PM_{2.5} is 28.3 µg/m³ also found at Potapara, due to poor road conditions. These levels are well in the standards limit of 100 µg/m³ and 60 µg/m³ prescribed by MoEFCC for PM₁₀ and PM_{2.5} respectively. However PM₁₀ level is found to be on higher side compared to World Bank prescribed Standards of 50 µg/m³ for interim stage 2. Overall the air quality along the subproject road is not an issue.

7. Ambient noise levels at all the monitoring locations are well within the permissible limits for residential areas prescribed by CPCB and also by World Bank EHS standards of 55 dB(A) and 45 dB(A) for day time and night time respectively. The maximum recorded day time noise level is 55.4 dB(A) and night time noise level is 52.7 dB(A) at N1, Potapara.

8. **Biological Environment:** The subproject area has moderate to low percentage of forest cover. The subproject road section of 6.450km length passes through forest area. About 1758 trees are likely to be affected due to proposed improvement work. The subproject road section do not pass through any protected area such as wildlife sanctuary, national park or bio-reserve. Also there are no notified protected areas wildlife within 10km radius of the subproject road. No rare or endangered species of flora and fauna reported along the corridor of impact of the subproject road.

9. **Socio-economic Environment:** No archaeological and historical monuments are located along the project road. However, small religious structures are located within the existing RoW. These religious structures will not be affected due to proposed improvement activities under the project.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Design and Construction Phase

10. **Physiography and Topography:** Since proposed project only involves widening of existing road within available ROW with minimum acquisition (12.900 ha. of agriculture and 11.67 ha. of forest) of additional land for improvement of road geometry, impacts on the physiography of the area would be insignificant during both construction and operation phases. The project design considered the improvement of roadside drainage conditions through the improvement of cross-drainage structures. Design of the cross drainage structures followed IRC Guidelines (IRC, 1995).

11. **Impacts on Soil:** Since all activities will occur within the available RoW, no adverse environmental impacts are anticipated on the productive soil. Land taken on lease for access roads and for construction camps will be restored to its original land use.

12. Land clearing and grubbing will remove vegetation and soil cover which may cause some soil erosion during monsoon. Excavations in borrow pits may lead to loss of top soil and soil erosion. There is risk of stream and river bank erosion near bridges and cross drainage works. To avoid or minimize erosion, land clearing and grubbing will be conducted during dry season, productive top soils from borrow pits will be stored and reused in road embankment slope protection. Erosion control measures like silt screens will be installed along rivers and *nallahs*.

13. There is a risk of contamination of soil from construction material and oil spills. Contractors are required to ensure proper handling materials and able to implement spills containment. Oil contaminated waste will be properly collected, stored, and disposed through 3rd party service providers. All fuel and lubricant storage and handling areas will be located at least 500 meters from the nearest water body and provided with perimeter interceptor drains. All construction debris will be disposed by the Contractor on pre-designated areas as identified by the environmental specialist of the construction supervision consultant.

14. **Water Resources and Drainage:** Deterioration of water quality may occur near the construction camp and active workers camps. This will be minimized by timing land clearing and earthmoving during the dry season; proper handling of materials including oil, and lubricants; prohibiting the disposal of untreated sewage; and proper erosion control near rivers and *nallahs*.

15. **Air and Noise Quality:** Significant amount of dust will be generated during project construction. The following mitigation measures will also be undertaken:

- i) Asphalt and hot-mix plants will be located at least 1 km away from any inhabited urban and rural stretches along the road with the NOC from the State Pollution Control Board.
- ii) Sprinkling of water on the active construction fronts and construction yard.
- iii) Regular maintenance of machinery and equipment.

16. Substantial noise will be generated from the use of heavy equipment and processing of rocks and asphalt. Adequate distance separating the rock crusher and hotmix plants will be required and the sourcing of "ready-made" gravel and asphalt will be promoted to avoid the establishment of these plants. Along the roads particularly near sensitive sites like schools and temples, the use of less noisy equipments, scheduling of noisy activities, and provision of noise barriers will be implemented by the contractor to minimize disturbance.

17. **Flora, Fauna and Ecosystem:** Clearing and grubbing activities will result to the removal of shrubs, grasses, and cutting of an estimated 4903 trees. All cut trees will be compensated at the rate of 1:10 with preference to fast growing local species that are more efficient in absorbing carbon emissions.

18. **Construction Workers' Camp:** As the Contractors are required to source labor from the local communities along the subproject roads, the size of the construction camps will be relatively small. It is the contractual responsibility of the Contractors to maintain a hygienic camp with adequate water and electric supply; toilet facilities located away from the water bodies and wells; proper disposal of domestic refuse; temporary medical facilities; pest control; clean and adequate food; and security.

19. **Social Environment:** Construction and operation phases of project road will have some beneficial impact on social environment. Some increase in income of local people is expected as local unskilled, semiskilled and skilled persons may gain direct or indirect employment during construction phase. Since the immigration of work force during construction phase is likely to be very small, the social impacts on literacy, health care, transport facilities and cultural aspects are expected to be insignificant.

2. Operation Phase

20. Increase in vehicular emissions, noise level, road crashes due to higher speed vehicular speed, and oil contaminated road surface runoff will occur during project operation phase. The impact on air quality is not expected to be significant given the low projected traffic. Community safety is enhanced through the crash barriers, speed brakes, traffic signs, and pavement markers. Oil contamination will occur but expected to be in trace amounts based on the low level vehicular traffic. To control the anticipated increase in noise level measures such as good road surface will reduce the road-tire noise, prohibition of horns along sensitive areas, road widening will increase capacity and decrease congestion of vehicles, and compensatory tree plantation will be located near sensitive areas will be implemented.

21. **Climate Change impacts:** A climate risk and vulnerability assessment study has been carried out for proposed project. Given the projected variations of temperature and precipitation the project road were screened for different types of climate risks and impact on road components. Key engineering measures taken to address flood risks in the design are: i) improvement in embankment heights by around 1 to 2 m in critical sections; ii) improvement in flood discharge capacities by replacement of all existing 300 mm and 600 mm dia pipes with larger 900 mm and 1200 mm dia pipes, and iii) replacement of culverts by small bridges and small bridges by larger bridges. Total costs for taking proposed measures add up to a total of Rs. 23.57 crores (\$ 3.31 millions). This is approximately 19.91% of the total civil works costs for the subproject road. An assessment on CO₂ emissions that was carried out using the Transport Emissions Evaluation Models for Projects (TEEMP) tool shows that the total CO₂ emission at business-as-usual scenario was estimated at 153,217 tons/year and without- and with- induced traffic are 31,192 tons/year and 67,532 tons/year, respectively. These values are below the 100,000 tons per year threshold set in the ADB SPS 2009.

E. Public Consultation and Information Disclosures

22. Public consultations have been carried out at four locations along the subproject road during initial field surveys for the IEE. In total 103 participants attended the consultation sessions. Public consultations have been also been carried out in the project area during the feasibility as well as detailed design stage.

23. Most of the people consulted and interviewed strongly support the subproject. The people living in the entire project areas expect the different project elements to facilitate transport, employment, tourism, boost economic development and thereby provide direct, or indirect, benefits to them.

24. The IEE will be disclosed in the English language in the office of PWD and also to the public through ADB website.

F. Institutional Arrangement and Capacity Building

25. CGPWD has set up a Project Implementation Unit (PIU) headed by Project Director at its head quarter for the implementation of ADB funded projects. PIU has a position of environmental specialist in its organization structure. However at present, this position is vacant and deputy project director is responsible to handle environmental concerns related with their activities. It is proposed to appoint an environment expert (EE) at PD office in PWD with adequate powers to collect information from field units. In addition to executive Engineer (the Nodal officer) of respective PWD division will designate one engineer with additional responsibility of Environmental and Social management task. This environmental expert will assist PWD in carrying out its responsibilities in implementing the EMP and EMoP. In addition, the E&S expert will also assist proposed district level committee for reviewing the effectiveness of EMP implementation.

26. The Public Works Department (PWD) will be responsible for the implementation of the EMP which it will implement through contractors and under the supervision of Construction Supervision Consultant (CSC) who will be responsible for the implementation of most of the mitigation and environmental management measures suggested for construction and operation of the project road.

27. CGPWD has the responsibility for undertaking environmental monitoring and the implementation of environmental mitigation measures. CGPWD will arrange monitoring as per monitoring responsibility defined under EMoP. The CGPWD will submit semiannual environmental monitoring reports to the ADB within three months' time of completion period. This monitoring will report on compliance with construction contracts, effectiveness of mitigation measures, and complaints (also known as project performance monitoring), and the state and health of nearby environmental resources (also known as 'ambient environmental monitoring').

28. To enable CGWPD officials responsible for environmental aspects its environmental and social obligations more effectively two training programmes on (i) Awareness programme on environmental issues associated with construction and improvement of road projects and legislative compliance requirements; and (ii) EMP and EMoP implementation requirements, its benefits and roles of different level and functions; are recommended. The costs of these programs is included in the EMP.

G. Environmental Management Plan

29. Civil works contract package specific fully budgeted environmental management plan has been prepared for mitigation/management/avoidance of the potential adverse impacts and enhancement of various environmental components along the project road section. For each mitigation measures to be carried out its location, timeframe, implementation and overseeing/ supervising responsibilities has been identified. Monitoring plan for construction and operation phase has been framed to ensure effective implementation of EMP.

30. The monitoring program included performance indicators for water, air, and noise level monitoring, frequency of monitoring, and institutional arrangements of the project in the construction and operation stages, along with the estimated cost. The reporting system included roles and responsibilities of each party involved in the project implementation i.e. PIU, Supervision Consultant and Contractor and reporting mechanisms during implementation and operation phases.

31. An environmental management budget of INR 19.48 million (US\$ 0.28 million) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings.

H. Conclusions and Recommendations

32. The findings of the IEE shows that overall the subproject has limited and short term environmental impacts. Effective implementation of EMP will ensure elimination and minimization of identified potential adverse impacts. PWD through PIU shall ensure that EMP and EMoP is included in the Bill of Quantity (BOQ) and forms part of bid document and civil works contract for each package. If there is any change in the project design the EMP and EMoP will be updated accordingly. Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned PWD officials.

33. This IEE including EMP are considered sufficient to meet the environmental assessment requirements of ADB and Government of India. Therefore, a full environmental impact assessment study is not required.

I. INTRODUCTION

A. Project Background and Rationale

34. The proposed Chhattisgarh Road Connectivity Project (the Project) will rehabilitate and upgrade about 900 kilometers (km) of state highways and major district roads (MDRs) in Chhattisgarh to improve connectivity, livelihood opportunities, and access to basic services for people in remote areas. The physical works will involve upgrading the state highways and MDRs to two-lane width with hard shoulder along built-up areas. For investment in the physical infrastructure to be efficient and sustainable, the project will also strengthen road maintenance through the provision of 5-year performance-based maintenance in each civil works contract, and introduce road safety audit (RSA) at design, construction and operation stages.

35. **Socioeconomic context.** Chhattisgarh is a state in the center-east of India, constituted in 2000. The state covers an area of 137,898 square km and has a population of about 25.5 million as indicated in the 2011 census. Chhattisgarh is predominantly rural—about 96% of the territory. Of its population, about 77% live in rural areas, indicating a population density of about 150 persons per square km. The literacy rate is around 71%, which is slightly below the country's average of 73%.¹ Chhattisgarh is rich in natural resources and is a major producer of various kinds of minerals, notably coal and iron ore, which significantly contribute in the production of steel and electricity in the country. The state has a large forest area (44% of the territory) and a large agricultural base which support the tribal economy and many small-scale industries. The state's gross domestic product (at current prices) has increased from \$22.9 billion in 2011–2012 to \$42.0 billion in 2016–2017, suggesting a compound annual growth rate of 10.65%.² With this strong growth, Chhattisgarh is considered among the fast-developing states in India.³

36. Despite the good economic growth in recent years, poverty remains a key issue that must be resolved. The 2011 census suggested that about 38% of the state population lives below the poverty line, which is among the highest in India. The state government has recognized the imbalanced distribution of socioeconomic benefits and poor access to livelihood opportunities in the state. Improving transport connectivity is an important factor in addressing these issues.

37. **Sector context.** The movement of people and goods in Chhattisgarh relies heavily on roads, particularly in rural areas. The total length of road network in the state is 74,434 km, which includes national highways (3,169 km), state highways (4,438 km) and district roads (25,569 km).⁴ The Chhattisgarh Public Works Department (CGPWD) manages these roads. Habitations in the rural areas of Chhattisgarh are connected to these major road networks through all-weather rural roads and village roads, totaling about 35,000 km. These rural roads are managed by the Panchayat and Rural Development Department.⁵ The rest of the network are urban roads and project-specific roads that are managed by other agencies or government bodies. The state of Chhattisgarh lacks an adequate road network to efficiently support the required mobility across areas with natural resources, social services, industrial centers, and economic development zones. As of 2015–2016, road density in Chhattisgarh is only 72.1 km per 100 square km, which is significantly below the national average of 139.1 km per 100 square km.⁶ About 70% of the state highways have only single or intermediate lane, whereas most of the major and other district roads are single lanes. Most of these roads need widening and strengthening to cater to the increasing traffic demand, especially larger-goods vehicles.

38. The lack of road safety measures has contributed to the poor connectivity in the state. Land use changes, such as ribbon developments along the roads, contribute to the number of accidents. Motorcycle and goods vehicles are the two highest contributors to road accidents. Suitable design standards that incorporate road safety measures, and increased road safety awareness among the affected communities, need to be integrated in road development.

39. **Vision 2030.** In the absence of a safe and efficient road network, the objective of socioeconomic development such as reducing poverty and isolation of disadvantaged groups in Chhattisgarh will not be achieved. To guide the development of the road sector, the state government, through the CGPWD, has established a development strategy as part of the state's Vision 2030, which will contribute to the country's strategy to achieve the Sustainable Development Goals.⁹ The vision includes three key initiatives in the road sector to connect: (i) the state capital to all district headquarters through four-lane roads, (ii) the district headquarters to all block headquarters through two-lane roads, and (iii) all block headquarters to village councils through all-weather roads. To achieve these targets by 2030, the CGPWD needs to upgrade 2,806 km of national highways, 2,675 km of state highways, and 16,134 km of other state roads, with an overall estimated cost of \$16.6 billion. In line with this development plan, by 2020 the CGPWD plans to upgrade 1,393 km of national highways under the National Highway Development Project with an estimated cost of \$1.6 billion, and to upgrade 4,100 km of state highways, major district roads and other roads with a budget provision of \$1.7 billion from loans, mineral development plans, and regular state funding.

40. **Proposed Solution.** To achieve the development target in the Vision 2030, the state government proposes to rehabilitate and upgrade the existing state highways and major district roads. This network improvement measures will contribute in the effort to facilitate safer and more efficient road network operations in Chhattisgarh. The project will have two outputs.

41. **Output 1:** State highways and major district roads improved. The CGPWD has identified 25 state highways and MDRs with a total length of about 870 km to be rehabilitated or upgraded under the project. The roads were selected based on (i) linkage to national highways, other state highways, MDRs, and key economic centers in accordance with Vision 2030, (ii) level of utilization, reflected by the annual average daily traffic, and (iii) least safeguard concerns. The selected state highways and MDRs will be rehabilitated or upgraded to two-lane width with hard shoulder along built-up areas. The roads have been designed to follow the Indian Road Congress design guidelines, which include provisions for road safety measures.

42. **Output 2:** Operation and maintenance of state highways and major district roads sustained. The sustainability of the physical investment will be facilitated through the provision of 5-year performance-based maintenance in each civil works contract. Road maintenance, including the 5-year maintenance contract, will be financed under the state government budget. The project will assist the CGPWD to manage road maintenance through the application of the maintenance toolkit that was developed under ADB-financed technical assistance projects. The project will introduce RSA to be performed at design, construction and operation stages, and provide institutional support to mainstream road safety in CGPWD operation. Road safety awareness sessions will also be carried out for school students and members of communities along the proposed roads.

43. **Impact and outcome.** The project is proposed to support the state government's initiative to improve connectivity, with a key objective to help eradicate imbalance in distribution of socioeconomic benefits and livelihood opportunities. This solution will result in the following outcome: road connectivity and safety in Chhattisgarh improved. The project will be aligned with the following impact: mobility and accessibility in India improved.

44. The identified 25 road sections (subprojects) have been divided into three groups (Group A, Group B, and Group C) for contract management and supervision purpose as shown in Table 1. The proposed subproject (Lambar-Bodesara-Birkol-Singhora Road) is one of the seven subprojects from Group A (Table 2). Table 3 provide summary of the proposed project road covered under this IEE.

Table 1: Details of Packages Under Group A, Group B and Group C

Sl. No.	Name of group	No. of Roads	Total Length (km)
1	Group A	07	296.320
2	Group B	10	347.410
3	Group C	08	226.810
Total		25	870.24

Table 2: Details of Group A Subprojects

Sl. No.	Name of Road	Class of Road	Length (Km)
1	Tikrapara Sejbahar Semra Bhakhara Dhamtari Road (Old Dhamtari Road)	MDR	57.840
2	Rajim, Chhura Road Vhaya Tarrighat Road	MDR	43.300
3	Panduka Jatmay Ghatarani Gaydbari Mudeli Mudagaon Road (Chhura Fingeshwar Road)	MDR	38.200
4	Dewari Saldih Garhphuljhar Toshgaon Toresingha Road	MDR	44.190
5	Ghotiya Palari Vatgan Ghirpuri Chikhali Samoda Achhola Tumgaon Road	MDR	43.700
6	Lambar Bodesara Birkol Singhora Road	MDR	40.00
7	Nipaniya Latuva Balodabazar Road	MDR	29.09
Total			296.320

Table 3: Lambar-Bodesara-Birkol-Singhora Road

Road	District	Environmental Setup	Length (Km)
Lambar Bodesara Birkol Singhora Road	Mahasamund District	The entire length of the project road runs through plain & rolling terrain and passing across several agricultural land, villages, and towns.	39.99*

*Note- The road length is 40.00 kms where as the design length is 39.99 kms.

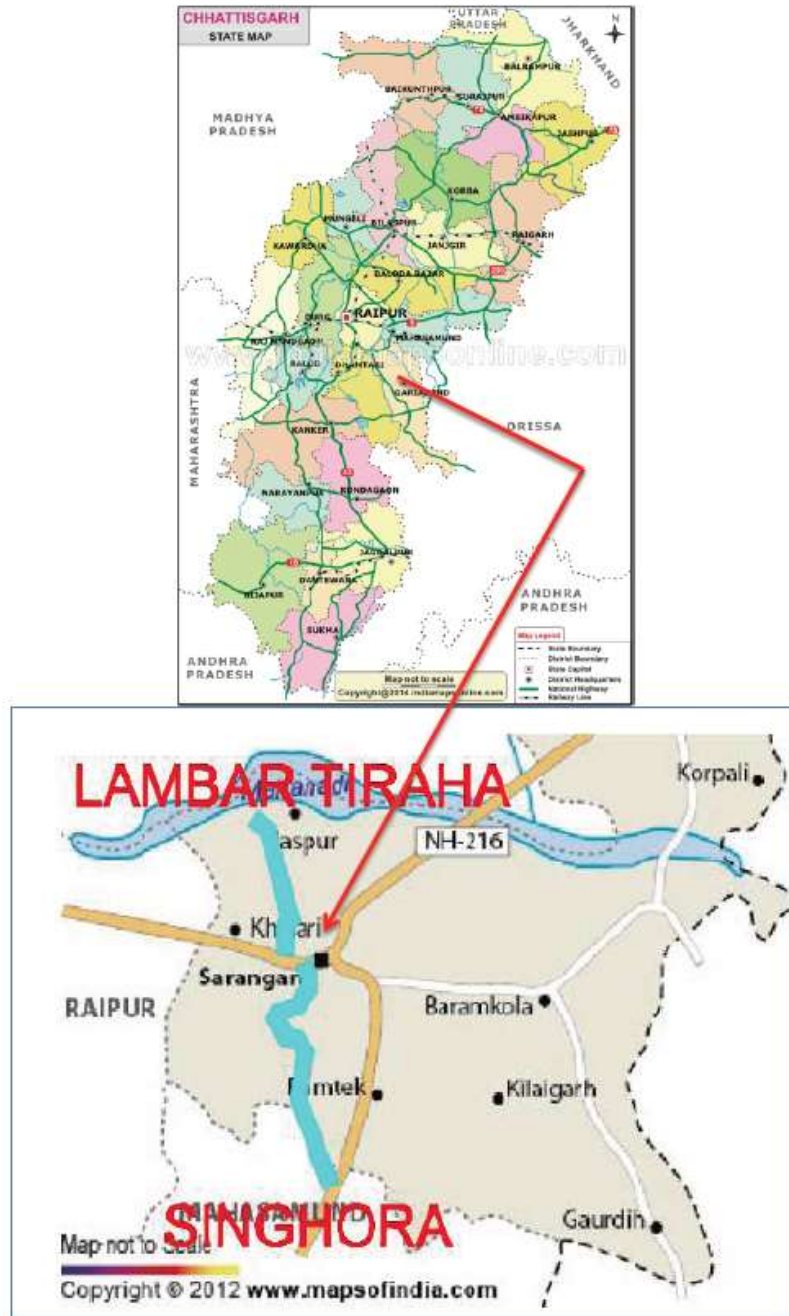
45. As part of detailed project report (DPR) preparation, this IEE report was prepared to cover Lambar-Bodesara-Birkol-Singhora Road subproject. All discussions thereafter focus only on this subproject to be taken up as Package 6. IEE has been prepared in accordance with relevant policies and regulations of the Government of India, GoCG, and the ADB Safeguard Policy Statement 2009 (SPS). This IEE report will be disclosed in the office of Chhattisgarh PWD and on the ADB website.

B. Nature, Size and Location of Subproject Road

46. The proposed subproject (Lambar-Bodesara-Birkol-Singhora Road) is situated in the eastern part of Chhattisgarh state and traverses in Mahasamund District covering a total length of 40.00 Km (Design Length 39.99 km). The Project Road starts Km 0+000 at Lambar Tiraha

(Km 17/3 of SH-16, L/s Lambar, R/s Saraipali) in Near Lambar, Mahasumund District and terminates at Km 39+994 (T-Junction of NH-6, L/s Sohela, R/s Saraipali) in Singhora Village, Mahasumund District having a total Design length of 39.994 Km. Total length of the project corridor is running between Latitudes of 21°26'57.74" N; Longitudes of 82°56'15.94" E and Latitudes of 21°18'00.59" N; Longitudes of 83°10'56.08" E. The road widening activities primarily will comprise of raising the embankment at certain locations and its stabilization including construction of retaining wall if required especially near water bodies overlay on the existing carriageway, junction improvement, and construction of minor bridges, culvert and RCC drain in built-up section. Figure 1 shows that location map of the proposed subproject road section.

Figure 1: Location of project Road Alignment on State Map



47. The subproject road is located in Chhattisgarh State covering Mahasamund District with a the length of 39.99 km. The proposed road section is part of the major district road network on Chhattisgarh State.

48. The existing carriageway is Intermediate lane and two lane having flexible pavement, with widths varying between 3.30 m to 5.50 m along the entire length of project road. The existing road has both paved and unpaved shoulder of varying lengths on either sides of the project road. The project involves up gradation of existing roads within available ROW to two lane and four lane. The pavement is bituminous asphalt in all the road sections and overall the riding quality is from fair to poor. The condition of shoulders is also poor and now covered with vegetation. There is no formal drainage system along the road. Major traffic on these roads is of passenger vehicles. The current and projected average daily traffic on the project road is given current traffic is relatively low, averaging about 2244 PSU each day.

C. Objective and Scope of the Study

49. This IEE report documents the environmental assessment of Lambar-Bodesara-Birkol-Singhora Road subproject and identifies the environmental issues to be considered in the project planning and design stages. In this report, the different activities that are likely to take place to achieve the project objectives have been analyzed and the potential impacts that may accompany them have been identified, assessed for significance, and concomitant avoidance, mitigation, and compensation measures were prepared in consultation with stakeholders. The IEE addresses the environmental management requirements of the Government of India (GOI) and ADB. Specifically, this report-

- provides information about the baseline environmental setting of the subproject.
- provides information on potential environmental impacts of the proposed subproject activities with its magnitude, distribution and duration.
- provides information on required mitigation measures with cost to minimize the impacts.
- analyses the alternatives options considering alternative locations, designs, management approaches for selection of most feasible and environmental acceptable options.
- provides details of stakeholder's consultations.
- designs an environmental management and monitoring plan with institutional measures for effective implementation of mitigates measures proposed and addressing grievances.

50. The environmental studies have been confined to the situation around the deemed areas of direct influence caused by constructional and operational facilities along the proposed road sections. The IEE was based on proposed road alignment and key construction activities such as site clearing, removal of trees, excavation, filling, grading and embankment formation, excavation for utility trenches, subgrade preparation, base course and asphalt overlay, shoulder, and construction of permanent structures like retaining walls, culverts and drains. The IEE also covered ancillary activities like camp site establishment and maintenance, sourcing of materials, and operation of equipment like rock crusher and hot mix plant. The corridor of impact is taken as 10 meters either side of the alignment. However, the study area impact zone is considered up to 5 km on both sides of road alignment to allow for coverage of indirect and induced impacts and a larger analysis of land use and other environmental features. Assessment is carried out on the following environment components: terrestrial and aquatic ecology, soil, water, air, noise, and socio economic aspects.

51. The following sections of the report, discusses the methodology adopted by the consultants in conducting the IEE study and presents the results of the same.

D. Methodology Adopted for IEE Study

52. The Initial Environmental Examination has been carried out, in accordance with the requirements of the ADB's Safeguard Policy Statement (SPS 2009) and environmental regulations of GOI. The study was carried out using reconnaissance survey, field visits, consultation with stakeholders, review of existing data, identification of adverse impacts and preparation of environmental management and monitoring plan. The stepwise activities carried out include:

- Review of legal requirements
- Review of feasibility technical study
- Reconnaissance survey for identification of key issues data requirement and preliminary consultation
- Primary and secondary data collection
- Consultation with stakeholders
- Identification of impacts and mitigation measures.

53. The major steps in the IEE process for the subproject were as follows:

1. Collection and Analysis of Data

54. Data was collected on various environmental components such as soil, meteorology, geology, hydrology, water quality, flora and fauna, habitat, demography, land use, cultural properties etc, to establish the baseline environmental setup. Secondary data on environment for the subproject corridors were collected both from published and other relevant sources e.g., the Departments of Forest, Chhattisgarh State Pollution Control Board, State Statistical Department etc. The data collection from the field was completed with the help of enumerators / investigators. The interviewers were trained for filling up the questionnaire at the site. To ensure the accuracy of the data it was collected under the supervision of the consultant. The type and source of information compiled in this IEE are shown in Table 4.

Table 4: Primary and Secondary Information Sources

Information	Sources
Technical information on existing road features and proposed Rehabilitation work. Inventorisation of road features; viz. water bodies community structures, environmental sensitive location areas, congested locations, etc.	PWD, PIU, ADB Project, Chhattisgarh Design Consultant Ground physical surveys and graphics consultants
Climatic Condition	Indian Meteorological Department, ENVIS Website, NIC, primary data Collection
Geology, Seismicity, Soil and Topography	Geological survey of India, SOI Toposheets, Primary data collection
Land Use/ Land Cover	Survey of India (Sol) Toposheet, Observation during survey.
Drainage Pattern	Survey of India Toposheet and field observation

Information	Sources
Status of forest areas, Compensatory afforestation norms etc.	Divisional Forest Office, Mahasamund District.
Status of Fishing Activity	District Fisheries Offices at Mahasamund District
Air quality Noise, Soil and Water	Onsite monitoring and Analysis of Field samples during field visit
Borrow Areas, Quarries and other construction material source	
River geo-morphology, hydrology, drainage, flood patterns	Feasibility report, field observations
Socioeconomic Environment	Primary Census Abstract of Mahasamund, District 2011. Official websites maintained by state Govt., and Public Consultation during the Field survey

2. Environmental Monitoring and Analysis

55. In order to assess the situation in particular section of the subproject road during the screening and site visit of the area, different locations were identified for monitoring and analysis the noise level, ambient air and water quality. The monitoring and analysis of water quality, air quality and noise level has been done by a leading environmental research laboratory. Air quality monitoring has been carried out as per MoEFCC notification of November 2009 the revised Air Quality standards and the on-site monitoring results are incorporated in Chapter- 4 of this IEE report.

3. Stakeholder and Public Consultations

56. Extensive consultations were held during different stages (reconnaissance, detailed design and design review) with key stakeholders that includes local and beneficiary population, government departments/agencies, road users, and project-affected persons. These consultations allowed the interaction between the stakeholders and road designers to identify road features and construction methods that will enhance road upgrading and minimize potential impacts. Information gathered was integrated in the project design and formulating mitigation measures and environmental management plan. Detailed description of public consultation is presented in Chapter-7 of this IEE report.

4. Assessment of Potential Impacts

57. Potential impacts were identified on the basis of: analytical review of baseline data; review of environmental conditions at site; analytical review of the underlying socio-economic conditions with the project influence area.

5. Preparation of the Environment Management Plan

58. An EMP for the subproject contract package has been prepared to specify the steps required to ensure that the necessary measures have been taken and the same will be incorporated during construction and operation stage of the subproject. The EMP includes

the monitoring plan giving details of the resources budgeted and the implementation arrangements.

E. Structure of the Report

59. This IEE report has been presented as per requirements of the ADB's Safeguard Policy Statement (SPS) 2009. The report is organised into following ten chapters, a brief of each chapter is described below:

- *Chapter 1 - Introduction:* This section describes the background information about the project and IEE study.
- *Chapter 2 - Policy, Legal, and Administrative Frameworks:* this section summarizing the national and local legal and institutional frameworks that guided the conduct of the assessment.
- *Chapter 3 - Project Description:* This section presents the key features and components of the proposed project.
- *Chapter 4 - Description of the Environment:* This section discussing the relevant physical, biological, and socioeconomic features that may be affected by the proposed project.
- *Chapter 5 - Anticipated Environmental Impacts and Mitigation Measures:* This section presents the environmental assessment of likely positive and adverse impacts attributed to the proposed project and concomitant mitigation measures.
- *Chapter 6 – Climate Change Impacts and Risks:* This section presents an assessment of climate change impacts and risks to the subprojects.
- *Chapter 7 - Consultation, Participation and Information Disclosure:* This section describes the consultation process undertaken during the environmental examination and its results, their consideration in the project design, and manner of compliance to the ADB's Publication Policy and related national laws.
- *Chapter 8 - Grievance Redress Mechanism:* This section describing the formal and informal redress procedures for registering, resolving, and reporting complaints.
- *Chapter 9 - Environmental Management Plan:* This section discussing the lessons from the impact assessment and translated into action plans to avoid, reduce, mitigate or compensate adverse impacts and reinforces beneficial impacts. This plan is divided into three sub-sections; mitigation, monitoring, and implementation arrangements
- *Chapter 10 - Conclusion and Recommendation:* This section stating whether there is a need for further detailed environmental studies / assessments and highlights key findings and recommendations to be implemented by the borrower.

60. An Executive Summary is also prepared and presented in the beginning of the report.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

61. India has well defined institutional and legislative framework. The legislation covers all components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. ADB has also defined its Environmental and Social Safeguard policies. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards. This section summaries the following:

- National (India) Environmental Policies, Legal and Administrative Framework,
- ADB safeguard policies and categorisation of the subproject,
- Summary of international treaties and applicability to the subproject

A. National (India) Environmental Policies and Regulatory Framework

62. The Government of India's Environmental Legal Framework comprises a set of comprehensive acts and regulations aimed at conserving various components of the biological and physical environment including environmental assessment procedures and requirements for public consultation. The policies and requirements which are most relevant in the context of this project are provided in Table 5 below.

Table 5: Summary of Relevant Environmental Legislation

Act / Rule	Objective	Responsible Institution
Environment (Protection) Act (1986) and Rules (1986)	To protect and improve the overall environment	MoEFCC
Environmental Impact Assessment (EIA) Notification under Environmental Protection Rules (2006, 2009, 2011) and relevant Office Memorandums (OM)	To provide guidance on environmental clearance requirements and clarification on related specific technical issues	MoEFCC
Wildlife Protection Act (1972 and amended in 1993)	To protect wild animals and birds through the creation of National Parks and Sanctuaries	MoEFCC
The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water.	CPCB
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes.	CPCB and Road Authorities
Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009 & 2016),	To protection the general public against improper handling, storage and disposal of hazardous wastes	State Pollution Control Board

Act / Rule	Objective	Responsible Institution
The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003)	To protect and manage forests	MoEFCC
Central Motor Vehicle Act (1988) and Rules (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution.	State Transport Department
Ancient Monuments and Archaeological Sites and Remains Act (1958)	Conservation of Cultural and historical remains found in India.	Archaeological Dept. GOI
Building and Other construction workers (Regulation and the Employment and conditions of service) Act, 1996	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Ministry of Labour and Employment
Construction and Demolition Waste Management Rules, 2016	Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodelling work,	State Pollution Control Board
Child labour (Prohibition and Regulation) Act, 1986	To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety.	Ministry of Labour and Employment

1. Requirement of Environmental Clearance

63. As per provisions of Environmental Impact Assessment Notification 2006 (amended 2009), and its amendments, vide notification S.O.3067(E), dated 1st December 2009; all State Highway expansion projects, except those in hilly terrain (above 1000 m AMSL) and ecologically sensitive areas, have been exempted from the requirements of obtaining environmental clearances.

64. Since, the subproject road (Lambar-Bodesara-Birkol-Singhora Road) is a major district road and not a state highway, the above EIA Notification, 2006 (amended till date) promulgated under Environment (Protection) Act 1986 is not applicable for the proposed subproject and hence no environmental clearance is required for this subproject proposed for financing under the ADB funding.

2. Forests Clearance

65. As per Indian Forests Conservation Act (1980), any project requiring diversion of forests land for non-forestry purposes require forest clearance from MoEFCC for the same. The forestry clearance is granted through two stages process.

66. Since the proposed improvement work for selected subproject road will be require additional land in forest area and diversion of forest land for improvement work is involved in the subproject, hence forest clearance is required.

3. Permission to Withdraw Ground Water

67. As per the power granted under Environmental Protection Act, 1986, permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective.

4. Required Clearances/Permissions

68. For up-gradation of the subproject road, required clearances/ permissions related to environment and forests have been summarized in Table 6.

Table 6: Applicable Permits and Clearances Required for the Subproject

S. No.	Permissions/ Clearances	Acts/ Rules/ Notifications/ Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				
1	Permission for cutting of trees	Forest Conservation Act (1980). Procedural Guidelines developed by the Department of Environment, Government of Chhattisgarh under the orders of the Honorable High Court Tree removal will be guided as per state government rules.	District Forest Office/State Forest Department for trees felling in forest areas and District Authorities in non-forests Areas (Compensatory tree plantation to be made 1:10 as per the permission granted)	PWD, PIU-ADB
2	Forest Clearance	Forest Conservation Act (1980), diversion of ofrest land for non-forest purposes as per state government rules.	State Forest Department for additional land required for road widening in forest area (Forest land diversion for non-forest uses)	PWD, PIU-ADB
B. Implementation Stage				
3	Consent to operate hot mix plant, Crushers, Batching plant	Air (Prevention andControl Pollution) Act of1981	State Pollution Control Board (To be obtained before installation)	Contractor
4	Authorization for disposal of hazardous waste	Hazardous Waste(Management andHandling) Rules 1989	State Pollution Control Board (To be obtained before generation)	Contractor
5	Consent for Disposal of sewage from	Water (Prevention and Control of Pollution) Act 1974	State Pollution Control Board (Before setting up the camp)	Contractor

	labor camps			
6	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Department of Transport, Government of Chhattishgarh authorized testing centers	Contractor
7	Employing Labour/ Workers	The Building and Other Construction Workers (Regulation and Employment Conditions of Service) Act, 1996	District Labour Commissioner	Contractor

69. Before the start of civil works for the any section of the subproject road, the project proponent (PWD PIU-ADB Project) must obtain necessary clearances / permits from statutory authorities.

B. International Treaties and Relevance to the Project

70. India has been playing an active role in environmental conservation since the first United Nations (UN) conference on Human Environment in Stockholm in 1972 and recognizes that protection of environment is closely linked to combating poverty. Key international agreements that India is signatory to and relevant for the project are provided below:

- (i) Convention Relative to the conservation of Flora and Fauna in their Natural State(1933)
- (ii) International Plan Protection Convention (1951)
- (iii) Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar,1971)
- (iv) Convention concerning the Protection of the World Cultural and Natural Heritage(Paris, 1972)
- (v) Convention in International Trade in Endangered Species of Wild Fauna andFlora (Washington, 1973)
- (vi) Convention on Migratory Species of Wild Animals (Bonn, 1979)
- (vii) Convention on the Prior Informed Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC or Rotterdam, 1990)
- (viii) United Nations Framework Convention on Climate Change (Rio De Janeiro,1992)
- (ix) Convention on Biological Diversity (Rio De Janeiro, 1992)
- (x) Protocol to the United Nations Convention on Climate Change (Kyoto, 1997)

71. The above list of international conventions served as requirements for the subproject to comply. However, due to the limited scale of the road upgrading and the predicted traffic increase during operation, the expected environmental issues that are governed by these international convention would be insignificant.

C. ADB Safeguard Policy Statement Requirements

72. The Asian Development Bank has defined its Safeguard requirements under its 'Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the

environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB's SPS 2009 classify a project depending on following three categories.

