भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
National Highways Authority of India

NATIONAL HIGHWAYS AUTHORITY OF INDIA
(MINISTRY OF ROAD TRANSPORT & HIGHWAYS)
PIU-BHUBANESWAR

DRAFT ENVIRONMENT IMPACT ASSESSMENT REPORT & ENVIRONMENT MANAGEMENT PLAN FOR

"Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. length 70.995 km in Odisha state by NHAI"

[SECTOR 34 / 7(f) - HIGHWAYS, CATEGORY A]

January, 2025

Baseline Study Period: October-December, 2024

DPR CONSULTANT
GEO DESIGNS & RESEARCH (P) LTD., VADODARA, GUJARAT

ENVIRONMENT CONSULTANT
CHAITANYA PROJECTS CONSULTANCY LTD., NOIDA, UTTAR PRADESH
QCI-NABET ACCREDITATION CERTIFICATE NO.: NABET/EIA/2023/SA0205
VALID TILL 29/01/2025, VIDE NABET LETTER NO.
QCI/NABET/ENV/ACO/24/3401 DATED 30/10/2024

QCI-NABL ACCREDITED LABORATORY FOR ENVIRONMENTAL BASELINE SAMPLING
AGSS ANALYTICAL AND RESEARCH LAB (P) LTD., NEW DELHI

QCI/NABET/ENV/ACO/24/3401 Oct 30, 2024

To

Chaitanya Projects Consultancy Private Limited, Noida
101, Ist Floor, Tower No. 3, Okaya Centre,
Sector 62, Noida

Sub.: Extension of Validity of Accreditation till Jan 29, 2025– regarding
Ref.. 1. Certificate no NABET/EIA/2124/IA0091
2. Request e-mail dated Oct 18, 2024

Dear Sir/Madam

This has reference to the accreditation of your organization under the QCI-NABET EIA Scheme, the validity of Chaitanya Projects Consultancy Private Limited is hereby extended to Jan 29, 2025, or completion of the assessment process, whichever is earlier.

The above extension is subject to the submitted documents/required information with respect to your application and timely submission and closure of NC/Obs during the process of assessment.

You are requested not to use this letter after the expiry of the above-stated date.

With best regards.

(A K Jha)
Sr. Director, NABET

QUALITY COUNCIL® OF INDIA
Creating an Ecosystem for Quality

National Accreditation Board for Education and Training

Certificate of Accreditation

Chaitanya Projects Consultancy Private Limited

101, I[st] Floor, Tower No. 3, Okaya Centre, Sector 62, Noida, Uttar Pradesh,201301

*The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals including opencast/ underground mining	1	1 (a) (i)	A
2	River Valley Projects	3	1 (c)	A
3	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs / ecologically sensitive areas including LNG terminal	27	6 (a)	A
4	Ports, harbours, break waters and dredging	33	7(e)	A
5	Highways	34	7 (f)	A
6	Building and construction projects	38	8 (a)	B
7	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated October 6, 2023 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/23/3029 dated November 20, 2023. The accreditation needs to be renewed before the expiry date by Chaitanya Projects Consultancy Private Limited, Noida following due process of assessment

Sr. Director, NABET
Dated: November 20, 2023

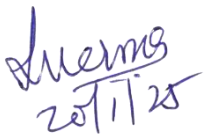
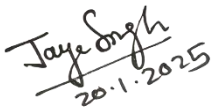
Certificate No.
NABET/EIA/2023/SA 0205

Valid up to
October 28, 2024

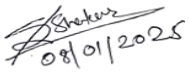
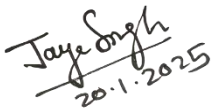
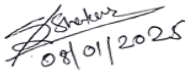
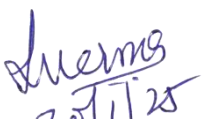
For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

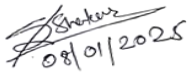
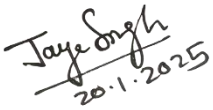
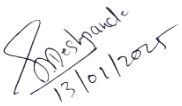
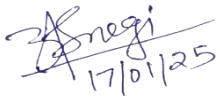
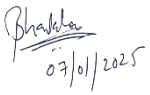
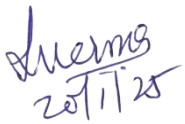
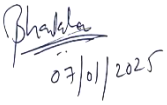
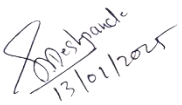
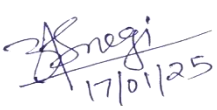
Declaration by Experts contributing to the EIA of "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. length 70.995 km in Odisha state by NHAI".

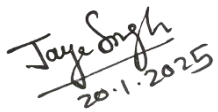
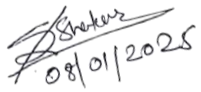
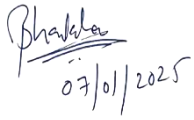
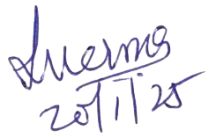
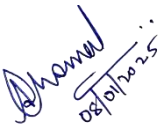
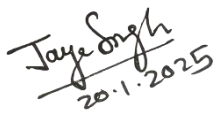
I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA coordinator/ Team member	Task Performed	Signature and Date	Contact information
Shashank Arora (EC) **Period of involvement** August 2024-January 2025	Report reviewed and discussed with all the FAEs and finalization of EIA report.		101, 1st Floor, Tower-3, Okaya Centre, Sector 62, Noida, Uttar Pradesh 201301
Sharad Verma (TM) **Period of involvement** August 2024-January 2025	Supervision of baseline monitoring. Supervision of EIA report preparation. Provide technical guidance for EIA report preparation.		101, 1st Floor, Tower-3, Okaya Centre, Sector 62, Noida, Uttar Pradesh 201301
Jaya Singh (TM) **Period of involvement** August 2024-January 2025	Review and finalization of baseline monitoring locations. Provide technical guidance for EIA report preparation.		101, 1st Floor, Tower-3, Okaya Centre, Sector 62, Noida, Uttar Pradesh 201301

Functional area experts:

S. No.	Functional Areas	Name of the Expert/s	Involvement (Period and Task**)	Signature and Date
1	AP*	Sanjay Shevkar	**October 2024-December 2024** Addressing air quality issues in EIA Report and suggesting mitigation measures for impacts due to air pollution	
		Jaya Singh (TM)	**August 2024-January 2025** Identifying the sources of emissions and mitigation measures; Site-specific micro-meteorology monitoring and collection of secondary data.	
2	WP*	Sanjay Shevkar	**October 2024-December 2024** Interpretation of water sampling data; Suggest impact and mitigation measures of the proposed project.	
		Sharad Verma (TM)	**August 2024-January 2025** Identification of water sampling locations, their time and frequency pertaining to site conditions; Counter checking of analysis of data by literature study.	

3	SHW*	Sanjay Shevkar	**October 2024-December 2024** Devising measures to minimize wastes, storage and management of hazardous solid wastes	
		Jaya Singh (TM)	**August 2024-January 2025** Estimation of the waste generation quantity due to various construction activity	
4	SE*	Sohaib Ali Sayed	**November 2024-January 2025** Design and develop format/ questionnaire for baseline survey; Evaluation of socio economic status of study areas; Public consultation; Assessment of social impact and suggest mitigation measures.	
5	EB*	Sameer V Deshpande	**October 2024-December 2024** Identification of potential impact due to the project interventions and suggesting mitigation measures.	
		Ajay Singh Negi (TM)	**August 2024-January 2025** Identification and assessment of major floral and faunal species and ecological condition of the study area.	
6	HG*	Bhanu Kala Srivastava	**November 2024-January 2025** Analyze them to identify the likely impacts and devise mitigation measures.	
		Sharad Verma (TM)	**August 2024-January 2025** Identification of the water source and drainage pattern of the study area.	
7	GEO*	Bhanu Kala Srivastava	**November 2024-January 2025** Identification of nature of geology of the project area; Identification of areas likely to be affected by soil erosion; Devised protection measures for embankment slope and water bodies.	
8	SC*	Sameer V Deshpande	**October 2024-December 2024** Assessing the impact on soil due to various activities of the project; Suggest mitigation measures to control the adverse impact	
		Ajay Singh Negi (TM)	**August 2024-January 2025** Identification of soil sampling locations; Identification of soil quality and soil type for establishing the baseline conditions.	

9	AQ*	Rakesh Kumar Pandey	**October 2024-December 2024** Suggesting mitigation measures for impacts due to air pollution; Air dispersion modelling for prediction of GLCS due to PM_{10}, PM $_{2.5}$, SO_2 and NO_2	
		Jaya Singh (TM)	**August 2024-January 2025** Identification of Air Quality monitoring locations and supervision of ambient air quality monitoring.	
10	NV*	Sanjay Shevkar	**October 2024-December 2024** Identification of Noise Quality monitoring locations and supervision of noise quality monitoring; Review of noise quality monitoring report; noise modeling for addressing noise related issues in EIA report and suggesting measures for impacts due to noise pollution.	
11	LU*	Bhanu Kala Srivastava	**November 2024-January 2025** Creation of GIS data base and processing of satellite imageries; Impact on land environment in respect to land form change; Devised measure to save sensitive and productive land uses.	
		Sharad Verma (TM)	**August 2024-January 2025** Identification and collection of satellite images and other associated maps for the project area; Creation of GIS data base and processing of satellite imageries.	
12	RH*	Anil Choumal	**November 2024-December 2024** Environment risk evaluation; On-site and Off-site emergency planning; Devising contingency plan for each type of hazards.	
		Jaya Singh (TM)	**August 2024-January 2025** Identification of the potentially hazardous material and natural hazards that might occur during various phases of the project.	

CHAITANYA
PROJECTS CONSULTANCY LTD.
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CIN NO. U74 40DL2004PTC124986
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Urban Infrastructures & Railways

(120) 4326472 - 4326474
chaitanya.projects@gmail.com
www.chaitanyaprojects.com

Undertaking by Head of Accredited Consultant Organization

I, **S. K. Sinha**, hereby, confirm that the above mentioned experts prepared the EIA report of "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by NHAI". I also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in this statement.

(S. K. Sinha)
Managing Director
For Chaitanya Projects Consultancy Ltd.

Name of the EIA consultant organization: Chaitanya Projects Consultancy Ltd.

NABET Certificate No. & Issue Date: NABET Certificate No. NABET/EIA/2023/SA0205 was valid till 28/10/24. The accreditation is extended till 29/01/2025, vide NABET letter no. QCI/NABET/ENV/ACO/24/3401 dated 30/10/2024.

Corporate Office:
Unit No. 101 1st Floor, Tower No. 3
Okaya Center Block-B, Sector-62
Noida 201301 India

Registered Office:
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Mayur Vihar Phase-I Extension, East Delhi India, 110091

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Urban Infrastructures & Railways.

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chaitanya.projects@gmail.com
www.chaitanyaprojects.com

UNDERTAKING

I, hereby, confirm that the above mentioned experts prepared the EIA "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by NHAI" and EIA Coordinator (EC) is fully aware of the content. The consultant organization shall be fully accountable for any misleading information. It is also certified that EIA Report has been analysed by the system for plagiarism check using in accordance with good scientific practice. No unethical practices have been carried out and external data/text have not been used without proper acknowledgement, while preparing this EIA report.

Certificate of Plagiarism check	
Title of EIA Report	Construction of new 6 lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by NHAI
Name of Accredited Organization	Chaitanya Projects Consultancy Ltd.
Unique Identification Number	Doc No.: CPC/FV-11-OR/ 2024/ V1.0/ DEIA
Name of EIA Co-coordinator	Shashank Arora
Time of Check:	Multiple time due to word limit

(S. K. Sinha)
Managing Director
For Chaitanya Projects Consultancy Ltd.

Corporate Office:
Unit No. 101 1st Floor Tower No. 3
Okaya Center Block B, Sector-62,
Noida 201301, India

Registered Office:
907-908 Tower A The Address, Plot No 4B District Centre,
Mayur Vihar Phase 1 Extension East Delhi India, 110091

CHAITANYA
PROJECTS CONSULTANCY LTD.
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Urban Infrastructures & Railways.

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chaitanya.projects@gmail.com
www.chaitanyaprojects.com

UNDERTAKING

I, hereby undertake that the ToR approved by the MoEFCC vide File No: 10/18/2024-IA.III for Proposal number IA/OR/INFRA1/482782/2024 dated 09/07/2024 for the project "Construction of new 6-lane Capital Region Ring Road (CRRR 1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by NHAI" have been complied with and the data submitted is factually correct to the best of my knowledge.

(Shashank Arora)
EIA Co-ordinator (Highway- Cat. A)

Date: 20.01.2025

Corporate Office:
Unit No. 101 1st Floor Tower No. 3
Okaya Center Block-B, Sector-62,
Noida 201301 India

Registered Office:
907-908, Tower A, The Address, Plot No-43, District Centre,
Mayur Vihar Phase 1 Extension East Delhi, India 110091

सत्यमेव जयते

भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
(सड़क परिवहन और राजमार्ग मंत्रालय)
National Highways Authority of India
(Ministry of Road Transport & Highways)
परियोजना कार्यान्वयन इकाई / Project Implementation Unit
303, उत्कल सिग्नेचर, 3 ताला, एनएच-5, पाहल, भुवनेश्वर-752101, ओडिशा
303, Utkal Signature, 3rd Floor, NH-5, Pahal, Bhubaneswar-752101, Odisha
दूरभाष / Ph.: 0674-2962600 (का / O)
ई-मेल / e-mail : bhu@nhai.org, वेबसाइट / Web : www.nhai.gov.in

UNDERTAKING

I, on behalf of the National Highways Authority of India (NHAI), do hereby undertake that the Environmental Management Plan (EMP) submitted before the EAC as part of the EIA report for the project "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by NHAI" shall be made a part of the Concessionaire Agreement and (or) any other relevant document.

(Suraj Kumar Singh, IDSE)
Project Director
PIU-Bhubaneswar
NHAI

Date: 21.01.2025

ACKNOWLEDGEMENT

M/s National Highways Authority of India have entrusted the work to **M/s Geo Designs & Research (P) Ltd., Vadodara, Gujarat** to carry out the Feasibility Study and Detail Project Report for the "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state".

M/s Chaitanya Projects Consultancy Ltd. have been engaged to carry out the EIA/EMP study for the project.

We are thankful to all the officials of the Ministry of Environment Forest and Climate Change (MoEF&CC) for their regular guidance and technical inputs during various meetings for this project.

We are thankful to all the concerned officials of the State Government of Odisha for their help in data collection and guidance.

We are grateful to all the concerned officials of NHAI HQ (Project Division, Environment Division), Regional Officer NHAI, Odisha and Project Implementation Unit., NHAI, Bhubaneswar for the regular guidance and help in preparing of the project documents.

Finally, the entire Environment team, Site teams of CPCL for their dedication and hard work put into the preparation of this EIA Report.

Date: 20.01.2025

(Vishal Sakpal)
GM - Projects
For GDRPL

CHAITANYA
PROJECTS CONSULTANCY LTD.
(An ISO 9001:2015 Certified Company)

CIN NO.: U74140DL2004PTC124286
Highways, Bridges & Expressways,
Urban Infrastructures & Railways.

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chaitanya.projects@gmail.com
www.chaitanyaprojects.com

ACKNOWLEDGEMENT

M/s Geo Designs & Research (P) Ltd. have entrusted the work to **M/s Chaitanya Projects Consultancy Ltd** to carry out the EIA Study for "Construction of new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.995 km in Odisha state by **NHAI**".

We are thankful to all the officials of the Ministry of Environment Forest and Climate Change (MoEF&CC) for their regular guidance and technical inputs during various meetings for this project.

We are thankful to all the concerned officials of the State Government of Odisha for their help in data collection and guidance.

We are grateful to all the concerned officials of NHAI HQ (Project Division, Environment Division), Regional Officer NHAI, Odisha and Project Implementation Unit, NHAI, Bhubaneswar for the regular guidance and help in preparing of the project documents.

Finally, the entire Environment team, Site teams of CPCL for their dedication and hard work put into the preparation of this EIA Report.

Date: 20.01.2025

(S. K. Sinha)
Managing Director
For Chaitanya Projects Consultancy Ltd.

Corporate Office:
Unit No. 1011, Floor, Tower No. 3
Okaya Center Block-B, Sector-62
Noida 201301, India

Registered Office:
907-908, Tower A, The Address, Plot No-4B, District Centre
Mayur Vihar Phase-I Extension, East Delhi, India, 110091

ToR File No: 10/18/2024-IA.III (Proposal No.: IA/OR/INFRA1/482782/2024 dated 09/07/2024)
ToR Id. No. TO24A3601OR5956634N

COMPLIANCE OF TOR BY MOEFCC

A. SPECIFIC CONDITIONS

S. No.	ToR Point	Compliance
1.	Elephant Underpasses suggested by the concerned DFO shall be constructed with the specifications for underpasses in Elephant Landscape prescribed in WII guidelines for Mitigating the impact of linear infrastructure on the wildlife.	There are total 10 EUP are proposed by the NHAI PIU -Bhubaneshwar as per the recommendation of the DFO vide letter No. RCCF Bhubaneswar circle letter no. 2064 dated 10.06.2022.
2.	Wildlife conservation/management plan for the area with special emphasis on elephants management shall be prepared in consultation with State Forest Department, WII or any other nationally reputed institution and implemented at the project cost.	Wildlife conservation/Management plan for the area with special emphasis on elephant's management has been prepared in consultation with the state forest department and are attached in Annexure 3.5
3.	Provide compilation of road kill data on the wildlife on the existing roads (national and state highways) in the vicinity of the proposed project. Provide measures to avoid road kills of wildlife by the way of road kill management plan.	As the project is a greenfield alignment and is not passing through any Wildlife Sanctuary or any Reserve Forest, hence no such road kill data is admissible in the proposed project.
4.	No tree can be felled/transplant unless exigencies demand. Preference should be given for transplantation of trees wherever possible. Where absolutely necessary, tree felling shall be with prior permission from the concern Authority. Old, large and heritage value trees should be retained based on girth and age regulations as may be prescribed by the Forest Department. Where the trees need to be cut/transplanted with prior permission from the concerned local Authority, compensatory plantation in the ratio of 1:10 (i.e. planting of 10 trees for every 1 tree that is cut/ non-survival of any transplanted tree) shall be done and maintained. Plantations to be ensured species (cut) to species (planted). All the plantation will be done by state forest department as deposit work and not by private contractors.	The alignment of road is so designed so that the cutting of trees is kept at bare minimum and NHAI shall obtain all the necessary permissions from the competent authorities. No such old, large and heritage trees are encountered within the RoW of the proposed alignment. NHAI shall obtain all the necessary permissions from the competent authorities.
5.	Measure above and below ground carbon stocks in biomass and soil in individual trees through scientifically established	Carbon stock for the trees to be planted during construction would be analysed and individual plantation saplings would be geo

	and verifiable methods using expert services from ICFRE/IIFM or any other reputed expert agency. Geo-tag each individual (seedling/sapling) plantation spot for future reference. A progress in this regard may be submitted in 6 monthly compliance report.	tagged. A progress in this regard will be submitted in 6 monthly compliance report.
6.	Green belt development (tree plantation) in lieu of the trees being felled in non-forest land should be carried out by the State forest department as deposit work and not by the private contractor. Green belt must be developed using exclusively native species including significant number of ficus trees. No exotic species to be used for the same. A comprehensive plan for plantation shall be prepared in consultation with state forest department (executing agency) including the costs involved. Such compensatory plantation will be over and above the compensatory afforestation to be carried in lieu of the diversion of forest land, if any.	The green belt development plan and tree plantation scheme has been presented in Chapter 10 and Annexure 10.1 respectively. The cost for regular maintenance has been covered in EMP budget.
7.	Measure above and below ground carbon stocks in biomass and soil in individual trees within forests and trees outside forest through scientifically established and verifiable methods using expert services. Maintain yearly growth measurements (diameter and height) records of individuals for a period of 20 years. Geo-tag each individual (seedling/sapling) plantation spot for future reference.	Carbon stock for the trees to be planted during construction would be analysed and individual plantation saplings would be geo tagged. A progress in this regard will be submitted in 6 monthly compliance report along with diameter and height.
8.	Trees with heronry (breeding ground for herons, egrets, etc.), pelicanary or community nesting of birds like Painted Storks, Ibis, Egrets, Pelican, etc. will not be allowed to fell. In case of presence of such, alignment will be required to be changed to save such trees.	All measures will be taken to ensure the compliance at site during construction.
9.	Project alignment should be managed in such a way to save the Heritage/old trees supposed to be affected by the proposed alignment.	The alignment of road is so designed so that the cutting of trees is kept at bare minimum and NHAI shall obtain all the necessary permissions from the competent authorities. No such old, large and heritage trees are encountered within the RoW of the proposed alignment.

10.	The proponent shall obtain permission from the competent authorities for tree felling along the proposed alignment.	The alignment of road is so designed so that the cutting of trees is kept at bare minimum and NHAI shall obtain all the necessary permissions from the competent authorities. No such old, large and heritage trees are encountered within the RoW of the proposed alignment.
11.	In borrow pits, the depth of the pit shall be regulated such that the sides of the excavation will have a slope not steeper than 1:2, from the edge of the final section of bank. Soil erosion checking measures shall be carried out. Details for borrow area operation and rehabilitation given in EIA report shall be followed.	Borrow areas would be identified during the construction by the contractor and all the necessary precautions admissible to the borrow areas as per IRC guidelines and State Minerals department would be ensured for the borrow areas. All measures given in the EIA report would be followed.
12.	Quarry areas shall be barricaded during mining operations. The abandoned quarry shall be developed as water reservoirs with proper fencing around quarry area.	The condition is being complied accordingly as per the provision given in the EIA/EMP report.
13.	In all the construction sites within 150 m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am. No noisy construction activities will be permitted around educational institutions/health centres (silence zones) up to a distance of 100 m from the sensitive receptors. All plants and equipment used in construction shall strictly conform to the CPCB/SPCB noise standards.	The condition is being complied. For crushing, concrete mixing etc., the necessary permission of CTE/CTO will be taken from Odisha pollution control Board. Noise standard are being strictly enforced for all vehicle, plants, equipment's and construction machinery. High noise producing generator such as concrete mixers, generators, Graders are provided with noise shield. During the night time between 10.00 PM to 6.00 AM the noise generating construction work is stopped.
14.	Traffic Control Devices/Road Safety Devices/Roadside Furniture including various types of cautionary, informatory, regulatory as mandatory signboards, road markers, studs, etc. shall be provided at appropriate locations all along the project stretch in accordance with the specifications laid down in Manual of Specifications and Standards for Expressways (IRC: SP:99-2013) and IRC:8, IRC:25, IRC:26, IRC:35, IRC:67, IRC:79, IRC:103 and Section 800 of MORTH Specifications.	During the construction phase delineators, caution tapes are provided at construction site. Also sign board such as work in progress, Go Slow, Men at Work, Diversion ahead etc. are provided. Diversion are done as per the guidelines of IRC SP 55 2014 and for public safety additional safety measures have been taken at cross roads junction. Before operation of the proposed highway all these provision as per specification and IRC guidelines/ standards for highway shall be completed.
15.	Rain water harvesting pit shall be at least 3-5 m above the highest ground water table.	Rainwater harvesting shall be proposed as per IRC-SP-58 and the details has been presented in Chapter 4
16.	No Ground water shall be extracted and used. Approval/permission of concerned authority shall be obtained before	NHAI along with the contractor shall not use groundwater without obtaining approval from CGWA as the case may be. The

	drawing surface water from canal or any other sources.	contractor shall apply to the Central Ground Water Authority (CGWA) Competent Authority, as the case may be, for obtaining No Objection Certificate (NOC), for withdrawal of ground water.
17.	All the major, minor bridges and culverts should not affect the drainage systems. Flood plains of the rivers/ drainage systems are not to be disturbed.	There are total 3 Major Bridges and 23 Minor Bridge and 233 culverts are being proposed. Flood plains of the rivers/ drainage systems are not being disturbed.
18.	Proponent shall keep the finish road level sufficiently elevated from ground level with provision of railing on both sides to restrict animal crossing in order to avoid the possibility of wildlife injury/death. Animal underpasses, watch tower, water holes and other mitigation measures proposed shall be constructed in supervision of forest department.	The road is being designed as per latest IRC standards and the same would be complied at site.
19.	While constructing the over bridges as proposed over major water bodies efforts should be made to avoid construction of pillars in beds of water bodies.	The road is being designed as per latest IRC standards and the same would be complied at site and all efforts would be made to comply the condition.
20.	As per the Ministry's Office Memorandum F. No. 22-65/2017-IA.III dated 30th September, 2020, the project proponent shall abide by all the commitments made by them to address the concerns raised during the public consultation. The project proponent shall initiate the activities proposed by them, based on the commitment made in the public hearing, and incorporate in the Environmental Management Plan and submit to the Ministry. All other activities including pollution control, environmental protection and conservation, R&R, wildlife and forest conservation/protection measures including the NPV, Compensatory afforestation etc., either proposed by the project proponent based on the social impact assessment and R&R action plan carried out during the preparation of EIA report or prescribed by EAC, shall also become part of EMP and shall be implemented.	All the commitments made by NHAI-PIU Bhubaneswar to address the concerns raised during the public consultation are properly addressed and the issues raised during the public hearing process would be implemented.

B. <u>Standard Terms of Reference for (Road)</u>

S. No.	ToR Point	Compliance
1. Project Details		
1.1	Examine and submit a brief description of the project, project name, nature, size, its	The details have been shown in Chapter 1.

	importance to the region/state and the country.	
1.2	Submit detailed alignment plan, with details such as nature of terrain (plain, rolling, hilly), land use pattern, habitation, cropping pattern, forest area, environmentally sensitive places, mangroves, notified industrial areas, sand dunes, sea, river, lake, details of villages, teshils, districts and states, latitude and longitude for important locations falling on the alignment by employing remote sensing techniques followed by ground truthing and also through secondary data sources.	The nature of the terrain is mostly plain. The land use pattern along the project area has been presented in Chapter 3. The detailed alignment plan with details such as nature of terrain (plain, rolling, hilly), habitation, cropping pattern, forest area, environmentally sensitive areas, notified industrial areas, sand dunes, sea, rivers, lakes, details of villages, tehsils, districts and states, latitude and longitude for important locations falling on the alignment by employing remote sensing techniques followed by "ground truthing" and also through secondary data sources have been presented in Chapter 3 as well as in Chapter 2 (details of villages, tehsils and districts).
1.3	Describe various alternatives considered, procedures and criteria adopted for selection of the final alternative with reasons.	The details of alternative analysis provided in Chapter 5 of EIA report. The chapter compares the scenario with and without project by virtue of geometrics, design speed, congestion, felling of trees, safety of pedestrians, effects on environment, drainage and other amenities. The alternatives of all the alignment proposed along the project stretch are discussed in the Chapter 5 along with justification for selection of final alignment among the various alternatives. Also, details on alternative technologies used in highway sector have also been presented in Chapter 5.
1.4	If the proposed route is passing through a city or town, with houses and human habitation on the either side of the road, the necessity for provision of bypasses/diversions/under passes shall be examined and submitted. The proposal should also indicate the location of wayside amenities, which should include petrol station/service centre, rest areas including public conveyance, etc. Noise reduction measures should also be indicated.	We have provided more than 3 culverts/km of size 3.0 m x 3.0 m for local hydrogeology as well as animal movement. The details are presented in Chapter 2. Also, light and small vehicular underpasses are also proposed in the alignment which are presented in Chapter 2 and Annexure 2-4.
1.5	Submit details about measures taken for the pedestrian safety and construction of underpasses and foot-over bridges along with flyovers and interchanges. If any.	The proposed expressway is partially access controlled for pedestrians. However, underpasses, footpaths are proposed at specific locations. The details have been presented in Chapter 2 and ***Annexure 2-4***

1.6	Assess whether there is a possibility that the proposed project will adversely affect road traffic in the surrounding areas (e.g. by causing increases in traffic congestion and traffic accidents). Specific care be also taken to ensure that by passes have a sufficient buffer to prevent unwanted obstructions defying the purpose of the bypass.	The project will enhance traffic movement and the design of the proposed highway will address safety concerns and reduce accidents.
1.7	If the proposed route involves cutting of earth, the details of area to be cut, depth of cut, locations, soil type, volume and quantity of earth and other materials to be removed with location of disposal/ dump site along with necessary permission.	The whole alignment is in plain area and hence no cutting is envisaged for the project.
1.8	If the proposed route is passing through low lying areas, details of fill materials and initial and final levels after filling above MSL, should be examined and submit.	Selected borrow pit soil is used for embankment fill with slope protection. Details shall be submitted by the contractor during construction.
1.9	Examine and submit the water bodies including the seasonal ones within the corridor of impacts along with their status, volumetric capacity, quality likely impacts on them due to the project.	The details of all the water bodies within the corridor and their mitigation measures have been presented in Chapter 4.
1.10	Examine and submit the details of use of fly ash in the road construction, if the project road is located within the 100 km from the Thermal Power Plant.	The details of the use of fly ash have been presented in Chapter 4.
1.11	Explore the possibilities of utilizing the debris/ waste materials available in and around the project area.	The waste generated during the construction shall be used under subgrade.
2. Forest		
2.1	In case the project involves diversion of forests land, guidelines under OM dated 20.03.2013 may be followed and necessary action taken accordingly.	The proposal for forest clearance is under process.
2.2	The information should be provided about the details of the trees to be cut including their species and whether it also involves any protected or endangered species. Measures taken to reduce the number of the trees to be removed should be explained in detail. Submit the details of compensatory plantation.	Approx. 13617 trees are recorded in Corridor of Impact. Some of the major species are Mahua (*Madhuca longifolia*), Mango (*Mangifera indica*), Coconut (*Cocos nucifera*), Sal (*Shorea robusta*), Teak (*Tectona grandis*), Neem (*Azadirachta indica*), etc. The details of the avenue plantation have been covered in Chapter-10 (Environment Management Plan). Compensatory afforestation scheme as finalised by the concerned DFOs would be implemented.
2.3	Necessary green belt shall be provided on both sides of the highway with proper central verge and cost provision should be made for regular maintenance.	The green belt development plan has been presented in Chapter 10. The cost for regular maintenance has been covered in EMP budget.

2.4	If there is a possibility that the construction/ widening of road will cause impact such as destruction of forest, poaching, reductions in wetland areas, if so, examine the impact and submit details.	The impact on the Flora, Fauna and Ecosystem due to the construction of the expressway and its mitigation measures has been presented in Chapter 4.
3. Court Matters		
3.1	Details of any litigation(s) pending against the project and/or any directions or orders passed by any court of law/any statutory authority against the project to be detailed out.	There is no litigation against the project with any court.
4. Land Environment		
4.1	Submit Land use map of the study area to a scale of 1:25,000 based on recent satellite imagery delineating the crop lands (both single and double crop), agricultural plantations, fallow lands, waste lands, water bodies, built-up areas, forest area and other surface features such as railway tracks, ports, airports, roads, and major industries etc.	The land use map of the study area of 1: 25,000 is shown in ***Annexure 3-2.***
4.2	submit a detailed ground surveyed map on 1:2000 scale showing the existing features falling within the right of way namely trees, structures including Archaeological & religious, monuments etc. if any.	The ground survey map of 1:2000 is enclosed as Annexure 3-3.
4.3	If the proposed route is passing through any hilly area, examine and submit the stability of slopes, if the proposed road is to pass through cutting or embankment / control of soil erosion from embankment. Landslide, rock fall protection measures to be indicated.	Adequate slope protection measures are proposed as part of engineering design. The slopes and embankments of the project road shall be stabilised through sound engineering techniques. The details of the measures for ensuring stability of slopes and to control soil erosion from embankment have been presented in Chapter 4.
5. Wildlife		
5.1	The project is located within 10km of the sanctuary a map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon should be furnished at the stage of EC.	The proposed project is located within 10 km of the Chandaka Dampara wild life sanctuary, but not coming within the ESZ of the Chandaka wildlife sanctuary. There are total 10 EUP are proposed by the NHAI PIU - Bhubaneshwar as per the recommendation of the DFO vide letter No. RCCF Bhubaneswar circle letter no. 2064 dated 10.06.2022.
5.2	Details of blasting if any, methodology/ technique adopted, applicable regulations/ permissions, timing of	There is no blasting required for this project. The conservation and mitigation measures for wildlife has been presented as Annexure

	blasting, mitigation measures proposed. Keeping in view mating season of wild life.	
5.3	Explore the possibilities of relocating the existing trees. Animal and wild life crossings to be provided in areas inhabited by wild life.	Approx. 13617 trees are recorded in Corridor of Impact. Some of the major species are Mahua (*Madhuca longifolia*), Mango (*Mangifera indica*), Coconut (*Cocos nucifera*), Sal (*Shorea robusta*), Teak (*Tectona grandis*), Neem (*Azadirachta indica*), etc. The details of the avenue plantation have been covered in Chapter-10 (Environment Management Plan). Compensatory afforestation scheme as finalised by the concerned DFOs would be implemented.
5.4	Study regarding the Animal bypasses / underpasses etc. across the habitation areas shall be carried out. Adequate cattle passes for the movement of agriculture material shall be provided at the stretches passing through habitation areas.	There are total 10 EUP are proposed by the NHAI PIU -Bhubaneshwar as per the recommendation of the DFO vide letter No. RCCF Bhubaneswar circle letter no. 2064 dated 10.06.2022. Also, light and small vehicular underpasses are also proposed in the alignment which are presented in Chapter 2 and Annexure 2-4.
5.5	Provide compilation of road kill data on the wildlife on the existing roads (national and state highways) in the vicinity of the proposed project. Provide measures to avoid road kills of wildlife by the way of road kill management plan.	As the project is a greenfield alignment and is not passing through any Wildlife Sanctuary or any Reserve Forest, hence no such road kill data is admissible in the proposed project.
6. Soil Quality Analysis		
6.1	Submit the details on compliance with respect to Research Track Notification of MoRTH 20) Examine and submit the details of sand quarry and borrow area as per OM no.2-30/2012-IA-III dated 18.12.2012 on 'Rationalization of procedure for Environmental Clearance for Highway Projects involving borrow areas for soil and earth as modified vide OM of even no. dated March 19, 2013.	Followed the IRC and MoRTH guidelines. The details of the sand quarry and borrow areas have been presented in Chapter 4. All latest guidelines would be followed during procurement of sand from quarry and soil from Borrow Areas
7. Climate and Meteorology		
7.1	Climate and meteorology (max and min temperature, relative humidity, rainfall, frequency of tropical cyclone and snow fall); the nearest IMD meteorological station from which climatological data have been obtained to be indicated.	The details have been presented in Chapter 3
8. Air Environment		
8.1	The air quality monitoring should be carried out as per the new notification issued on 16th November, 2009.	The air quality monitoring has been carried as per the mentioned notification of MoEF&CC regarding EIA
8.2	Examine the impact during construction activities due to generation of fugitive	The brief details for Air modelling for 1 homogenous sections has been presented in

	dust from crusher units, air emissions from hot mix plants and vehicles used for transportation of materials and prediction of impact on ambient air quality using appropriate mathematical model.	Section Chapter 4. Detailed Air Quality Modelling report is attached as Annexure 4-1.
8.3	Description of model, input requirement and reference of derivation, distribution of major pollutants and presentation in tabular form for easy interpretation shall be carried out.	The details of model, input requirement and reference of derivation, distribution of major pollutants and presentation have been presented in Chapter 4.
9. Noise Environment		
9.1	Identify project activities during construction and operation phases, which will affect the noise levels and the potential for increased noise resulting from this project.	The impact on the noise levels during construction and operation phase and the corresponding mitigation measures has been presented in Chapter 4.
9.2	Discuss the effect of noise levels on nearby habitation during the construction and operational phases of the proposed highway.	Prediction of noise levels on nearby habitation during the construction and operational phases of the proposed highway are done using noise modelling study.
9.3	Identify noise reduction measures and traffic management strategies to be deployed for reducing the negative impact if any.	The impact on the noise levels during construction and operation phase and the corresponding mitigation measures has been presented in Chapter 4.
9.4	Prediction of noise levels should be done by using mathematical modelling at different representative locations.	The brief noise modelling study has been presented in Chapter 4. Detailed Noise Modelling report is attached as Annexure 4-2.
9.5	Also examine and submit the details about the protection to existing habitations from dust, noise, odour etc. during construction stage.	Mitigation measures for protection to existing habitations from dust, noise, odour etc has been presented in Chapter 4.
9.6	If the proposed route is passing through low lying areas, details of fill materials and initial and final levels after filling above MSL, should be examined and submit.	Selected borrow pit soil is used for embankment fill with slope protection. Details shall be submitted by the contractor during construction.
10. Water Environment		
10.1	Examine and submit the water bodies including the seasonal ones within the corridor of impacts along with their status, volumetric capacity, quality likely impacts on them due to the project.	The details of all the water bodies within the corridor and their mitigation measures have been presented in Chapter 4.
10.2	Examine and submit details of water quantity required and source of water including water requirement during the construction stage with supporting data and also categorization of ground water based on the CGWB classification.	The peak water requirement is 1200 KLD during construction stage and will be extracted from local surface water resources or any other sources approved by the competent authority.
10.3	Examine and submit the details of measures taken during constructions of	03 nos. of major bridges and 23 nos. of minor bridges have been proposed. The details of

	bridges across river/ canal/ major or minor drains keeping in view the flooding of the rivers and the life span of the existing bridges.	provision of safety signals, service lanes and foot paths to avoid accidents has been presented in Chapter 4. Provision of diversions with direction signs, speed breakers and other safety requirements followed as per IRC & MoRTH guidelines.
10.4	In case of river/ creek crossing, details of the proposed bridges connecting on either banks, the design and traffic circulation at this junction with simulation studies.	Adequate number of bridges have been proposed to cater to the rivers and estuaries' crossing. The details have been presented in Chapter 2.
10.5	Details to ensure free flow of water in case the alignment passes through water bodies/river/ streams etc.	Adequate number of bridges and culverts have been proposed to cater to the rivers and estuaries' crossing and ensure free flow of water. The details have been presented in Chapter 2.
11. Drainage		
11.1	If there will be any change in the drainage pattern after the proposed activity, details of changes shall be examined and submitted.	No major change is anticipated and adequate culverts and bridges are proposed in the project. The details of drainage pattern have been given in section chapter 3 as well as details of proposed culverts have been given in Chapter 2.
11.2	If the proposed route involves tunnelling, the details of the tunnel and locations of tunnelling with geological structural fraction should be provided. In case the road passes through a flood plain of the river, the details of micro drainage, flood passages and information on high levels flood periodicity at least of last 50 years in the area should be examined.	No tunnelling is proposed for the above project road. The proposed project intersects the flood plains of two rivers, namely Devi and Mahanadi. However, adequate number of major and minor bridges, culverts are proposed on the affected project areas to cater to the micro-drainage, flood passage of the area. The details of proposed structures is presented in Chapter 2 as well as ***Annexure 2-4***.
12. Rain Water Harvesting		
12.1	Rain water harvesting pit should be at least 3-5 m. above the highest ground water table.	Rainwater harvesting shall be proposed as per IRC-SP-58 as per site conditions and DPR
12.2	Provision shall be made for oil and grease removal from surface runoff.	The details has been presented in Table 9-4 of Chapter 4
13. Road and Traffic		
13.1	Submit the details of road safety, signage, service roads, vehicular under passes, accident prone zone and the mitigation measures.	The proposed highway is partially access controlled. However, provision of diversions with direction signs, speed breakers and other safety requirements followed as per IRC & MoRTH guidelines.
13.2	IRC guidelines shall be followed for widening & upgradation of road.	This is green field alignment which is designed as per the IRC guidelines.

13.3	IRC guidelines to be followed for traffic safety while passing through the habitat.	Traffic management plan has been prepared and presented in chapter 10.
13.4	Provision of speed breakers, safety signals, service lanes and foot paths should be examined at appropriate locations throughout the proposed road to avoid the accidents.	Provision of diversions with direction signs, speed breakers and other safety requirements followed as per IRC & MoRTH guidelines.
13.5	In case of bye passes, the details of access control from the nearby habitation/ habitation which may come up after the establishment of road.	This is a greenfield alignment and is proposed as a new National Highway
13.6	Submit details of social impact assessment due to the proposed construction of road.	The details of the Social Impact Assessment have been presented in Chapter 7.
13.7	Examine road design standards, safety equipment specifications and Management System training to ensure that design details take account of safety concerns and submit the traffic management plan.	All relevant guidelines have been followed for designing the highway as per traffic, pedestrian and accident safety. The details of the traffic Management plan have been presented in Chapter 2.
13.8	Accident data and geographic distribution should be reviewed and analysed to predict and identify trends – in case of expansion of the existing highway and provide Post accident emergency assistance and medical care to accident victims.	Proposed expressway is mostly green field. However, provision for accident emergency assistance and medical care to accident victims has been considered as road safety measures.
13.9	The proponent shall carry out a detailed traffic flow study to assess inflow of traffic from adjoining areas like airport/urban cities. The detailed traffic planning studies shall include complete design, drawings and traffic circulation plans (taking into consideration integration with proposed alignment and other state roads etc.). Wherever required, adequate connectivity in terms of VUP (vehicle underpass)/ PUP (Pedestrian underpass) needs to be included.	Detailed traffic study has been carried out and is presented as ***Annexure 2-3***
14. Land Acquisition and R&R		
14.1	Details of the properties, houses, businesses religious and social places etc. activities likely to be effected by land acquisition and their financial loses annually.	The details of properties, houses, business activities etc. likely to be affected by land acquisition have been presented in sections 7.4.1, 7.5.4 and 7.5.5. of Chapter 7. The estimation of their financial losses is presented in Chapter 7.
14.2	Detailed R&R plan with data on the existing socio-economic status of the population in the study area and broad plan for resettlement of the displaced population, site for the resettlement colony, alternative livelihood concerns/	The details of the existing socio-economic profile of the study area have been presented in section 3.4.3 of Chapter 3. The Land Acquisition plan & policy has been presented in Chapter 7.

	employment and rehabilitation of the displaced people, civil and housing amenities being offered, etc. and the schedule of the implementation of the project specific.	
14.3	Whether governmental or on the basis of BOT etc. and provide details of budget provisions (capital & recurring) for the project specific R&R Plan.	The total project budget and R&R components as sanctioned by the Ministry have been presented in Chapter-1 and Chapter-7.
14.4	Examine and submit the details of sand quarry, borrow area and rehabilitation.	The details of the sand quarry and borrow areas have been presented in Chapter 4. All latest guidelines would be followed during procurement of sand from quarry and soil from Borrow Areas.
14.5	If the proposed project involves any land reclamation, details to be provided for which activity land to reclaim and the area of land to be reclaimed.	The proposed project does not involve any land reclamation.
15. Socio-economic Environment		
15.1	The proponent shall carry out a comprehensive socio-economic assessment and also impact on biodiversity with emphasis on impact of ongoing land acquisition on the local people living around the proposed alignment. The Social Impact Assessment should have social indicators which can reflect on impact of acquisition on fertile land. The Social Impact Assessment shall take into consideration of key parameters like people's dependency on fertile agricultural land, socioeconomic spectrum, impact of the project at local and regional levels.	The details of the Social Impact Assessment have been presented in Chapter 7.
15.2	As per the Ministry's Office Memorandum F.No.22-65/2017-IA.III dated 30th September, 2020, the project proponent, based on the commitments made during the public hearing, shall include all the activities required to be taken to fulfil these commitments in the Environment Management Plan along with cost estimates of these activities in addition to the activities proposed as per recommendations of EIA Studies and the same shall be submitted to the ministry as part of the EIA Report. The EMP shall be implemented at the project cost or any other funding source available with the project proponent.	CER is not applicable for NHAI, however all the issues raised during the public hearing process would be implemented.

16. Environmental Monitoring and Management		
16.1	Estimated cost of the project including environmental monitoring cost and funding agencies. Submit environmental management and monitoring plan for all phases of the project viz. construction and operation.	Details of the project cost is presented in chapter-2, the cost of environmental monitoring and schedule during operation and construction phase are given in chapter -6
16.2	The cost of the Project (capital cost and recurring cost) as well as the cost towards implementation of EMP should be clearly spelt out.	Details of the project cost is presented in chapter-2 and cost towards implementation of EMP are presented in chapter -10
16.3	Any further clarification on carrying out the above studies including anticipated impacts due to the project and mitigative measure.	Anticipated impacts due to the project and mitigative measure has been described in chapter -4
17. Alignment, ESZ & CRZ		
17.1	In case of alignment passing through coastal zones	The proposed alignment is not passing through the coastal zones
17.2	HTL/LTL map prepared by authorized agencies superimposed with alignment and recommendation of Coastal Zone Management Authority.	Not applicable
17.3	Details of CRZ-I areas, mangroves required to be removed for the project along with the compensatory afforestation, area and location with budget.	Not applicable
17.4	Details of road on stilt in CRZ-I areas, design details to ensure free tidal flow.	Not applicable
18. Employment		
18.1	Details of Labour camps, machinery location.	The alignment is divided into Two packages and the contractors will set up at least 2 camps during the construction appropriately following all the statutory requirements.
19. Miscellaneous		
19.1	The Action Plan on the compliance of the recommendations of the CAG as per Ministry's Circular No. J-11013/71/2016-IA. I (M), dated 25th October, 2017 needs to be submitted at the time of appraisal of the project and included in the EIA/EMP Report.	Addresses the compliance points in EIA / EMP Report as per MOEFCC Circular No J11013/71/2016-IA.I (M) dated 25.10.2017. Will be followed.

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LIST OF ABBREVIATIONS

Abbreviation	Description
AAQ	Ambient Air Quality
AE	Authority Engineer
BA	Borrow Area
BIS	Bureau of Indian Standards
BLQ	Below Level of Quantification
BOD	Biochemical Oxygen Demand
BoQ	Bill of Quantities
BoT	Build Operate Transfer
CGWB	Central Ground Water Board
cm	Centimeters
CO	Carbon Monoxide
CO_2	Carbon di-oxide
COD	Chemical Oxygen Demand
CoI	Corridor of Impact
CPCB	Central Pollution Control Board
CSR	Corporate Social Responsibility
Cum	Cubic Metres
dB	Decibel
DG	Diesel Generator
DMP	Disaster Management Plan
DO	Dissolved Oxygen
DPR	Detailed Project Report
EAC	Expert Appraisal Committee
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMC	Environmental Management Cell
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
ESZ	Eco Sensitive Zone
EUP	Elephant Underpass
GoI	Government of India
GW	Ground Water
ha	Hectares
ham	Hectare Meter
HC	Hydrocarbon
IMD	Indian Meteorological Department
IRC	Indian Road Congress
IS	Indian Standard
ISO	International Organization for Standardization
kl	Kilo Litres

km	Kilometre
LHS	Left Hand Side
m	Metre
mm	Milli Metre
MoEF&CC	Ministry of Environment, Forests and Climate Change
MPN	Most Probable Number
NABL	National Accreditation Board for Testing and Calibration Laboratories
NGOs	Non-Governmental Organization
NHAI	National Highways Authority of India
no.	Number
NOC	No Objection Certificates
NTU	Nephelometric Turbidity Units
OSPCB	Odisha State Pollution Control Board
PAF	Project Affected Family
PAP	Project Affected People
PIA	Project Influence Area
PM	Particulate Matter
PM_{10}	Particulate Matter < 10 Micrometre size
$PM_{2.5}$	Particulate Matter < 2.5 Micrometre size
ppm	Parts Per Million
R&R	Rehabilitation and Resettlement
R.F.	Reserved Forests
RHS	Right Hand Side
RO	Regional Officer
RoB	Road over bridge
RoW	Right of Way
RWH	Rain Water Harvesting
SC	Scheduled Caste
SO_2	Sulphur Dioxide
sq.	Square
ST	Scheduled Tribe
SW	Surface Water
SWM	Solid Waste Management
TDS	Total Dissolved Solids
ToR	Terms of Reference
VUP	Vehicular Under Pass
WII	Wildlife Institute of India

1. INTRODUCTION

1.1 Overview

Highway projects are undertaken to improve the socio-economic life of the people through the areas which they pass. At the same time, they may also create impacts on the surrounding environment. People and property in the direct path of the alignment are largely affected due to this. The environmental impact of road projects include damage to sensitive ecosystems, soil erosion, changes to drainage pattern and thereby groundwater, interference with animal and plant life, loss of productive agricultural lands, resettlement of people, disruption of local economic activities, demographic changes, accelerated urbanization and increase in air pollution. To minimize these adverse effects that may be created by highway development projects, the techniques of Environmental Impact Assessment (EIA) become necessary. EIA is a technique which is necessary for identification, quantification and assessment of potential environmental impacts. Assessment of these impacts should commence early in the planning process of the project to enable full consideration of alternatives and to avoid later delays and complications in the proposed project. The National Highways Authority of India (NHAI) is responsible for the development and improvement of the project roads for the connectivity of National Highways under Bharatmala Scheme or the new NH (O) scheme.

NHAI has entrusted the work to M/s. Geo Design & Research Pvt. Ltd to carry out the Feasibility study and the Detailed Project Report for 6-laning NH configuration under NH(O) Scheme from Rameswar in Khordha district to Gobindpur in Dhenkanal district in Odisha state to augment capacity of the highway. NHAI has issued the Letter of Acceptance of CRRR-1 via letter NHAI/13012/21/RO/OD/59/2020 Dated 10.01.2020. Odisha Government approved the alignment on 23/05/2023, the MoM is attached as **Annexure 1-1.** M/s. Geo Design & Research Pvt. Ltd has appointed M/s. Chaitanya Projects Consultancy Ltd. for carrying out the EIA study, vide work order GDRPL /CPCPL /ECP/2024/02 signed on 10.06.2024 is attached as **Annexure 1-2.**

The new highway starts from its junction with NH-16 near Rameswar in Khordha district and terminating at its junction with NH-55 at Gobindpur in Dhenkanal district in the State of Odisha. The length of the proposed alignment is approx. 70.995 km.

According to new EIA Notification issued on 14th September, 2006 by the MoEF&CC, GoI and amended Notification on 22nd August, 2013 on Highway projects, the proposed new highway project between Rameswar to Gobindpur is falling under Category -A Project (Schedule -7f of Notification). The above proposal was considered by the Expert Appraisal Committee (EAC) for Infra-I Sector, in its 370th Expert Appraisal Committee during 23rd-24th July, 2024, recommended the project for grant of Terms of Reference (ToR).

The EIA & EMP report is prepared in accordance to the Terms of Reference (ToR) issued by MoEFCC, New Delhi, vide letter no. F. No. 10/18/2024-IA.III, and Proposal No. IA/OR/INFRA1/482782/2024 dated 09th September 2024 (attached as **Annexure 1-3**).

1.2 Project Proponent & Description

National Highways Authority of India (NHAI) is an autonomous organisation under the Ministry of Road Transport & Highways (MoRTH) and was constituted by an Act of Parliament, the National Highways Authority of India Act, 1988. NHAI is responsible for the development, maintenance and management

of National Highways and for matters concerned thereto. The authority was made operational with the appointment of full time chairman and other members in the year 1995. The National Highways Authority of India, Ministry of Road Transport and Highways, Government of India intends for development of fully access control highway under NH(O) from its junction with NH-16 near Rameswar village, Khordha District and terminating at its junction with NH-55 at Gobindpur in Dhenkanal district in the State of Odisha

1.3 Brief Description of the Project

The proposed project is construction of new six lane NH configuration under NH (O)/Bharatmala Scheme- starts from its junction with NH-16 near Rameswar village, Khordha district and terminating at its junction with NH-55 at Gobindpur in Dhenkanal district in the State of Odisha (Lot-3/Odisha & Jharkhand- Package - 3). The project stretch Rameswar -Gobindpur starts at NH-16 (Lat. 20° 1'9.39"N, Long. 85°30'17.81"E) near Rameswar which is in Khordha district and passes through Balarampur, Kuanrakalipatna, Radhakantapur, Talabasta, Gholpur, Shankarpur, Baladiabandha villages and ends at Gobindpur village at NH-55 in Dhenkanal (Lat. 20°36'11.33"N, Long. 85°38'59.94"E). Total length of the stretch is about 70.995 km. The project stretch is mainly lies in plain terrain.