- **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.
- **Category B:** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.
- **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

D. Category of the Project as per SPS 2009

73. The subproject road (Lambar-Bodesara-Birkol-Singhora Road) have been evaluated and categorized using the prescribed ADB Rapid Environmental Assessment Checklist (see Appendix 1). The subproject evaluated is classified as environmental category 'B'. This categorization was primarily based on the following considerations:

- (i) subproject road is existing roads and upgrading activities are mostly limited to the available RoW; with minimum additional land acquisition,
- (ii) anticipated impacts from road upgrading on relatively flat terrain along agricultural land, are mostly site specific and easily mitigated through proper design and good construction practices, majority of the activities have short-term duration co-terminus with the construction phase, and
- (iii) project road does not pass through or located within 10 km from any wildlife sanctuary, national park, or any other environmentally sensitive or protected areas.

III. PROJECT DESCRIPTION

A. Type of Project

74. The project involves construction and upgradation of existing road mostly within available ROW to two lane carriageway except at few locations with additional land acquisition 1-3m bothside mostly for geometrical improvements. The salient Features of the subproject road are given in Table 7.

Table 7: Summary Road Components and Design Standard

Parameter	Details
Road Length	39.99 km

Alignment	Follow the existing road alignment. Except some of the locations where geometric improvements is required.
Flyovers/overpasses/ROB	There is no flyovers/overpasses/ ROB in the alignment.
Major Bridges	2 Major bridge,
Other Structures	2 Minor bridge, 137 Culverts along the Project road. (Replacement of existing structures wherever required, provision of new structure wherever required)
Embankment Design	During inventory and reconnaissance survey of project road, it is found that the embankment height of small road section is low. Also as per local enquiry, the existing road top level at some locations are equal to HFL. The raising is required at these locations.
Design Standard	As per IRC Codes and MOR&TH Guidelines Vertical Clearance 0.60 m above HFL for bridges upto 30 m length 0.90m above HFL for bridges above 30 m length. The discharges for which the bridge has been designed are maximum flood discharge on record for a period of 100 years for major bridges and 50 years for minor bridges.
Speed	Design : 80 Km/h
Horizontal Controls	As per IRC: SP: 73 – 2015
	Maximum value of 4% for super elevation, the minimum radius for horizontal curves is 230m for design speed 80Km/hr
Vertical Controls	Grade break of 0.3%, vertical curves will be provided.
Carriageway	Carriageway: 7m Cross fall will be 2.5% for pavement and 3% for earthen shoulder.

Source: Detailed Project Report, 2017-18

B. Location and Features of the Project Road

75. The The project road is located in Mahasamund district of Chhattisgarh State. Figure 2 shows the location map of subproject road alignment on google map.

Figure 2: Alignment route Lambar-Bodesara-Birkol-Singhora Road



76. The existing alignment is a link between Kashipal, Lehrindipa, Prtapara, Awlechaka, Baheraapali, Mohanmuda, Kosampali, Jalpur, Birkul, Rosspali, Chuipal, Pareskol, Kendinda, Dhyapali and Singhora. The project road passes through only plain and rolling terrain. The landuse pattern on both side of road is mixed type dominated by agricultural, forest and built up.

77. The project road section has varying carriageway width configuration of 3.30 to 5.50m. The pavement is bituminous type for the stretch and its condition is generally poor to good. The existing road has both paved and unpaved shoulder of varying lengths on either sides of the project road. Major traffic on this road is of passenger vehicles and average daily traffic on this road is of passenger vehicles and average daily traffic is 2244 PCUs.

78. Road conditions and landuse pattern along the subproject road alignments is given in Table 8.

Table 8: Existing conditions and Landuse along the Subproject Road

Type of Land	Length (Km)	Percentage (%)
Build up	5.6	14.06
Agricultural	24.6	61.77
Forest	6.45	16.19
Semi Build up	1.97	4.94
Barren	1.2	3.01
TOTAL	39.994	100

C. Engineering Surveys and Investigations

79. Following surveys and investigations had been carried out on the project road for collection of data for incorporation in the DPR and evolve the design for improvement and upgradation:

- topographic surveys;
- traffic surveys;
- road and pavement condition survey and inventory;
- culverts and bridges condition survey and inventories;
- material surveys;
- hydrology studies for new bridge structures;
- Geotechnical investigations & subsoil exploration for structures; and
- existing utilities surveys.

80. These surveys had been carried out to fulfill requirement in the TOR.

D. Current and Projected Daily Traffic

81. Traffic survey stations were selected of project road after detailed reconnaissance survey and in line with the TOR. All traffic surveys were carried out as per IRC Guidelines given in IRC: SP 19-2001, IRC: 108-1996, IRC SP: 41-1994, IRC: 102-1998, IRC 103- 1988 Pedestrian Facilities and IRC: 09-1972.

Table 9: Average Traffic on road section

Vehicle Type	ADT				Average ADT	
	Km 10+300		Km 21+400			
	No. of Vehicles	PCU	No. of Vehicles	PCU	No. of Vehicles	PCU
Two - Wheeler	792	396	878	439	835	418
Car	144	144	36	36	90	90
Van/Light motor Vehicle	1	1	0	0	1	1
Tempo / LCV	30	45	10	14	20	30
2-Axle	12	36	5	16	8.5	26
3-Axle	11	34	4	12	7.5	23
4 to 6 Axle	12	55	5	24	8.5	40
7- more Axle	0	0	0	0	0	0
Mini Bus	0	0	0	0	0	0
Bus	2	5	2	6	2	6
Animal Cart	59	470	99	796	79	633
Cycle	845	423	530	265	687.5	344
Auto	19	19	23	23	21	21
Auto Trolleys	0	0	0	1	0	1
Tractors	91	137	107	160	99	149
Tractors Trolleys	104	469	103	462	103.5	466
Total Motorised Vehicles	1218	1341	1173	1193	1196	1267
Total Commercial vehicles	67	175	26	73	46.5	124
Total Non Motorised Vehicles	904	893	629	1061	767	977
Total Tollable Vehicles	231	339	85	132	158	236
Total Vehicles	2122	2234	1802	2254	1962	2244

E. Design Standards

82. This section describes the design standards and principles based on which the various designs have been carried out. The formulation of the design standards is required in order to avoid any inconsistency in design from one section to the other and to provide a desired level of service and safety. These proposed standards are consistent with the parameters recommended in the relevant standards of the Indian Roads Congress (IRC). The aim of this chapter is to evolve Design Standards for the study primarily based on IRC publications and MORT&H circulars for concurrence/approval of CSRSP, GoCG. The relevant IRC/ MORT&H design standards adopted for the Engineering Design are given below.

- Manual of Specifications and Standards for Two Laning of State Highways: IRC SP 73– 2015
- Manual of Specifications and Standards for Four Laning of State Highways: IRC SP 84 – 2014

- Ministry of Road Transport & Highways (MoRT&H) specifications and circulars – Fifth edition.

1. Geometric Design

83. While doing the geometric design, the following have been taken into consideration:
- The designed facility shall not become obsolescent before the design year.
 - Design shall be consistent and the standards followed for different elements shall be compatible with one another.
 - The design shall cover all geometric aspects of road including Road, safety Features, Road furniture, signages, grade separated structures, etc.
 - The design will be done aiming at minimizing the vehicle operating cost including initial cost, cost of maintenance etc.
 - The design will take into consideration the environmental, aesthetic and landscaping aspects of the project road.

2. Geometric Design Control

84. The detailed design for geometric elements covered, but not be limited to the following major aspects:

- Horizontal alignment
- Longitudinal Profile or Vertical Alignment
- Cross-sectional elements
- Junctions, intersections and Interchanges

85. The detailed analysis of traffic flow and level of service for the existing road has been made and traffic flow capacity for the project road was worked out and this analysis establish the widening requirements with respect to the different horizon period.

86. Different options for providing grade separated interchanges and at grade intersections have been examined and the geometric design of interchanges has taken into account the site conditions, turning movement characteristics, level of service, overall economy and operational safety.

3. Horizontal Alignment

a. Design Speed

87. Design speed is the basic parameter, which determines the geometric features of the road. The proposed design speeds for Major District Roads in different terrain categories as per IRC-73-1980 is presented in Table 10.

Table 10: Design Speed

Terrain Categories	Design Speed (km/h)	
	Desirable/Ruling	Minimum
Plain	80	65
Rolling	65	50
Mountainous	40	30

88. As the project road is on plain terrain, for the section passing through open areas design speed of 80 kmph has been considered while at stretches where it cannot be adhered to, speed has been restricted to 65 kmph. Considering safety aspect in built-up sections, speed calming measures have been adopted and consequently design speed has been reduced to 50 kmph.

b. Radii of Curve

89. The geometry of the road is corrected to have the horizontal geometry correspond well with the IRC standards. At the locations where the existing geometry is not in accordance with the design standards, an attempt has been made to regularize it. The minimum radii of the curve corresponding to the design speed have been applied as per IRC stipulations.

90. The minimum radius of horizontal curves is calculated from the following formula:

$$R = V^2 / 127 (e+f)$$

Where,

V = vehicle speed in Kmph

e = Super elevation in %

f = Co-efficient of friction between vehicle tyre and pavement (taken as 0.15)

R = radius in metres

91. Adopting a maximum value of 5% for super elevation and 15% for side friction factor, the minimum radius for horizontal curves works out to be per Table 11 as per IRC: 38/IRC SP-48.

Table 11: Radius for Horizontal Curves

Terrain Categories	Radius of horizontal curves (m)	
	Desirable	Minimum
Plain	400	255
Rolling	255	170
Mountainous	100	65

It is required to provide the desirable radius on the curves.

c. Super-elevation

92. The super elevation at curves have been arrived at as per the following equation:

$$e = V^2 / 225R$$

where:

- V - Vehicle speed in m/sec.
- e - Super elevation ratio in meter per meter
- R - Radius in meters.

93. The super elevation has been calculated keeping in view the horizontal radii and gradient at curves at different locations and maximum super-elevation is restricted to 5%.

d. Curves without Super Elevation

94. When the value of super elevation obtained from the parameters stated above is less than the road camber, the normal cambered sections are continued on the curve portion, without providing any super elevation. Normal camber of 2% is provided for rigid pavement.

e. Transition Curves

95. Transition curves are necessary for vehicle to progress smoothly from a straight section into a circular curve or between curves of different radius. The transition curve also facilitates a gradual application of the super elevation and any widening of the carriageway that may be required for the horizontal curves. The minimum length of the transition curve is determined from the following two considerations:

a) As per Comfort criteria,

$$L_s = 0.0215 V^3 / CR$$

Where,

L_s = length of transition in metres

V = Speed in kmph

R = radius of circular curve in metres

$C = 80 / (75 + V)$ (subject to maximum of 0.8 and minimum of 0.5)

b) As per rate of change of Super-elevation,

The rate of change of super elevation can not be steeper than 1 in 150. The formula for minimum length of transitions depending on the terrain (plain/rolling) is:

$$L_s = 2.7 V^2 / R$$

f. Sight Distance

96. Intermediate sight distances have been adopted for the highway design as per the requirements of 4 lane Manual provision. In general Intermediate Sight distance is adopted for the 2 lane sections but at locations where minimum intermediate sight distance cannot be followed safe stopping sight distance has been adopted.

4. Vertical Alignment

a. Gradients

97. The vertical alignment of the carriageway have generally been compatible with the guidelines given in the IRC SP 23 and the maximum gradient at all structure approaches is restricted to 2%.

- At locations of grade break of 0.5%, vertical curves have been provided.
- The length of vertical curve is restricted to minimum 50 m
- Number of PVI are not be more than 4 in one km.
- At locations of sight deficiency, at least Stopping Sight Distance (SSD) are provided.

98. Safe stopping sight distance, both in the vertical and horizontal directions are applied in design. The sight distance values as per IRC recommendations are given in Table 12.

Table 12: Sight Distance

Design Speed (km/h)	Safe stopping sight distance (m)
80	120
65	90
50	60
40	45

b. Vertical Curves

99. Vertical curves are designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values have been adopted wherever this is economically feasible. Valley curves are designed for headlight sight distance. The 'K' values for design control and the minimum length of vertical curves for the project road which is in plain terrain is as given in Table 13:

Table 13: Radius for Horizontal Curves

Design Speed (kmph)	'K' value**		Minimum length of curve (m) [#]
	Summit Curves for Stopping Sight Distance (SSD)	Valley Curves for Headlight Distance	
80	33	26	50
65	19	18	40
50	9	10	30

** as per Table 6 of "Vertical Curves for Highways", IRC: SP- 23 – 1983

as per Table 20 of "Geometric Design Standards for Rural (Non-Urban) Highways", IRC: 73– 1980

c. Crossfall

100. Each carriageway has unidirectional crossfall. The crossfall for the pavement is 2.5%. For earthen shoulders, the corresponding value is 4.0%.

101. Cross Sectional elements are described below in Table 14.

Table 14: Cross-sectional Element

Particulars	MDR (10 m)	SH (12m)
Proposed Carriageway	Two lane: 7m (3.5m + 3.5m)	Two lane: 7m (3.5m + 3.5m) Four lane: 15m (7.5m + 7.5m)
Proposed paved shoulder	-----	3m (1.5m + 1.5m)
Proposed earthen shoulder	3m (1.5m + 1.5m)	-----
Proposed Hard shoulder	-----	2m (1.0m + 1.0m)
Cross camber on Proposed carriageway	Rigid Pavement : 2.0 % Flexible Pavement: 2.5%	Rigid Pavement : 2.0 % Flexible Pavement: 2.5%

Proposed Earthen/ Hard Cross camber on shoulder	4%	4%
Proposed Median width		Four lane : 1.5 m
Paver Block and Covered Drain	In Settlement Area : Varies as per Available ROW	In Settlement Area : Varies as per Available ROW

5. Pavement Design

102. The entire road stretch is proposed as per the guidelines comprise the following for different sections:

a. Rigid Pavement

103. Payment design has been carried out by IRC-58: 2015 or equivalent method in jointed plain cement concrete (JPCP), placed on lean concrete base and sub-base layer with flexible shoulder. The pavement has been designed for a service life of 30 years.

b. Flexible Pavement

104. Design is primary in accordance with IRC guidelines. The recommendation given in IRC-37:2012, or equivalent method are used for new carriageway and paved shoulders. The pavement are designed for a service life of 15 years. Strengthening of the pavement by bituminous overlay are done periodically after 15 years.

c. Flexible Pavement Strengthening

105. Thickness requirements has been established based on IRC: 81:1997.

6. Embankments

106. **Width:** The width of the embankment is as per the approved typical cross-sections.

107. **Height:** The height of the embankment is as per the final rod levels.

108. **Slope Protection** Embankments is protected with stone pitching as per “IRC 75-2015; Guidelines for Design of High Embankments”.

7. Grade Intersections

109. The locations where at grade junctions are required, the designs have been done as per the Guidelines given in Ministry of Surface Transport (MoRTH) and on the basis of “IRC SP: 41-1994, Guidelines for the Design of At-grade Intersections in Rural and Urban Areas.”

8. Bus Stops

110. The bus bays where provided in accordance with guidelines specified in “IRC: 80-1981, Type Designs for Pick-up Bus Stops on Rural (i.e. Non-Urban) Highways”. The bus stop layout have been provided safe entry and exit of buses and safe movement of passengers. Bus stops with passenger shelter are proposed at suitable selected locations.

9. Truck Parking Areas

111. The proposed layout and the locations of truck lay bye are generally based on the provisions of 2 lane Manual if required.

10. Traffic Safety Features, Road Furniture, Road Markings and Other Facilities

112. For safety and operational reasons suitable safety features, road furniture and other facilities along the project road have been provided. These features included safety barriers, road signs, road markings, road lighting, route markers, kilometer and hectometer stones, road delineators, ROW pillars, parking areas & rest areas, bus stops/bays, and landscaping. Wherever possible these features are provided in accordance with relevant IRC or other standard, as detailed below. If no IRC Codes or the MOSRTH Specifications are available, international standards such as BIS / AASHTO / ASTM / British Standards have been used in detail design.

- **Safety Barriers:** Safety Barriers have been provided at the outer edges of roadways for the following locations:
 - 1) Where height of embankment is 3m or more, for a continuous stretch of at least 50m long
 - 2) Either sides of major and minor bridges for a length of 25m
 - 3) Wherever the road is abutted by pond, well or any other water bodies.
 - 4) Either side of carriageway where ever horizontal curves having radius less than 450m for four lane, 360m for two lane roads.
- **Road Signs:** The road sign requirements have been provided in accordance with “IRC: 67 – 2012, Code of Practice for Road Signs”.
- **Road Markings:** Pavement markings along the project road are in accordance with “IRC: 35-2015, Standard for Road Markings”. These markings are applied to road centre, edge line, continuity line, stop line, give way lines, diagonal/chevron markings and zebra crossing and at parking areas.
- **Lighting:** Lighting have been provided along urban areas, settlements, ROBs and major junctions. The following codes are followed while designing the lighting system on the Project road for different locations.
 - 1) IS: 1944 (Parts I and II) – 1970
 - 2) IS: 1944 (Part V) - 1981; and
 - 3) IS: 1944 (Part VI - 1981)
- **Pedestrian Facilities:** Pedestrian facilities have been adequately provided at built-up locations, major junctions etc.
- **Kilometer stones:** Kilometer stones (Km stones, 5th Km stone and Hectometer stones) for the project have been provided in accordance with “IRC: 8-1980, Type Designs for

Highway Kilometer Stones” and “IRC: 26-1967, Design of 200m Stone”. The foundation details, text size, height and locations are in accordance with the IRC codes stated above.

- **Boundary stones:** ROW Boundary stones are provided to be at an interval of 50m on both sides.
- **Reflective Studs/ Road Studs:** Road Studs are provided for the curves with radius less than 400m. Spacing adopted for the same is as per Table 9.1 of IRC-SP- 73-2015 and IRC SP: 84-2014. Road studs are provided at Junctions, Pedestrian crossings at Bus Bays, Bridges and all other structure locations and approaches.
- **Hazard Markers:** Hazard markers are put up wherever there are objects close to the road as to constitute an accident hazard, E.g.: Bridge abutments, Culvert locations etc. They are provided as per IRC-79-1981, Type 1 or Type 2.
- **Delineators:** Primary use of roadway delineators is in rural sections of main roads, especially in curved reaches. Delineators are provided as per IRC-79-1981 and spacing has been adopted for as per Table 1 of IRC-79-1981.
- **Landscaping & Tree Plantation:** Tree plantation have been provided in accordance with “IRC: SP 21- 2009, Guidelines on Landscaping and Tree Plantation” and Set back distance of trees in different situations is as per “IRC: 66-1976, Recommended Practice for Sight Distance on Rural Highways”

F. Proposed Improvement

113. The Project Roads will receive the following upgrades under the project:

- a) Realignment
- b) Junction Improvement
- c) Design of Road side Drain
- d) Project facilities
- e) Proposed Crust/Pavement design- New Construction/Strengthening
- f) Landscaping
- g) CD Structures
- h) Additional Provision related to Safety
- i) Improvement of Horizontal and Vertical Geometry
- j) Traffic signage/pavement marking
- k) Improvement Proposal for Bridges and Culverts
- l) Road Embankment.

1. Alignment and Geometry

114. The most of the length of project roads runs through plain terrain cutting across several agricultural land, villages, and towns with a number of sub-standard curves. These curves will be improved following standards to the extent possible within the available ROW and maximizing the use of existing pavement in rural stretches. Vertical alignment has been designed to correct the existing road conditions in compliance to road standards.

2. Proposed ROW

115. Based on the measurements carried out during the inventory survey and data collected, the existing available width of Row of the project road varies from 6m to 35m (max) and the same has been considered for evolving the design.

116. In order to meet future traffic requirements, the existing carriageway is proposed to be upgraded to two lane with Paved shoulder. Concentric widening scheme is followed to minimize land acquisition issues and to ensure maximum utilization of existing configuration.

Table 15: Details of proposed improvement carriageway and shoulders

Section	Approximate Length of section (km)	Widening requirement based on most likely scenario	
		Two lane with paved shoulders	Four lane divided carriageway
Lambar-Bodesara-Singhora Road	39.994	39.994	0

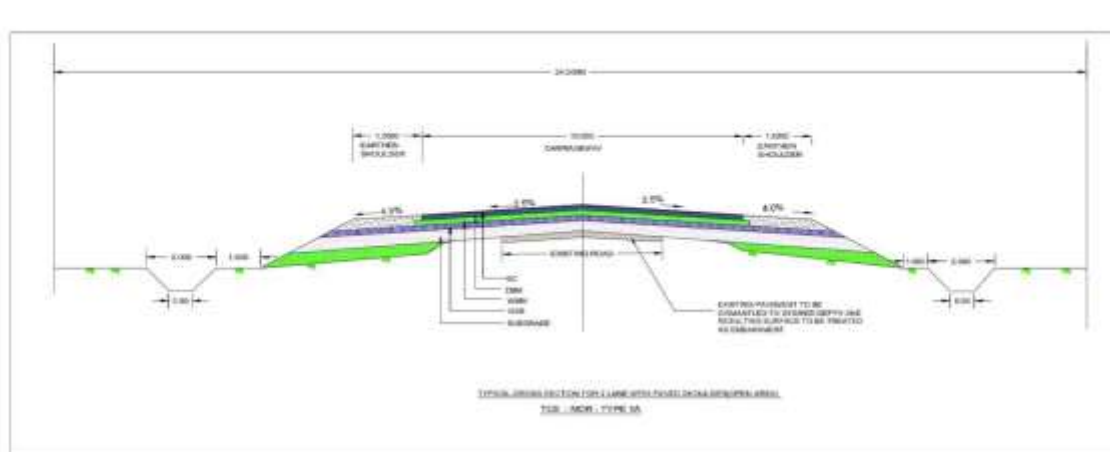
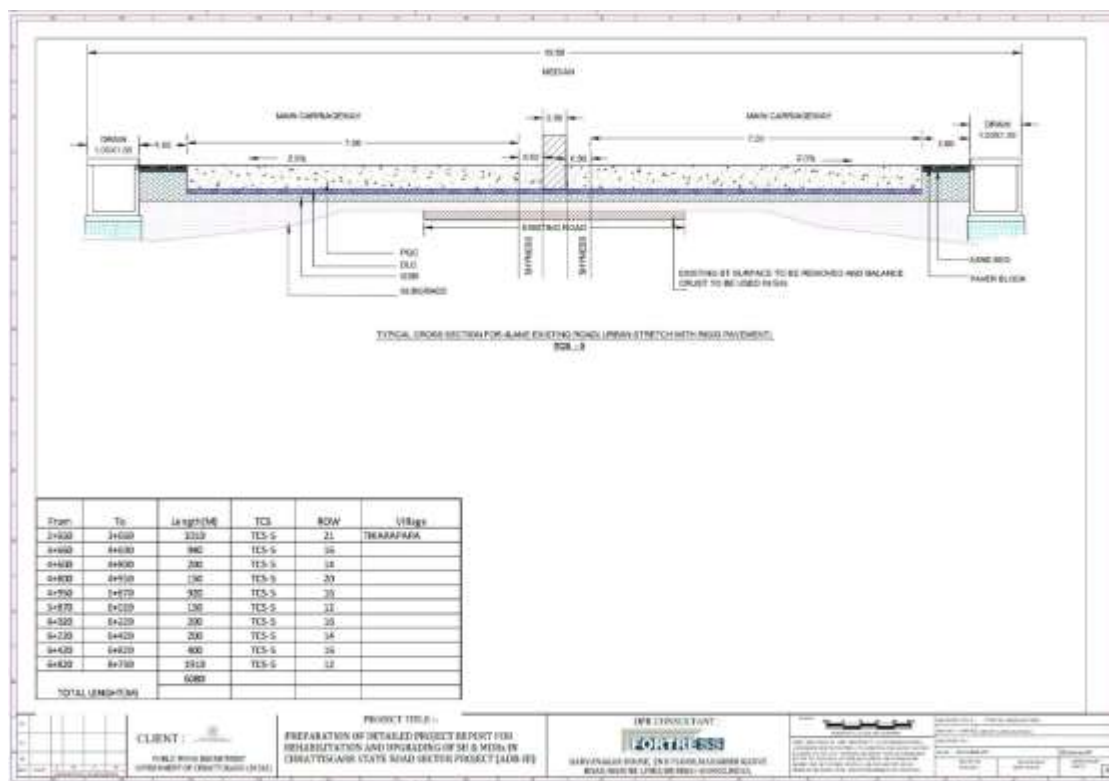
117. The existing Right of Way (ROW) of the subproject road varies from 6 m to 35 m (Variable) on the basis of revenue map. Now the proposed improvement of two lane will be require 16 m right of way. For the same there will be a provision of land acquisition where the available ROW is less than required for the as per the up-gradation plan. For 2-lane road the required ROW is 16m, the additional land required approx. 12.900 ha. agriculture land and 11.67ha. area of forest land.

3. Cross Sectional Details

118. The project road section has varying carriageway width configuration of 3.5 to 15.3m. Carriageway width of the project road is mainly two lane without paved shoulder and followed intermediate lane. The pavement is bituminous type for the stretch and its condition is generally poor to good. The shoulder is mostly earthen with width varying between 0.5 to 1.5m and the condition is generally poor.

119. The project is proposed for widening of existing road to two lanes/ 4 lanes with paved shoulders. The typical cross sections (TCS) in built-up area, rural areas, overlay locations are shown in Figure 3.

Figure 3: Typical Cross Sections



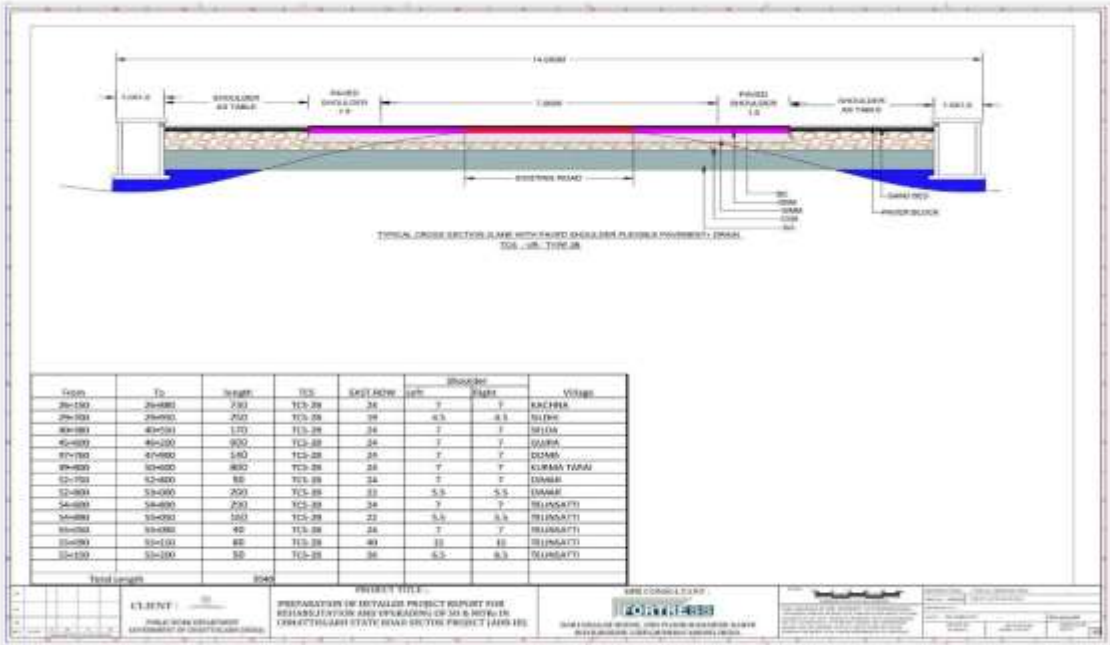
FROM	TO	LENGTH (m)	TCS	ROW	Shoulder	Village
					Left	Right
0+000	0+100	100	TCS-2A	16		
0+100	0+200	100	TCS-2A	16		
0+200	0+300	100	TCS-2A	16		
0+300	0+400	100	TCS-2A	16		
0+400	0+500	100	TCS-2A	16		
0+500	0+600	100	TCS-2A	16		
0+600	0+700	100	TCS-2A	16		
0+700	0+800	100	TCS-2A	16		
0+800	0+900	100	TCS-2A	16		
0+900	0+1000	100	TCS-2A	16		
TOTAL LENGTH (m)		6000				

CLIENT: PUBLIC WORKS DEPARTMENT

PROJECT TITLE: PREPARATION OF DETAILED PROJECT REPORT FOR REHABILITATION AND UPGRADING OF 30.6 KM IN CHHATTISGARH STATE ROAD SECTOR PROJECT (A&B)

DPR CONSULTANT: JYOTI ASSOCIATES

CHHATTISGARH STATE ROAD SECTOR PROJECT (A&B)



4. Pavement Design

120. The general design procedure is based on the prevalent practices in the country. The design of pavement structure has been carried out as per IRC Guide lines and TOR. The detailed design of new pavement and overlays on existing pavement shall be based primarily on IRC-37:2012 and IRC-81: 1997 for flexible pavement and IRC-58: 2011 for rigid pavement. General pavement composition include i) thickness in BM (12mm), ii) thickness in term of BC/DBM (230mm), Overlay portion (BC-50mm and DBM (225mm).

5. Junctions Design

121. All intersections falling on the project corridor have been studied for the improvement to allow a safe connection to the corridor and minimum interference to the through traffic. Based on the above considerations, improvement scheme in respect of each junction has been finalized. Details of intersection improvement are tabulated below in Table 16.

Table 16: Major and Minor Intersections

S.No.	Type	Side and Road name
0	T	LHS-BILASHPUR, RHS-SARAIPALI
0.6	T	BHORADADER
2.3	T	VILLAGE ROAD
2.6	T	VILLAGE ROAD
4.5	T	VILLAGE ROAD
6.5	T	VILLAGE ROAD
6.7	T	RHS-VILLAGE ROAD
7.9	T	RHS-VILLAGE ROAD
10.3	T	LHS-MOHANMUDA
15.7	T	RHS-SAHENALI
15.9	Y	VILLAGE ROAD
17.8	T	RHS-VILLAGE ROAD
18.5	T	LHS-SARANG GARH,RHS-SARAIPALI
19.5	Y	LHS-VILLAGE ROAD
19.7	T	VILAGE ROAD
21.6	+	LHS-MENGERMATI,RHS-SINGHORA
22	T	LHS-VILLAGE ROAD(CC)
22.5	Y	VILLAGE ROAD
24.3	+	RHS-KAMPERPALI,LHS-FOREST ROAD
27.5	Y	VILLAGE ROAD
28.3	T	VILLAGE ROAD
29.7	T	RHS-LOTTI
34.7	+	RHS-KALENDA
35.7	+	LHS-VR,RHS-VR
36.5	T	VILLAGE ROAD
37.5	+	LHS-VR,RHS-VR

38.5	T	VILLAGE ROAD
38.7	T	VILLAGE ROAD
39.7	+	RHS-SARAIPALI,LHS-SHINGHODA GAON
39.994	T	LHS-SOHELA,RHS-SARAIPALI

6. Improvement of Bridges

122. During bridges and culverts inventory, it was observed that there are 02 no. Major bridges exist along the corridor and both the bridges are retained with repair. There are Nallahs/ water streams, where Minor Bridge have already been constructed. Improvement proposals for minor bridges. of culverts have been prepared in keeping the view of hydraulic analysis as per IRC: SP: 13-2004. Other drainage arrangement for CD Structures shall be as per Clause no. 116 of IRC: 05-1990.

7. Culverts

123. There are many (137 nos.) culverts on project road. Some of them will be reconstructed and additional new Hume pipes and slab culverts will be installed to balance water flows. Improvement proposals for all CD Structures have been prepared in keeping the view of hydraulic analysis as per IRC: SP: 13-2004. Other drainage arrangement for CD Structures shall be as per Clause no. 116 of IRC: 05-1990.

8. Roadside Drainage

124. The design of drainage system requirements such as surface and sub-surface drainage for pavement, median, shoulder, high embankment shall be carried out in accordance with “IRC: SP 42-2014, Guidelines on Road Drainage” and “IRC: SP 50-2013, Guidelines on Urban Drainage”. The following types of drains shall be provided for surface drainage arrangement within ROW.

- Longitudinal lined/unlined drains shall be considered for adequate cross section, bed slopes, invert levels and outfalls by surface run off from the main highway, embankment slopes and service roads.
- Closed lined drains on both sides in urban sections.
- Turfing of side slopes shall be considered for embankment height upto 6m.
- Combination of longitudinal drains and chute drains in high embankments of 6m height and above.

125. The culverts will be built to the same width as the flanking roadway and will be designed following IRC: SP-13-2004, IRC 78-2014, IRC-5 2015.

126. Minimum cross fall / camber will be kept as 2.5% both sides for the deck drainage. Water will be taken down to ground/drainage courses through proper downspouts and take down pipes at the edge of carriageway shall be provided according to standard practice to provide efficient transverse drainage.

127. Longitudinal drainage is much more efficient and a minimum nominal longitudinal gradient of $\pm 0.5\%$ to 1% may be proposed to minimize intrusion of drainage inlets.

9. Borrow and Quarry Materials Sourcing

128. The construction material will be sourced from state approved supplier in the project area. Borrow and quarries areas will be identified by contractor and approval for use of material will be taken from CSC/Client. (Guidelines for Borrow Area Management are given in Appendix 10).

10. Water for Construction

129. Water for construction of the project road will be taken from ground water and surfacewater sources after obtaining necessary permissions. No public water sources will be used for road construction.

G. Construction Camps

130. One construction camp will be set up by the contractor at a suitable location along the project corridor which will be in consultation with the Project Director and Chhattisgarh State Pollution Control Board.

H. Project Cost

131. The basic cost data for the project is based in a “Schedule of Rates for Roads and Bridges” published periodically by the GoCG. The cost of civil works including maintenance cost (as shown in Table 17) amounts to about INR 1451.10 million (US\$ 20.44 million) covering 39.99 km road length. The maintenance component is based on an average 3% of total cost of Civil Works for 5 years.

Table 17: Cost of Civil Works and Maintenance Components of project road

S.No.	Description of work	Civil Cost (INR Million)
1	Flexible Pavement Two Lane Road	980
2	Rigid Pavement Two Lane Road	220.10
Sub-total (A)		1101.00
3	Cost estimate of structures	350.10
Sub-total (B)		350.10
Total (A+B)		1451.10
US\$		20.44

I. Construction Packaging and Implementation Schedule

132. It is proposed to carry out construction of the subproject road section under one construction package with a time period of 24 months. The subproject is proposed to be undertaken through International Competitive Bidding (ICB). Currently the project is at bidding stage and scheduled to award contract in the first quarter of 2019. The project is expected to complete in last quarter of 2020.

J. Project Benefits

133. The implementation of various subproject items is envisaged to have the following direct benefits:

- better connectivity to key locations within State;
- smooth flow of traffic on State and National Highway Network;

- improved quality of life for the rural population in the project influence: this as a result of better access to markets, health, education and other facilities; and the derived stimulus for local economic activity;
- a more efficient and safe road transport system: through reduced travel times, reduced road accidents, reduced vehicle operating and maintenance costs and reduced transportation costs for goods;
- the facilitation of tourism.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

134. In order to assess the impacts of the proposed improvement to the subproject road, field visits were undertaken to understand environmental profile of the project influence area. This involved field inspections at all the sensitive locations, collection of secondary information for all the environmental components and discussions with the officials, NGO's and local populace. The profile presented below comprises of the following:

- Physical environmental components such as meteorology, geology, topography, soil characteristics, ambient air quality, surface and sub-surface water quality;
- Biological environmental components such as aquatic, biotic and marine flora, fauna and mammals, and
- Land environment in terms of land use, soil composition.

B. Physical Environment

135. Information of various physical parameters was collected from the Indian Meteorological Department, Statistical Department, Gazetteer of Chhattishgarh, Forest Department, Department of Environment and other concern Government Departments and discussions with the officials from these agencies.

1. Meteorological Conditions

136. The climate in Chhattisgarh is governed by a monsoon weather pattern. The distinct seasons are summer (March through May), winter (November through February), and the intervening rainy months of the southwest monsoon (June through September). The state has a tropical wet and dry climate, temperature remain moderate throughout the year, except from March to June, which can be extremely hot. The temperature in April–May sometime rises above 48 °C (118 °F). These summer months also have dry and hot winds. In summers, the temperature can also go up to 50 °C. The average annual rainfall is about 1,300 millimeter (51 in) of rain, mostly in the monsoon season from late June to early October. Winters last from November to January and are mild, although lows can fall to 5 °C (41 °F) making it reasonably cold.

137. The salient climatic features of the state are as follows:

Average Annual Rainfall	-	1292 mm
Concentration of precipitation-		June to September

Humidity	-	25 to 75 %
Cloudiness	-	Heavily clouded in monsoon
Wind	-	Generally light
Mean Temperature	-	Summer 30 to 50 °C
	-	Winter 0 to 25 °C

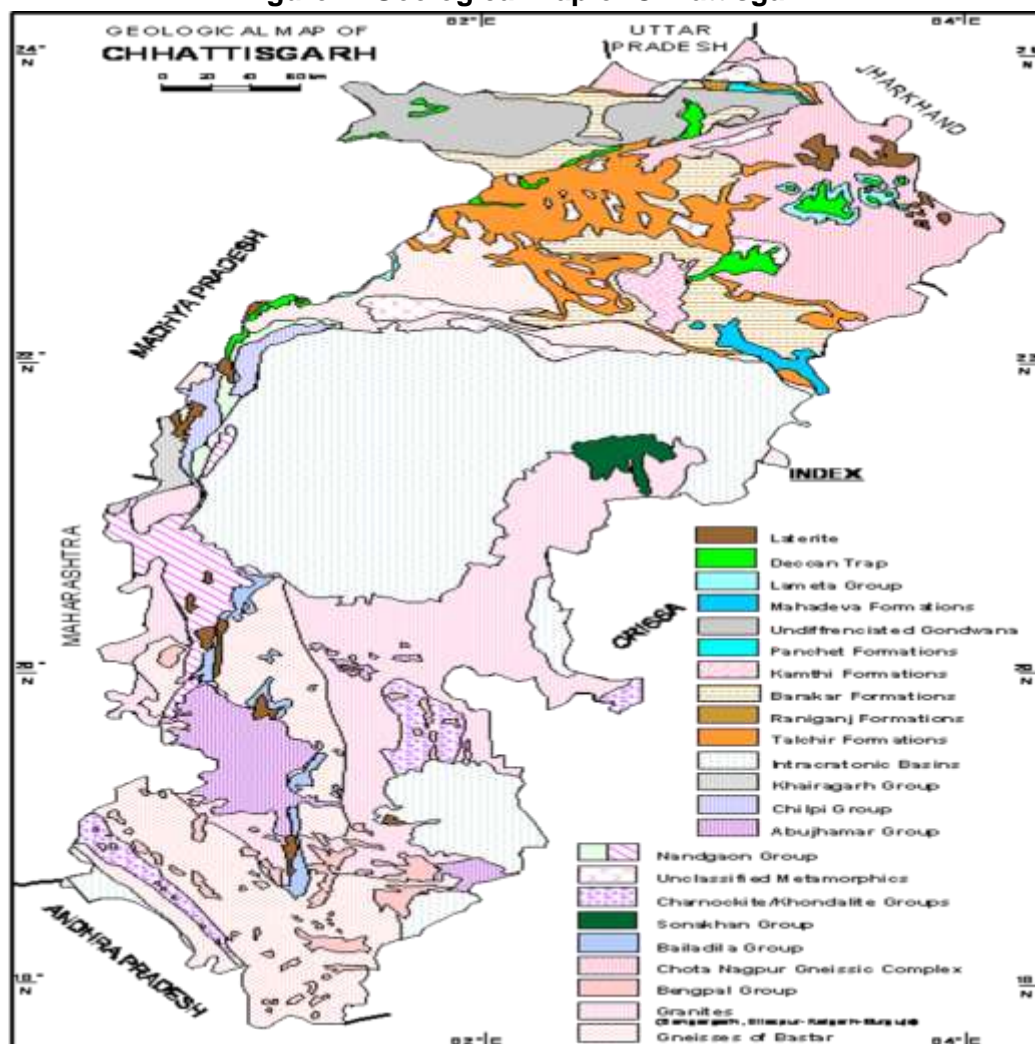
2. Topography, Land Use, Geology and Soils

138. Chhattisgarh state of India, located in the center-east of the country. It is the tenth-largest state in India, with an area of 135,198.5 square km. With a population of 25.5 million, Chhattisgarh is the 17th-most populated state in the country. The state was formed on 1 November 2000 by partitioning sixteen Chhattisgarhi-speaking southeastern districts of Madhya Pradesh. Chhattisgarh borders the states of Madhya Pradesh in the northwest, Maharashtra in the southwest, Telangana in the south (Bhupalpally district), Odisha in the southeast, Jharkhand in the northeast and Uttar Pradesh in the north. Currently the state comprises 27 districts. The northern and southern parts of the state are hilly, while the central part is a fertile plain. The highest point in the state is the Gaurkata.

139. In the north lies the edge of the great Indo-Gangetic plain. The Rihand River, a tributary of the Ganges, drains this area. The eastern end of the Satpura Range and the western edge of the Chota Nagpur Plateau form an east-west belt of hills that divide the Mahanadi River basin from the Indo-Gangetic plain. The central part of the state lies in the fertile upper basin of the Mahanadi River and its tributaries. This area has extensive rice cultivation. The upper Mahanadi basin is separated from the upper Narmada basin to the west by the Maikal Hills (part of the Satpuras) and from the plains of Odisha to the east by ranges of hills. The southern part of the state lies on the Deccan plateau, in the watershed of the Godavari River and its tributary, the Indravati River. The Mahanadi is the chief river of the state. The other main rivers are Hasdo (a tributary of Mahanadi), Rihand, Indravati, Jonk, Arpa and Shivanth.

140. Chhattisgarh hosts a wide variety of minerals found associated with igneous, sedimentary and metamorphic rock formation. A few of them form large economic deposits while a number of other minerals are reported as occurrences. Large deposits of Coal, Iron ore, Limestone, Dolomite and Bauxite are located in parts of the State, see Figure-4. Diamondiferous kimberlites identified in Raipur district are also likely to yield substantial quantity of diamonds. Tin (Cassiterite) bearing pegmatites containing moderate deposits are also known. Medium to small deposits of gold, base-metals, quartzite, soapstone/steatite, fluorite, corundum, graphite, lepidolite, amblygonite of workable size are also known that may grade in the category of large deposits after exploration. Occurrences of garnet, amethyst, beryl, andalusite, kyanite, sillimanite and rare precious mineral alexandrite are also reported from different parts of the State. A few of these may prove to be of sizable deposit. Deposits of grey, pink, red and black (dolerite, amphibolite and gabbro), granites and flagstone of grey, black and purple shades are widely distributed that are suitable for dimension stone and decorative purposes.

Figure 4: Geological Map of Chhattisgarh



141. Soil samples at two locations along the subproject road section were collected and analyzed for its physiochemical properties using various standard testing procedures including IS:2720(Part-26) for pH and IS:2720(Part-21) for electrical conductivity etc. The samples were collected from following locations.

Table 18: Soil sampling locations along subproject alignment

S. No	Code	Sample Location Vill.	Change
1	S1	Mohanmuda	8+800
2	S2	Singhora	39+500

142. The proposed (Lambar-Bodesara-Birkol-Singhora Road) is situated on the eastern part of state and is a fertile plain. The soils of state are rich and fertile. The state has a variety of soils ranging from rich clayey to gravelly. The major groups of soils found in the state can be divided in to following four categories i.e. alluvial, medium & deep black; shallow & medium black; and mixed red & black. two soil samples were collected and analyzed along the project corridor and results are presented in Table 19. The result shows that soil is mostly

found as Sandy clay loam soil at all the three sampling locations and it is heavily loaded with sand percentage which ranges from 53 to 57 %. Nitrogen content ranges from 60 mg/1000g and is poor in organic carbon content.

Table 19: Soil Quality along the Project road

S. No	PARAMETERS	TEST METHOD	UNIT	S1	S2
1.	pH(1:5 suspension)	IS:2720 (Part-26)	-	7.51	7.60
2.	Electrical Conductivity at 25°C (1:5suspension)	IS:2720 (Part-21)	µmhos/cm	55.2	56.1
3.	Bulk Density	STP/SOIL	gm /cm ³	1.26	1.30
4.	Moisture	STP/SOIL	%	18.5	18.1
5.	Texture	STP/SOIL	-	Sandy Loam	
6.	Sand	STP/SOIL	% by mass	53	57
7.	Clay	STP/SOIL	% by mass	15.8	11.8
8.	Silt	STP/SOIL	% by mass	31.2	31.2
9.	Cation Exchange Capacity	STP/SOIL	mg/ kg	1.28	1.20
10.	Nitrogen	STP/SOIL	mg/1000g	61	60.1
11.	Potassium (as K)	STP/SOIL	mg/kg	0.2	0.2
12.	Phosphorus	STP/SOIL	mg/1000g	82	85
13.	Calcium	STP/SOIL	mg/1000g	3.4	3.1
14.	Magnesium	STP/SOIL	mg/1000g	1.30	1.20
15.	Organic Carbon	STP/SOIL	%by mass	0.13	0.17

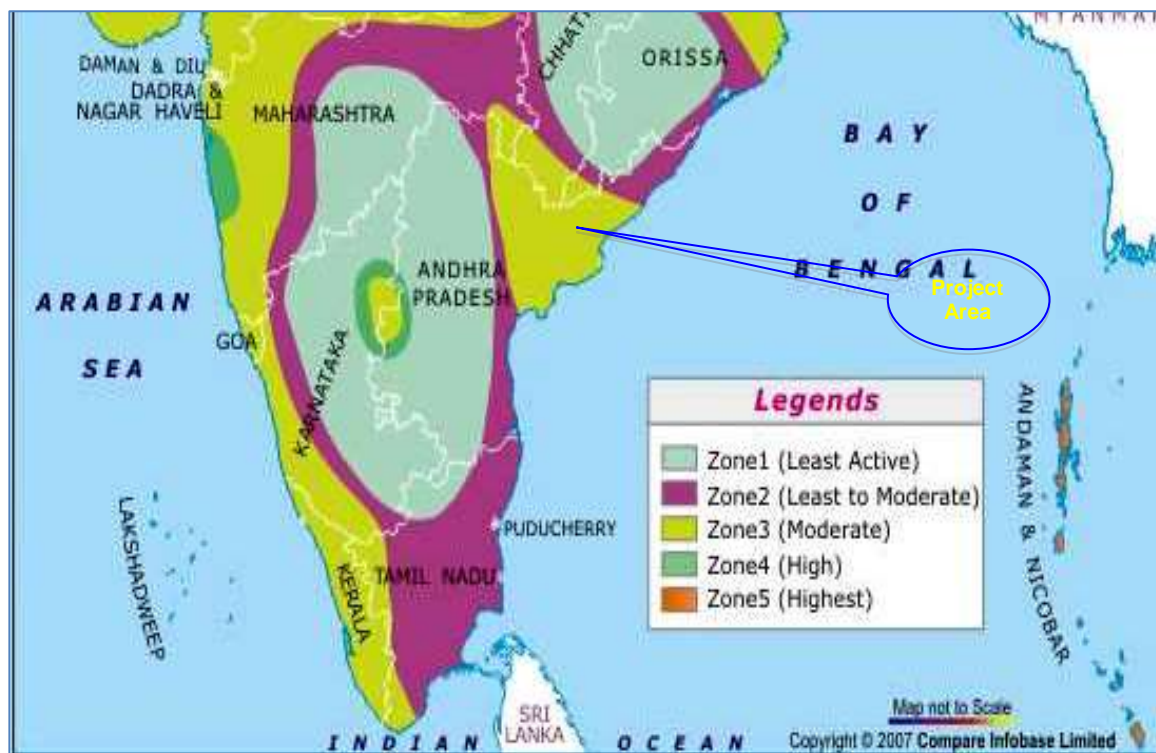
Source: Soil testing conducted by DPR Consultant team

3. Seismicity

143. Chhattisgarh has very low rates of seismic activity. In recent years, tremors from earthquakes in neighboring states have been felt, most notably in 1969. Minor seismic activity has been recorded in the vicinity of Chirai kund and Muirpur along the border with Madhya Pradesh. A few faults which form the eastern section of the Narmada-Son Fault Zone have shown movement during the Holocene epoch another active fault is the Tatapani Fault which trends in an east-west direction in the vicinity of Manpura in Sarguja district. In the south, the Godavari fault, which forms the northern flank of the Godavari Graben run through the southern part of the state and is also active. However, it must be stated that proximity to faults does not necessarily translate into a higher hazard as compared to areas located further away, as damage from earthquakes depends on numerous factors such as subsurface geology as well as adherence to the building codes.

144. The seismic hazard map of India was updated in 2002 by the Bureau of Indian Standards (BIS). Apart from the merging of Zones I and II into Zone II in the latest map, there are no major changes from the BIS 1984 map. Zone III stretches across the length of the state, some portion near Jharkhand also come Zone II. The maximum expected intensity is VI and VII (MSK). According to GSHAP data, the state of Chhattisgarh falls in a region of low to moderate seismic hazard. As per the 2002 Bureau of Indian Standards (BIS) map, figure-5 Chhattisgarh falls in Zones II & III. Historically, parts of this state have experienced seismic activity in the M 5.0-6.0 range.

Figure 5: Seismic Zoning Map showing Project Road Location (Source: IS 1893 - Part I: 2002)



4. Water Resources and Hydrology

145. The surface water inflow into State is through four major interstate rivers Ganga, Mahanadi, Godavari and Narmada. Chhattisgarh is surrounded by Orissa and Jharkhand in the East, Andhra Pradesh in the South. There is no major river crossing along the present road.

146. Ground water is the major water source in the area for drinking purpose. The source of recharging of ground water is mostly from rainfall and small channels. Hand pumps are commonly used to draw the water from ground in the villages. Static water levels vary along the stretch of the priority roads. First or upper ground water aquifer lies in the range of 2.75m to 15m below ground level (bgl) during pre monsoon and increase to 0.56 to 7.86 m(bgl) during post monsoon season. The details of water source/bodies along the project road are given in Table 20.

Table 20: Water source/bodies along the Project Road

#	Chainage	Distance from centre	Left or Right	Type-Ponds, river, well, hand pump, tube well etc	Remarks (Village name etc)
1	3.200 + 3.400	2	R/S	Hand pump	Kashipal
2	4.800 + 5.000	7	L/S	Pond	Patapara
3	5.000+5.200	5.5	L/S	Pond	Awlacheke
4	7.600+7.800	-	L/S	Pond	Mohanmuda
5	9.800+10.000	11	R/S	Pond	Dudumchumba

6	12.600+12.800	9.5	R/S	Pond	Kosampali
7	17.600+17.800	7	R/S	Pond	Jalpur
8	19.000+19.200	8.5	L/S	Pond	Amlidipa
9	20.200+20.400	5	L/S	Pond	Birkol
10	25.600+25.800	8	L/S	Pond	Rosspali
11	28.400+28.600	5.5	R/S	Pond	Pareskol
12	39.000+39.200	5	L/S	Pond	Singhora

Source: Field inventory by DPR Consultant team

5. Water Quality

147. In order to establish baseline conditions, groundwater samples were collected. The sampling locations were selected after the field reconnaissance and a review of all the water bodies/ resources in the project influence area. Samples were collected as per IS- 2488 (Part I-V). Samples were taken from ground water sources during January, 2018 along road corridor. Ground water (drinking water) samples were analysed as per IS: 10500-1991. Grab sample were collected from water source and were analysed for various Physico- chemical parameters as per the procedures laid down in the APHA and BIS. Atomic Absorption Spectrophotometer and UV/VIS Spectrophotometer were used for analysis of water samples according to the necessity.

148. The water samples were collected from following locations (Table-21) along the project road.

Table 21: Water sample location along the project alignment

S. No	Code	Sample Location Vill.	Chanaage
1	W1	Potapara	4+600
2	W2	Singhora	39+100

149. The results of the analysed of these samples are presented in Table 22. The results were compared with standards for drinking water quality (Appendix 5).

150. It can be seen from Table 22 that the pH of the sampled water in the region is well within permissible limits (7.1 – 7.3). All water quality parameters analysed like Total Hardness, TDS, chloride, sulphate, fluorides are found well within the permissible limits for drinking waters as specified by CPCB on project road. Overall the ground water quality in the project areas is good.

Table 22: Water Quality Characteristics along the Project Road

S. No.	Parameter	Unit	Method No.	Requirement as per IS-10500-2012		Location	
				Desirable Limit	Permissible Limit	W1	W2
1	pH	-	4500	6.5-8.5	No relaxation	7.14	7.27
2	Temperature	°C	-	-	-	19.7	21.2
3	Dissolved Oxygen	mg/lit	3025(P-38)	-	-	5.7	6.8

4	Conductivity	□mhos/cm	2510	-	-	574.6	683
5	Total Suspended Solid	mg/lit	3025(P-17)	-	-	4.9	5.7
6	Total Dissolved Solid	mg/lit	2540	500	2000	392	429
7	Alkalinity	mg/lit	2320	200	600	172	192
8	Total Hardness as CaCO ₃	mg/lit	2340	300	600	220	237
9	Ca Hardness as CaCO ₃	mg/lit	3500	-	-	140	141
10	Mg Hardness as CaCO ₃	mg/lit	2340	-	-	68	75
11	Chlorides as Cl	mg/lit	4500	250	1000	51	54.2
12	Phosphate as PO ₄	mg/lit	3500	-	-	0.04	0.05
13	Nitrates as NO ₃	mg/lit	4500	45	100	21.1	27.4
14	Sulphates as SO ₄	mg/lit	4500	200	400	25.2	26.1
15	Sodium as Na	mg/lit	3025 (P-45)	-	-	26.1	37.3
16	Potassium (as K)	mg/lit	3025(P-45)	-	-	6.0	7.1
17	COD	mg/lit	APHA-5220B	-	-	7.1	7.3
18	BOD (at 27°C 3- Days)	mg/lit	IS-3025 (P-44)	-	-	3.6	4.0
19	Total Coliform	mg/lit	IS-1622	Nil	Nil	Absent/100ml	Absent/100ml
20	Fecal Coliform	mg/lit	IS-1622	Nil	Nil	Absent/100ml	Absent/100ml

Source: Water Quality Monitoring carried out by Consultant Team as part of DPR, 2017-18

6. Air Quality

151. Ambient air quality in the state is quite pure compared to other neighboring states. Except for few urban centers, the ambient air quality along the selected subproject road is good. There are no major industrial activities along the project road. Dust arising from unpaved surfaces, forest fire, smoke charcoal production and domestic heating, and vehicular pollution are sources of pollution in the region. Firewood burning is the major contributor in the ambient pollution load. Industrial and vehicular pollution is mainly concentrated in the major commercial areas.

152. Vehicular pollution is a secondary source of pollution in the region as the traffic density is low. Pollution from vehicles is mainly due to use of low-grade fuel, and poor maintenance of vehicles. The level of pollution in rural areas is much lower than that of the urban areas due to lower volume of traffic. The traffic density in the state is very low. There is sudden increase in the number of vehicles in the town area during the last one decade producing a lot of smoke.

153. Secondary information is not available on ambient air quality of the project road area. The major transport on the project road sections is the traffic flowing on unpaved or damaged roads. This might also add to the air pollution load on the project sections.

154. The base-line status of the ambient air-quality was assessed using a scientifically designed ambient air-quality monitoring network. The design of this network was based on the following:

- meteorological conditions;
- the assumed regional influences on background air quality;
- the areas where impact would most likely be greatest;
- present land use along the proposed alignment; and
- traffic congestion points.

155. To establish the baseline ambient air quality, Ambient Air Quality Monitoring (AAQM) stations were set up at 2 locations as indicated in Table 23.

Table 23: Details of Ambient Air Quality Monitoring Locations

S. No	Code	Sample Location Vill.	Chanage
1	AQ1	Potapara	4+600
2	AQ 2	Singhora	39+400

156. At each of the two locations monitoring was undertaken as per new notification issued by MoEFCC on 16th November 2009, in the first quarter of 2018. Data for the following parameters was collected.

- Particulate Matter PM₁₀
- Particulate Matter PM_{2.5}
- Sulphur Dioxide (SO₂)
- Oxides of Nitrogen (NO_x)
- Carbon monoxide (CO)

157. The sampling of PM₁₀, PM_{2.5}, SO₂, and NO_x was undertaken on a 24-hourly basis while 8- hourly samples were collected for CO. PM, SO₂, and NO_x were monitored using M/s Envirotech Instruments Private Ltd; make Respirable Dust Sampler (APM 460) along with gaseous attachment (Model APM 415 & 411). Whatman GF/A filter papers were used for PM. Carbon monoxide (CO) samples were monitored by using M/s Endee Engineers Pvt. Ltd. make gas detector model No. CO96 & GP - 200P; respectively.

158. Methodology adopted for sampling and analysis and instrument used for analysis in laboratory are presented in Table 24.

Table 24: Techniques Used for Ambient Air Quality Monitoring

Sl. No.	Parameter	Technique	Instrument Used	Minimum Detectable Limit (µg/m ³)
1.	PM ₁₀	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
2.	PM _{2.5}	Respirable Dust Sampler (Gravimetric method)	Electrical Balance	1.0
3.	Sulphur Dioxide	Improved West & Gaeke Method	Colorimeter	5.0
4.	Nitrogen Oxide	Jacob & Hochheiser modified (Na-Arsenite)	Colorimeter	5.0

		Method		
5.	Carbon Monoxide	Gas Chromatograph		0.01

159. A summary of results for each location is presented in Table 25. These results are compared with the new National Ambient Air Quality Standards prescribed by the MoEFCC for respective zones.

Table 25: Summary of AAQM Results along the project Road Section (Average Values)

Sl. No.	Parameter	NAAQ Standards	AQ-1	AQ -2
1	Particulate Matter (PM ₁₀) µg/m ³	100	75	72.8
2	Particulate Matter (PM _{2.5}) µg/m ³	60	28.3	26.1
3	Sulphur Dioxide (SO ₂) µg/m ³	80	8.8	7.0
4	Nitrogen Oxide (NO _x) µg/m ³	80	14.0	12.1
5	Carbon Monoxide (CO) mg/m ³	4	0.378	0.314

Source: Air Quality Monitoring carried out by Consultant Team as part of DPR, 2017-18

160. The monitored values are compared with National Ambient Air Quality Standards prescribed by Central Pollution Control Board (CPCB) for residential, rural and other areas. The Ambient air quality levels meet the National air quality standards for rural, residential and industrial area all along the project road.

- **PM2.5:** The mean PM2.5 concentration at ambient air quality monitoring locations varies from 26 to 28 µg/m³. The values are within the permissible limit at all the stations.
- **PM10:** The mean PM10 concentration at ambient air quality monitoring locations varies from 75 to 73 µg/m³. The values are within the permissible limit at all the stations.
- **SO2:** The mean concentrations of SO2 at all ambient air quality monitoring locations varies from 7 to 9 µg/m³. The values are within the permissible limit at all the stations.
- **NOx:** The mean concentrations of NOx at all AAQM locations range from 12 to 14 µg/m³. The values are within the permissible limit at all the stations.
- **CO:** The mean concentrations of CO at all AAQM locations range from 0.314 to 0.378 mg/m³. The values are within the permissible limit at all the Stations.

161. Overall the air quality along the subproject road is not an issue. The National Ambient Air Quality Standards (NAAQS) prescribed by MOEF and World Bank (IFC) air quality standards are given in Appendix 3.

7. Noise

162. Noise pollution is not a current problem in the region except in commercial location in urban areas where major settlements are along the road, and high traffic flow. However, few commercial locations will experience increase in noise levels but still the ambient noise quality is expected to be higher than the permissible limits.

163. During construction period, temporary increase in the noise levels are expected from the movement of construction machineries and construction activities. Suitable barriers and timely scheduling of construction activities will minimize these impacts.

164. No secondary information was available on noise level in the project areas. In order to establish the baseline noise quality in the project areas, a reconnaissance survey was therefore undertaken to identify noise generating sources and sensitive receptor such as school, hospitals, temples, built-up areas. Two locations listed in Table 26 were selected for monitoring the noise level.

Table 26: Details of Noise Level Monitoring Locations

S. No	Code	Sample Location Vill.	Chanage
1	N1	Potapara	4+600
2	N 2	Singhora	39+400

165. **Methodology:** At each of the slected locations, Sound Pressure Level (SPL) measurements were taken at an interval of 1 minute using a sound level meter of Lutron make Digital Sound Level Meter. At all these locations, daytime noise levels were monitored during the period 6 am to 9 pm and night-time noise levels during the period 9 pm to 10 pm. Noise readings, with setting at 'A' response - slow mode, were recorded. The readings were tabulated and a frequency distribution table prepared from which 24 hourly, hourly, and Average Leq noise levels were calculated.

166. **Presentation of Results:** It can be seen from the table 27 that at all the monitoring locations the ambient noise levels are well within the permissible limits for residential areas prescribed by CPCB and also by World Bank EHS standards of 55 dB(A) and 45 dB(A) for day time and night time respectively. The maximum recorded day time noise level is 55.4 dB(A) and night time noise level is 52.7 dB(A) at N1 location.

Table 27: Ambient Noise Level in decibel (A) along the Project Road

Location	Noise Level dB (A)		CPCB / World Bank Standard for residential zones-dB(A)
	Day Time	Night Time	
	L _{eq}	L _{eq}	
N-1	55.4	52.7	55 for day time and 45 for night time
N-2	44.1	42.0	

Source: Noise Monitoring carried out by Consultant Team, 2017-18

C. Biological Environment

1. Forests and Vegetation

167. Variability in climatic and edaphic conditions brings about significant difference in the forest types of the state. There are four important forest types viz. Tropical Moist, Tropical

Dry, Tropical Thorn, Subtropical broadleaved Hill forests. The forest area can also be classified based on the composition of forest and terrain of the area. Based on composition, there are three important forest formations namely Teak forest, Sal forest and miscellaneous Forests. Bamboo bearing areas are widely distributed in the state. To obviate pressure on the natural forests, plantations have been undertaken in forest and non forest areas to supplement the availability of fuel wood, small timber, fodder etc. About 12% of the India's forests are in Chhattisgarh, and 44% of the state's land is under forests. Identified as one of the richest bio-diversity habitats, the Green State of Chhattisgarh has the densest forests in India and above all, over 200 non-timber forest products, with tremendous potential for value addition. The state covers 4.4% of the total geographical area of the country. Over 0.59 lakh sq. km area in the State is under forest constituting about 44% of its geographical area. Its neighboring state Madhya Pradesh has 26.9% of its entire area comprising of 83,016 sq.km for forest cover and it constitutes about 11.0% of the country's forest and tree cover. Out of the total forest cover placed at 56448 Sq.Km. the extent of dense forest is 37880 and open forest is 18568 Sq.Km. The changes in forest cover in the year 2001 as compared to 1999 shows a decline in forest cover by 245 Sq.Km. (0.432%).

168. The floral biodiversity is complex comprising of different species including Aonla, Neem, Imli, Harra, Bel , Baheda , Baibidang , Baichandi, Adusa, Kalihari, Safed Mulsi, Kali musli, Aloe vara , Lemon grass , Bixa orellana , Ashwagandha, Isabghol , Sarpa gandha, Malkangni , Kali haldi , Nirmali , Kuchla , Tikhur , Keokand , Kiwanch , Sarphokha Bhuai amla , Giloy , Nagar motha , Kalmegh , Satabar , Bidarikand , Ananth Mul , Brahmi , Bach , Jangli haldi , Jangli piaj , Rasna , Chitrak, Shankpuspi , Ratti, Tejrāj , Bhojraj , Gokhaur , Bavachi, Bhagnraj , Salparni and senna . In Chhattisgarh 1,685 specimens of different plant species have been collected. Till now 1685 species belonging to 785 genera and 147 families have been identified and preserved in the herbarium. The Forest map of the Chhattishgarh state is given in Figure 6.

169. The project road is passing through forest area at few locations. If widening will be proposed on forest land then diversion of forest land required under forest conservation act 1980. Details of project road section passing through forest area & their type & legal status is provided at following locations.

Figure 6: Forest Map of Chhattisgarh State

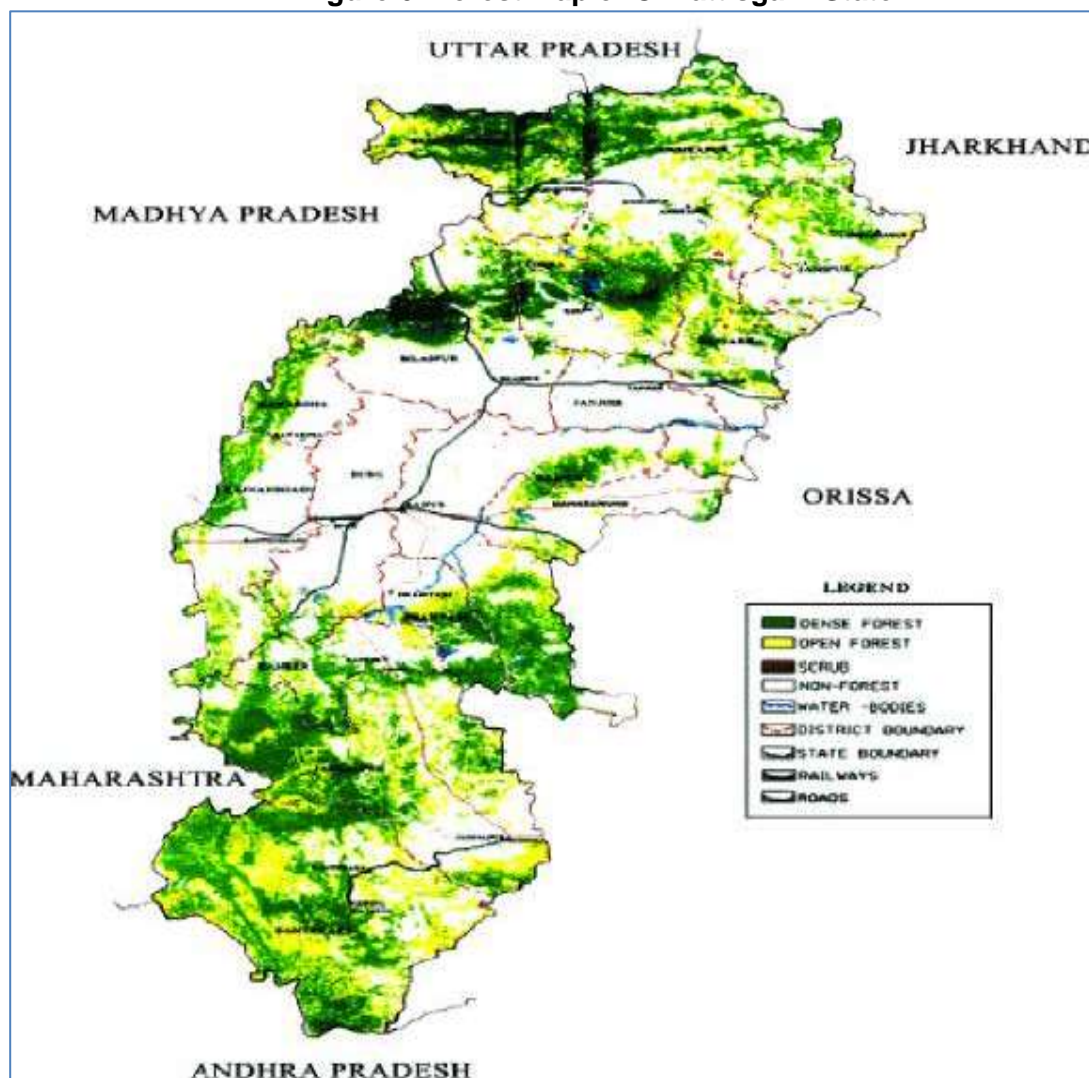


Table 28: Details of Project Road Section In Forest Area

Sr. No.	Chainage (In Km)		Total Length (In Km)	Status of Forest Land		Remarks
	From	To		LHS	RHS	
1.	19.550	19.650	0.100	Yes	Yes	
2.	24.400	24.800	0.400	Yes	Yes	
3.	25.200	26.350	1.150	Yes	Yes	
4.	26.600	26.700	0.100	Yes	Yes	
5.	26.900	31.600	4.700	Yes	Yes	

Source: Field survey by DPR Consultant, 2017-18

170. Field survey has been carried out to identify the number and type of trees to be affected by the proposed improvement work of main alignments. It is envisaged that about 1758 trees are likely to be cut for the implementation of the improvements proposed under

the project road. Main species found are Mahua (*Madhuca Longifolia*), Pipal (*Ficus religiosa*), Jamun (*Syzygium Cumin*), Sarai (*Shorea robusta*), Chola (*Cicer arietinum*), Babool (*Acacia arabica*, Willd.), Aam (*Mangifera indica*), Sagon (*Tectona grandis* Linn.), Mahua (*Bassia longifolia*), Babool (*Arabica nilotica*), Chirol (*Holoptelea integrifolia*), and Neem (*Azadirachta indica*). Table 29 show road side wise details of the trees to be affected.

Table 29: Detail of Trees existing within the Proposed ROW of the Project Road

Sl. No.	Road Side	No. of Existing with ROW	Main Tree Species Local name (botanical name)
1.	Right Hand Side	778	Mahua (<i>Madhuca Longifolia</i>), Pipal (<i>Ficus religiosa</i>), Jamun (<i>Syzygium Cumin</i>), Sarai (<i>Shorea robusta</i>), Chola (<i>Cicer arietinum</i>), Babool (<i>Acacia arabica</i> , Willd.) and Aam (<i>Mangifera indica</i>), Sagon (<i>Tectona grandis</i> Linn.), Mahua (<i>Bassia longifolia</i>), Babool (<i>Arabica nilotica</i>), Chola (<i>Cicer arietinum</i>), Chirol (<i>Holoptelea integrifolia</i>), and Neem (<i>Azadirachta indica</i>)
2.	Left Hand Side	980	
	Total	1758	

Source: Field inventory carried out by the DPR Consultant Team, 2017-18

2. Wildlife and Protected Area Network

171. In the state there are 3 National Parks and 11 Sanctuaries spread over an area of 0.29 million ha. And 0.36 million ha. respectively. A total of 0.65 million ha. area constituting 4.79% of the geographical area of the state is under protected area network. Figure 7 shows the details of National Parks and Wildlife Sanctuaries of the State.

Figure 7: Protected Area Map of Chhattisgarh State



172. During the field surveys, informal interviews were held with the local villagers and livestock herders to gather information on the presence of wildlife and their habitats along the

project roads. Officials from local forest department were also consulted in the process. Local communities and local forest officials informed that there are no protected areas along the proposed alignment of the subproject road. It can also be seen from the Figure 7 that the subproject road section does not pass through any protected area such as Wildlife Sanctuary, National park or bio –reserve. There is no wildlife sanctuary Wildlife Sanctuary, National park or bio –reserve within 10 km from the project road.

3. Rare or Endangered Species

173. No rare or endangered species found in corridor of impact along the project road.

4. Fauna and Wildlife

174. The subproject road section traverses mainly through agricultural fields and during field survey no wild animals were spotted. However in discussion with the forestry department and during the public consultations, it was found that common fauna in the study area are wild dogs, wild cats; monkey (*Rhesus macaque*), and hare (*Lepus nigricolis*). There are listed as least concern by the IUCN based on the wide range of occurrence. The subproject road does not have presence of any Schedule 1 species as per Wildlife Protection Act of GOI.

D. Socio-economic Environment

1. Demography

175. Chhattisgarh is a land-locked state in the central part of country. Chhattisgarh is primarily a rural state with only 20% of its population (around 5.1 million people in 2011) residing in urban areas. According to a report by the government of India, at least 34% are Scheduled Tribes, 12% are Scheduled Castes and over 50% belong to the official list of Other Backward Classes. The plains are numerically dominated by castes such as Teli, Satnami and Kurmi; while forest areas are mainly occupied by tribes such as Gond, Halbi, Halba and Kamar/Bujia and Oraon. A large community of Bengalis has existed in major cities since the times of the British Raj. They are associated with education, industry and services.

176. The total population of Chhattisgarh state as per 2011 census is 2,55,45,198 of which male and female are 50.24% and 49.76% respectively. In Chhattisgarh state sex ratio per 991 over 1000 males and density of population 189 Per Sq.Km. Literacy rate has seen 70.28 per cent with male literacy of 80.27 per cent and female literacy of 59.58 per cent.

177. The majority of the population of Chhattisgarh lives in rural areas (76.76%) as compared to urban population (23.24%). In actual numbers of males and females were 12832895 and 12712303 respectively. In rural area female sex ratio per 1000 males was 1001 while for the child (0-6 age) it was only 977 girls per 1000 boys. Child population forms 14.92 per cent of total rural population. Literacy rate in rural areas was 65.99 per cent in which 76.98% males were literate while female literacy rate of 55.15%.

178. The official language of the state is Chhattisgarhi & Hindi. Chhattisgarhi is spoken and understood by the majority of people in Chhattisgarh. Among other languages, Odia is widely spoken by a significant number of Odia populations in the eastern part of the state. Marathi and Telugu are also spoken in parts of Chhattisgarh. Chhattisgarhi was known as "Khaltahi" to the surrounding hill-people and as "Laria" to Odia speakers. In addition to Chhattisgarhi,

there are several other languages spoken by the tribal people of the Bastar region, geographically equivalent to the former Bastar state, like Halbi, Gondi and Bhatri.

179. As per census, 2011, 34% are Scheduled Tribes, 12% are Scheduled Castes and over 50% belong to the official list of Other Backward Classes. The plains are numerically dominated by castes such as Teli, Satnami and Kurmi; while forest areas are mainly occupied by tribes such as Gond, Halbi, Halba and Kamar/Bujia and Oraon. A large community of Bengalis has existed in major cities since the times of the British Raj. They are associated with education, industry and services. Demography of the Chhattisgarh is shown in Table 30.

Table 30: Demographic Features of State as per 2011 census

Description	Rural	Urban	Total
Population (%)	76.76	23.24	100.00
Total Population	19607961	5937237	25545198
Male Population	9797426 (49.97%)	3035469 (51.12%)	12832895
Female Population	9810535 (50.03%)	2901768 (48.87%)	12712303
Population Growth (%)	17.78	41.84	22.61
Sex Ratio (over 1000)	1001	956	991
Child Sex Ratio (0-6)	977	937	
Child Population (0-6)	2924941	736748	
Child Percentage (0-6) (%)	14.92	12.41	
Literates	11008956	4370966	
Average Literacy (%)	65.99	84.05	
Male Literacy	76.98	90.58	
Female Literacy	55.15	73.39	

Source: <http://www.census2011.co.in/census>

2. Land Resources

180. The total geographical area of the state is around 13790 thousand ha. The contribution of forest (45.95 per cent) area was found to be maximum in total geographical area followed by net area sown (34.06 per cent), area not available for cultivation (7.39 per cent), other cultivated land excluding waste land (2.57 per cent), current fallow land (1.83 per cent), land other than current fallow land (1.99 per cent), permanent pastures & other grazing lands (6.20 per cent). The land put under miscellaneous tree crops and groves (0.01 per cent), area sown more than once (7.07 per cent), land put under culturable fallow and & unculturable land uses (8.78 per cent). The gross cropped area was found to be increased by 41.13 per cent in the year 2010-11 as compared to 2000-01. The maximum change is found in current fallow (15.06 per cent) followed by gross cropped area (6.48%), land not available for cultivation (0.59%) forest (0.52%) permanent pastures & other grazing land (0.23%). The change in land under misc. tree crops/cultivable waste land (-99.70%), land put under current fallow (-9.64%), and net area sown (-1.39 %) found to be decreases in the year 2010-11 as compared to 2000-01. The cropping intensity of Chhattisgarh was found to be changed by 9% increase in the year 2010-11 which was mainly due to increase in double cropped areas 72.87% in Chhattisgarh.