The Consultant presented the Alignment Options proposal to stake holders on 01.09.2021 in 52nd LAC meeting at NHAI HQ, New Delhi which was approved by NHAI, vide letter NHAI/ Odisha/ CRR/ RG/ 2021/efile-99212 on 23.08.2021.

Table 1-1: Details about the Project Road

S. No.	Project Road	Contract Length of Section (km)
1	Rameswar to Gobindpur Section	70.995
Total Length of Project Road		**70.995**

1.4 Importance of the Project

The proposed project is mostly green field alignment highway, and is proposed for 6 Lane with paved shoulder with NH configuration under NH(O) scheme. The main objective of the proposed project is to give connectivity to Dhenkanal, Angul and bypass the major cities of Cuttack, Bhubaneswar and Khordha as this alignment is the first part of Capital Region Ring Road. The project lays emphasis on development of these areas and to make them available with the socio-economic benefits that accrue with the development of highways. The proposed highway with new alignment has been envisaged through an area which shall have the advantage of simultaneous development as well as shall result in a shorter distance to travel. The junctions with existing road will be planned in the form of interchanges and flyover to ensure uninterrupted flow of traffic. The proposed highway would act as the prime artery for the economic flow to this region. It will enhance economic development, provide employment opportunities to locals, strengthen tourist development, ensure road safety, and provide better transportation facilities and other facilities such as way side amenities, vehicular underpasses, culverts, etc. Vehicle operating cost will also be reduced due to improved road quality and road geometry. The compensatory plantation and road side plantation shall further improve the air quality of the region.

1.5 Salient Features of the Project

The project stretch starts at Rameswar village in Khordha district and ends at Gobindpur in Dhenkanal, district in Odisha state. The length of the proposed alignment is approx. 70.995 km. The salient features of the project road are described below in **Table 1-2**.

Table 1-2: Salient Features of the Project

Sl.	Particulars	Details	
1.	Project Road	Rameswar-Gobindpur (Capital Region Ring Road-I)	
2.	Type of funding and project execution	EPC/HAM mode	
3.	Location of the proposed project	Khordha, Dhenkanal and Cuttack districts of Odisha	
4.	No, of affected villages by Land acquisition	65	
5.	Total Length of the proposed project	70.995 km	
6.	Total Area of Land Acquisition	547.51 ha (including Govt. and Revenue Forest land)	
7.	Protected area	The proposed alignment does not pass through any wild life sanctuary however is passing through a minimum distance of 0.87 km and maximum distance of 6.67 km from the ESZ Boundary of Chandaka Wildlife Sanctuary.	
8.	Terrain	Plain	
9.	Seismic Zone	Seismic zone – III	
10.	Geographical Location	UTM 45 Q	
11.	Proposed Bridges	Major Bridge-03, Minor Bridge-23	
12.	Proposed Underpasses / Flyover including Pedestrian underpass	VUP-12, LVUP-14, SVUP-10, EUP-10, Fly over-5, Viaduct-1, ROB-1	
13.	Culverts	233 Culverts	
14.	Right of Way	60m (Additional at WSA, Interchange, diversion locations)	
15.	Design Speed	100 kmph	
16.	Carriageway	6 Lane	
17.	Embankment	2-5 m height (varying)	
18.	Proposed Toll Plazas	1 number on Main Carriageway and 8 numbers on Entry/Exit Ramps.	
19.	Safety Measure	ATMS	
20.	Lighting	At all structure locations, Approaches of structures, WSA, Interchange locations	
21.	No. of Structures Affected	71	
22.	Total Cost (Civil and Capital)	Civil Construction Cost-	Capital Cost
	PKG-1	Rs. 15,84,36,27,745	Rs. 24,74,05,38,158
	PKG-2	Rs. 13,14,22,16,616	Rs. 20,67,04,65,661
23.	Water bodies Impacted	34 Nos.	
24.	Existing trees within ROW	13617	

25.	Compensatory plantation	Approx. 25200 trees will be planted in CA area as per CA scheme.
26.	Green belt development (Avenue Plantation)	11500 Nos. (Avenue + Median plantation)
27.	No. of project affected persons (PAFs) & (PAPs)	3426 & 15621
28.	Resettlement Action Plan (RAP) including Land Acquisition Budget	Approx. Rs.778 Cr.

1.6 Objectives of the EIA Study

Environment Impact Assessment is a formal process for identifying the likely effects of projects on the components of Valued Eco System and acts as a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA/EMP should assist planners and government authorities in the decision making process by identifying the key impacts / issues and formulating mitigation measures. The objective of EIA Study can best be described as follows.

1. **Identify**: Sources of Pollution and Resource Utilization during Construction and Operation phases of the project.
2. **Assess**: Extent of Environment Degradation and Resource Utilization.
3. **Devise:** Cost Effective, Environment Friendly, Technically Feasible mitigation measures to offset or mitigate the adverse impact on Valued Eco System Components.
4. **Develop:** Environment Management and Monitoring Plan to ensure effective implementation of mitigative measures and to check whether predicted impacts are within predictable limits.

1.7 Scope of the EIA study

An environmental screening and categorization framework is prepared for the proposed project to identify the environmental analysis and planning aspects of the project as per EIA guidelines, 2006 by Ministry of Environment, Forest & Climate Change (MoEF&CC) and subsequent amendments guidelines etc.

Review of national, state and local environmental regulatory requirements on environmental aspects, including assisting NHAI for getting necessary approvals from the statutory organisations and funding agencies.

- Establishing environmental baseline, covering the specific location of project sites such as major towns, junctions, bypasses, forest stretches, borrow areas, quarries, sensitive locations (schools, temples, hospitals, archaeological sites etc.).
- Carry out environmental study in the light of baseline conditions and proposed project activities to identify key environmental issues and defining the scope of detailed environmental assessment to be carried out. During screening, consideration shall be paid to:
- Location of the project stretch with respect to environmentally sensitive areas, and community concerns.

- Volume, nature and technology of construction. The screening process shall include stakeholder consultations.
- Conduct environmental analysis of alternatives for roads and provide specific inputs to technical analysis of alternatives.
- The objectives of such analysis shall be to minimize environmental impacts and provide specific inputs to feasibility analysis.
- Impact assessment and prediction with respect to various environmental attributes i.e., land, air, water, noise, soil, socio-economic, archaeological, ecological & biodiversity aspects of the project.
- Preparation of implementable EMP with budgetary provisions and suggesting post project monitoring plan.

1.8 Need for the EIA Study

Road developmental activities should be planned and executed after considering the potential environmental impacts. To minimize these adverse impacts that may be created by road development projects, the techniques of EIA become necessary. Identification and assessment of potential environmental impacts should be an integral part of the project life cycle. It should commence early in the planning process of the project to enable a full consideration of alternatives and to avoid later delays and complications.

1.9 Implementing Agency

National Highways Authority of India (NHAI) is an autonomous organisation under the Ministry of Road Transport & Highways (MoRT&H) and was constituted by an act of Parliament, the National Highways Authority of India Act, 1988. NHAI is responsible for the development, maintenance, and management of National Highways and for matters concerned thereto. The authority was made operational with the appointment of full time chairman and other members in the year 1995.

NHAI's vision is to meet the nation's need for the provision and maintenance of national highways network to global standards and to meet user expectations in the most time-bound and cost-effective manner, within the strategic policy framework set by the Government of India and thus promoting economic well-being and quality of life of the people.

NHAI is the nodal authority / project proponent for the development of the present highway project.

1.10 Policies, Legal and Administrative Framework

The Government of India and respective state Governments have enacted various Policies, Laws, Legal and Administrative Framework to minimise the impact of projects on the environment, project proponent has to abide by these so as not to attract any legal issues. Various statutory acts applicable for a project are detailed in **Table 1-3**.

Table 1-3: Various statutory acts applicable for a project

Sl. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
1.	Environmental (Protection) Act	1986	To protect and improve the overall environment	Yes	As all environmental notifications, rules and schedules are issued under this act	MoEF&CC GoI, Forests & Env. Dept., Govt. of Odisha, CPCB, OSPCB
2.	Environmental Impact Assessment (EIA) Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	Yes	The project attracts the conditions of EIA Notification 2006 and further amendments	MoEF&CC
3.	Forest (Conservation) Act	1980	To check deforestation by restricting conversion of forested areas into non-forested areas	Yes	RF and PF Forest area is identified along the alignment. At The crossings point of roads / railway / canal), the proposed project will also fall in notified protected forest areas declared for management purposes (Avenue plantations).	Forest Department Govt. of Odisha and MoEF&CC
4.	Water (Prevention and Control of Pollution) Act and Cess Act of 1977 as amended in 1988	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Yes	This act will be applicable during construction, for establishments of hot mix plant, stone crusher, construction camp, workers' camp, water use for construction, etc.	OSPCB

Sl. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
5.	Air (Prevention and Control of Pollution) Act as amended in 1987	1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Yes	This act will be applicable during construction; for obtaining NOC for establishment of hot mix plant, workers' camp, stone crusher, construction camp, etc.	OSPCB
6.	Noise Pollution (Regulation and Control) rules	2000	Noise pollution regulation and controls	Yes	This act will be applicable as vehicular noise on project routes required to assess for future years and necessary protection measure need to be considered in design. Operation of various plants during construction	OSPCB
7.	Ancient Monuments and Archaeological. Sites and Remains (Amendment and Validation) Act, 2010	2010	Conservation of Cultural and Historical remains found in India	No	The project route is not close to any Ancient Monument, declared protected under the act.	Archaeological Dept. GoI, Dept. of Archaeology, Govt. of Odisha.
8.	The Wild Life (Protection) Act	1972	Conservation and protection of wild animals, control poaching, and regulate the trade of wildlife and its products	No	The proposed alignment does not pass through any wild life sanctuary however is passing through a minimum distance of 0.87 km and maximum distance of 6.67 km from the ESZ Boundary of Chandaka Wildlife Sanctuary.	MoEF&CC, NBWL
9.	Notification for use of fly ash	2016	Promoting the utilization of fly ash in the manufacture of building materials and in construction activity within a specified radius of 300 kilometers from coal or lignite based thermal power plants	Yes	Fly ash is available at Talcher Thermal Power station and IMFA Thermal Power Plant.	MoEF&CC

Sl. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
10.	The Explosives Act (& Rules)	1884	An Act to regulate the manufacture, possession, use, sale, transport, import and export of Explosives	Yes	For transporting and storing diesel, bitumen etc.	OSPCB
11.	Public Liability Insurance Act	1991	Insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	Yes	Contractor needs to stock hazardous material like diesel, Bitumen, Emulsions etc. safely	District Collector/ OSPCB
12.	Coastal Regulation Zone	2011	To regulate activities in the coastal zone to protect ecologically sensitive areas	No	The proposed expressway does not pass through CRZ areas	MoEF&CC
13.	Hazardous and Other Wastes (Management and Transboundary Movement) Rules	2016	Storage, handling, transportation and disposal of hazardous waste	Yes	Storage and handling of hazardous waste during construction	OSPCB
14.	Solid Waste Management Rules	2016	Management and handling of solid waste	Yes	For disposal of solid waste generated during construction	OSPCB
15.	Construction and Demolition Waste Management Rules	2016	Management of construction and demolition waste	Yes	For disposal of solid waste generated due to construction and demolition	OSPCB
16.	Batteries (Management & Handling) Amendment Rules	2010	Management and handling of used lead batteries	Yes	Safe disposal of used lead batteries	OSPCB
17.	E-Waste (Management) Rules	2016	Effective mechanism to regulate generation, collection, storage, transport, import, export,	Yes	Handling of e-waste	OSPCB

Sl. No	Act/Rules	Year	Objective	Applicable Yes/No	Reason for applicability	Authority
			recycling, treatment and disposal of e-wastes			
18.	Central Motor Vehicles Act	1988	To control vehicular air and noise pollution.	Yes	This rule will be applicable to road users and construction machinery and vehicles used	MoRTH and Traffic Police
19.	Minor Mineral and concession Rules	1960	For opening new quarry	Yes	Regulate use of minor minerals like stone, soil, river, sand etc.	District Collector, Department of mining, Govt. of Odisha
20.	The Mining Act	1952	The mining act has been notified for safe and sound mining activity	Yes	The construction of proposed expressway will require aggregates. These will be procured through mining from quarries	Department of mining, Govt. of Odisha.
21.	National Forest Policy (Revised)	1988	To maintain ecological stability through preservation and restoration of biological diversity	Yes	This policy will not be applicable.	Forest Department GoI, Govt. of Odisha
22.	The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act	2013	Set out rules for fair compensation and acquisition of land	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	District Collector, Revenue Department State Government
23.	The National Highway Act	1956	For Land Acquisition	Yes	This act will be applicable as there will be acquisition of land for widening, geometric improvements and bypasses	NHAI, Revenue Department, Govt. of Odisha

1.11 EIA Methodology

The EIA procedure carried out simultaneously with design of the project road and methodology is shown in below **Figure 1-1**. The important findings of the assessment provided important feedback to the design team, especially in terms of the sensitive receptors, Forest and wildlife area, archaeological sites and religious properties. It helped in modification of the designs report and incorporated mitigation measures, wherever the impacts are avoidable.

The present EIA study has been undertaken based on EIA Notification 2006 (amended thereof), ToR accorded for the project from MoEF&CC and Environmental Impact Assessment Guidance Manual for Highways prepared by Administrative Staff College of India. The sections below detail out the methodology adopted for the assessment of environment for the present project.

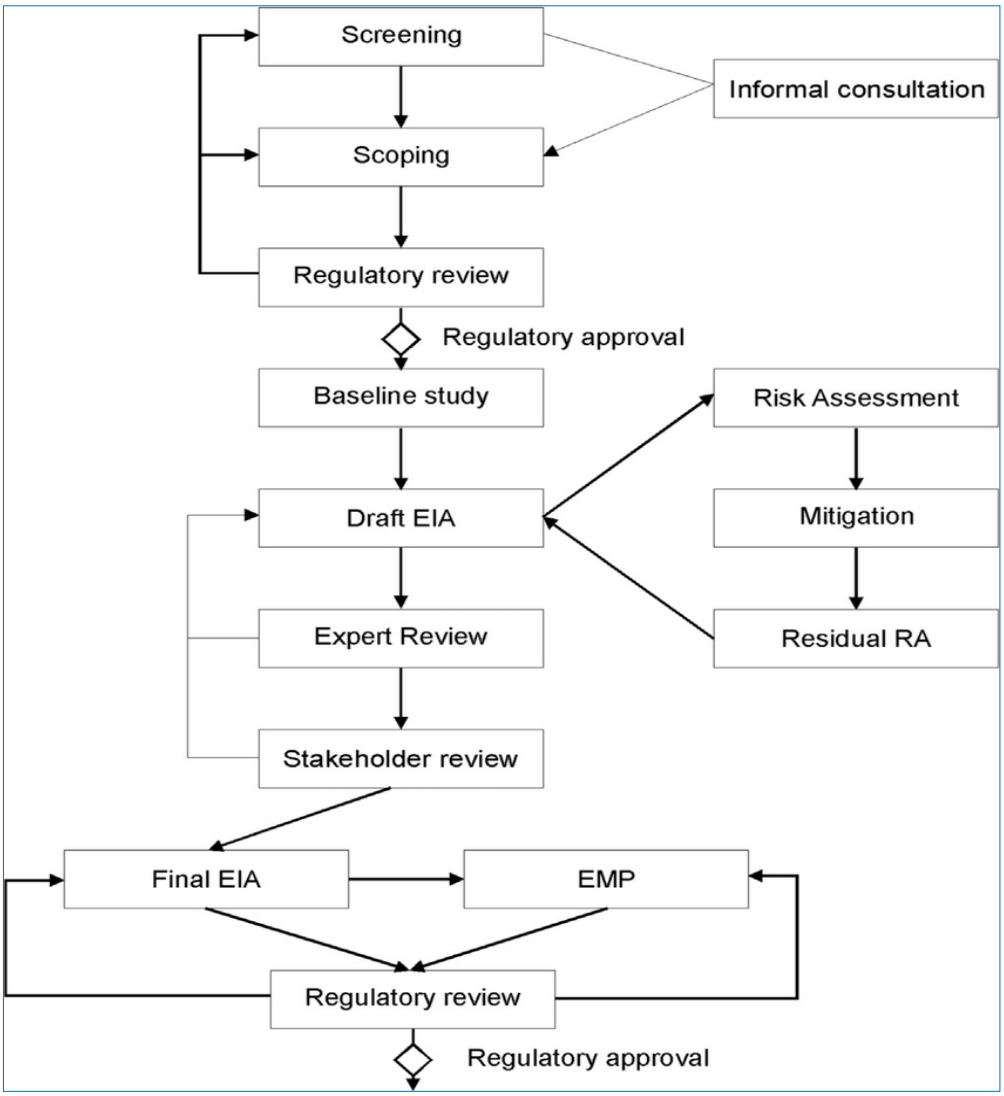


Figure 1-1: Methodology of EIA

1.11.1 Approach and Methodology of EIA Process

An Environmental Impact Assessment study is proposed to be conducted as per the TOR received by MoEFCC. The approach is to follow the sequence of steps adopted in an EIA study. The study should ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz.

physical, biological and socio-economic etc. shall be studied, analysed and quantified, wherever possible. The accurate analysis of assessment depends upon the reliable data generated/available on environment. The consultant has documented the baseline data for various parameters of ecology (Flora & Fauna), environmental pollution (air, water, noise and solid waste) and socio-economic (public health, education and economics).

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The National Acts, Legislation are consulted with a view to ensure compliance with various requirements. The consultant is collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the following paragraphs. However, more elaborate methodology is presented in the main text in the relevant sections. The following Acts, legislation and laws will be consulted with a view to ensure compliance with various requirements:

- The Wildlife (Protection) Act, Rules and Amendments, 1972, 1973, 1991
- The Forest (Conservation) Act and Rules, 1980, 1981 amended in 1989.
- Air (Prevention & Control of Pollution) Act, 1981
- Water (Prevention & Control of Pollution) Act, 1974 with Amendment 1991
- Environment (Protection) Act, 1986
- EIA Guidelines, MoEF&CC, Govt. of India Notification, 2006
- Noise Pollution (Regulation and Control) Rules, 2000 amendment in 2010
- Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules, 2008
- Municipal Solid Waste Rules, 2000 a) Data Review - draw together and review available data.

Data Collection

Land use: The existing land-use pattern of the area has been identified mainly as urban human settlements, roads, Trees and water bodies. Physical and chemical parameters of soils along the project corridor are studied from the available data in the DPR. Based on this data, impact on soil has been predicted.

Water environment: The water samples are collected from surface water sources (rivers/canals) and ground water source (wells/hand pumps/bore wells) for analysis as per IS: 10500-2012. The secondary data, if any, has been studied and compiled. The impact on water quality due to the proposed project activities has been evaluated.

Air and Noise environment: Air and Noise quality is an important consideration during construction and operation phases. Ambient air quality and noise levels are monitored in and around project area to develop present baseline levels in the area. Location of Air & Noise monitoring have been identified on the basis of land use at East-West and North-South corridor.

Vibration: Vibration levels are measured along the project corridor along the sensitive identified locations with the objective to establish the baseline data and assess the impacts of vibration at sensitive receptors (nine listed heritage structures) and at other selected locations.

Biological Environment: Terrestrial ecology was studied along the proposed metro corridors. The vegetation types will be documented through the visual inspection, past research and field

investigations. A survey was carried out in the project area to find the existing flora and fauna. The list of birds, animals, aquatic ecology etc. of the area is compiled along with the existence of any rare and endangered species.

Climate: Meteorological data for temperature, relative humidity, wind speed, wind direction, wind rose, rainfall and cloud cover are obtained from the nearest Meteorological station.

Based on project particulars and the existing environmental conditions, potential impacts are identified that are expected to be affected as a result of the proposed project and wherever possible, these are quantified. Both positive and negative impacts are evaluated to have an idea about resultant impacts. These impacts are assessed for various phases of project cycle namely, location & design, construction and operation. The standard methodology is adopted for impact prediction and assessment. The issues in each phase are considered as follows.

Impacts due to project location & design

- Change in land use,
- Loss of forest,
- Encroachment into natural reserves, if any
- Loss of historical and cultural monuments,
- Impact on surface water (rivers/canals) and ground water resources,
- Risk due to earthquake,
- Drainage problem.

Impacts due to project construction

- Soil pollution at construction sites,
- Pollution by construction spoils,
- Air and noise pollution,
- Vibration,
- Water pollution,
- Health risks and Cultural hazards.

Impacts due to project operation

Positive Impacts

- Employment opportunities
- Improved infrastructure
- Reduction in Air and Noise Pollution
- Reduction in Travel time
- Reduction in Traffic on road
- Better connectivity
- Aesthetic Improvement,
- Improvement in overall productivity

Negative Impacts

- Change in water quality and extraction of ground water,
- Disposal of Solid Waste
- Impact on soil at Depot

Environmental Management Plan

An environmental management strategy is developed to mitigate the adverse impacts during construction and operation phases of the project. The strategy includes evaluation of alternative methods to reduce or eliminate adverse impacts of the most critical areas likely to contribute to the most significant environmental burdens. The Environmental Action Plan (EAP) would specifically highlight the proposed mitigation measures to be implemented during project construction phase like compensatory afforestation plan, infrastructure facilities like sanitation, labour camps, and refuse disposal etc. Cost estimates for each of the proposed mitigation measures are given in chapter 10.

Public Consultation

Consultation and communication with stakeholders during the project preparation is an integral part of the process of gathering relevant data for impact assessment, and facilitates the development of appropriate options for the affected population. In addition, informal consultations were organized with individuals and nearby people, in order to present the project and collect their views on the perceived positive and negative impacts on the environment on account of this new development.

Preparing Draft EIA

A draft EIA is prepared in accordance with the Terms of Reference and/ or the range of issues identified during the scoping process. The draft EIA must also meet the content requirements of the overarching EIA law or regulations. This step will ideally engage a wide range of technical specialists to evaluate baseline conditions, predict the likely impacts of the project, and design mitigation measures.

Public Hearing

EIA involves and engages the public at numerous points throughout the process with a two-way exchange of information and views. Public participation may consist of informational meetings, public hearings, and opportunities to provide written comments about a proposed project. However, there are no consistent rules for public participation among current EIA systems. Even within a particular country, there can be variations in the quality and extent of public involvement in the EIA process, depending on the type of project being

Preparing Final EIA

Final impact assessment report that addresses the viewpoints and comments of the parties that reviewed the draft EIA and suggestion &comments of public during public hearing. These comments may prompt revisions or additions to the text of the draft EIA. In some cases, the final EIA will contain an appendix summarizing all of the comments received from the public and other interested parties and provide responses to those comments.

Decision

A decision to approve or reject a project is generally based on the final EIA, but in some instances, an environmental clearance may be just one step in the permitting process. The decision may be accompanied by certain conditions that must be fulfilled, such as posting a reclamation bond or filing an Environmental Management Plan.

1.12 Structure of the EIA Report

The report structure is as per guidelines issued by MoEFCC. The report consists of twelve Chapters and the content are briefly described in this section.

Chapter- 1: Introduction

This chapter contains the general information about the project, scope of the EIA/EMP study and the policies, legal and administrative framework and identification of the project proponent.

Chapter- 2: Project Description

Describes the project design features related to environment, health and safety aspects.

Chapter-3: Description of the Environment

Describes the existing environmental set up of the study area.

Chapter- 4: Anticipated Environmental Impact & Mitigation Measures

Details out about impacts associated with the proposed developmental activities. Mitigation measures for identified impacts are also covered in this chapter.

Chapter-5: Analysis of Alternatives (Technology& Site)

Details out the various alternatives for the project stretch, construction technology alternative, etc.

Chapter- 6: Environmental Monitoring programme

Discusses about the monitoring indicators, reporting mechanism and responsibility distribution for successful implementation of Environment Management Plan.

Chapter -7: Additional Studies

Covers details about the Public Consultation and Hearing. Chapter also contains the brief of additional studies suggested by MoEF&CC during ToR appraisal meeting.

Chapter- 8: Project benefits

Benefits to the local community and environment are discussed in this chapter;

Chapter- 9: Cost benefit analysis

This chapter shall cover the Environmental Cost Benefit Analysis of the project, if recommended by the Expert Appraisal Committee at the scoping stage.

Chapter- 10: Environmental Management Plan

Details both the generic and specific EMPs for the project highway. Implementation arrangements give a brief about the implementation methodology. This chapter also discusses about the Environmental Budget.

Chapter- 11: Summary and Conclusion

Briefs the EIA study outcome along with recommendation for the project.

Chapter- 12: Disclosure of the Consultant

Provides the details of the accredited consultant organization and NABL laboratory.

2. PROJECT DESCRIPTION

2.1 Project Profile

The Govt. of India (GOI) through Ministry of Roads & Highways (MORT&H) is contemplating to enhance the traffic capacity and safety for efficient transhipments of goods as well as passenger traffic on the selected stretches/ corridors of National Highways. Ministry of Road Transport and Highways through National Highway Authority of India (NHAI) has proposed construction of a New 6-Lane National Highway to be executed through HAM/EPC Mode of Contract.

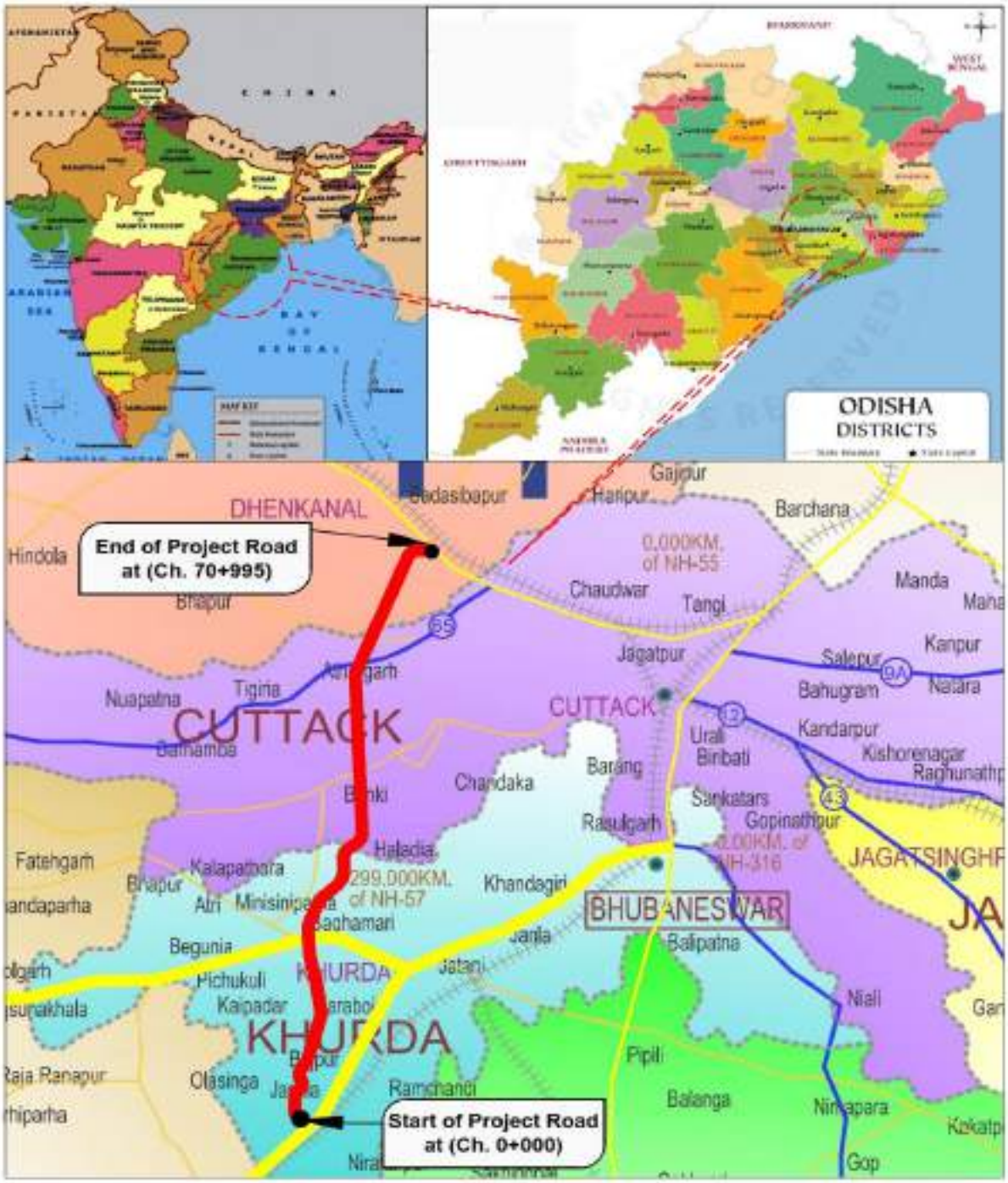


Figure 2-1: Index Map of the Project

The project under consideration aims at construction of the new NH (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) through Khordha, Cuttack and Dhenkanal with 6-Lane configuration bypassing the cities of Khordha, Bhubaneshwar and Cuttack. The proposed alignment of the project covers three districts viz. Khordha, Cuttack and Dhenkanal and seven tehsils viz. Khordha, Tangi, Begunia, Dampara, Banki, Athagarh and Dhenkanal in the state of Odisha. The entire alignment is greenfield. The index map of the project is given in **Figure 2-1.**

The geographical coordinates of start and end points are given in **Table 2-1.** Start and end points of the proposed alignment are shown in **Figure 2-2.**

Table 2-1: Geographical coordinates of alignment

Description	Coordinates
Start point	Lat.: 20°1'10.09"N and 20°21'24.62"N Long.: 85°30'16.69"E and 85°34'37.59"E
End point	Lat.: 20°21'24.62"N, Long.: 85°34'37.59"E

Figure 2-2: Project Corridor and Start-End point

2.2 Proposed Project Alignment

The proposed project alignment starts from Ch. 0+000 near Rameshwar in Tangi tehsil of Khordha district and ends at Ch. 70+995 in Gobindpur in Dhenkanal tehsil of Dhenkanal district of Odisha state of total length of 70+995 km. The proposed highway is a greenfield with 6 lane configuration.

Further, project road is divided in two construction packages i.e., Package-1 from Km. 0.000 to Km. 40.700 and Package-II from km. 40.700 to km. 70.995 considering nature of scope of work. The package wise bifurcation of project is given in below Table 2-2. Glimpses of project site is shown in Figure 2-2.

Table 2-2: Alignment bifurcation (Construction Packages)

S. No.	Package	Name of Section	(Design Chainage)		Length (km)
			From km	To km	
1.	Package-1	Rameswar - Bilipada	0+000	40+700	40+700
2.	Package-2	Bilipada - Gobindpur	40+700	70+995	30+295

Source: DPR, Geo Designs & Research (P) Ltd.

The entire alignment has a 60 m of proposed ROW. The alignment runs through mainly plain terrain with Agricultural land at most locations.

Wasteland near the alignment

Pond near the alignment

Undulating terrain near the alignment

Railway crossing near the alignment

Figure 2-3: Glimpses of Project Site

2.3 Distance from Protected Area

The proposed alignment does not pass through any wild life sanctuary. As per final notification notified vide S.O. no. 2906 dated 9th September, 2016 declaring Eco Sensitive Zone around Chandaka Dampara Wildlife Sanctuary **(Figure 2-4)**, alignment is passing at a minimum distance of 0.87 km and maximum distance of 6.67 km from the ESZ boundary of Chandaka Dampara Wildlife Sanctuary **(Figure 2-5)**.

The Chandaka Dampara Wildlife Sanctuary is located in the Cuttack and Khordha districts of Odisha and extends over an area of 194.98 km^2 as per the notification. The ESZ of Sanctuary lies in Khordha and Cuttack districts of Odisha and is extended over an area of 85.06 km^2**.** There is an abundance of Dhaman, Bankapasia, Jamu, Kansa, Kusum, Sidha Karanja apart from other trees, shrubs, herbs & climbers in the sanctuary. There is presence of mammals like Elephant, Hanuman Langur, Macaque, three types of deer species (Spotted Deer, Barking Deer and Mouse Deer), Wild Pig, Porcupine and Hare form other herbivores. Among carnivores, Sloth Bear, Hyena, Fox, Jackal and Mongoose are important.

The end point of the alignment is also near to but outside the ESZ of Kapilash Wildlife Sanctuary in Dhenkanal district at a distance around 1.55 km.

2.4 Project Features

The Project highway is a 6 lane green-field highway and follows highway design standards as per IRC: SP:87-2019. The various aspects of design that have been considered in the development of design for the proposed highway are brought out in this section. It mainly consists of geometrics of highway, interchange design, junction design, cross sections, drainage design, pavement design, structure design for culverts, bridges, flyover, EUP's, VUP's and interchanges.

2.4.1. Proposed Right of Way (PRoW)

The project road is a complete green field alignment passing through agricultural land and revenue forest. The proposed carriageway of CRRR-1 is about 21 m (10.50 +10.50) and right of way is mostly having ROW of 60 m throughout the project corridor.

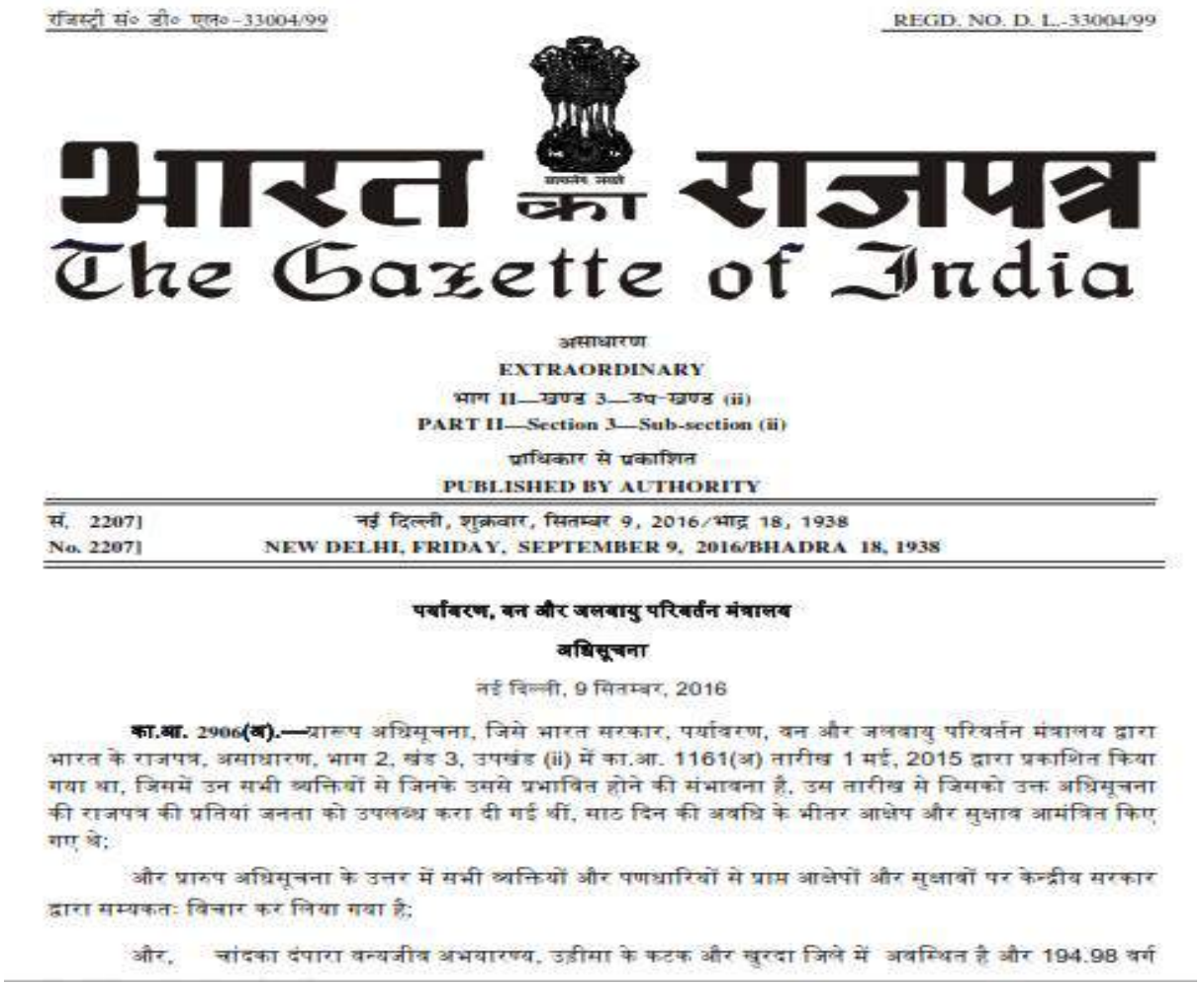
2.4.2. Carriageway and Laning Configuration

The proposed highway shall be a 6 lane greenfield highway with paved shoulders of 1.5-2.0 m width and a median of 7.0 m width. Each lane of the proposed highway will be of 3.5 m width. Highway's carriage way and lane configuration is presented below.

Table 2-2: Highway Existing Cross Section Element

Homogeneous Section	From (km)	To (Km)	Length (km)	Lane Config. (Each c/way) (m)	Paved Shoulder (m)	Earthen Shoulder (m)	Median (m)
1	0+000	70+995	70+995	3.5	1.5	2.0	7.0

Source: DPR, Geo Designs & Research (P) Ltd.



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असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

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अधिसूचना

नई दिल्ली, 9 सितम्बर, 2016

का.आ. 2906(अ).—यतरूप अधिसूचना, जिसे भारत सरकार, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय द्वारा भारत के राजपत्र, असाधारण, भाग 2, खंड 3, उपखंड (ii) में का.आ. 1161(अ) तारीख 1 मई, 2015 द्वारा प्रकाशित किया गया था, जिसमें उन सभी व्यक्तियों से जिनके उससे प्रभावित होने की संभावना है, उस तारीख से जिसको उक्त अधिसूचना की राजपत्र की प्रतियां जनता को उपलब्ध करा दी गई थीं, साठ दिन की अवधि के भीतर आक्षेप और सुझाव आमंत्रित किए गए थे;

और प्रारुप अधिसूचना के उत्तर में सभी व्यक्तियों और पणधारियों से प्राप्त आक्षेपों और सुझावों पर केन्द्रीय सरकार द्वारा सम्यकतः विचार कर लिया गया है;

और, चांदका डंपारा वन्यजीव अभयारण्य, उड़ीसा के कटक और खुरदा जिले में अवस्थित है और 194.98 वर्ग

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 9th September, 2016

S.O. 2906(E).—WHEREAS, a draft notification was published by the government of India in the Ministry of Environment, Forest and Climate Change, in the Gazette of India, Extraordinary, Part-II, Section 3, Sub-section(ii) vide number S.O. 1161 (E), dated 1st May, 2015, inviting objections and suggestions from all persons likely to be affected thereby within the period of sixty days from date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS, objections and suggestions received from all persons and stakeholders in response to the draft notification have been duly considered by the Central Government;

AND WHEREAS, the Chandaka Dampara Wildlife Sanctuary is located in the Cuttack and Khurda District of Odisha and extends over an area of 194.98 square kilometres;

Figure 2-4: Cover page of final ESZ notification of Chandaka Dampara Wildlife Sanctuary

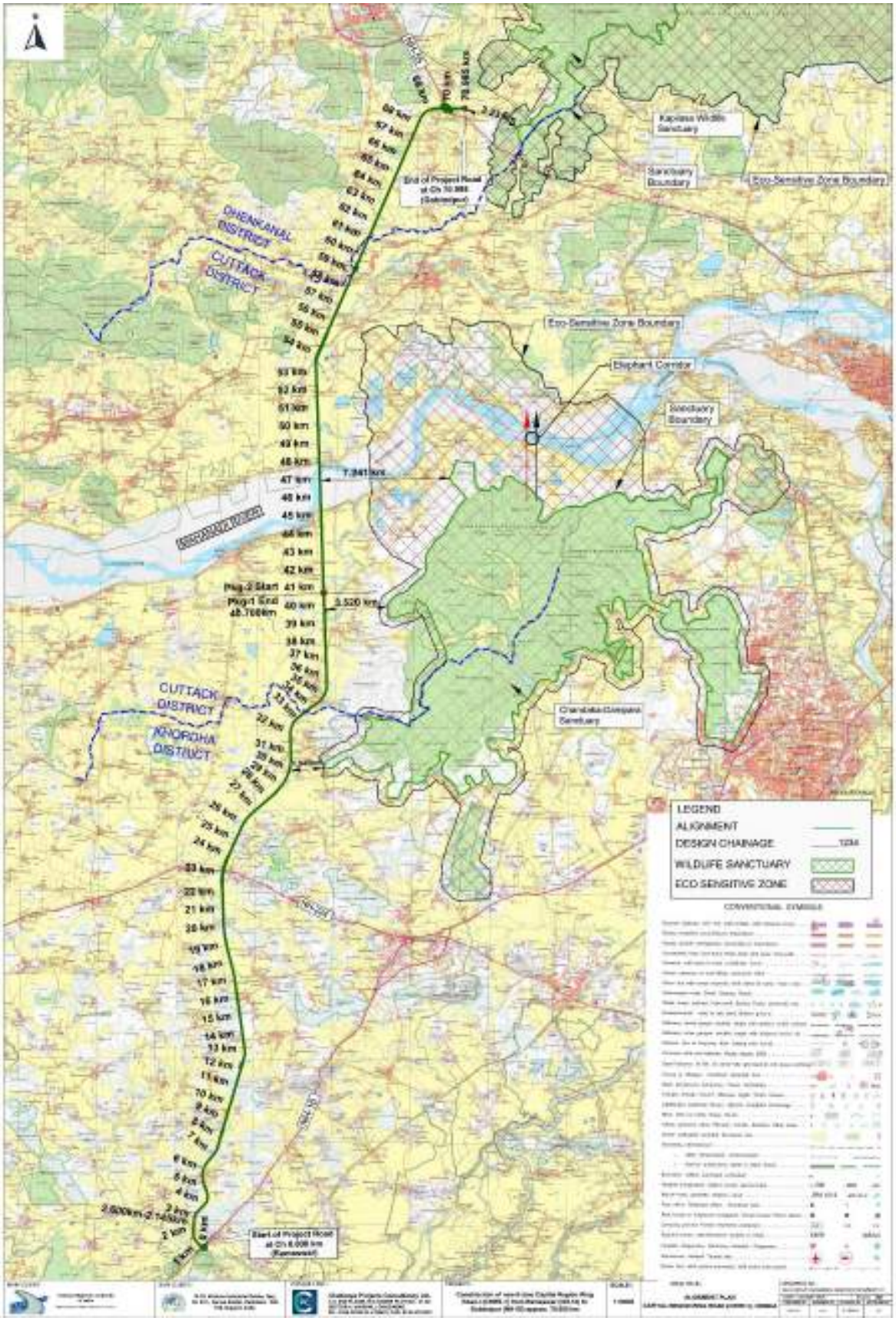
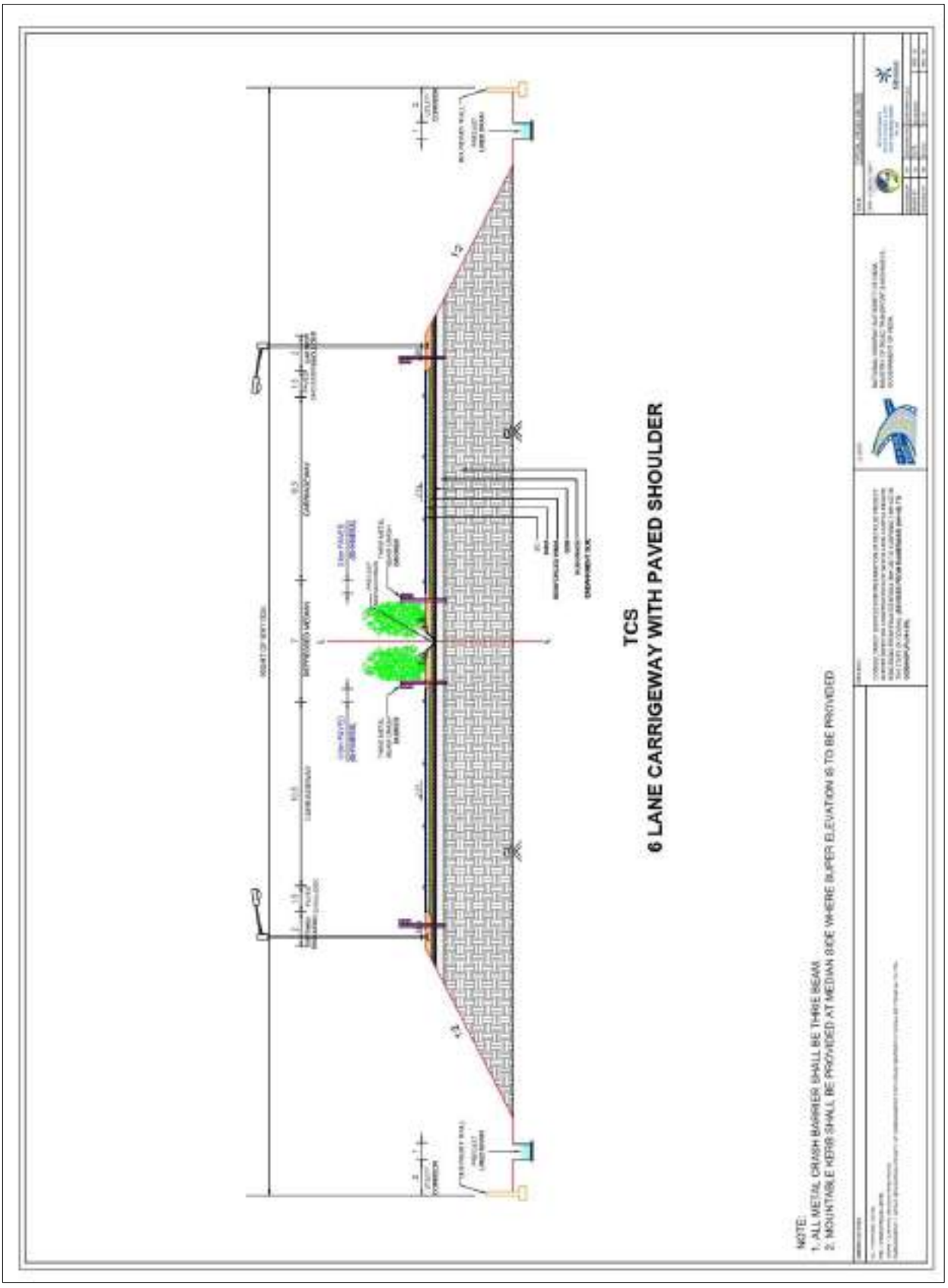


Figure 2-5: Proposed alignment passing near to Chandaka Dampara WLS, Odisha



Source: DPR, Geo Designs & Research (P) Ltd.

Figure 2-6: TCS of 6-Lane Carriageway with Paved Shoulder

2.4.3. Typical Cross Section

The project highway shall be constructed to 6-lane configuration. The details of the cross sections for package I and II are presented in **Table 2-3** and **Table 2-4** respectively. A typical cross section of the highway is shown in the following **Figure 2-6.** All TCS applicable to the project are presented in **Annexure 2-1.**

Table 2-3: Summary of type of TCS and Length (Package-I)

Sl.	TCS	TCS Configuration	Length (m)
1	TCS-1	6 Lane Carriageway with Paved Shoulder Having Embankment Height > 3.0m	15712
2	TCS-2	6 Lane Carriageway with Paved Shoulder and Full Height RE Wall	12580
3	TCS-3	6 Lane Carriageway with Service Road and Full Height RE Wall	22630
4	TCS-4A	6 Lane Carriageway with Slip Road and Full Height RE Wall	3880
5	TCS-4B	6 Lane Carriageway with Slip Road with Embankment > 3m	420
6	TCS-5	6 Lane Carriageway with Paved Shoulder Having Embankment Height Upto 3.0m	14480
7	TCS-6	6 Lane Carriageway with Paved Shoulder and Retaining Wall	7780

Source: DPR, Geo Designs & Research (P) Ltd.

Table 2-4: Summary of type of TCS and Length (Package-II)

Sl.	TCS	TCS Configuration	Length (m)
1	TCS-1	6 Lane Carriageway with Paved Shoulder Having Embankment Height > 3.0m	8006
2	TCS-2	6 Lane Carriageway with Paved Shoulder and Full Height RE Wall	6825
3	TCS-3	6 Lane Carriageway with Service Road and Full Height RE Wall	17840
4	TCS-5	6 Lane Carriageway with Paved Shoulder Having Embankment Height Upto 3.0m	16000
5	TCS-6	6 Lane Carriageway with Paved Shoulder and Retaining Wall	6130

Source: DPR, Geo Designs & Research (P) Ltd.

2.4.4. Design Speed

The project corridor passes through mainly plain terrain with some undulation. The adopted design speed is 100 kmph throughout the stretch. Design speed for project is given in **Table 2-5.**

Table 2-5: Details of design speed for project terrain

Nature of terrain	Cross slope of ground (%)	Design Speed (kmph)
Plain	Up to 25	100

Source: DPR, Geo Designs & Research (P) Ltd.

2.4.5. Settlements

The proposed project stretch is passing through 3 districts, 7 tehsils and 65 villages. Khordha district includes 3 tehsils viz. Khordha, Tangi, Begunia which comprises of 36 villages, Cuttack district includes 3 tehsils i.e. Dampada, Athagarh and Banki which comprises of 20 villages whereas Dhenkanal district

includes one tehsil i.e. Dhenkanal which comprise of 9 villages. Detail list of villages is given in **Table 2-5**.

Table 2-6: List of villages falling on the proposed alignment

District	Tehsil	S. No.	Village Name	District	Tehsil	S. No.	Village Name
Khordha	Tangi	1	Balarampur	**Khordha**	Begunia	34	Lokanathapur
		2	Rameswar			35	Kathakhuntia
		3	Ambabil			36	Patanibar
		4	Damanbhumi	**Cuttack**	Damapada	37	Talabasta
		5	Kuanrakalipatna			38	Bilipada Saradhapur
		6	Nayakot			39	Badapadanpur
		7	Bagheiput			40	Simil Pur
		8	Gayabandha			41	Makundapur Charigharia
	Khordha	9	Jankia		Banki	42	Kantapahara
		10	Madhapur			43	Patugadadharpur
		11	Kaipadar			44	Sahanga gopal pur
		12	Bhatapara			45	Gholpur
		13	Kankadahad		Athagarh	46	Mahidharpur
		14	Mangalpur			47	Gopiballav Pur
		15	Radhakantapur			48	Nuabandha
		16	Bangida			49	Chirigunipat
		17	Kumbhilo			50	Khuntakata
		18	Adhakhandia			51	Gudupada
		19	Balisahi			52	Samsarpur
		20	Basanta			53	Amrutamanohipatana
		21	Brahmanabereni			54	Jagannath Pur
		22	Hatasahi			55	Kuanal
		23	Kuaput			56	Koranga
	Begunia	24	Parichhal	**Dhenkanal**	Dhenkanal	57	Shankarpur
		25	Dalak			58	Jenasahupatana
		26	Goda			59	Padmalabhapur
		27	Masania			60	Patarabhaga
		28	Ramasinghprasad			61	Manipur
		29	Phulachhanchuni			62	Talabarkote
		30	Karadagadia			63	Siaria
		31	Botalama			64	Baladiabandha
		32	Kesarada			65	Gobindapur
		33	Sarua				

Source: DPR, Geo Designs & Research (P) Ltd.