181. Table 31 present the land use pattern and decade change in land use in Chhattisgarh state. The land use along the project road is mainly agricultural with residential patches. The

land use along the project road is predominately agricultural (73.82%), followed by built up area(22.92%),Barren land (3.17%) and industrial (0.09%).

Table 31: Area under Different Lanuses in the State

Particulars	Area in1000 ha (% of total area)		Absolute Change	Relative Change %
	2000-01	2010-11		
1. Geographical area	13787 (100)	13790 (100)	3	0.02
2. Forests	6303 (45.72)	6336 (45.95)	33	0.52
3. Land not available for cultivation	1013 (7.35)	1019 (7.39)	6	0.59
4. Culturable fallow and & Un-culturable land	1189 (8.62)	1211 (8.78)	22	1.85
A. Permanent pastures & other grazing lands	853 (6.19)	855 (6.20)	2	0.23
B. Land under misc. tree crops & groves/ Cultivable waste Land	336 (2.44)	1 (0.01)	-335	-99.70
5. Land available for cultivation	NA (00.00)	355 (2.57)		
6. Fallow Land	519 (3.76)	528 (3.83)	9	1.73
A. Current fallows	280 (2.03)	253 (1.83)	-27	-9.64
B. Land other than current Fallow	239 (1.73)	275 (1.99)	36	15.06
7. Net area sown	4763 (34.55)	4697 (34.06)	-66	-1.39
8. Area sown more than once	564 (4.09)	975 (7.07)	411	72.87
9. Gross Cropped Area	5327 (38.64)	5672 (41.13)	345	6.48
10. Cropping intensity %	112	121	9	

3. Economic Development

182. The economy of Chhattisgarh depends mainly on the agricultural sector. Chhattisgarh's gross state domestic product for 2010 is estimated at INR 600.79 billion in current prices. The economy of Chhattisgarh has grown rapidly in recent years with a growth rate of 11.49 per cent in GDP for 2009–2010. Chhattisgarh's success factors in achieving high growth rate are growth in agriculture and industrial production. The various kinds of crops grown in the state of Chhattisgarh are rice, pulses, wheat, oilseeds, grams, soybeans, and maize.

183. Agriculture is counted as the chief economic occupation of the state. According to a government estimate, net sown area of the state is 4.828 million hectares and the gross sown area is 5.788 million hectares. Horticulture and animal husbandry also engage a major share of the total population of the state. About 80% of the population of the state is rural and

the main livelihood of the villagers is agriculture and agriculture-based small industry. In the state GSDP of manufacturing sector (18.61%) contributed maximum share followed by agriculture (12.99 %), mining (10.63%), construction (9.62%), banking & insurance (9.80%), trade, hotel & restaurants (8.96%), electricity gas and water supply (6.41%), forestry & logging (3.90 %), transport (3.09%), community and personal services (2.54%), fishing (1.03 %), communication. & storage (0.11%), in the year 2009-10.

4. Agriculture

184. Chhattisgarh, rice, the main crop, is grown on about 77% of the net sown area. Only about 20% of the area is under irrigation; the rest depends on rain. Of the three agroclimatic zones, about 73% of the Chhattisgarh plains, 97% of the Bastar plateau and 95% of the northern hills are rainfed. The irrigated area available for double cropping is only 87,000 ha in Chhattisgarh plains and 2300 ha in Bastar plateau and northern hills. Due to this, the productivity of rice and other crops is low, though agriculture is the main occupation of more than 80% of the population.

185. Other important food and cash crops that are vital to agriculture in Chhattisgarh are millets, sunflower, wheat, Jowar, Gram, Soyabean, Pulses etc.

5. Industry and Minerals

186. Chhattisgarh economy also depends for its revenue on the mineral resources sector for the state has a rich storehouse of minerals. It produces 20% of the country's total cement produce. It has the highest output of coal in the country with second-highest reserves. It is third in iron ore production and first in tin production. Limestone, dolomite and bauxite are abundant. It is the only tin ore-producing state in India. Other commercially extracted minerals include corundum, garnet, quartz, marble, alexandrite and diamond. The steel industry is one of the biggest heavy industries of Chhattisgarh. Bhilai Steel Plant, Bhilai operated by SAIL, with a capacity of 5.4 million tonnes per year, is regarded as a significant growth indicator of the state. More than 100 steel rolling mills, 90 sponge iron plants and ferro-alloy units are in Chhattisgarh. Along with Bhilai, today Raipur, Bilaspur, Korba and Raigarh have become the steel hub of Chhattisgarh. Today, Raipur has become the centre of the steel sector, the biggest market for steel in India.

6. Archaeological and Historical Monuments

187. No archaeological sites or historical monuments are located along the subproject road section.

7. Sensitive Receptors

188. During the environmental and social screening survey, number of sensitive receptors such as school, temple etc. are located along the alignment. However no structure are going to be affected by the proposed road improvement works. The list of these structures is presented in Table 32.

Table 32: Physical /Sensitive Features along the project road

S.no	Chainage	Left or Right	Type-Temple, school, hospital, community building etc.	Remarks (Village name etc)
1	4+800	L/S	School	Potapara
2	7+400	R/S	School	Baherapali
3	7+800	L/S	Temple	Baherapali
4	9+000	L/S	Temple	Mohanmuda
5	15+400	R/S	School	Kendua
6	15+600	R/S	Panchyat Bavan	Kendua
7	15+600	R/S	School	Kendua
8	19+600	L/S	Samudayik Bawan	Amlidipa
9	27+000	R/S	School	Chupali
10	34+600	R/S	School	Kalenda
11	38+800	R/S	School	Singhora

Source: Field inventory carried out by the DPR Consultant Team, 2017-18

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Introduction

189. This chapter presents key environmental issues associated with various aspects of the proposed project. The environmental impacts caused due to the development of the subproject road section can be categorised as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are induced directly by the project where as the secondary impacts are those which are indirectly induced and typically include the associated investment and changing patterns of social and economic activities due to the proposed action. Interaction of the project activities with environmental attributes is presented as Activity-Impact matrix in Table 33.

Table 33: Activity-Impact Identification Matrix

Sl. No.	Activities	Type of Impact							
		Air	Water	Noise	Flora	Fauna	Drainage	Soil	Topography
1.	Labour camp activities		- ve/t						
2.	Quarrying	-ve/t		- ve/t	- ve/t		- ve/t		- ve/p
3.	Material transport and storage	- ve/t		- ve/t					
4.	Drilling, blasting and hill cutting	- ve/t		- ve/t	- ve/t	- ve/t			
5.	Earthwork						- ve/p	- ve/t	- ve/t
6.	Payment works	- ve/t	- ve/t	- ve/t	- ve/t			- ve/t	- ve/p
7.	Use of construction equipments	- ve/t	- ve/t	- ve/t		- ve/t			
8.	Plantation	- ve/p		- ve/p	- ve/p				
9.	Drainage work						- ve/p		
10.	Culvert and bridge construction		- ve/t	- ve/t			- ve/p		
11.	Stripping of top soil							- ve/p	
12.	Debris generation						- ve/t	- ve/t	
13.	Oil and grease							- ve/t	
14.	Construction in forest and sensitive areas	- ve/t	- ve/t	- ve/t	- ve/t	- ve/t	- ve/p	- ve/p	- ve/p

Notes: t – temporary, p – permanent. Impact indicated in bold letters indicates significant impacts.

190. Identification and assessment of the potential environmental impacts are based on secondary information supplemented by field visits. Impacts on various environmental components have been assessed at four different stages, namely:

- (i) the project location;
- (ii) design and pre-construction;
- (iii) construction; and
- (iv) operation stages.

191. A few permanent as well as short-term and long-term adverse effects, mainly at the construction and operation stages, are, nonetheless, anticipated. Temporary short-term impacts can be kept in check through proper planning and adopting environment friendly road construction methods and the appropriate regulatory measures.

B. Positive Environmental Impacts due to improvement of project road section

192. The positive impacts expected from the improvement of the project road section includes:

- (a) improved quality of life for the rural population in the projects influence area: this as a result of better access to markets, health, education and other facilities; and the derived stimulus for local economic activity;
- (b) a more efficient and safe road transport system: through reduced travel times, reduced road accidents, reduced vehicle operating and maintenance costs and reduced transportation costs for goods;
- (c) the facilitation of tourism;
- (d) Interstate connectivity to neighbouring districts; and
- (e) Better connectivity to the State Highway and National Highway network.

C. Adverse Environmental Impacts due to improvement of project road section

193. The adverse environmental impacts anticipated from the improvement of the project road section are:

- (a) Loss of productive soil and agriculture land,
- (b) A total of 12.900 ha. agriculture land and 11.67 ha. of forest land will be acquired for road widening purposes,
- (c) Cutting of about 1758 trees that falls within formation width i.e. 10m may reduce the ecological balance of the area and also increase soil erosion problem.
- (d) Noise, air and water pollution and disposal of construction waste, during construction, will adversely impact both local residents. These latter effects should, however, only be temporary/reversible.
- (e) A number of quarries and other sources will be established which will change the landscape. However, the operation of quarries is an independent and already regulated activity. Adverse impacts on water quality of rivers crossing or running parallel to the proposed alignments in the form of silt deposition and runoff during construction are expected. However, this is short term and will be taken care of by controlled construction activities.
- (f) Improvement on existing road and construction of new road and bridges, although limited, may enhance soil erosion, landslips and reduce the micro-level ecological balance of the area. Construction may also disturb the habitation of fauna living in this area. These should, however, be only temporary/reversible effects. The improvement will also require the cutting of about 1758 trees.
- (g) Noise and air quality for those now living and workings close to the subproject roads (mainly at urban centers) will deteriorate during the construction period and afterwards during operation.

D. Impacts Related to Project Location, Preliminary Planning and Design

1. Forest Clearing and Tree Felling

194. The project road is passing through plain terrain with main land use being agriculture and patches of forest area. The project road section length is passing through forest area. Hence, diversion of forest land is envisaged, adverse impacts are anticipated due to land clearing which will involve cutting of about 1758 trees. Construction in areas with agriculture crops will be planned to be carried out during the lean/post harvesting seasons to avoid damage to crops and losses to the local people. Hence, there will be no need Problem of soil erosion is expected in some locations. To minimize loss of trees, the following mitigation measures have been /been adopted during the detailed design and these will be implemented during construction stage of the subproject road:

- (a) Widening proposal considered option with minimal tree cutting.
- (b) Widening is restricted to minimum width in the length passing through forest areas.
- (c) Adequate measures are included in the design to minimize any unforeseen impacts on flora and fauna in the forest areas.
- (d) Land stabilization measures were included in identified areas prone to erosion.
- (e) Strictly enforce the environmental conditions put as part of the forest clearance and no objection certificates issued by the Forest Department and SPCB.
- (f) Adopting Environmental Friendly Road Construction (EFRC) methods such as proper planning, design, implementation, monitoring, controlled execution of activities, use of latest machineries and equipments, bio-engineering etc.

195. Based on the tree inventory carried out during the field surveys in year 2017-18, the total number of trees to be cleared along project road are 1758. The main species of trees to be cut are local species namely Mahua (*Madhuca Longifolia*), Pipal (*Ficus religiosa*), Jamun (*Syzygium Cumin*), Sarai (*Shorea robusta*), Chola (*Cicer arietinum*), Babool (*Acacia arabica*, Willd.), Aam (*Mangifera indica*), Sagon (*Tectona grandis Linn.*), Chirol (*Holoptelea integrifolia*), and Neem (*Azadirachta indica*). Table 34 present details of the trees to be affected due to proposed road improvement work. As per compensatory afforestation requirement, the tree plantation will be done ten times of tree cutting (1:10 of tree cutting). At sensitive locations such as schools and temples along the project roads suitable noise barrier shall need to be provided.

196. The compensatory plan will be developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done by plannting about 17580 i.e. ten times of tree cutting (1:10 of tree cutting) as detailed in Table 34.

Table 34: Detail of Trees to be impacted in corridor of impact

Subproject Road Section	No. of Trees to Cut	No. of Trees to be planted	Main Tree Species Local name (botanical name)
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Subproject Road Section	No. of Trees to Cut	No. of Trees to be planted	Main Tree Species Local name (botanical name)
Lambar-Bodesara-Birkol-Singhora Road	1758	17580	Mahua (<i>Madhuca Longifolia</i>), Pipal (<i>Ficus religiosa</i>), Jamun (<i>Syzygium Cumin</i>) Sarai (<i>Shorea robusta</i>) Chola (<i>Cicer arietinum</i>), Babool (<i>Acacia arabica</i> , Willd.) and Aam (<i>Mangifera indica</i>), Sagon (<i>Tectona grandis</i> Linn.), Mahua (<i>Bassia longifolia</i>), Babool (<i>Arabica nilotica</i>), Chola (<i>Cicer arietinum</i>), Chirol (<i>Holoptelea integrifolia</i>), and Neem (<i>Azadirachta indica</i>)

Source: Field Survey carried out by the Consultant Team, 2017-18

Note: The exact number of trees to be cut might vary from these figures. Joint inspection with forest range officers shall be carried out to estimate the number and type of trees to be cut by improvement proposals. In case of any change, numbers will be updated and accordingly compensatory plan be updated.

2. Construction Camps, Borrow Pits and Quarries

197. There is a need to establish construction camps and related facilities, such as borrow pits and quarries. These must be located in environmentally sound and socially safe areas. It is expected that construction materials for the road works will be mined mostly from approved quarries. The following criteria is applied for locating the borrow areas:

- (a) Borrow areas are not established in ecologically sensitive areas;
- (b) Villagers are consulted in regard to the design and location of all borrow areas – these should ensure the safety of local communities and, if possible, should incorporate beneficial post construction features for the villages;
- (c) Located away from the road and hill slopes as well as settlements facing the road, so as to minimise visual impacts;
- (d) In case of protected areas/ reserve forest areas, construction facilities such as temporary workers camp, hot mix plants, and concrete batching plant and stone crushers should not be established in stretches that passes through reserve / protected forests. Local forest department / village forest management committees should be consulted before locating these temporary subproject facilities;
- (e) Construction camps for labourers should be located at least 500 m away from settlements and 1 km away from forest/protected areas;
- (f) Living accommodation and ancillary facilities should be erected and maintained to standards and scales approved by the Engineer-in-Charge; and
- (g) Toilets and urinals should be provided in accessible places away from the asphalt plant and mixing yard.

3. Cultural Heritage

198. There are no adverse impacts anticipated on historical places/monuments. However, there are few temples and small shrines along the road. Care must be taken to avoid any

damage to these structures. Earthworks, as associated with the road construction/improvement works, or deriving from secondary sites such as quarries or borrow pits, may reveal sites or artifacts of cultural/archaeological significance. In the event of such discovery, the concerned authorities should be informed and the requirement to take such action should be incorporated in contract documents.

4. Other Impacts deriving from the Project Planning and Design Process

199. During preliminary planning and design of the project road, the Consultant has taken into account the need for:

- optimum siting and control of borrow areas;
- reduced incidence of slope failures due to inadequate drainage;
- providing adequate culverts/drains;
- providing side-drainage structures;
- mechanised construction methods and thereby, for example, reduced use of firewood for heating bitumen;
- maximising safety and thereby reducing traffic accidents;
- reducing travel times and, thereby, fuel consumption and emissions;
- adequate signages for wildlife protections,
- increased accessibility for residents to education and health facilities, markets etc., and for others who might come for tourist or other purposes; and
- improving the socio-economic conditions of residents in the project areas of influence.

200. As part of the engineering works for this work, the following guiding principles have been used in determining the alignments:

Table 35: Measures for environmental issues mitigation

Environmental Issue	Measures taken
Alignment	Final alignment has been determined so as to minimise land take, tree removal, air pollution and the impact on people and animals and to avoid unfavourable geological condition and cultural relics.
Balancing cut and fill	The design attempted to equalise cut and fill. The centreline has been aligned so that on all slopes below 60 degrees, half cut and half fill is achieved.
Soil erosion	Temporary and permanent drainage systems have been designed to minimise the soil erosion.
Dust and air pollution	Borrow sites, waste disposal sites and asphalt mixing sites have been identified – keeping in mind environmental issues such as dust.
Cultural heritage	Any archaeological sites identified along the alignment should be excavated prior to construction.
Wildlife Habitat	Care has been taken in preservation of wildlife and construction workers should be educated on wildlife protection.

E. Environmental Impacts - Construction Stage

1. Permits and Clearances

201. As a requirement of Environmental Impact Assessment Notification, 2006, by Government of India, any development activities should not be taken in any part of the Country unless it has granted environmental clearance by the Ministry of Environment and Forests, Government of India.

202. Highways are classified as one of the project, listed in said notification, which require prior clearance. However, an amendment to this notification clarifies, that the highway improvement projects are excluded from purview of this notification. Also major district roads are not required to comply with the Environmental Protection Act and Rules 1986 and the EIA notification (2006, 2009, 2011) and relevant amendments. Hence, the roads under this sector project are not required to obtain environmental clearances and prepare environmental assessment reports under national laws. Some of the relevant applicable sections are:

- (i) Since the proposed project interventions are primarily limited to the improvement of existing major district road and the alignments of the project road does not pass through any environmentally sensitive areas, therefore it does not falls under the purview of Notification no. S.O. 195(E) dated 19 January 2009 by the Ministry of Environment and Forests on amendment to the EIA Notification. Also major district roads are not required to comply with the Environmental Protection Act and Rules 1986 and the EIA notification (2006, 2009, 2011) and relevant amendments. Hence, the roads under project are not required to obtain environmental clearances and prepare environmental assessment reports under national laws.
- (ii) As per the Forest Conservation Rules (1981, amended 2003) a forestry clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process. Since, the improvement of the proposed project is restricted to the available ROW with minimum additional land requirement in forest area, diversion of forest land is required. Therefore, forest clearance is required for proposed subproject.
- (iii) Cutting of trees in non forest land require a tree cutting permit from the local forestry department. All trees cut under a project must be compensated by compensatory afforestation as required by the Forest Department.
- (iv) As per Office Memorandum (OM) issued by MOEF on 19 March 2013 the grant of environmental clearance for linear projects including roads has been delinked from the forestry clearance procedure. Hence, after receipt of environmental clearance construction works may commence on sections/parts of a linear project that do not require forestry clearance. Construction works may commence on sections requiring forestry clearance only after receipt of the respective clearance.
- (v) Placement of hot-mix plants, quarrying and crushers, batch mixing plants, discharge of sewage from construction camps requires No Objection Certificate (Consent to Establish and Consent to Operate) from State Pollution Control

Board prior to establishment.

- (vi) Permission from Central Ground Water Authority is required for extracting ground water for construction purposes, from areas declared as critical or semi critical from ground water potential prospective by them.

203. Before the start of civil works for any section of subproject the project proponent (State PWD, PIU-ADB Project) must obtain necessary clearances / permits from the forest department and Chhattisgrah State Pollution Control Board. Table 36 outlines the applicable clearances and permits and the authorised bodies that issue them along with the procedures involved. The status of the permits / clearances has also been presented in this table.

Table 36: Clearances and Permits Required for the Subprojects

S. No.	Permissions/ Clearances	Concerned Agency	Responsibility / time required
A. Pre-construction Stage			
1	Permission for cutting of trees	District Forest Office/ State Forest Department for trees felling in forest areas and District Authorities in non-forests Areas (Compensatory tree plantation to be made 1:10 as per the permission granted)	PWD, PIU-ADB project / 3-6 months
2	Forest Clearance	State Forest Department for additional land required for road widening in forest area (Forest land diversion for non-forest uses)	PWD, PMU-ADB project / 3-6 months
B. Implementation Stage			
3	Consent to operate hot mix plant, Crushers, Batching plant	Chhattisgrah State Pollution Control Board (To be obtained before installation)	Contractor / 3-6 months
4	Authorization for Disposal of hazardous waste	Chhattisgrah State Pollution Control Board (To be obtained before generation)	Contractor / 3-6 months
5	Consent for Disposal of sewage from labor camps	Chhattisgrah State Pollution Control Board	Contractor / 3-6 months
6	Pollution Under Control Certificate	Department of Transport, Government of Chhattisgrah authorized testing centers	Contractor / 1-2 month
7	Employing Labour/Workers	District Labour Commissioner	Contractor / 1-2 month

204. Any felling of trees requires forestry clearance and appropriate permits. The procedures necessary to obtain such permits will require liaison with local territorial forestry offices and their head office in district headquarters. Joint verification and making of trees to be cut is being carried out jointly with divisional forest departments of districts involved. No clearance is required for the use of surface sand and stone from the river banks as for commercial purposes they can only be purchased in an open auction carried out by the forestry office. It is imperative that all necessary clearances and permits be obtained before commencement of work.

2. Physical Environment

a. Topography, Geology and Soil

205. During the improvement works for the road section, the cutting of hill slope, filling, the cutting of trees, stone quarrying, and construction of structures, the micro-level topography may change. With proper planning, these topographical impacts can be kept within acceptable limits and sometimes even used to enhance local aesthetics. Any negative impacts on topography (existing), particularly soil erosion due to a lack of drainage facilities, will be minimized with the provision of proper drainage facilities such as culverts, causeways etc.

206. The terrain and geological conditions of areas are such that, even with reasonable care exercised during final design, during construction the interaction between proposed road features and existing land features may reveal/result in some land instabilities.

207. During the construction phase following restrictions should be imposed:

- existing vegetation including shrubs and grasses along the roads (except within the strip directly under embankments or cuttings) should be properly maintained;
- sites for quarrying, borrowing and disposal of spoils are to be confirmed according to the applicable laws and regulations in the state and the practices followed in recent/ongoing internationally funded road projects should be continued;
- controlled and environmentally friendly quarrying techniques should be applied to minimise erosions; and
- cut material should be disposed of in suitable depressions.

208. It is also important to:

- maintain adequate vegetative cover above and below the roads;
- maintain the natural course of water bodies (that is as far as possible) and avoid throwing debris into stream courses;
- construct proper drainage structures to avoid erosion; and
- minimise the construction of hair-pin bends that are close to each other: as this often adds to instability.

b. Erosion and Silt Run-Off

209. All activities will occur within the available RoW with minimum additional land acquisition, no adverse environmental impact is anticipated on the productive soil. Land taken on lease for access road and for construction camp will be restored its original land use.

210. Land clearing and grubbing activities will remove vegetation and soil cover which may cause some soil erosion during monsoon. Excavations in borrow pits may lead to loss of top soil and soil erosion. There are risks of stream and river bank erosion near bridges and cross drainage works. To avoid or minimize erosion, land clearing and grubbing will be conducted during dry season, productive top soils from borrow pits will be stored and reused in road embankment slope protection. Erosion control measures like silt screens will be installed along rivers and nallahs (small local streams).

211. There is the risk of contamination of soil from construction material and oil spills. Contractors are required to ensure proper handling materials and able to implement spills containment. Oil contaminated waste will be properly collected, stored disposed through 3rd party service providers. Third party service providers are authorized vendors from State Pollution Control Board for collection, transfer, store and disposal of hazardous waste. All fuel and lubricant storage and handling areas will be located at least 500 meters from the nearest water body and provided with perimeter interceptor drains. All construction debris will be disposed by the Contractor on predesignated area as identified by the CSC-Environmental Specialist.

c. Climate

212. The proposed improvement/construction works will be localised activities and the subproject will not have significant impact on climatic conditions, such as rainfall, temperature and humidity in the project area. A climate change impact and risk analysis has been carried out using TEEMP model (Chapter 6: Climate Change Impact and Risks) and appropriate adaptation measures are incorporated in the subproject design.

d. Surface and Ground Water, Drainage and Hydrology

213. Given the presence of rivers, streams and small ponds in the subproject area and some of them crossing and /or running parallel to subproject road; improvement of road may result in disruptions to the natural hydrology and water mismanagement and lead to further problems of soil erosion.

214. The natural courses of rivers/streams will be maintained. Appropriate temporary diversions of streams will be made and brought back to their natural course as soon works are completed in that section. No disposal of construction debris in streams and rivers is allowed. Community ponds located close to alignment will be enhanced by providing stone pitching and platforms for community usage.

215. Minor impacts on water resources are expected during the construction phase. The rehabilitation of existing bridges may also cause soil erosion and turbidity in downstream water bodies. To mitigate this, river-bank slope stabilities will be monitored and, if necessary, appropriate remedial measures applied throughout the construction period. Construction work at bridges during rainy season will be minimized to avoid erosion and sedimentation.

216. The likely impacts of surface water movements are changes in the natural drainage systems, downstream scour, and erosion due to constriction in flows. If suspended solid concentrations in the water are affected, this could also affect aquatic river ecology. However since there are no perennial water bodies across the project. The work will be carried out in dry seasons. Hence, impacts on river ecology will be negligible.

217. To mitigate these impacts the following measures should be implemented:

- chemicals and oils are stored in secure, impermeable containers, and disposed of well away from surface waters;
- no vehicle cleaning activity is allowed within 300 m of water bodies/ drains;
- construction camps are equipped with sanitary latrines that do not pollute surface waters;

- the work on bridges and culverts is limited to dry seasons, when many of the smaller streams will have low water - water diversion works can be minimised and the original course restored immediately after the work has been completed;
- drivers are made aware of diversions and other works at bridge construction site to avoid accidents;
- drainage structures are properly designed to accommodate forecast discharges;
- side drain waters must be discharged at every available stream crossing to minimize volume and prevent erosion at discharge point;
- provide lined drainage structures;
- where an increased discharge of surface water endangers the stability of the water outlet, erosion protection measures such as bioengineering measures, ripraps, and check dams are incorporated;
- in areas with high water tables, seepage may occur and side drains and up-slope catch drains must always been lined to avoid percolation; and
- all debris and vegetation, clogging culverts are regularly cleared.

218. Impacts on ground water quality will be limited to campsite area in the subproject road. These impacts can be mitigated with provisions of septic tanks for sewerage generated from construction camp.

e. Air Quality

219. During construction air quality may be degraded for short periods due to (i) the exhaust emissions from the operation of construction machinery; (ii) fugitive emissions from concrete and asphalt plants; (iii) the dust generated from the haulage of materials, exposed soils and material stockpiles; (iv) cleaning of the road; (v) material loading; (vi) unloading; and (vii) blasting activities (if any). The impact is expected to be localised, temporary and confined to construction areas.

220. Adverse air quality impacts during construction are likely to result from three main sources; (i) emissions from construction equipment, including delivery trucks; (ii) fugitive dust from earth-moving operations and demolition; and (iii) localised increased traffic congestion in construction areas.

221. The adverse impacts on air quality during construction stage were classified and presented in Table 37. There are two types of pollution i.e. dust pollution and pollution from harmful gases.

Table 37: Impact on Air Quality during Construction Stage

Sl. No.	Impact	Source
1.	Generation of Dust (SPM)	<ul style="list-style-type: none"> • Transportation and tipping of cut material - while the former will occur over the entire stretch between the cutting location and disposal site, the latter is more location specific and more intense; • Blasting operations; • Transportation of raw materials from quarries and borrow sites; • Stone crushing, handling and storage of aggregates in asphalt plants; • Site levelling, clearing of trees, laying of asphalt, construction of bridges;

Sl. No.	Impact	Source
		<ul style="list-style-type: none"> Concrete batching plants; Asphalt mix plants – due to the mixing of aggregates with bitumen; and Construction of structures and allied activities.
2.	Generation of polluting gases including SO ₂ , NO _x and HC	<ul style="list-style-type: none"> Hot mix plants; Large construction equipment, trucks and asphalt producing and paving equipment; The movement of heavy machinery, oil tankers etc. on steep slopes will cause much higher emissions of gases; Toxic gases released through the heating process during bitumen production; and Inadequate vehicle maintenance and the use of adulterated fuel in vehicles.

222. On the proposed subproject road section, it is expected that air quality will be affected to some minor extent by dust and particulate matters generated by construction, vehicular movements, site clearance, earth filling and material loading and unloading. The impacts are expected to be localised, temporary and confined to construction areas. Care should, however, be taken at sensitive urban locations so that harmful impacts can be minimised.

f. Noise Levels

223. The ambient noise level along the project road section is within standards. During the construction period, noise will be generated from the operation of heavy machinery, blasting works, the haulage of construction materials to the construction yard and the general activities at the yard itself. Concrete mixing and material movements will be the primary noise generating activities and will be uniformly distributed over the entire construction period. These construction activities are expected to produce noise levels in the range of 80-95 dB(A) at a distance of about 5 m from the source.

224. Construction noise is not normally regulated, though still may cause concern among local villagers. The range of typical noise levels in relation to distance from a construction site is shown in Table 38.

Table 38: Construction Noise / Distance Relationship

Distance from construction site (m)	Range of Typical Noise Level dB(A)
8	82 – 102
15	75 – 95
30	69 – 89
61	63 – 83
91	59 – 79
122	57 – 77
152	55 – 75

Distance from construction site (m)	Range of Typical Noise Level dB(A)
305	49 - 69

Source: Department of Transportation, State of Wisconsin (USA)

225. Piling, if necessary, will also cause vibration. Noise and vibration from this source will be unavoidable but the impact will only be temporary and affect people living or working near piling locations. In construction sites within 500 metres of a settlement, noisy operations should cease between 22:00 and 06:00 hrs. Regular maintenance of construction vehicles and machinery must also be undertaken to reduce noise. The impact and sources of noise and vibration are summarised in Table 39.

Table 39: Likely Impact on Noise Quality in the Vicinity of Project Area

Impact	Source
Increased noise levels causing discomfort to local residents, workers and local fauna	<ul style="list-style-type: none"> • Mobilisation of heavy construction machinery; • Accelerations/ decelerations/ gear changes – though the extent of impact will depend on the level of congestion and smoothness of the road surface; • Excavation work for foundations and grading; • Construction of structures and other facilities; • Crushing plants, asphalt production plants; and loading, transportation and unloading of construction materials.

226. Typical noise levels associated with various construction activities and equipments are presented in Table 40.

**Table 40: Typical noise levels of principal construction equipments
(Noise Level in db (A) at 50 Feet)**

Clearing		Structure Construction	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation and Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84

Clearing		Structure Construction	
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading and Compaction		Landscaping and clean-up	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
Paving		Front and end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94
Source: U.S. Environmental Protection Agency, noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. 300.1.December 31, 1971			

227. The noise levels indicated for various construction activities/equipment, while far exceeding permissible standards of CPCB and WB EHS for residential areas, it will occur only intermittently. Still, these extremely high sound levels present real risk to the health of workers on- site. Timely scheduling of construction activities, proper maintenance of construction machineries, use of personnel protective equipments etc. will minimize these impacts.

228. Residences, schools, temples, and other noise sensitive areas within 100 m the roadways will be affected temporarily during construction. The number of persons potentially affected and the duration of these effects cannot be estimated based on available information.

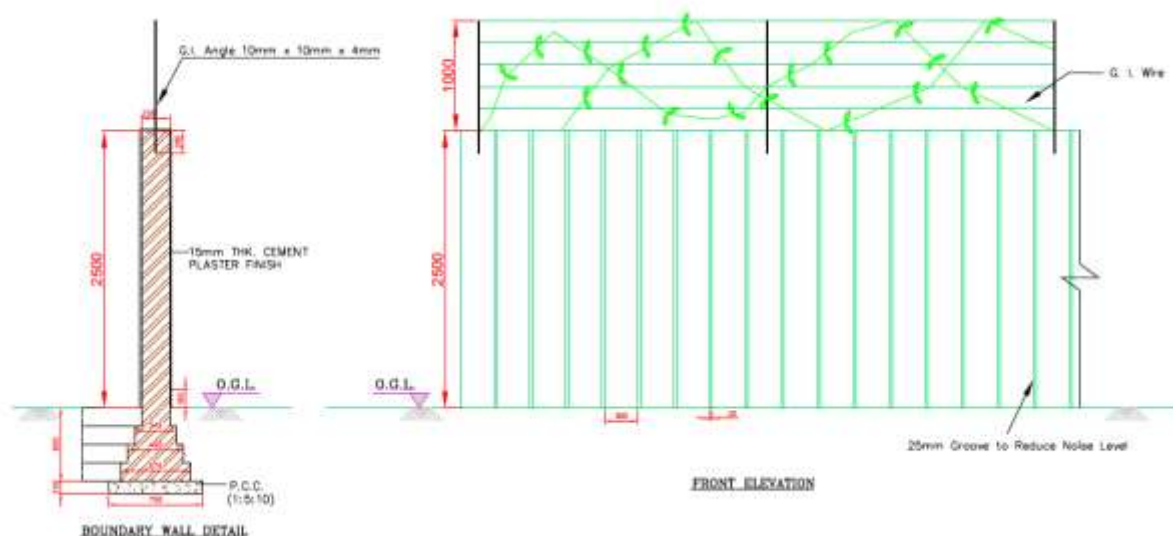
229. During construction, varying degree of noise impacts are likely to be felt by the communities of main settlements along the project roads. Although temporary in nature, the construction noise will affect the most communities living close to the construction zone.

230. Noise impacts are an unavoidable consequence of construction that should be mitigated by limiting the timing of construction to daylight hours (8am-5pm) in the vicinity of sensitive receptors. Further to minimize noise impacts near sensitive receptors (particularly schools), operation of excavator and other heavy machineries will be carried out mostly during off-hours (7 am to 9 am and 3.30 pm to 7 pm) and on holidays (Saturday and Sundays). Baseline noise will be established for all sensitive areas prior to construction and follow up noise monitoring will be carried out during the construction.

231. It is proposed that suitable noise barriers will be installed at selected sensitive receptor locations along the subproject road. The Noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. To effectively reduce sound transmission through the barrier, the material chosen must be rigid and sufficiently dense (at least 20 kilograms/square meter). All noise barrier material types are equally effective, acoustically, if they have this density. To effectively reduce the noise coming around its ends,

a barrier should be at least eight times as long as the distance from the home or receiver to the barrier. A provision of five Noise barrier locations in each corridor is made which should be provided based on the willingness of the school/temple or religious structures authorities and technical feasibility. Conceptual drawing of the noise barrier is provided in Figure 8 below. Environmental Specialist of supervision consultant will prepare site specific design of the noise barriers and will provide it to the Contractor.

Figure 8: Conceptual Drawing of the Noise Barrier



232. Although the measures noise levels over the project duration is well within WB EHS standards; implementation of suitable mitigation measures will reduce the construction noise to acceptable limits. Mitigation measures should include:

- Installations of noise barriers;
- construction machinery should be located away from settlements;
- careful planning of machinery operation and the scheduling of such operations;
- controlled blasting should only be carried out with prior approval from the Engineer in charge;
- contractors should be required to fit noise shields on construction machinery and to provide earplugs to the operators of heavy machines; and
- only controlled blasting should be conducted.

233. Trees will be planted along the roads to act as natural barrier to noise. Further, physical noise barriers have been provided in the subproject design at sensitive locations. These physical noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. To effectively reduce sound transmission through the barrier, the material chosen must be rigid and sufficiently dense (at least 20 kilograms/square meter). To effectively reduce the noise coming around its ends, a barrier should be at least eight times as long as the distance from the home or receiver to the barrier.

g. Topography and Appearance

234. Construction activities of the subproject road will bring permanent changes in the local-level topography and appearance of the project sites. There will be loss in aesthetic

beauty of the project areas mainly due to the earthwork. Table 41 elaborates potential effects on the topography and appearance and appropriate mitigation measures.

Table 41: Potential Effects on Topography by the Proposed Road Sections Upgrading

Sl. No.	Construction activity	Potential effect on topography and appearance	Mitigation
1.	Clearing of vegetation for widening of the road	Scarring of landscape from cutting and potential erosion(short term and long term) may be caused. There may be minor permanent changes in the landscape.	Cut material should be used to widen the road or disposed off at proper disposal sites. Cut slopes should be re-vegetated immediately after widening activities.
2.	Stone quarrying	Scarring of landscape and potential landslides (rock slides/falls). There may be permanent changes in the landscape.	Stone quarrying should only be undertaken in legally approved areas. Controlled and environmental friendly quarrying should be carried out to minimise landslides and erosion.
3.	Earthwork from borrow areas	Scarring of landscape due to unearthing activities. Minor but permanent changes in landscape.	Borrow areas should be in legally approved locations. As soon as construction activities are complete, they should be re-vegetated and brought back as far as possible to their previous appearance.
4	Waste disposal	Disposal of cut soils and debris at improper locations which will make the area look untidy and unattractive.	Cut off material should be used to widen the road or disposed of at proper disposal sites.
5	Establishment of labour camps	Disposal of waste and litter at improper locations and deforestation for fire-wood will make the area look dirty and unattractive.	Provision and allocation of proper waste disposal bins and sites are required. A supply of cooking gas should be provided by the contractor to eliminate the use of fire wood.

3. Ecological Resources

3.1 Wildlife

235. The proposed road alignment does not located inside or fall within a 10 kilometer distance from a legally protected or key biodiversity area which was identified as the corridor of impact.

236. The impacts of road building to wildlife includes direct and indirect mortality; destroying, degrading, and fragmenting habitat; serves as barriers to movement; and spurs domino effect brought by a change in land-use. Small animals that often disperse, large

animals like ungulates and carnivores are at risk to road kills during project operation. Since improvement will be carried out on existing roads wildlife habitat fragmentation is not expected. However construction work in forest areas may cause temporary disruption of wildlife movements in the project areas.

237. To avoid impacts to wildlife the following measures will be implemented:

- Bridge design including approaches will take into account wildlife movements along riparian corridors,
- Where smaller animals are known to disperse, road design will consider the construction of faunal culvert or pipe crossing
- Where endangered and critically endangered bird species are known take territories along the road, strict noise control will be implemented particularly during construction period to avoid disturbance
- Information and cautionary roadside signages will be installed to warn drivers of impending sensitive areas.

3.2 Vegetation

238. Removal of the existing vegetative cover and the uprooting of approx.1758 trees is an unfortunate activity, which will reduce the ecological balance in the areas. This will also enhance soil erosion. Scrub forests and vegetation will also be removed for improvement of subproject road sections. The loss of vegetative cover will mostly be permanent and only some might be revived through mitigation efforts. Another impact from road construction activities and deriving from the quarrying, preparation and transfer of stone chips and other earthwork; is the accumulation of dust on the surrounding vegetation. This leads to deterioration of the vegetative health, which in turn will affect the ecology as well as the aesthetic beauty of the area. Induced impacts may result from the following:

- increased forest harvesting for fire-wood, construction timber, forage, medicinal plants and other products;
- increased earth and rock extraction;
- construction crew demands for wood as a fuel and for building materials;
- construction crew demands for food and recreational hunting and fishing;

239. To minimise negative impacts on the vegetative cover the contract documents should specify that:

- all wood building material for workers' housing should be brought from outside the project area;
- workers should be supplied with non-wood fuels such as kerosene or liquefied petroleum gas for the duration of the contract;
- all contract equipment and plants should be cleaned to the satisfaction of the project engineer in charge prior to their relocation to project sites;
- during site clearance, care should be taken to ensure that the minimum area of vegetation area is affected; and
- water sprinkling of trucks used as construction vehicles should be properly and regularly undertaken, so that dust deposition problem on vegetation are minimised.

4. Human Use Values

240. Field reconnaissance surveys of the project road was conducted to assess the environmental and social conditions. It was noted that since the proposed improvements will be carried out within available road width except a few stretches, relocation of structures will not be required. The widening options have been devised to avoid impacts of structures.

241. At certain locations on the roads, particularly at bridge /culvert sites, traffic will be temporarily diverted from the existing carriageway while construction is in progress and temporary traffic diversions will be managed within the ROW. In other instances, traffic may have to be diverted across adjacent private land, in which case compensation will be paid for any loss of crops or the replacement of damaged structures. In other situations, most frequently not at bridge sites, for example when bitumen surfacing is in progress, it may be required to close the road temporarily. In these circumstances, adequate radio and press releases should be made beforehand and a date/time given for the re-opening.

242. Most construction will be undertaken during the dry season when few crops are planted. Losses should be minimised during construction.

5. Sensitive Location Such as School, College and Hospital along the Project Road

243. The sensitive location such as school, college and hospital along subproject road within 100 meter from the edge of the existing road has been identified as given Table 32.

244. These sensitive structures are kept unaffected by the proposed improvement proposals. Short term impacts during the construction stage are expected. Measures such as timely scheduling of construction activities in these areas, provision of sign boards, appropriate noise barriers such as planting trees and / or raised boundary walls are adopted to minimize impacts.

6. Health, Safety and Hygiene for Construction Workers

245. Construction of the subproject road sections will result in the generation of waste. In isolated places, the amount of waste generated may be greater than normal because of substandard subsoil materials, which will need to be replaced.

246. The Contractor will be required to control the construction sites, keep it clean and provide facilities such as dust bins and collectors for the temporary storage of all waste. This waste should be adequately stored to avoid pollution of water supplies and water sources and to avoid dust formation. The Contractor will be responsible for the safe removal and/or storage of all waste in order to prevent environmental pollution of any type that may be harmful to people or animals.

247. All necessary safeguards should be taken to ensure the safety, welfare and good health of all persons entitled to be on the sites and to ensure that works are carried out in a safe and efficient manner. All personnel working at vulnerable site locations will wear safety helmets and strong footwear. It should be ensured that all workmen and staff employed on site use proper safety equipment – for example, eye protectors, ear plugs, safety helmets, the designated safety equipment when working over water - and that proper rescue equipment is available. Fire extinguishers and first-aid equipment will be kept at all sites.

248. The construction camps are anticipated to house up to 200 people for about two years. With this concentration of people, the potential for the transmission of diseases and illnesses will increase. The main health and safety risks during construction will arise from:

- inadequate sanitation facilities in worker camps;
- introduction of sexually transmitted, and other diseases, by immigrant workers; and
- outbreaks of malaria, typhoid, cholera etc. amongst the labour force.

249. The following actions will be undertaken at construction camps and stipulated in construction contracts:

- submit and obtain approval for a health and safety plan prior to the commencement of work;
- provision of adequate health care facilities; and
- workers will be required to undergo pre-employment medical screening and treatment (if required) and periodic health checks thereafter.

250. The subprojects will support a public health education programme for workers and villagers covering road safety, malaria, hygiene, and sexually transmitted diseases. The district health departments will also be invited to participate in monitoring and educating communities and workers affected by the project.

7. Nuisance to Nearby Properties

251. Nuisance to nearby properties is likely to result from:

- noise and vibration from mechanical devices and construction plant;
- dust during quarrying, construction and the trafficking of new surfaces prior to sealing;
- gaseous emissions from heavy equipment; and
- fumes from asphalt boiling sites.

252. Much of the subproject road sections are existing roads in plain terrains and presently air/dust pollution is not a major issue. Nonetheless, there will be regular watering of the road surfaces or the application of emulsion coats near villages, where dust is a nuisance. Noise generating equipment such as power generators and concrete mixers will be kept away from populated/commercial areas. Provisions will be incorporated into the contractor's contract to require the use of dust suppression measures.

8. Interference with Utilities and Traffic

253. On the subproject roads, utilities interfere with the ROW at few locations that will have to be shifted / removed prior to construction. This should not be a major problem.

254. Traffic may experience minor delays when diverted around active construction areas, but will be more severely hampered at the locations where temporary road closures are necessary. Such hazard points will have proper signs indicating the nature of the problem envisaged.

255. Contractor will ensure that information on the timing of construction works and notifications of road closure (if any) is provided via the local media (radio, TV, newspaper etc.) or through the local community heads.

9. Community Impacts

256. Construction camps may put stress on local resources and the infrastructure in nearby communities resulting to people raising grievances. This sometimes leads to aggression between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment. The use of local labourers during the construction will be promoted to minimise these problems.

10. Quality of Life

257. The impact of the improvements of subproject roads on the socio-economic environment will be significantly beneficial. Improved access and reduced travel time and cost will be major stimuli to economic growth, particularly in rural areas. Better access of agricultural goods to market will be important and a major contributor to poverty reduction.

258. Increased labour mobility will occur. This has both positive and negative impacts. Increased access is a two-way phenomenon, and the corollary to increased access to the project areas is increased access for the residents of these areas to more urban life-styles. Out-migration may result. There is also the likelihood of the relocation of homes and businesses to new road-side locations.

259. During construction, benefits to local people can be maximised if the contractor recruits construction workers locally regardless of gender. Where possible, he/she should also not discriminate in the employment of women.

11. Construction Materials

260. Adequate earth material is available from barren land in the vicinity. Estimated quantity for the road section is about 3,00,000 cum Aggregates (6,60,000 MT) will be mostly sourced from licensed quarries available locally. Sand 150,000 cum will be taken from river beds after prior permission from competent authority.

261. Construction water requirement (avg. 250KLD and peak 300 KLD for the road section) will be met through local rivers and other local streams. Domestic water requirement (50 KLD) for workers will also be met mainly through local streams. If needed, groundwater may also be abstracted.

262. Road maintenance, repair and new construction will continue to cause large demands for construction materials. There is a clear need for a better materials supply policy in each district to minimise environmental impacts of small-scale, poorly managed operations and improve the quality and reliability of supply. In some districts, it may be appropriate to develop centralised quarries, if an operator can be attracted. In any case, pre-designation of sources would give contractors a level playing field for bidding and minimise incentives for environmentally damaging cost cutting.

263. The engineering team as part of material survey has identified and recommended sources of the construction materials. Details are these sources are provided in Main Volume 1 (Material survey chapter) of Detailed Project Report. As a prior requirement of subproject, every new quarry and borrow area should also be subjected to a site specific environmental

investigation work according to an approved plan; and should be left in a safe condition or restored to a productive land use. Subject to these conditions, obtaining construction materials for subprojects will not cause unacceptable impacts.

264. Quarry and borrow pits may be filled with rejected construction waste and afterwards should be given a vegetative cover. If this is not possible, then the excavated slopes will be filled in such a way that they resemble an original ground surface.

265. Mitigation for Quarries

- aggregates will be first sourced from licensed quarry sites (which are in operation) that comply with environmental and other applicable regulations;
- occupational safety procedures/practices for the work force will be adhered to in all quarries;
- quarry and crushing units will be provided with adequate dust suppression measures; and
- regular monitoring of the quarries by concerned authorities to ensure compliance with environmental management and monitoring measures.

266. Mitigation of Borrow Areas

- prior approval will be obtained from concerned authorities and all local environmental regulations be complied with;
- within all identified borrow areas, the actual extent of area to be excavated will be demarcated with signs and access to the operational area controlled;
- borrow pit plant and machinery will conform to CPCB and World Bank EHS noise emission regulations;
- protective gear will be provided to the workforce exposed to noise levels beyond threshold limits and there should be proper rotation of such personnel; and
- all operation areas will be water sprinkled to control dust levels to national ambient air quality standards.

267. The subproject will require large amounts of bitumen or bitumen emulsion usually stored in drums. These empty bitumen drums are generally recycled as steel sheeting, or used in road construction as parapets or for river bank stabilisation. When supplied and used in this manner, bitumen is not regarded as a significant environmental hazard.

268. The subproject will require the import, transport and use of fuel and oils. Minor diesel spills are common in region, especially around fuel stations. To mitigate these impacts following measures will be applied.

- Secondary containment around fuel tanks and at fuelling stations will be built;
- Oil and fuel spills, and other runoff from contaminated areas will be controlled; and
- Equipment and fuel depots will be placed in safe zones away from drinking water sources and along river banks.

269. The subproject provides an opportunity to assist the PIU and contractors in improving fuel handling practices so as to minimise future fuel spillage.

F. Environmental Impacts - Operation Phase

1. Noise Vibration, Air Pollution, Runoff, Spoils of Hazardous Materials

270. The current low traffic flows along the subproject roads is expected to increase because of improved economic activities associated with better access. The larger numbers of vehicles will be an additional source of noise and gaseous emissions.

271. An incremental increase of about 3 to 5 dB(A) noise level is expected due to increased traffic over the designed life of the project i.e. 20 years. Most of these increase in noise level will be attenuated by natural means i.e. distance from source, obstacles from nearby and surrounding building and structures, difference in levels of vehicle and receptor as well as installation of recommended mitigation measures such as installation of noise barriers at sensitive location, planning of trees etc.

272. Repairs to culverts and new drainage work will eliminate/reduce the soil erosion problems presently caused by poor cross drainage. Also, the situation will remain good because these roads pass through area that are largely vegetated and plants have the capacity to absorb gaseous as well as noise pollutants. Bioengineering techniques (such as turgid of slopes through rough grassing, tree plantation along the slopes etc.) may also help to absorb pollution.

273. Since the subproject roads are mostly passing through plain terrain and works will not include blasting of rocks (which is mainly requires in hilly terrains), therefore possibilities of Acid Rock Drainage (ARD) are very remote. ARD causes mainly due to leaching of sulphur containing materials from rocks that become exposed to atmospheric oxygen by blasting work.

2. Air Quality Modelling and Prediction of Impacts

274. To assess the likely concentrations at the critical location along the subproject road corridors, the prediction of the pollutant concentrations has been carried out for a subproject using CALINE-4, a dispersion model based on Gaussian Equation. Considering the current and projected traffic volume Tikrapara-Sejbahar-Semara-Bhakhara-Dhamtari Road (which has highest traffic among selected subprojects) has been selected for prediction of air quality. The input data and details are provided in Appendix -14. The result for the prediction are detailed in subsequent paragraphs.

275. **Results:** For One-hour simulations, the concentrations were estimated at three receptors to obtain an optimum description of variations in concentrations over the distance of 30m, 50m & 100m downwind from the centerline for the worst angles as identified by the model. The nearest receptor was considered to be at 30m from the centerline of the proposed alignment of the subproject road. Air modeling results are presented in Table-42.

Table 42: Air Modeling Results (Predicted Conc. of CO)

Predicted Maximum 1-hour Concentration of CO (ppm)					
Receptor Distance from Center Line	2017	2022	2027	2032	2037
at 30 m	0.1	0.2	0.2	0.3	0.4
at 50 m	0.1	0.1	0.2	0.2	0.3
at 100 m	0.1	0.1	0.1	0.2	0.2

Predicted Maximum 1-hour Concentration of CO ($\mu\text{g}/\text{m}^3$)					
at 30 m	115	229	229	344	458
at 50 m	115	115	229	229	344
at 100 m	115	115	115	229	229

276. The predicted 1hr maximum concentration of CO after construction of the subproject road is found to be within $4000 \mu\text{g}/\text{m}^3$ prescribed in National Ambient Air Quality Standards, 2009 for residential, rural and other areas.

277. Table 43 describes the average baseline concentration (24 hour average) of $\text{PM}_{2.5}$ and PM_{10} monitored during selected period at different locations around the proposed subproject road.

Table 43: Baseline pollutant concentration ($\mu\text{g}/\text{m}^3$) at different locations

Location Name	PM_{10}	$\text{PM}_{2.5}$
Siddharth Chowk	95	54
Bhenger Bhata Chowk	84	47
Sihad mod	64	38
Arjuni Chowk	76	42

278. It has been observed from the model output that when the traffic volume increases, the concentration of air pollutants also increases correspondingly. The maximum predicted pollutant concentrations of CO, and PM_{10} over the existing ambient air quality are found to be within the National Ambient Air Quality Standards (Appendix 3) as well as IFC (World Bank EHS Guidelines). Also the predicted concentration of maximum concentration of CO after construction of the subproject road is found to be within $4000 \mu\text{g}/\text{m}^3$ prescribed in National Ambient Air Quality Standards, 2009 for residential, rural and other areas.

3. Land Use and Settlements

279. The likely impacts on land use and settlement patterns are limited. Improved access will lead to increased migration, but this will occur gradually and over a prolonged period. There will be time for new residential areas to be established. There will be a need to control ribbon development.

4. Social Impacts

280. Specific benefits to local people will include:

- easier communication;
- easier access to markets (both internally and regionally) with savings in travel times and costs;
- enhanced market efficiency through better distribution and accelerated deliveries etc.;
- improved access to health, education and other social services;
- employment generation;

- improved technical skills; and
- enhanced economic activity.

281. Likely adverse social impacts will include:

- increased chances of exposure to communicable diseases, particularly during construction;
- influxes of new settlers leading to increased pressure on natural resources causing hardship to local communities relying on local/forest resources; and
- rural-to-urban migration causing labour shortages in the depleted rural areas and other negative impacts in the urban areas.

G. Cumulative and Induced Environmental Impacts

282. According to the ADB Environment Safeguards Sourcebook¹ Cumulative Impacts is described as: “The combination of multiple impacts from existing projects, the proposed subprojects, and anticipated future projects that may result in significant adverse and/or beneficial impacts that cannot be expected in the case of a stand-alone project.” The sourcebook also describes Induced Impacts as: “Adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location.

283. Economic activities supporting transport like fuel stations, automotive repair shops, lodging, and restaurants are expected to increase with increase of traffic and induce development in the project areas. The improved roads will provide better connectivity and result in (i) Reduction in travel time (ii) better mode and frequency of transport (iii) access to quality health care facilities, educational and other infrastructural facilities (iv) enhanced tourism activities in the areas, districts and state which in many terms will boost the local economy (v) better investment climate for industries creating more employment opportunities to local people.

284. In terms of environment safeguard issues the improved road surface is expected to result in less dust and noise due to traffic plying on the damaged roads. However, the increased traffic due to the improved road will generate more air pollution due to vehicle exhaust and noise. The smoother road conditions will also result in increase of traffic speeds, hence creating more risks for accidents amongst traffic users as well as the local communities in the subproject areas of district in Chhattisgarh.

285. For addressing the impacts of air pollution and noise, regular maintenance of the road surface, maintenance and monitoring of newly planted trees and installation of noise barriers where necessary have been included in the EMP for implementation during operation stage. For addressing safety related impacts, regular maintenance of the road furniture include safety related furniture, enforcing rules against encroachment of structures and sensitive structures (schools, temples etc.) inside the ROW and implementation of the emergency response system has been included in the EMP for implementation during operation stage,

286. Information on future development projects along the subproject road was not available. Hence, it is difficult to assess cumulative impacts from other projects which may get implemented in the project areas. However road upgrade projects usually do not have any cumulative environmental impacts except for wildlife habitat fragmentation, which is not

¹Environment Safeguards, A Good Practice Sourcebook, Draft Working Document, December 2012

the case here with selected subproject under the project, since the road upgrade will be completed within the existing right of way.

H. Potential Environmental Enhancement/ Protection Measures

287. Appendix 9 to Appendix 12 of this IEE Report presents good environmental management practices and guide documents in the aspects of road construction: i) Tree Plantation and Management – Appendix 9; ii) Borrow Area Management – Appendix 10; iii) Emergency Management System – Appendix 11; iv) Debris Disposal Management – Appendix 12.

VI. CLIMATE CHANGE IMPACTS AND RISKS

A. Climate Change Mitigation

288. The Transport Emissions Evaluation Model for Projects (TEEMP)² developed by Clean Air Asia³ was utilized to assess the CO₂ gross emissions with and without the project improvements. The model has been run for one subproject road section on which current and projected traffic data is highest among the selected subproject under this project. The main improvement from the project that was considered for the model are better surface roughness with initially 2m/km which may deteriorate over a period but not less than 3.5 m/km and widening of roads from intermediate lane (5.5) to two lane with paved shoulders. These were translated into impacts on traffic speed and hence fuel consumption. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume/capacity saturation limit.

289. Information that was fed into the model for projecting the CO₂ emissions were:

- (i) The project will rehabilitate and widen approximately 54.68 km of the major district roads in the State of Chhattisgarh.
- (ii) The road configuration will change from single lane to two lane with carriageway width of 7m with 1.5 m paved shoulder each side and will have an asphalt concrete surface.
- (iii) Existing road roughness is mostly 6.0 m/km and will be improved to 2.0 m/km, which may further reach upto 3.5 m/km during 7 years of road operations and hence will be resurfaced after every 7 years.
- (iv) Construction will take place over a period of 24 months in 2019-2020 and road operations will begin in the end 2021.
- (v) The design life of the road is 20 years.
- (vi) Other improvements include the repair or reconstruction of damaged culverts, introduction of lined longitudinal and cross drains for the road and removal of irregularities on the existing vertical profile and road safety appurtenances.

² TEEMP is an excel-based, free-of-charge spreadsheet models to evaluate emissions impacts of transport projects. It has been run for Tikrapara Sejbahar Semra Bhakhara Dhamtari, a subproject selected under project funding.

³A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

290. Traffic forecasts were taken from the detailed project reports prepared for the subproject road section. Maximum PCU for 1.0 lanes and 2 lanes were considered as 7,000 and 12,000 respectively in consistent to IRC guidelines. The volume/capacity saturation limit was taken at 2.0 for optimum travel speed and fuel consumption. Emission factors were mostly taken from the CBCP/MOEF (2007) Draft Report on Emission Factor Development for Indian Vehicles, the Automotive Research Association of India, and C. Reynolds et.al (2011) Climate and Health Relevant Emissions from in-Use Indian for three-wheelers rickshaw as shown in Table 44.

Table 44: CO2 Emission Factors

Vehicle Type	Gasoline	Diesel
2-Wheel	2.28 kg/l	
3-Wheel		2.63 kg/l
Cars/ Jeeps	2.59 kg/l	2.68 kg/l
LCV		3.21 kg/l
Bus		3.61 kg/l
HCV		3.50 kg/l

291. It was assumed that the 2-wheelers and 3-wheelers have average trip distance of 1/4th of the total road length in each section, whereas all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 100% and 90%, respectively of the total local traffic.

292. It has also been assumed that over the time, the fleet composition will change and the assumptions taken for the same are shown in Table 45.

Table 45: Emission Standards of Fleet (%)

Vehicle Type	Current Scenario				Year 2037		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
2-Wheel		50%	50%		30%	70%	-
3-Wheel	80%	20%			40%	60%	
Cars/ Jeeps		40%	40%	20%		40%	60%
LCV/Bus/HCV		70%	20%	10%	10%	40%	50%

293. Emissions from road construction were estimated by using the emission factor for rural roads, by using 'Impact of Sri Lankan Rural Roads on Greenhouse Gas Emissions & Mitigation and Climate Change – A Case Study 2 (<http://www.rshanthini.com/tmp/CP551SD/RuralRoadandGHG.pdf>) which is equivalent to 11,000 kg CO₂/km of road construction.'

294. **Estimated carbon emissions.** The proposed road upgrading resulting to surface roughness and road capacity improvements have implications in CO₂ emissions. Improved roughness results to higher speed and lesser emissions while increase road users increases emissions. These factors are further affected by traffic congestion once the volume/capacity saturation limit.

295. CO₂ emissions will also result from the processing and manufacturing of raw materials needed to upgrade the project road and in the case of subproject, to upgrade and strengthen the road length of approximately 55 km, total CO₂ emissions will be of the order of 5992.92 tons as shown in Table 46.

Table 46: Estimated Total CO2 Emissions during Road Construction

Road Section	Length (km)	Emission Factor (ton CO2/km)	CO2 Emission (tons)
Tikarapara Sejbahar Semara Bhakhara Dhamtari Road (Old Dhamtari Road)	54.68	109.6	5992.92

296. The design life of road is 20 years. Total CO2 emission at business-as-usual scenario was estimated at 153,217 tons/year and without- and with- induced traffic are 31,192 tons/year and 67,532 tons/year, respectively. These values are below the 100,000 tons per year threshold⁴ set in the ADB SPS 2009. A summary of the expected annual CO2 emissions is provided in Table 47.

Table 47: Section-wise Project CO2 Emissions Intensity Indicators

Road Sections	Particular	CO2 emission		
		Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
Tikarapara Sejbahar Semara Bhakhara Dhamtari Road (Old Dhamtari Road)	tons/km	30141	6136	13285
	tons/year	153217	31192	67532
	tons/km/year	1675	341	738
	g/t km	416	48	204

297. While there is an increase in the CO2 emissions due to increase in traffic the levels are still far below the 100,000 tons per year threshold set in the ADB SPS 2009 and therefore not required to implement options to reduce or offset CO2 emissions.

1. Climate Risks and Adaptation Needs

298. A climate risk and vulnerability assessment (CRVA) study has been carried out for the proposed Chhattisgarh Road Connectivity Project. The aim was to analyse the impacts on road components due to likely change in climatic variables, mainly temperature and precipitation. Key findings and mitigation measures are summarized in subsequent sections.

1.1 Review of Climate Change Literatures Specific to Chhattisgarh

299. The draft Chhattisgarh State Action Plan for Climate Change (CSAPCC 2013⁵) mentions that the climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. Summer in Chhattisgarh is from April to June and temperatures can reach 48°C (100°F). Winters are pleasant with low temperatures and less humidity. The temperature varies between 30° and 47°C (86 and 117°F) in summer and between 5° and 25°C (41 and 77°F) during winter. However, extremes in temperature are observed with scales falling to less than 0°C to 49°C. In terms of precipitation, Chhattisgarh receives an average of 1,292 mm (50.9 in) of rain during the monsoon season. The monsoon season that spans late June to October is reported as a welcome respite from the pre-monsoon heat.

⁴ Page 38, Appendix I, footnote 10 of SPS 2009

⁵ Chhattisgarh State Action Plan for Climate Change, (For discussion only- not to be quoted or reproduced), Final Draft, May 2013, Government of Chhattisgarh.

1.1.1 Climate Change Trends

300. For the Indian sub-continent, a most recent literature on observed climate change trend is the meteorological monograph⁶ of 2013, published by the Indian Meteorological Department (IMD). The literature features relevant topics concerning meteorological and allied sciences with a comprehensive, long-term assessment of the climate change during 1951-2010 undertaken for each state of the country. The IMD monograph concludes that results revealed that many states in India have indeed experienced significant state-wide warming in both maximum and minimum temperatures over the last six decades. However, the changes are not equal for all states of India, spatially and temporally. Trends in temperatures showed a much higher degree of spatial coherence and statistically significant warming, reflecting increases in both maximum and minimum temperatures. Though rainfall trends are not significant in many states, spatially coherent decrease in rainfall in most of the states in India particularly in monsoon season is a cause of worry, the report states. Notable extracts from Sections 3.1.1 and 3.1.2 of the cited monograph with respect to temperature and precipitation trends in observed data of 1951-2010 are summarized in Table 48.

Table 48. Summary of Climate Change Trends

Annual Mean Maximum Temperature Trend	State-wise averaged annual mean maximum temperature time series (1951-2010) has shown increasing trends over many states of India <u>except</u> Bihar, Chhattisgarh , Delhi, Haryana, Meghalaya, Punjab, Tripura and Uttar Pradesh; No trend observed over Chhattisgarh
Diurnal Temperature Range (DTR) -an index of climatic change in addition to mean temperature changes	DTR, (which is the variation between a high temperature and a low temperature that occurs during the same day); The state averaged summer DTR for the state of Chhattisgarh is shown to be increasing at the rate of +0.02°C/year.
Annual Mean Minimum Temperature Trend	State-wise averaged annual mean minimum temperatures have shown significantly increasing trends over Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Kerala, Lakshadweep, Manipur, Meghalaya, Rajasthan, Sikkim, Tamil Nadu and Tripura. Annual mean minimum temperature trends are <u>significantly decreasing</u> over Chhattisgarh (-0.01°C/year)
Average Annual Rainfall Trend	State averaged annual rainfall trends have increased over Andhra Pradesh, Bihar, Gujarat, Haryana, Jharkhand, Lakshadweep, Manipur, Meghalaya, Mizoram, Orissa, Rajasthan, Tamil Nadu, Tripura and West Bengal during 1951-2010. However, <u>annual rainfall has decreased</u> over Chhattisgarh

1.1.2 Frequency and Intensity of Extreme Point Rainfall Events under Climate Change Scenario⁷

301. The Indian Institute of Tropical Meteorology (IITM) analyzed the daily rainfall data of 165 stations across the Indian region to find out their extreme point rainfall events (highest 24-hour rainfall) and examined whether there is any change in the number and the intensity of such events during past four decades. The study revealed that their frequency has gone

⁶ State Level Climate Change Trends in India, Meteorological Monograph No: ESSO/IMD/EMRC/02/2013, Ministry of Earth Science, Indian Meteorological Department, Ministry of Earth Sciences, Government of India, 2013

⁷ Alarming Rise in the Number and Intensity of Extreme Point Rainfall Events over the Indian Region under Climate Change Scenario, Indian Institute of Tropical Meteorology, August 2009; ISSN 0252-1075 IITM Research Report No. RR-123

up considerably after 1960 with an alarming rise in the intensity thereafter. It was noticed that the major cities, hill stations and the islands were affected with increasing heavy downpours. The conspicuous feature was that from the mid 90s, the regional as well as the world records were established over this part of the globe on different time scales. The study conjectures that these events may be associated with the global and the regional warming under the climate change scenario, and warns that in the event of their continuation, there would be severe impact on societal and environmental issues warranting appropriate precautionary measures in near future to safeguard the interest of the vast population of this region.

1.1.3 Heat Waves

302. The National Disaster Management Authority (NDMA) of India describes a heat wave as a period of abnormally high temperatures, more than the normal maximum temperature ($>40^{\circ}\text{C}$), that occurs during the summer season in many parts of India. Heat waves typically occur between March and June, and in some rare cases even extend till July. In the Indian context, the extreme temperatures and resultant atmospheric conditions adversely affect people living in the northern States, including Chhattisgarh. In April and May 2017, heat waves intensified in isolated parts of Chhattisgarh where the maximum temperature hovered between 44° and 47°C and the State recorded the highest ever maximum temperature of 49.3°C .

303. The NDMA asserts that with rising high daily peak temperatures lasting longer, more intense heat waves are becomingly increasingly frequent globally due to climate change. India too is feeling the impact of climate change in terms of increased instances of heat waves which are more intense in nature with each passing year, and have a devastating impact on human health thereby increasing the number of heat wave casualties. In terms of transport infrastructure heat waves cause railway lines to expand to the point where they buckle and caused derailment of train. Road damages also occur with bitumen melting and concrete expanding and cracking. Even bridges suffer similar type of damages.

1.1.4 Tropical Cyclones and Flooding

304. India is persistently prone to tropical cyclones as the subcontinent is surrounded by oceans from three sides. Although cyclones affect the entire India, the east coast is more prone to cyclone than west coast. Among all the east coastal states, Odisha is worst affected by tropical cyclones having experienced landfalls of 260 cyclones within a time span of 100 years. To say that the inland state of Chhattisgarh is a safe haven from cyclonic influences would be an understatement. The Super cyclone of the century (OSC99) struck the Odisha coast on October 29, 1999, with an intensity of about 300 km/h accompanied by a 7 meter high storm surge. Out of a total of 30 districts, 11 coastal districts were heavily affected, leading to a death toll of more than 10,000 people. The destructive effects of every cyclone that hit Odisha are felt in Chhattisgarh although comparatively less in terms of intensity and magnitude.

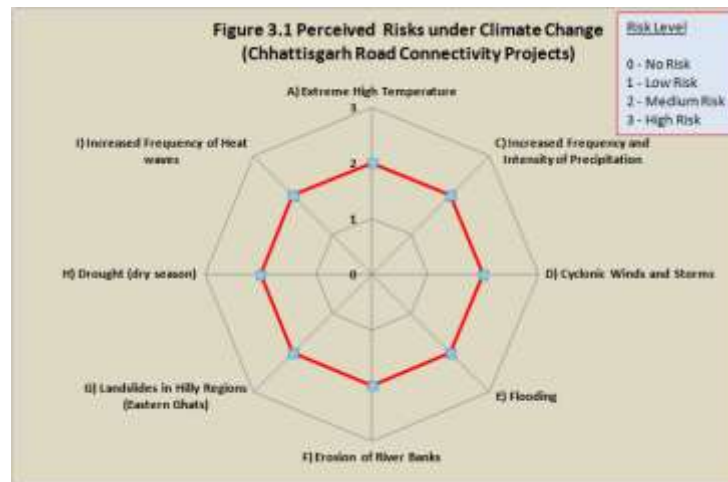
305. A tropical cyclones study⁸ points that though the occurrence of tropical cyclones remains steady, the frequency of severe cyclonic storms is increasing. A significant increase of nearly 46% with a confidence level of 99% is noticed for severe cyclonic storms, while the increase of cyclonic disturbances and cyclones is not statistically significant.

⁸ Modeling and Data Assimilation for Tropical Cyclone Predictions, India-US Science and Technology Forum, Connect, Vol. 4(2), September 2012

306. Floods are a perennial phenomenon in at least 5 states of India – Assam, Bihar, Odhisa, Uttar Pradesh and West Bengal. On account of climate change, floods are reported to have also occurred in recent years in areas that are normally not flood prone. Although the state of Chhattisgarh does not fall within an annually perennial flood-prone zone, nonetheless devastating floods do occur and are associated with low land stretches exposed to direct spillage from large flooding rivers and also road stretches are subjected to flash floods caused by high intensity, short duration rainfall.

1.2 Climate Change Risks

307. The literature review on climate change provide noteworthy information on risks specific to road projects in the state of Chhattisgarh. A climate risk chart illustrated in Figure 3.1 are those resulting from increased frequency and intensity of extreme weather events, temperature and precipitation changes, increased cyclonic storms and flooding, and water availability during the dry season. Overall the road transport sector of the Chhattisgarh State seems to be of medium risk category.



1.2.1 Possible Climate Events, Risks and Adaptation Measures in Road Transport Infrastructure

308. Based on physical observations undertaken during the road asset survey and updated hydrological assessments of drainages along the subproject roads traversing through various regions of Chhattisgarh, engineering adaptations included in the project design are considered significant to addressing climate change risks. Key engineering measures taken to address flood risks in the design are: i) improvement in embankment heights by around 1 to 2 m in critical sections; ii) improvement in flood discharge capacities by replacement of all existing 300 mm and 600 mm dia pipes with larger 900 mm and 1200 mm dia pipes, and iii) replacement of culverts by small bridges and small bridges by larger bridges. These are based on the risks and measures outlined in Table 49. It must be noted that all these events either simultaneously or in isolation have the possibilities to generate severe disastrous impacts on road infrastructure.

Table 49. Possible Climate Events, Risks and Adaptation Measures and Costs

Climate Change Events	Risks to the Road Infrastructure	Adaptation Measures incorporated in Detailed Design of Project Roads	Design Modification	Cost Estimate (INR)
(1) Extreme rainfall events	<ul style="list-style-type: none"> i. Overtopping and wash away ii. Increase of seepage and infiltration pass iii. Increase of hydrodynamic pressure of roads iv. Decreased cohesion of soil compaction v. Traffic hindrance and safety 	<ul style="list-style-type: none"> a. Certain critical sections affected by overland flooding of the road raised (vertical alignment, embankment improvement) in order to be free from onslaught of flooding events under intense precipitation. b. Road asset survey by the DPR team revealed certain critical road sections where the sub-grade strength and integrity were found to be compromised; DPR has now upgraded the sub-grade strength specification to minimum CBR-6%. meeting the recent-most IRC specifications 	Additional height ranging from 1 – 2 m for selected sections	24,310,820.00
(2) Changes in seasonal and annual average rainfall	<ul style="list-style-type: none"> i. Impact on soil moisture levels, affecting the structural integrity of roads, culverts, bridges ii. Adverse impact of standing water on the road base iii. Risk of floods from runoff, landslides, slope failures and damage to roads if changes occur in the precipitation pattern 	<ul style="list-style-type: none"> c. The DPR has adopted the highest assessment of design discharge for sizing culverts and bridges from among the several discharge methods as outlined in recent IRC guidelines. Further to tackle bridge scour under an uncertain future regime, a 30% increase in the design discharge has been taken in the DPR. d. In terms of flood water conveyance to prevent stagnation, lateral drains are proposed along the entire length of the road; closed concrete drains in settlement pockets, and earthen drains in remaining parts of road. e. The DPR has improved the cross drainage capacities required for quick conveyance of flood water by replacing all existing 300 mm and 600 mm diameter pipes with larger 900 mm and 1200 mm diameter pipes. In certain critical parts of the road, box culverts with 	Provision of pipe culverts; increase from 300-600 mm diameter to 900-1200 mm diameter pipes	19,143,451.00

Climate Change Events	Risks to the Road Infrastructure	Adaptation Measures incorporated in Detailed Design of Project Roads	Design Modification	Cost Estimate (INR)
		higher discharge openings are included in the DPR. f. All causeways are converted into minor bridges and some critical existing minor bridges are replaced by larger bridges with higher flood discharge capacities in the design drawings. Overall design standards are upgraded to meet the recent specifications prescribed by IRC.	0 culverts replaced by small bridges; flood water conveyance improvement by 0% 11 small bridges replaced by larger bridges; flood water conveyance improvement by 2.76%	1,036,491,60.00 88,597,854.29
(3) Increased maximum temperature and higher number of consecutive hot days (heat waves)	i. Concerns regarding pavement integrity, e.g. softening, traffic-related rutting, cracking, fracture, etc. ii. Thermal expansion in bridge expansion joints and paved surfaces iii. Temperature break soil cohesion and increase dust volume which caused health and traffic accidents	a. Bituminous layer thickness of the project roads has been proposed to be increased to minimum 50 mm from 25 -35 mm earlier to offset wear and surface fatigue under climate stresses. b. In terms of pavement integrity, the choice of viscosity grade VG30 has been maintained as usual, although recent bitumen grade VG40 can resist temperature stresses in excess of 45°C. (Reason for not upgrading to VG40 according to the DPR engineers - bituminous surfaces are redone at routine intervals (after every 5 years) and the decision to upgrade to the higher standard can be done at a subsequent future based on performance of the lower cost VG30.)		
(4) Extreme wind speed under cyclonic conditions	i. Threat to stability of bridge decks ii. Damage to signs, lighting fixtures and supports	✓ BAU		
Total Civil Cost				1,183,830,305.46
Total Amount for Adaptation to Climate Change				235,701,285.31
% increase under Climate Change				19.91%

1.3 Cost of Climate Proofing

309. Table 49 also presents the costs of the civil works and corresponding cost of the climate adaptation measures proposed for the subproject road. Total costs for taking proposed measures add up to a total of Rs. 23.57 crores (\$ 3.31 millions). This is approximately 19.91% of the total civil works costs for the subproject road. It must be pointed out that these measures would have been considered anyway in the conventional design as the issue of flooding is a threat to the sustainability of the road. However, these measures also contribute to adaptation of the roads for future increases in precipitation. This risk screening and risk identification exercise has helped to ensure that project roads with climate risks have adequate risk mitigation or adaptation measures. Provisions have also been made in the bidding documents for the contractor to prepare contract package specific EMP based on the final detailed design to address a range of issues including climate related risks and vulnerabilities and accordingly incorporate required costs in the BOQ.

VII. CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

310. In accordance with ADB's Safeguard Policy Statement (SPS) 2009 meaningful consultations were held early and throughout the subproject development stages to allow the incorporation of relevant views of the stakeholders in the final project design, mitigation measures, implementation issues, and enhance the distribution of benefits. All the five principles of information dissemination, information solicitation, integration, co-ordination, and engagement into dialogue were incorporated in the consultation process. The analysis of environmental impacts likely from the subprojects was strengthened and modified based on opinions of all those consulted, especially in the micro level by setting up dialogues with the village people from whom information on site facts and prevailing conditions were collected. The requirement of public consultation during the implementation of the subproject have been proposed as part of the mitigation plan.

A. Objectives of the Consultations

311. Stakeholder's consultations were held with intent to understand their concerns, apprehensions, overall opinion and solicit recommendations to improve subproject design and implementation. Informal meetings, interviews were organized covering the entire subprojects design stage. Consultations provide affected people a platform to ensure incorporation of their concerns in the decision making process and foster co-operation among officers of PWD, PIU-ADB, the community and the stakeholders to achieve a cordial working relationship for smooth implementation of the subprojects. It inculcates the sense of belongingness in the public about the subproject.