2.4.6. Land Acquisition

The land acquisition for the proposed alignment is approximately 547.51 ha out of which Private land is 422.47 ha, Government land is 96.72 ha, Revenue Forest land is 28.32 ha. The district wise proposed land acquisition details are given in **Table 2-6** and 3(D) is given in **Annexure 2-2**.

Table 2-7: Land Acquisition of the proposed alignment

S. No.	District	Type of Land	Area in ha
1	Khordha	Govt. Land	52.69
		Pvt. Land	186.55
		Revenue Forest Land	9.29
		Total	**248.53**
2	Cuttack	Govt. Land	31.71
		Pvt. Land	167.72
		Revenue Forest Land	0.05
		Total	**199.48**
3	Dhenkanal	Govt. Land	12.32
		Pvt. Land	68.19
		Revenue Forest Land	18.98
		Total	**99.49**
G. Total			**547.51**

Source: ORSAC authenticated land schedule, 3D of project's villages

2.5 Traffic Analysis

An accurate estimate of the traffic that is likely to use the project road is very important as it forms the basic input in planning, design, operation and financing. A thorough knowledge of the travel characteristics of the traffic likely to use the project road as well as other major roads in the influence area of the study corridor is essential for future traffic estimation. The estimation of revenue through toll collection is important to assess the financial viability of the project and to finalize the financial agreements for the concession agreement. Hence, detailed traffic surveys are carried out to assess the baseline traffic characteristics on the project road.

❖ **Traffic Survey Location**

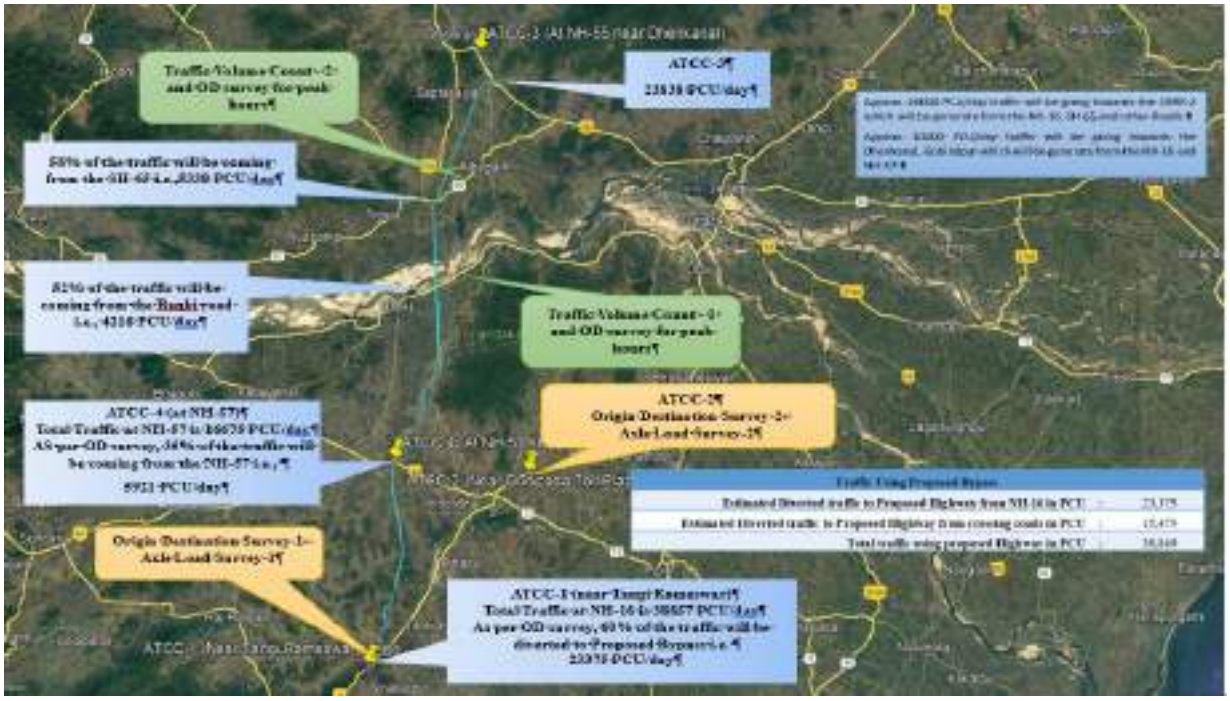
To capture traffic flow characteristics and travel pattern of users passing through the project road, the following primary traffic surveys have been conducted in five locations. Following **Table 2-7** is showing schedule of traffic surveys at project sites.

Table 2-8: Traffic Survey Schedule

S. No.	Survey Name	Location		Location Name
		Latitude	Longitude	
1.	ATCC-1	20.011529	85.495072	At NH-16 near Tangi (Rameswar)
2.	ATCC-2	20.201281	85.664146	Near Godipada Toll (NH-16)
3.	ATCC-3	20.632183	85.623039	At NH-55 near Dhenkanal
4.	ATCC-4	20.219090	85.524591	At NH-57 near Khordha
5.	Axle Load-1	20.011529	85.495072	At NH-16 near Tangi (Rameswar)

S. No.	Survey Name	Location		Location Name
		Latitude	Longitude	
6.	Axle Load-2	20.201281	85.664146	Godipada Toll Plaza
7.	OD-1	20.011529	85.495072	At NH-16 near Tangi (Rameswar)
8.	OD-2	20.201281	85.664146	Godipada Toll Plaza

Source: DPR, Geo Designs & Research (P) Ltd.



Source: DPR, Geo Designs & Research (P) Ltd.

Figure 2-7: Traffic Survey Locations

❖ Traffic projections

Traffic projections are important in order to assess the amount of vehicles running on the road in the future. It helps to estimate the amount of air and noise pollution in the nearby areas. Hence, mitigation measures can be taken to attenuate or reduce the pollution levels.

As per new circular provided by GOI, Ministry of Shipping, Road Transport & Highways, 5% traffic growth rate as given in approved MCA is to be considered for determination of lane requirement/ project preparation and also for viability of the project. So, the Growth rate has been taken 5% for all class of vehicles. The entire Project road has one homogeneous section. The following **Table 2-8** presents estimated traffic projection based on growth rates mentioned above.

Table 2-9: Traffic projection for project road

Year/	Type of Vehicle										Total No. of Vehicle per Day
	S/c - M/c	3 – Wheeler	Car/ Jeep/ Taxi	Std. Bus	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with Trailer	Tractor Without Trailer	
PCU Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	
2021	2145	539	9642	22	737	1606	1786	2097	17	12	18604

Year/	Type of Vehicle										Total No. of Vehicle per Day
	S/c - M/c	3 – Wheeler	Car/ Jeep/ Taxi	Std. Bus	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with Trailer	Tractor Without Trailer	
PCU Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	
2022	2258	567	10125	23	775	1687	1876	2202	18	14	19545
2023	2376	596	10632	25	814	1772	1970	2313	19	15	20532
2024	2500	626	11164	27	855	1861	2069	2429	20	16	21567
2025	2631	658	11723	29	898	1955	2173	2551	21	17	22656
2026	2789	691	12310	31	943	2053	2282	2679	23	18	23819
2027	2957	726	12926	33	991	2156	2397	2813	25	19	25043
2028	3135	763	13573	35	1041	2264	2517	2954	27	20	26329
2029	3324	802	14252	37	1094	2378	2643	3102	29	21	27682
2030	3524	843	14965	39	1149	2497	2776	3258	31	23	29105
2031	3736	886	15714	41	1207	2622	2915	3421	33	25	30600
2032	3961	931	16500	44	1268	2754	3061	3593	35	27	32174
2033	4199	978	17325	47	1332	2892	3215	3773	37	29	33827
2034	4451	1027	18192	50	1399	3037	3376	3962	39	31	35564
2035	4719	1079	19102	53	1469	3189	3545	4161	41	33	37391
2036	5003	1133	20058	56	1542	3348	3722	4369	43	35	39310
2037	5304	1190	21061	58	1620	3516	3908	4588	45	37	41327
2038	5623	1250	22115	61	1701	3692	4104	4817	47	39	43449
2039	5961	1313	23221	64	1786	3876	4309	5058	50	41	45679
2040	6319	1379	24383	68	1875	4070	4524	5311	52	44	48025
2041	6699	1448	25603	72	1969	4274	4751	5577	55	47	50495
2042	7101	1521	26884	76	2068	4488	4989	5856	58	50	53091
2043	7528	1598	28229	80	2172	4713	5239	6149	61	53	55822
2044	7980	1678	29641	84	2281	4949	5501	6457	65	56	58692
2045	8459	1762	31124	89	2396	5197	5777	6780	69	59	61712
2046	8967	1851	32681	94	2516	5457	6066	7119	73	62	64886
2047	9506	1944	34316	99	2642	5730	6370	7475	77	66	68225
2048	10077	2042	36032	104	2775	6017	6689	7849	81	70	71736
2049	10682	2145	37834	110	2914	6318	7024	8242	86	74	75429

Year/	Type of Vehicle										Total No. of Vehicle per Day
	S/c - M/c	3 – Wheeler	Car/ Jeep/ Taxi	Std. Bus	LCV	2 Axle Truck	3 Axle Truck	Multi Axle Truck	Tractor with Trailer	Tractor Without Trailer	
PCU Factor	0.5	1	1	3	1.5	3	3	4.5	4.5	1.5	
2050	11323	2253	39726	116	3060	6634	7376	8655	91	78	79312
2051	12003	2366	41713	122	3213	6966	7745	9088	96	82	83394
2052	12724	2485	43799	129	3374	7315	8133	9543	101	82	87685
2053	13488	2610	45989	136	3543	7681	8540	10021	107	82	92197
2054	14298	2741	48289	143	3721	8066	8967	10523	113	82	96943
2055	15013	2879	50704	151	3908	8470	9416	11050	119	82	101792
2056	15914	3052	53747	159	4104	8894	9887	11603	125	82	107567
2057	16869	3236	56972	167	4309	9339	10381	12183	131	86	113674

Source: DPR, Geo Designs & Research (P) Ltd.

Traffic summary of the project is given in below table which represents current and forecasted traffic growth which indicates that total daily vehicles are projected to increase more than threefold (230%), showing significant traffic growth over 30 years. PCU values grow faster than vehicle numbers (295%), indicating a rise in larger or more impactful vehicles. Daily commercial vehicles reflecting a 226% increase, likely due to economic and industrial expansion.

TRAFFIC SUMMARY	
From: 18.07.2021 to 25.07.2021 (ATCC)	Road Classification: National Highway
State: Odisha	Road Length: 70.995 km
Project Name: CRRR	Location: TANGI (Near Rameswar)
ANNUAL AVG. DAILY TRAFFIC (AADT)	
Total Nos. of Vehicle for Per Days =	**22137**
Passenger car units (PCU)value per days =	**38849**
Total Nos. of commercial vehicle per day(CVPD) =	**8595**
No. of Tollable Vehicle per Day =	19333
% of Tollable Vehicle =	87.33%
No. of Non Tollable Vehicle per Day =	2804
% of Non Tollable Vehicle =	12.67%
FORECAST TRAFFIC DATA	
For Design Period 20 Year	
MSA up to 20-year Design Period (@Year 2045) =	178
Forecast Total Nos. of Vehicle Per Days =	73367
Forecast Passenger car units (PCU)value per days =	153386
Forecast Total Nos. of commercial vehicle per day (CVPD) =	28033

TRAFFIC SUMMARY	
From: 18.07.2021 to 25.07.2021 (ATCC)	Road Classification: National Highway
State: Odisha	Road Length: 70.995 km
Project Name: CRRR	Location: TANGI (Near Rameswar)
ANNUAL AVG. DAILY TRAFFIC (AADT)	
Forecast No. of Tollable Vehicle per Day =	62683
% of Tollable Vehicle =	85.44%
Forecast Total Nos. of Vehicle for Per Days =	10684
% of Non Tollable Vehicle =	14.56%

Source: DPR, Geo Designs & Research (P) Ltd.

❖ **Detailed traffic flow study**

The proposed project is aimed at improving connectivity to the region that lies between the start point at Ch. 0+000 in Rameswar in Tangi Tehsil of Khordha district and ends point at Ch. 70+995 near Gobindpur village in Dhenkanal tehsil of Dhenkanal district of Odisha state. The proposed road intersects four National Highways (NHs), various Major District Roads (MDRs), and other roads such as village roads at various places of the total 70+995 km that is proposed. An influx of traffic is expected from the NH-16, NH-57, NH-65 and NH-55 as this road will serve as a bypass connecting the NH-16 to NH-55, bypassing three cities i.e. Khordha, Bhubaneswar and Cuttack, thereby reducing the travel time by approximately 50 minutes. A detailed traffic flow study has been conducted and has been presented in **Annexure 2-3**.

2.5.1. Intersections

At-grade intersections are not provided. All major and minor junctions are overpassed by providing VUP/LVUP/SVUP.

2.5.2. Proposed Structures

A total of 315 structures are proposed in the stretch, showing a diverse range of structures designed to support and enhance transportation networks, with a significant emphasis on culverts with a total 233 nos. and minor bridges with total 23 nos. for maintaining the local hydrology. The Summary of new proposed structures is given in the following **Table 2-9** and details of the proposed structures are presented in **Annexure 2-4.** There are 36 vehicle underpasses and 10 elephant underpasses.

Table 2-10: Summary of Proposed Structures on Main Carriageway

Sl. No.	Name of the Structure	Package I	Package II	Total
1	Box Culvert	134	81	215
2	Minor Bridge	10	11	21
3	Major Bridge	Nil	3	3
4	ROB	1	-	1
5	Fly over	2	3	5
6	Viaduct	1	-	1
7	VUP	8	3	11
8	LVUP	8	6	14
9	SVUP	7	3	10

10	EUP	7	3	10
	Total	**178**	**113**	**291**

Source: DPR, Geo Designs & Research (P) Ltd.

Table 2-11: Summary of Proposed Structures on Access Roads & Connecting Road

Sl. No.	Name of the Structure	Package I	Package II	Total
1	Box Culvert	9	9	18
2	Light Vehicular Underpass	-	1	1
3	Minor Bridges	-	2	2
	Total	**9**	**12**	**21**

Source: DPR, Geo Designs & Research (P) Ltd.

As per the discussions with DFO, total 10 EUPs have been proposed in the alignment. Details of elephant underpasses are given below.

Sr. No.	Design Chainage	Type of structure	Proposed structure (No. x Span) (m)	Minimum Vertical Clearance (m)
1	03+822	PSC- I Girder (Precast)	2 x 25	6
2	06+943	PSC- I Girder (Precast)	2 x 25	6
3	07+321	PSC- I Girder (Precast)	2 x 25	6
4	10+742	PSC- I Girder (Precast)	2 x 25	6
5	28+655	PSC- I Girder (Precast)	2 x 25	6
6	32+786	PSC- I Girder (Precast)	2 x 25	6
7	36+860	PSC- I Girder (Precast)	2 x 25	6
8	43+003	PSC- I Girder (Precast)	2 x 25	6
9	50+155	PSC- I Girder (Precast)	2 x 35	6
10	65+575	PSC- I Girder (Precast)	2 x 25	6

Source: DPR, Geo Designs & Research (P) Ltd.

2.5.3. Pavement Design

Flexible pavement shall be provided for the proposed project.

❖ **Flexible pavement**

Flexible pavement has been proposed for 6 lane carriageway for 178 MSA considering a design period of 20 years with Design CBR value of 11% CBR as per IRC: 37: 2018. Details are presented in the following **Table 2-11.**

Table 2-12: Flexible Pavement Crust

S. No.	Pavement Layers	Thickness (mm)
1.	Bituminous Concrete	40
2.	Dense Bituminous macadam (DBM)	60
3.	Reinforced Wet Mix Macadam (WMM) (with Biaxial Geogrid)	250
4.	Granular Sub-base (GSB)	240
5.	Subgrade	500

Source: DPR, Geo Designs & Research (P) Ltd.

2.5.4. Drainage Proposal

The drainage has been designed in accordance with IRC: SP:42-2014 "Guidelines on Road Drainage" and IRC: SP:50–2013 "Guidelines on Urban Drainage". The selection on type of drain i.e., open drains (lined or unlined) and covered drains are proposed to be construct accordingly. Roadside trapezoidal lined drain and RCC Box drains shall be provided at various locations and Precast PCC Lined Drain in depressed median shall be constructed.

2.6 Project Cost

The total cost includes Cost of Construction (flexible pavement), Cost of Structures, Protection Works & Safety Barriers, Road Appurtenances, Centages Charges, Land Acquisition Cost, Environment Cost, and Shifting of Utilities. The total civil construction cost of the project is **Rs.2898.58 crores**. The total project cost is **Rs.4541.10 crores**. The Total EPC Cost includes GST, Contingencies, Supervision Charge and Agency Charge as per MoRTH circular dated August 2021. Details of Project cost are mentioned in below **Table 2-12**.

Table 2-13: Cost Estimate (Rs.)

S. No.	Details	PKG 1	PKG 2
1	**Total Civil Cost**	**Rs. 15,84,36,27,745**	**Rs. 13,14,22,16,616**
2	**Total Civil Cost as on March 2024(A):**		
	Utility Shifting	Rs. 25,64,21,535	Rs. 11,77,01,872
3	**Civil Construction Cost incl. GST(B):**	**Rs. 16,10,00,49,280**	**Rs. 13,25,99,18,487**
	IC/Pre-operative Expenses	Rs. 16,10,00,493	Rs. 13,25,99,185
	Financing	Rs. 7,18,00,000	Rs. 5,89,00,000
	Interest During Construction	Rs. 82,03,00,000	Rs. 57,50,00,000
4	**Estimated Project Cost(C):**	**Rs. 17,15,31,49,772**	**Rs. 14,02,64,17,672**
	18% GST on Civil Construction cost:	Rs. 2,93,99,00,000	Rs. 2,52,47,55,181
	Contingency Charge:	Rs. 15,84,36,277	Rs. 13,14,22,166
	Supervision on Utility	Rs. 64,10,538	Rs. 29,42,547
	Loss of revenue cost OPTCL	Rs. 18,01,41,570	Rs. 13,66,88,095
	Tree Felling	Rs. 20,00,00,000	Rs. 13,32,40,000
	Environment Mitigation Charges	Rs. 2,00,00,000	Rs. 2,00,00,000
	Land Acquisition	Rs. 4,08,25,00,000	Rs. 3,69,50,00,000
5	**Total Project Cost(D):**	**Rs. 24,74,05,38,158**	**Rs. 20,67,04,65,661**
Total Cost (PKG 1 to PKG 2)			**45,41,10,03,819**

Source: DPR, Geo Designs & Research (P) Ltd.

2.7 Project Facilities

Toll Plaza and Wayside Amenities at various locations to serve as vehicular and passenger users rest areas, and refreshment areas, etc. are proposed along the alignment.

2.7.1. Toll Plaza

There is one toll plaza on the main carriageway proposed for the project stretch. Details of proposed toll plaza is given in the **Table 2-13** below. Apart from this, there are various entries and exits at various location as given below. Apart from these, there are ram and loop are also given.

Table 2-14: Location of Toll Plaza

Sr. No.	Facility	Chainage	Sr. No.	Facility	Chainage
Package-I			**Package-II**		
1	**Main Toll Plaza**	**8+265**	1	**Main Toll Plaza**	**-**
Close Tolling			**Close Tolling**		
1	Exit Closed Toll	22+896	8	Entry Closed Toll	34+876
2	Entry Closed Toll	23+383	9	Exit Closed Toll	44+467
3	Exit Closed Toll	33+528	10	Entry Closed Toll	49+329
Close Tolling			**Close Tolling**		
4	Exit Closed Toll	54+249	11	Ramp-1 Closed Toll	69+963
5	Entry Closed Toll	54+724	12	Ramp-2 Closed Toll	
6	Exit Closed Toll	57+503	13	Loop-1 Closed Toll	
7	Entry Closed Toll	58+493	14	Loop-2 Closed Toll	

Source: DPR, Geo Designs & Research (P) Ltd.

All Toll lanes will be FASTag enabled. Entry approach to each toll plaza shall be having speed restriction. Weigh-in-Motion equipment as per NHAI Policy Circular No. NHAI/13013/2016-17/CO/Hybrid ETC/ 122586 dated 20/08/2018 and FOB shall be constructed for connecting toll booths and toll office for collection of toll fees as per NHAI Policy Circular No. 17.5.82 Dated 24th May, 2021.

2.7.2. Wayside Amenities

Total two numbers of Wayside amenities shall be provided alongside the highway. Wayside amenities shall be provided for user comfort areas with parking, eating, breakdown/repair, and toilet facilities, etc. Detail of wayside amenities is given in **Table 2-14** below.

Table 2-15: Location of Wayside Amenities

Sr. No.	Facility	Chainage	Sr. No.	Facility	Chainage
Package-I			**Package-II**		
1	Way side Amenities (LHS)	12+205	1	Way side Amenities (RHS)	59+055

Source: DPR, Geo Designs & Research (P) Ltd.

2.7.3. Truck Lay Bye

No truck lay-byes are planned along the project stretch.

2.7.4. Bus shelters

No Bus shelters are planned along the project stretch.

2.7.5. Highway Nest (Mini)

No Highway Nests (Mini) are planned along the project stretch.

2.8 Projected Impacts and Mitigation Measures

The various projected impacts during the construction and operation phase on the environmental parameters have been studied to estimate the impacts on the environment. The various projected

impacts and mitigation measures during the construction and operation phase on the environmental parameters have been studied which is discussed in details in the chapter 4 and summarised in **Table 2-15.**

Table 2-16: Summarized Major Environmental Impacts and Mitigation Measures

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
1.	Air Environment	No impact	Increase in particulate matter		Dust suppression through water sprinkling, provision of anti-pollution masks to workers
			High concentrations of harmful gases like SO_2, NOx, CO from machinery		Hot mix plant to be set up at least 1000 m away from settlement, in the downwind location, regular check-up of machinery
				PM generation minimal	Avenue plantation will be done at various location where able possible containing pollutant absorbing broad leaved plants
				Harmful gases from vehicular exhaust like CO, HCs, etc.	Regular checks of PUC certificates at important junctions
2.	Land Environment	Soil erosion due to deforestation	Soil erosion prevalent	Erosion minimum	Felling of trees limited to CoI only, Provision of Avenue plantation, embankments.
			Soil compaction	Compaction minimum to non-existent	Limited movement of vehicles, keeping compaction in check in areas other than ROW
			Loss of top soil reducing fertility		Top soil has to be preserved carefully and used for rehabilitation
			Improper waste disposal causing soil contamination	Soil Contamination minimum to non-existent	Storage of harmful chemicals, oils, toxic materials in separate places with RCC surface; septic tanks with soak pit facility.
3.	Water Environment	No impact	Increased runoff due to cut and fill operations		Proper drainage structures, Silt fencing to be provided
			Natural flow of water bodies		Revision of alignment or compensatory digging for any water body being

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
			blocked due to construction		affected. Natural flow of major river will not be changed and due embankment protection works will ensure smooth water flow.
			Water table depletion due to water requirements		Use of water obtained from the surface water bodies
			Water quality degradation due to seepage of wastes, increased runoff to the surface water bodies, etc.		Storage of harmful wastes in lined pits, management of runoff using cross-drainage structures
4.	Noise Environment	No impact	Noise levels of the areas under construction will increase considerably		Construction activities to be stopped between 9 p.m. and 6 a.m.
			Increased noise from construction activities will affect settlements and also forest areas and wildlife		Construction camps to be situated 1000m from habitat or forest area; provision of temporary sound barriers
				Condition and type of vehicles plying on the road, pavement condition, etc. will affect the noise levels	Increasing the quality of pavement; use of sound absorbing trees in avenue plantation where able possible.
5.	Biological Environment (forests, flora and fauna)	Indiscriminate deforestation may cause loss of forest areas			Minimum twice the number of trees cut to be planted as a part of Compensatory

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
					Afforestation (CA) or as per state government rule.
		Habitat fragmentation			Strips of vegetation along the proposed highway to attract animal movement
			Degradation of Habitat Quality		Precautions to avoid leakage of chemicals during construction; Labour camps located far from habitat area
			Noise from construction activities inducing physiological and behavioral changes in the wildlife	Noise from vehicular movement affecting wildlife	Provision of noise barriers, boundary walls along the highway, marking of silence zone, etc.
				Avoidance of road by animals	Animal underpasses /overpasses; Culverts, provision of fences along the sides of highway; plantation and artificial lights to be made less attractive for birds
				Glaring headlights impacting wildlife	Provision of hedges/wall along the sides of highway to lower intensity of light
				Reduced access to waterholes, etc.	Construction of artificial waterholes/improvement of existing waterholes
		Discontinuity of canopy			Width of linear clearing in such areas to be kept small
			Increased Human-Wildlife conflict	Human-Wildlife conflict	Provision of caution signs to alert drivers about presence of wildlife; restriction of speed limit; restriction of parking
6.	Socio-Economic Environment		Temporary 'skew' in demographic profile due to influx of workers		Temporary impact, will normalize after construction completes.

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
			Traffic congestion due to construction activities		Proper traffic management to be followed as per IRC codal provisions.
			Human Health & Safety		All safety measures such as provision of PPE to the workers, proper storage of electric machinery and instruments so as to minimize the risk of electric shock; availability of IS certified drinking water, water draining from pits to control mosquito breeding, availability of first aid kits, etc.

3. DESCRIPTION OF BASELINE ENVIRONMENT

3.1 General

Transportation network serves as a support to any nation's economy. Apart from the direct impact of easy accessibility to places and fast movement, roads constructed indirectly helps increase the commercial value of land as well as strengthen livelihood opportunities. However, expressways and highways, which are at the highest in the hierarchy of road, gives fast movement for thorough traffic with restricted access triggering development especially in the origin and destination places. Unlike the other kind of roads, it instigates more of macro level development and less of micro level economic development.

Construction and operation of a highway may have impacts both adverse and positive on the physical environment of an area it passes through viz. topography, micro climate, drainage pattern, floral and faunal habitats. Environmental Impact Assessment study becomes necessary to assess the possible adverse impact and find ways to mitigate them creating a balance between anthropogenic and natural settings. It is essential to consider environmental and socio-economic aspects while planning or designing a road so as to let the benefits reach the community.

3.2 Study Area and Period

The base line status of environment quality near the project site serves as a basis for identification and prediction of impact. This chapters illustrates the description of existing environment status of the study area with reference to the prominent environment attributes the data collected and analysed from both primary and secondary sources. Primary data has been collected within 500 meters on either side of the proposed alignment. Secondary data were collected from published reports, research papers, working plans, consultation and discussion with Govt. officials.

The environmental sampling in the proposed project study area has been carried out by NABL accredited laboratory AGSS Analytical and Research Lab (P) Ltd. for the period of one season from October, 2024 to December, 2024. The consolidated report for baseline sampling of ambient air quality, groundwater quality, surface water quality, soil quality and noise environment is attached as **Annexure 3-1.**

3.3 Methodologies followed

In order to correctly assess the baseline environmental conditions of the project area, the following methodologies were adopted:

- Preparation of questionnaire/data sheets related to environmental surveys.
- Field observations of baseline conditions.
- Screening, testing and monitoring of environmental factors like air, water, soil and noise.
- Secondary data collection from verified authentic sources like Government departments and published literature.

3.3.1. Design of questionnaires

Thorough study of the environmental guidelines and conditions of the Ministry of Environment, Forest & Climate Change (MoEF&CC) led to the preparation of questionnaires for field survey/data collection. Individual questionnaires were prepared for Social Impact Assessment study and Environmental study. Two survey questionnaires were prepared for Social Impact Assessment study related to 'Project Affected Families' and 'Village Consultation'.

3.3.2. Field observations based on questionnaires

The field survey as per the questionnaire was undertaken by a team under the leadership of an environmental and social expert. Environmental aspects like waterbodies, flora, fauna, structures coming on the alignment, archaeological and religious sites were noted for the entire alignment, household schedules were filled with the help of head of household, village schedule was filled through group discussion/consultation in villages.

3.3.3. Screening, testing and monitoring of various environmental factors

The entire stretch of the alignment was surveyed and screened for the collection of samples related to various physical and chemical environmental parameters like air, water (surface and ground water), soil and noise. These samples were analysed in NABL accredited laboratory.

❖ Ambient Air Quality

The Ambient Air Quality (AAQ) helps in quantifying the impact of the developmental project on the natural and biophysical environment.

AAQ was monitored at specific locations both along the entire proposed alignment, details of the same are presented in later sections in this chapter. The air quality parameters considered for the study include Particulate Matters (PM_{10} & $PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_2), Carbon Monoxide (CO) and Ozone (O_3), among others. The process of sampling for various parameters are given below.

a) Particulate Matters (PM_{10} & $PM_{2.5}$)

The particulate matters were measured using Respirable Dust Samplers (RDS) and $PM_{2.5}$ Sampler. A pre-conditioned and pre-weighted glass fiber filter paper was used for PM_{10} and PTFE filter paper was used for $PM_{2.5}$ sampling. A known quantity of air was drawn in by the sampler for a period of time as prescribed by CPCB. The flow was noted by the manometer provided in the sampler. By multiplying the flow rate with time elapsed, and removing and weighing the filter paper, the concentrations of the particulate matters in the ambient air were found out.

b) Sulphur Dioxide (SO_2)

A known quantity of air was bubbled through impingers containing tetrachloromercurate, which formed disulfitomercurate complex with SO_2. The complex gave a pinkish-blue colour with p-rosaline and formaldehyde solution. The intensity of colour produced was proportional to the SO_2 concentration and it was measured using a spectrophotometer at 560 nm.

c) Nitrogen Oxides (NO_2)

A known quantity of air was passed through impingers containing sodium hydroxide-sodium arsenite solution. The NO_2 reacted with the said solution mixture and produced a complex, which further was made to react with hydrogen peroxide, sulfanilamide, NEDA, etc. to produce a characteristic colour, whose intensity was measured using a spectrophotometer at 540nm.

d) Carbon Monoxide (CO)

NDIR based sampler was used to monitor the concentrations of CO in the ambient air.

❖ Water Quality

Groundwater (GW) samples were collected in sterile containers from existing tube wells, wells and hand pumps whereas the surface water (SW) samples were collected from existing surface water bodies like ponds, rivers or lakes near the proposed highway as well as the alternate alignment option. The water quality of both GW as well as SW were analyzed for specific parameters upon which the proposed alignment may have an impact. The analyses were done as per IS:10500 criteria.

❖ Soil Quality

Soil quality of the area was analyzed by sampling the soil at specific locations representing various land use conditions. A core cutter was rammed into the soil up to 90 cm depth to collect the soil samples. The collected samples were then analyzed for relevant physical and chemical characteristics which may be impacted due to the proposed project.

❖ Noise Level

The noise level at specific locations on the proposed alignment was measured using a sophisticated sound level meter (Envirotech Sound Monitoring Device). The noise level was measured during day (6.00 am to 10.00pm) and night (10.00 pm to 6.00 am) and was expressed as equivalent noise level (Leq). Leq is the measurement duration of sound pressure level as the averaging time. It is calculated as follows:

$$L_{eq} = 10Log\left(\frac{1}{T}\int_0^T \frac{P^2(t)}{P_0^2}dt\right) \quad \text{dB}$$

Where:
T: Time measured in seconds,
P(t): Sound pressure moment on the square in Newton,
Po: Reference sound pressure, equal to ($2x10^{-5}$) N/m^2.

Noise Standards

The Govt. of India has stipulated the Ambient Noise Quality Standards with respect to noise via Gazette Notification dated 14.02.2000. The following table details the Ambient Noise Standards as set by the CPCB.

Table 3-1: Ambient Noise Standards

Area Code	Category	Noise Limits (Leq) in dB(A)	
		Day	Night
A	Industrial	75	70

B	Commercial	65	55
C	Residential	55	45
D	Silence zone*	50	40

***Silence zone** is defined as any area upto 100 m around such premises as hospitals, educational institutions and courts. Silence zones are declared by the competent authority.

3.3.4. Secondary Available Data

The secondary data was collected from various departments and sources as per the requirement of the study and the same is presented in **Table 3-2**.

Table 3-2: Secondary data sources

Sl. No.	Particulars	Sources
1.	General information of districts	District Statistical Office, Khordha, Cuttack and Dhenkanal
2.	Statistical data including census data	Directorate of Census Operations; Department of Economics and Statistics, Govt. of Odisha.
3.	Meteorological and environment data	Indian Meteorological Department, CPCB, Odisha Space Pollution Control Board, KVK.
4.	Irrigation and Hydrology data	Central Ground Water Board, Department of Irrigation, Govt. of Odisha
5.	General Land Use and Cropping pattern	Ministry of Agriculture, GoI, Department of Agriculture, Govt. of Odisha, Revenue Dept. Govt. of Odisha
6.	Maps and Toposheet of Relief and Slope	Survey of India, Govt. of India
7.	Rocks and Minerals	Geological Survey of India; State Mining Department, Govt. of Odisha
8.	Industries	District Industries Centre, Govt. of Odisha
9.	Forest types, wildlife and biodiversity	State Forest Department, Govt. of Odisha, Forest Survey of India, Dehradun
10.	Archaeological data	Archaeological Survey of India, State Archeological department, Govt. of Odisha

3.3.5. Analyses, compilation and preparation of report

The data collected through surveys and field visits were compiled and tabulated, and this along with the secondary data were analyzed to identify potential areas where environmental problems could have a possibility.

The analyses of the compiled data led to the following conclusions:

- After comparing the environmental parameter levels with the limits prescribed by the CPCB, the potential sites where the load of pollution is higher than the limit and demands special attention was determined. The stretches which will not be adversely affected in spite of construction of the proposed highway shall not be considered for further study.
- The areas where there is minimum or no impact could be utilized as potential storage or camp sites.

- The areas where there may be adverse impacts due to construction activities are considered and the corresponding mitigation measures as well as environmental management plan has been detailed in subsequent chapters covering both the operational as well as construction phases.

3.4 Baseline Environmental Status

The study of the baseline environmental conditions provides an idea about the environmental parameters that may be affected due to the construction activities of the proposed project. This ultimately helps the decision maker in incorporating certain precautionary measures/mitigation measures wherever the impacts are projected to be detrimental in nature. The baseline data has been gathered through extensive field survey, interaction with local community as well as published secondary data sources and desk research, keeping in view the sustainable mode of development to conserve the existing physical and biological natural resources as best possible.

The 'study area' mentioned in the report corresponds to the environmental features such as forests, water bodies, industries, protected areas such as national parks/wildlife sanctuaries, places of historical importance, tourism areas, etc. present within a strip of 500 m. or affected area, whichever is more, on either side of the proposed alignment.

3.4.1. Physical Environment

❖ Geographical location of the project highway

The proposed alignment of the project covers three districts viz. Khordha, Cuttack and Dhenkanal in the state of Odisha. The proposed project alignment starts from Ch. 0+000 near Rameswar in Tangi tehsil of Khordha district and ends at Ch. 70+995 in Gobindpur in Dhenkanal tehsil of Dhenkanal district of Odisha state of total length of 70+995 km traversing through 7 Tehsils viz. Khordha, Tangi, Begunia, Dampara, Banki, Athagarh and Dhenkanal. The entire alignment is greenfield. The co-ordinates of the proposed project are Lat.: 20°1'10.09"N and 20°21'24.62"N, Long.: 85°30'16.69"E and 85°34'37.59"E at the start end; and Lat.: 20°21'24.62"N, Long.: 85°34'37.59"E at the end points respectively. The alignment runs through plain terrain with Agricultural land at most locations.

❖ Physiography and terrain

Odisha's physiography is characterized by five major morphological regions. The Odisha Coastal Plain in the east, the Middle Mountainous and Highlands Region, the Central plateaus, the western rolling uplands and the major flood plains., which collectively contribute to its diverse climate, vegetation, and natural resources. The project study area comes under three districts viz. Khordha, Cuttack and Dhenkanal. These three districts present distinct physiographic features, reflecting their varied landscapes and geographical settings. Here's a brief overview of the physiography of each district:

Khordha district: As per the physiographic set up, the district can be broadly divided in to four natural divisions such as (a) Coastal sand dune (b) Alluvial plain, (c) Lateritic upland and (d) Hilly terrain.

I. **Coastal sand dune:** The dunes having limited width occur along the Chilika coast discontinuously. These deposits are fluvio aeoline in origin and are of longitudinal type.

II. **Alluvial plain:** It is the most potential hydrogeomorphic unit. It occurs as narrow strip along Chilika coast in the south east & along the courses of major rivers. The Alluvial plain in the northeast is a part of Mahanadi delta system.
III. **The lateritic upland:** It constitutes the major parts of the district. This forms an undulating terrain covered with lateritic capping over Gondwana sand stone and Precambrian rocks.
IV. **The hilly terrain:** is prominent in southwestern and western part. The area is underlain by Precambrian hard rocks and major part of this terrain is capped by laterities and lateritic gravels. The subunits in this terrain are (a) shallow buried pediplain (b) Moderately buried pediment (c) pediments (d) intermontane valley (e) residual hills (f) structural hills etc.

Cuttack district: Physio-graphically the district can be divided into two distinct units viz-deltaic plain and lateritic uplands and hilly tract.

I. **Lateritic uplands and hilly tract:** The lateritic uplands and hilly tract is seen in the western part of the district. The Laterite upland bordering the hilly tract is characterized by moderately undulating topography supporting some vegetation. The hilly tract consists of a series of detached hill range s of Pre-Cambrian and upper Gondwana formation. The average altitude varies from 50 to 100 m. above msl with the maximum of 337m. above msl.
II. **Deltaic plains:** The deltaic plains occupy the eastern part of the district which is formed under the fluvial environment. The area is characterized by parallel to radial drainage pattern. It forms the most fertile part of the district.

Dhenkanal district: The district can be broadly divided into four natural physiographic units. These are (i) Southern Mountainous Region, (ii) Eastern Valley and Plain, (iii) Central Undulating Plain and (iv) Northern Mountainous Region.

I. **The Southern Mountainous Region** comprises hill ranges trending NNW-ESE and is covered by part of Hindol block of Hindol sub-division and also parts of Dhenkanal, Odopada and Gondia blocks of the Dhenkanal sub-division. The elevation varies from 60 m to 971 m above mean sea level. These hill ranges from the water divide between the Mahanadi and Brahmani basins. The hill slopes are covered with moderate to dense forest.
II. **The Eastern Valley and Plain** occurs as small strips along the curves of the river Brahmani and its tributaries. Residual hills and ridges characterize it. The elevation varies from 40 m to 630 m above mean sea level.
III. **The Central Undulating Plain** spreads over Parjang block of the Kamakhyanagar sub-division. The area is characterized by undulating to broad flat topography with low-lying hills having flat top.
IV. **The Northern Mountainous Region covers** the Kankadahad, Bhuban and Kamakhyanagar block of Kamakhyanagar sub-division. This terrain is covered with dense forest. Broad valleys and low-lying hilly regions separate the hills.

❖ Climatology

Climate

The State has a tropical climate, characterized by high temperature, high humidity, medium to high rainfall and short and mild winters. As per Koppen's climatic classifications most part of Odisha comes

under the AW having a tropical Savannah type of climate. The south-west monsoon normally sets in between 1st and 2nd week of June in the coastal plain, and by 1st week of July the whole part of the state is under the full sway of the south-west monsoons. By October, the south-west monsoon withdraws completely from Odisha. These are the normal periods which fluctuate from year to year. As per "Thornthwaite's classification", Odisha comes under the "Sub humid" category, implying deficient winter rains. On the basis of climate type, Orissa has been divided into ten agro-climatic zones.

Table 3-3: Agro-climatic Zones of Odisha

S. No.	Agro-climatic Zone	Agricultural Districts	Climate	Normal		
				Mean annual rainfall (mm)	Mean maximum summer temp (°C)	Mean minimum winter temp (°C)
1.	North Western Plateau	Sundargarh, parts of Deogarh, Sambalpur & Jharsuguda	Hot & moist sub-humid	1600	38.0	15.0
2.	North Central Plateau	Mayurbhanj, major parts of Keonjhar, (Except Anandapur & Ghasipura block)	Hot & moist sub-humid	1534	36.6	11.1
3.	North Eastern Coastal Plain	Balasore, Bhadrak, parts of Jajpur & hatdihi block of Keonjhar	Moist Sub-humid	1568	36.0	14.8
4.	East & South Eastern Coastal Plain	Kendrapara, Khurda, Jagatsinghpur, part of Cuttack, Puri, Nayagarh & part of Ganjam	Hot & Humid	1577	39.0	14.8
5.	North Eastern Ghat	Phulbani, Rayagada, Gajapati, part of Ganjam & small patches of Koraput	Hot & moist, sub-humid	1597	37.0	10.4
6.	Eastern Ghat High Land	Major part of Koraput, Nabarangpur	Warm & humid	1522	34.1	7.5
7.	South Eastern Ghat	Malkangiri & part of Keonjhar	Warm & humid	1710	34.1	13.2
8.	Western Undulating Zone	Kalahandi & Nuapada	Hot & moist sub-humid	1352	37.8	11.9
9.	Western Central Table Land	Baragarh, Bolangir, Boudh, Sonepur, parts of Sambalpur & Jharsuguda	Hot & moist sub-humid	1614	40.0	12.4
10.	Mid Central Table Land	Angul, Dhenkanal, part of Cuttack & Jajpur	Hot & moist sub-humid	1421	38.7	14.0

(Directorate of Agricultural and Food Production, Odisha, 2005)

The normal rainfall of the state is 1451.2 mm. About 75% to 80% of rainfall is received from June to September. Floods, droughts and cyclones occur almost every year with varying intensity.

Temperature

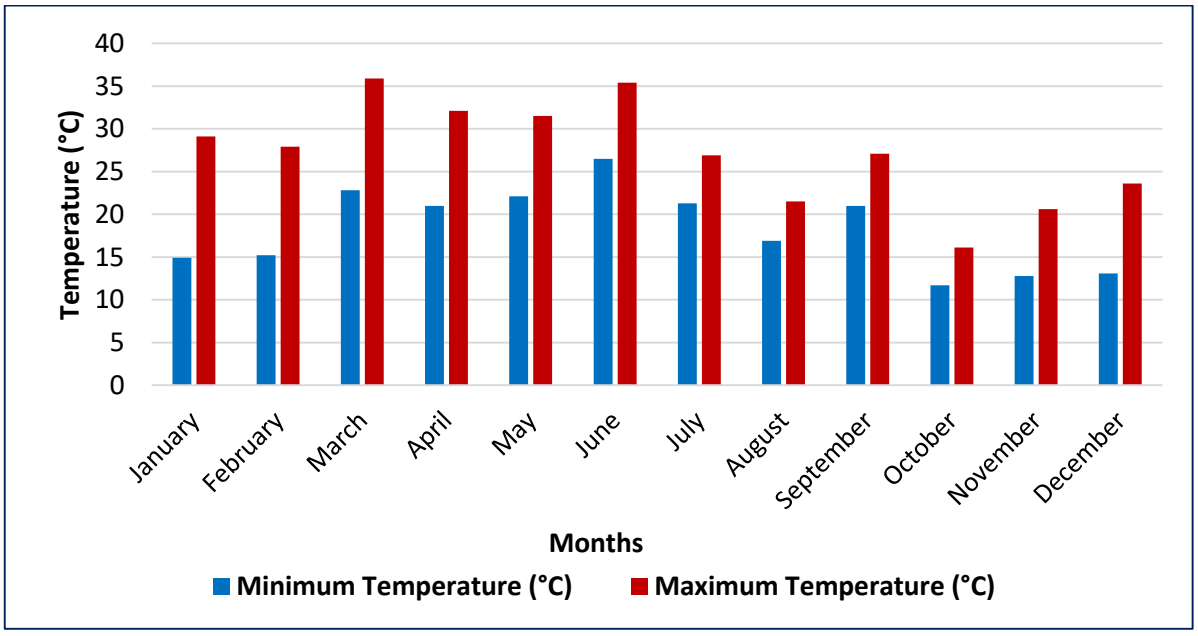
During summer, Odisha witnesses scorching temperatures, often soaring above 40°C in many parts of the state. Coastal areas tend to experience relatively milder temperatures due to the moderating influence of sea breezes. However, the interior regions, such as the western and northern districts, can endure intense heatwaves, leading to discomfort and health risks. After the monsoon retreats, Odisha experiences a transitional phase characterized by clear skies, moderate temperatures, and decreasing humidity.

Table 3-4: Monthly average temperature of Odisha (period: 2014-2023)

Month	Maximum Temperature (°C)	Minimum Temperature (°C)	Month	Maximum Temperature (°C)	Minimum Temperature (°C)
January	29.1	14.9	July	26.9	21.3
February	27.9	15.2	August	21.5	16.9
March	35.9	22.8	September	27.1	21
April	32.1	21	October	16.1	11.7
May	31.5	22.1	November	20.6	12.8
June	35.4	26.5	December	23.6	13.1

(Source: Climate Data Service Portal, IMD)

This period is ideal for outdoor activities, festivals, and tourism, as the weather remains pleasant and conducive to exploration. Winter in Odisha is relatively mild compared to northern parts of India but still brings cooler temperatures, particularly during the early mornings and late evenings. Coastal regions enjoy temperate weather, while inland areas may experience slightly colder conditions. However, frost and snowfall are rare occurrences in the state.



(Source: Climate Data Service Portal, IMD)

Figure 3-1: Average monthly maximum and minimum temperatures of Odisha (2014-2023)

Rainfall

The southwest monsoon, originating from the Bay of Bengal, is the primary contributor to rainfall in Odisha. It typically arrives in June and lasts until September, bringing heavy showers across the state. Coastal areas receive substantial rainfall during this period, often leading to waterlogging and flooding in low-lying regions. The monsoon is crucial for replenishing water reservoirs, supporting agricultural activities, and sustaining the state's biodiversity.

Table 3-5: Average monthly time series (2013-2023) rainfall data for Odisha

Yr.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2013	0.0	0.0	0.0	37.6	92.8	269.1	393.6	127.1	238.9	480.7	0.0	0.0	**1639.6**
2014	1.3	29.9	44.8	0.0	114.3	55.6	530.8	313.1	234.9	105.3	0.0	0.0	**1429.8**
2015	9.9	4.3	4.4	37.0	39.9	218.9	343.3	224.6	142.2	16.4	0.2	31.9	**1073.0**
2016	1.6	32.1	32.0	2.2	97.3	118.8	370.0	344.3	120.5	67.8	21.1	0.0	**1207.7**
2017	0.0	0.0	38.0	5.9	74.3	126.4	197.0	241.9	224.1	167.8	56.3	1.9	**1133.5**
2018	0.0	0.0	0.5	96.8	115.9	171.2	422.4	265.3	359.0	154.6	0.0	34.3	**1620.1**
2019	0.0	23.1	21.9	34.8	149.4	198.8	213.5	344.9	314.9	159.6	0.0	3.1	**1463.9**
2020	18.5	50.4	63.0	128.4	126.3	233.6	157.7	625.7	99.2	142.2	0.0	0.0	**1644.9**
2021	0.0	0.0	5.4	31.4	167.4	184.8	275.3	167.8	494.7	59.9	41.1	49.6	**1477.4**
2022	52.1	8.7	0.0	3.4	101.1	198.8	352.3	413.3	172.9	119.2	0.0	0.0	**1421.7**
2023	0.0	0.0	62.5	67.0	70.5	252.7	293.7	367.3	366.6	133.1	1.0	15.4	**1629.7**
Avg.	**7.6**	**13.5**	**24.8**	**40.4**	**104.5**	**184.4**	**322.7**	**312.3**	**251.6**	**146.1**	**10.9**	**12.4**	**1431.0**

(Source: https://dhenkanalkvk.org/district.html and Climate Data Service Portal, IMD)

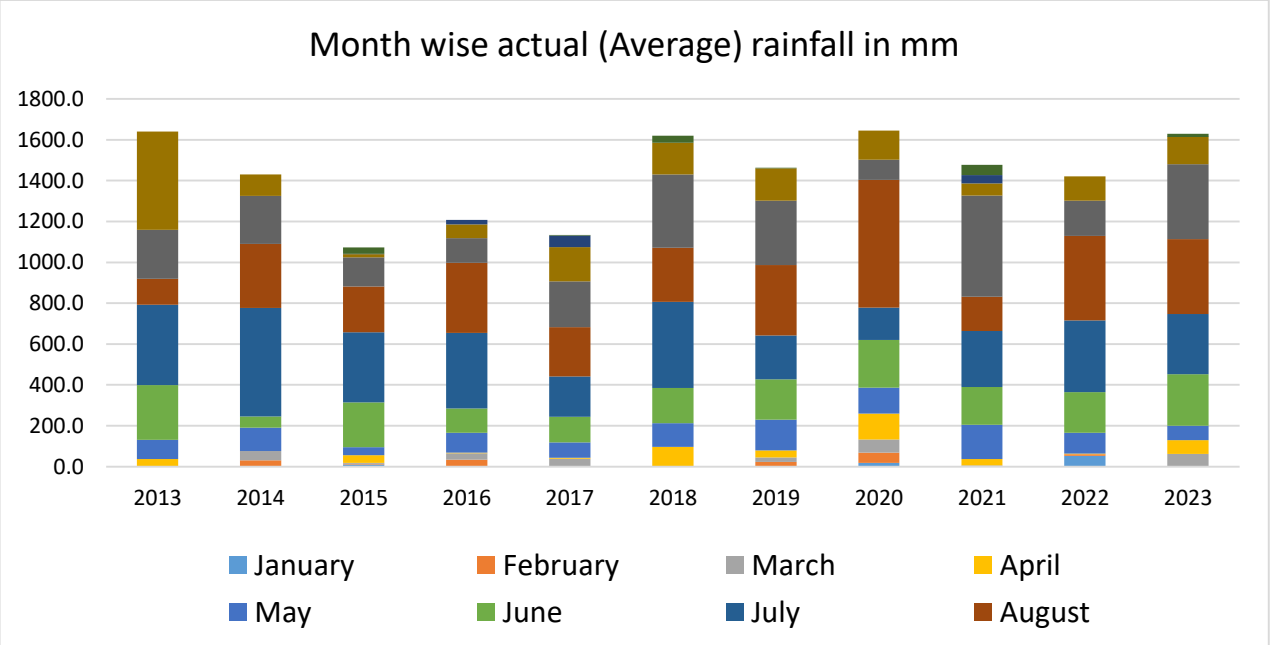


Figure 3-2: Monthly Average Rainfall of Odisha (2013-2023)

Following the southwest monsoon, Odisha experiences the northeast monsoon, characterized by moderate to light rainfall. This secondary monsoon season occurs as moisture-laden winds from the northeast bring intermittent showers to the region. While the northeast monsoon contributes less

rainfall compared to its southwest counterpart, it still plays a vital role in maintaining soil moisture levels and supporting post-monsoon cultivation activities.

The highest rainfall typically occurs in the month of July, with an average of 322 mm in the period of 2014-2023. Minimum rainfall in the state occurs in the month of January, averaging 7.6 mm between 2013 and 2023.