312. The discussions were designed to receive maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the subproject. They were given the brief outline of the subprojects to which their opinions was required particularly in identifying and mitigating any potential adverse impact.

B. Methodology for Consultations

313. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questionnaires. Questionnaire survey/ discussions were designed to obtain background information and details of general environmental issues that concern people in the project areas. In addition, environmental issues were discussed with relevant organizations, government officials, beneficiaries, community leaders and experts. Besides, personal discussions with officials, on site discussion with affected stakeholders, and reconnaissance visits have also been made to the project areas. Public consultation has been carried out at several locations along the subproject road section during initial surveys. In total 4 consultation session were organized involving 103 participants. Table 50 show the details of the public consultations carried out along various road sections.

Table 50: Subproject wise details of the Public consultation

Sr. No.	Village/Town Name	Date of Consultation	No of participants		
			M	F	T
1	Kashipal	14/03/2018	17	6	23
2	Potapara		22	15	37
3	Birkol		14	3	17
4	Singhora		19	7	26

Source: Field surveys during DPR preparation, 2018

1. Project Stakeholders

314. All types of stakeholders were identified to ensure as wide coverage as possible.
- Residents, shopkeepers and business people who live and work along the road specially the project affected persons
 - All type of road users/commuters
 - Executing Agency, Construction Supervision Consultant and Implementing NGOs
 - Other government institutions whose remit includes areas or issues affected by the subproject (state environment and forest department, Pollution Control Board (PCB), Irrigation Department, Public Health Engineering (PHED) Department
 - The beneficiary community in general.

2. Consultation with Government Departments

315. Various officials consulted during IEE preparation included PWD Officials, State pollution control board for air, noise and water quality information, IMD for the climatic data, statistical officer for population and demographic profile, panchyat department for village level information, Survey of India for the toposheet requirement, revenue department for the land record information, PHQ officers for hand pump relocation and quality assessment, CGSEB offices for electric pole shifting etc.

316. These departments helped to provide various project related data and information which helped preparation of reports and data analysis.

3. Consultation with Local People and Beneficiaries

317. The informal consultation generally started with explaining the subprojects, followed by an explanation to potential impacts. Participant's views were gathered with regard to all aspects of the environment which may have direct or indirect impact on local people. Key Issues discussed are:

- Awareness and extent of the project and development components;
- Benefits of the project for the economic and social upliftment of community;
- Labour availability in the project area or requirement of outside labour involvement;
- Local disturbances due to project construction work;
- Necessity of tree felling etc. at project sites;
- Impact on water bodies, water logging and drainage problem if any;
- Environment and health aspects;
- Flora and fauna of the project areas, and
- Socio-economic standing of the local people.

318. The subproject has immense acceptability among the local people. They perceive that in addition to providing all weather connectivity, the subproject road will bring positive socioeconomic changes in the areas. Local people mainly discussed on the issues related to flooding, rehabilitation, resettlement, and road safety issues. The list of participants views and outcome of the consultations have been summarized in Table 51.

319. The Details of Participants and Public Consultation attendance list are attached in Appendix 6. In addition information on the GRM procedures and formats in local language i.e. Hindi was shared with the local people as provided in Appendix-7.

Table 51: Summary of Issues Discussed and Measures Taken

Location and Date	Issues Discussed	Measures Taken	Participant
14 th March, 2018 at Kashipal, Potapara, Birkol and Singhora.	<ul style="list-style-type: none"> • People are facing acute problem related to poor condition of the road. • Where the road passing through the settlements there should be • provision of Speed breakers Suggestion viz. (i) design shall take into hydrological aspects into consideration (ii) minimal loss of structures (iii) adequate settlement and rehabilitation measures including provision of jobs to land losers • Local people informed that present road in some sections of this area submerges during normal rainfall also. Adequate measures shall be taken to avoid water logging during normal rainfall. 	<p>Proposed widening and strengthening of the road will provide better level of services in terms of improved riding quality and smooth traffic flow.</p> <ul style="list-style-type: none"> • There will be considerable reduction in the number of accident and level of pollution. • Accessibility to social health and educational infrastructure will increase through all-weather road. • Generation of employment during construction phase of the road. • The discussion generates. • considerable awareness of the project . • As the proposed road shall be a widened one, it shall provide an efficient public 	Total 103 Participant was Participated in the consultation.

Location and Date	Issues Discussed	Measures Taken	Participant
	<ul style="list-style-type: none"> • They suggested that existing alignment shall also be improved and maintained properly. • Suggestion viz., Minimal loss of structures, Adequate rehabilitation and resettlement ,measures • Area is one of the congested stretches due to that problem of traffic jam and accident is common. • Stress was put by the community on adequate safety provisions to be made along the road particularly at locations of school, • cattle underpass, provision of bus stop and provision of green belt development Compensation should be as per market value. 	<p>transportation system besides.</p> <ul style="list-style-type: none"> • ensuring reduction in congestion level • The title holders shall also be compensated as per ADB guidelines. • Drainage system is mention in built-up area and earthen drainage for rural area. • Drainage system is mention in built-up area and earthen drainage for rural area. Road safety features like traffic signs, Overhead Sign Boards, Road Illumination, Delineators, • pavement marking, pedestrian path and rumble strips has been included in the design. • Proper Rehabilitation measures will be taken for . Affected Household's and compensation will be as per market rate. 	

320. Most of the people interviewed were well aware of the environmental conditions in and around their villages. A major percentage was ignorant about any deterioration in the air and noise quality due to expansion of existing highway. However, their major concern was related to the drain blockage and stagnant water at dig holes. The villagers are quite enthusiastic about the proposed project as it will give fillip to rural economy and present them many employment opportunities during construction of project road. Overall positive approach towards the project is observed.

4. Results of Consultation with Local People

321. Most of the people interviewed strongly support the subproject work. The people living in the entire project area expect the different project elements to facilitate transport, employment, tourism, boost economic development and thereby provide direct, or indirect, benefits to them. In order to access the existing environment and likely impacts on surrounding population, an interview survey was carried out. A priority of the population was interviewed through a designed questionnaire. Precaution has been exercised during the survey to ensure that the priority interviewed is truly representative of the affected groups and the questions are worded so as not to generate a bias response.

322. It is observed from the interview survey that there is increased environmental awareness among the people. It can also be seen from Table 52 that about 85 percent of the persons are in the opinion that an environmental condition of the area is good. About 90 percent of the people are agreed that the quality of air, in the area is good; whereas, only about 5 to 10 percent responded feel that the environmental quality is being deteriorated. Poor road condition and vehicular emissions are the major sources they feel responsible for this. People are unaware about presence of archaeological, historical and cultural sites.

There is no major history of natural disasters in the region and local people have mixed response about natural disasters. Overall, the general environmental conditions in the region are good and people have increased environmental awareness. Table 52 shows the result of public opinion survey carried out in the region.

Table 52: Peoples' Perception about Environmental Scenario

Sr. No.	Question asked about	No.ofpeople interviewed	Positive response (%)	Negative response (%)	No response (%)
1	Water quality of rivers, ponds,wells,and canals	103	88	12	00
2	Noise quality of the area		86	14	0
3	Air quality of the area		88	7	5
4	Archaeological sites		60	10	30
5	Natural disaster		28	72	00
6	Rare species of animals		80	10	10
7	Cultural sites i.e. market, melas		90	8	2

Note: Positive response shows that the overall environmental scenario in the area is good and wise versa. For rare species positive answer to question means species are presence.

323. Overall, most of the people interviewed strongly support the subproject. The people living in the entire project areas expect the different project elements to facilitate transport, employment, tourism, boost economic development and thereby provide direct, or indirect, benefits to them. Construction camps may, however, put stress on local resources and the infrastructure in nearby communities. In addition, local people raised construction-process related grievances with the workers. This sometimes leads to aggression between residents and migrant workers. To prevent such problems, the contractor should provide the construction camps with facilities such as proper housing, health care clinics, proper drinking water and timely payment. The use of local laborers during the construction will, of course, increase benefits to local peoples and minimise these problems. Wherever possible, such people should be employed.

C. Interaction with NGOs

324. In order to get independent views on the likely impacts of the subproject, non-government organizations at local as well as regional level were consulted during the IEE process. Aspects such as conservation activities, presence of flora and fauna, likely project impacts and possible mitigation measures were discussed and views and suggestions from these NGO's were incorporated in the EMP. Consultation will continue with these NGO's during project implementation and operation.

D. Public Disclosure

325. The PWD will be responsible for the disclosure of this IEE in compliance to ADB's Communication Policy 2011 and ADB's SPS 2009. The IEE will be disclosed in the English language in the office of PWD. The report will also be made available to interested parties on request from the office of the PWD. Since this is Category B subproject, this IEE report will be

disclosed to the public through the ADB website. This IEE report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009.

VIII. GRIEVANCE REDRESS MECHANISM

326. The grievance and outcome related to the implementation of the subproject, particularly regarding the environmental management plan will be acknowledged, evaluated, and responded to the complainant with corrective action proposed. The outcome shall also form part of the semiannual environmental monitoring reports that will be submitted to ADB. Complaints may be lodged verbally directly to the contractor or CSC or PIU at the site level. To the extent possible efforts will be made by the contractor, CSC or PIU to address these complaints immediately on site. Only those complaints that cannot be addressed immediately at the site level will be submitted to the Grievance Redress Committee (GRC). Necessary assistance for completing the complaint form or lodging a written complaint will be made to illiterate complainants by the respective receiver of the complaint. A Grievance GRC will be established at the PWD, PIU-ADB state level and at the PIU level to assure accessibility for Affected Persons. The GRC is expected to resolve grievances of the eligible persons within a stipulated time. The decision of the GRC will be binding, unless vacated by the court of law.

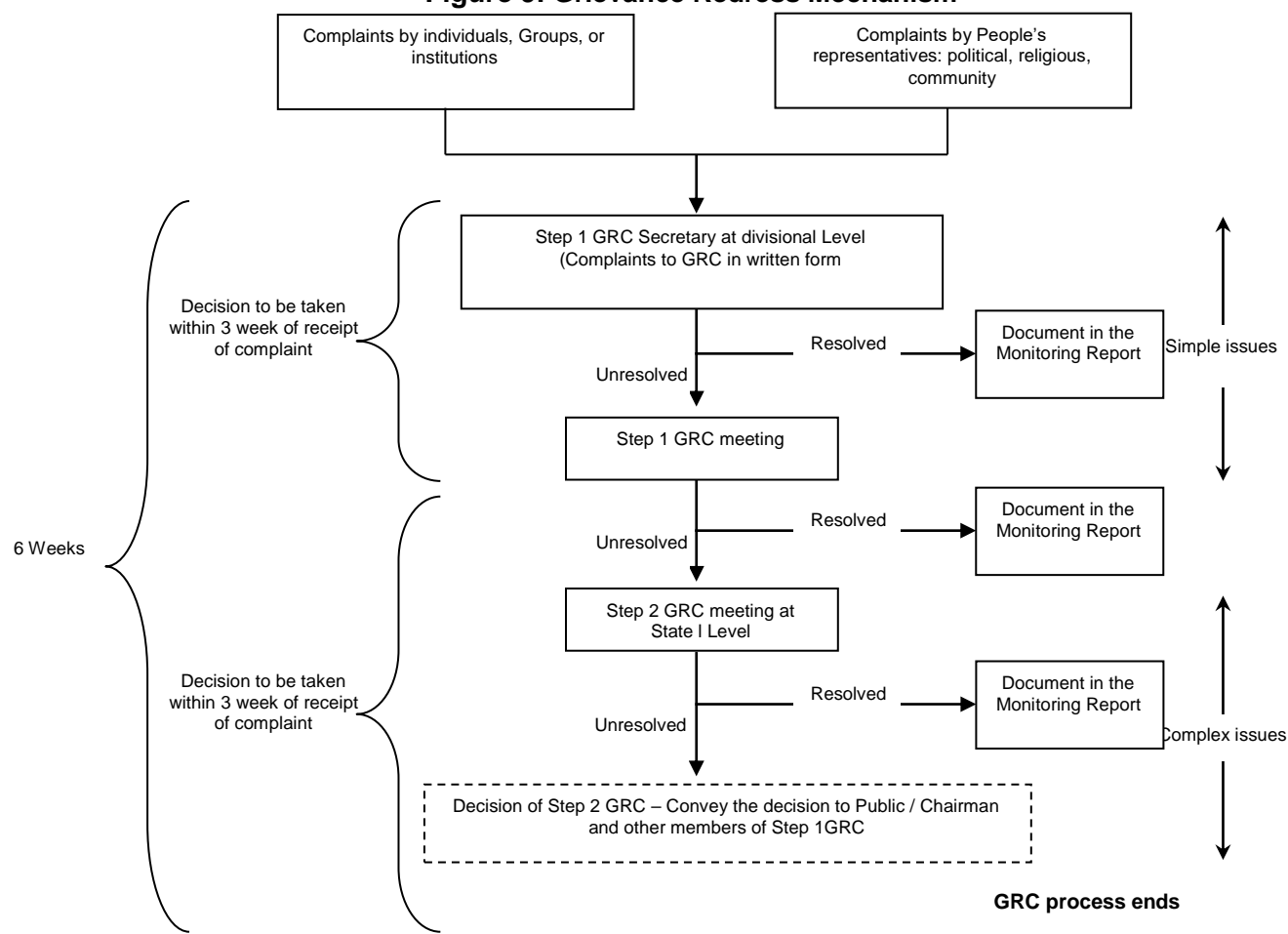
327. The State level GRC will comprise of the:

- i) Chief Engineer, PWD, Raipur
- ii) Superintended Engineer, PWD, Raipur
- iii) Executive Engineer, PWD, Raipur
- iv) Manager (Environment & Social), PWD, Raipur

328. The PIU level GRC will comprise of the:

- i) Divisional Manager from PWD
- ii) Executive Engineer, local PWD office
- iii) A representative from local NGOs or a local person of repute and standing in the society, elected representative from Zila Parisad /District Council.
- iv) Two representative from affected people including vulnerable groups and women from a relevant agency which could be from the government, or NGO or local community

329. One of the above members in the PIU level GRC will be a woman. The GRC will continue to function, for the benefit of the APs, during the entire life of the project including the five year maintenance period. Figure 9 defines the process of the GRM. An information sheet on GRM procedures including a sample form for submitting complaints in the local language is attached in Appendix 7.

Figure 9: Grievance Redress Mechanism

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

330. The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time-frame with specific responsibility assigned and follow-up actions defined. It contains all the information for the proponent, the contractor and the regulatory agencies to implement the subprojects within a specified time-frame

331. This EMP consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the Environmental Management Plan are:

- Mitigation of potentially adverse impacts;
- monitoring of EMP implementation during project implementation and operation; and
- Institutional arrangements to implement the EMP.

332. Prior to start of construction work Environmental Expert of the CSC team in coordination with Contractor will update this EMP to make it site specific in the form of Construction EMP (CEMP).

B. Objectives of Environmental Management Plan

333. The main objectives of this EMP are:

- To ensure compliance with ADB's SPS, and regulatory requirements of Chhattishgarh State and the Government of India;
- To formulate avoidance, mitigation and compensation measures for anticipated adverse environmental impacts during construction and operation, and ensure that environmentally sound, sustainable and good practices are adopted; and
- To stipulate monitoring and institutional requirements for ensuring safeguard compliance.

C. Impacts and Mitigation Measures

334. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision and monitoring have been provided in a matrix format in Appendix 8. However, anticipated potential impacts and suggested mitigation measures specific to the subproject are summarised in following paragraphs. These mitigation measures will be implemented as part of the subproject.

1. Impacts

335. Following are anticipated potential adverse environmental impacts from subproject:

1. impacts on surrounding area due to tree cutting (1758) for the proposed improvement work along the subproject road;
2. Land acquisition of additional 12.900 ha. area for agriculture land and 11.67 ha. area of forest land for widening and geometry improvement;
3. Temporary impact on land and air environment due to locating construction camp;
4. Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
5. Impact on biophysical environment due to quarry operation;
6. Impact on air quality, water quality, drainage, road users due to construction activities of project road;
7. Impact on land and water environment due to disposal of waste materials; and
8. Impact on occupational health and safety due to all onsite and offsite construction works.

2. Mitigation Measures

2.1 Compensatory Tree Plantation

336. The compensatory plan is being developed in consultation with local forest department. As per compensatory afforestation, the tree plantation will be done ten times of tree cutting (1:10 of tree cutting) as detailed in Table 53.

Table 53: Details of Trees to be affected due to subproject

Subproject Road Section	No. of Trees to Cut	No. of Trees to be planted	Main Tree Species Local name (botanical name)
Lambar-Bodesara-Birkol-Singhora Road	1758	17580	Mahua (<i>Madhuca Longifolia</i>), Pipal (<i>Ficus religiosa</i>), Jamun (<i>Syzygium Cumin</i>) Sarai (<i>Shorea robusta</i>) Chola (<i>Cicer arietinum</i>), Babool (<i>Acacia arabica</i> , Willd.) and Aam (<i>Mangifera indica</i>), Sagon (<i>Tectona grandis</i> Linn.), Mahua (<i>Bassia longifolia</i>), Babool (<i>Arabica nilotica</i>), Chola (<i>Cicer arietinum</i>), Chirol (<i>Holoptelea integrifolia</i>), and Neem (<i>Azadirachta indica</i>)

Note: These are tentative estimate. Actual number of trees to be cut will be much less then these numbers, to be verified with forest/district authorities

2.2 Excavated Road Side Debris and its Disposal

337. The provision has been made in cost estimate to use the roadway excavated materials as necessary for the construction of roads, which are as follows.

- For all types of soil, such as ordinary rock, hard rock and
- Excavation from drain and foundation of other structures.

338. As per above description, the Contractor will use the excavated road side material for construction of road. The rest unsuitable material will be disposed suitably. The lead and lift has been considered in cost estimates. The Contractor will not dispose the excavated unsuitable material generated from high section to other side (low laying side) of the subproject road. Proper disposal plan will be prepared by the Contractor to dispose the unsuitable material generated from cutting/ road excavation.

2.3 Protection of Water Bodies

339. The surface water bodies along the subproject road require protection during construction phase of the subproject roads particular at locations of river/stream crossing (Table 20 show the locations of the main water bodies/rivers along the subproject road). The Contractor shall not disturb/ pollute these surface water bodies due to construction activities of the subproject roads. The Contractor will be responsible to protect these surface water bodies and extra payment for the same will not be given.

2.5 Re-development of Borrow Area

340. The items for redevelopment of borrow area such as preservation of top soil and re-application of stored top soil has been considered in proposed EMP cost. The Contractor will re-develop the borrow areas before closing of same. The estimated quantities for

preservation and re-application of the top soil has been considered for redevelopment of borrow area.

2.6 Protection of Sensitive Receptors

341. Sensitive receptors along the subproject road will be protected by implementing suitable measures such as timely scheduling of construction activities in these areas, provision of sign boards, appropriate noise barriers such as planting trees and / or raised boundary walls are adopted to minimize impacts. Table 32 show the locations of the sensitive receptors (schools, temples etc.) along the subproject road. Specific mitigation measures as detailed in EMP matrix shall be implemented at these locations.

D. Environmental Monitoring and Reporting Program

342. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. To ensure the effective implementation of mitigation measures and environmental management plan during construction and operation phase of the up gradation of subproject roads, it is essential that an effective Environmental Monitoring Plan be designed and followed.

343. Environmental monitoring program has the underlying objective to ensure that the intended environmental mitigations are realized and these results in desired benefits to the target population causing minimal deterioration to the environmental parameters. Such program targets proper implementation of the EMPs. The broad objectives are:

1. To evaluate the performance of mitigation measures proposed in the EMP.
2. To evaluate the adequacy of environmental assessment.
3. To suggest ongoing improvements in management plan based on the monitoring and to devise fresh monitoring on the basis of the improved EMP.
4. To enhance environmental quality through proper implementation of suggested mitigation measures.
5. To meet the requirements of the existing environmental regulatory framework and community obligations.

1. Performance Indicators

344. The potential physical, biological and social components affecting the environment at critical locations serve as wider/overall Performance Indicators. However, the following specific environmental parameters can be quantitatively measured and compared over a period of time and are, therefore, selected as specific Performance Indicators (PIs) for monitoring because of their regulatory importance and the availability of standardized procedures and relevant expertise.

1. Air Quality with respect to PM_{2.5}, PM₁₀, CO, NO_x and SO₂ at selected location.
2. Water Quality with reference to DO, BOD, Oil and grease, COD, Suspended Solids and Turbidity, Alkalinity, Chloride, Lead, Zinc and Cadmium at crossing points on rivers/streams at selected points.
3. Noise levels at sensitive receptors (schools, hospitals, community/religious places).
4. Survival rates of trees planted as compensatory plantation to compensate for lost forestland and compensatory plantation raised for removal of roadside trees.

1.1 Ambient Air Quality (AAQ) Monitoring

345. Ambient air quality parameters recommended for monitoring road development subprojects are PM_{2.5}, PM₁₀, Carbon Monoxide (CO), Oxides of Nitrogen (NO_x) and Sulphur Dioxide (SO₂). These are to be monitored, right from the commencement of construction activity at selected locations of plants and machinery, crushers on sites, excavation works etc. Data should be generated once in a season excluding monsoon at the monitoring locations in accordance with the revised National Ambient Air Quality Standards formulated by MoEFCC in 2009 (**Appendix-3**).

1.2 Water Quality Monitoring

346. The physical and chemical parameters recommended for analysis of water quality relevant to road development subprojects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, Chloride, Lead, Zinc and Cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are given in the Environmental Monitoring Plan. The monitoring of the water quality is to be carried out at locations identified along the subproject roads during construction and operation phase. The Indian Standard Specifications – IS10500: 1991 is given in **Appendix – 5**.

1.3 Noise Level Monitoring

347. The measurements for monitoring noise levels would be carried out at sensitive receptors and construction sites along the subproject roads. The Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989 or the standards by State Pollution Control Board of Chhattisgarh if such standards are stringent than those of the CPCB are to be complied. The CPCB standards are given in **Appendix – 4**. Sound pressure levels would be monitored on twenty-four hour basis. Noise should be recorded at “A” weighted frequency using a “slow time response mode” of the measuring instrument.

1.4 Success of Re-vegetation

348. The subproject involves widening and up-gradation including construction of cross drainage structures, hence these will require felling of trees. Such lost vegetation will be required to be replaced by compensatory plantation. As per policy of the State Government norms 10 trees have to be planted for each tree removed. These compensatory plantations will have to be monitored by the implementing agency with the help of the Forest Department. Such monitoring will be conducted through random samples. Such sampling should cover at least 5% of the area planted up.

E. Environmental Reporting System

349. The monitoring plan covering various performance indicators, frequency and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in Appendix 8.

350. The reporting system will operate linearly with the contractor who is at the lowest rank of the implementation system reporting to the CSC, who in turn shall report to the PIU. All reporting by the contractor and CSC shall be on a quarterly basis. The PIU shall be responsible for preparing targets for each of the identified EMP activities.

351. The compliance monitoring and the progress reports on environmental components may be clubbed together and submitted to the PIU quarterly during the implementation period. The operation stage monitoring reports may be annual or biannual provided the Project Environmental Completion Report shows that the implementation was satisfactory. Otherwise, the operation stage monitoring reports will have to be prepared as specified in the said Project Environmental Completion Report.

352. Responsibilities for overseeing will rest with the CSC's staff reporting to the PIU. Capacity to quantitatively monitor relevant ecological parameters would be an advantage but monitoring will primarily involve ensuring that actions taken are in accordance with contract and specification clauses, and specified mitigation measures as per the EMP.

353. During the implementation period, a compliance report may include description of the items of EMP, which were not complied with by any of the responsible agencies. It would also report to the management about actions taken to enforce compliance. It may however, be noted that certain items of the EMP might not be possibly complied with for a variety of reasons. The intention of the compliance report is not to suppress these issues but to bring out the circumstances and reasons for which compliance was not possible (such as jurisdictional issues). This would help in reinforcing the implementation of the EMP.

354. Photographic records will also be established to provide useful environmental monitoring tools. A full record will be kept as part of normal contract monitoring. Reporting and Monitoring Systems for various stages of construction and related activities have been proposed to ensure timely and effective implementation of the EMP.

355. The reporting system has been prepared for each of the stage of road construction namely:

- Pre construction stage
- Construction Stage
- Operation Stage

356. This reporting shall be done through:

- Reporting by the Contractor to the CSC
- Reporting by CSC to PIU.

357. The stage-wise reporting system is detailed out in the following Table 55.

Table 54: Stage-wise Reporting System of PIU

Format* No.	Item	Contractor	Construction Supervision Consultant (CSC)		Project Implementation Unit (PIU)	
		Implementation and Reporting to CSC	Supervision	Reporting to PIU	Oversee / Field Compliance Monitoring	Reporting to Environment Officer of PIU
C1	Monitoring of construction site and construction	Before start of work	-	Quarterly	-	Quarterly

Format* No.	Item	Contractor	Construction Supervision Consultant (CSC)		Project Implementation Unit (PIU)	
		Implementation and Reporting to CSC	Supervision	Reporting to PIU	Oversee / Field Compliance Monitoring	Reporting to Environment Officer of PIU
	camp					
C2	Target sheet for Pollution Monitoring	-	As required	After Monitoring	-	After Monitoring
C3	Target sheet for roadside plantation	-	Monthly	Quarterly	Quarterly	Bi-annual
C4	Target sheet for monitoring of cleaning water bodies	-	Monthly	Quarterly	Quarterly	Bi-annual
O1	Target sheet for Pollution Monitoring	-	-	-	As per monitoring plan	After Monitoring
O2	Target sheet for survival reporting of roadside plantation	-	-	-	Quarterly	After Monitoring
O3	Target sheet for monitoring of cleaning water bodies	-	-	-	Quarterly	After Monitoring

- Formats will be developed and provided by supervision consultant to the contractor.

F. Institutional Requirements

358. The Executing Agency for the project will be GoCG through PWD, PIU-ADB. PWD is wholly owned by GoCG and has been equipped with adequate capacity to implement the project. A Project Director (PD) at PWD headquarter has been designated as person in charge for project implementation. The Environmental and Social Cell (ESC) at PWD, PIU-ADB headquarter, reporting to the Project Director, will be responsible for ensuring compliance with environmental and social safeguards of all roads under the project. The Deputy General Manager (DGM) of the PIU will be the nodal officer for environment and social safeguards. The DGM will be responsible for the overall management safeguards under the project, supported by an environment officer and a resettlement officer. Each project manager, who leads a field office, will be supported by an assistant project manager who will also serve as the safeguards focal at the site level. Project implementation support including for safeguards implementation will be provided to the PIU by the PMC. Three CSCs will supervise and manage the construction works including safeguards implementation. The civil works contractors will be responsible for implementing the EMP and will include

environment, health and safety officers in their team. An initial coordination cum training workshop will be organized by the CGPWD to clarify the roles and responsibilities of each party for complying with environment safeguard requirements. Continued hands on training will be conducted by the CSC or ADB as necessary during project implementation.

359. The detailed responsibilities of PWD PMU-ADB, PIUs, CSC, contractor and ADB are provided in the following sections.

1. PWD - PIU Responsibilities

360. The responsibilities will be for the following:

- i. Ensure that Project complies with ADB's SPS and GOI's laws and regulations;
- ii. Prepare IEE reports including EMP as may be required and hire an environmental consultant as required;
- iii. Prepare the Rapid Environmental Assessment screening checklist and forward this checklist to ADB for evaluation and confirmation of the project category;
- iv. Based on the confirmation of the environmental categorization of the subprojects, prepare TORs to conduct IEE studies including preparation of EMP and Environmental Monitoring Plan in accordance with the environmental policy principles and safeguard requirements under the ADB SPS;
- v. Ensure that the preparation of environmental studies will be completed with meaningful consultations with affected people and other concerned stakeholders, including civil society throughout the project preparation stages as required by the ADB SPS;
- vi. Review the budgetary needs for complying with the Government's and ADB's requirements on environment safeguards and ensure the proposed budget is in line with EMP;
- vii. Obtain necessary consents or permissions (e.g. environment permission, forest clearance) from relevant Government Agencies to minimize risks to the environment and mitigate environmental impacts associated. Also ensure that all necessary regulatory clearances will be obtained prior to commencing any civil work of the subproject;
- viii. Submit to ADB the final IEE including EMP reports with consent letter for disclosure of the report on the ADB website;
- ix. Ensure that the EMP which includes required mitigation measures and monitoring requirements forms part of bidding document after seeking concurrence from ADB. EMP items may be included in the Bill of Quantities (BOQ) as necessary;
- x. Ensure that contractors have access to the IEE report including EMP of the subproject;
- xi. Organize training and awareness programs on implementation of environment safeguards for relevant staff of PWD PIU-ADB, PIU, CSC and contractors;
- xii. Ensure that contractors understand their responsibilities to mitigate environmental problems associated with their construction activities;
- xiii. Ensure and Monitor that the EMP including Environmental Monitoring Plan will be properly implemented;
- xiv. In case of unanticipated environmental impacts during project implementation stage arrange to prepare and implement an updated EMP to account for such

- impacts after seeking concurrence from ADB. The updating shall be carried out after due consultation with the stake holders;
- xv. In case during project implementation a subproject needs to be realigned, review the environmental classification and revise accordingly, and identify whether supplementary IEE study is required. If it is required, prepare the TOR for undertaking supplementary IEE and hire an environment consultant to carry out the study;
 - xvi. Ensure that construction workers work under safe and healthy working environment in accordance with the World Bank EHS guidelines relating to occupational health and safety;
 - xvii. Ensure effective implementation of Grievance Redress Mechanism to address affected people's concerns and complaints, promptly, using understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people;
 - xviii. Submit semiannual monitoring reports (template provided in Appendix 13) for all sub-projects on the implementation of EMPs to ADB for disclosure on the ADB website;
 - xix. Ensure proper implementation of corrective action plan if identified in the monitoring report; and
 - xx. Disclose information as defined in the EMP
 - xxi. Verify and approve monitoring checklists and/or reports that will be prepared and submitted by the CSC;
 - xxii. In case of unanticipated environmental impacts during project implementation stage, identify the need to prepare and implement an updated EMP to account for such impacts after seeking concurrence from ADB;
 - xxiii. Ensure proper implementation of corrective action plan if identified in the monitoring report.

2. PMC Responsibilities

361. Environmental Specialist of the PMC will assist PIU in executing tasks and responsibilities are defined above.

3. CSC Responsibilities

362. The CSC of each package will be responsible for the following activities:

- i. Ensure that Project complies with ADB's SPS and GOI's laws and regulations;
- ii. Ensure that the project complies with all environment safeguard requirements as given in this IEE and EMP;
- iii. Provide necessary technical advice and support to the PIU and/or contractor to obtain consents or permissions (e.g. forest clearance, no objection certificate) from relevant Government Agencies. Also ensure that all necessary regulatory clearances will be obtained prior to commencing any civil work of the subproject;
- iv. Ensure that contractors have access to the IEE report including EMP of the subprojects;
- v. Ensure that contractors understand their responsibilities to mitigate environmental problems associated with their construction activities;
- vi. Closely coordinate and communicate with the contractor to facilitate implementation of all mitigation measures identified in EMP;
- vii. Conduct training and awareness programs on implementation of environment

- safeguards for PIU and the contractors during the pre-construction stage and further organize on the job or subject specific training for the contractor during project implementation as necessary;
- viii. Conduct regular on site monitoring to ensure proper implementation of the EMP including Environmental Monitoring Plan;
- ix. Prepare monitoring checklists and/or reports based on the site monitoring and submit them to the PIU for approval;
- x. In case of unanticipated environmental impacts during project implementation stage, upon the advice from the PIU prepare an updated EMP to account for such impacts after seeking concurrence from ADB;
- xi. Ensure that construction workers work under safe and healthy working environment;
- xii. Facilitate effective implementation of the approved Grievance Redress Mechanism to address affected people's concerns and complaints, promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people, and
- xiii. Prepare quarterly monitoring reports for subproject on the implementation of EMP for submission to PIU and PMC and further submission to ADB for disclosure on the ADB website.

4. Contractor's Responsibilities

363. The contractor will be responsible for the following activities:

- i. Ensure that adequate budget provisions are made for implementing all mitigation measures specified in the EMP;
- ii. Participate in training and awareness programs on implementation of environment safeguards;
- iii. Identify further needs for conduction of on the job or subject specific training during project implementation by the CSC or PWD, PMU or PIU;
- iv. Obtain necessary environmental permission etc. from relevant agencies as specified by IEE for project road works, quarries, hot-mix plant etc. prior to commencement of civil works contracts;
- v. Implement all mitigation measures as given in the EMP in the contract documents;
- vi. Ensure that all workers, site agents, including site supervisors and management participate in training sessions organized by the PIU, PWD -PCU or CSC;
- vii. Ensure compliance with environmental statutory requirements and contractual obligations;
- viii. Respond promptly to grievances raised by the local community or any stakeholder and implement environmental corrective actions or additional environmental mitigation measures as necessary, and
- ix. Based on the results of EMP monitoring, cooperate with the PIU and CSC to implement environmental corrective actions and corrective action plans, as necessary.

5. ADB's Responsibilities

364. ADB is responsible for the following:

- i. Review REA checklist and endorse or modify the project classification

- proposed by the PWD -PIU;
- ii. Review IEE report, including this environmental assessment and review framework, and disclose draft and final reports through ADB's website as required;
- iii. Issue subproject's approval based on the IEE report;
- iv. Monitor implementation of environment safeguard requirements under the project through due diligence missions;
- v. Provide assistance to PWD-PIU, if required, in carrying out its responsibilities for implementing environment safeguards and for building capacity for safeguard compliance; and
- vi. Review and approve semiannual environmental monitoring reports submitted by PIU and disclose them on the ADB website.

6. Institutional Capacity Building

365. To ensure that all parties clearly understand their role and responsibilities for implementing environment safeguards under the project, the following training and awareness programme is proposed:

- i. Awareness programme on environmental issues associated with construction and improvement of road projects and legislative compliance requirements.
 - **Target audience:** designated engineers from field units, contractor's
 - **Faculty:** Environmental Expert and Environment Expert of CSC.
 - **No. of Programmes:** Minimum one per contract package
- ii. EMP and EMoP implementation requirements, its benefits and roles of different level and functions.
 - **Target audience:** designated engineers from field units, contractor's officials, and key workers, other officials of PWD, PIU-ADB associated for the project.
 - **Faculty:** EE and Environment Expert of CSC.
 - **No of Programmes :** Minimum one per contract package

G. Environmental Management Budget

366. An environmental management budget of INR 19.48 million (US\$ 0.28 million) has been estimated for implementation of the environmental management plan. This budget also includes cost of environmental monitoring and associated trainings. A detail of environmental management budget is given in Table 56.

Table 55: Environmental Management Cost Estimate *

Sl. No.	Description	Quantity	Unit	Rate	Total Amount (Rs)	Responsibility
A	Forest Clearance and Compensatory Afforestation					
A1	Compensatory Afforestation and avenue plantation including 3 year maintenance	17580trees	Nos.	1000	17580000	PIU with Forest department
B	Environmental Monitoring					
B1	Air Quality monitoring during construction & operational stage	12	Nos.	10000	120000	PIU with Monitoring Person
B2	Notice Quality monitoring during construction & operational stage	12	Nos.	3000	36000	
B3	Water Quality monitoring for surface water during construction & operational stage	9	Nos.	5000	45000	
B4	Water Quality monitoring for ground water during construction & operational stage	9	Nos.	5000	45000	
B5	Soil Quality monitoring for surface during construction & operational stage	3	Nos.	10000	30000	
B6	Monitoring of tree survival during construction operational stage	3	Nos.	20000	60000	Monitoring with PIU
C	Noise Barrier and Protection of Ponds					
C1	3.5 m High of wall made from hollow bricks. In nearby School, Religious places, Hospital etc.	110	RM	1200	156000	
C2	Enhancement measures to protect ponds	4	LS	100000	400000	
D	Environmental Training					
D1	Training as per law	Lumsumb			1500000	
	Grand Total				Rs. 19,948,000.00	

X. CONCLUSIONS AND RECOMMENDATIONS

367. The subproject proposed for the improvement is classified as environment Category B projects as per ADB SPS requirements. As per GOI requirements major district roads do not fall in the purview of EIA Notification 2006 of MoEFCC, therefore as per GOI norms environmental clearance is not required for this subproject. For ADB the categorization has been done based on environmental screening and assessment of likely impacts. While the environmental assessment ascertains that it is unlikely to cause any major significant environmental impacts, some impacts were identified attributable to the proposed subproject, all of which are localized and temporary in nature and easy to mitigate.

368. Factors contributing to minimal impacts include, widening of the subproject road confined within the available RoW with minimum additional land acquisition, presence of no sensitive environmental issue like wildlife sanctuary, national park, bio reserve, with 10 km from the subproject road and most of water body crossed by the road are non-perennial in nature except which are already bridged.

369. The length of 6.450kms road section passes through forest area and forest clearance is required. There are no other ecologically sensitive areas along the subproject road neither there are any archaeological/protected monument located in the vicinity of subproject corridor. The land use pattern around the proposed alignment is predominantly agricultural except in patches of section where land use predominantly mix of built-up and agriculture land.

370. The potential adverse impacts of the road sections upgrading are:

- Impacts on surrounding area due to tree cutting (1758) for the proposed widening;
- Land acquisition of additional 12.900ha. area of agriculture land and 11.67ha. area of forest land for widening and geometry improvement
- Temporary impact on land and air environment due to locating construction camp;
- Temporary impact on land, air and water environment due to establishing and operating construction plants (Hot Mix Plant and Diesel Generator [DG] sets);
- Impacts on roadside flora and fauna particularly on sections of road passing through forest area;
- Impact on air quality, water quality, drainage, road users due to construction activities of project road;
- Impact on land and water environment due to improper disposal waste water and improper disposal of solid waste generated from camps and construction activities; and
- Impact on occupational health and safety due to all on-site and off-site construction works.