Humidity

Odisha experiences high levels of humidity throughout the year, primarily attributed to its coastal location and tropical climate. The state witnesses a pronounced difference in humidity levels between its coastal and inland regions. During the summer months, which extend from March to June, Odisha encounters the highest humidity levels. The combination of high temperatures and moisture-laden winds from the Bay of Bengal contributes to oppressive humidity, making summers uncomfortable for residents. Humidity levels during this period often exceed 70% and can even reach 90% or higher, particularly in coastal areas.

Table 3-6: Monthly average Humidity of Odisha (2019–2023) (Bhubaneswar)

Month	Monthly Average Humidity (%)	Month	Monthly Average Humidity (%)
January	59	July	72.4
February	58	August	74.2
March	59.6	September	79.4
April	62.4	October	75.8
May	64.4	November	62.4
June	64.6	December	57.2

(Source: worldweatheronline.com)

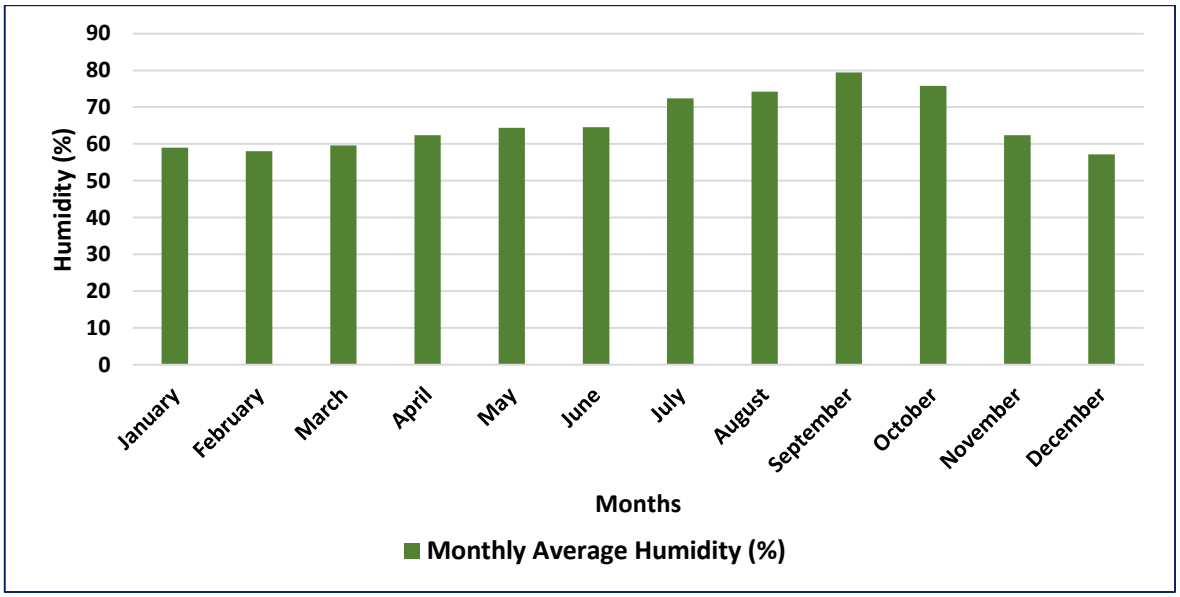


Figure 3-3: Monthly Average Humidity of Odisha (2019-2023)

Monsoon season, spanning from June to September, brings relief from the scorching heat but elevates humidity levels further. Post-monsoon months, from October to December, witness a gradual decline

in humidity levels as the weather transitions towards a cooler and drier phase. Even during the winter months (December to February), when temperatures drop, humidity levels in Odisha typically range from 50% to 70%, with coastal areas experiencing higher levels compared to inland regions.

Site-specific Meteorological Data

The meteorological data obtained at site for the study period October, 2024 to December, 2024 from the weather station at Bhubaneswar, Odisha is given in Table 3-7 and the wind rose diagram for Bhubaneswar, Odisha are also shown in Figure 3-4 and Figure 3-5**.** The following wind rose diagrams indicate that, the wind is blowing majorly from SSW direction.

Table 3-7: Site-specific meteorological data for the baseline data collection

Month	Average Temperature (°C)	Average Relative Humidity (%)	Precipitation (mm)
October, 2024	28.66	81.15	2.79
November, 2024	24.72	72.89	0.25
December, 2024	22.46	73.58	3.30

(Source: Monthly weather average- Bhubaneswar weather station, wunderground.com)

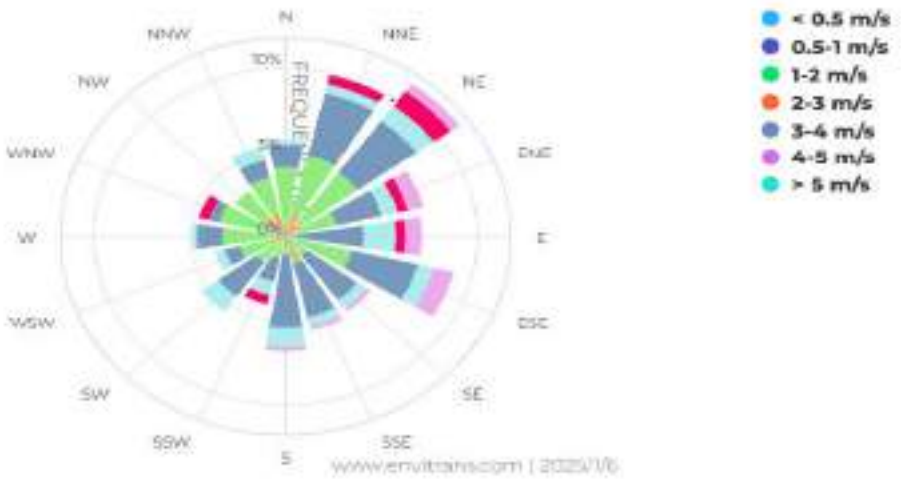


Figure 3-4: Wind rose for Cuttack/Bhubaneswar, Odisha for the study period

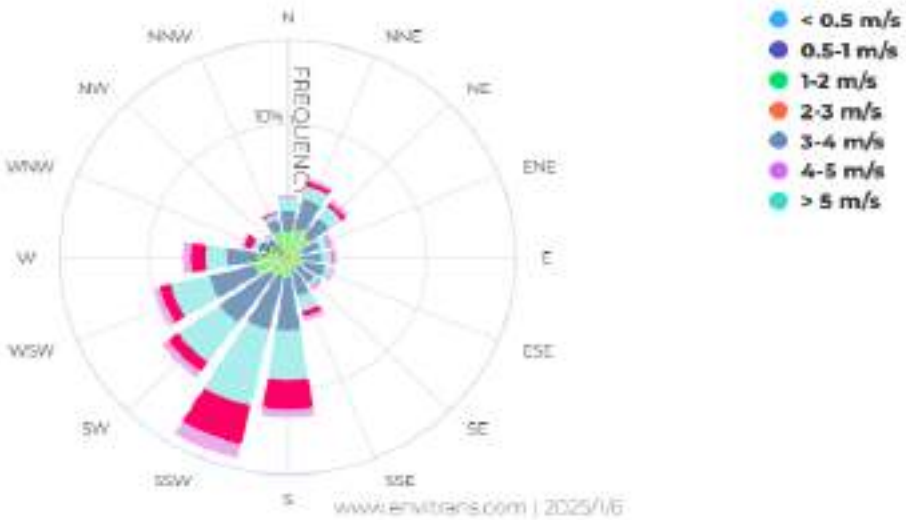


Figure 3-5: Annual Wind rose for Cuttack/Bhubaneswar, Odisha

❖ Land Use

A land use study is crucial for Environmental Impact Assessment (EIA) for several reasons such as understanding current land use pattern, identifying impacts of a proposed project on different land uses, and evaluating how the proposed project will alter land use patterns. Thus, it supports informed decision-making, helps in minimizing adverse impacts, and ensures that development is conducted in an environmentally responsible manner.

The proposed alignment passes through three districts of Odisha namely Khordha, Cuttack and Dhenkanal traversing through different land uses such as agriculture land, some habitation and forest patches. The land use pattern of the project districts, is presented in the table below. Majority of the area is net sown area followed by current fallow and forest areas, least is under miscellaneous tree crops and groves.

Table 3-8: Land use details of Odisha and Project districts (2021-22)

S. No.	Land Use Category	Area (ha)			
		Odisha	Khordha	Cuttack	Dhenkanal
1	Reporting area for Land Use	11571449	274081	333290	338206
2	Forest area	1941771	38740	24136	59160
3	Area under non-agricultural uses	1360567	41320	78319	42308
4	Barren and unculturable land	978010	27436	11881	11638
5	Permanent pasture and other grazing land	509290	13932	13061	12082
6	Land under miscellaneous tree crops and groves	251557	17208	8950	8531
7	Culturable waste land	576819	20849	12814	43343
8	Fallow lands other than current fallows	688167	17507	22977	38281
9	Current fallows	943456	9731	43387	44284
10	Net area sown	4321812	87358	117765	78579
11	Cropped area	4997378	103380	144290	82055
12	Area sown more than once	675566	16022	26525	3476

(Source: DACNET)

Visual interpretation combined with digital processing aided in the preparation of the land use/land cover map of the proposed project influence area. Survey of India maps on 1:50000 scale was used to prepare the base map and for geometric correction of satellite data. Ground survey was carried out to validate the accuracy of the remotely sensed data. The digital processing of the spatial data was done using Arc GIS 9.3 and Q GIS software. The land use study encompassing 500m of buffer length on either side of the proposed alignment revealed that the proposed highway passes through mainly Greenfields and agricultural land.

The detailed land use map of the proposed alignment with 500m buffer length on either side has been prepared in 1:25000 scale based on recent satellite imagery, which have been presented as **Annexure 3-2** for proposed alignment. The LULC map showing entire proposed alignment have been presented in subsequent pages. Also land use map taking 10 km buffer length on both sides of the proposed alignment have been prepared and presented in the subsequent pages. The maps show various features including crop lands, built-up areas, forest areas, etc.

Moreover, a detailed ground survey map was prepared on a scale of 1:2000 for proposed alignment as per requirement of ToR, showing existing features falling within the RoW such as trees as well as structures including archaeological and religious, monuments, etc., which is presented as **Annexure 3-3.** The following figures showing the land use of the project districts.

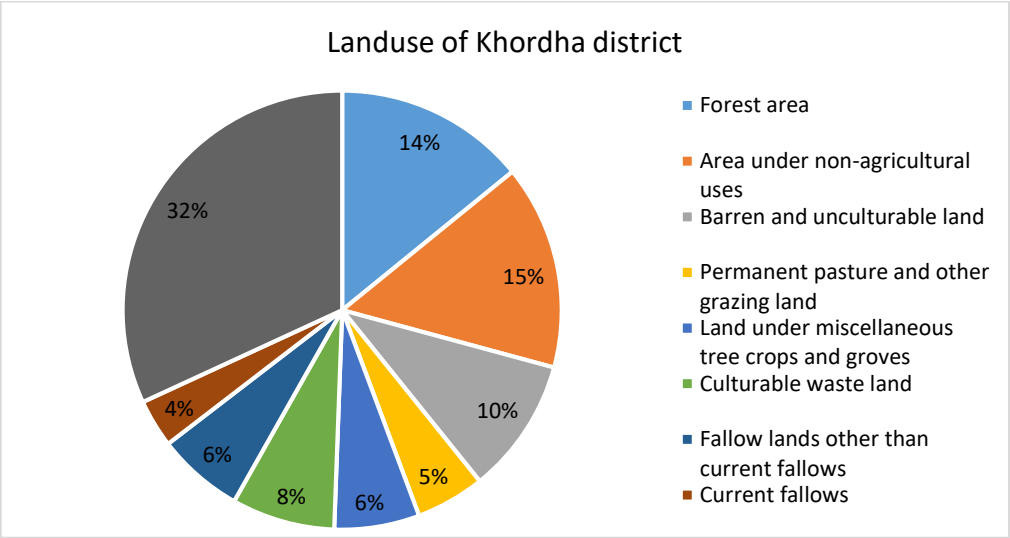


Figure 3-6: Land-use of Khordha district

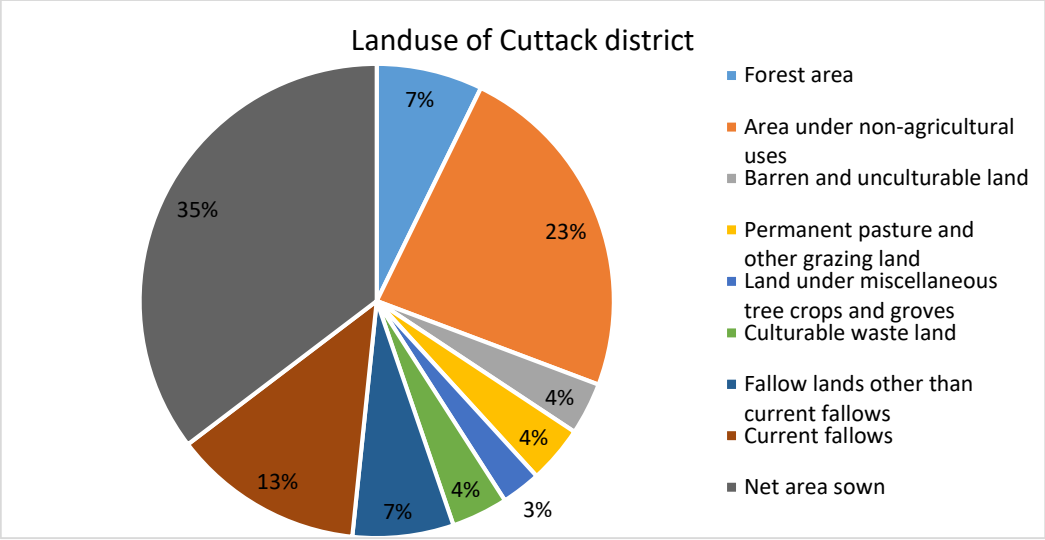


Figure 3-7: Land-use of Cuttack district

Majority of the area in the project districts is net sown area followed by area under non-agricultural us and forest areas, least is under tree crops and groves. In khordha district, net sown area is 32% followed by area under non-agricultural use (15%) and forest (14%). In Cuttack district, net sown area is 35% followed by area under non-agricultural use (23%) and current fallow (13%). In Dhenkanal district, net sown area is 23% followed by forest (17%) area and under non-agricultural use (13%), current fallow (13%), culturable waste land (13%).

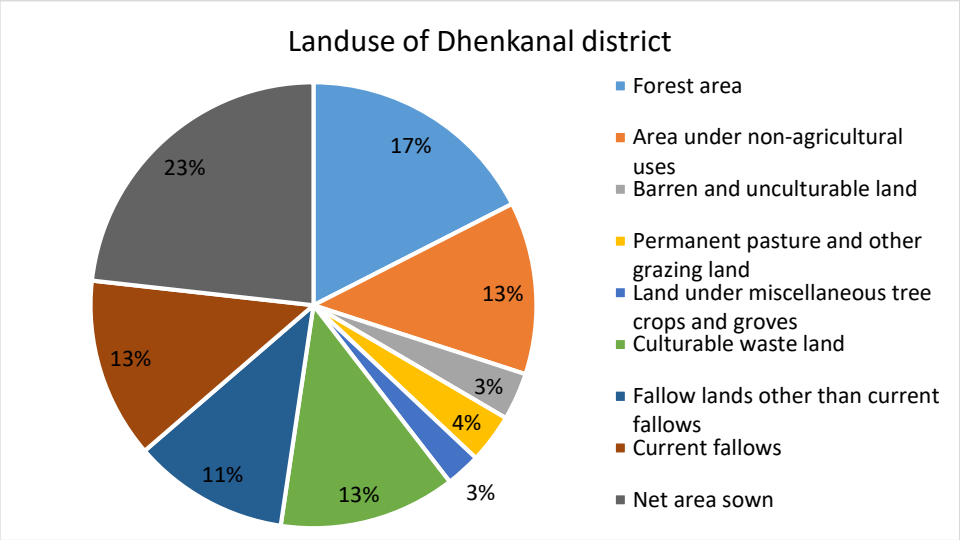


Figure 3-8: Land-use of Dhenkanal district

❖ Geology

Orissa is situated on the eastern coast of India and is a state where a range of mineral wealth exists in abundance. The state is endowed with large reserves of bauxite, iron ore, China-clay, chromite, coal, dolomite, fireclay, graphite, gemstones, limestone, manganese ore, mineral sand, nickel ore, pyrophylite and quartz. Recent finding of diamond in the Dharambandha area of Nuapada district by the State Directorate of Geology has further added to the mineral wealth of the state. Other minerals found in the state include copper ore, lead ore, titanium bearing magnetite, talc, soap stone and high magnesia igneous rocks. The rich mineral wealth of the state is attributed to its favourable geological setup. Situated on the eastern border of the peninsular India, Orissa has about 72.5% of the area occupied by Precambrian metamorphic rocks (of Archaean and Proterozoic age) which host the majority of the minerals. The Gondwanas hosting the coal resources occur over about 8% of the land mass. The Tertiary and Quaternary formations, occupying rest of the area, provide avenues for aluminous/ nickeliferous laterite and heavy minerals (in beach sand).

The Archaean rocks in northern Orissa include the Supracrustal belts of meta-sedimentary rocks including Iron Ore Super Group having deposits of iron, manganese, gold and basemetals. These are also represented by the gneisses, granite, migmatite (Singhbhum, Bonai and Mayurbhanj Plutons) and mafic/ ultramafic intrusives. These intrusives are associated with the chromite, titaniferous vanadiferous magnetite and PGM. The Bastar cratonic complex of Archaean age in the Western Orissa includes gneisses, granite, migmatite and Strontium-Tantalum-Niobium bearing pegmatites.

Proterozoic rocks in the western Orissa exhibit platformal sedimentary formations and associated limestone deposits. In north-western Orissa they contain metasediments of low to medium metamorphic grade classified as the Gangpur Group, which host manganese, limestone and Lead-Zinc deposits. In central and southern Orissa, the Proterozoics are represented by the Eastern ghats granulite belt comprising of khondalite, charnockite, migmatite, anorthosite and alkaline rocks accounting for the mineralisation of bauxite, manganese, graphite and gemstones.

The Mesozoic rocks of Gondwana Super Group host the major coal resources of the state. Formations of Cenozoic age occupy the eastern coastal plains in form of alluvial sediments, ash beds and low level laterite, providing avenues for occurrence of beach sand minerals and building materials. The deltaic fans extending into offshore regions play hosts for oil and gas.

Orissa has a major share of the Country's mineral reserves. Chromite, nickel, bauxite, iron ore and coal resources of the state respectively stand at 83, 92, 55, 38 and 26 percent of India's total reserves.
The geological map of the State is presented in Figure 3-8. Figure 3-9 shows the mineral deposits location in the state of Odisha. As can be seen most of the state's mineral wealth is located in the western to central part of the state.

Topography: On the basis of homogeneity, continuity and physiographic characteristics, Odisha has been divided into five major morphological regions: Odisha Coastal Plains in the east, the Middle Mountainous and Highlands Region, the Central plateaus, the western rolling uplands and the major flood plains.

Odisha Coastal Plains: The Odisha Coastal Plains are the depositional landforms of recent origin and geological belong to the Post-Tertiary Period. The 75-meter contour line delimits their western boundary and differentiates them from the Middle Mountainous Region. This region stretches from the West Bengal border, i.e. from the River Subarnarekha in the north to the River Rushikulya in the south. The coastal region is predominantly made up of Alluvial sand deposits.
This region is the combination of several deltas of varied sizes and shapes formed by the major rivers of Odisha, such as the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. It stretches along the coast of the Bay of Bengal having the maximum width in the Middle Coastal Plain (the Mahanadi Delta), narrow in the Northern Coastal Plain (Balasore Plain) and narrowest in the Southern Coastal Plain (Ganjam Plain).

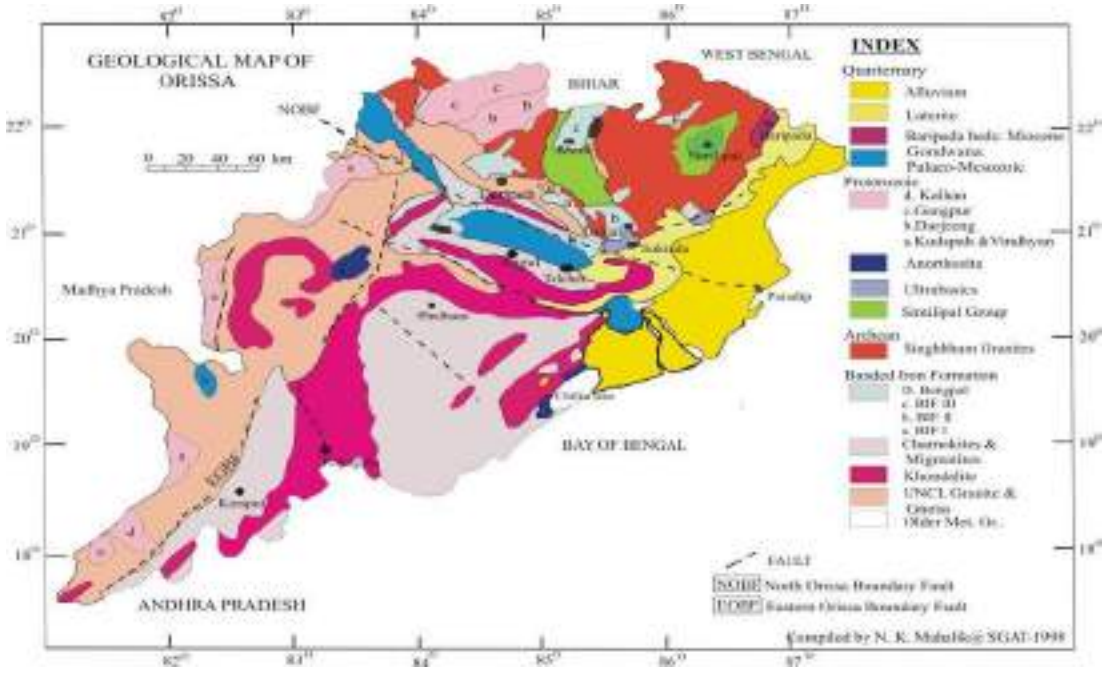
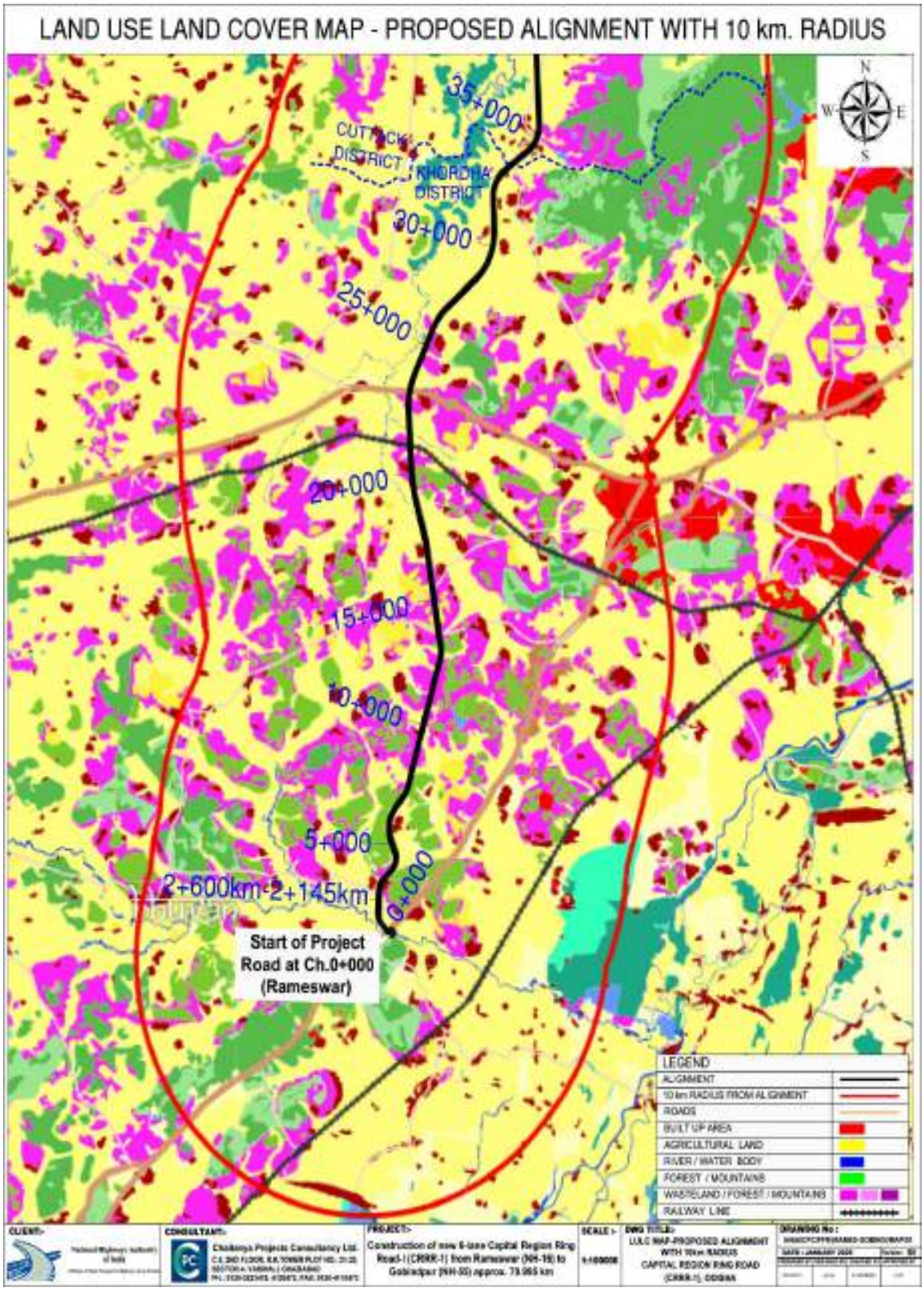


Figure 3-9: Geological Map of Odisha


LAND USE LAND COVER MAP - PROPOSED ALIGNMENT WITH 10 km. RADIUS
N
W
E
S
CUTTACK DISTRICT
KHORDHA DISTRICT
35+000
30+000
25+000
20+000
15+000
10+000
5+000
0+000
2+600km
2+145km
Start of Project Road at Ch.0+000 (Rameswar)
LEGEND
ALIGNMENT
10 km RADIUS FROM ALIGNMENT
ROADS
BUILT UP AREA
AGRICULTURAL LAND
RIVER / WATER BODY
FOREST / MOUNTAINS
WASTELAND / FOREST / MOUNTAINS
RAILWAY LINE
CLIENT:-
CONSULTANT:-
PROJECT:-
Construction of new 6-lane Capital Region Ring Road-I (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 73.995 km
SCALE :-
DWG TITLE:-
LULC MAP-PROPOSED ALIGNMENT WITH 10km RADIUS
CAPITAL REGION RING ROAD (CRRR-1), ODISHA
DRAWING No :
DATE : JANUARY 2020

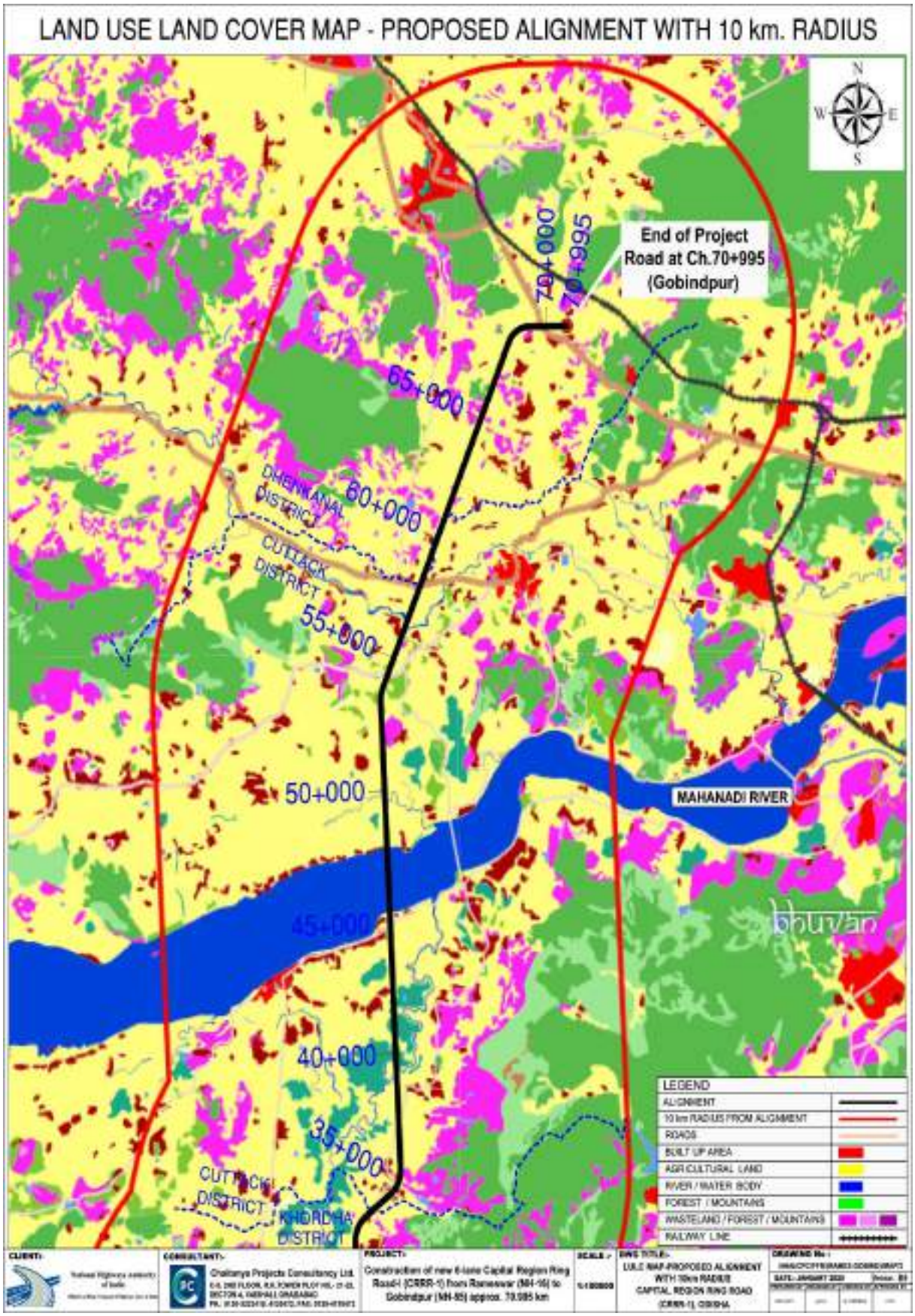


Figure 3-10: LU/LC map of project area (with 10 km buffer length along the alignment)

The North Coastal Plain comprises the deltas of the Subarnarekha and the Budhabalanga rivers and bears evidences of marine transgressions. The Middle Coastal Plain comprises the compound deltas of the Baitarani, Brahmani and Mahanadi rivers and bears evidences of past 'back bays' and present lakes. The South Coastal Plain comprises the lacustrine plain of Chilika lake and the smaller delta of the Rushikulya River.

Middle Mountainous and Highlands Region: The region covers about three-fourth of the entire State. Geologically it is a part of the Indian Peninsula which as a part of the ancient landmass of the Gondwanaland. The major rivers of Odisha with their tributaries have cut deep and narrow valleys. This region mostly comprises the hills and mountains of the Eastern Ghats which rise abruptly and steeply in the east and slope gently to a dissected plateau in the west running from north-east (Mayurbhanj) to north-west (Malkangiri). This region is well marked by a number of interfluves or watersheds. The Eastern Ghats is interrupted by a number of broad and narrow river valleys and flood plains. The average weight of this region is about 900 meters above the mean seal level.

Central Plateaus: The plateaus of the state are mostly the eroded plateaus forming the western slopes of the Eastern Ghats with elevation varying from 305-610 meters. There are two broad plateaus in Odisha: (i) the Panposh - Keonjhar -Pallahara plateau comprises of the Upper Baitarani catchment basin, and (ii) the Nabrangpur - Jeypore plateau comprises the Sabari basin.

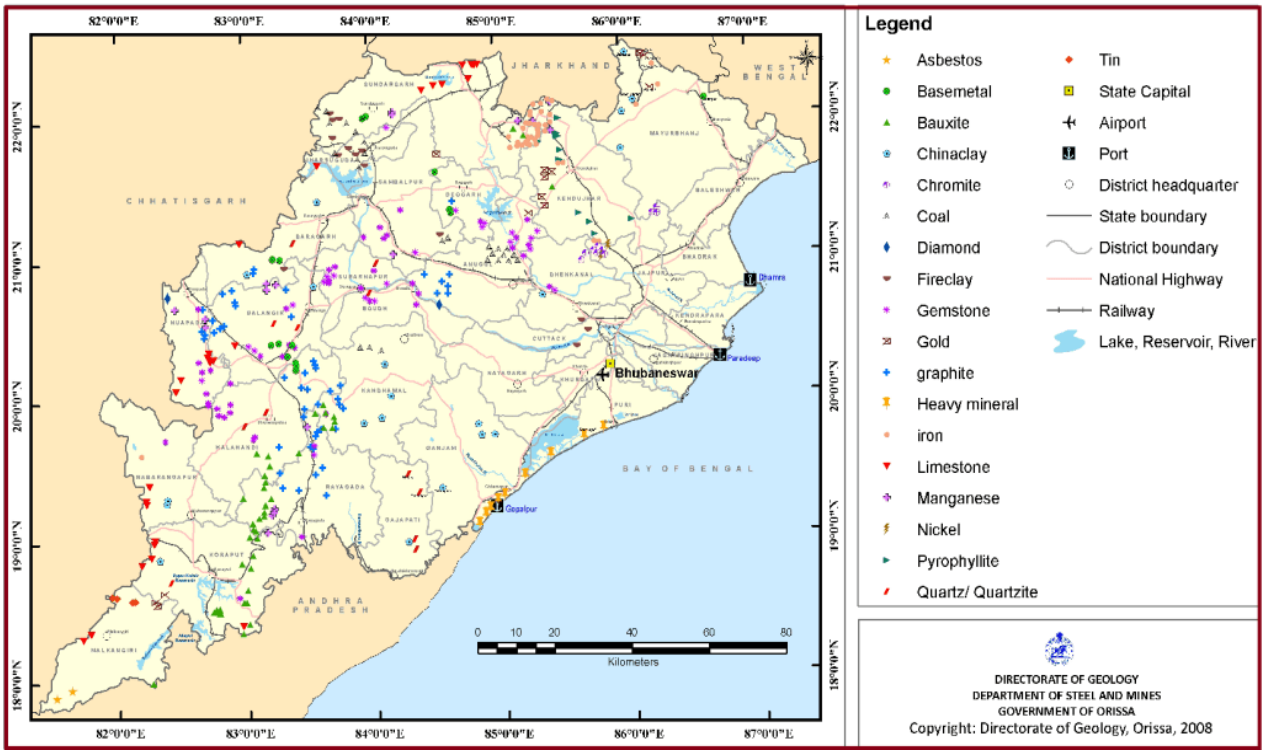


Figure 3-11: Minerals location in Odisha

Western Rolling Uplands: These are lower in elevation than the plateaus having heights varying from 153 m to 305 m.

Rivers systems of Odisha: There are four groups of rivers which flow through Odisha into the Bay of Bengal. The details of the same are presented here.

- Rivers that have a source outside the State (the Subarnarekha, the Brahmani and the Mahanadi).
- Rivers having a source inside the State (the Budhabalanga, the Baitarini, the Salandi, and the Rushikulya).
- Rivers having a source inside the Odisha, but flow through other states (the Bahudu, the Vansadhara, and the Nagavali).
- Rivers having a source inside Odisha, but tributary to rivers which flow through other states (the Machkund, the Sileru, the Kolab, and the Indravati).

River Mahandi is the major river of Odisha and the sixth largest river in India. It originates from the Amarkantak hills of the Bastar Plateau in Raipur district of Madhya Pradesh. It is about 857 km. Long (494 km. In Odisha) and its catchment area spreads over 141,600 sq.km. (65,580 sq.km.) in Odisha). The river carries on an average about 92,600 million m^3 of water.

The Brahmani is the second largest river in Odisha. It originates as two major rivers like the Sankh and the Koel from the Chhotanagpur Plateau of Bihar and both join at Veda Vyasa near Rourkela of Sundargarh district of Odisha forming the major River Brahmani. It flows through the Eastern Ghats in Sundargarh, Kendujhar, Dhenkanal, Cuttack and Jajpur districts into the Coastal Plains and enters into the Bay of Bengal along with a combined mouth with the Mahanadi known as the Dhamra. The Brahmani is 799 km. long (541 km. in Odisha) and its catchment area spreads over 39,033 sq.km. in Odisha).

The Rushikulya originates from the Rushyamala hills of the eastern ghats in Phulbani district. It is 165 km long with 8900 sq. km of catchment areas. It's tributaries are the Baghua the Dhanei Badanadi etc. It has no delta at its mouth.

Lakes: The Chillika Lake is brackish water lagoon located in the southern part of the Odisha coastal plane. It is spread over an area of 1100 sq. km. It salinity declines to a minimum during the monsoon, but in winter due to the overflow of the tidal water through the narrow opening from the Bay of Bengal, it reaches to maximum.

Khordha District

The district is drained by a number of streams which are mostly tributaries and distributaries of the river Mahanadi and a few other streams discharging in to lake Chilika. The important distributaries of Mahanadi are the Kuakhai, Bhargabi, Kushabhadra and the Daya River. The tributaries of the Mahanadi are the Ran and Kalijiri. The streams draining the southern parts of the district are Sulia, Kharia and the Kusumi. All the streams are ephemeral and effluent in nature. Chilika, the largest salt water lake of India is situated in the southeastern part of the district.

Geomorphological Set up:

Based on the physiographic set up, the district may be broadly divided in to four natural divisions such as (a) Coastal sand dune (b) Alluvial plain, (c) Lateritic upland and (d) Hilly terrain.

The dunes having limited width occur along the Chilika coast discontinuously. These deposits are fluvio aeoline in origin and are of longitudinal type. Alluvial plain is the most potential hydrogeomorphic unit. It occurs as narrow strip along Chilika coast in the south east & along the courses of major rivers. The

Alluvial plain in the northeast is a part of Mahanadi delta system. The lateritic upland constitutes the major parts of the district. This forms an undulating terrain covered with lateritic capping over Gondwana sand stone and Precambrian rocks. The hilly terrain is prominent in southwestern and western part. The area is underlain by Precambrian hard rocks and major part of this terrain is capped by laterities and lateritic gravels. The subunits in this terrain are (a) shallow buried pediplain (b) Moderately buried pediment (c) pediments (d) intermontane valley (e) residual hills (f) structural hills etc.

Soil & Landuse:

There are three types of soil generally found in the district

1) Alfisols

2) Ultisols

3) Entisols

Alfisols: The deltaic alluvial soil in the eastern part of the district and the red loamy soils in the northwestern part of the district come under this class. It consists of a wide range of soils including mixed red and black soils, red earth, red loamy soils, red sandy soils, red gravelly soils and other alluvial soils. The red soils are light textured, usually devoid of lime concretions deficient in nitrogen, phosphate & organic matter. The PH of the soil varies from 6.5 to 7.3. These soils are suitable for cultivation of paddy and other crops.

Ultisols: These include laterite & lateritic soil, red and yellow soils of the northern and north central part of the district. They are characterized by low contents of Nitrogen, Phosphate, Potassium & Organic matter. The PH of the soils ranges from 4.5 to 6.0. Due to granular nature of these soils cultivation is possible immediately after heavy rains without the danger of any unsatisfactory physical state.

Entisols: these include the coastal alluvial soils along the Chilika lake and younger alluvial soils in the central part of the district. The texture in general is sandy to loamy and soils in general are deficient in nitrogen, phosphoric acid and humus. These soils are suitable for wide variety of crops including paddy.

Ground Water Scenario

Hydrogeology:

Aquifer system of the area may be divided in to (a) fissured (b) porous types based on the lithological characteristics of the area.

(a) Fissured formation: The Precambrian crystalline rocks which mainly consists of granite and granite gneiss, Khondalites, Charnockites and Anothosites occupy major parts of the district covering western as well as central and parts of eastern sector of the district. Ground water in these rock types occurs under unconfined conditions within weathered residuum and under semi confined to confined conditions in fractures at greater depths. The thickness of weathered residuum varies from negligible to 35/40m depending on rock types. The thickness of the weathered zone is minimum in Charnockites and Anothosites while the same is maximum in Khondalites. These weathered zones form shallow aquifer where ground water occurs under unconfined conditions. The average yield of dug wells in granitic rocks is around 20 to 22 m3/day with the maximum around 36 to 40 m3/day. In other hard rocks the yield is restricted within 25 m3/day with the average value around 12 to 15 m3/day.

(b) Porous formation: The porous formation in the district are a) Semi-consolidated Athagarh formation of upper Gondwana Group b) Quarternary alluvium and upper Tertiary sediments and also laterites and lateritic gravels with limited extent with respect to time and space.

(a) Athagarh formation: This aquifer system occurs at shallow as well as deeper depths, are mainly formed of sandstones. The shale form mainly pheratic aquifers and that also with limited potential. The weathered zone extends down to 12 to 15m and top weathered part up to 5 to 6m is lateritised. The yield of dug wells in the weathered zone is on an average is around 20 to 25 m3/day. The yield at deeper fractures is on an average 7 to 10 lps.

(b) Quarternary Alluvium & Upper tertiary formations: This formation occurs in the extreme northeast corner of the district covering Balianta and Balipatna blocks of the district. The ground water occurs under pheratic condition at shallow depth and under semi -confined to confined condition at deeper depths. The bedrocks occur at 119m depths at Bhingarpur of Balianta block and at 198m depth at Balipatna and 230 m at Orakhand in the southern part of Balipatna block. Quarternary alluvial deposits occur in minor pockets near Chilika lake area with limited thickness and ground water is mostly saline barring few meters at top. The aquifer zones at deeper depth generally occur within 100m depths. The Transmissivity values are generally high, more than 7000m2/day.

Laterites: Laterites occur as capping over consolidated and semiconsolidated formation and prominent occurrences are found in Bolagarh, Khurda town, Bhubaneswar and Tangi area. The average thickness is around 20m.

Depth to water level:

The pheratic zone constitutes the most potential ground water reservoir in the district. This zone has been mapped in course of hydrogeological surveys. With a view to ascertain the changes in the ground water regime and make an overall assessment of the ground water resources CGWB has, so far, established 28 network hydrograph stations throughout the district which are monitored manually 4 times in a year, during January, April, August and November. The depth to water table values depend on several factors like rainfall, topography, drainage characteristics, proximity to drainage channels, lithology, water bearing and water yielding properties of the rocks.

The depth to water level in the hydrograph network stations of the district mostly ranges from 1.84 to 12.33m below ground level during premonsoon period. The water table is shallow in most part of the district. The depth to water table contour map of both pre and post monsoon seasons are attached in the Figure 3-xx. The pre monsoon depth to water level in about 11.9% of the wells fall in the range of 10 to 20 m & 52.9% of the wells fall in the range of 5 to 10m. About 23.5% of the wells show depth to water level between 2 to 5 m and about 11.8% of the wells, less than 2m.

Ground Water Resources

The principal source of recharge to ground water are rainfall, seepage from canals, return flow from applied irrigation, seepage from tanks and ponds. Ground water exploitation for domestic use in the district is mainly through private dug wells and hand pump fitted government bore wells. The total annual dynamic ground water resource of Khordha district is assessed to be 47618 hectare metre. The annual utilizable ground water resource earmarked for domestic and industrial use is 5001 hectare metre which is based on the projection of requirement by the year 2025. The gross annual draft for all uses is 14141 hectare metre leaving a balance ground water resource of 29874 hectare metre for further development for irrigation use. The present average stage of groundwater development in the

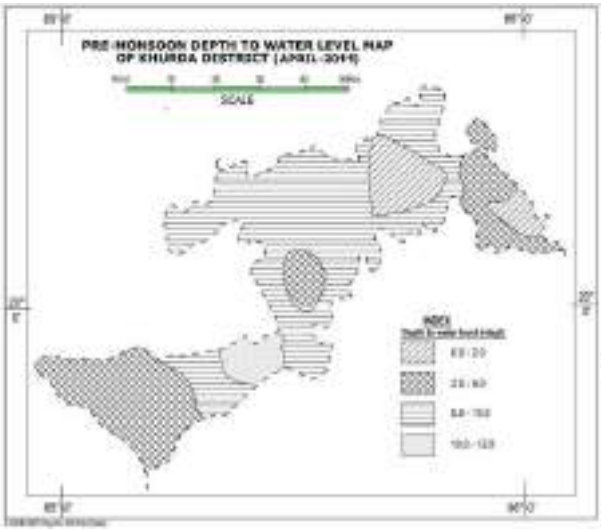
district has been worked out to be only 29.7%. The stage of ground water development varies from a maximum of 48.7% in Bhubaneswar block to a minimum of 18.56 % in Banapur block.

Ground Water Quality

Quality of ground water is an important factor for assessing its suitability for various uses. Ground water quality depends upon the lithological and chemical composition of the aquifer, climatic conditions, quantum of recharge made and its movement, activities of microorganisms, temperature and presence of contaminants in the environment. High Nitrate concentration viz. more than 100 mg/l (as per BIS-10500) has adverse effect on human health. High nitrate may cause infant Methaemoglobinaemia, a disease commonly known as Blue Babies that causes reduction in oxygen carrying capacity of blood. The process of high nitrate in drinking water causes Gastric cancer and adversely affect the central nervous system and cardio vascular system. High nitrate concentration (> 100mg/l) has been found in a few wells of Khandagiri (130 NO3), Jatni (117 mg/l), Balakati (104) of Khurda district.

The concentration of fluoride is within the permissible limit (1.5 mg/l) in both shallow and deeper aquifers except at few isolated pockets. At Chatu in Jatani block deeper aquifer water contains 1.67 mg/l of fluoride. In shallow zones high fluoride concentration has been noted from Balasing-Singhpur area of Bolagarh block.

High concentration of Iron in ground water gives bittersweet astringent taste making it aesthetically undesirable in colour, odour and turbidity. Intake of high dose of Iron present in ground water may result in Haemochromotosis i.e. accumulation of Iron in kidneys, lungs, liver etc. resulting in stone formation and malfunctioning of these organs. The concentration of Iron more than permissible limit (> 1.0 mg/l as per BIS 10500) have been recorded in wells from Khandagiri (2.8 mg/l), Bharatpur (2.1 mg/l), & Jagannathprasad (4.6 mg/l) in Khordha district.



Source: Ground water information booklet, Khordha, CGWB

Figure 3-12: Premonsoon water table of Khordha

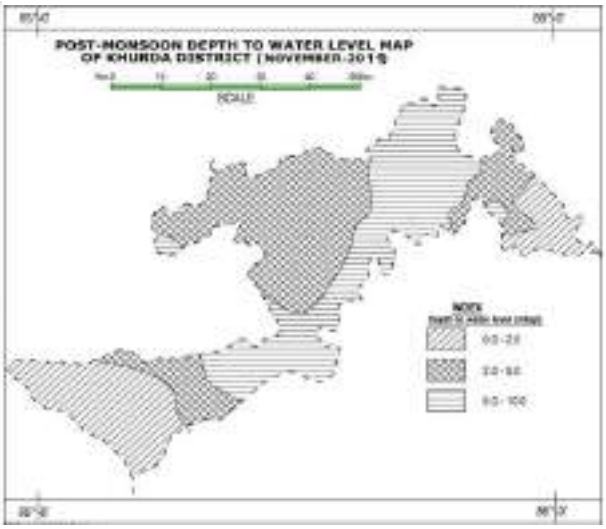
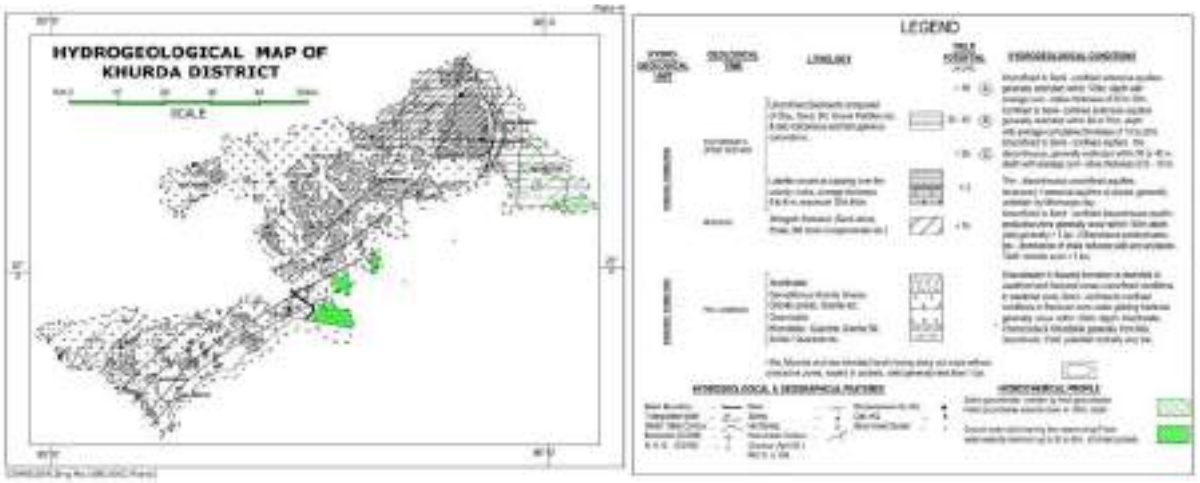


Figure 3-13: Postmonsoon water table of Khordha



Source: Ground water information booklet, Khordha, CGWB

Figure 3-14: Hydrogeological map of Khordha

Cuttack District

Drainage: The Mahanadi River along with its distributaries controls the drainage system of the district and traverses the district from west to east. In the eastern part i.e. in the deltaic plain the river Mahanadi along with its distributaries form the anatomising drainage pattern. The prominent distributaries of the river are Koakhye, Kathjuri, Chitolpala, etc.

Geomorphology & Soil Types

Physiography: Physio-graphically, the district can be divided into two distinct units i.e.-deltaic plain and lateritic uplands and hilly tract.

Lateritic uplands and hilly tract: The lateritic uplands and hilly tract is seen in the western part of the district. The Laterite upland bordering the hilly tract is characterized by moderately undulating topography and supporting some vegetation. The hilly tract consists of a series of detached hill ranges of Pre-Cambrian and upper Gondwana formation. The average altitude varies from 50 to 100 m. above msl with the maximum of 337m. above msl.

Deltaic plains: The deltaic plains occupy the eastern part of the district which is formed under the fluvial environment. The area is characterized by parallel to radial drainage pattern. It forms the most fertile part of the district.

Soil Types: Three types of soils, viz. Alfisols, Ultisols and Entisols are found in the district. As per the agroclimatic classification, the district falls under the North Eastern Coastal plain.

Alfisols: These soils can be further sub-divided in to red loamy soils, red sandy soils, older alluvial soils and deltaic alluvial soils. The red soils are found in the hilly area in the western part of the district and older alluvial soils are found in minor pockets in northern part. The deltaic soil is found in major parts of the district.

Ultisols: These include laterite and lateritic soils, which are found in pockets and characterized by compact to vescicular mass in subsoil horizon composed essentially of a mixture of the hydrated oxide of allumina and iron.