371. Measures such as use of EFRC i.e. slope protection measures are proposed to minimize the impacts of slope instability, compensatory afforestation @ 1:10 ratio, engineering alternatives to limit impacts on forest areas etc. are proposed to minimize the potential impacts.

372. Besides, series of mitigation measures have been proposed that are described in the IEE Report and addressed comprehensively in the environmental management plan. These include use of spoil disposal areas to minimize destruction of forests along the alignment, proper sizing of hydraulic structures to assure adequate capacity and prevent destruction of adjacent land, provision of sign boards along forest areas and other precious ecological zones,

identification of vulnerable community infrastructure that must be preserved or replaced under construction contracts, limits on location and access of workers and other provisions regarding construction to assure minimum impact, and other basic provisions on air pollution control, noise control, waste management as found in the EMP. All the above observations and mitigation measures will be included in the tender documents for contract works.

373. Application of these measures in parallel with MoRTH environmentally friendly road construction practices will reduce significantly any potential environmental impact. Impacts remaining on the physical environment (air and water pollution) are temporary and often occur away from the presence of people.

374. A systematic approach for surveillance and monitoring is provided by means of a management framework, and monitoring and reporting protocol. In general, the subproject received good support from local people. The local people appreciated that besides providing an all-weather efficient connectivity to large rural populations and improving the traffic scenario in the region, it will bear out several other socio-economic positive benefits. Follow-up public consultation is intended to provide future input to the identification of environmental impact during the construction phase as well as a grievance redress mechanism for project affected persons. The EMP is a living document and the same will be revised if necessary during subproject implementation or if there is any change in the subproject design and with approval of ADB during the construction period. The environmental mitigation measures are itemized in the EMP and the PIU shall ensure that EMP and EMoP are included in Bill of Quantity (BOQ) and forms part of bid document and civil works contracts for each package.

375. Before the start of civil works for the any section of the subproject roads, the project proponent (PWD, PIU-ADB) must obtain necessary clearances / permits from statutory authorities.

376. Environmental benefits of the proposed road improvement and long-term project objectives far outweigh the minor and temporary inconveniences that will arise during project construction. Provided the EMP is properly implemented there will be no unacceptable impacts arising from the project.

377. This IEE including EMP are considered sufficient to meet the environmental assessment requirements of ADB and Government of India. Therefore, a full environmental impact assessment study is not required.

APPENDICES

Appendix 1: ADB's Rapid Environmental Assessment (REA) Checklist

Country/Project Title: India / Chhattisgarh Road Connectivity Project

Sector Division: SARD - SATC

Screening Questions	Yes	No	Remarks
A. PROJECT SITING Is the project area adjacent to or within any of the following environmentally sensitive areas?			The proposed subproject road (Lambar-Bodesara-Birkol-Singhora Road) is not located in any environmentally sensitive/protected areas.
▪ Cultural heritage site		X	
▪ Protected Area		X	There are no environmentally sensitive/protected areas exist along the subproject road. Mitigation measures are included in the EMP to avoid impacts on flora and fauna in the forest areas. PWD, PMU-ADB will obtain necessary clearances/permits from statutory authority at State Level.
▪ Wetland		X	
▪ Mangrove		X	
▪ Estuarine		X	
▪ Buffer zone of protected area		X	
▪ Special area for protecting biodiversity		X	
B. POTENTIAL ENVIRONMENTAL IMPACTS Will the project cause...			
▪ encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?		X	The topography of subproject road sections is predominantly plain & rolling areas. Some impacts of landscape by road embankments, cuts and fills are anticipated. Proper management plan for will be required during construction to sustain the quarries.
▪ encroachment on precious ecology (e.g. sensitive or protected areas)?		X	
▪ alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?		X	Subproject areas are medium rainfall and it is not prone to floods. However small rivers/stream crosses the project road. Controlled construction activities will ensure sediment discharge into streams.

Screening Questions	Yes	No	Remarks
<ul style="list-style-type: none"> deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction? 		X	<p>During construction period suitable mitigation measures will be required to control the silt runoff.</p> <p>Adequate Sanitary facilities and drainage in the workers camps will help to avoid this possibility. As the construction activity in this project will not contain any harmful ingredients, no impact on surface water quality is anticipated.</p>
<ul style="list-style-type: none"> increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing? 	X		With appropriate mitigation measures and use of most modern environment friendly equipments/machineries air pollution shall be reduced to permissible levels.
<ul style="list-style-type: none"> risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation? 	X		Possible. With appropriate mitigation measures such risks would be minimized.
<ul style="list-style-type: none"> noise and vibration due to blasting and other civil works? 	X		Short term minor impact may occur during construction period, Suitable mitigation measures will be required to minimize the adverse effects
<ul style="list-style-type: none"> dislocation or involuntary resettlement of people? 		X	Improvement work will be restricted to existing ROW with minimum land acquisition in open areas/agriculture. Therefore no resettlement is required.
<ul style="list-style-type: none"> dislocation and compulsory resettlement of people living in right-of-way? 		X	Improvement work will be restricted to existing ROW. Therefore resettlement is not required.
<ul style="list-style-type: none"> disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups? 		X	Possible. Gender Action Plan and Indigenous People Development Plan shall be prepared as part of the Project.
<ul style="list-style-type: none"> other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress? 	X		Imposing of appropriate mitigation measures in contract agreement to keep the air pollution within permissible levels will keep a check on this problem.
<ul style="list-style-type: none"> hazardous driving conditions where construction interferes with pre-existing roads? 		X	To minimized the impact suitable traffic management plan will be required
<ul style="list-style-type: none"> poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations? 	X		<p>Proper provisions for sanitation, health care and solid waste disposal facilities will be available in the contract documents to avoid such possibility.</p> <p>Workers will be made aware about communicable diseases</p>
<ul style="list-style-type: none"> creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents? 		X	
<ul style="list-style-type: none"> accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials? 	X		Adoption of suitable traffic signage system at sensitive places will reduce such possibility.

Screening Questions	Yes	No	Remarks
▪ increased noise and air pollution resulting from traffic volume?	X		Due to improvement in Riding Quality & Comfort in driving due to unidirectional traffic such pollution will be reduced. Mitigation measures along with monitoring plan will be required
▪ increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?	X		Controlled construction activities and proper drainage system will reduce this possibility.
▪ social conflicts if workers from other regions or countries are hired?		X	Not anticipated. Local labors would be hired to the extent possible.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?	X		Possible.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?	X		Possible. EMP shall be followed to minimize this risk.
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.		X	Not anticipated.

A Checklist for Preliminary Climate Risk Screening

Country/Project Title:

Sector :

Subsector:

Division/Department:

Screening Questions		Score	Remarks ⁹
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	0	
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	0	
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	0	
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s) ?	0	
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	0	

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response, will be categorized as high risk project.

Result of Initial Screening (Low, Medium, High): _____ Low _____**Other****Comments:** _____**Prepared by:** _____

⁹ If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

Appendix 2: List of Proposed Road Sections and Packages

Package No	Road Name	Estimated Length (Km)	Category of Road
Package -A			
1	Tikarapara Sejbahar Semara Bhakhara Dhamtari Road (Old Dhamtari Road)	57.84	MDR
2	Chhura Rajim Road Vhaya Tarrighat Road	43.30	MDR
3	Panduka Jatmay Ghatarani Gaydbari Mudeli Mudagaon Road (Chhura Fingeshwar Road)	38.20	MDR
4	Dewari Saldih Gadfuljhar Toshgaon Toresingha Road	44.19	MDR
5	Ghotiya Palari Vatgan Ghirpuri Chikhali Samoda Achhola Tumgaon Road	43.70	MDR
6	Lambar Bodesara Birkol Singhora Road	40.00	MDR
7	Nipaniya Latuva Balodabazar Road	29.09	MDR
	Total	296.32	
Package -B			
8	Thelkadih Durg Road	28.23	MDR
9	Bihrikala Dangad Somatola Gotatola Khadgaon Road	39.34	MDR
10	Anda Runchirai Jamgaon Road	23.87	MDR
11	Dongargaon Khujji Pinapar Jevartala Road	23.43	MDR
12	Chhuikhadan Udaypur Bundeli Road	27.44	MDR
13	Purur Fagunda Palari Arar Belhari Jamgaon Road	28.00	MDR
14	Karhibhadar Nipani Mokha Batler Jamgaon Road	35.60	MDR
15	Kurud Megha Magrlod Amlidih Dhourabhatha Khisora Panduka Road	36.00	MDR
16	Budeni Nayapara Parsavani Magarlod Mohandi Borsi Bhoyena Road (Dhamtari SH-23)	67.90	SH-20
17	Kalle Anvari Semara Gadadih Hanchalpur Kurra Bagtarai Aamdi Raod	37.60	MDR
	Total	347.41	

Package -C			
18	Mangala Bhaisarjhar Road	26.12	MDR
19	Karubhatha Raksapali Kachhar Usrouth Tarapur Putkapuri Supa to NH-216 Road	48.34	MDR
20	Dharamjaygarh Kapu Road	32.87	MDR
21	Lormi to Paijania, Masna to Masni Jarhagaon Road	25.14	MDR
22	Sakti Tundri Road	31.70	SH-29
23	Pali to Silli Road	21.58	MDR
24	Bakaruma Lailunga Road	23.00	MDR
25	Jaijipur Malkharoda Chhoteseepat Paraswani Gobarabhata Road	18.06	MDR
	Total	226.81	

Note: Totals may not exactly match because of rounding

Appendix 3: Comparison of World Bank and GoI Ambient Air Quality Standards

A comparison between the ambient air quality requirements between the World Bank (WB) Environment, Health and Safety (EHS) guidelines and the National Ambient Air Quality standards (NAAQS) under the Air (Prevention and Control of Pollution) Act, 1981 of GOI as given in table below shows that the NAAQS has requirements on three more parameters (Pb, Co and NH₃) in comparison to the WB EHS. The NAAQS has differentiated standards for two types of areas: i) industrial, residential, rural and other areas and ii) ecologically sensitive areas. The WB EHS has guideline values which are the required standards but allows for gradual compliance to the guideline values through staged interim targets. Most WB EHS guideline requirements are more stringent than NAAQS except for the NO_x one year average in ecologically sensitive areas where the NAAQS requirements are more stringent.

Table 1: Ambient Air Quality standards of WB EHS Vs. the GOI NAAQS

Ambient Air Quality Parameter	Averaging Period	WB Guideline Value		GOI Standards for Industrial, Residential, Rural and Other Areas	GoI Ecologically Sensitive Area (notified by Central Government)
Sulfur dioxide (SO ₂) (ug/m ³)	24-hr	125	(Interim target 1)	80	80
		50	(Interim target 2)		
		20	(guideline)		
	10 min	500	(guideline)		
	Annual	None		50	20
Nitrogen dioxide (NO ₂) (ug/m ³)	1 Year	40	(guideline)	40	30
	24 Hour	None		80	80
	1 Hour	200	(guideline)		
PM ₁₀ (ug/m ³)	1 Year	70	(Interim target 1)		
		50	(Interim target 2)		
		30	(Interim target 3)		
		20	(guideline)	60	60
	24-hr	150	(Interim target 1)		
		100	(Interim target 2)		
		75	(Interim target 3)		
		50	(guideline)	100	100
PM _{2.5} (ug/m ³)	1 year	35	(Interim target 1)		
		25	(Interim target 2)		
		15	(Interim target 3)		
		10	(guideline)	40	40
	24-Hour	75	(Interim target 1)		
		50	(Interim target 2)		
		37.5	(Interim target 3)		
		25	(guideline)	60	60
Ozone (O ₃) (ug/m ³)	8-hr daily max	160	(Interim target 1)		
		100	(guideline)	100	100
Lead (Pb) (ug/m ³)	Annual			0.5	0.5
	24 hours			1.0	1.0
Carbon Monoxide (CO) (ug/m ³)	8 hours			2000	2000
	1 hour			4000	4000
Ammonia	Annual			100	100

Ambient Air Quality Parameter	Averaging Period	WB Guideline Value		GOI Standards for Industrial, Residential, Rural and Other Areas	GOI Ecologically Sensitive Area (notified by Central Government)
(NH ₃) µ/m ³	24 hours			400	400

Appendix 4: Comparison of WB EHS and GoI Ambient Noise Level Standards

A comparison on noise level requirements between the WB EHS guidelines and the NAAQS under the Air (Prevention and Control of Pollution) Act, 1981 of GOI as given in table B shows that the required levels are equal for residential, institutional and educational areas. The NAAQS requirements for commercial areas are more stringent while the WB EHS requirement for daytime noise in industrial area is more stringent.

Table 2: Ambient Noise level standards of WB EHS Vs. the GOI NAAQS

Receptor	WB EHS		GOI NAAQS	
	Daytime	Nighttime	Daytime	Nighttime
	7:00-22:00	22:00-7:00	6:00-22:00	22:00-6:00
Residential	55	45	55	45
Institutional; educational			None	None
Industrial	70	70	75	70
Commercial			65	55
Silence Zone	None	None	50	40

Appendix 5: Indian Standard Drinking Water Specification: IS 10500:1991

Sl. No.	Substance/ Characteristic	Desirable Limit	Permissible limit	Remarks
1	Colour, Hazen units, Max	5	25	Extended to 25 if toxic substance are not suspected in absence of alternate sources
2	Odour	Unobjectionable		a) Test cold and when heated b) Test at several dilution
3	Taste	Agreeable		Test to be conducted only after safety has been established
4	Turbidity NTU, Max	5	10	
5	pH value	6.5 to 8.5	No relaxation	
6	Total Hardness (as CaCO ₃ mg/lit)	600	600	
7	Iron (as Fe mg/lit, Max	0.3	1.0	
8	Chlorides (as Cl mg/lit Max	250	1000	
9	Residual Free Chlorine, mg/lit Max	0.2		To be applicable only when water is chlorinated. Treated at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/lit
10	Dissolved Solids mg/l, Max	500	2000	
11	Calcium (as Ca) mg/l, Max	75	200	
12	Copper (as Cu) mg/l, Max	0.05	1.5	
13	Manganese (Mn) mg/l Max	0.1	0.3	
14	Sulphate (As SO ₄), Max	200	400	May be extended up to 400 provided (as Mg) does not exceed 30
15	Nitrate (as NO ₃) mg/l, Max	45	100	
16	Fluoride (as F) mg/l, Max	1.0	1.5	
17	Phenolic Compounds (as C ₆ H ₅ OH) mg/l Max	0.001	0.002	
18	Arsenic (as As mg/l	0.05	No relaxation	To be tested when pollution is suspected
19	Lead (as Pb) mg/l	0.05	No relaxation	
20	Anionic Detergents (as MBAS) mg/l	0.2	1.0	
21	Chromium (as Cr) mg/l	0.05	1.0	To be tested when pollution is suspected
22	Mineral Oil mg/l	0.01	0.03	
23	Alkalinity mg/l	200	600	
24	Total Coliform	95% of the sample should not contain coliform in 100 ml. 10 coliform /100 ml		

Appendix 6: Record Of Public Consultations



List of Stakeholders/Participant at Public Consultation Meeting

S. No.	Name & Address of Respondent	Occupation	Signature	Remarks/Opinions
1	Sant Pradhan	Shopkeeper		Ther lane
2	Laam chand	"		
3	Praveshan	Farmer		
4	Tikendra Sahu	"		Managing Field
5	Satyamand	"		
6	Ram Prasad	Labour		
7	Jai Lal bati	Shop		Start light
8	Sant Ram	Farmer		
9	Narayan Sando	Farmer		
10	Jaswantam Bag	Farmer		
11	Meeza Bag	Farmer		
12				

List of Stakeholders/Participant at Public Consultation Meeting				
S. No.	Name & Address of Respondent	Occupation	Signature	Remarks/Opinions
1	Hemraj Bhoi	Farmer	[Signature]	
2	Prasad Bhoi	Doctor	[Signature]	
3	Parasur Bhoi	Farmer	[Signature]	
4	Kesat Bhoi	Farmer	[Signature]	
5	Dole Bhoi	Shop	[Signature]	
6	Kuber	Shop	[Signature]	
7	Anum	Shop	[Signature]	
8	Manoj Kumar Pandey	Farmer	[Signature]	
9	Raj Pandey	Farmer	[Signature]	
10	Omprakash Pandey	"	[Signature]	
11	Sankar Pandey	"	[Signature]	
12	Kunwar Pandey	Shop	[Signature]	
13	Pratul Pandey	"	[Signature]	
14	Jagdishwar Pandey	"	[Signature]	

List of Stakeholders/Participant at Public Consultation Meeting				
S. No.	Name & Address of Respondent	Occupation	Signature	Remarks/Opinions
1	Abhishek Pandey	Shipyard	[Signature]	
2	Vishwanath Pandey	"	[Signature]	
3	Vikram Bhoi	Labourer	[Signature]	
4	Kailash Bhoi	Farmer	[Signature]	
5	Chandrabhan Bhoi	"	[Signature]	
6	Ramkrishna Bhoi	Labourer	[Signature]	
7	Chandrabhan Pandey	Driver	[Signature]	
8	Jogendra	Farmer	[Signature]	
9	Mahipal Pandey	Shipyard	[Signature]	
10	Tooli Bhoi	Carpenter	[Signature]	

Appendix 7: GRM Information Sheet

सहमति पत्र

(व्यक्तिगत रूप से हस्ताक्षर करने हेतु)

यह सहमति पत्र दिनांक _____ 2019 को श्री/श्रीमति _____
निवासी _____(जिन्हे बाद में प्रथम पक्ष कहा जायेगा) एवं छत्तीसगढ़
राज्य लोक निर्माण विभाग की तरफ से श्री _____(पक्ष)
_____(जिन्हे बाद में द्वितीय पक्ष कहा जायेगा) के मध्य हस्ताक्षरित किया गया।

गवाहों/साक्षी की उपस्थिति में यह दस्तावेज निष्पादित किया गया है।

- 1- यह कि प्रथम पक्ष दुकान का स्वामी/किरायेदार/अतिक्रमणधारी /फेरी वाला है। तथा वह अपना _____व्यवसाय पिछले _____वर्षों से इस स्थान पर चला रहा है। दुकानदार इस दुकान का पट्टेदार है/नहीं है। प्रस्तावित सड़क के निर्माण के दौरान व्यवसाय का स्वामी/पट्टेदार का व्यवसाय तथा आमदनी सड़क निर्माण के दौरान बाधित होने की आशंका है। यह कालावधि 30 दिन से अधिक नहीं होगी।
- 2- यह कि प्रथम पक्ष ने छत्तीसगढ़ राज्य सड़क संपर्क परियोजना (MDR & State Highway) की आवश्यकताओं के तहत आयोजित सार्वजनिक लोक सहमति में भाग लिया है, रोड निर्माण से प्राप्त होने वाले लाभ को समझ लिया है एवं रोड निर्माण हेतु सहमति दे दी है।
- 3- यह कि प्रथम पक्ष द्वारा अपनी मर्जी से ग्राम _____तहसील _____में परियोजना अंतर्गत रोड निर्माण विकास हेतु आपनी आजीविका में संभावित अस्थायी व्यवधान को देखते हुये भी सहमति प्रदान की है।
- 4- यह कि प्रथम पक्ष रोड निर्माण से होने वाले अस्थायी आजीविका व्यवधान के खिलाफ किसी भी प्रकार के मुआवजे का दावा नहीं करेगा।
- 5- यह कि द्वितीय पक्ष को अस्थायी आजीविका व्यवधान संबंधित सहमति स्वीकार है।

- 6- यह कि द्वितीय पक्ष निर्माण कार्य के दौरान रोड के समीप स्थित सभी व्यवसायिक इकाईयों को नुकसान से बचाने के लिये सभी संभव सावधानियां पूर्वक कार्य करेगा।
- 7- यह कि प्रथम पक्ष द्वारा द्वितीय पक्ष को यह आश्वासन दिया जाता है कि यह परियोजना अंतर्गत रोड निर्माण को किसी प्रकार का नुकसान नहीं पहुँचायेगा, ना ही सार्वजनिक वाहनों के आवागमन में व्यवधान पैदा करेगा एवं ना ही ऐसे कार्यों में शामिल होगा।
- 8- यह कि दोनों पक्ष परियोजना अंतर्गत प्रस्तावित इस रोड निर्माण हेतु सहमत है।
- 9- यह कि हस्ताक्षरित किये जाने की तारीख से यह सहमति पत्र प्रभावी होगा।

साक्षी/गवाहों की उपस्थिति में दोनों पक्षों ने उपर लिखित तारीख को इस पत्रक को हस्ताक्षरित किया है।

हस्ताक्षर प्रथम पक्ष

द्वितीय पक्ष की ओर से अधिकृत
(मोहर सहित)

गवाह

गवाह

1- हस्ताक्षर.....

1- हस्ताक्षर.....

नाम -.....

नाम -.....

पूरा पता -.....

पूरा पता -.....

2-हस्ताक्षर.....

2- हस्ताक्षर.....

नाम -.....

नाम -.....

पूरा पता -.....

पूरा पता -.....

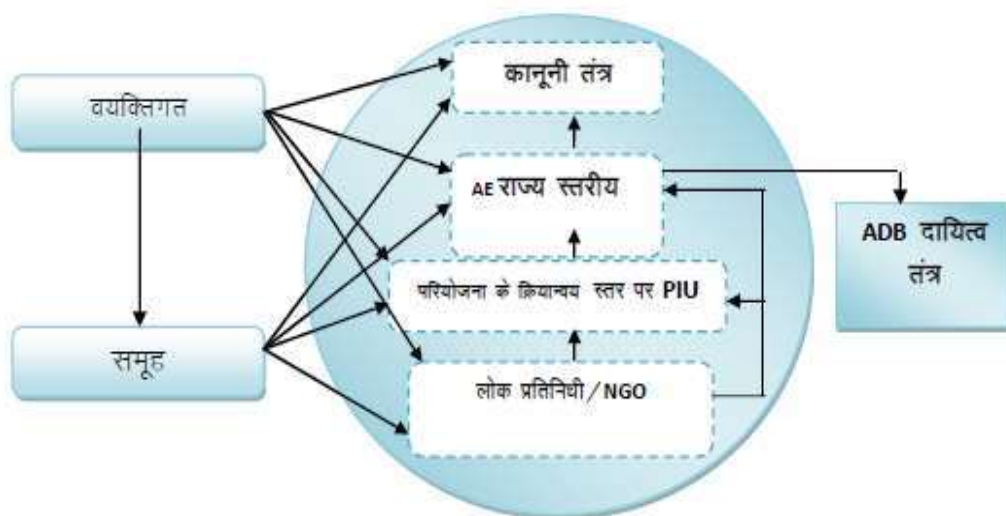
(गवाह/साक्षी में गांव के सरपंच, ग्राम पंचायत के सदस्य, डी.पी.आर. कंसलटेन्ट के प्रतिनिधि, गैर शासकीय संगठनों के प्रतिनिधि तथा ग्राम के बुजुर्ग/वरिष्ठ नागरिकों को शामिल किया जा सकता है)

शिकायत निवारण तंत्र

- 5.1 सड़क निर्माण परियोजना से संबंधित विशेष शिकायत निवारण तंत्र (GRM) स्थापित किया जायेगा जिसके तहत विस्थापित व्यवसायिक इकाईयाँ, संबंधित शिकायतों, सामाजिक तथा पर्यावरण संबंधित शिकायतों का निराकरण करने की सुविधापरियोजना स्तर पर प्रदान की जायेगी, यह तंत्र सामाजिक तथा पर्यावरण संबंधी समस्या, शिकायत या शकाओं के निवारण में सहायक सिद्ध होगा। यह परियोजना प्रभावित व्यक्तियों की शंकाओं तथा समस्या निराकरण करने के उद्देश्य से निर्मित किया गया है। GRM का उद्देश्य शासन की निवारण प्रक्रिया को नज़र अंदाज़ करना नहीं है बल्कि जन साधारण को निर्माण से होने वाले लाभ को बताना तथा पारदर्शिता के साथ समस्या तथा शंकाओं का निवारण करना है।
- 5.2 निवारण प्रक्रिया (RP) यह तंत्र प्रभावी तरीके से जन साधारण/लोक सामान्य को इस कार्य के लाभ बतलाते हुए तार्कजिनिक सहमति प्राप्त करेगा शिकायत निवारण सहमति (GRC) एक समय सीमा में समस्या निवारण कार्य करेगी। कमेटी का निर्णय मा न्यायालय के आदेश पूर्व बाध्यकारी होगा इस समिति को परियोजना के प्रबंध संचालक की अध्यक्षता में गठित किया जायेगा। RU स्तर पर प्रबंधक (PM) पुर्नवास अधिकारी, NGO के प्रतिनिधी, समाज के प्रतिष्ठित व्यक्ति, जन प्रतिनिधी, जिला परिषद प्रतिनिधी, कमजोर तबके के व्यक्ति तथा 2 महिला प्रतिनिधी शामिल होंगे जो परियोजना कार्य पूर्ण होने तक पदस्थ रहेंगे।
- 5.3 शिकायत निवारण समिति द्वारा शिकायत को 3 सप्ताह के दौरान प्रतिक्रिया करेगी। निर्माण कार्य के पूर्व समस्त शिकायतों व शंकाओं का समाधान कर लिया जायेगा।

शिकायत निवारण समिति की बैठक 3 सप्ताह में कम से कम एक बार अवश्य होगी, माननीय न्यायालय के तहत स्वामित्व अधिकारी से संबंधित विवादों के अलावा यह समितित समस्त पुर्नवास स्थानारतण, मुआवजे के भुगतान तथा अन्य सहायता हेतु चरण बन्द कार्य करेगी।

शिकायत निवारण प्रक्रिया तंत्र



Appendix 8: Environmental Management and Monitoring Plan (Contract Package No. 6)

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
A. Pre-construction and Design Stage								
1. Alignment								
1.1 Pavement damage and inadequate drainage provision habitat areas	<ul style="list-style-type: none">Construction of concrete pavement in habitat areas considering alignment level and drainage.Raise road level above the nearby areas with provision of adequate side drains to evacuate the rainwater an domestic discharges (drained by habitats occasionally to prevent damage to road and rain water entry to habitats' houses.Provision of adequate no. of cross drainage structures based on drainage pattern around the alignment	Design requirement	All habitat areas throughout the alignment	Design of both cross & side drains, no. of slab/box culverts, no & size of Hume pipes	Review of detail design documents & drawings	Included in construction cost	Design Consultant	PIU (CSC)
1.2 Loss of about 1758 trees and vegetation cover	<ul style="list-style-type: none">Restricting tree cutting within construction limit.Avoiding tree cutting at ancillary sites.Providing and maintaining compensatory tree plantation of 17580tress @ 1:10 ratio.	Design requirement	Throughout the alignment	Number of trees to be cut	Observations	Included in construction cost	Design Consultant	PIU (CSC)
1.3 Protection of sensitive receptors	<ul style="list-style-type: none">Careful selection of alignment to avoid damages to the sensitive receptorsTimely scheduling of construction activitiesProvision of noise suitable barriers	Project requirement	Locations of temples, schools and other sensitive receptors along the project roads (Refer to Table 32 of IEE Report).	Design and alignment plan	Review of design	Included in construction cost	Contractor	
1.4 Safety along the proposed alignment	<ul style="list-style-type: none">Make provisions of crash barriers at accident prone areas as identified in the road safety studiesProvision of rumble strips in habitat areas to regulate speed.	Design requirement	Places where height of embankment is more than 3.0 m.	No. of accident & Vehicle collision	Field observation interview of locals	Included in construction cost	Design Consultant	PIU (CSC)

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<ul style="list-style-type: none"> Provision of retro-reflective warning sign boards nears school, hospital, religious places and forests areas Provision of proper side-walks /pedestrian zone along the road near habitat areas, school, hospital, religious places and forests Compliance with norms specified in IRC codes for state highway for curvature and grading Provision of safety kerb at all bridges The design should attempt to equalize cut and fill. Minimize the cutting in hill areas. Incorporate slope stabilization measures to prevent any land slide situation. 							
2. Natural Hazards								
2.1 Protection for damage from Earthquake	<ul style="list-style-type: none"> Design considering seismic standards stipulated in the clause under IRC: 6-2014 for earthquakes in bridges 		Throughout the stretch	Incorporation of IRC guidelines for earthquake in bridge design	Review of bridge design	Project preparation Cost	Design Consultant	PIU (CSC)
2.2 Protection of road embankment in Flood prone Areas	<ul style="list-style-type: none"> Raise embankment height above the HFL levels in the flood prone areas. Provision of adequate balancing culverts. Improvement in existing culverts/ Bridges to increase their carrying capacity. 	IRC: 34 Recommendations for road construction in waterlogged area and IRC: 75 and MORT&H guidelines for Design of High Embankments	All the existing culverts/ bridges.	Design of both cross & side drains, no. of slab/box culverts, no & size of Hume pipes		Included in construction cost	Design Consultant	PIU (CSC)
3. Shifting of utility structures								
3.1 Disruption of utility services to local community	<ul style="list-style-type: none"> All telephone and electrical poles/wires and underground cables should be shifted before start of construction Necessary permission and payments should be made to 	Project requirement	Throughout the corridor	Utility shifting plan Complaints from local people	Interaction with concerned utility authorities and local	Included in construction.	Contractor/CS C	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	relevant utility service agencies to allow quick shifting and restoration of utility services <ul style="list-style-type: none"> Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services if any 			Status of local utility services	public			
B. Construction Stage								
1. Air Quality								
1.1 Dust Generation due to construction activities and transport, storage and handling of construction materials	<ul style="list-style-type: none"> Transport, loading and unloading of loose and fine materials through covered vehicles. Paved approach roads. Storage areas to be located downwind of the habitation area. Water spraying on earthworks, unpaved haulage roads and other dust prone areas. Provision of PPEs to workers. 	MORT&H Specifications for Road and Bridge works Air (P and CP) Act 1981 and Central Motor and Vehicle Act 1988	Throughout project corridor.	PM10 level measurements Dust pollution or complain of locals	Standards CPCB methods Observations Public consultation	Included in project cost	Contractor	PIU (SQC)/CSC
1.2 Emission of air pollutants (HC, SO2, NOX, CO etc) from vehicles due to traffic congestion and use of equipment and machinery	<ul style="list-style-type: none"> Regular maintenance of machinery and equipment. Batching, asphalt mixing plants and crushers at downwind (1km) direction from the nearest settlement. Only crushers licensed by the PCB shall be used DG sets with stacks of adequate height and use of low sulphur diesel as fuel. Ambient air quality monitoring Follow traffic management plan as given in Section 8. 	The Air (Prevention and Control of Pollution) Act, 1981 (Amended 1987) and Rules 1982	Asphalt mixing plants, crushers, DG sets locations	Monitoring of ambient air quality & checking PUC certificates	Standards CPCB methods	Included in project cost	Contractor	PIU (SQC)/CSC
2. Noise								
2.1 Noise from construction vehicle, equipment and machinery.	<ul style="list-style-type: none"> All equipment to be timely serviced and properly maintained. Bottlenecks to be removed. Construction equipment and machinery to be fitted with silencers and maintained properly. Only IS approved 	Legal requirement Noise Pollution (Regulation and Control) Rules, 2000 and amendments	Throughout project section especially at construction sites,	Noise levels Measurements Complaints from local people	As per Noise rule, 2000 Consultation with local people	Included in Project Cost Plantation cost is separate	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<p>equipment shall be used for construction activities.</p> <ul style="list-style-type: none"> Timing of noisy construction activities shall be done during night time and weekends near schools and selected suitable times near temples when there are no visitors, concurrent noisy operations may be separated to reduce the total noise generated, and if possible re-route traffic during construction to avoid the accumulation of noise beyond standards. Else provision of temporary noise barrier at sensitive locations or near sources. Time regulation near residential, built up and forest areas construction shall be restricted to daylight hours. Initiation of multi layered plantation, to serve as mitigation option for operation phase Honking restrictions near sensitive areas PPEs to workers Noise monitoring as per EMoP. 	thereof + Clause No 501.8.6. MORT&H Specifications for Road and Bridge works	residential and identified sensitive locations.					
3. Land and Soil								
3.1 Land use Change and Loss of productive/top soil	<ul style="list-style-type: none"> Non-agricultural areas to be used as borrow areas to the extent possible. If using agricultural land, top soil to be preserved and laid over either on the embankment slope for growing vegetation to protect soil erosion. 	Project requirement	Throughout the project section and borrow areas	Borrow pit locations Top soil storage area	Review borrow area plan, site visits	Included in construction cost	Contractor	PIU (SQC)/CSC
3.2 Slope failure and Soil erosion due to Construction	<ul style="list-style-type: none"> Bio-turfing of embankments to protect slopes. Slope protection by providing frames, dry stone pitching, 	IRC: 56 -1974 Recommended practice for treatment	Throughout the entire project road especially	Occurrence of slope failure or erosion issues	Review of design documents and site	Included in Construction cost	Design consultant and Contractor,	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
activities, earthwork, and cut and fill, stockpiles etc.	masonry retaining walls, planting of grass and trees. <ul style="list-style-type: none"> The side slopes of all cut and fill areas will be graded and covered with stone pitching, grass and shrub as per design specifications. Care should be taken that the slope gradient shall not be greater than 2:1. The earth stockpiles to be provided with gentle slopes to prevent soil erosion. 	of embankment slopes for erosion control Clause No. 306 and 305.2.2 MORT&H Specifications for Road and Bridge works Guidelines IX for Soil erosion	along hilly areas		observation			
3.3 Borrow area management	<ul style="list-style-type: none"> Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions/consents. Depths of borrow pits to be regulated and sides not steeper than 25%. Topsoil to be stockpiled and protected for use at the rehabilitation stage. Transportation of earth materials through covered vehicles. IRC recommended practice for borrow pits (IRC 10: 1961). Borrow areas not to be dug continuously. To the extent borrow areas shall be sited away from habitated areas. Borrow areas shall be leveled with salvaged material or other filling materials which do not pose contamination of soil. Else, it shall be converted into fishpond in consultation with fishery department and land owner/community. Rehabilitation of the borrow areas as per Guidelines for redevelopment of Borrow Areas. 	IRC Guidelines on borrow areas and for quarries (Environmental Protection Act and Rules, 1986; Water Act, Air Act) + Clause No. 305.2.2 MORT&H Specifications for Road and Bridge works Guidelines V for Borrow Areas management	Borrow sites location	Existence of borrow areas in inappropriate unauthorized locations. Poor borrow area management practices. Incidents of accidents. Complaints from local people.	Review of design documents and site observation	Included in Construction cost	Design consultant and Contractor,	PIU (SQC)/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<ul style="list-style-type: none"> Sand mining activities will be performed as per state/national regulations from licenced borrow and quarries areas. 							
3.4 Quarry Operations	<ul style="list-style-type: none"> Aggregates will be sourced from existing licensed quarries. Copies of consent/ approval / rehabilitation plan for a new quarry or use of existing source will be submitted to EO, PIU. The contractor will develop a Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy of the approval to PIU. 	Clause No. 111.3 MORT&H Specifications for Road and Bridge works Guidelines VI for Quarry Areas Management	Quarry area locations	Existence of licenses for all quarry areas from which materials are being sourced Existence of a quarry redevelopment plan Complaints from local people.	Review of design documents, contractor documents and site observation	Included in Construction	Contractor	PIU (SQC)/CSC
3.5 Compaction of soil and impact on quarry haul roads due to movement of vehicles and equipment	<ul style="list-style-type: none"> Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction. Approach roads/haulage roads shall be designed along the barren and hard soil area to reduce the compaction. Transportation of quarry material to the dumping site through heavy vehicles shall be done through existing major roads to the extent possible to restrict wear and tear to the village/minor roads. Land taken for construction camp and other temporary facility shall be restored to its original conditions. 	Design requirement	Parking areas, Haulage roads and construction yards.	Location of approach and haulage roads Presence of destroyed/compacted agricultural land or land which has not be restored to its original condition	Site observation	Included in construction cost	Contractor	PIU (SQC)/CSC
3.6 Contamination of soil due to leakage/ spillage of oil, bituminous and non bituminous	<ul style="list-style-type: none"> Construction vehicles and equipment will be maintained and refueled in such a fashion that oil/diesel spillage does not contaminate the soil. Fuel storage and refueling sites to be kept away from drainage channels. 	Design requirement	Fuelling station, construction sites, and construction camps and disposal	Quality of soil near storage area Presence of spilled oil or bitumen in project area	Site observation	Included in construction cost.	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
debris generated from demolition and road construction	<ul style="list-style-type: none"> Unusable debris shall be dumped in ditches and low lying areas. To avoid soil contamination Oil-Interceptors shall be provided at wash down and refueling areas. Waste oil and oil soaked cotton/cloth shall be stored in containers labeled 'Waste Oil' and 'Hazardous' sold off to MoEFCC/SPCB authorized vendors Non-bituminous wastes to be dumped in borrow pits with the concurrence of landowner and covered with a layer of topsoil conserved from opening the pit. Bituminous wastes will be disposed off in an identified dumping site approved by the State Pollution Control Board 		location.					
4. Water Resources								
4.1 Sourcing of water during Construction	<ul style="list-style-type: none"> Requisite permission shall be obtained for abstraction of groundwater from Central Groundwater Authority Arrangements shall be made by contractor that the water availability and supply to nearby communities remain unaffected. 	-	Throughout the Project section	Approval from competent authority Complaints from local people on water availability	Checking o documentation Talk to local people	Included in construction cost	Contractor	PIU (SQC)/CSC
4.2 Disposal of water during construction	<ul style="list-style-type: none"> Provisions shall be made to connect road side drains with exiting nearby ponds otherwise make provision of water harvesting pits intermittently. 	Clause No. 1010 EP Act 1986 MORT&H Specifications for Road and Bridge works	Throughout the Project section	Design of road side drains Existence of proper drainage system for disposal of waste water	Standards methods Site observation and review of documents	Included in construction cost	Contractor	PIU (SQC)/CSC
4.3 Alteration in surface water hydrology due to embankment	<ul style="list-style-type: none"> Existing drainage system to be maintained and further enhanced. Provision shall be made for adequate size and number of 	Design requirement, Clause No 501.8.6.	Near all drainage channels, river crossings	Design of road side drains	Review of design documents Site	Included in construction cost	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	cross drainage structures esp. in the areas where land is sloping towards road alignment. <ul style="list-style-type: none"> Road level shall be raised above HFL level wherever road level is lesser than HFL. 	MORT&H Specifications	etc.		observation			
4.4 Siltation in water bodies due to construction activities/ earthwork	<ul style="list-style-type: none"> Embankment slopes to be modified suitably to restrict the soil debris entering water bodies. Provision of Silt fencing shall be made at water bodies. Silt/sediment should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated. Earthworks and stone works to be prevented from impeding natural flow of rivers, streams and water canals or existing drainage system. 	Design requirement , Clause No 501.8.6. MORT&H Specifications for Road and Bridge works (CP and CP) and worldwide best practices	Near all water bodies, river embankment slopes.	Siltation of rivers, streams, ponds and other water bodies in project area	Field observation	Included in construction cost	Contractor	PIU (SQC)/CSC
4.5 Deterioration in Surface water quality due to leakage from vehicles and equipments and waste from construction camps.	<ul style="list-style-type: none"> No vehicles or equipment should be parked or refueled near water-bodies, so as to avoid contamination from fuel and lubricants. Oil and grease traps and fuelling platforms to be provided at re-fuelling locations. All chemicals and oil shall be stored away from water and concreted platform with catchment pit for spills collection. All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including reporting, will be 	The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof.	Water bodies, refuelling stations, construction camps.	Water quality of ponds, streams, rivers and other water bodies in project Presence of oil floating in water bodies in project area	Conduction of water quality tests as per the monitoring plan Field observation	Included in construction cost	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	provided by the contractors							
	<ul style="list-style-type: none"> Construction camp to be sited away from water bodies. Wastes must be collected, stored and taken to approve disposal site only. Water quality shall be monitored periodically 							
5.Flora and Fauna								
5.1 Vegetation loss due to site preparation and construction activities and	<ul style="list-style-type: none"> Minimize tree cutting to the extent possible. Roadside trees to be removed with prior approval of competent authority. Compensatory plantation of 17580 trees at 1:10 basis and additional plantation as per the IRC guidelines in consultation with Forest Department. Regular maintenance of all trees planted. Provision of LPG in construction camp as fuel source to avoid tree cutting, wherever possible. Plantation of trees on both sides of the road. Integrate vegetation management (IVM) with the carriage way completely clear of vegetation. From the edge of the road to the boundary of ROW , vegetation structured with smaller plants near the line and larger trees further away to avoid costly and provide habitats for a wide variety of plant and animals. Additional plantation near river banks to check erosion as part of compensatory plantation. In the event of design changes during the construction stages additional assessments including 	Forest Conservation Act 1980 + IRC SP: 21 and IRC SP:66	Throughout project corridor	ROW width Number of trees for felling Compensatory plantation plan Number of trees replanted	Review of relevant documents – tree cutting permit, compensatory plantation plan Field observation s	Road side Plantation cost is included in project costs.	Relevant agency specialized in afforestation	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<p>the possibility to save trees shall be made by the EA.</p> <ul style="list-style-type: none"> Road side Plantation Strategy as per IRC specifications including manuring. Controlled use of pesticides/ fertilizers 							
6. Construction Camps								
6.1 Impact associated with location	<ul style="list-style-type: none"> All camps should maintain minimum distance from following: # 500 m from habitation # 500 m from forest areas where possible # 500 m from water bodies where possible # 500 m from through traffic route where possible The average distance between two camps should be 50 km 	Design Requirement	All construction camps	Location of campsites and distance from habitation, forest areas, water bodies, through traffic route and other construction camps	<p>On site observation</p> <p>Interaction with workers and local community</p>	Included in construction cost	Contractor and EO	PIU (SQC)/CSC
6.2 Worker's Health in construction camp	<ul style="list-style-type: none"> The location, layout and basic facility provision of each labor camp will be submitted to SQC prior to their construction. The construction shall commence only after approval of SQC. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner as approved by the EA. Adequate water and sanitary latrines with septic tanks attached to soak pits shall be provided. Preventive medical care to be provided to workers including a First-Aid kit that must be available in the camp. Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out . 	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof	All construction camps	<p>Camp health records</p> <p>Existence of proper first aid kit in camp site</p> <p>Complaints from local people</p>	<p>Camp records</p> <p>Site observation</p> <p>Consultation with local people living nearby</p>	Part of the Contractors costs	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<ul style="list-style-type: none"> The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides which should comply with local regulations. No alcoholic liquor or prohibited drugs will be imported to, sell, give, barter to the workers of host community. Awareness raising to immigrant workers/local community on communicable and sexually transmitted diseases. 							
7. Management of Construction Waste/Debris								
7.1 Selection of Dumping Sites	<ul style="list-style-type: none"> Unproductive/wastelands shall be selected for dumping sites. Away from residential areas and water bodies Dumping sites have adequate capacity equal to the amount of debris generated. Public perception and consent from the village Panchayats has to be obtained before finalizing the location. 	Design Requirement and MORT&H guidelines	At all Dumping Sites	Location of dumping sites Public complaints	Field survey and interaction with local people	Included in construction cost.	Contractor.	PIU (SQC)/CSC
7.2 Reuse and disposal of construction and dismantled waste	<ul style="list-style-type: none"> The existing bitumen surface shall be utilized for paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions, and haulage routes. All excavated materials from roadway, shoulders, verges, drains, cross drainage will be used for backfilling embankments, filling pits, and landscaping. Unusable and non-bituminous debris materials should be suitably disposed off at pre-designated disposal locations, with approval of the concerned authority. The 	MORT&H guidelines	Throughout the project corridor	Percentage of reuse of existing surface material Method and location of disposal site of construction debris	Contractor records Field observation Interaction with local people	Included in construction cost.	Contractor.	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	bituminous wastes shall be disposed in secure landfill sites only in environmentally accepted manner. For removal of debris, wastes and its disposal MOSRTH guidelines should be followed. <ul style="list-style-type: none"> Unusable and surplus materials, as determined by the Project Engineer, will be removed and disposed off-site. 							
8. Traffic Management and Safety								
8.1 Management of existing traffic and safety	<ul style="list-style-type: none"> Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'. The traffic control plans shall contain details of diversions; traffic safety arrangements during construction; safety measures for night time traffic and precautions for transportation of hazardous materials. control plans shall be prepared in line requirements of IRC's SP 55 document'. The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed. Restriction of construction activity to only one side of the existing road. The contractor shall inform local community of changes to traffic routes, and pedestrian access arrangements with assistance from "Engineer". 	Design requirement and IRC SP:55	Throughout the project corridor especially at intersections .	Traffic management plan Safety signs on site Number of traffic accidents	Review traffic management plan Field observation of traffic management and safety system Interaction with people in vehicles using the road	Included in construction cost.	Contractor	PIU (SQC)/CSC
	<ul style="list-style-type: none"> Use of adequate signages to ensure traffic management and 							