Entisols: These soils include younger alluvial soils occurring along the course of Mahanadi river mainly in western part and central part of the district. These soils are deficient in nitrogen, phosphoric acid and humus, but not in potash and lime.

Ground Water Scenario

Hydrogeology: The water bearing formation of the area can be divided into (a) Fissured formation (b) porous type.

(a) Fissured formation-The Pre-cambrian crystallines which mainly consists of granitic rocks, Khondalites and Charnockites and occupy western part of the district formed the fissured formation.

(b) Porous formation-The porous formation comprises of semi consolidated Athagarh formation, quarternary alluvium and upper tertiary sediments, and laterites in limited area. Semi consolidated Athagarh formation occurs in between hard rocks and unconsolidated formation covering the parts of Athagarh, Barang and Tangi-Choudwar blocks It is composed of mainly alternate layer of shale and sandstone. Quaternary alluvial deposits underlain by upper Tertiary sediments occupy half of the district covering the eastern part. The sand, gravel, pebbles horizons form the aquifer system in the area. Laterites occur as capping over consolidated and semi-consolidated formation. These laterites generally form the shallow aquifer and mostly tapped by dug wells.

Occurrence of ground water:

Fissured formations: Ground water in the fissured formations occurs under unconfined conditions within the weathered residuum and under semi confined to confined conditions in fractures at depth. The thickness of the weathered zone varies from negligible to 40 m. In general thickness of weathered zone is minimum in charnockite and maximum in khondalite. The weathered zone forms the shallow unconfined aquifer. Among all rock types the weathered zone as well as fractured zone in granitic rocks forms better aquifer and charnockite forms poor aquifer. In weathered formation the yield on an average varies from 20 to 22 m^3/day where as in khondalite and charnockite it is 10 to12 m^3 /day within the deeper aquifer the yield potential of granitic is better and in charnockite is very poor. The fractured granitic rock can yield upto 10 lps whereas in charnockite it is restricted to 2 lps. The fractured zones are mostly confined within 100 m depth and within this depth 2 to 3 fractures are found.

Porous formation:

Athgarh formation: In Athgarh formation sandstone mainly forms the aquifer systems. The weathered zone in sand stone extend down to a depth of 12 to 15 m. The yield of dug well in weathered zone of sandstone is around 20 to 25 m^3/day. The fractured zones are found to occur down to a depth of 100m with 2 to 4 sets of fractures and having maximum yield up to 20 lps.

Quarternary and upper Tertiary sediments: Sands, gravels and pebbles form the main aquifer systems in Quarternary alluvial deposits under lain by Tertiary sediments. Groundwater occurs under phreatic condition at shallow depth and semi confined to confined in deeper depth in these formation. At deeper depth granular zones contains both saline and fresh water in the extreme south-eastern part and also in pockets in extreme eastern and north eastern part. The shallow near surface aquifers, which are mainly exploited by, dug wells yield fresh water in the entire district. The yield of the existing dug well varies from 30 to 50 m^3/day. The average depth of these dug well is around 6 to 7 m.

Laterites: It generally forms the shallow aquifer and ground water mostly tapped by shallow dug wells. On an average the yield from dug wells in laterites, is around 25 to 30 m/day.

Shallow Aquifers: Near surface aquifer in which ground water occurs under unconfined (phreatic) condition and is mainly tapped by dug wells for ground water extraction is generally identified as shallow aquifer. The specific capacity and hydraulic conductivity in different formations are stated in table below.

Table: Specific capacity and hydraulic conductivity in different formations

Formation	Specific Capacity Index (lpm/min/m draw down)	Hydraulic conductivity (m/day)
Alluvium	1.42-3.61	4.72-13.68
Laterite	1.1-2.89	3.66-9.23
Athgarh formation	0.7-2.11	2.78-10.15
Granitic rocks	0.60-2.23	1.89-8.21
Khondalite and Charnockite, etc	0.41-0.82	1.66-3.62

Deeper Aquifers: Aquifers, which occur below the phreatic zone and extends down to a greater depth, are termed as deeper aquifers. Ground water in deeper aquifer occurs under semi-confined to confined conditions. Deeper aquifers are tapped by tube/bore wells for ground water extraction. Characteristics of deeper aquifers in different formations are presented below.

Consolidated Formation: The specific capacity values for Khondalites and Charnockites are low and generally restricted within 0.09 lps/m of drawdown and Transmissivity values are mostly within 4 m^2/day. While the specific capacity values for granitic rocks may go upto 5 lps/m of draw down. Transmissivity values range between 0.23 and 36 m^2 /day. With the average value ranging from 5 to 10 m^2/day.

Semi-Consolidated Formation: The specific capacity values in semi consolidated Athgarh formation range from 0.19 to 5.60 lps/m of drawdown and on an average Transmissivity values are mostly within 10.54 to28.76 m^2/day.

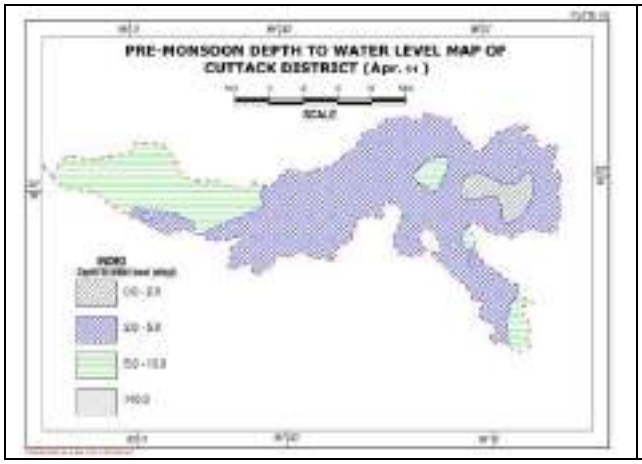
Unconsolidated Formation: The specific capacity values in unconsolidated formation range from 1.46 to 20.2 lps/m of drawdown and Transmissivity values range from198.16 to 8254 m^2/day. with the average value ranging from 1000 to 2000 m^2/day. Storativity values calculated from two exploratory wells at Kantapara and Madhab of Niali block were 8.34 X 10-4 and 2.11 X 10-4 respectively indicating semi confined to confined conditions of aquifer.

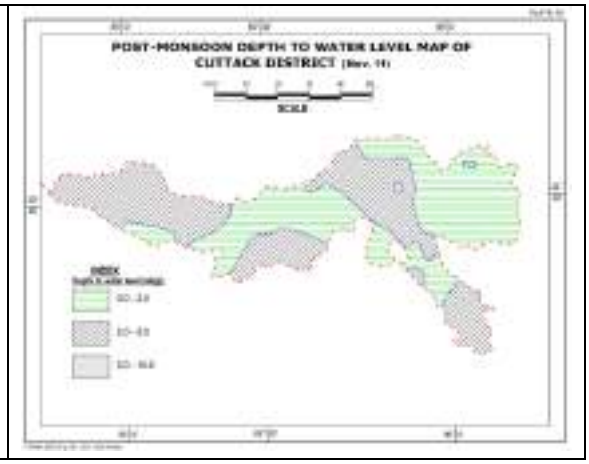
Depth to water level (Pre & post monsoon 2011): The pre and post monsoon depth to water levels in the district range from 1.56 m to 8.17m below ground level and 0.44 to 5.38 m below ground level respectively. It is observed that during pre-monsoon about 80% of the total area show the water level varying between 2 to 5m below ground level and the rest part of the area lying towards the left has the water level between 5 to 10 m below ground level. Water level within 2 m. is found in localised patches around the Bahugram and Jagatpur. During post monsoon nearly 50% of the area has water levels within 2m. While the rest 50% has between 2 to 5m below ground levels.

Seasonal Fluctuation: The seasonal fluctuation of water levels with respect to pre and post monsoon periods (2011) varies from zero to 4.85m. The depth to water levels in different seasons and seasonal fluctuation of water levels are more in western part, which gradually decreases towards east.

Ground Water Resources: As per the ground water resources assessed during 2009, the total annual replenishable ground water resources in the district is 70646 ham. About 23674 ham is reserved for domestic and industrial uses. The available ground water resource for irrigation in net terms is around 7175 ham. The present level of ground water development is only 33.51% in the district with the maximum in Tigiria block with 52.89% and minimum in Tangi-Choudwar block 19.88%. Hence the district as well as all the blocks come under the white category.

Ground water Quality: In general, chemical quality of ground water both from shallow and deeper aquifers are good and fit for both domestic and irrigation purposes except in fewer isolated pockets of alluvium where the deeper aquifer has the salinity problem. These patches are restricted to south-east and extremes eastern part of the district.



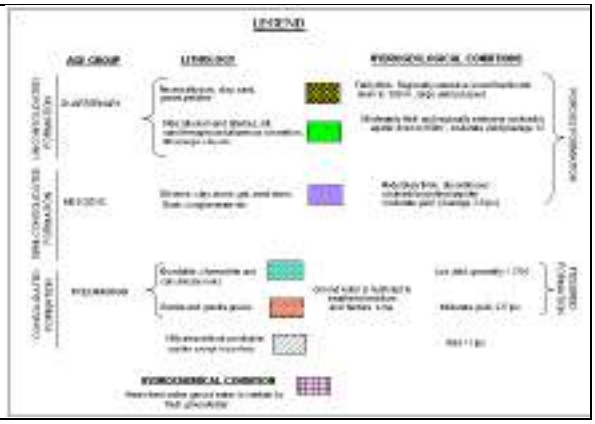


Source: Ground water information booklet, Cuttack, CGWB

Figure 3-15: Premonsoon water table of Cuttack **Figure 3-16: Postmonsoon water table of Cuttack**

Suitability of Ground Water for Drinking Purpose: The concentration of major chemical constituents and also the pollutants like fluoride and nitrate content in fresh ground water of shallow and deeper aquifers are well within permissible limit of drinking water specification. Hence the fresh ground water may be used as safe drinking water source.

Suitability of Ground Water for Agricultural Purpose: Ground water in general is suitable for irrigation purpose. However, in local pockets like Tigiria and Gopalpur where water occurs in shallow and deeper aquifer respectively belong to low alkaline and medium to high salinity class.



Source: Ground water information booklet, Cuttack, CGWB

Figure 3-17: Hydrogeological map of Cuttack district

Dhenkanal District:

Drainage: The river Brahmani controls the drainage of the district and it's tributaries. Brahmani is the second longest river in Orissa and flows through the district in a general east-west direction. It divides the district into two halves. Initially, the river flows in a north-south direction, then follows a northwest-southeast course and subsequently changes to northeast-southwest direction. Finally, it changes to a northwest-southeast course near the eastern border of the district. Most part of the district falls within It's basin. The Brahmani is perennial in nature with a nominal flow during the summer season. Its important tributaries are Ramiala Nadi, Nigre Nadi, Purajhor Nadi etc. The smaller streams show dendritic pattern while the major river and its tributaries show sub-parallel drainage, indicating structural control.

Geomorphology & Soil Types: The district can be broadly divided into four natural physiographic units. These comprise of (i) Southern Mountainous Region, (ii) Eastern Valley and Plain, (iii) Central Undulating Plain and the (iv) Northern Mountainous Region.

The Southern Mountainous Region comprises of hill ranges trending NNW-ESE and is covered by part of Hindol block of Hindol sub-division and also parts of Dhenkanal, Odopada and Gondia blocks of the Dhenkanal sub-division. The elevation varies from 60 m to 971 m above MSL. These hill ranges from the water divide between the Mahanadi and Brahmani basins. The hill slopes are covered with moderate to dense forest.

The Eastern Valley and Plain occurs as small strips along the curves of the river Brahmani and its tributaries. Residual hills and ridges are the characteristics of the area. The elevation varies from 40 m to 630 m above MSL.

The Central Undulating Plain spreads over Parjang block of the Kamakhyanagar sub-division. The area is characterized by undulating to broad flat topography with low-lying hills having flat top.

The Northern Mountainous Region covers the Kankadahad, Bhuban and Kamakhyanagar block of Kamakhyanagar sub-division. This terrain is covered with dense forest. Broad valleys and low-lying hilly regions separate the hills.

The distribution of different soil types in the district depends much on its physiographic and lithological variation. Based on the physical and chemical characteristics, mode of original occurrence, soils of the district are classified into three types, namely Alfisols, Ultisols and Entisols.

Alfisols: The main part of the district is covered by this type of soils, which include red sandy soil, red loamy soil, red gravelly and old alluvial soils. The red soil is constricted textured, usually devoid of concretions and is also free of carbonates. It is usually deficient in nitrogen, phosphate, organic matter and lime. Adoption of proper irrigation practices makes it suitable for cultivation of paddy and other crops varieties.

Ultisols: These include lateritic soil found as patches in northern, eastern and central part of the district. The laterite and lateritic soil are characterized by a compact to vesicular mass in the sub-soil horizon, composed essentially of a mixture of hydrated oxides of aluminium and iron. The peculiar granular condition of the soil makes it suitable for cultivation immediately after heavy rain.

Entisols: These are younger alluvial soils, found along the Mahanadi river in the eastern part of the district. It contains high amount of iron, Calcium and Magnesium. It is lacking in organic matter, nitrogen and phosphorous but rich in potash and lime. pH of the soil varies from normal to alkaline.

The texture varies from sandy to loamy sand. It is fertile and crops grown are generally paddy, cotton, wheat, sugarcane, banana, tobacco and chilli.

Groundwater Scenario

Hydrogeology: The geological set-up of the area, to a large extent, governs the occurrence as well as the movement of groundwater in the district. The major part of the district is underlain by hard crystalline rocks and is devoid of any primary porosity and hence when weathered and fractured, secondary porosity is developed.

The semi-consolidated Gondwana sandstone forms moderately good aquifer, when weathered and fractured. The recent alluvium, which occurs in limited patches, sustains very good yield. Since major part of the district is underlain by hard rocks of diverse lithological compositions and structures, the water-bearing properties of the formations vary widely. Hydrogeological surveys reveal the lithological characteristics and the role of the tectonic deformation thus resulting deep-seated intersecting fractures, on the occurrence and distribution of groundwater reservoirs and their water-bearing as well as water-yielding properties. Groundwater occurs under water table condition in recent alluvium as well as in the semi-consolidated formations whereas in the deeper fractured rocks, the groundwater occurs under semi-confined to confined condition. Depending on the different aquifer systems and their parameters in different litho units, the major hydrogeological units can be divided into three categories: i) Consolidated formations, ii) Semi-consolidated formations and iii) Un-consolidated formations.

Water-bearing properties of the Consolidated Formations: The crystalline rocks like granite, granite gneiss, khondalite etc. that comprise most part of the district is devoid of any primary porosity. But the process of weathering and fracturing imparts secondary porosity in these rocks, permit storage and transmission of groundwater. The thickness of the weathered zone is usually more in the topographic lows and undulating plains than in the highlands. Groundwater occurs under water table condition in the weathered zone and under semi-confined to confined condition in the deeper fractured zones. The water yielding capacity of the fractured rocks largely depends on the degree of fracturing, their horizontal extent as well as their interconnection.

Aquifer System and Aquifer Parameters of the Different Lithospheres:

Granite and Granite Gneiss: Major parts in the district are occupied by the granite, granite gneiss that are highly weathered and fractured. The thickness of the weathered zone varies from 5 m to 20 m, which form the repository of groundwater at shallow depth. Groundwater occurs under phreatic condition in this zone and can be developed through dug wells. The depth of dug wells varies from 4.5 m to 14.0 m and the water level varies from 1.26 to 13.70 m below ground level during premonsoon and from 0.60 to 12.50m below ground level during post-monsoon period.

The deep bore wells yield up to 12.0 litre per second depending upon the topographic setting, proximity to major lineaments, thickness of weathered zone and number as well as potential of saturated fracture zones. The result of shallow deposit wells constructed by CGWB in this district indicates that weathered as well as semi-weathered granite gneiss form moderately potential aquifer.

Khondalite: These rocks are restricted to higher elevations forming steep linear ridges and hence groundwater potential is limited although foliated nature of the rock facilitates deep weathering. In pediment areas, the thickness of the weathering varies widely. The average depth of dug wells is about 10 m. The water level varies from 7.0 to 8.0 m below ground level during pre-monsoon and from 3.0 to 6.0 m below ground level during post-monsoon period.

Water-bearing Properties of the Semi-Consolidated Formations

These are represented by rocks of Gondwana formation, which have faulted contact with the Pre-Cambrian rocks. It consists mainly of sandstone and shale. The friable and loosely cemented sandstone forms the aquifer. Ground water occurs in pheratic condition in the weathered zone and semi-confined to confined condition in deeper fractured and friable sandstone beds. The aquifer in these formations may sustain limited to moderate yield. Auto-flowing condition has been encountered at Kumuda.

The average depth of dug wells in these formations range from 7.40 m to 8.60 m bgl. The depth of wells drilled by CGWB varies from 28.24 m (Kusponga) to 289.0 m (Kumuda) and the yield ranges from 0.50 to 12.0 litres per second.

Water-bearing Properties of the Un-Consolidated Formations

Laterites and alluvium of Sub-Recent to Recent age constitute the unconsolidated formations which occur as thin, discontinuous patches adjoining the rivers. Laterites occur as capping over the older formations and tapped through dug wells. The depth to water level ranges from 3.34m to 10.12 m bgl during pre-monsoon and from 0.97 to 6.87 m bgl. during post monsoon period. The thickness of alluvium is about 25 m and form shallow potential aquifer. The aquifer sustains moderate yield. Recent alluvium occurs in thin, discontinuous patches as valley fills and also along the course of major rivers and streams.

Aquifer Characteristics of Crystalline Rocks

In the hard crystalline rocks, the recharge of ground water from precipitation or seepage from surface water bodies percolate into the weathered and semi-weathered (Saprolite) zone.

The presence of fractures in the basement rock, which open up to the overlain saprolite zone facilitates downward percolation and movement of the water, which can be tapped through dug wells in the weathered and semi-weathered zone and through bore wells in the deeper horizons. At places, confined condition gives rise auto flowing wells (Kumuda). The groundwater potential of various zones i.e. saprolite (tapped through dug wells), weathered basement rock and shallow fractured rocks (tapped mostly through hand pumps) and deeper fractured rock (tapped through deep bore wells) vary considerably depending upon their lithological and structural characteristics. By conducting pumping tests both in dug wells and in bore wells in different litho-units and by analysing the data adopting various methods, it has been concluded that granite gneiss forms the most potential aquifer followed by khondalites. Yield is poor in Gondwana sediments in deeper horizons whereas moderate yield can be obtained in the weathered zone. But the un-consolidated alluvium forms the most prolific aquifer.

Ground Water Exploration: The depth range of these wells varies from 70 to 200 m and the yield of these wells varies from negligible to 5.9 lps.

Depth to Water Level: (Pre-monsoon and Post- monsoon), 2011: The depth to water level is measured from the National Hydrograph Stations and the water level data varies 3.34m to 10.99m bgl in pre monsoon. The post monsoon, 2011 water level data varies 1.08 to 8.0 m bgl.

Ground Water Resources: The net annual replenishable ground water resources in the district has been computed as 44264 ha. m, out of which the Ground Water Draft for irrigation is 2745 ha. m. The ground water draft for irrigation is through dug wells and shallow tube wells. A large number of hand pumps, fitted in PHED bore wells and tube wells, also cater to the rural and urban water supply needs. Presently, the ground water development in the district has been meagre and all the blocks fall under

the safe category. The stage of ground water development varies from 13.55% to 39.55% in different blocks. The overall stage of ground water development of the district is 16.82%. Hence, there is ample scope for stepping up ground water development in the district.

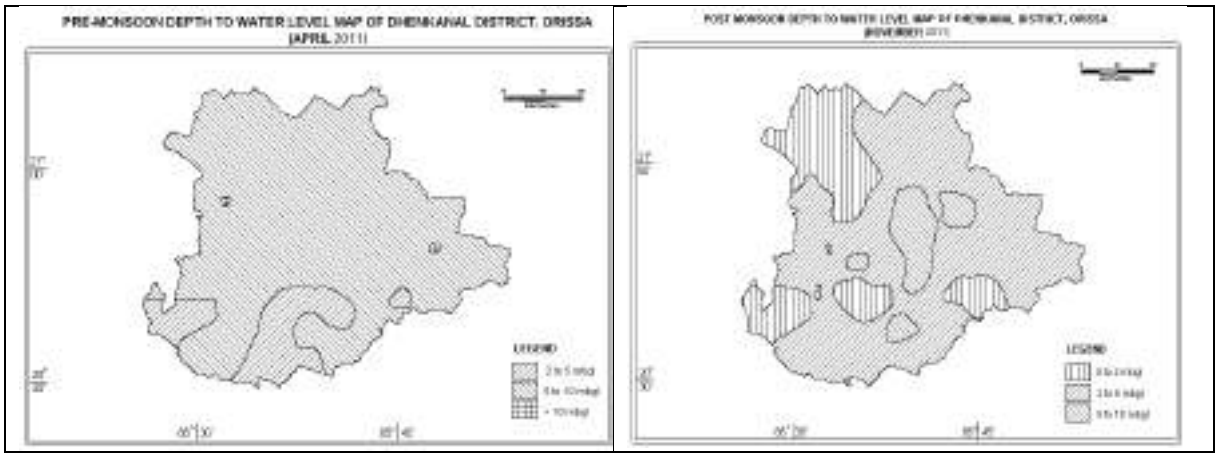
Ground Water Quality

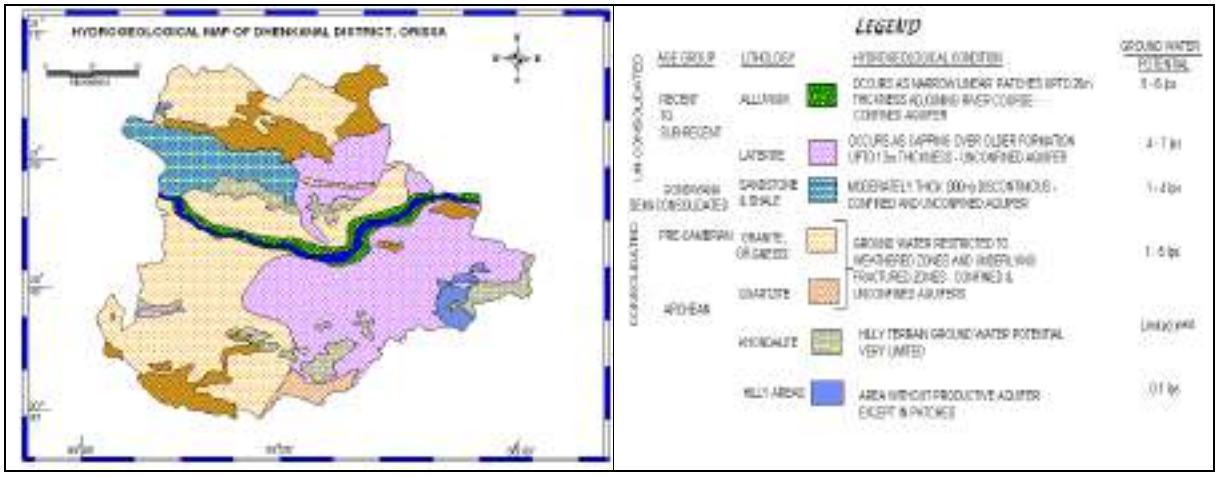
The quality of ground water in the district has been assessed on the basis of ground water samples collected during ground water monitoring, hydrogeological surveys and ground water exploration by CGWB. The range of different ground water components in shallow as well as in deeper aquifers is as under:

Sl. No	Chemical Constituents	Range in	
		Shallow aquifer	Deeper aquifer
1	pH	7.60-8.56	7.38-8.24
2	Ec	127-790	147-422
3	F	0.19-1.20	0.12-0.49
4	Ca	20-78	14-50
5	Mg	16-44	2.4-50
6	Na	14-48	1.5-33
7	K	1.4-3.5	<1-53
8	Cl	11-67	7.1-53
9	SO_4	1.7-68	0.90-7.80
10	NO_3	2.6-36	0.20-36
11	HCO_3	24-348	24-238

As has been observed from the analysed data the quality of ground water from both the shallow as well as deeper aquifers are well within the permissible limit for drinking as well as for irrigation purposes.

Ground Water Related Issues and Problems: Ground Water Problems include water pollution, water level depletion and also in some case water logging. Permanent water logging condition does not exist in the district. During pre-monsoon period depth to water level remains greater than 2 m throughout the district, even in canal command areas. Water table depletion is not pronounced in the district. It is also observed that almost all chemical constituents are well within the permissible limits for drinking as well as irrigational purposes.





Source: Ground water information booklet, Dhenkanal, CGWB

Figure 3-18: Premonsoon, Post-monsoon water table and Hydrogeological map of Dhenkanal

❖ Air Environment

Air pollution means the presence in the outdoor atmosphere of one or more contaminants or combinations thereof in such quantities and of such duration as are or may tend to be injurious to human, plant or animal life or property. The assessment of air environment involves the collection and analysis of baseline air quality data in the project area, assessing the existing levels of pollutants such as particulate matter (PM), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), and volatile organic compounds (VOCs). With forthcoming construction activities, a range of different pollutants are released into the atmosphere that are dispersed and have a significant impact on neighbourhood air environment. Thus collection of base line data of air environment occupies a predominant role in the impact assessment statement. The ambient air quality status across the study zone forms basis for prediction of the impacts due to the project.

Detailed studies were carried out at five specific locations in the proposed alignment to ascertain the air quality in the areas along the proposed highway. Air sampling was done at each location using a high-volume air sampler (HVS) and fine dust sampler. The details of selected sampling locations are given in the following table.

Table 3-9: Details of sampling locations for Ambient Air Quality monitoring

Parameters	Location Code	Location	Coordinates	
			Latitude (N)	Longitude (E)
Ambient Air	AAQ-1	Bagheiput	20° 1'58.00"	85°31'8.40"
	AAQ-2	Madhapur	20° 6'49.77"	85°31'59.86"
	AAQ-3	Lokanathpur	20°13'9.22"	85°31'32.18"
	AAQ-4	Padanpur	20°18'52.67"	85°34'45.25"
	AAQ-5	Sahangagopalpur	20°25'28.74"	85°34'25.78"
	AAQ-6	Dhenkanal	20°32'2.94"	85°35'50.27"
	AAQ-7	Siaria	20°36'8.60"	85°38'25.26"

The collected samples were analyzed as per guidelines set in IS:5182. The summarized results of main parameters namely PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3 and CO, pertaining to the AAQ of the selected regions of the proposed alignment are given in Table 3-11.

Table 3-10: Ambient Air Quality (AAQ) at selected sampling locations of proposed alignment

S. No.	Location code	Results					
		PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	CO (mg/m^3)	O_3 ($\mu g/m^3$)
1	AAQ-1	75	42	12	18	0.9	26
2	AAQ-2	67	40	13	18	0.5	24
3	AAQ-3	71	36	12	16	0.6	26
4	AAQ-4	71	40	13	16.9	0.5	24
5	AAQ-5	69	36	13	19	0.9	27
6	AAQ-6	71	43	18	16	0.5	26
7	AAQ-7	68	39	12	19	0.6	26
8	Average	70.29	39.43	13.29	17.56	0.64	25.57
9	**Permissible Limits as per CPCB guidelines**	**100**	**60**	**80**	**80**	**4**	**180**

Source: AGSS Laboratory

The following graph represents the concentration of air quality parameters at all the sampling locations of the proposed alignment.

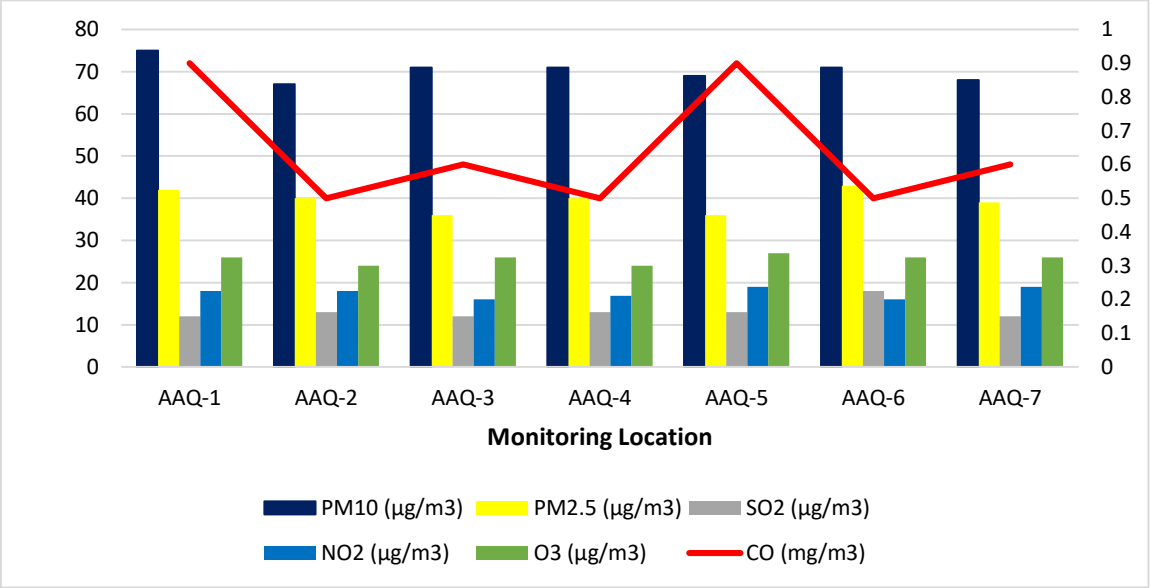


Figure 3-19: Results of AAQ parameters at sampling locations of Proposed Alignment

As it is evident from the table and graphs, that, in absence of any major pollution source, the baseline parameters of the AAQ of the project area are below the permissible limits set by the National Ambient Air Quality Standards (NAAQS) (**Annexure 3-4**) indicating the overall air quality appears suitable for the majority of environmental and public health purposes. In the proposed alignment, PM_{10} varies between 67-75 $\mu g/m^3$, $PM_{2.5}$ ranges within 36-42 $\mu g/m^3$. The concentration of SO_2, NO_2, O_3 and CO ranges between 12-18 $\mu g/m^3$, 16-19 $\mu g/m^3$, 24-27 $\mu g/m^3$ and 0.5-0.9 $\mu g/m^3$ respectively.

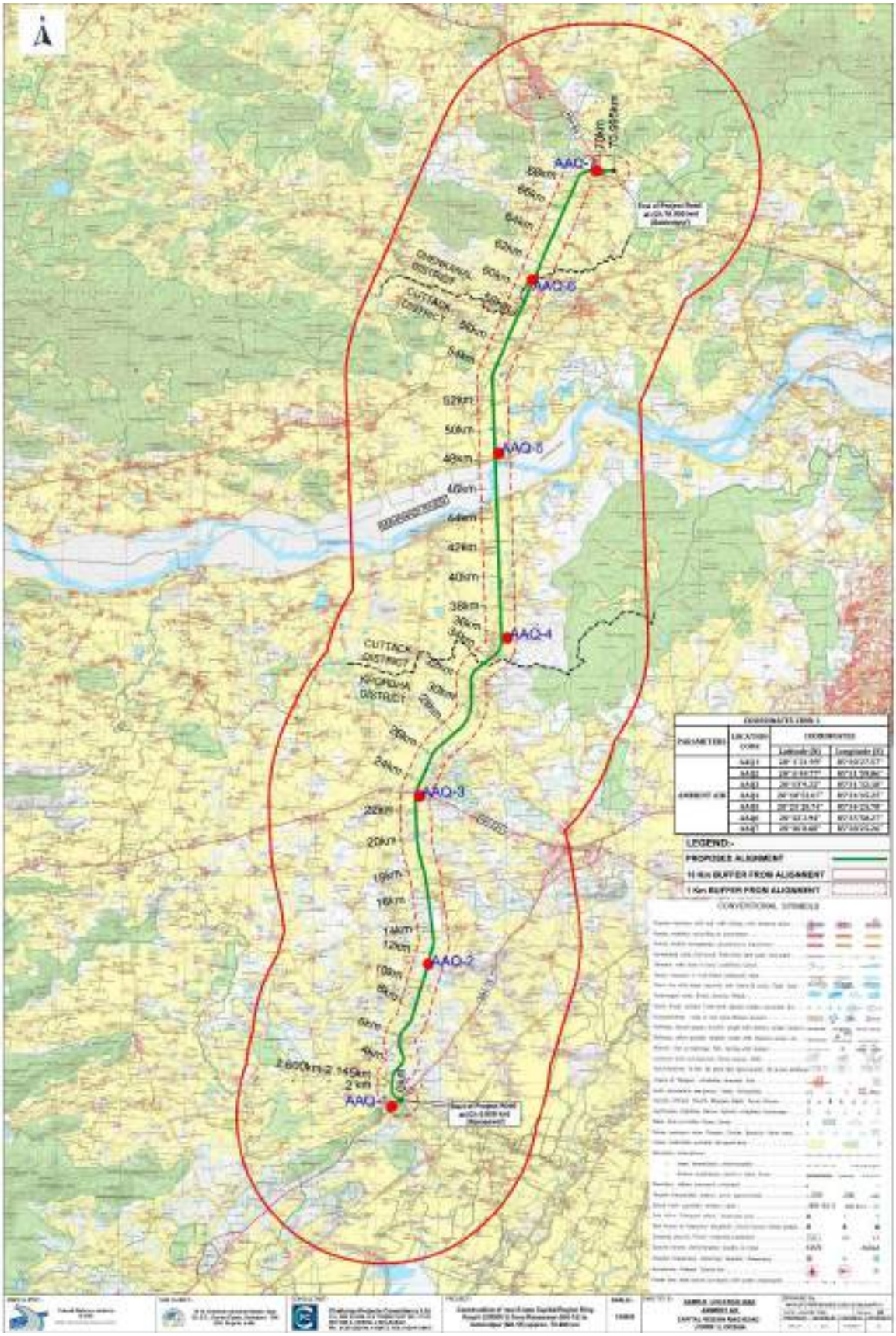


Figure 3-20: Sampling locations for ambient air quality (AAQ) of proposed alignment

Figure 3-21: Air sampling at various locations in proposed alignment

❖ Water Resources

Water resources play a vital role in any developmental project, specifically in the construction phase. That is why any such project should aim towards sustainable use of these resources for their benefit, without severely hampering the same. The baseline status of water resources gives an insight about the condition of the region under consideration, and may help policy makers and stakeholders to

ascertain the impact that the developmental project may have on the existing resources, and effectively mitigate these impacts.

Rainfall and drainage pattern

Most of the surface flows of the rivers in Odisha occur during the monsoon season from the middle of June to October. Further, the availability of water varies from place to place and is not spread uniformly over the State of Odisha, creating pockets of scarcity. Due to the paucity of surface water, particularly in the lean period, taping of groundwater becomes imperative. About 78% of the total annual rainfall occurs during the period from June to October and the balance is 22% in the remaining period from October to May. In addition to seasonal availability, the rainfall in the State also shows spatial variation, i.e., from about 1200 mm in the southern coastal plain to about 1700 mm in the northern plateau. The long-term average annual rainfall in the State is of the order of 1452 mm, which corresponds to an annual precipitation of about 230.76 billion cubic meters (BCM) of water. Out of the total precipitation, a part is lost by evaporation & transpiration, a part goes towards increasing ground water storage, and the remaining appears as surface runoff. The ground water reserve and surface runoff constitute the water resources of the State.

The important river systems in Odisha are Mahanadi, Brahmani, Baitarani, Subarnarekha, and Rushikulya, which flow eastward into the Bay of Bengal. There are twelve major rivers flowing in the State, of which the Mahanadi is the longest, and the Bahuda is the shortest. The coastal rivers drain into the sea near the delta of the east coast. Many of these are non-perennial and are rainfed, and fluctuate in volume. The hydrology map of the alignment with 10 km radius marked is given in the following Figure 3-6.

Drainage pattern of project districts

Khordha district: The district is drained by a number of streams which are mostly tributaries and distributaries of the river Mahanadi and a few other streams discharging in to lake Chilika. The important distributaries of Mahanadi are the Kuakhai, Bhargabi, Kushabhadra and the Daya River. The tributaries of the Mahanadi are the Ran and Kalijiri. The streams draining the southern parts of the district are Sulia, Kharia and the Kusumi. All the streams are ephemeral and effluent in nature. Chilika, the largest salt water lake of India is situated in the southeastern part of the district.

Cuttack district: The river Mahanadi and its distributaries and also tributaries control the drainage system of the district. The Mahanadi river traverses the district from west to east. In the eastern part of the district is the deltaic plains the Mahanadi river and its distributaries form the anatomizing drainage pattern and among the distributaries Birupa, Koakhye, Katjhuri, Chitropal are prominent.

Dhenkanal district: The river Brahmani controls the drainage of the district and its tributaries. Brahmani is the second longest river in Orissa and flows through the district in a general east-west direction. It divides the district into two halves. Initially, the river flows in a north-south direction, then follows a northwest-southeast course and subsequently changes to northeast-southwest direction. Finally, it changes to a northwest-southeast course near the eastern border of the district. Most part

of the district falls within It's basin. The Brahmani is perennial in nature with a nominal flow during the summer season. Its important tributaries are Ramiala Nadi, Nigre Nadi, Purajhor Nadi etc.

Groundwater Quality

Groundwater is the most preferred source of water in various user sectors in India on account of its near universal availability, dependability and low capital cost. Ground water is the source for more than 85 percent of India's rural domestic water requirements, 50% of its urban water requirements and more than 50% of its irrigation requirements and the state of Odisha is no exception. Ground water is annually replenishable resource but its availability is non-uniform in space and time. Odisha being an agrarian State, there is a lot of dependence on bore well / Tube well irrigation. This makes the ground water table recede to a great extent.

Hence, the sustainable development of ground water resources warrants precise quantitative as well as qualitative assessment based on the reasonably valid scientific principles.

Keeping in view the sustainable use of the groundwater resources, baseline groundwater quality along the project stretch was estimated by sampling and consequently analyzing groundwater for various chemical as well as biological parameters at seven (7) locations of the proposed alignment, whose details are given in the following table.

Table 3-11: Groundwater Quality Monitoring locations

Parameters	Location Code	Location	Coordinates	
			Latitude	Longitude
Ground Water	GW-1	Bagheiput	20° 1'58.00"	85°31'8.40"
	GW-2	Madhapur	20° 6'49.77"	85°31'59.86"
	GW-3	Lokanathpur	20°13'9.22"	85°31'32.18"
	GW-4	Padanpur	20°18'52.67"	85°34'45.25"
	GW-5	Sahangagopalpur	20°25'28.74"	85°34'25.78"
	GW-6	Dhenkanal	20°32'2.94"	85°35'50.27"
	GW-7	Siaria	20°36'8.60"	85°38'25.26"

Five liter of sample was collected from each location and transferred aseptically to laboratory for analysis as per guidelines set in various IS codes. The results were compared with standards set in IS:10500. The list of parameters that were analyzed is given below:

Table 3-12: List of parameters analyzed from Groundwater sample

S. No.	Parameters analyzed	S. No.	Parameters analyzed
1	Colour, Hazen	**Metal Analysis (mg/l):**	
2	Odour	22	Manganese (as Mg)
3	pH Value	23	Copper (as Cu)
4	Turbidity, NTU	24	Cadmium (as Cd)
5	Taste	25	Iron (as Fe)
6	Total Dissolved Solids, mg/l	26	Aluminium (as Al)
7	Calcium (as Ca), mg/l	27	Arsenic (as Ar)
8	Magnesium (as Mg), mg/l	28	Lead (as Pb)

9	Fluoride (as F), mg/l	29	Silver (as Ag)
10	Chloride (as Cl), mg/l	30	Zinc (as Zn)
11	Cyanide (as CN), mg/l	31	Chromium (as Cr)
12	Nitrate (as NO_3), mg/l	32	Mercury (as Hg)
13	Phenolic Compounds (as C_6H_5OH), mg/l	33	Boron (as B)
14	Sulphate (as SO_4), mg/l	34	Selenium (as Se)
15	Residual free Chlorine, mg/l	35	Barium (as Ba)
16	Ammonia (as Total Ammonia-N), mg/l	36	Nickel (as Ni)
17	Sulphide (as H_2S), mg/l	37	Molybdenum (as Mo)
18	Total Alkalinity (as CaCo3), mg/l	38	Mineral Oil (mg/l)
19	Total Hardness (as CaCo3), mg/l	**Microbiological Analysis (per 100ml)**	
20	Chloramine (as Cl2), mg/l	39	Coliform
21	Anionic detergents (as MBAS), mg/l	40	E. coli

Source: AGSS Laboratory

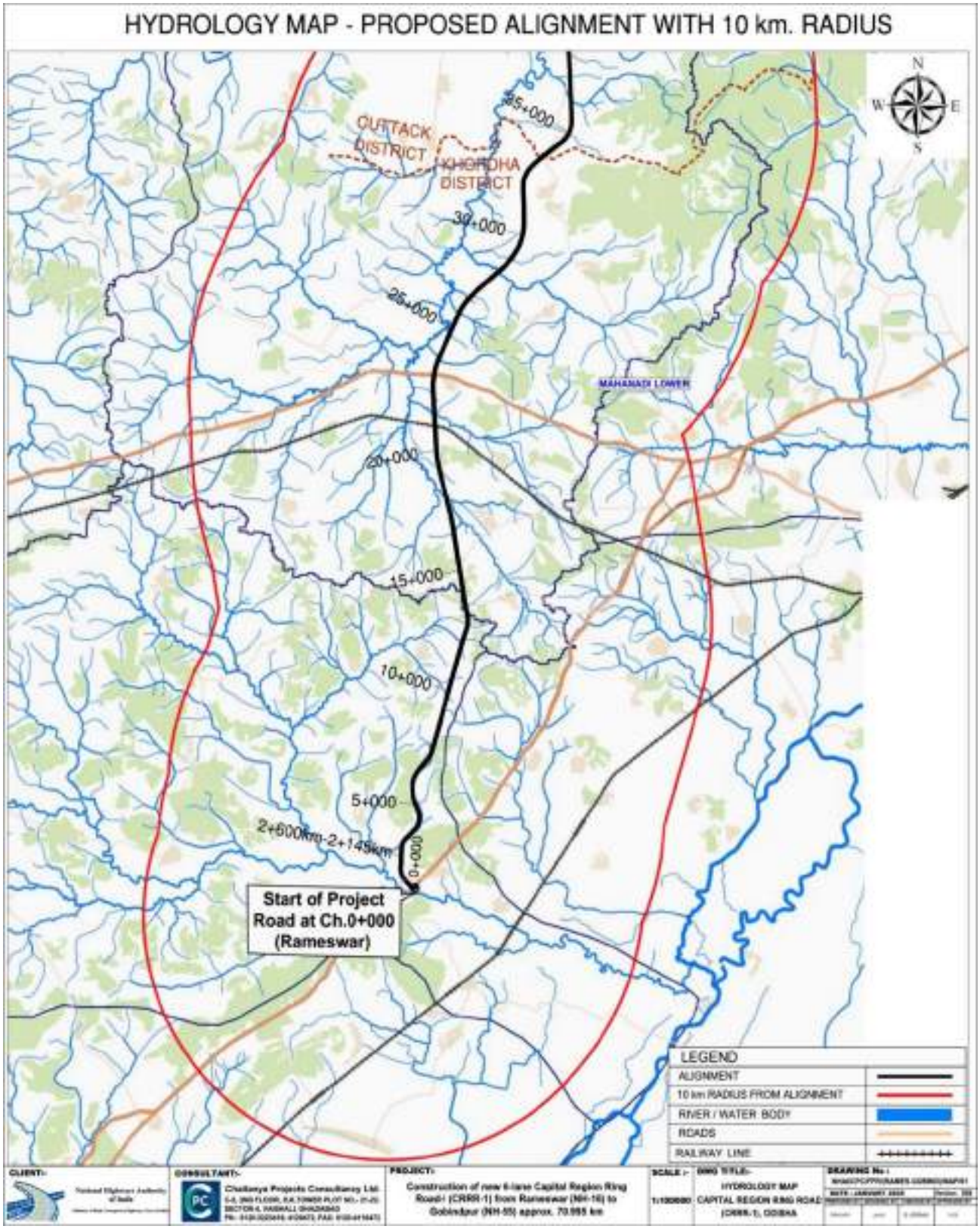
Table 3-13: Results of baseline groundwater quality parameters in the proposed alignment

Parameters	Unit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	Standard as per IS 10500:2012	
									Acceptabe limits	Permissible limits
Colour	Hazen	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5 Max	15 Max
Odour	-	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able
pH	-	7.63	7.45	7.45	7.45	7.45	6.69	7.39	6.5-8.5	No Relation
Turbidity	NTU	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0 Max	5.0 Max
Taste	-	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able
Total Dissolved Solids	mg/l	395	306	298	415	392	316	265	500 Max	2000 Max
Calcium (as Ca)	mg/l	31.3	52	29	49	32	59	52	75 Max	200 Max
Magnesium (as Mg)	mg/l	11.3	9.4	12.7	10.3	18.4	7.6	13.6	30 Max	100 Max
Fluoride (as F)	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0 Max	1.5 Max
Chloride (as Cl)	mg/l	53.98	102	39	92	64	129	39	250 Max	1000 Max
Nitrate (as NO3)	mg/l	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	45 Max	No Relation
Sulphate (as SO4)	mg/l	12.49	29	36	29	11.9	89	56	200 Max	400 Max
Total Alkalinity (as HCO3)	mg/l	190	126	105	136	132	129	136	200 Max	600 Max
Total Hardness (as CaCO3)	mg/l	125	169	125	165	1256	179	186	200 Max	600 Max
Copper (as Cu)	mg/l	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	0.05 Max	1.5 Max
Cadmium (as Cd)	mg/l	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	0.003 Max	No Relation
Iron (as Fe)	mg/l	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	0.3 Max	No Relation

Arsenic (as As)	mg/l	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	0.01 Max	0.05 Max
Zinc (as Zn)	mg/l	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	5 Max	15 Max
Mercury (as Hg)	mg/l	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	0.001 Max	No Relation
Nickel (as Ni)	mg/l	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	0.02 Max	No Relation
Mineral Oil	mg/l	BLQ (0.5)	BLQ (0.5)	BLQ (0.5)	BLQ (0.5)	BLQ (0.5)	BLQ (0.5)	BLQ (0.5)	0.5 Max	No Relation

Source: AGSS Laboratory

Figure 3-22: Groundwater sampling at various locations


HYDROLOGY MAP - PROPOSED ALIGNMENT WITH 10 km. RADIUS
CUTTACK DISTRICT
KHORDHA DISTRICT
35+000
30+000
25+000
20+000
15+000
10+000
5+000
0+000
2+600km-2+145km
MAHANADI LOWER
Start of Project Road at Ch.0+000 (Rameswar)
N
S
E
W
LEGEND
ALIGNMENT
10 km RADIUS FROM ALIGNMENT
RIVER / WATER BODY
ROADS
RAILWAY LINE
CLIENT:-
CONSULTANT:-
PROJECT:-
Construction of new 6-lane Capital Region Ring Road-I (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) approx. 70.955 km
SCALE :-
1:100000
DWG TITLE:-
HYDROLOGY MAP
CAPITAL REGION RING ROAD (CRRR-1), ODISHA
DRAWING No :-

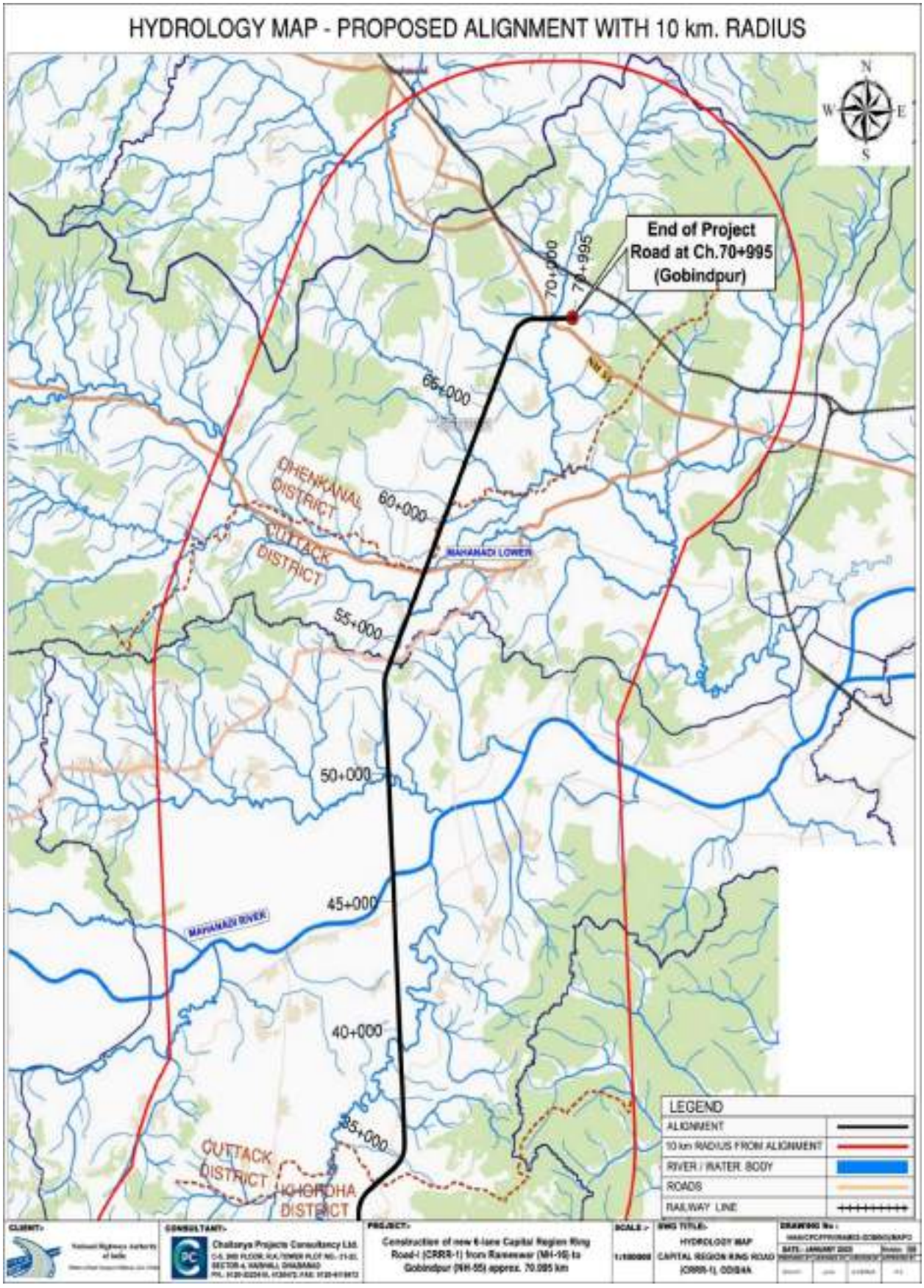


Figure 3-23: Hydrological Map of proposed alignment (Source: Bhuvan, ISRO, GoI)

Among these parameters, the following results were general to all the sampling locations:

- Colour was <5 hazen units (acceptable limit as per IS:10500) at all locations.
- Odour was agreeable at all locations as per IS:10500.
- Taste was found to be agreeable at all locations, as per IS:10500.
- All the metals (like Mn, Cu, Fe, As and Hg etc.) and all pesticide residues (like DDT, DDE and HCH etc.) were found below level of quantification and also found well below the standards as per IS:10500.
- Microbiological parameters such as Coliform and E. coli were found to be absent at all locations (analyzed as per IS: 15185:2016).