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	safety. Conduct of regular safety audit on safety measures.							
8.2 Pedestrians, animal movement	<ul style="list-style-type: none"> Temporary access and diversion, with proper drainage facilities. Access to the schools, temples and other public places must be maintained when construction takes place near them. Fencing wherever cattle movement is expected. To avoid the need for cattle underpasses, some of the proposed culverts near habitations may be widened to facilitate cattle movement. 	Design requirement And IRC: SP: 27 -1984 IRC:SP: 32 -1988 Road Safety for Children (5-12 Years Old) IRC:SP: 44 - 1994 Highway Safety Code IRC: SP: 55 - 2001 Guidelines for The Building and other Construction workers Act 1996 and Cess Act of 1996 Factories Act 1948	Near habitation on both sides of schools, temples, hospitals, graveyards, construction sites, haulage roads, diversion sites.	Road signage & drainage as per IRC guideline Complaints from local people	Field observation Interaction with local people	Included in construction cost.	Contractor	PIU (SQC)/CSC
8.3 Safety of Workers and accident risk from construction activities	<ul style="list-style-type: none"> Contractors to adopt and maintain safe working practices. Usage of fluorescent and retroreflectory signage, in local language at the construction sites Training to workers on safety procedures and precautions. Mandatory appointment of safety officer. All regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress shall be complied with. 		Construction sites	Availability of Safety gears to workers Safety signage Training records on safety Number of safety related accidents	Site observation Review records on safety training and accidents Interact with construction workers	Included in construction cost	Obligation of Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	<ul style="list-style-type: none"> Provision of PPEs to workers. Provision of a readily available first aid unit including an adequate supply of dressing materials. The contractor will not employ any person below the age of 18 years for any work Use of hazardous material should be minimized and/or restricted. Emergency plan (to be approved by engineer) shall be prepared to respond to any accidents or emergencies. 							
	<ul style="list-style-type: none"> Accident Prevention Officer must be appointed by the contractor. 							
8.4 Accident risk to local community	<ul style="list-style-type: none"> Restrict access to construction sites to authorized personnel. Physical separation must be provided for movement of vehicular and human traffic. Adequate signage must be provided for safe traffic movement 		Construction sites	Safety signs and their location Incidents of accidents Complaints from local people	Site inspection Consultation with local people	Included in construction cost	Contractor	PIU (SQC)/CSC
9. Site restoration and rehabilitation								
9.1 Clean-up Operations, Restoration and Rehabilitation	<ul style="list-style-type: none"> Contractor will prepare site restoration plans, which will be approved by the 'Engineer'. The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. All construction zones including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used/affected by the project will be left clean and tidy, at the contractor's expense, to the satisfaction of the Environmental officer. All the opened borrow areas 	Project requirement	Throughout the project corridor, construction camp sites and borrow areas	Clean and restored camp sites Presence/absence of construction material/debris after completion of construction works on construction site	Site observation Interaction with locals Issue completion certificate after restoration of all sites are found satisfactory	Included in construction cost.	Contractor	PIU (SQC)/CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	will be rehabilitated and 'Engineer' will certify in this regard.							
C. Operation stage								
1. Air quality								
1.1 Air pollution due to due to vehicular movement	<ul style="list-style-type: none">Roadside tree plantations shall be maintained.Regular maintenance of the road will be done to ensure good surface conditionVehicular air pollution will be managed and monitored.Ambient air quality monitoring. If monitored parameters are above the prescribed limit, suitable control measures must be taken.Technological and behavioral changesRoad signs shall be provided reminding the motorist to properly maintain their vehicles to economize on fuel consumption and protect the environment.	Environmental Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981	Throughout the Corridor	Ambient air quality (PM10, CO, NOx) Survival rate of trees planted	As per CPCB requirements Site inspection	Included in Operation/ Maintenance	PIU (SQC)	
2. Noise								
2.1 Noise due to movement of traffic	<ul style="list-style-type: none">Effective traffic management and good riding conditions shall be maintained to reduce the noise level throughout the stretch and speed limitation and honking restrictions may be enforced near sensitive locations.The effectiveness of the multilayered plantation should be monitored and if need be, solid noise barrier shall be placed.Create awareness amongst the residents about likely noise levels from road operation at different distances, the safe ambient noise limits and easy	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof	Sensitive receptors	Noise levels	Noise monitoring as per noise rules ,2000 Discussion with people in sensitive receptor sites	Included in Operation/ Maintenance cost	PIU (SQC)	

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
6.1 Accident Risk due to uncontrolled growth of vegetation	<ul style="list-style-type: none"> Efforts shall be made to make shoulder completely clear of vegetation. Regular maintenance of plantation along the roadside Invasive plant not to be planted near the road. 	Project requirement	Throughout the Project route	Presence of and extent of vegetation growth on either side of road Accident data	Visual inspection Accident records	Included in operation/ Maintenance cost	PIU (SQC)	
6.2 Accident risks associated with traffic movement.	<ul style="list-style-type: none"> Traffic control measures, including speed limits, will be enforced strictly. Further encroachment of squatters within the ROW will be prevented. No school or hospital will be allowed to be established beyond the stipulated planning line as per relevant local law Monitor/ensure that all safety provisions included in design and construction phase are properly maintained Highway patrol unit(s) for round the clock patrolling. Phone booths for accidental reporting and ambulance services with minimum response time for rescue of any accident victims, if possible. Tow-away facility for the break down vehicles if possible. 	IRC:SP:55	Throughout the Project route	Police records on accident Condition and existence of safety signs, rumble strips etc. on the road Presence/absence of sensitive receptor structures inside the stipulated planning line as per relevant local law	Review accident records Site observations	Included in operation/ Maintenance cost	PIU (SQC)	
6.3 Transport of Dangerous hazardous Material	<ul style="list-style-type: none"> Existence of spill prevention and control and emergency responsive system Emergency plan for vehicles carrying hazardous material 		Throughout the project stretch	Status of emergency system – whether operational or not	Review of spill prevention and emergency response system	Included in operation/ Maintenance cost.	PIU (SQC)	

Notes: **EA is PIU, PWD (ADB PROJECT DIVISION), CHHATTISGARH:** Chhattisgarh Road Development Corporation, **SQC:** Supervision Quality Controller, **EO:** Environmental Officer, **IRC:** Indian Road Congress

a. The “Project engineer” or “the engineer” is the team of Construction Supervision Consultants (CSC) responsible for approving the plans, engineering drawing, release of payments to contractor etc. on behalf of the employer (PIU). It is usually the team leader of the CSC that takes the responsibility of signing approval documents on behalf of the CSC team.

b. The “environmental officer” is the environmental specialist under the CSC who is responsible for providing recommendations to the CSC team leader for approving activities specific to environment safeguards on behalf of “the engineer”.

Table 2: Environmental Monitoring Plan (Contract Package No. 1)

Environmental Components	Monitoring			Location	Frequency	Institutional Responsibility	
	Parameters	Special Guidance	Standards			Implementation	Supervision
Air Quality	PM _{2.5} , PM ₁₀ , SO ₂ , NO _x , CO	As per CPCB guidelines	The Air (Prevention and Control of Pollution) Rules, CPCB, 1982	At sites where hotmix plant/ batching plant is located	3 times in a year for 2 years construction period at selected sites & once in year for 5 years at selected sites (on each road) during operation/ defect liability period	Contractor through approved monitoring agency	PIU, PWD, CSC
Water Quality	pH, BOD, COD, TDS, TSS, DO, Total coliform, Conductivity, Oil & Grease, Chloride, Lead, Zinc and Cadmium	Grab priority collected from source and analyze as per standard methods for examination of water and wastewater	Water quality standards by CPCB	River tributaries, road side ponds and ground water at construction camp sites	Once during pre-construction stage 3 times in a year for 2 years construction period at 2 locations (on each road)	Contractor through approved monitoring agency	PIU, PWD, CSC
Noise Levels	Noise level for day and night on dB (A) scale	In free field at 1m distance from the equipment to be monitored	Noise standard by CPCB	At equipment yards, camp and villages along the alignment.	3 times in a year for 2 years construction period at 2 sites & once in year for 5 years at 2 sites (on each road) during operation/ defect liability period	Contractor through approved monitoring agency	PIU, PWD, CSC
Soil Quality	Monitoring of NPK & heavy metals and grease		As per IR Code of practice	Ad-hoc if accident/ spill locations involving bulk transport of carrying hazardous materials	-	PIU through an approved agency	PIU, PWD
Roadside plantation	Monitoring of felling of trees	It should be ensured that only marked trees are felled	As given in the IEE report	All along the corridor	During the felling of trees	Forest department/ Competent Agency	PIU, PWD
	Survival rate of trees, success of re-vegetation	The number of trees surviving during each visit should be compared with the number of saplings planted	The survival rate should be at-least 75% below which re-plantation should be done	At locations of compensatory afforestation	Every year for 3 years	PIU	PIU, PWD

Note: PIU – Project Implementation Unit, CSC-Construction Supervision Consultant

Appendix 9: Guidelines for Tree Plantation and Management

Preparation of the Plantation Area: For plantation in new areas it always economical and comfortable to plant trees in blocks. The open areas near the subproject roads will be identified and selected. During the selection of the block plantation sites, the availability of the water in nearby areas will be taken into consideration as the survival of the tree saplings depends on the availability of water or watering facilities.

Preparation of Pits and Sapling Transplantation: The location of each plantation pit will be marked according to the design and distance of the plantation. The size of the plantation pit varies depending upon the species of the plants, height of the saplings. Trees will be planted on the alternate rows in a straight line for the prevention of the horizontal dispersion of the pollutants. Hence the pit will be dig accordingly. During the time of placing the tree saplings the roots will be freed from plastic or any type of cover which is normally use for the transplantation of the tree saplings from the seed bed to the tree plantation pits. This exercise will help the root hairs to reach the soil.

Spacing: For the survivability of the tree species planted spacing between the saplings should be maintained. Spacing which are usually used for teak planting are $2 \times 2 \text{ m}^2$, $3 \times 1 \text{ m}^2$, $3 \times 3 \text{ m}^2$, $4 \times 2 \text{ m}^2$ and $4 \times 4 \text{ m}^2$, depending on site condition. However, wider spacing of $6 \times 1 \text{ m}^2$ can also be adopted sometimes where the survivability is high. Closer spacing is used for straight timber of good quality.

Time of Plantation: As per the normal practices followed under the silvicultural guidelines plantation of the tree sapling to be done only after the first shower during the rainy season. The best time for plantation is after 15 days from the day of first shower during rainy season.

Protection of Tree saplings: Circular tree guard should be placed after the plantation of the saplings for the protection of these young plants from the ravages of cattle, sheep and goat and other animals. If tree saplings died or damage occur after placing the circular tree guard, timely replacements of damaged plant and thereafter care is important.

Selection of Tree Species: The selection of the tree species to be planted plays a crucial role for higher survivability rate. This is always better to choose the local and Vulnerable, endemic species.

Maintenance (include thinning) : Weeding: Low pruning at 6 months, **Thinning:** Thinning will start after the stand is 3-4 years old and repeated every 4 years until the stand is 15 years old. Between 15-25 years old, thinning should be conducted every 5 years and after 25 years old, thinning will be done after every 10 years. When the canopy closes, at about 6 years, 30-40% of the stems will be thinned to selectively remove suppressed, diseased and badly formed trees.

Survivability: Periodic assessment will be carried for survivability of the trees. Minimum 70% survival rate will be achieved.

Records:

The following records will be maintained:

1. Record of Tree plantation
2. Record of Survivability rate

Reporting:

The tree plantation and survivability report will be sent to EA six monthly

Responsibility:

Prime Responsibility: PIU through contractor or Forest Department Contractor will be responsible for tree cutting or plantation

Supervisory Responsibility: Supervision Consultant to check compliance of above guidelines.

Appendix 10: Guidelines for Borrow Area Management

Selection and Rehabilitation of Borrow Pits: Guidelines for selection of borrow pits, amount that can be borrowed and its rehabilitation in line with The Indian Road Congress (IRC):10-1961 will be followed and are as follows:

- Contractor must identify the borrow areas before start of construction and submit these details with rehabilitation plan.
- Borrow areas will not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth will not exceed 45 cm. The topsoil to a depth of 15cm will be stripped and set aside. Thereafter, soil may be dug out to a further depth not exceeding 30 cm and used in forming the embankment.
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Ridges of not less than 8m widths will be left at intervals not exceeding 300m. Small drains will be cut through the ridges, if necessary, to facilitate drainage. The slope of the edges will be maintained not steeper than 1:4 (vertical: Horizontal).
- Borrow pit will be selected from wasteland ;
- Priority will be given to the borrowing from humps above the general ground level within the road land;
- Priority will be given to the borrowing by excavating/enlarging existing tanks;
- Borrowing will be from land acquired temporarily and located at least 500m away from the road;
- Borrowing will be from mounds resulting from the digging of well and lowering of agricultural fields in vicinity of the road;
- Borrow area near to any surface water body will be at least at a distance of 15m from the toe of the bank or high flood level, whichever is maximum.
- In case of settlements, borrow pits will not be selected within a distance 800 m from towns or villages. If unavoidable, earth excavation will not exceed 30cm in depth;
- The haulage distance from site will not be too far.
- Redevelopment plan will be prepared by the contractor before the start of work which should be duly agreed upon by land owner.
- Borrow pits will be backfilled with rejected construction wastes and covered with vegetation.
- Borrow areas might be used for aquaculture in case landowner wants such development.
- Borrow pits located near habitat areas will be re-developed immediately after borrowing is completed. If spoils are dumped, that will be covered with a layers of stockpiled topsoil in accordance with compliance requirements with respect MOEFCC/SPCB guidelines.
- Prohibit dumping of waste except inert construction rubble

Records: The following records will be maintained:

1. List of Borrow areas identification with capacity and rehabilitation plan
2. Agreement with land owners where applicable
3. Details of Earth excavated
4. Closure report of rehabilitated borrow pits.

Reporting:

The Borrow area opening, earth borrowed and borrow area rehabilitation details will form part of half yearly report

Responsibility:

- Prime Responsibility: Contractor will be responsible for borrow area management and reporting
- Supervisory Responsibility: Supervision Consultant will check compliance with the above guidelines.

Appendix 11: Guidelines for Emergency Management System

Many emergencies can occur in construction sites and will need to be effectively handled. The environmental and occupational health and safety aspects and related emergency can includes incidence such as Collapse / subsidence of soil / Fire / Explosion / Gas Leak, Collapse of Building / Equipment and other Occupational Accidents. On site and off site emergency management plan will be developed to effectively handle them. The following guidelines will be used to develop these plans

Guidelines:

Availability of 'On-Site Emergency Management Plan'

- The contractor will have a written on site emergency management plan. The contractor should submit a copy of this plan to PWD, PMU-ADB and the Supervision Consultant before the start of the work.
- Contractor will develop the onsite emergency plan considering the potential environmental, occupational health and safety emergency situation at site.
- Contractor will include a list of potential emergency situations in the emergency management plan including potential Environmental and Occupational Health and Safety Emergency Situations during construction, operation and maintenance stages.

Examples of potential emergency situations have been defined below for guidance purposes. The contractors may follow refer to this for developing site specific on site emergency preparedness plan.

Emergency conditions / situations	Sources
Collapse / subsidence of soil and structures	<ul style="list-style-type: none"> ▪ Civil structures ▪ Heavy construction machinery
Bulk spillage	<ul style="list-style-type: none"> ▪ Hazardous substance / inflammable liquid storage ▪ Vehicular movement on highway
Fire and explosion	<ul style="list-style-type: none"> ▪ Inflammable Storage Areas ▪ Gas Cylinder Storage Areas ▪ Electrical Circuits ▪ Isolated Gas Cylinders (LPG / DA) ▪ Welding / Gas Cutting Activity
Flooding	<ul style="list-style-type: none"> ▪ Heavy monsoons ▪ Upstream activities of irrigation or damming ▪ Glacial lake outburst Flood at the source of the river
Electrical Shock	<ul style="list-style-type: none"> ▪ HT line ▪ LT distribution ▪ Electrically Operated Machines / Equipment / Hand Tools / Electrical Cables
Gaseous Leakage	<ul style="list-style-type: none"> ▪ Gas Cylinder Storage Areas ▪ Gas Cylinder used in Gas Cutting / Welding Purposes

Emergency conditions / situations	Sources
Accidents due to Vehicles	<ul style="list-style-type: none"> ▪ Heavy Earth Moving Machinery ▪ Cranes ▪ Fork Lifts ▪ Trucks ▪ Workman Transport Vehicles (cars / scooters / motor cycles / cycles) ▪ Collapse, toppling or collision of transport equipment
Slips & Falls (Man & Material)	<ul style="list-style-type: none"> ▪ Work at Height (Roof Work, Steel Erection, Scaffold, Repair & Maintenance, Erection of equipment, Excavation etc.) ▪ Slips (Watery surfaces due to rain) ▪ Lifting tools & Tackles (Electric Hoist & Forklifts) ▪ Falling into the river and drowning
Collision with stationary / moving objects	<ul style="list-style-type: none"> ▪ Vehicular movement on highway
Other Hazards	<ul style="list-style-type: none"> ▪ Cuts & Wounds ▪ Confined Space (under & inside machinery etc.) ▪ Hot Burns ▪ Pressure Impacts (Plant contains several Pressure Vessels & pipefitting containing CO₂, Air, Water, product & Steam, which can cause accidents & injuries to person around.)

Design of 'On-Site Emergency Plan'

The 'On-site emergency plan' to be prepared by contractor will include a minimum of the following information :

- Name & Address of Contractor
- Updation sheet
- Project Location
- Name, Designation & Contact Numbers of the organization, nearby hospitals, fire agencies etc. and key personnel including their assigned responsibilities in case of an emergency.
- The roles and responsibilities of executing personnel
- Site Layout Diagram
- Identification of Potential Emergencies Situations/ preventive measures / control & response measures
- Location of Emergency Control Centre (or designated area for emergency control / coordination) with requisite facilities.
- Medical services / first aid
- List of emergency equipment including fire extinguishers, fire suits etc.

Emergency Control Centre

The emergency control centre will be equipped with following facilities

- Copy of current on-site emergency plan
- Display of the name of site emergency controller
- Appropriate numbers of artificial respiratory sets
- Appropriate numbers of Stretchers
- Vehicle/ambulances on each construction site for 24 hours
- Adequate and reliable communication facilities (phone, handset etc.)

- Site layout diagram with entry and exit routes / Assembly points
- Directory of internal / external emergency phone Numbers
- Fire extinguishers (DCP type / Foam Type / CO2) on all construction camps and yards
- List of fire extinguishers installed in the construction sites and yards including maintenance records
- A set of personal protective equipment (PPE) for each and every member of the construction team
- First-aid boxes with prescribed first-aid medicines in every construction camp site and yard
- List of competent first-aiders
- List of fire trained personnel
- Appropriate numbers of blankets, rescue ropes and high beam torches
- Drinking water
- Gas leak detectors
- Life boats & jackets

Records:

The following records will be maintained:

1. Record of emergency preparedness plan with emergency contact numbers
2. Mock drill/emergency preparedness exercise records
3. Corrective preventive action record after emergency is occurred

Reporting:

The accident and incident records and emergency preparedness drill reports will form part of quarterly report to PWD, PIU-ADB and the Supervision Consultant

Responsibility:

Prime Responsibility: Contractor will be responsible for implementing the Emergency plan and reporting

Supervisory Responsibility: The Supervision Consultant will check compliance of the contractor with the above guidelines

Appendix 12: Guidelines for Waste Disposal and Management

A Waste disposal and management plan will be prepared by the contractor before start of construction works and submitted to PWD, PIU-ADB and the Supervision Consultant for their review and approval. The management plan will follow the guidelines as given below:

- (i) The debris disposal site should be identified which are preferably barren or low-lying areas away from settlements.
- (ii) Prior concurrence will be taken from concerned Govt. Authorities or land owner
- (iii) Due care should be taken during site clearance and disposal of debris so that public/private properties are not damage or effected, no traffic are interrupted.
- (iv) All efforts should be made to use debris in road construction or any other public utilities.
- (v) The debris should be stored at site ensuring that existing water bodies and drains within or adjacent to the site are kept safe and free and no blocking of drains occurs.
- (vi) All dust prone material should be transported in a covered truck.
- (vii) All liquid waste like oils and paint waste should be stored at identified locations and preferably on a cemented floor. Provision of spill collection pit will be made in the floor to collect the spilled oil or paint. These should be sold off to authorized recyclers.
- (viii) All domestic waste generated at construction camp preferably be composted in portable mechanized composter. The composted material will be used as manure. In case composting is not feasible, the material will either be disposed off though municipal waste disposal system or disposed of through land burial. The dump site must be covered up with at least six inch thick layer of soil.
- (ix) Only appropriately design and compliant landfills will be used for disposing waste
- (x) All efforts should be made that no chemical/ oily waste spill over to ground or water bodies.
- (xi) All precautions should be followed for emergency preparedness and occupational health & safety during construction and handling a waste.
- (xii) Provision of fire extinguishers will be made at the storage area
- (xiii) Adequate traffic control signals and barriers should be used in case traffic is to be diverted during debris disposal. All efforts should be made to ensure avoidance of traffic jam, which otherwise results in air pollution, noise pollution and public unrest.
- (xiv) Hazardous waste and chemicals should be stored in a dedicated storage area that has: 1) weather protection, 2) solid impermeable surface and drainage to treatment system, 3) security fence/lock, 4) primary and secondary containment with 110% volume for liquids.
- (xv) Domestic waste shall only be disposed of at the approved, appropriately designed, compliant waste management facility (landfill). Land burial of waste shall not be permitted.

Records: The following records will be maintained

- Generation and disposal quantity with location of disposal
- Recyclables waste generation and disposal
- Domestic waste disposal locations details

Reporting:

The waste generation and disposal details will form part of quarterly report to PWD, PIU-ADB

Responsibility:

Prime Responsibility: Contractor will be responsible for waste management and reporting

Supervisory Responsibility: Supervision Consultant will check the contractor's adherence to the above guidelines

Appendix 13: Outline of an Environmental Monitoring Report

1. Introduction

(Report Purpose, Brief project background including organizational set up, list of roads, planned project schedule etc., Details on Project Implementation Progress with details on current site works, location, earthworks, vegetation clearing, spoils disposal, establishment of construction camp and other construction related facilities (e.g., concrete mixing plant, asphalt batching plant, crushing plant, etc.), establishment and operation of quarry/borrow areas, etc., including locations, schedules, dates, etc., Schedule of construction activities for the subsequent months).

2. Compliance on Environment Safeguards Requirements

(Status of compliance with ADB loan covenants: provide a list of environmental loan covenants and specify level of compliance).

Status of compliance with government environmental requirements: provide a list of government environmental requirements (permits, etc.) for the project as well as construction-related facilities/ activities and specify level of compliance, indicate any required environmental permit/license/consent obtained to date and to be obtained (including schedule) for the project and construction related facilities/activities).

3. Changes in project scope

(Such as change in alignment or footprint in case of horizontal infrastructure, implementation of additional Project component/s, etc. (with reference to the Project scope identified in the ADB-cleared environmental assessment report , i.e., IEE or EIA) and corresponding safeguard measures undertaken, if applicable).

4. Implementation of Environmental Management Plan

(Indicate the manner by which EMP requirements are incorporated into contractual arrangements, such as with contractors or other parties.

Summary of Environmental Mitigations and Compensation Measures Implemented.

Based on EMP; may include measures related to air quality, water quality, noise quality, pollution prevention, biodiversity and natural resources, health and safety, physical cultural resources, capacity building, and others. Provide a table/matrix showing a summary of each environmental mitigation measure specified in the EMP.

EMP Requirement (list all mitigation measures specified in the EMP)	Compliance Attained (Yes, No, Partial)	Comment on Reasons for Partial or Non-Compliance	Issues for Further Action and Target Dates
1.			
2.			
3.			
4.			
5.			
etc.			

5. Environmental Monitoring Activities

(Compliance Inspections, Summary of Inspection Activities, Mitigation Compliance¹⁰ Mitigation Effectiveness¹¹. Findings of Environmental Monitoring Plan (EMOP) on quality of air, noise, water etc. and Results Assessment¹²)

6. Key Environmental Issues

(Key Issues Identified (e.g., non-compliance to loan covenants, EMP and/or government environmental requirements, insufficient mitigation measures to address Project impacts, incidents, accidents, etc.) Actions Taken and Corrective Action Plan (specify actions taken and corrective action plans to be implemented to address non-compliance and other identified issues. Such action plan should provide details of specific actions to be undertaken to resolve identified issues, responsible persons who will carry out such actions and timeframe/target date to carry out and complete required actions. The action plan could be presented in a tabular/matrix form (see below). Timeframe and responsibilities for reporting to ADB on the progress of implementation of corrective action plan should also be specified under this section.)

¹⁰ Overall compliance with mitigation implementation requirements could be described in qualitative terms or be evaluated based on a ranking system, such as the following:

1. Very Good (all required mitigations implemented)
2. Good (the majority of required mitigations implemented)
3. Fair (some mitigations implemented)
4. Poor (few mitigations implemented)
5. Very Poor (very few or no mitigations implemented)

Additional explanatory comments should be provided as necessary.

¹¹ Effectiveness of mitigation implementation could be described in qualitative terms or be evaluated based on a ranking system, such as the following:

1. Very Good (mitigations are fully effective)
2. Good (mitigations are generally effective)
3. Fair (mitigations are partially effective)
4. Poor (mitigations are generally ineffective)
5. Very Poor (mitigations are completely ineffective)

Additional explanatory comments should be provided as necessary.

¹² Discharge levels should be compared to the relevant discharge standards and/or performance indicators noted in the EMP. Any exceedences should be highlighted for attention and follow-up. In addition, discharge levels could be compared to baseline conditions (if baseline data is available) and described in qualitative terms or be evaluated based on a ranking system, such as the following:

1. Very Good (overall conditions are generally improved)
2. Good (conditions are maintained or slightly improved)
3. Fair (conditions are unchanged)
4. Poor (conditions are moderately degraded)
5. Very Poor (conditions are significantly degraded)

Additional explanatory comments should be provided as necessary.

Issue	Cause	Required Action	Responsibility	Timing (Target Dates)	Description of Resolution and Timing (Actual)
Old Issues from Previous Reports					
1.					
2.					
New Issues from this Report					
1.					
2.					

Complaints: Details of Complaint/s (Provide details of any complaints that have been raised by the local population and other stakeholders regarding environmental performance and environmental impacts (complainant, nature of complaint, date complaint was filed, which office received the complaint, etc.)

Action Taken (Document how the complaints were addressed or will be addressed by indicating the following:

- i. names and designation of specific staff or officials within the Grievance Redress Committee, executing agency, project management unit, local government, contractor and/or supervision consultant involved in receiving, documenting, and resolving the complaint (s).
- ii. specific actions taken to be taken to resolve the complaint and corresponding timeframe

7. Conclusion and Recommendation

Overall Progress of Implementation of Environmental Management Measures¹³

Problems Identified and Actions Recommended

Monitoring adjustment (recommended monitoring modifications based on monitoring experience/trends and stakeholders response)

8. Appendices

Site Inspection / Monitoring Reports

Source and Ambient Monitoring Results (Laboratory Analysis)

Photographs

Location Map of Sampling Stations

Copies of Environmental Permits/Approvals

Other relevant information/documents

¹³Overall sector environmental management progress could be described in qualitative terms or be evaluated based on a ranking system, such as the following:

1. Very Good
2. Good
3. Fair
4. Poor
5. Very Poor

Additional explanatory comments should be provided as necessary.

Appendix 14: Air Modeling Details

MODEL NAME

California Line Source Dispersion Model Version 4 (CALINE4)

MODEL DESCRIPTION

The air dispersion model used is ***CL4 (A Graphical User Interface for CALINE4)*** developed by the California Department of Transportation (Caltrans) for predicting air pollutant concentrations near roadways. CALINE4 is a simple line source Gaussian plume dispersion model.

CALINE4 is a model based on the Gaussian diffusion equation and employs a mixing zone concept to characterize pollutant dispersion over the roadway. The purpose of the model is to assess air quality impacts near transportation facilities. Given source strength, meteorology and site geometry, the model can predict pollutant concentrations for receptors located within 500 meters of the roadway. It also has special options for modeling air quality near intersections, street canyons and parking facilities.

CALINE4 divides individual highway sections into a series of elements from which incremental concentrations are computed and then summed to form a total concentration estimate for a particular receptor location. Downwind concentrations from the element are modelled using the crosswind FLS (Finite Line Source) Gaussian formulation, but σ_y and σ_z are modified to consider the mechanical turbulence created by moving vehicles and the thermal turbulence created by hot vehicle exhaust in the region directly over the highway, region considered as a zone of uniform emissions and turbulence.

INPUT DATA REQUIREMENT:

- **Emissions**

The emissions are provided by traffic volume (vehicles/h) and emission factor (gr/mile/vehicle) for each section

- **Meteorology**

Wind speed Wind direction Wind direction standard deviation Atmospheric stability
Class Mixing Height Ambient Temperature.

The details of input parameters considered for the modeling exercises are presented in the following paragraphs.

- **Traffic Data**

Traffic data for base year 2017 has been collected at site and based on that traffic projection has been done for coming years. Average hourly traffic data has been considered for the present modeling exercises.

- **Meteorological Data**

“Worst case wind angle” run type was considered to predict the worst-case scenario. The met inputs entered were:

- Wind speed: 1.0m/s
- Stability Class: F
- Mixing Height: 50m
- Standard Deviation: 5°
- Ambient Air Temperature: 25°C

PRESENTATION OF RESULTS

For One-hour simulations, the concentrations were estimated around 3 receptors to obtain an optimum description of variations in concentrations over the distance of 30m, 50m & 100m downwind from the centerline for the worst angles as identified by the model. The nearest receptor was considered to be at 30m from the centerline of the proposed alignment of the project road. Air modeling results are presented in following table.

Table:- Air Modeling Results (Predicted Conc. of CO)

Predicted Maximum 1-hour Concentration of CO (ppm)					
Receptor Distance from Center Line	2017	2022	2027	2032	2037
at 30 m	0.1	0.2	0.2	0.3	0.4
at 50 m	0.1	0.1	0.2	0.2	0.3
at 100 m	0.1	0.1	0.1	0.2	0.2

Predicted Maximum 1-hour Concentration of CO (µg/m³)					
Receptor Distance from Center Line	2017	2022	2027	2032	2037
at 30 m	115	229	229	344	458
at 50 m	115	115	229	229	344
at 100 m	115	115	115	229	229

The predicted 1hr maximum concentration of CO after construction of the project road is found to be within 4000 µg/m³ prescribed in National Ambient Air Quality Standards, 2009 for residential, rural and other areas.