Apart from the above-mentioned general results, some particular parameters showed varied results after analysis, whose summarized results are given in the following figure.

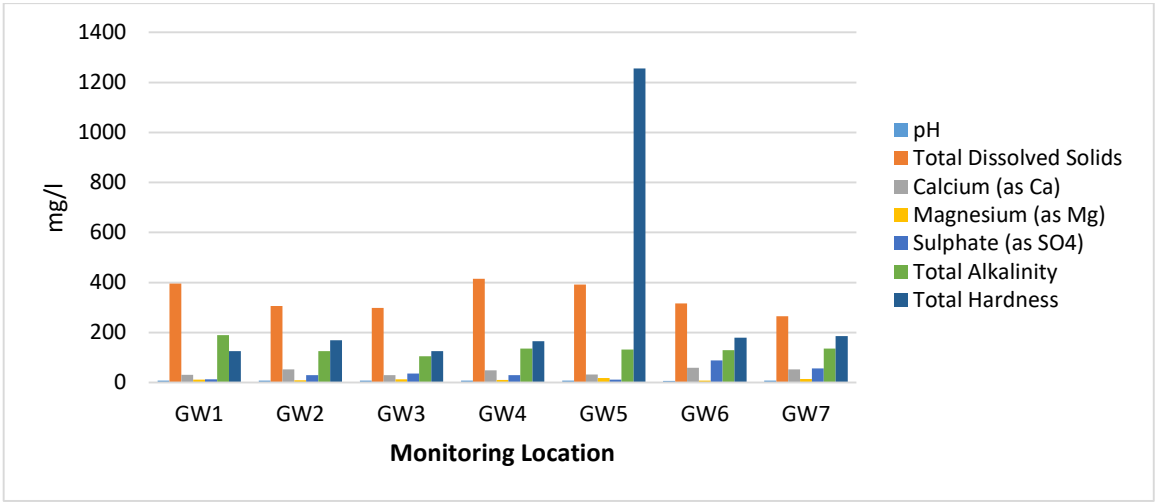


Figure 3-24: Ground water parameters for various locations of proposed alignment

From the analysis results of various parameters of Groundwater given in the above table and the graph, it is clear that the parameters at most of the locations along the proposed highway are well within the permissible limits as prescribed in IS:10500. The pH ranges from 6.69-7.63, Total Dissolved Solids are found within 265-415 mg/l. The concentrations of Iron, Calcium, Magnesium, Sulphate, Fluoride, Total Alkalinity, Total Hardness were found to be within ranges BLQ (0.1) mg/l, 29-59 mg/l, 7.6-18.4 mg/l, 11.9-89 mg/l, <0.1 mg/l, 105-190 mg/l, 125-1256 mg/l, respectively.

Surface Water Quality

Mahanadi and Brahmani are the major rivers of the project districts, however, no river is crossing the proposed alignment. There are some streams and nalahs lying within the proposed stretch of the highway, where minor bridges and culverts are proposed to be constructed. The details of available surface water resources that the proposed alignment is crossing is given in Chapter-4 (Anticipated Environmental Impacts and Mitigation Measures). Conservation of these water resources as well as maintaining their baseline quality are of utmost importance to maintain the natural characteristics of the local environment.

To assess the baseline status with respect to quality of the surface water resources, 5 litre of sample was collected from five (5) sampling locations and transferred aseptically to laboratory for analysis as

per guidelines set in IS:3025 and compared with standards set in IS:10500. The details of sampling locations are given below:

Table 3-14: Surface water sampling locations

Parameters	Location Code	Location	Coordinates	
			Latitude	Longitude
Surface Water	SW-1	Bagheiput	20° 1'38.81"	85°30'48.54"
	SW-2	Madhapur	20° 6'49.77"	85°31'59.86"
	SW-3	Lokanathpur	20°13'9.22"	85°31'32.18"
	SW-4	Padanpur	20°18'52.67"	85°34'45.25"
	SW-5	Sahangagopalpur	20°25'28.74"	85°34'25.78"
	SW-6	Dhenkanal	20°32'2.94"	85°35'50.27"
	SW-7	Siaria	20°36'8.60"	85°38'25.26"

The list of parameters that were analyzed is given in the following table.

Table 3-15: List of parameters analyzed from Surface water sample

S. No.	Parameters analyzed	S. No.	Parameters analyzed
1	Colour, Hazen	22	DO, mg/l
2	Odour	23	BOD, mg/l
3	pH Value	**Metal Analysis (mg/l):**	
4	Turbidity, NTU	24	Manganese (as Mg)
5	Taste	25	Copper (as Cu)
6	Total Dissolved Solids	26	Cadmium (as Cd)
7	Calcium (as Ca), mg/l	27	Iron (as Fe)
8	Magnesium (as Mg), mg/l	28	Aluminium (as Al)
9	Fluoride (as F), mg/l	29	Arsenic (as Ar)
10	Chloride (as Cl), mg/l	30	Lead (as Pb)
11	Cyanide (as CN), mg/l	31	Silver (as Ag)
12	Nitrate (as NO_3), mg/l	32	Zinc (as Zn)
13	Phenolic Compounds (as C_6H_5OH), mg/l	33	Chromium (as Cr)
14	Sulphate (as SO_4), mg/l	34	Mercury (as Hg)
15	Residual free Chlorine, mg/l	35	Boron (as B)
16	Ammonia (as Total Ammonia-N), mg/l	36	Selenium (as Se)
17	Sulphide (as H_2S), mg/l	37	Barium (as Ba)
18	Total Alkalinity (as CaCo3)	38	Nickel (as Ni)
19	Total Hardness (as CaCo3)	39	Molybdenum (as Mo)
20	Chloramine (as Cl2)	40	Lead (as Pb)
21	Anionic detergents (as MBAS), mg/l	41	Mineral Oil (mg/l)

Source: AGSS Laboratory

Table 3-16: Results of surface water quality parameters of the project alignment

Sl.	Parameters	Units	SW1	SW2	SW3	SW4	SW5	SW6	SW7
1	Colour	Hazen	<5.0	<5.0	<5.0	<5.0	<1.0	<5.0	<5.0
2	pH	-	7.69	7.45	7.49	7.45	7.49	7.69	7.69
3	Turbidity	NTU	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable

5	TDS	mg/l	965	1230	1190	965	936	945	876
6	Calcium (as Ca)	mg/l	87	125	106	105	96	92	126
7	Magnesium (as Mg)	mg/l	50.4	47.9	25	47	60	58	24.5
8	Fluoride (as F)	mg/l	0.16	0.15	0.15	0.15	0.42	0.42	0.69
9	Chloride (as Cl)	mg/l	295	235	316	316	130	125	462
10	Nitrate (as NO3)	mg/l	2	2.6	2.6	2.6	2.9	3.1	3.6
11	Sulphate (as SO4)	mg/l	126	19	73	216	29	BLQ (0.05)	114
12	Total Alkalinity (as CaCO3)	mg/l	698	795	680	895	395	369	695
13	Total Hardness (as CaCO3)	mg/l	425	510	369	456	489	469	416
14	Cadmium (as Cd)	mg/l	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)
15	Arsenic (as As)	mg/l	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)
16	Zinc (as Zn)	mg/l	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)	BLQ (0.1)
17	Mercury (as Hg)	mg/l	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)	BLQ (0.001)
18	Nickel (as Ni)	mg/l	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)	BLQ (0.005)
19	DO	mg/l	7	5.9	7	7	7	6	6.2
20	BOD	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
21	Coliform	per 100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent
22	E. Coli	per 100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Source: AGSS Laboratory

Among these parameters, the following results were general to all the sampling locations:

- Colour was <5 hazen units at all locations.
- Turbidity was found <1.0 NTU at all locations.
- Taste was found to be agreeable at all locations.
- All the metals (like Cd, Cu, Fe, As and Hg etc.) were found below level of quantification.
- Microbiological parameter such as Coliform and E. Coli were found to be absent at all locations.
- BOD was also found <2.0 mg/l at all locations.

Figure 3-25: Sampling for Surface water at various location of project alignment

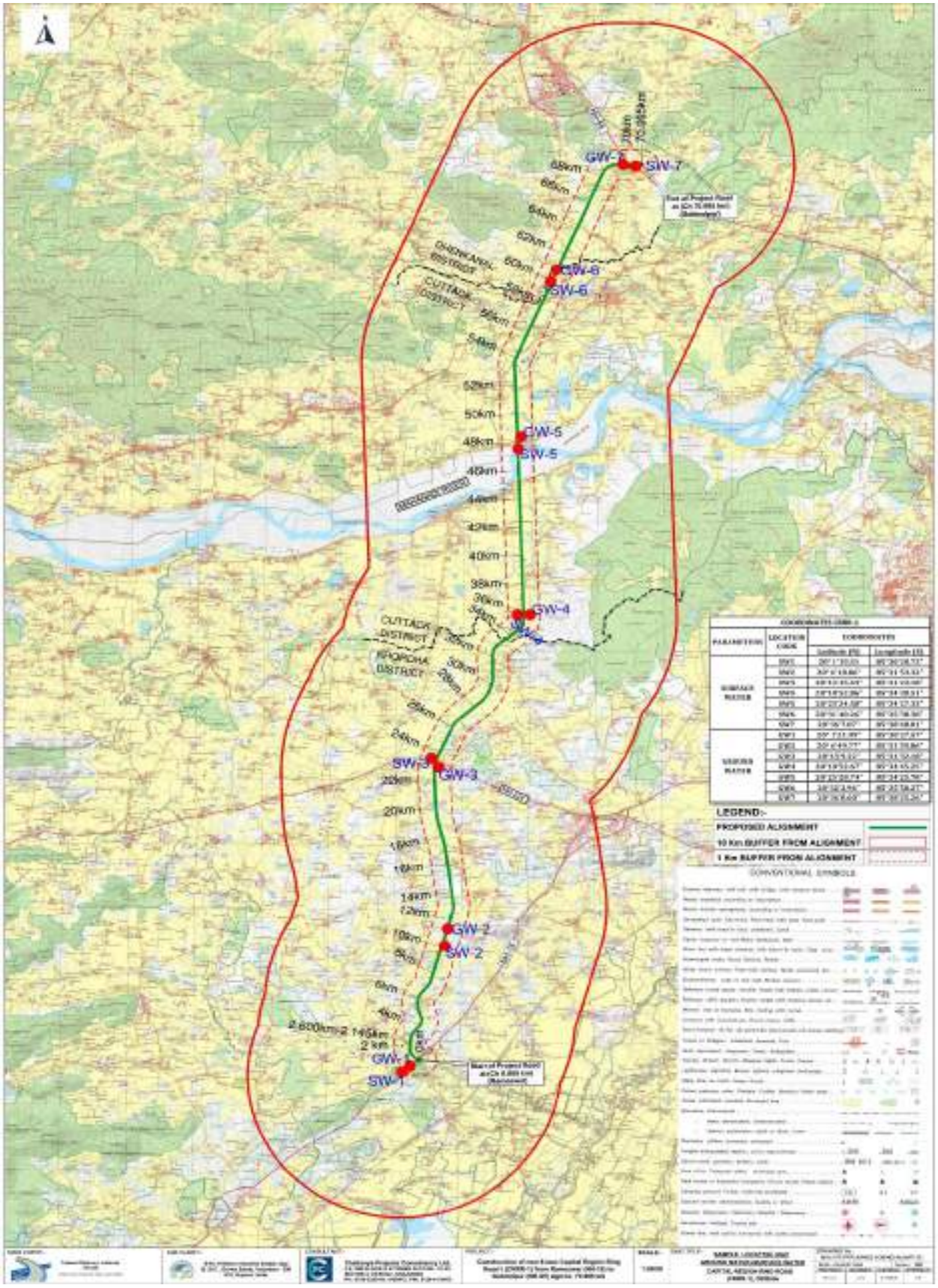


Figure 3-26: Sampling locations of Ground water and Surface water of the proposed alignment

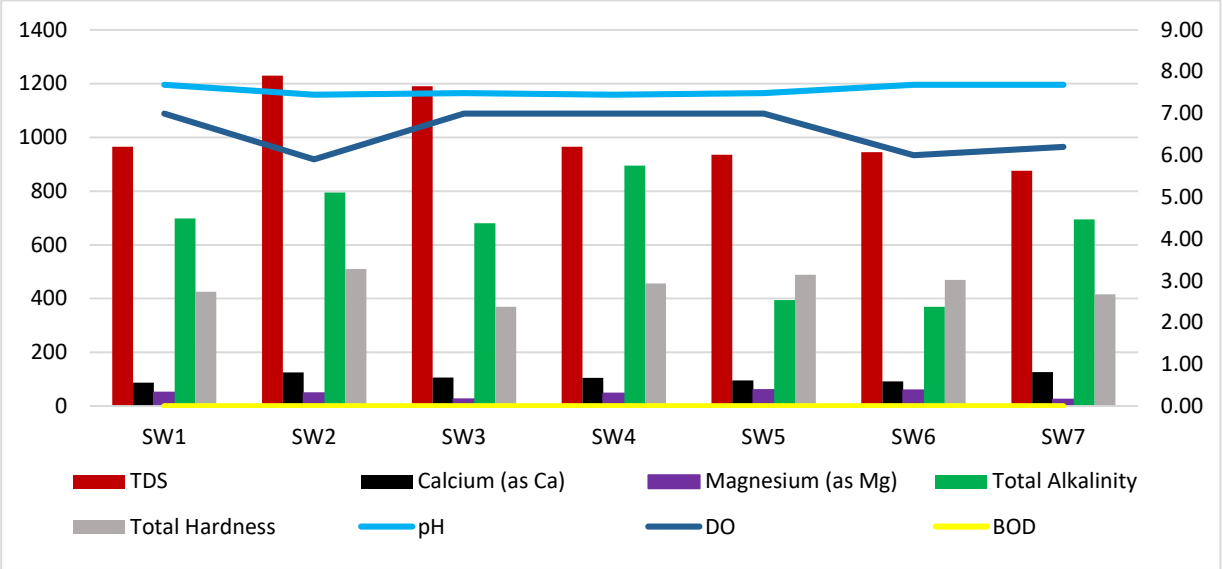


Figure 3-27: Baseline data of surface water quality for various locations

As is evident from the table and graph, the baseline level of some important parameters of surface water with respect to its quality is within the maximum tolerance limits as per IS:2296 for Class C water. pH was found within 7.45-7.69, Total Dissolve Solid between 876-1230 mg/l, Calcium (as Ca) ranges between 87-126 mg/l, Fluoride ranges between 0.15-0.69 mg/l, Magnesium (as Mg) ranges between 24.5-60 mg/l, total alkalinity (as CaCO3) and total hardness (as CaCO3) were found between 369-895 mg/l and 369-510 mg/l respectively. Dissolved Oxygen was found to be between 5.9-7.0 mg/l and BOD is within <2.0 mg/l. Total Coliform and E. Coli are not found in all sampling sites.

Water requirement during construction is proposed to be met majorly through the use of surface water resources, and thus it is absolutely necessary to keep the surface water quality in check during construction activities through regular monitoring.

❖ Soil Characteristics

Khordha, Cuttack and Dhenkanal districts of Odisha predominantly feature fertile soils, primarily classified as Alluvial, Red, Lateritic, Mixed Red & Black soils. In Cuttack, the soil is largely alluvial and red, rich in nutrients, which supports agricultural activities, especially rice, sugarcane, and vegetables. Dhenkanal, on the other hand, exhibits lateritic and red soils, which are slightly acidic, though support crops like paddy, pulses, and horticultural plants. The texture of the soils in these districts varies from sandy to clayey, influencing water retention and agricultural productivity. (Crop Contingency Plan 2024, Department of Agriculture & Farmers' Empowerment, Odisha)

To determine the soil quality of the study area, soil analysis has been carried out for different soil samples collected from different locations along the proposed project alignment to understand the Soil characteristics along the project road. Composite soil samples were collected from adjacent land were collected in the months of December, 2024. The soil sampling locations with respect to the proposed project road has been presented in Table 3-18.

Table 3-17: Details of sampling locations of soil for proposed alignment

Parameters	Location Code	Location	Coordinates	
			Latitude	Longitude
Soil	SQ-1	Bagheiput	20° 1'58.00"	85°31'8.40"
	SQ-2	Madhapur	20° 6'49.77"	85°31'59.86"
	SQ-3	Lokanathpur	20°13'9.22"	85°31'32.18"
	SQ-4	Padanpur	20°18'52.67"	85°34'45.25"
	SQ-5	Sahangagopalpur	20°25'28.74"	85°34'25.78"
	SQ-6	Dhenkanal	20°32'2.94"	85°35'50.27"
	SQ-7	Siaria	20°36'8.60"	85°38'25.26"

Figure 3-28: Soil Sampling at Various Locations

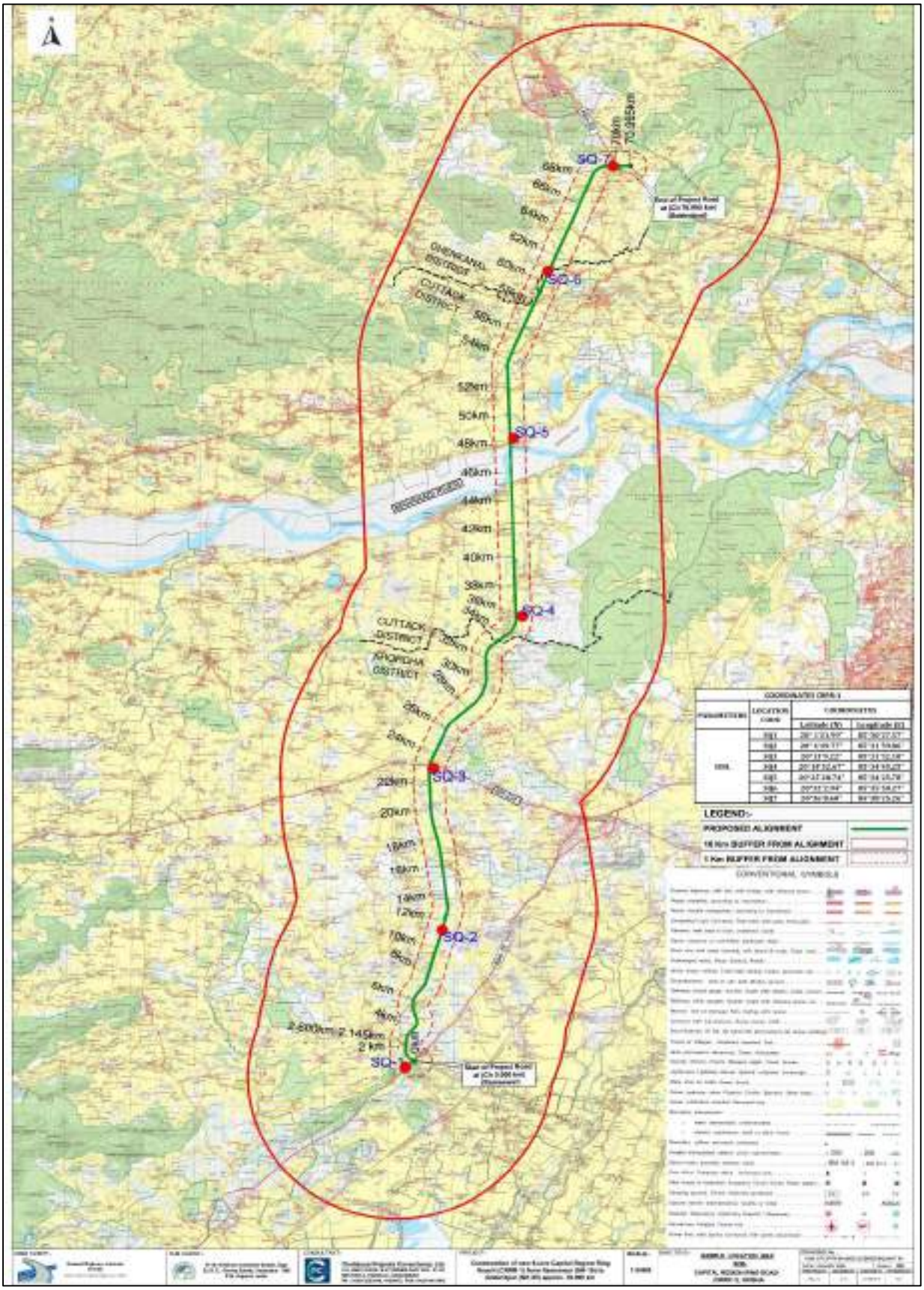


Figure 3-29: Sampling locations of soil quality for proposed alignment

The analysis was done based on individual IS standards for individual parameters. Results of sample analysis is given in the following table:

Table 3-18: Soil quality analysis of sampling locations

S. No	Parameters	Units	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7
Physical Characteristics									
1	Sand	%	73	63	74	79	79	86	70
2	Silt	%	9	12	8	6	10	6	9
3	Clay	%	18	25	18	15	11	8	21
4	Porosity	%	26	26	29	29	26	32	26
5	Bulk Density	g/cc	1.16	1.1	1.12	1.16	1.1	1.16	1.09
6	Water Holding Capacity	%	40	36	46	45	30	32	40
Chemical Characteristics									
1	pH	-	7.19	7.69	7.42	7.69	7.69	7.62	7.29
2	Electrical Conductivity	µs/cm	326	616	416	630	416	698	419
3	Total Alkalinity	mg/kg	126	142	105	109	92	106	96
4	Organic Carbon	%	0.46	0.65	0.89	0.96	0.63	0.96	0.65
5	Calcium	mg/kg	316	817	985	516	495	936	316
6	Magnesium	mg/kg	196	216	269	169	216	216	195
7	Potassium	mg/kg	39	46	26	26	94	46	46
8	Phosphorous	mg/kg	12	12	10	9	10	21	13
9	Nitrogen	mg/kg	132	142	139	152	147	136	136

Source: AGSS Laboratory

The following are the graphical representations related to the characteristics of soil of the proposed alignment:

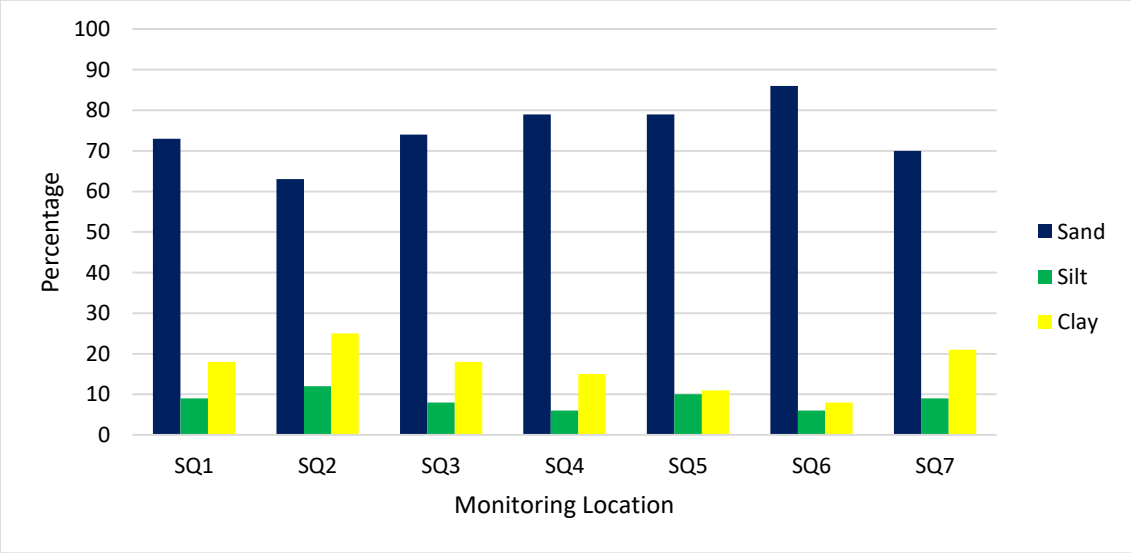


Figure 3-30: Baseline data of soil texture for various locations of proposed alignment

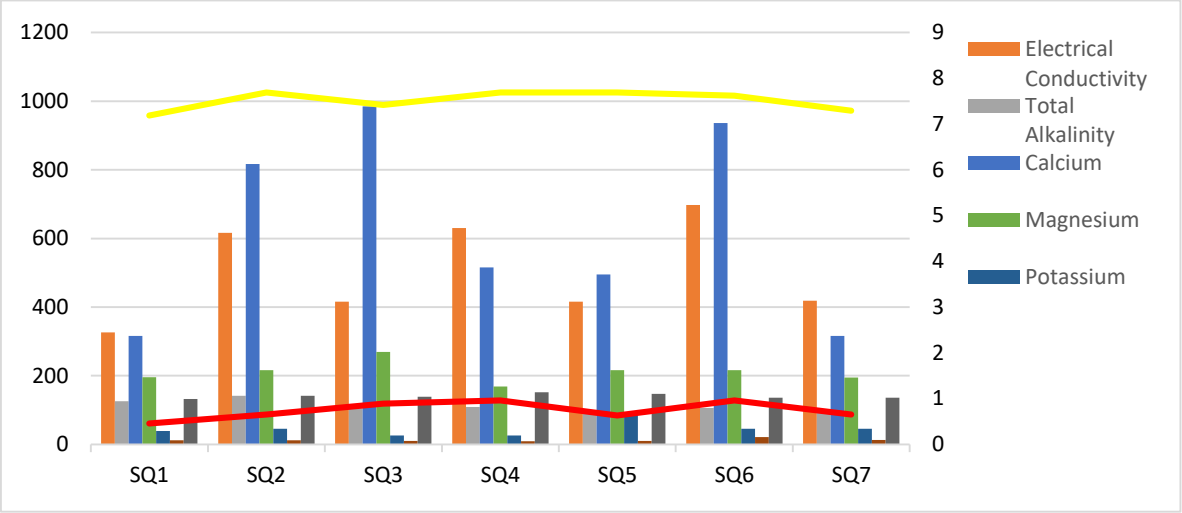


Figure 3-31: Baseline data of soil quality parameters

In general, the soil of the project area is mostly of sandy clay type with average value of sand, silt and clay in all sampling sites are 74.86%, 8.57% and 16.57% respectively which indicate that the soil of the study area is sandy clay in nature. pH of soil along proposed project area was found in ranges from 7.19 to 7.69 which indicate neutral to slightly alkaline nature. Porosity is range from 26% to 32%, water holding capacity is range from 30% to 46 %, organic carbon is range from 0.46% to 0.96%, available nitrogen is range from 132 mg/kg to 152 mg/kg, available phosphorous is range from 9 mg/kg to 21 mg/kg and potassium is range from26 mg/kg to 46 mg/kg.

❖ **Noise Environment**

The CPCB has set ambient noise standards for Residential, Commercial, Industrial as well as silence zones for both Day and Night times, as per "The Noise Pollution (Regulation and Control) Rules, 2000" notified by the MoEF&CC on February 14, 2000 and amendments thereof.

Keeping in view the possible increase in ambient noise levels during construction of the proposed highway, it is imperative to know the baseline status of the ambient noise environment, to clearly identify problem zones for controlling the noise pollution better.

A standard noise level meter was employed for measuring background noise levels during day time (10 am to 6 pm) at selected locations, including residential, commercial and environmentally sensitive areas. The details of noise monitoring locations are given in the following Table 3-20.

Table 3-19: Location details of ambient noise monitoring of proposed alignment

Parameters	Location Code	Location	Coordinates	
			Latitude	Longitude
Noise	NL-1	Bagheiput	20° 1'58.00"	85°31'8.40"
	NL-2	Madhapur	20° 6'49.77"	85°31'59.86"
	NL-3	Lokanathpur	20°13'9.22"	85°31'32.18"
	NL-4	Padanpur	20°18'52.67"	85°34'45.25"
	NL-5	Sahangagopalpur	20°25'28.74"	85°34'25.78"
	NL-6	Dhenkanal	20°32'2.94"	85°35'50.27"
	NL-7	Siaria	20°36'8.60"	85°38'25.26"

Figure 3-32: Ambient noise level monitoring at various locations

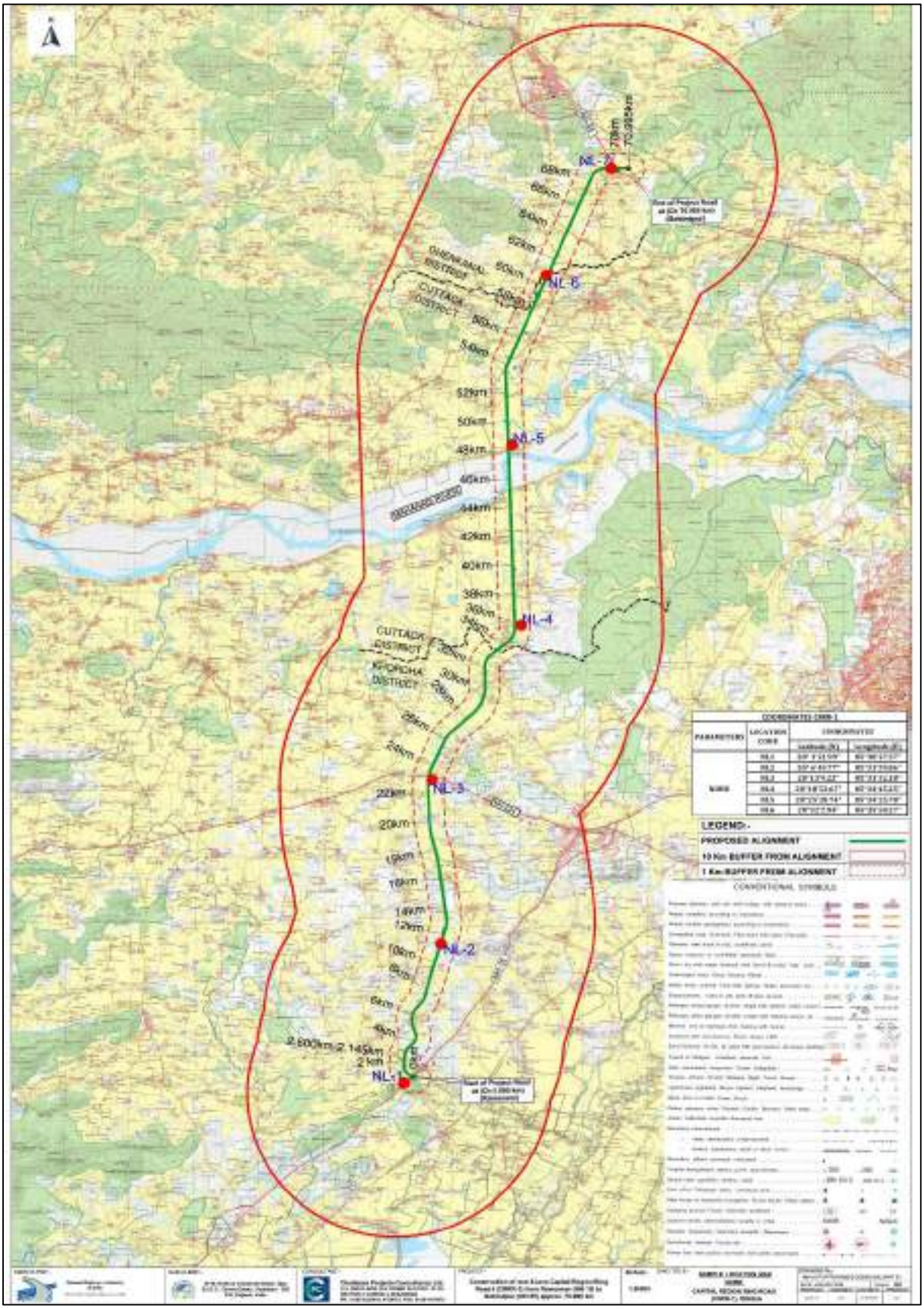


Figure 3-33: Map showing the various noise monitoring stations of proposed alignment

The results of ambient noise level monitoring are given in following table.

Table 3-20: Results of Ambient Noise Level monitoring along proposed alignment

S. No.	Location code	Results	
		Noise Level at Day, dB(A)	Noise Level at Night, dB(A)
1	NL-1	56	26
2	NL-2	43	25
3	NL-3	43	26
4	NL-4	49	26
5	NL-5	52	39
6	NL-6	49	32
7	NL-7	53	42
Max. Limits set by CPCB (Residential area)		**55**	**45**

Source: AGSS Laboratory

The equivalent noise levels in the area through which the proposed alignment will pass are varies between 43 dB(A) to 56 dB(A) at day time and ranges between 26 dB(A) to 42 dB(A) at night.
The figure below contains the graphical representation depicting the noise levels at various sampling locations along the entire stretch of proposed highway alignment, compared with the CPCB guidelines.

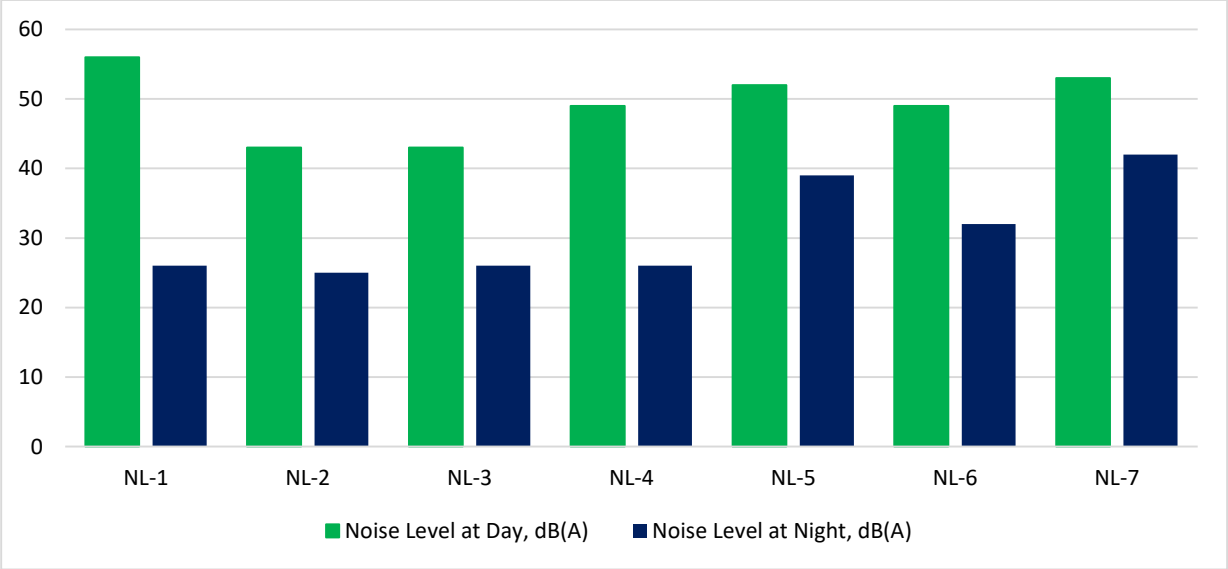


Figure 3-34: Noise levels at various locations along the proposed alignment

3.4.2. Biological Environment

The basic purpose of exploring the biological environment under Environmental Impact Assessment (EIA) is to assist in the decision making process and to ensure that the project options under consideration are bio-environmental-friendly. EIA identifies ways of improving the project by minimizing, mitigating or compensating for impacts before construction and in development phase. Thus the project becomes eco-friendlier. The present study on the biodiversity assessment of the

proposed project is based on field survey of the area supported by secondary data from various governmental and non-governmental sources. The study was carried out during post-monsoon season of 2024.

❖ Objective

The objectives of this study were as follows:

1. To conduct detail study for floral / faunal elements in the proposed project site.
2. To assess RET (Rare, Endangered, Threatened) and scheduled species in the proposed site.
3. To identify locations and features of ecological significance
4. To identify Impact of project during construction and operational phases on the biological environment.

❖ Methodology

Primary Data Collection

Primary baseline study has been carried out in the month of October, 2024. Field visits in various landscapes viz. forest land, wasteland, agriculture land etc. have been carried out to get the maximum diversity of flora and fauna found in the study area.

- **Floral Survey**

The study on the floral assessment for the proposed project was based on extensive field survey of the area. The study has been conducted in pre monsoon season. Floral survey includes identification and documentation of tree, shrub, herb, and climber species of the proposed project study area.

- **Faunal Survey**

The fauna of the study area was surveyed during pre-monsoon season. Surveys were conducted by systematically walking on fixed routes throughout the study area. The fauna was observed during most active period of the day i.e. 6:00 AM to 8:30 AM and 15:30 PM to 18:30 PM. The following methodology was adopted for faunal survey:

Taxa	Sampling Methods
Butterflies	Visual encounter survey
Amphibians	Visual encounter survey
Reptiles	Visual encounter survey
Birds	Point count, opportunistic observation
Mammals	Tracks, signs and visual encounter survey

Secondary Data Collection

Secondary data has been collected through various govt. websites, published journals, reports, forest working plans, and many other platforms to gather information about ecology and biodiversity studies

in the study area, and selected forest divisions. The data retrieved from various sources are authentic and verified.

❖ Survey Limitation

This survey records the flora and fauna observed during site visit and field survey. It does not record any flora or fauna that may appear at other times of the year, and as such, were not evident at the time of the visit. The report represents ecological status of the area recorded during the period of the study which may be different from what is found in other seasons. The survey team has tried to collect the secondary information for the species which are not observed during site visit but can be seen in the study area otherwise. This was done by public consultation.

❖ Forest types

The proposed project alignment would pass through three district viz. Khordha, Cuttack and Dhenkanal. As per the ISFR 2023, the districts have a cumulative forest area of 2787.96 sq.km. Details of forest cover in the Project's districts given in Table 3-22.

Table 3-21: Details of forest cover in the Project's districts

S. No.	District	Geo-graphical Area (sq. km)	Very Dense Forest (sq. km)	Mod. Dense Forest (sq. km)	Open Forest (sq. km)	Total (sq. km)
1.	Khordha	2813	22.19	188.73	319.48	530.40
2.	Cuttack	3932	51.98	233.51	532.80	818.29
3.	Dhenkanal	4452	172.60	436.89	829.78	1,439.27

Source: ISFR, FSI, Dehradun, 2023

As per Champion and Seth classification of forest types (1968), the study area represents two main forest types viz. Northern Moist Mixed Deciduous Forest and Tropical Dry Evergreen Forest. In some parts mainly tropical dry deciduous is also found.

1. **Northern Moist Mixed Deciduous Forests**
   The main species in this forest are *Xylia xylocarpa*, *Lagerstroemia parviflora, Aegle marmelos, Bridelia retusa, Pterocarpum marsupium, Madhuca latifolia, Shorea robusta, Terminalia bellirica, Buchanania lanzan, Buchanania lanzan and Careya arborea etc.*

2. **Tropical Dry Evergreen Forests**
   The main species in this forest are *Alangium salvifolium, Albizia lebbeck, Anogeissus latifolia, Careya arborea, Lannea coromandelica, Madhuca longifolia, Terminalia tomentosa, Terminalia arjuna, Diospyros ebenum, Schleichera oleosa,* etc.

3. **Tropical Dry Deciduous Forests**
   This forest type is dominated by *Shorea robusta* associated with species like *Bauhinia variegata*, *Buchanania lanzan*, *Acacia auriculiformis*, *Cleiostanthus collinus*, *Carissa spinarum*, *Pterocarpus marsupium*, *Diospyros melanoxylon, Holarrhena pubescens, Mitragyna parviflora, Madhuca longifolia, Terminalia tomentosa* and *Ziziphus mauritiana*, etc.

❖ Presence of Ecologically Sensitive Area

The proposed alignment does not pass through any wild life sanctuary. As per final notification notified vide S.O. no. 2906 dated 9th September, 2016 declaring Eco Sensitive Zone around Chandaka Dampara Wildlife Sanctuary (Figure 3-37), alignment is passing at a minimum distance of 0.87 km and maximum distance of 6.67 km from the ESZ boundary of Chandaka Dampara Wildlife Sanctuary.

❖ Floral analysis

Analysis of the flora revealed that there are 155 plant species falling under 51 plant families. The most dominant plant family is Fabaceae (26 species) followed by Poaceae (8 species), Combretaceae (8 species) and Asteraceae (7 species). Among 155 floral species, 78 species of trees, 21 species of shrubs, 33 species of herbs, 15 species of climbers and 8 species of grasses were recorded. Detail taxonomic account of floral species found in the study area is given in Table 3-23 and percentage distribution of floral species is depicted in Figure 3-35.

Table 3-22: Number of floral species found in the study area

S. No.	Species	Number
1.	Trees	78
2.	Shrubs	21
3.	Herbs	33
4.	Climbers	15
5.	Grasses	8
Total		**155**

(Source: Primary and Secondary Survey)

The dominant tree species observed in the study area are *Xylia xylocarpa, Lagerstroemia parviflora, Aegle marmelos, Shorea robusta, Bridelia retusa, Pterocarpus marsupium, Madhuca longifolia, Alangium salvifolium, Terminalia tomentosa, Terminalia arjuna, Careya arborea, Holarrhena pubescens, Acacia auriculiformis, Helicteres isora. Undergrowth has bushes of Phoenix acaulis, Flacourtia indica, Diospyros chloroxylon, Carissa spinarum, Casssia tora, Parthenium hysterophorus, Lantana camara and the ground flora is composed of Erathemum capense, Desmodium ganeticum, Chromolaena odorata, Peristrophe paniculata, Sisa acuta, Blumeopsis flava, Cynadon dactylon, Digitaria ciliaris, etc. Some climber species represents by Combretum roxburghii, Ichnocarpus frutescens, Hemidesmus indicus, Ampelocissus latifolia, Argyreia nervosa, etc.*

No rare, Endangered and Threatened (RET) species of flora were found in the study area.

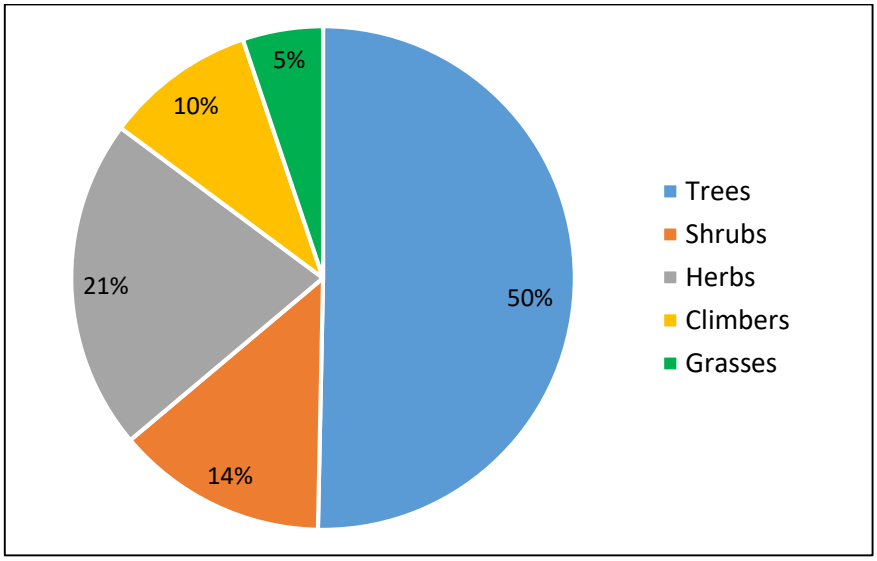


Figure 3-35: Percentage distribution of floral species in the study area

Table 3-23: Taxonomic account of floral species found in the study area

S. No.	Scientific Name	Common Name	Family
	Trees		
1.	*Acacia auriculiformis**	Earleaf Acacia	Fabaceae
2.	*Acacia leucophloea*	White Bark Acacia	Fabaceae
3.	*Acacia nilotica*	Babul	Fabaceae
4.	*Aegle marmelos**	Bel	Rutaceae
5.	*Alangium salvifolium*	Akol	Cornaceae
6.	*Albizia lebbeck**	Black Siris	Fabaceae
7.	*Alstonia scholaris**	Chatian	Apocynaceae
8.	*Anacardium occidentale**	Kaju	Anacardiaceae
9.	*Annona squamosa*	Sitaphal	Anonaceae
10.	*Anthocephalus cadamba**	Kadam	Rubiaceae
11.	*Anogeissus acuminata*	Phasi	Combretaceae
12.	*Anogeissus latifolia*	Dhaura	Combretaceae
13.	*Artocarpus heterophyllus**	Jackfruit	Moraceae
14.	*Averrhoa carambola*	Karmanga	Averrhoaceae
15.	*Azadirachta indica**	Neem	Meliaceae
16.	*Bauhinia variegata**	Kanchan	Fabaceae
17.	*Bombax ceiba**	Cotton-Tree	Malvaceae
18.	*Boswellia serrata**	Salai	Burseraceae
19.	*Bridelia retusa*	Spinous Kino Tree	Phyllanthaceae
20.	*Borassus flabellifer**	Tal Palm	Arecaceae
21.	*Buchanania lanzan**	Char	Anacardiacea
22.	*Butea monosperma**	Palas	Fabaceae
23.	*Careya arborea*	Kumbhi	Lecythidaceae
24.	*Cassia fistula**	Amaltas	Caesalpiniaceae
25.	*Cassia siamea**	Kassod Tree	Caesalpiniaceae
26.	*Cleistanthus collinus*	Toxic Gooseberry	Phyllanthaceae
27.	*Combretum roxburghii*	White Combretum	Combretaceae

28.	*Cinnamomum tamala*	Tejpatra	Lauraceae
29.	*Cocus nucifera**	Coconut	Arecaceae
30.	*Dalbegia sissoo**	Shisham	Fabaceae
31.	*Dillenia indica*	Oau	Dilleniaceae
32.	*Diospyros melanoxylon**	Kendu	Ebenaceae
33.	*Erythrina indica*	Paldhua	Fabaceae
34.	*Erythrina variegata*	Indian Coral Tree	Fabaceae
35.	*Eucalyptus hybrid**	Patas	Myrtaceae
36.	*Ficus benghalensis**	Bargad	Moraceae
37.	*Ficus religiosa**	Pipal	Moraceae
38.	*Gmelina arborea*	Gambhari	Verbenaceae
39.	*Grewia tiliifolia**	Dhaman	Malvaceae
40.	*Helicteres isora*	East-Indian screw tree	Sterculiaceae
41.	*Holarrhena pubescens**	Indrajao	Apocynaceae
42.	*Lagerstroemia speciosa**	Crepe Myrtle	Lytheraceae
43.	*Lannea coromandelica*	Mahi	Anacardiaceae
44.	*Limonia acidissima*	Kaitha	Rutaceae
45.	*Madhuca longifolia**	Mahula	Sapotaceae
46.	*Mangifera indica**	Mango	Anacardiaceae
47.	*Mimusops elengi**	Maulsari	Sapotaceae
48.	*Mitragyna parviflora**	Kaim	Rubiaceae
49.	*Moringa oleifera**	Sajana	Moringaceae
50.	*Morus alba **	Sehtut	Moraceae
51.	*Murraya koenigii**	Bhrusanga Patra	Rutaceae
52.	*Neolamarckia cadamba**	Kadamba	Rubiaceae
53.	*Peltophorum pterocarpum*	Copperpod	Caesalpiniaceae
54.	*Phoenix sylvestris**	Khajur	Arecaceae
55.	*Phyllanthus emblica**	Amla	Phyllanthaceae
56.	*Pithecolobium dulce**	Madras Thorn	Fabaceae
57.	*Polyalthia longifolia **	Debdaru	Annonaceae
58.	*Pongamia pinnata**	Karanj	Fabaceae
59.	*Pterocarpus marsupium**	Piasala	Fabaceae
60.	*Samanea saman**	Monkey Pod Tree	Fabaceae
61.	*Saraca asoca*	Ashok	Fabaceae
62.	*Schleichera oleosa**	Kusum	Sapindaceae
63.	*Semecarpus anacardium*	Bhilwa	Anacardiaceae
64.	*Sesbania grandiflora*	Agasti	Fabaceae
65.	*Shorea robusta**	Sal	Dipterocarpaceae
66.	*Soyamida febrifuga*	Rohini	Meliaceae
67.	*Spondias pinnata**	Ambada	Anacardiaceae
68.	*Streblus asper**	Sahada	Moraceae
69.	*Strychnos nux-vomica*	Kochila	Loganiaceae
70.	*Syzygium cumini**	Jamun	Myrtaceae
71.	*Tamarindus indica**	Imali	Fabaceae
72.	*Tectona grandis**	Teak	Lamiaceae
73.	*Terminalia arjuna**	Arjun	Combretaceae
74.	*Terminalia bellirica**	Bahada	Combretaceae
75.	*Terminalia catappa**	Kathabadam	Combretaceae

76.	*Terminalia tomentosa**	Asan	Combretaceae
77.	*Xylia xylocarpa**	Kangara	Fabaceae
78.	*Ziziphus mauritiana**	Ber	Rhamnaceae
		Shrubs	
1.	*Abrus precatorius**	Kaincha	Fabaceae
2.	*Adhatoda vasica*	Adulsa	Acanthaceae
3.	*Antidesma acidum*	Mamuri	Phyllanthaceae
4.	*Calotropis procera**	Arakha	Apocynaceae
5.	*Carissa spinarum**	Wild Karanda	Apocynaceae
6.	*Cassia alata*	Candle-Stick Tree	Fabaceae
7.	*Clerodendrum infortunatum*	Hill Glory Bower	Lamiaceae
8.	*Diospyros chloroxylon**	Kala Tendu	Ebenaceae
9.	*Flacourtia indica**	Bilangada	Salicaceae
10.	*Indigofera pulchella*	Giral	Fabaceae
11.	*Ixora parviflora*	Telkoruan	Rubiaceae
12.	*Jatropha gossypiifolia**	Ratanjoti	Euphorbiaceae
13.	*Lantana camara**	Lantana	Verbenaceae
14.	*Nerium oleander*	Kaner	Apocynaceae
15.	*Phoenix acaulis**	Stemless Date Palm	Arecaceae
16.	*Ricinus communis**	Castor Bean	Euphorbiaceae
17.	*Smilax zeylanica*	Smilax	Smilacaceae
18.	*Vitex negundo*	Chaste Tree	Lamiaceae
19.	*Withania somnifera*	Aswagandha	Solanaceae
20.	*Woodfordia fruticosa*	Fire Flame Bush	Lythraceae
21.	*Ziziphus oenopolia*	jackal jujube	Rhamnaceae
		Herbs	
1.	*Achyranthes aspera**	Apamarg	Amaranthaceae
2.	*Aerva lanata**	Mountain Knotgrass	Amaranthaceae
3.	*Ageratum conyzoides**	Goat Weed	Asteraceae
4.	*Alternanthera sessilis**	Madaranga Sag	Amaranthaceae
5.	*Ammania baccifera**	Blistering Ammannia	Lythraceae
6.	*Andrographis paniculata*	Green Chiretta	Acanthaceae
7.	*Argemone mexicana**	Mexican Poppy	Papaveraceae
8.	*Boerhavia diffusa**	Kencha	Nyctaginaceae
9.	*Blumeopsis flava*	Yellow Blumea	Asteraceae
10.	*Casssia tora**	Sickle Senna	Fabaceae
11.	*Cleome viscosa**	Tick Weed	Cleomaceae
12.	*Chromolaena odorata**	Siam weed	Asteraceae
13.	*Corchorus capsularis*	Nalita	Tiliaceae
14.	*Datura stramonium**	Dhatura	Solanaceae
15.	*Desmodium gangeticum*	Shalparni	Fabaceae
16.	*Eclipta prostrata**	False Daisy	Asteraceae
17.	*Eichhornia crassipes**	Common Water Hyacinth	Pontederiaceae
18.	*Eranthemum capense*	Konkan Eranthemum	Acanthaceae
19.	*Euphorbia hirta**	Dudhi	Euphorbiaceae
20.	*Heliotropicum indicum**	Indian Heliotrope	Boraginaceae
21.	*Hemidesmus indicus**	Anantamula	Apocynaceae
22.	*Hyptis suaveolens**	Bantulsi	Lamiaceae

23.	*Vernonia cinerea**	Little Ironweed	Asteraceae
24.	*Mimosa pudica**	Lajwanti	Fabaceae
25.	*Oxalis corniculata**	Creeping Woodsorrel	Oxalidaceae
26.	*Parthenium hysterophorus**	Congress grass	Asteraceae
27.	*Peristrophe paniculata*	Lady flower	Acanthaceae
28.	*Phyllanthus niruri**	Bhui Amla	Phyllanthaceae
29.	*Plumbago zeylanica**	Chitrak	Plumbaginaceae
30.	*Sida acuta**	Common Wireweed	Malvaceae
31.	*Sida cordata**	Long Stalk Sida	Malvaceae
32.	*Solanum nigrum*	Black Nightshade	Solanaceae
33.	*Tridax procumbens**	Tridax Daisy	Asteraceae
Climbers			
1.	*Bauhinia vahlii*	Maloo Creeper	Fabaceae
2.	*Ampelocissus latifolia*	Wild Grape	Vitaceae
3.	*Argyreia nervosa*	Elephant creeper	Convolvulaceae
4.	*Clitoria ternatea**	Blue Pea	Fabaceae
5.	*Combretum roxburghii*	White Combretum	Combretaceae
6.	*Dioscorea alata*	Purple Yam	Dioscoreaceae
7.	*Dioscorea bulbifera*	Genthi	Dioscoreaceae
8.	*Gymnema sylvestre**	Gurmar	Apocynaceae
9.	*Ichnocarpus frutescens*	Black Creeper	Apocynaceae
10.	*Ipomoea carnea*	Pink Morning Glory	Convolvulaceae
11.	*Ipomoea purpurea**	Common Morning-Glory	Convolvulaceae
12.	*Mucuna pruriens*	Velvet Bean	Fabaceae
13.	*Smilax macrophylla**	Kumarika	Smilacaceae
14.	*Tinospora cordifolia**	Giloy	Menispermaceae
15.	*Tinospora cordifolia**	Giloy	Menispermaceae
Grasses			
1.	*Bambusa arundinacea**	Baunsa	Poaceae
2.	*Chrysopogon zizanoides**	Vetiver	Poaceae
3.	*Cynodon dactylon**	Duba	Poaceae
4.	*Dichanthium annulatum**	Marvel grass	Poaceae
5.	*Digitaria ciliaris**	Wild Crabgrass	Poaceae
6.	*Heteropogon contortus**	Black Speargrass	Poaceae
7.	*Saccharum spontaneum**	Wild sugarcane	Poaceae
8.	*Themeda triandra**	Kangaroo Grass	Poaceae

(Source: Survey Team in consultation with concern state forest officials and local people)

*Note: *Species observed by Survey Team*

❖ Other Non-Vegetation Classes

Current croplands and current fallow lands were also studied under single class –Agriculture. Most of the land use area in the study area is under agriculture, as this is the main occupation of people. Paddy, cotton, sugarcane, maize, pulses, sorghum, bajra, ground nut and wheat are the principal crops.

❖ Faunal analysis

Total 98 numbers of faunal species recorded from the study area. Among faunal species, 19 species of mammals, 64 species of avifauna, 11 species of reptiles and 4 species of amphibians are recorded in the study area. The most common faunal species observed in the study area are Hanuman Langur, Rhesus Macaque, Five-Striped Palm Squirrel, Indian Grey Mongoose, Coppersmith Barbet, Rose-Ringed Parakeet, Rock Pigeon, Spotted Dove, Common Moorhen, Red Wattled Lapwing, Black Drongo, House Crow, Red Vented Bulbul, Indian Garden Lizard, Bark Gecko, Skink and Common Asian Toad.

Table 3-24: The following lists of faunal elements were observed from the site

S. No.	Species	Number
1.	Mammals	19
2.	Avifauna	64
3.	Reptiles	11
4.	Amphibians	4
Total		**98**

(Source: Primary and Secondary Survey)

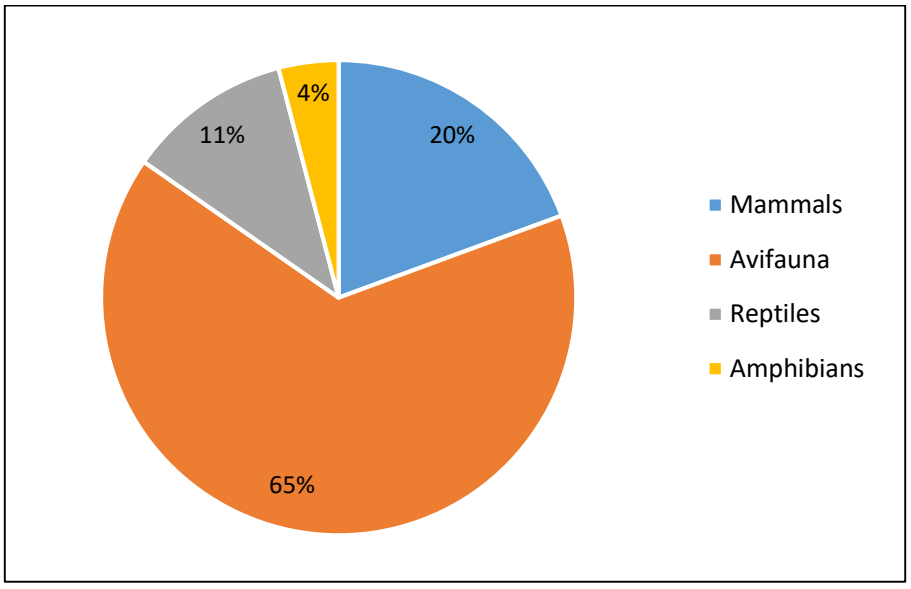


Figure 3-36: Percentage distribution of faunal species in the study area

Regarding the conservation status of the fauna, 16 faunal species (12 mammals, 1 avifauna and 3 reptiles) are identified from the study area which belong to Schedule-I species as per Wildlife Protection (Amendment) Act, 2022. Most of them are common and widely distributed and the range of occurrence extended to wide geographical area. Percentage distribution of faunal species in the study area is shown in the Figure 3-36. Detail taxonomic account of faunal species found in the study area is given in Table 3-25.

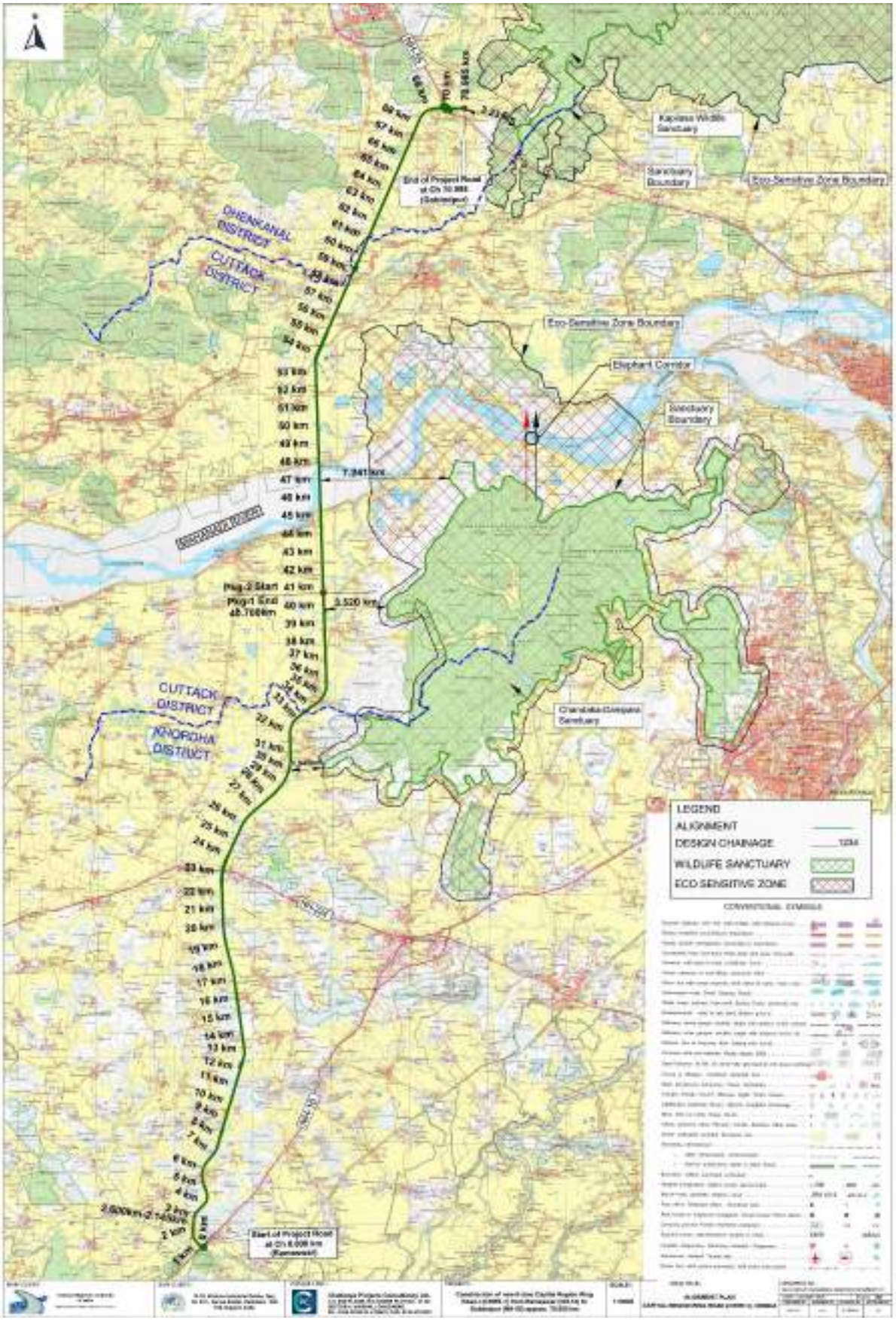


Figure 3-37: Eco-sensitive map of the study area

Table 3-25: Faunal species found in the study area

S. No.	Scientific Name	Common Name	Family	Schedule Status (IWLPA, 2022)	IUCN Status
Mammals					
1.	*Canis aureus*	Golden Jackal	Canidae	I	LC
2.	*Axis axis*	Spotted Dear	Cervidae	II	LC
3.	*Elephas maximus*	Asian Elephant	Elephantidae	I	EN
4.	*Felis chaus*	Jungle Cat	Felidae	I	LC
5.	*Funambulus pennantii**	Five-Striped Palm Squirrel	Sciuridae	II	LC
6.	*Herpestes edwardsii*	Indian Grey Mongoose	Herpestidae	I	LC
7.	*Hystrix indica*	Porcupine	Hystricidae	I	LC
8.	*Lepus nigricollis*	Indian Hare	Leporidae	II	LC
9.	*Macaca mulatta**	Rhesus Macaque	Cercopithecidae	II	LC
10.	*Melursus ursinus*	Sloth Bear	Ursidae	I	VU
11.	*Muntiacus muntjak*	Barking Deer	Cervidae	II	LC
12.	*Mus booduga*	Common Field Mouse	Muridae	-	LC
13.	*Pteropus giganteus*	Fruit Bat	Pteropodidae	-	LC
14.	*Rattus rattus**	Common House Rat	Muridae	-	LC
15.	*Semnopithecus entellus**	Hanuman Langur	Cercopithecidae	II	LC
16.	*Suncus murinus**	House Shrew	Soricidae	-	LC
17.	*Sus scrofa**	Wild Boar	Suidae	II	LC
18.	*Vulpes bengalensis**	Indian Fox	Canidae	I	LC
19.	*Viverricula indica*	*Small Indian Civet*	Viverridae	I	LC
Avifauna					
1.	*Acridotheres ginginianus**	Bank Myna	Sturnidae	II	LC
2.	*Acridotheres tristis**	Common Myena	Sturnidae	II	LC
3.	*Aegithina tiphia*	Common Iora	Aegithinidae	II	LC
4.	*Alauda gulgula*	Oriental Sky Lark	Alaudidae	II	LC
5.	*Alcedo althis**	Common Kingfisher	Alcedinidae	II	LC
6.	*Anastomus oscitans**	Asian Openbill	Ciconiidae	II	LC
7.	*Anthus rufulus*	Paddyfield Pipit	Motacillidae	II	LC
8.	*Apus affinis**	House Swift	Apopidae	II	LC
9.	*Ardea alba**	Great Egret	Ardeidae	II	LC
10.	*Ardeola grayii**	Indian Pond Heron	Ardeidae	II	LC
11.	*Athene brama*	Spotted Owlet	Strigidae	II	LC
12.	*Bubulcus ibis**	Cattle Egret	Ardeidae	II	LC
13.	*Caprimulgus asiaticus*	Indian Nightjar	Caprimulgidae	II	LC
14.	*Centropus sinensis**	Greater Coucal	Centropodidae	II	LC
15.	*Ceryle radis**	Pied Kingfisher	Alcedinidae	II	LC
16.	*Chrysocolaptes festivus**	White-Naped Woodpecker	Indicatoridae	II	LC
17.	*Columbia livia **	Rock Pigeon	Columbidae	II	LC

18.	*Copsychus saularis**	Oriental Magpie Robin	Saxicolini	II	LC
19.	*Coracias bengalensis*	Indian Roller	Coraciidae	II	LC
20.	*Corvus splendens**	House Crow	Corvidae	II	LC
21.	*Dendrocitta vagabunda**	Rufous Treepie	Corvidae	II	LC
22.	*Dicrurus macrocereus**	Black Drongo	Dicrurini	II	LC
23.	*Egretta garzetta**	Little Egret	Ardeidae	II	LC
24.	*Eudynamys scolopacea*	Asian Koel	Cuculidae	II	LC
25.	*Gallinula chloropus**	Common Moorhen	Rallidae	II	LC
26.	*Halcyon smyrnesis**	White-Throated Kingfisher	Halcyonidae	II	LC
27.	*Hirundo rustica*	Barn Swallow	Hirundinidae	II	LC
28.	*Lanius cristatus**	Brown Shrinke	Laniidae	II	LC
29.	*Lonchura atricapilla*	Black-Headed Munia	Estrildidae	II	LC
30.	*Megalaima haemacephala*	Coppersmith Barbet	Megalaimidae	II	LC
31.	*Merops orientalis*	Green Bee-Eater	Moropidae	II	LC
32.	*Merops philippinus*	Blue-Tailed Bee-Eater	Meropidae	II	LC
33.	*Milvus migrans**	Black Kite	Accipitrinae	II	LC
34.	*Motacilla alba**	White Wagtail	Motacillidae	II	LC
35.	*Motacilla cinerea*	Grey Wagtail	Motacillidae	II	LC
36.	*Nectarinia asiatica**	Purple Sunbird	Nectariniidae	II	LC
37.	*Oriolus xanthornus*	Black-Hooded Oriole	Oriolidae	II	LC
38.	*Orthotomus sutorius*	Common Tailor-Bird	Sylviidae	II	LC
39.	*Passer domesticus**	House Sparrow	Passeridae	II	LC
40.	*Phalacrocorax niger*	Little Cormorant	Phalacrocoracidae	II	LC
41.	*Pavo cristatus*	Indian Peafowl	Phasianidae	I	LC
42.	*Ploceus philippinus**	Baya Weaver	Ploceidae	II	LC
43.	*Prinia inornata*	Plain Prinia	Cisticolidae	II	LC
44.	*Prinia socialis**	Ashy Prinia	Cisticolidae	II	LC
45.	*Psilopogon haemacephalus*	Coppersmith Barbet	Megalaimidae	II	LC
46.	*Psilopogon zeylanicus*	Brown Headed Barbet	Megalaimidae	II	LC
47.	*Psittacula eupatria*	Alexandrine Parakeet	Psittacidae	II	LC
48.	*Psittacula krameri**	Rose-Ringed Parakeet	Psittacidae	II	LC
49.	*Pycnonotus cafer**	Red Vented Bulbul	Pycnonotidae	II	LC
50.	*Pycnonotus jocosus*	Red-Whiskered Bulbul	Pycnonotidae	II	LC
51.	*Rhipidura albicollis*	White Throated Faintail	Rhipidurini	II	LC
52.	*Saxicoloides fulicatus*	Indian Robin	Muscicapidae	II	LC
53.	*Saxicola caprata*	Pied bushchat	Muscicapidae	II	LC

54.	*Spilopelia chinensis**	Spotted Dove	Columbidae	II	LC
55.	*Streptopelia decaocto**	Eurassian Collared Dove	Columbidae	II	LC
56.	*Sturnia malabarica*	Chestnut-Tailed Starling	Sturnidae	II	LC
57.	*Sturnus pogodarum*	Brahminy Starling	Sturnidae	II	LC
58.	*Terpsiphone paradise**	Indian Paradise Flycatcher	Monarchidae	II	LC
59.	*Tringa nebularia*	Common Greenshank	Scolopacidae	II	LC
60.	*Turdoides caudatus**	Common Babler	Sylviinae	II	LC
61.	*Turdoides stritus**	Jungle Babler	Sylviinae	II	LC
62.	*Upupa epops**	Common Hoopoe	Upopidae	II	LC
63.	*Vanellus cinereus**	Red Wattled Lapwing	Charadriinae	II	LC
64.	*Zosterops palpebrosus*	Oriental White-Eye	Zosteropidae	II	LC
Reptiles					
1.	*Bungarus fasciatus*	Banded Krait	Elapidae	II	LC
2.	*Bungarus caeruleus*	Common Indian Krait	Elapidae	II	LC
3.	*Calotes versicolor**	Indian Garden Lizard	Agamidae	-	LC
4.	*Eutropis carinata*	Common Indian Skink	Scincidae	-	LC
5.	*Hemidactylus leschenaultii**	Bark Gecko	Gekkonidae	-	LC
6.	*Hemidactylus flaviviridis*	Common Indian House Gecko	Gekkonidae	-	LC
7.	*Daboia russelii*	Rusell's Viper	Viperidae	I	LC
8.	*Lygosoma punctata**	Common Snake Skink	Scincidae	-	LC
9.	*Naja naja*	Indian Cobra	Elapidae	I	LC
10.	*Ptyas mucosa*	Indian Rat Snake	Colubridae	I	LC
11.	*Xenochrophis piscator*	Checkered Keelback	Colubridae	I	LC
Amphibians					
1.	*Duttaphrynus melanostictus**	Common Asian Toad	Bufonidae	-	LC
2.	*Duttaphrynus stomaticus*	Marbled Toad	Bufonidae	-	LC
3.	*Euphlyctis cyanophlycti**	Indian Skipper Frog	Dicroglossidae	II	LC
4.	*Fejervarya limnocharis*	Indian Cricket Frog	Dicroglossidae	II	LC

(Source: Survey Team in consultation with concern state forest officials and local people)

Note: *Species observed by Survey Team

❖ Additional Wildlife Study

As per the specific condition no. 2 of the ToR (File No: 10/18/2024-IA.III) granted by the MoEF&CC dated 19/09/2024, a Wildlife conservation/management plan for the area with special emphasis on elephants' management is prepared in consultation with State Forest Department. The report is

presented to State Forest Department for the various mitigation measures required for proper animal movement at the project site. Elephant underpasses have been proposed at 10 locations after consultation with Forest department. Apart from these, 233 culverts have also been proposed for movement of smaller animals. Summary and recommendation is incorporated in the report and detail wildlife conservation/management plan is attached as **Annexure 3-5.**

Figure 3-38: Baseline study in the proposed project study area.

❖ Reference

- *Champion, H. G. and Seth, S. K. (1968). Revised Survey of Forest Types of India, New Delhi. Govt. of India. National Remote Sensing Agency, Department of Space, Hyderabad.*
- *Das P K, Sahoo T, Panda P C. Forest trees of Odisha, India: An updated checklist. Plant Science Today, (2022); 9(4): 1021–1031*
- *https://fsi.nic.in/isfr-2021/chapter-13.pdf.*
- *https://odishaforest.in/forests-in-odisha/forest-types.*
- *India State of Forest Report (ISFR), (2023). Forest Survey of India (MoEFCC), Dehradun.*

- *Mohapatra, Pratyush & Behera, Satyaranjan & Dutta, Sushil & Mahapatra, Cuckoo & Upadhyay, Hari. (2019). Mammals of Odisha, India: updated checklist, distribution, and conservation status. Volume- XXXI. 1-113.*
- *Mohapatra, Pratyush & Mahapatra, Cuckoo & Dutta, Sushil. (2017). Studies on Amphibians of Odisha: An overview. Wildlife and Protected Areas. Vol. 19 (pp.11-32)*
- *Nimain C. Palei et al. Avifauna of Athgarh Forest Division, Odisha. Eastern India. Journal of Entomology and Zoology Studies, 2014; 2 (5): 329-334.*
- *Panda, Pratap & Das, Prabhat & Sahoo, Tirthabrata, (2022). Forest trees of Odisha, India: An updated checklist. Plant Science Today. 9. 1021-1031. 10.14719/pst.1972.*
- *Pattnayak et al. (2021). Assessment of woody plant species composition in secondary deciduous forests of Odisha, India. Environment Conservation Journal 22 (3):327-339*
- *Sudhakar Reddy et al. Mapping The Vegetation Types of Orissa, India Using Remote Sensing.*
- *Tambe, Satish & Nimbalkar, Varsha & Rani, Anju & Gupta, Adesh & Kumar, Sanjeet & Saradar, Binod, (2023). Ethnobotanical survey of medicinal plants used in different health problems. Indigenous Traditional Knowledge and Ethnopharmacology (pp.36-46).*
- *Zoological Survey of India, (1993). Fauna of Orissa (Part IV). State Fauna Series. Govt. of India.*
- *Tirthabrata Sahoo et al. (2018). Qualitative and quantitative assessment of plant diversity of Chandaka-Damapara Sanctuary with special emphasis on identification of useful, keystone and threatened species. Plant Science Research 40 (1&2): 7-18.*
- *Kambaska Kumar Behera et al, (2008). Floristic and Medicinal Uses of Some Plants of Chandaka Denudated Forest Patches of Bhubaneswar, Orissa, India. Ethnobotanical Leaflets 12: 1043-53.*
- *Debata.S. & K.K. Swain (2020). Mammalian fauna in an urban influenced zone of Chandaka-Dampara Wildlife Sanctuary in Odisha, India Journal of Threatened Taxa 12(8): 15767–15775.*
- *Kumar, Sanjeet & Mahanti, Padma. (2020). A check list of Avifaunal diversity in semi-urban areas of Cuttack, India: Implication on conservation and environmental studies.*

3.4.3. Socio-Economic Profile

The primary purpose of socio-economic analysis is to provide an overview of the State's socio-economic status and the relative status of the Project Influence Area (PIA) within the State. The project alignment is passing through green field and starts from starts from Ch. 0+000 near Rameshwar in Tangi tehsil of Khordha district and ends at Ch. 70+995 in Gobindpur in Dhenkanal tehsil of Dhenkanal district of Odisha state of total length of 70+995 km.

This section presents the socio-economic profile of Odisha and the project influence districts i.e. Khordha, Cuttack and Dhenkanal, which contains the Project Influence Area (PIA) of the proposed highway.

❖ Methodology

Socio-economic survey was conducted in villages along the proposed alignment through consultation with village headmen and individual villagers to understand the socio-economic status of the Project Influence Area (PIA). Details were recorded in survey sheets and then tabulated and analyzed respectively.

❖ Socio-Economic Profile of Odisha

According to the 2011 Census of India, the total population of Odisha is 4,19,74,218 of which male and female are 2,12,12,136 and 2,07,62,082 respectively. The total population growth in between 2001 and 2011 was 14.05 percent while in previous decade it was 15.94 percent. The population of Odisha forms 3.47% of total population of India in 2011. Sex Ratio of Odisha was 979 females per 1000 males. Literacy rate in Odisha was 72.87%, of which male literacy stood at 81.59 percent while female literacy was at 62.46 percent as per 2011 census.

Hinduism constitutes the largest religious group in the state of Odisha, with a majority of 93.63% adherents. Christianity is the second most prevalent religion in Orissa, with 2.77% of the population practicing it while Islam is embraced by 2.17% of the state's residents. Jainism has 0.02% followers, Sikhism stands at 0.05%, and Buddhism also at 0.05%. Additionally, approximately 1.14% of the population identifies with 'Other Religions,' and about 0.18% profess 'No Particular Religion'.

Table 3-26: Socio-Economic profile of Odisha

S. No.	Indicator	Year	Unit	Amount/value
1.	Total Geographical area	2011	sq.km.	1,55,707
2.	Population	2011	Number	4,19,74,218
3.	Males	2011	Number	2,12,12,136
4.	Females	2011	Number	2,07,62,082
5.	Total GSDP at current (2022-23) prices	2022-23	Rupees	Rs. 7.2 lakhs crore
6.	Per capita GSDP at current (2022-23) prices	2022-23	Rupees	INR 150,676
7.	Literacy rate	2011	Percentage	72.87
8.	Sex ratio	2011	Ratio (Female: Male)	979 :1000
9.	Scheduled caste	2011	Number	71,88,463
10.	Scheduled tribe	2011	Number	9,590,756
11.	Total Workers	2011	Number	10,709,664
12.	Total cultivators	2011	Number	3,279,769
13.	Total agricultural labourers	2011	Number	2,420,540

(Source: Census 2011 India & Odisha Economic Survey, Govt. of Odisha-2022-23)

❖ Population Distribution pattern in the project districts

The analysis of the population distribution pattern of the PIA's revealed that in the total 65 number of villages being affected by the project, approximately 20000 people will be potentially affected by the project if the proposed alignment is considered.

The population distribution according to the 2011 census of the three districts as well as the PIAs of proposed alignment are given in the following table.

Table 3-27: Population distribution of Project districts and PIA

Items	Khordha		Cuttack		Dhenkanal	
	Total District	PIA in district	Total District	PIA in district	Total District	PIA in district
Total Population	22,51,673	49052	26,24,470	23065	11,92,811	18218
Household	8,08,341	7471	5,81,766	7684	14,22,293	6702
Male	11,67,137	25426	13,52,760	11889	612,593	9356

Female	10,84,536	23626	12,71,710	11176	580,218	8862
Gender Ratio	929	937	940	956	947	968
SC Population	2,97,472	6480	4,98,633	4382	2,34,079	3575
ST Population	1,15,051	1299	93,745	425	1,62,056	1271

(Source: Census 2011 India & Odisha Economic Survey, Govt. of Odisha-2022-23 and Primary Survey)

❖ Population Density

The total land area of Odisha spans 155,707 square kilometers, and its population density is 270 persons per square kilometer, which is below the national average of 382 persons per square kilometer. The population density of the project districts viz. Khordha, Dhenkanal and Cuttack are 800, 667 and 331 persons/sq. km respectively, which are more than the national average.

Table 3-28: Population density in project districts and PIA

Items	Khordha		Cuttack		Dhenkanal	
	Total District	PIA in district	Total District	PIA in district	Total District	PIA in district
Population density (person/sq.km)	800	811	667	679	331	308

(Source: Directorate of Census Operations, GoI, 2011)

❖ Sex Ratio

The sex ratio in Odisha stands at 979 females per 1000 males, which is higher than the national average of 943, according to the 2011 Census. The sex ratio of the project districts viz. Khordha, Cuttack and Dhenkanal were 929, 940 and 947 respectively as per the Census, 2011.

Table 3-29: Sex ratio

Items	Khordha		Cuttack		Dhenkanal	
	Total District	PIA in district	Total District	PIA in district	Total District	PIA in district
Sex ratio (females/1000 males)	929	937	940	956	947	968

(Source: Directorate of Census Operations, GoI, 2011)

❖ Literacy Rate

The literacy rate in Odisha has shown an upward trend, reaching 72.87 percent according to the 2011 population census. Among this, male literacy is at 81.59 percent, while female literacy stands at 62.46 percent.

Table 3-30: Literacy rate

Items	Khordha		Cuttack		Dhenkanal	
	Total District	PIA in district	Total District	PIA in district	Total District	PIA in district
Literacy rate (%)	77.71	81.16	85.5	87.3	78.76	83.44

(Source: Directorate of Census Operations, GoI, 2011)

As per the Census of 2011, project districts Khordha, Dhenkanal and Cuttack have literacy rates of 77.71%, 85.50% and 78.76% respectively. The PIA of the proposed alignment had a cumulative average literacy rate of 85.46%.

❖ Employment Pattern

The Census 2011 classified the workers (both main and marginal) into four categories namely cultivators, agricultural labourers, household industries and other workers. The categorisation of workers revealed that majority of the population is working in agricultural sector with 30.63% cultivators and 22.61% agricultural labourers, forming a total of 53.24%, followed by 'other workers' with a share of 42.64% and 'household workers' have minimum shares i.e. 4.12%. The employment pattern is given in the following tables.

Table 3-31: Employment Pattern of Main and Marginal Workers in Odisha

Industry Classification	Population	Percentage (%)
Cultivators	3279769	30.63
Agricultural Labourers	2420540	22.61
Household Workers	441486	4.12
Other Workers	4565748	42.64
Total Workers	**10707543**	**100**

(Source: Directorate of Census Operations, GoI, 2011)

Table 3-32: Employment Pattern in Project Districts and PIA

Industry classification	Number of workers-2011					
	Khordha		Cuttack		Dhenkanal	
	Total District	PIA in district	Total District	PIA in district	Total District	PIA in district
Cultivators	88452	3068	137393	3031	357487	1362
Agricultural Labourers	108498	2398	244808	3927	821118	2650
Household Workers	19134	428	51828	476	88174	196
Other Workers	203382	6664	512505	3950	947175	3219
Total Workers	**419466**	**12558**	**946534**	**11384**	**2213954**	**7427**

(Source: Directorate of Census Operations, GoI, 2011)

As per Census 2011, project district wise data reveal that, among the four categories, other workers have maximum shares and household workers have minimum shares. As per districts stats, maximum other workers are recorded in Cuttack district with 54.15% shares whereas maximum household worker also recorded in Cuttack district with 5.48% shares.

In project influence area (PIA) of the Khordha districts, people are engaged maximum in other worker and minimum in household works. In PIA Cuttack district, people are engaged maximum as other workers and minimum in household works, whereas in PIA of Dhenkanal district, maximum workers are engaged in other works and household workers are minimum. Shares of cultivators are maximum in Cuttack district (26.63%) and minimum in Dhenkanal district (18.34%). Agricultural labourers are recorded more in Dhenkanal district (35.68%) and minimum in Khordha district (19.10%). In household works, Cuttack district has maximum share (4.18%) and Dhenakanal district has minimum share (2.64%). In other workers categories, people of Khordha district have greater contribution (54.15%) and people of Cuttack district have lesser contribution (34.70%).

❖ State Income

The net state domestic product (NSDP) and per capita NSDP for the period 2011-12 to 2022-23 (A) shown here in given table is as per Directorate of Economics and Statistics of Odisha state. The annual growth rate of NSDP and per capita NSDP showed a highest growth in 2022-23 and the details are given in Table 3-33.

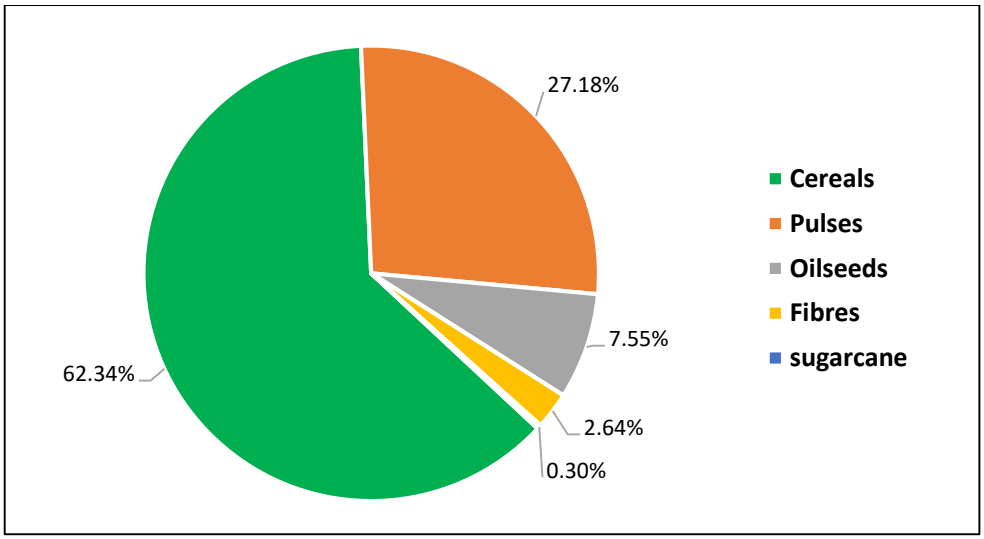
Table 3-33: NSDP and Per Capita NSDP at current prices of Odisha

Year	NSDP (Lakhs)	Per Capita NSDP (Rs.)
2011-12	20422595	48387
2012-13	23331248	54762
2013-14	26097737	60687
2014-15	27492342	63345
2015-16	28397902	64835
2016-17	34233170	77507
2017-18	38751692	87055
2018-19	43964875	98005
2019-20 (3rd RE)	47348001	104741
2020-21 (2nd RE)	46538857	102166
2021-22 (1st RE)	59107630	128873
2022-23 (A)	69546061	150676

(Source: Directorate of Economics and Statistics, Govt. of Odisha)

❖ Agricultural Profile

The total cultivated land of the state is 61.80 lakh ha out of which 29.14 lakh ha (47%) is High land, 17.55 lakh ha (28%) Medium land and 15.11 lakh ha (25%) low land and about 65% of cultivated land in Kharif season is irrigated. Majority of the farmers are small and marginal and have limited access to resources. Literacy too is a concern for this vulnerable group of farming community. As per Agricultural Census-2015-16 the number of operational holdings of the State is 48.66 lakh with an operational area of 46.19 lakh ha.



(Source: Odisha Crop Contingency Plan, 2022)

Figure 3-39: Gross cropped area percentage of Odisha state in 2021-22

The State witnessed a decline in operational area from 48.52 lakh ha in 2011- 12 to 46.19 lakh ha in 2015-16 due to urbanization and more of land put to non-agricultural use. Accordingly, the average size of land holding for all social groups in the State too has declined to 0.95 ha.
The major crops grown in the 2 districts through which the alignment passes are paddy, potato, sesamum, mustard and maize. Vegetable such as tomatoes, brinjals and leafy vegetables are also grown. Mango, banana, papaya, jackfruit and citrus fruits like oranges are some fruits grown in the project districts. The cropping area of the state is given in following figure.

Above chart shows that cereals are cultivated over the maximum area in the state, followed by pulses, oilseeds, fibres, and sugarcane are also cultivated in the state. The particulars about the cropping pattern of the project districts between 2011 and 2019 are given in the following tables.

Table 3-34: Cropping pattern of Khordha district

Sl. No.	Period	Area of Cultivation of Crops (ha.)				
		Rice	Maize	Potato	Rapeseed & Mustard	Sesamum
1.	2010-11	693110	64	119	42	104
2.	2011-12	97000	47	88	155	180
3.	2012-13	291000	27	73	48	68
4.	2013-14	98000	25	114	138	185
5.	2014-15	102000	6	114	138	185
6.	2015-16	99000	17	108	32	110
7.	2016-17	95070	14	134	10	15
8.	2017-18	84020	1	14	-	7
9.	2018-19	88160	12	11	19	-
10.	2019-20	89060	2	22	-	-

(Source: DACNET, GoI)

Table 3-35: Cropping pattern of Cuttack district

Sl. No.	Period	Area of Cultivation of Crops (ha.)				
		Rice	Maize	Potato	Rapeseed & Mustard	Sesamum
1.	2010-11	136000	37	1055	113	309
2.	2011-12	138000	17	775	30	194
3.	2012-13	504000	11	631	80	71
4.	2013-14	121000	5	401	10	5
5.	2014-15	122000	3	559	4	22
6.	2015-16	121000	3	517	3	-
7.	2016-17	119480	-	182	108	18
8.	2017-18	109010	-	118	11	-
9.	2018-19	97850	-	203	32	-
10.	2019-20	116810	-	309	8	-

(Source: DACNET, GoI)

Cropping pattern of Khordha, Cuttack and Dhenkanal districts (Table 3-35, Table 3-36 & Table 3-37) overall shows similar decreasing trend. Among crops, rice is cultivated in the largest area, followed by potato, rapeseed and mustard, sesame and maize.

Table 3-36: Cropping pattern of Dhenkanal district

Sl. No.	Period	Area of Cultivation of Crops (ha.)				
		Rice	Maize	Potato	Rapeseed & Mustard	Sesamum
1.	2010-11	92000	258	260	226	512
2.	2011-12	93000	80	216	105	174
3.	2012-13	308000	164	218	126	141
4.	2013-14	93000	36	329	95	108
5.	2014-15	98000	129	505	262	304
6.	2015-16	86000	41	170	1	210
7.	2016-17	75370	11	257	106	176
8.	2017-18	62640	21	146	24	75
9.	2018-19	89940	30	138	33	71
10.	2019-20	80970	103	177	109	53

(Source: DACNET, GoI)

❖ Industrial Profile

Odisha has drawn investments in a variety of industries over the past two decades, leading the nation's economic and industrial growth. By taking advantage of the various benefits that Odisha has offers, investors and entrepreneurs from all over the world are flocking to Odisha to create value for all the stakeholders- business, community, and working class. To give the industry players a more fulfilling experience, the State maintains industry-friendly policies, facilitates industry-friendly infrastructure, and guarantees quick and flexible administration. Occupying an important position on the country's map, Odisha's rich mineral reserves constitute 28% Iron ore, 24% coal, 59% Bauxite and 98% Chromite of India's total deposits. The state's comparative advantage on this account has attracted the attention of many mining and metallurgical companies.

Apart from large scale industries, major type of MSME operating in the state are food & allied, chemical & allied, electrical & electronics, engineering & metal based, forest & wood based, glass & ceramics, livestock & leather, paper & paper product, rubber & plastics, textiles, repairing & servicing and miscellaneous manufacturing etc.

Micro Small and Medium Enterprises (MSMEs)

Micro, Small, and Medium Enterprises (MSMEs) form the backbone of Odisha's economy, contributing significantly to employment generation, industrial output, and overall economic development. Odisha boasts a diverse landscape of MSMEs spanning sectors such as manufacturing, agro-processing, handicrafts, textiles, tourism, and more. as.

Table 3-37: MSME Udyam Registration details of project districts

District Name		Number of Udyam			
		Micro	Small	Medium	Total
1	Dhenkanal	1257	307	6	**1570**
2	Cuttack	11388	1621	57	**13066**
3	Khordha	12407	3654	157	**16218**
TOTAL		**25052**	**5582**	**220**	**30854**

(Source: Ministry of Micro, Small and Medium Enterprises, Govt. of India)

❖ Tourism

Odisha is a state of rich tourist hubs. The state has a very good strategic and geographical location. The state has wonderful demographic composition carrying very important historical, cultural and plenty of beautiful natural sites to visit. It has sites like Atri and Taptapani, the hot Sulphur springs, Balighai, an exquisite sea side resort, Banapur; the famous shrine of Goddess Bhagwati, Banki; a traditional spot of Shaktism named Maa Charchika, Bhitarkanika NP and Chilika WLS; attracting a large number of tourists of all kinds in to the state.

Odisha is famed for its forests, mountains, valleys, waterfalls, gorges, soaring peaks with stunning wildlife in their own natural habitats. For nature-tourists looking to experience wild landscapes in a sustainable way, from camping to eco-resorts, from trekking to birding, from sightseeing to boating.

Eco Tourism

Eco-tourism is about integrating conservation, communities, and sustainable travel. Eco-tourism in Odisha is operated by the Wildlife Wing of the state. Odisha has 2 National parks and 19 wildlife sanctuaries which promote tourism in the state.
However, the excellent spots outside the protected areas, in certain districts such as Anjar in Keonjhar, Sidhamula in Nayagarh, Ansupa in Cuttack, Mahavinayak & Olasuni in Jajpur, Nrusinghnath in Baragarh, Pakidi hill, Saluapali&Lalsing in Ganjam, Manchabandha in Mayhurbhanj, Dhaltangarh in Jagatasinghpur and Saptasajya in Dhenkanal have been developed with providing facilities for minimal camping, trekking and nature exploration to attract nature lovers. Besides, employment opportunities have also been created by engaging local communities living in and around the areas for maintaining the facilities like nature trails, watch towers, interpretation centers. The major tourist destination close to the PIA are the following:

- Kapilash Wildlife Sanctuary
- Saptasajya
- Chandaka-Dampara Wildlife Sanctuary
- Ansupa Lake Nature Park

❖ Comprehensive Socio-Economic Assessment

The standard term of reference for Road condition no. ‘15’ of the ToR (File No: 10/18/2024-IA.III) granted by the MoEF&CC dated 19/09/2024 states the following:

“The proponent shall carry out a comprehensive socio-economic assessment and also impact on biodiversity with emphasis on impact of ongoing and acquisition on the local people living around the proposed alignment. The Social Impact Assessment should have social indicators which can reflect on impact of acquisition on fertile land.
The Social Impact Assessment shall take into consideration of key parameters like people’s dependency on fertile agricultural land, socio-economic spectrum, impact of the project at local and regional levels.”.

In this regard, a comprehensive socio-economic assessment study with emphasis on impact of ongoing land acquisition on the local people living around the proposed alignment is undertaken. The study as

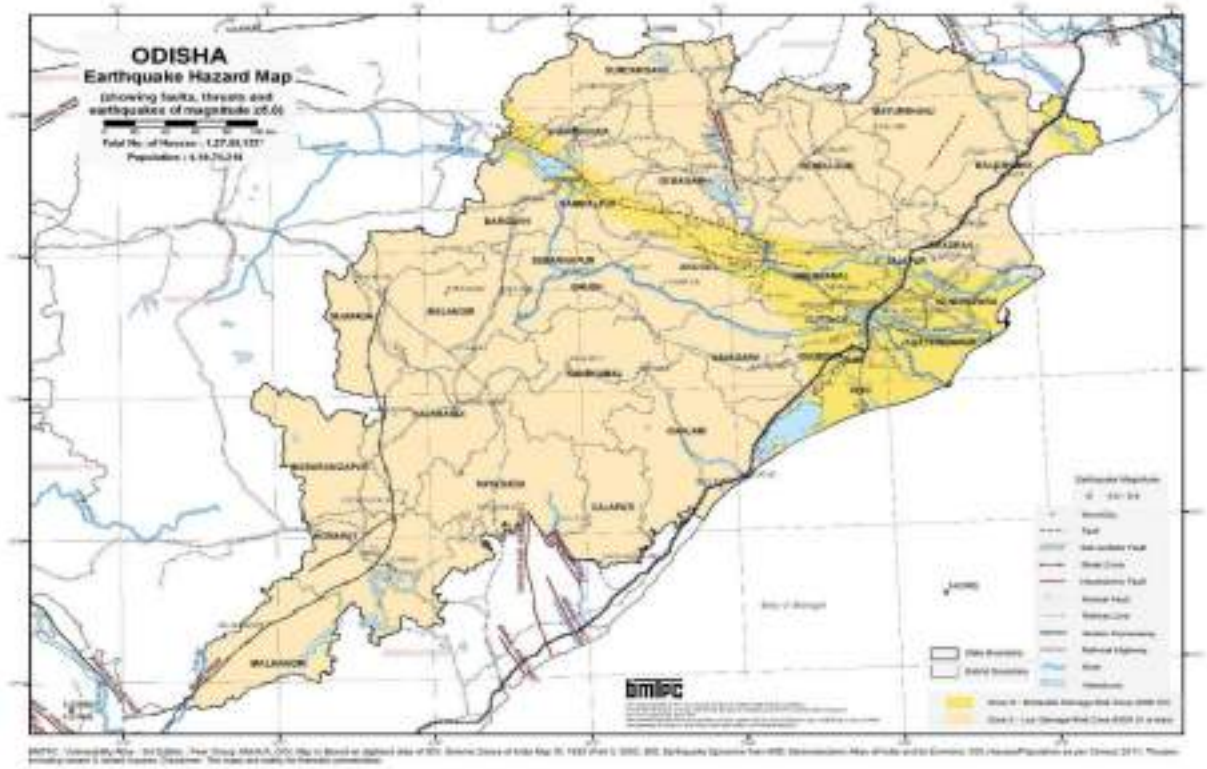
such addresses the impact of the highway on the local population. As such the project does not have any adverse impact on the local population. The detailed study is presented in Chapter 7 of this report.

3.4.4. Seismo-Technic Appraisal of the Project Area

Bureau of Indian Standards [IS-1893 part 1: 2002], based on various scientific inputs from a number of agencies including earthquake data supplied by IMD, has grouped the country into four seismic zones viz., Zone-II, -III, -IV and -V. Of these, zone V is rated as the most seismically prone region, while zone II is the least. The state of Odisha falls in Zone II and III, and as such the proposed project falls in Earthquake zone III, i.e. moderate damage risk zone as shown in Figure 3-40.

3.4.5. Other Meteorological Hazard Issues

The state of Odisha, being a coastal state of India on the east coast is also prone to other meteorological hazards such as cyclones, floods, heavy rainfall, heat waves, droughts and or possible tsunamis, arising due to its closeness to the Bay of Bengal. Climate change is significantly putting the coastal areas of the country in a vulnerable position in respect to the natural hazards.

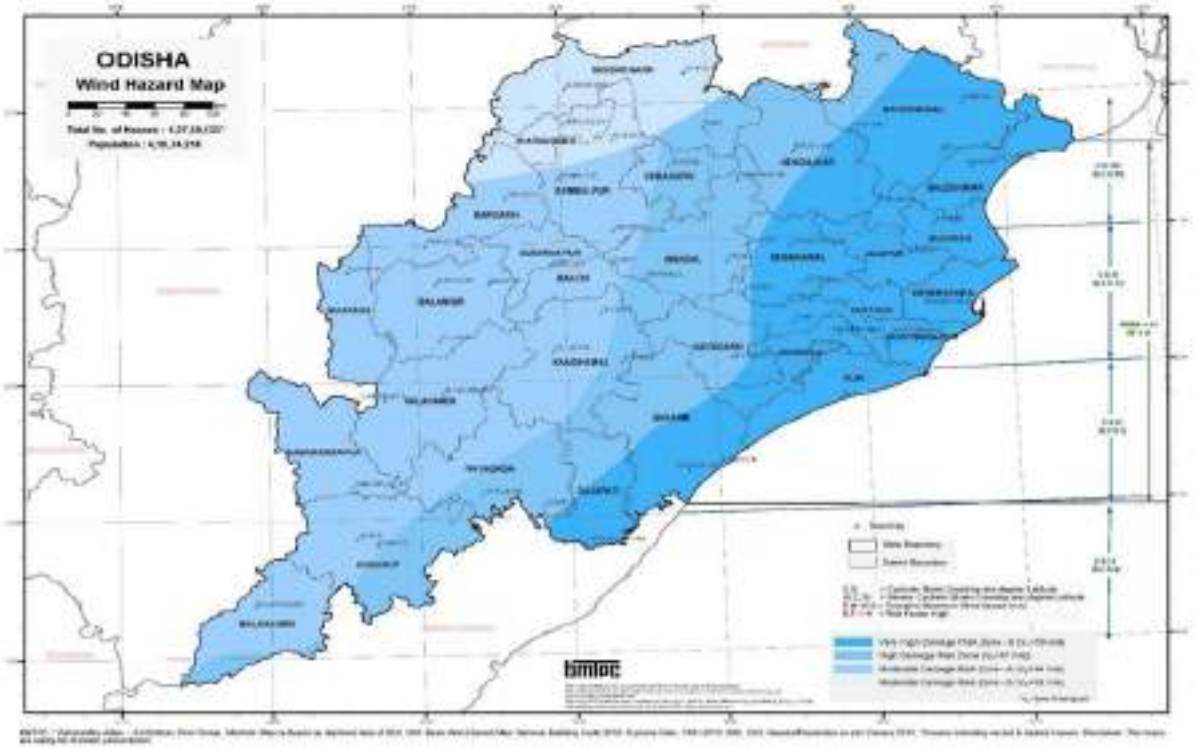


(Source: BMPTPC, GoI and Odisha State Disaster Management Authority, Govt. of Odisha)

Figure 3-40: Map showing earthquake zones of Odisha.

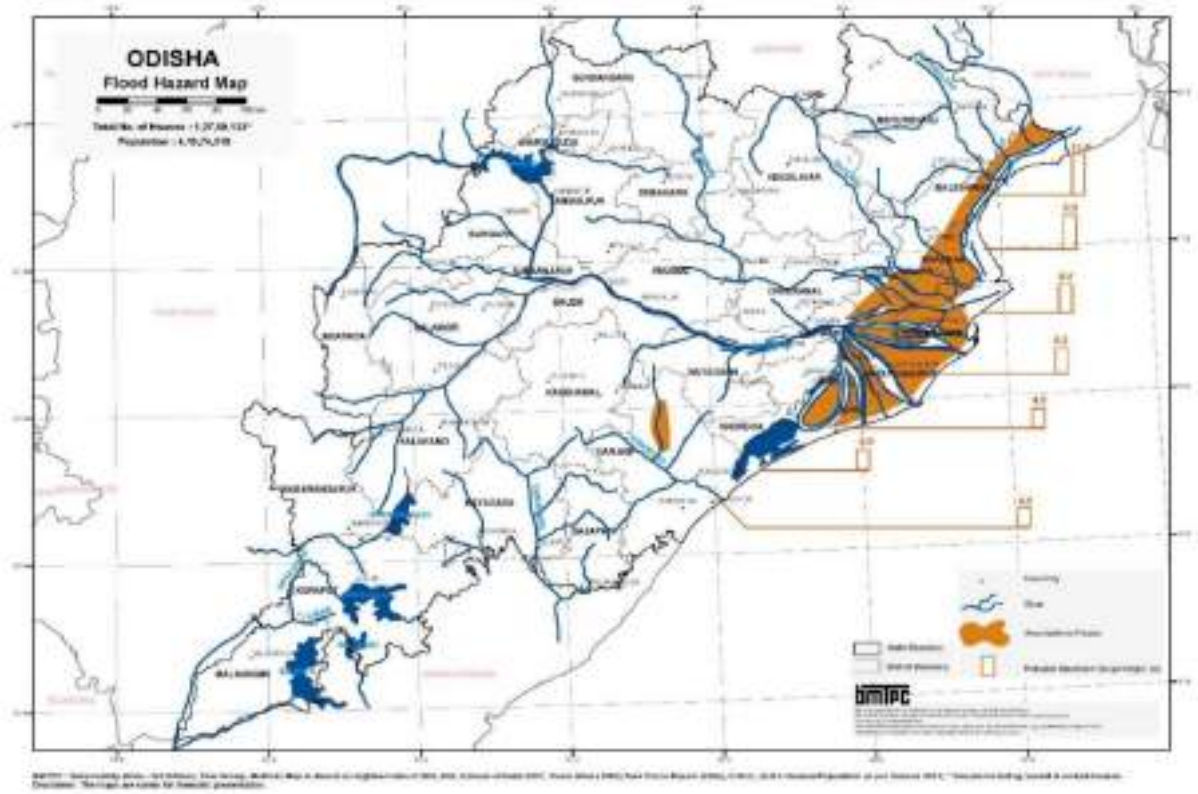
According to a report released by National Disaster Management Authority (NDMA), the districts of Khordha, Cuttack and Dhenkanal of Odisha, i.e. the project districts have a very high damage risk zone to high speed winds and tropical cyclonic storms. The Bay of Bengal has in the past few years seen a number of cyclones like, Laila and Jal (2010), Nilam (2012), Virayu, Phalin, (2013), Hudhud (2014), Roanu and Vardha (2016), Fani (2019), Amphan (2020), that have impacted the region and recently

Dana (2024) made landfall in the state with minimum impact. Some of the cyclones have generated winds of upto 150 kmph. The wind disaster map for the state is presented in Figure 3-41.



(Source: BMPTPC, GoI and Odisha State Disaster Management Authority, Govt. of Odisha)

Figure 3-41: Map showing Wind hazard zones of Odisha.



(Source: BMPTPC, GoI and Odisha State Disaster Management Authority, Govt. of Odisha)

Figure 3-42: Flood Hazard Map of Odisha

Being a coastal state, the coastal areas are also prone to coastal erosion and the same lies in low, medium to high-risk areas, the coastal risk erosion is an important factor to consider and various measures like tree plantation, mangrove plantation should be taken up to prevent coastal erosion.

The state is also prone to heavy rainfalls that lead to flooding and waterlogging in the region, the terrain and soil type also play an important part in this aspect. Among project districts, some part of Cuttack district is prone to flooding and flood surge varying from 4-8 m. The flood and landslide hazard map of Odisha is presented in Figure 3-42.

3.4.6. HTL/LTL and CRZ details

As the proposed alignment is not passing through any coastal zones, the CRZ clearance is not applicable on the project.

4. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 Introduction

Road development projects exhibit a symbiotic relationship between the environment and development with both positive and negative in addition to reversible and irreversible impacts. The assessment of potential environmental impact consists of comparing the expected changes in the environment with or without the project. The analysis predicts the nature and significance of the expected impacts. The magnitude and duration (short-term or long-term) of impacts are also discussed.

The identification of potential impact which follows are based on field inspection of existing road with due consideration of direct, indirect, cumulative and secondary impacts related to the following:

- Tree removal and replacement tree planting;
- Land acquisition and potential realignments;
- Eviction from habitation and work places;
- Protection of sacred groves, gravesites and temples;
- Effective restorations of borrow areas and quarries;
- Noise and air quality;
- Maintaining drainage including waterways areas and preventing siltation;
- Waste management, particularly from construction camps;
- Flora and fauna;
- Protection of forests, natural reserves;
- Cultural heritage;
- Road safety;
- Impact during construction period;
- Asphalt plants and equipment's;
- Resettlement and rehabilitation;
- Contractual enhancement;
- Institution buildings

4.2 Categorization of Impacts Based on time of Occurrence

The impacts on the various environmental components were assessed considering following stages.

- Planning and design stage (pre-construction stage);
- Construction stage; and
- Operation stage

The description and magnitude of impacts for the various environmental components as visualized for the project are presented in the following sections along with proposed mitigation measures.

4.3 Impacts on the Physical Environment & their Mitigation

4.3.1 Impacts on Meteorological Parameters

There will be very insignificant and temporary impact on the micro climate of the immediate project corridor because of paved surfaces and removal of approximately 13617 nos. of trees falling in Right

of way. Loss of agricultural lands will also cause micrometeorological changes but this will not cause any discomfort, as habitation are generally located away from the Corridor of Impact (CoI). With the provision of turfs on new embankments and compensatory plantation along the project corridor over much larger areas, there will be beneficial impacts on the micrometeorology of the project corridor.

A. Temperature

Construction Phase

- During construction phase an increase in temperature along the road at micro level is anticipated due to tree cutting, machine operations and paved surface.
- Transportation of construction material will increase heavy vehicle traffic movement on the road during construction phase, which may lead to minor increases in levels of temperature.
- There might be a short term and localized increase in temperature due to slow moving highway traffic along limited passage to the traffic in stretches where construction will be in progress.

Operation phase

During operational phase the temperature of the project road will normalize, as traffic will be speedier on improved and wider road surfaces. Such impacts will be very low, short term and reversible. Therefore, no mitigation measure is required.

B. Rainfall

There will neither be any micro nor macro level change in the rainfall pattern keeping in view the localised extent of operations.

C. Humidity

Construction phase

The humidity along the project road may be influenced only during the period of dust suppression through sprinkling of water.

This will be spatially confined within a very narrow corridor, short term and reversible. Hence no mitigation measures are necessary.

Common Mitigation Measures

Trees shall be planted in single to double rows on both sides at specific vacant spaces of proposed highway like Wayside amenities and empty spaces of RoW, in addition to median plantation. Compensatory afforestation shall be carried out in accordance with Forest Conservation Act, 1980. During construction stage proper traffic management will be carried out in according to with IRC Guidelines.

4.3.2 Impacts on Air

The Air Quality of the project area will probably be severely impacted during pre-construction and construction activities, with severity becoming lesser during the operational phase. The former will be short term impacts and will affect the settlements nearby to the project area as well as those areas situated downwind from the project location. On the other hand, operational phase impacts will be confined generally to around 100m from the edge of the lane on either side of the proposed corridor due to traffic movement.

Pre-construction & Construction phase

- Considerable dust may be generated during construction activities due to removal of old structures, Site clearance, earthwork & excavation works, use of heavy machinery, mixing of road materials and transport of raw materials from quarry to site, earth filling on alignment, thereby increasing the amount of particulate matter (PM_{10} & $PM_{2.5}$) in the immediate environment.
- The movement of heavy machinery, oil tankers will most probably generate exhaust gases. Operation of machineries, stone crushing operations in the crushers; Concrete batching plants, Asphalt mix plants due to mixing of aggregates with bitumen,High concentrations of harmful gases like SO_2, NO_2 as well as HCs likely to be generated from hot mix plant operations. Bitumen production releases volatile toxic gases. Impacts are generally localized, but may spread downwind owing to the direction of prevailing wind.

The details of materials which may have a potential impact on the air quality of the proposed project area are given below:

- **Use of Fly Ash:** As per ministry circular RW/NH-33044/01/2019-S&R (P&B) dated 21/10/2020, use of fly ash in road construction has been made mandatory within a radius of 300 Km of Thermal Power Plant. A thermal power plant of Odisha Jindal power Angul (70 km),Talcher NTPC (102 KM), IMFA Thermal Power Plant, Chaudwar (40 km) are falling within 300 km of proposed project alignment and the fly ash will be used from these power plants in the project depending upon their availability .
- **Use of coarse aggregates (stone) and fine aggregates (sand):** The total 15086634.58 cum amount of Coarse Aggregate shall be used for the construction of the proposed project. The Coarse Aggregate shall be brought from approved quarry from quarries located around nearby areas.
- **Use of bitumen**: Bitumen (VG 40) will be used for the construction of the road surface. Around 22904.49 MT of Bitumen (VG-40) shall be used for the construction of the proposed project, which will be obtained from IOCL or other approved suppliers. Mixing of bitumen will cause the emissions of harmful toxic gases and fumes, degrading the air quality.
- **Use of cement:** Cement used for the buildup of proposed structures along the entire highway stretch will lead to fugitive dust emissions if not managed correctly. The total 2877463.78 MT of Cement (OPC-43) will be used for the construction of the proposed project. The total amount of cement will be brought from the nearby approved suppliers of the project districts of Odisha.
- **Use of steel**: Steel will also be used for the construction of the highway as well as other structures along the proposed highway. The total of around 43466.29 MT of HYSD Steel will be used for the construction of the proposed project and will meet through the nearby approved suppliers in the project districts of Odisha or elsewhere in the state.

Operation Phase

- Dust generation is anticipated to be minimum during this phase. The shoulders being paved will reduce the generation of fugitive dust.

- The major impact on air quality during this phase will come from the exhaust gases emanating from vehicular traffic on the proposed road. CO, HC, Non-methane HCs and particulate matter are the primary pollutants that may arise from the vehicular exhaust.

Prediction of Impact on Ambient Air Quality

To assess the impact on air quality of the project area during operation phase, air pollution dispersion modeling was carried out using future traffic projections. CALINEpro is used to estimate emissions from vehicular emissions during the operational phase of the proposed project.

The following objectives were identified for conducting air dispersion modeling studies:

- To identify the quantum of air pollutants proposed to be released in the air environment; during the proposed construction and operational phase.
- To estimate the emission rate of identified air pollutants concerning different activities and related appropriate units.
- To identify the sensitive receptors, present along with the proposed road link.
- To identify the incremental concentration in baseline concentration due to proposed activity.
- To identify impacts due to estimated incremental concentration on nearby receptors.
- To suggest suitable mitigation measures to reduce the impacts of a proposed activity on the air environment.

Air Quality Dispersion Modelling

The operation phase of the proposed road development project is likely to have a significant impact on the air quality of the entire road stretch. However, during the construction phase, the impact will be temporary; even subject to the implementation of mitigation measures during construction activities & associated emissions.

To advocate suitable & cost-effective mitigation measures it is necessary to identify the parameter-wise quantitative impact of different air pollutants from different sources on a various component of the environment.

The air dispersion modelling tool is utilized to identify the incremental concentration proposed to be generated during the construction and operational phase of the proposed project. It shall be noted that two different air dispersion models are performed to get incremental values, for the phase-wise (construction &operational) impact assessment of the project.

AERMOD Cloud is used to estimate emission/incremental values during the construction phase, however; CALINEPro is used to estimate emissions from vehicular emissions during the operational phase of the proposed project.

The following objectives were identified for conducting air dispersion modelling studies:

- To identify the quantum of air pollutants proposed to be released in the air environment; during the proposed construction and operational phase
- To estimate the emission rate of identified air pollutants concerning different activities and related appropriate units.
- To identify the sensitive receptors, present along with the proposed road link.
- To identify the incremental concentration in baseline concentration due to proposed activity.

- To identify impacts due to estimated incremental concentration on nearby receptors.
- To suggest suitable mitigation measures to reduce the impacts of a proposed activity on the air environment.

Operational Phase

Operational phase i.e. vehicular movement, after construction of road is considered for conduction of air modelling studies.

Traffic projection values are considered to estimate the emission rate from proposed operational activity.

Analysis Method

For the quantitative impact analysis on the baseline due to the proposed activity, air dispersion modelling is performed. The criteria pollutants like PM, NOX & CO generated from vehicular movement are considered.

CALINEpro developed by Envitrans is used for air modelling simulation. The CALINEpro is an Air Modelling Software used to predict pollutant concentration near roadways/highways. Given source strength, meteorology and site geometry, the model predict pollutant concentration for receptors located within 500 meters of the road way.

The model is based on CALINE3's algorithm (See USEPA Preferred/ Recommended Models). It divides individual highway links in to 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 σy and σz 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.

Model option used for computation

- Traffic Emission Source Modelling is considered;
- 8 hours average concentrations are used by default;
- Average values are used for prediction by default;
- Grid receptors have been used for computations.

Modeling Procedure

The prediction of the Ground Level Concentrations (GLC's) due to proposed activity has been computed by CALINEpro. CALINE3 based CO model with queuing and hot spot calculations and with a traffic model to calculate delays and queues that occur at signalized intersections.

Meteorological Data Processing

The atmospheric inversion level at Bhubaneshwar during post monsoon period for 12 hours from 7:00 hour to 19:00 hour was analysed.

Modelling Data Input & Interpretation

Following conditions/activities are considered to perform ambient air quality modelling studies.

1) Vehicular emissions during operational phase

The emission factor used in the air dispersion modelling for estimating the pollutants from vehicular movement is are calculated using document of Automotive Research Association of India (ARAI).

Considering above sections proposed PUC load for each section is different, therefore emission factors are calculated for 4 different stretches.

Table 4-1: List of Reference Documents for Emission Rate Calculation

Sr. No	Emission Source	Reference document to calculate emission factors
Operation Phase		
1	Vehicular emissions during operational phase	Emission Factors Calculated by Automotive Research Association of India (ARAI)

Table 4-2: Model Input Parameters for Modelling

Sr. No.	Parameters	Values
1.	Source: Tail pipe of Vehicles	As per traffic study report the projection of vehicle movement in year 2024. However, 8 Hours of peak period is considered
2	Mixing Zone Width (m)	63 m
3	Link height	As per DPR provided
5.	Roughness	User defined

Table 4-3: Model Input Parameters for Modeling for year

Year's	D & P Vehicles/Day	Electrical Vehicles/Day	Total (D& P) Vehicles/Hr	Parameters	Package-1 (g/KM)	Package-2 (g/KM)
2024-25	8754	35	364.8	CO	1.63478	1.21686
				Nox	2.86963	2.13601
				PM	0.06934	0.05161
2029-30	14873	50	619.7	CO	1.40364	1.04483
				Nox	3.08756	2.29822
				PM	0.06650	0.04950
2039-40	26322	59	1096.8	CO	1.50022	1.11671
				Nox	3.02199	2.24942
				PM	0.05664	0.04216
2049-50	42227	651	1759.5	CO	1.40364	1.04483
				Nox	2.89900	2.15787
				PM	0.04443	0.03307
2059-60	67882	1907	2828.4	CO	1.32033	0.98285
				Nox	2.76906	2.06115
				PM	0.04443	0.03307

Air modelling was carried out for the year 2024-25, which was considered to be the end of construction phase and the starting year of the operation phase and subsequently modelling was run for the year 2060 and its results were calculated. Variation for both the years was analysed and it was found that there is a slight variation in the concentrations of PM, NO_2 and CO values, the incremental increase is very minimal. The detailed figures and table of the dispersion models for both the years are presented below. Detailed air quality modelling report with outcomes are attached in **Annexure 4-1.**

Figure 4-1: Index Dispersion model for CO (Operation phase -PK-1-Year 2024-25)

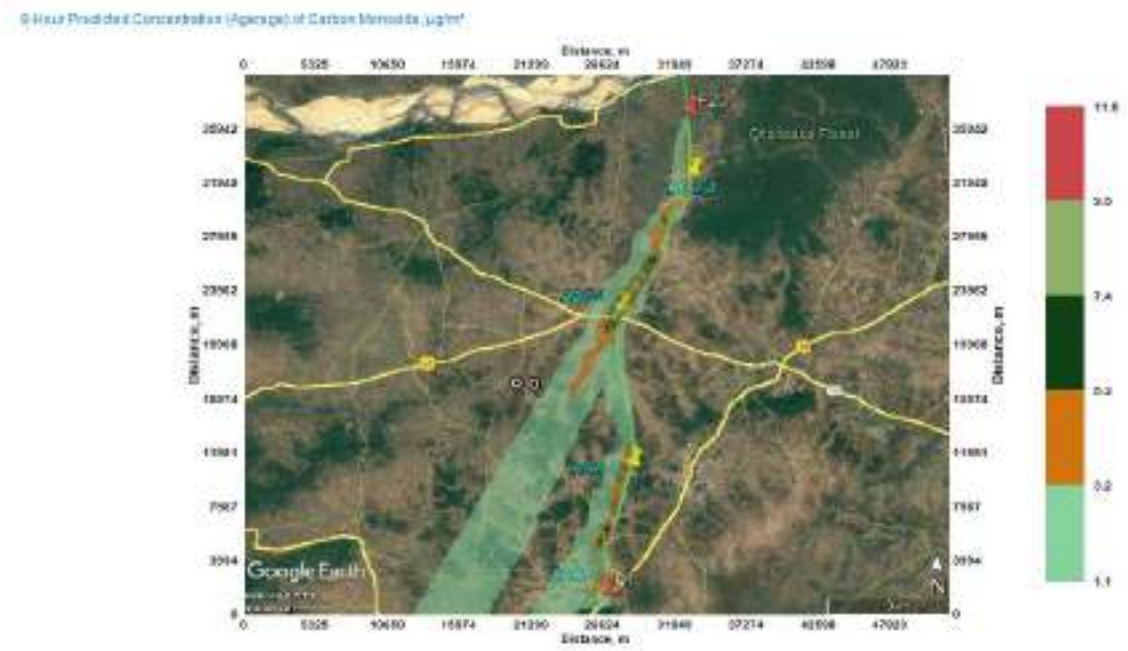


Figure 4-2: Dispersion model for NOx (Operation phase -PK-1-Year 2024-25)

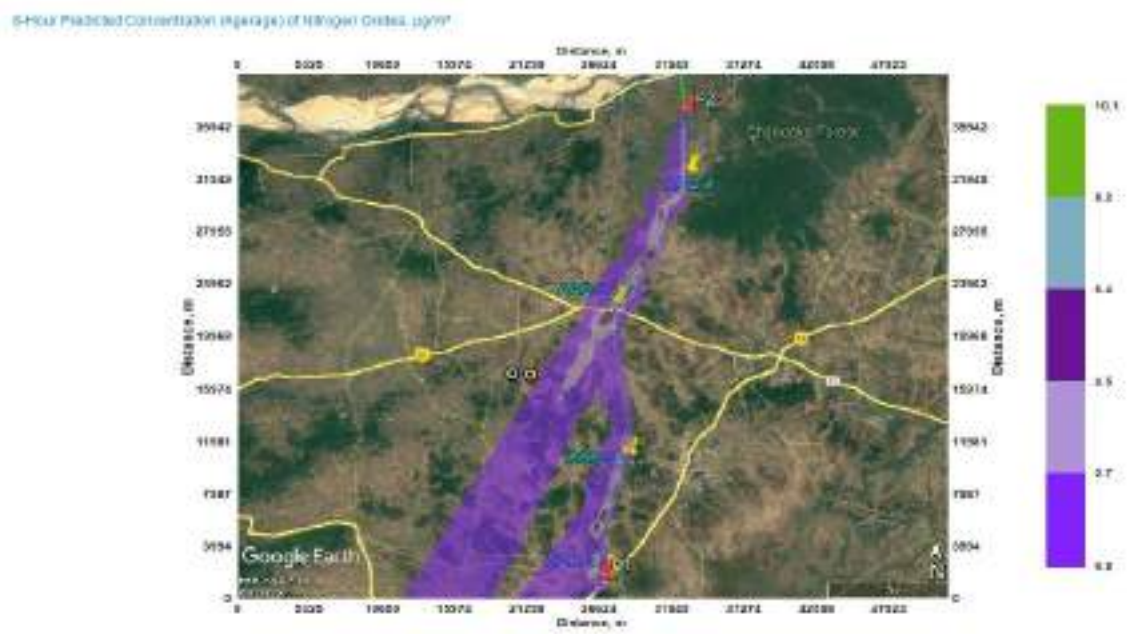


Figure 4-3: Dispersion model for PM (Operation phase -PK-1-Year 2024-25)

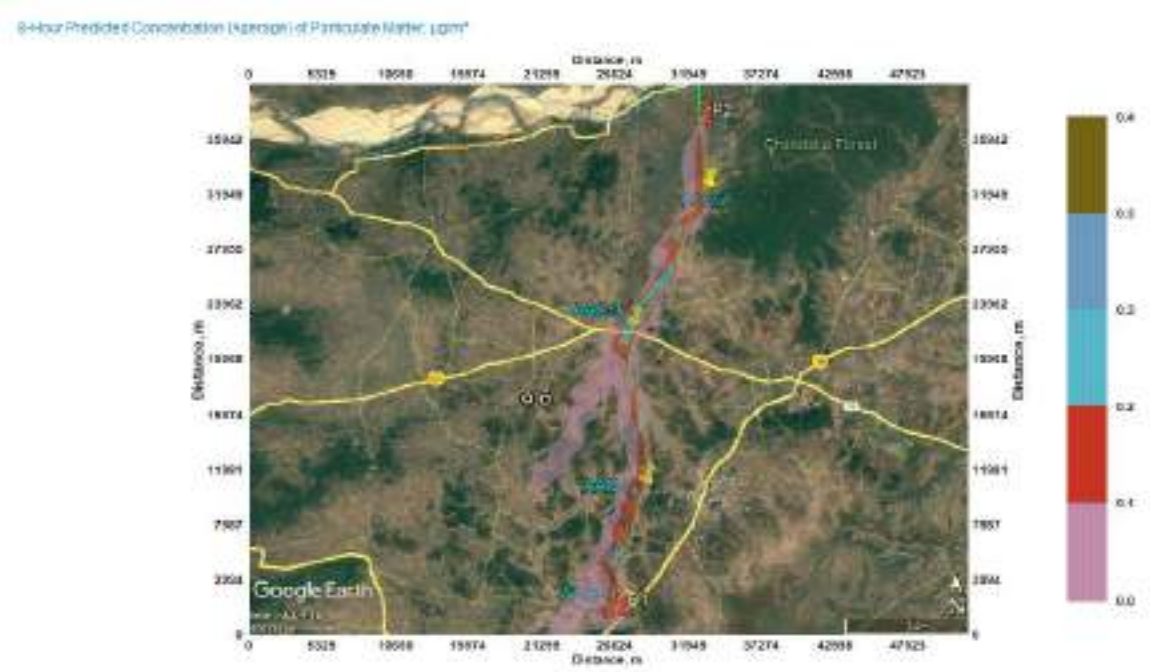


Figure 4-4: Dispersion model for CO (Operation phase -PK-2-Year 2024-25)

Figure 4-5: Dispersion model for NO_X (Operation phase -PK-2-Year 2024-25)

Figure 4-6: Dispersion model for PM (Operation phase -PK-2-Year 2024-25)

Figure 4-7: Dispersion model for CO (Operation phase -PK-1-Year 2059-60)

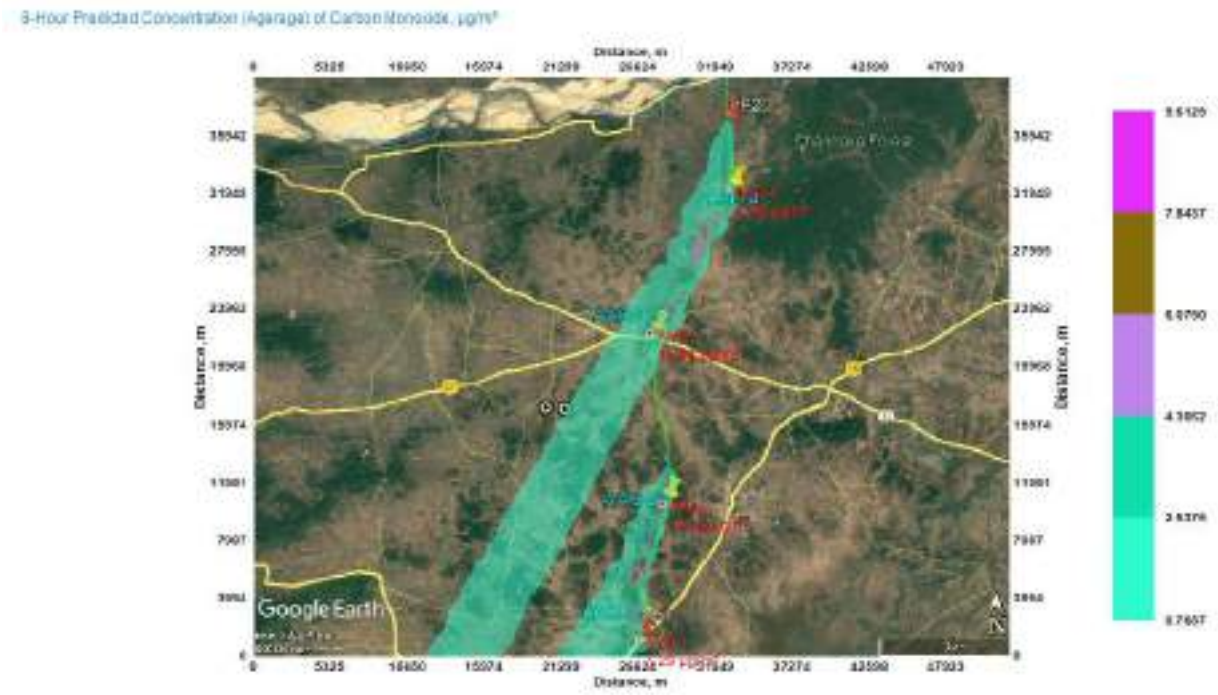


Figure 4-8: Dispersion model for NO_X (Operation phase -PK-1-Year 2059-60)

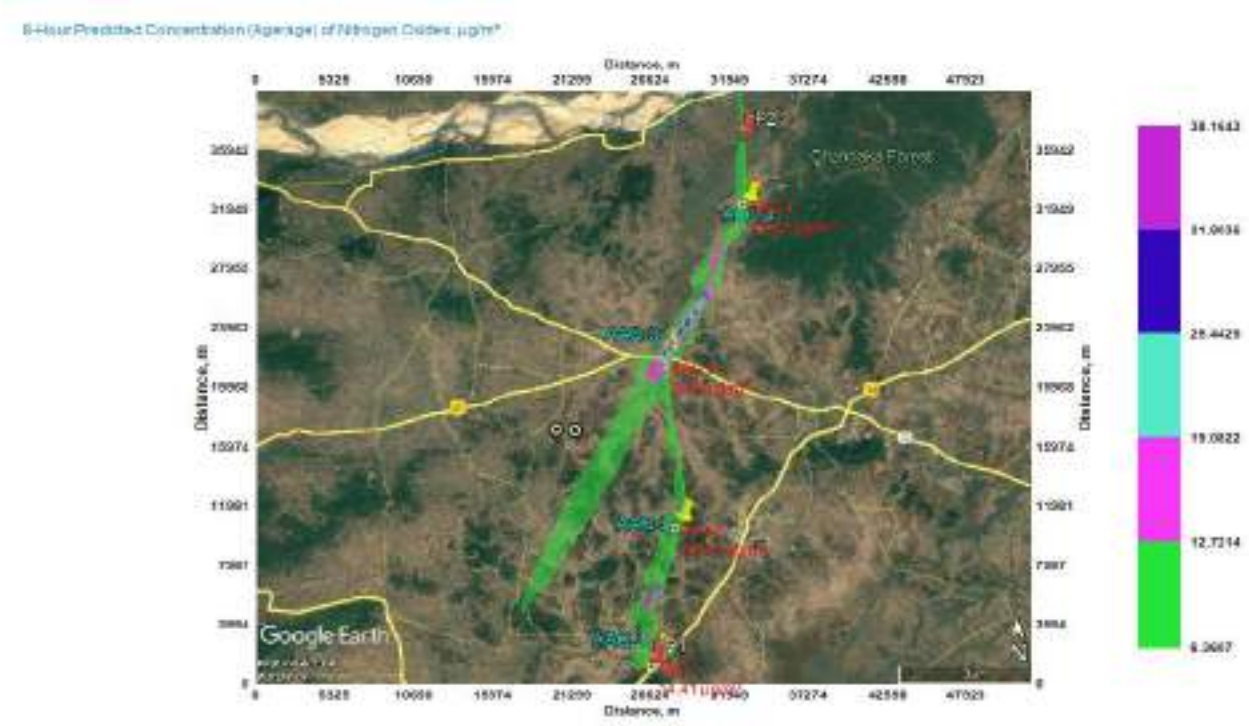


Figure 4-9: Dispersion model for PM (Operation phase -PK-1-Year 2059-60)

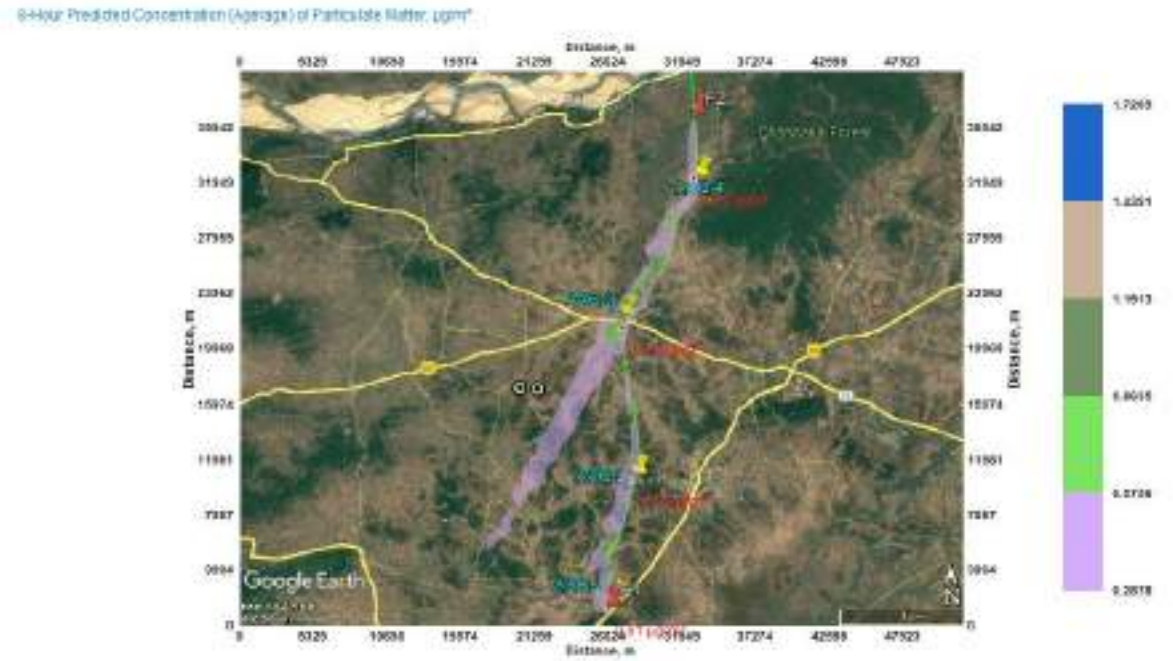


Figure 4-10: Dispersion model for CO (Operation phase -PK-2-Year 2059-60)

Figure 4-11: Dispersion model for NO_X (Operation phase -PK-2-Year 2059-60)

Figure 4-12: Dispersion model for PM (Operation phase -PK-2-Year 2059-60)

Table 4-4: Interpretation of Incremental Values (Operational Phase Year 2059-60)

S. No.	Sampling Location Code & Name	PM10 (ug/m3)			NOx (ug/m3)			CO (ug/m3)		
		BV	IV	RV	BV	IV	RV	BV	IV	RV
1	A1	75	0.612	75.612	18	14.412	32.412	900	7.29	907.29
2	A2	67	1.5	68.5	18	33.311	51.311	500	13.025	513.025
3	A3	71	0.412	71.412	16	9.33	25.33	600	15.833	615.833
4	A4	71	0.575	71.575	16.9	13.271	30.171	500	5.188	505.188
5	A5	69	0	69	19	0.075	19.075	900	0.075	900.075
6	A6	71	1.188	72.188	16	36.75	52.75	500	35.05	535.05
7	A7	68	0		19	0		600	0	600
NAAQS Standards		100 (24 hourly)			80 (24 hourly)			4 (1 hourly)		

As per modelling performed for operation phase, the resultant values obtained for operation phase by adding incremental values (IV) with observed baseline values (BV). It shall be noted that, by implementation of mitigation measures the resultant values (RV) will not exceed the limits of NAAQ standards.

4.3.2.1.1 Mitigation Measures

The predicted average concentrations with baseline along with the negligible proposed contribution from the project will be below the standards. Hence considering the present and the future scenario, it can be concluded that there will be minimal impact of the project. Whereas construction phase impacts have to be mitigated to the most so as to keep the air quality within prescribed standards. Therefore, following environment management measures need to be considering during operational phase;

1. BS-IV or higher version accommodating engines shall be adopted in future, however modeling has been performed considering emission factors for BS-II version vehicles.
2. Roads shall be maintained on timely basis to avoid dust emissions
3. Tree plantation shall be done to avoid dispersion of particles
4. Native trees with comparatively higher APTI (Air Pollution Tolerance Index) value shall be planted.
5. The generation of dust during the pre-construction and construction phases will mostly be contained within the RoW. Measures such as water sprinkling on haul roads around site, covering the material trucks carrying sand or other construction materials, provision of anti-pollution masks will mitigate these impacts. Generation of dust during operation phases may be curbed by avenue plantation as well as median plantation as per IRC SP-21:2009.
6. Regular pollution checks and maintenance of construction vehicles and machinery will likely reduce the impact of harmful exhaust gases.
7. Hot mix plant is suggested to be set up in downwind direction at least 1000m away from the nearest settlement.

8. Other mitigation measures may include reduction of vehicular emissions, ensuring vehicular maintenance and upkeep, as well as educating drivers on correct driving behavior. The project proponent together with the SPCB may do periodic inspections for PUC certificates at major junctions.
9. Wind direction masts will be set up at critical places at construction site such as hot mix plant, batching plant etc.

4.3.3 Impacts on Land & Soil

The land of the project location will likely be impacted during pre-construction and construction activities owing to excavation, pillar fixing, build-up of structures, etc. A total of 547.51 ha. land is to be acquired. Appropriate mitigation measures have to be employed for good management of the land in and around the project area.

Diversion of Forest Land- The alignment is passing through 3 districts namely Dhenkanal, Cuttack, and Khordha. The forest area with in the PROW of the alignment is 28.32 ha. Total 13617 trees will be affected.

Table 4-5: Affected structure details

Sl. No.	Alignment	Commercial structure	Community structure	Household structure	Religious structure
1	Ch 0+000 to Ch 70+995	22	4	43	2

Pre-construction & Construction phase

- The local people whose land is to be acquired will get affected.
- Construction activities may alter the local physiography and disrupt the prevailing drainage patterns as well as destabilize slopes due to cut and fill operations.
- Quarrying in non-scientific manner may make the soil condition of the area unstable and affect the terrain of the area. This may also lead to dust-generation.
- The very fertile top soil of the borrow area may be lost if mishandled. The borrow land may turn into potential breeding ground for mosquitoes and other disease-causing organisms if stagnant water is allowed to stand.
- Deforestation will cause soil erosion and cause increased runoff, which will lead to the erosion of the productive top soil. This may also lead to destabilization of the soil in the area.
- Elevated road sections will be vulnerable to erosion. Construction of new bridges will in turn result in the destabilization of the area, if not managed properly.
- Movement of heavy vehicles will likely cause soil compaction, beyond the carriageway, even within the vegetated area of the ROW.
- Improper waste disposal will cause contamination of the soil. Soil pollution from accidental vehicular spills or leaks are less probable.

Operation Phase

- Soil erosion during the operation phase will be minimum to non-existent because all slopes and embankments will be stabilized using proper engineering techniques such as pitching of

slopes, cement grouting and grass turfing, which shall prevent the soil erosion along the proposed road.

- Soil compaction will be restricted to the carriageway only and not affect the pavement.
- Contamination of soil from accidental vehicular spillage and leaks will be less likely at this stage if proper safety measures are employed.

Mitigation Measures

- All earthwork will be completed in such a way so that the soil erosion and carryover of the materials in other areas are protected.
- Excavated soil will be used for green-belt development
- Measures should be taken to protect top soil, water channels and flora and fauna, prevent animal injuries and mortality during earthwork, and minimize clearing of vegetation.
- The Project Affected Persons (PAPs) will be compensated for their land as per the National Highways Act (NH Act), 1956 and relevant Acts and Rules of the Government of India and State Government.
- Existing approved quarries are recommended for use, with proper access roads, mitigating the generation of fugitive dust. Sand should be collected from approved river quarries in close proximity to the project location. Proper care for transportation of materials from the quarries to the site are recommended to minimize the impact due to spillage from the vehicles.
- Borrow area location have to be selected in a scientific manner taking into consideration the local environmental, social sensitivity and State departments approvals.
- Borrow area will be taken at distance of 5km in the range of 500 either side of the proposed alignment.
- The top soil from the borrow areas shall have to be preserved carefully and used for rehabilitation.
- Tree felling has to be limited to the Corridor of Impact (CoI) only to check soil erosion. Other measures include stone pitching the high embankments, cement grouting, avenue and provision of Silt-fencing to prevent the runoff of eroded materials.
- Regular cleaning of drains by the contractor will help in keeping the drainage structures clear of debris. During operation stage, appropriate measures have to be employed such as pitching of slopes and turning.
- The movement of vehicles have to be limited to reduce the compaction of soil of nearby productive land. Compaction in areas other than ROW shall have to be kept in check.
- Soil contamination can be mitigated by employing the following strategies:
- Storage of fuel in separate designated areas with RCC surface for prevention of soil contamination due to spillage and proper oil-grease traps.
- Septic tanks will have to be provided with soak pit facility to prevent soil contamination due to sewage discharge or seepage.
- Bitumen waste has to be disposed-off in designated landfill sites.

Generation of Solid Waste Material

Proposed project does not produce any solid waste, however, some of the solid waste shall be generated during the construction phase by the construction labour i.e. domestic waste, Discarded tires, drums will be sold to authorized declares. 18 kg/day of dry waste and 27 kg/day of wet waste

will be generated by 150 nos. of labour. Dry Waste will be sold to authorized recycler whereas Wet waste will be handed over to municipal council authorities.

Mitigation measures-

All outside material left over after construction or repair (including stones, sand, cement, packaging material, papers, cartons, oils, cans, bags, wires, metal objects, housing sheds, plastics and glass) should not be left on the project site, but should be carefully removed and carried away outside the reserved forest area and safely disposed of or reused elsewhere

4.3.4 Impacts on Water Resources

The water resources of the Project Influence Area (PIA) will be affected mainly due to construction activities, which may threaten to deplete the water resources of the region adversely if overexploitation is not managed properly.

A. Surface Water Resources

The surface water bodies will likely be affected due to the various construction activities and also during the operation stages of the project.

Pre-Construction & Construction phase

- No adverse impact is estimated during the pre-construction.
- Increased runoff due to removal of trees and soil compaction will increase the sediment load flowing into the surface water bodies in the vicinity of the project area.
- Runoff of harmful chemicals into the surface water bodies due to accidental spillage are less likely to occur.
- Natural flow of the surface water bodies like the rivers and nalahs may be blocked due to the proposed alignment crossing them.
- Total 19 surface water bodies which may be affected during Pre-Construction & Construction phase

Operation Phase

No adverse impact is estimated during the operation stage of the project.

Mitigation Measures

- Physical loss of water bodies is to be avoided by designing in appropriate way like compensatory digging for any pond being affected, etc.
- The designing of culverts/bridges, over the natural streams/rivers/canals shall be designed in such a manner that it does not hamper the natural course of water, does not give rise to waterlogging and also does not hamper movement of wild animals. Cross-drainage structures need to be constructed to maintain the natural flow of water.
- Silt fencing is to be provided for effective management of runoff and to avoid possible siltation.
- Proper drainage systems are proposed for management of surface runoff, taking care of extra flow.

B. Groundwater Resources

Pre-Construction & Construction phase

- No adverse effect during pre-construction phase.
- Total requirement of water for the construction is estimated 750 KLD which will be met through surface water and ground water proposed to be used only for camp site for transient period after obtaining the permissions from appropriate authority, which may lead to the depletion of the water table of the region.

Operation Phase

- No adverse effect on groundwater is anticipated in the operation phase.

Mitigation Measures

- Considerable efforts will be made to use surface water sources as the primary source for collecting water during the construction phase.
- Prior permissions will be taken from the respective authorities for the use of surface and groundwater resources in construction activities.
- Rainwater harvesting techniques may be used wherever possible. Rainwater harvesting pit will have to be situated at least 3-5 m above the highest ground water table.

4.3.5 Impacts on Water Quality

A. Surface Water Quality

Pre-construction & Construction phase

- Surface water quality will be degraded due to runoff of sediments during construction activities emanating from removal of trees, excavation of soil, removal of grass cover, etc. The increased runoff will make the water more turbid. This may also cause hindrance to the growth of algae and completely cause the alteration of the natural balance. Fish and other aquatic life may also get disrupted due to excessive sedimentation.
- Water pollution may occur due to rainwater flow from muck disposal area, water flow from scarified bitumen materials, oil spills from machinery, discharge of sewage or wastes, etc.

Operation Phase

- No adverse effect on surface water quality is anticipated in the operation phase.

Mitigation Measures

- The designing of culverts/bridges, over the natural streams/rivers/canals is in such a manner that it does not hamper the natural course of water, does not give rise to waterlogging and also does not hamper existing seasonal stream Silt fencing will be provided to keep the sediment runoff in check.
- Silt fencing will be provided to keep the sediment runoff in check.
- Oil interceptors will be provided at prime locations from where oil and grease discharge into the water bodies is anticipated. The collected materials will be disposed-off as per MoEF&CC and SPCB guidelines.

B. Groundwater Quality

Pre-construction & Construction phase

- No adverse effect on groundwater is anticipated during pre-construction phase.

During construction, Groundwater quality may be affected due to:

- Spillage of chemicals or other harmful substances which may lead to groundwater pollution in the long run.
- Leaching of substances such as water from scarified bituminous waste materials, oil containing cotton wastes, etc.

Operation Phase

- No adverse effect on groundwater quality is anticipated in the operation phase.

Mitigation Measures

- Harmful and toxic chemicals should be stored carefully in lined, leak-proof containers.
- Oil interceptors may be used to prevent oil from seeping into the ground.

4.3.6 Impact of Solid Waste

No impact is envisaged during operation phase of the project. Disposal of waste may impact the natural environment scenic areas and roadsides by travelers.

Mitigation Measures

- Proper management and disposal of solid waste generated from tourist
- Top soil will be used for plantation

4.3.7 Impacts on Noise Environment

The noise level of the PIA is likely to get increased due to site clearing activities, movement of man as well as various machineries such as Vehicles, Crusher, DG sets and Hot Mixing Plant, etc. Noise pollution will mainly occur from movement of vehicles, transportation of construction materials as well as other construction activities. No adverse effect of noise is anticipated during the pre-construction activities.

Construction phase

- Construction activities will likely increase the noise levels of the area more than 55dB(A) i.e. CPCB-prescribed day time noise limit at about 100m from the construction site and 45dB(A) i.e. CPCB-prescribed night time noise limit at about 300m from the construction site.
- The high levels of noise will likely affect the settlements as well as any wildlife in forest areas falling nearby to the alignment. The details of settlements and forest area adjacent to the alignment and their locations are given in tables below.

Table 4-6: List of villages falling within RoW of the proposed alignment

District	Tehsil	S. No.	Village Name	District	Tehsil	S. No.	Village Name
Khordha	Tangi	1	Balarampur	**Khordha**	Begunia	34	Lokanathapur
		2	Rameswar			35	Kathakhuntia
		3	Ambabil			36	Patanibar

		4	Damanbhumi		Damapada	37	Talabasta
		5	Kuanrakalipatna			38	Bilipada Saradhapur
		6	Nayakot			39	Badapadanpur
		7	Gayabandha			40	Simil Pur
		8	Gayabandha			41	Makundapur Charigharia
	Khordha	9	Jankia		Banki	42	Kantapahara
		10	Madhapur			43	Patugadadharpur
		11	Kaipadar			44	Sahanga gopal pur
		12	Bhatapara			45	Gholpur
		13	Kankadahad	**Cuttack**	Athagarh	46	Mahidharpur
		14	Mangalpur			47	Gopiballav Pur
		15	Radhakantapur			48	Nuabandha
		16	Bangida			49	Chirigunipat
		17	Kumbhilo			50	Khuntakata
		18	Adhakhandia			51	Gudupada
		19	Balisahi			52	Samsarpur
		20	Basanta			53	Amrutamanohipatana
		21	Brahmanabereni			54	Jagannath Pur
		22	Hatasahi			55	Kuanal
		23	Kuaput			56	Koranga
	Begunia	24	Parichhal	**Dhenkanal**	Dhenkanal	57	Shankarpur
		25	Dalak			58	Jenasahupatana
		26	Goda			59	Padmalabhapur
		27	Masania			60	Patarabhaga
		28	Ramasinghprasad			61	Manipur
		29	Phulachhanchuni			62	Talabarkote
		30	Karadagadia			63	Siaria
		31	Botalama			64	Baladiabandha
		32	Kesarada			65	Gobindapur
		33	Sarua				

Table 4-7: Details of Forest falling within the RoW of the proposed alignment

S. No.	District	Type of Land	Area in ha.
1	Khordha	Revenue Forest land	9.29
2	Cuttack	Revenue Forest land	0.05
3	Dhenkanal	Revenue Forest land	18.98
Total			**28.32**

Operation Phase

- During operation stage, noise emanating from road will depend on many factors such as traffic intensity, vehicular type and condition, as well as the condition of the road.
- Assessment of Noise Impact intensity at various distances from the proposed highway is estimated using Dhwani Pro software, a computer program developed to undertake construction, industrial and traffic noise propagation modelling.

Prediction of Impact on Noise Environment

Noise modelling study has been done using the Software tool "DhwaniPRO", which predicts the noise levels at various receiver points due to the sources present at the site. A google earth image of the project site has been imported into the software. Various sources of noise have been added with their Sound Pressure Levels (SPLs) and based on reconnaissance survey, sensitive receptors such as schools, hospitals, religious places,were identified in order to measure the intensity of noise due to vehicles plying on the project road

4.3.6.1 Impact on Noise levels

The assessment of potential road noise impacts helps in understanding one of the most significant pollution, the noise pollution. Some salient features related to potential noise impact of a road development include: (i) the road noise impact is greatest where busy road passes through densely populated areas, townships and markets (ii) the range of noise level should be understood in relation to the habitation type also; for example, road noise in industrial area is not likely to be problematic but at sensitive location like schools and hospitals; its impact may be significant, (iii) mitigation of noise in urban areas is rather difficult, especially at the road intersections.

Environmental noise particularly highway traffic noise, is a complex phenomenon because its intensity and characteristics vary with time depending upon the frequency as well as type of vehicles on the road.

The impacts of noise due to the project will be of temporary significance locally in the construction phase and slight increase may occur during the operation stages. Table below presents the source of noise pollution and the impact categorization.

Table 4-8: Source of the Noise pollution and its impact

Sr. No.	Phase	Source of Noise pollution	Impact categorization
1	**Pre-construction**	• Man, material & machinery movements • establishment of labor camps, onsite offices, stock yards and construction plants	• all activities will last for a short duration and also shall be localized in nature
2	**Construction Phase**	• **Plant Site** stone crushing, asphalt production plant and batching plants, diesel generators etc • **Work zones** Community residing near to the work zones	• **Plant Site:** Impact will be significant within 500m. • **Work zones**: Such impacts again will be of temporary nature as the construction site will go on changing with the progress of the works.

Sr. No.	Phase	Source of Noise pollution	Impact categorization
3	**Operation Phase**	• Due to increase in traffic (due to improved facility)	• Will be compensated with the uninterrupted movement of heavy and light vehicles.

Although the baseline day & night time noise levels monitored at nine locations along the proposed project are within permissible limits specified by the MoEF&CC. The noise levels vary from 43 dB(A) to 56 dB(A) during daytime and whereas during night time the noise level varies from 26 dB(A) to 42 dB(A). The Mathematical equation is used for noise prediction is L2 = L1-20 Log D2/D1.

Prediction of Noise Impact on Noise level

A noise propagation modelling study has been conducted to find out the impact from the noise generated because of the estimated total traffic flow as well as the significance of these impacts. The noise modelling has been done taking into account the design speed at various stretches and the stretches with restricted speeds have also been considered. DhwaniPRO is a computer program developed to undertake construction, industrial and traffic noise propagation studies for noise assessment.

Different operative speeds have been used for various horizon years in the design life to get a realistic picture of the noise levels. DhwaniPRO is used for noise modelling. The table below presents noise level predictions for the receptors at the homogenous intersections.

Table 4-9: Noise level predictions for the receptors at homogenous intersection

S. No.	Locations	Noise Level in dB(A)							
		Year 2021	Year 2027	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050	Year 2055
1.	N1	56	57	58	59	60	61	62	63
2.	N2	43	44	45	46	47	48	49	50
3.	N3	44	45	46	47	48	49	50	51
4.	N4	49	50	51	52	53	54	55	56
5.	N5	52	53	54	55	56	57	58	59
6.	N6	49	50	51	52	53	54	55	56
7.	N7	53	54	55	56	57	58	59	60

Based on the prediction results as provided in Table 4-9, it can be concluded that the noise level is 44 dB(A) in the year 2021 and will be 50 dB(A) in the year 2055. This level is higher for land use like sensitive areas. In case of the presence of sensitive areas in the stretch (From Ch. 76+420 – 77+500), barriers of height 2 m shall be provided. Table 4-10 represents the noise level after taking mitigation measures such as noise barrier etc.

Table 4-10: Noise level predictions for the receptors after taking mitigation measures

S. No.	Locations	Noise Level in dB(A)				
		Year 2021	Year 2030	Year 2040	Year 2050	Year 2060
1.	N2	31	33	35	36	38

4.3.6.2 Outcome of the Noise Level Modelling:

- The predicted noise levels during both day and night time are within limit for base year 2021 for the respective land use area like commercial. At the end of design period of the project it exceeds the limit for residential and commercial area as per CPCB norms and this can be controlled using general linear wall type sound barrier or by proposed tree and shrub plantations.

The contour map showing noise levels due to total traffic outcome at noise monitoring location 1 (NL1) and monitoring location 4 (NL4) has been shown in **Figure 4-13** to **Figure 4-22.**

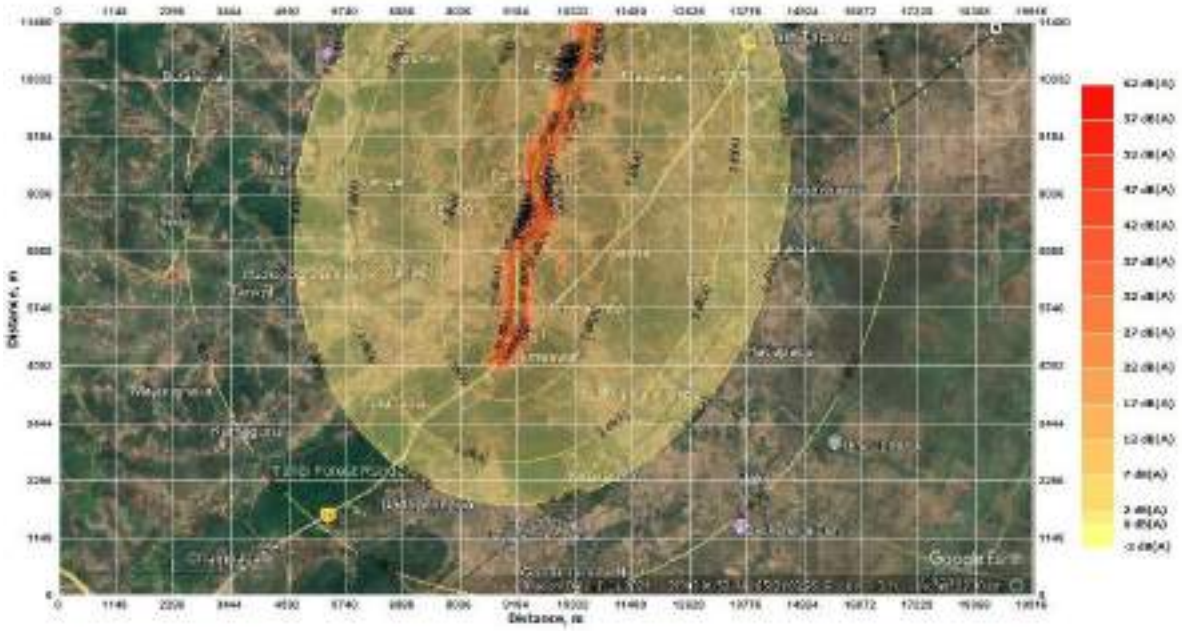


Figure 4-13: Contour map showing noise levels due to total traffic outcome during 2021 year for NL1

From Figure 4-13, it can be observed that the noise levels in 2021 range from a maximum of 62 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL1 location is measured at 56 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL1 site remains within the regulatory standards for environmental noise levels.

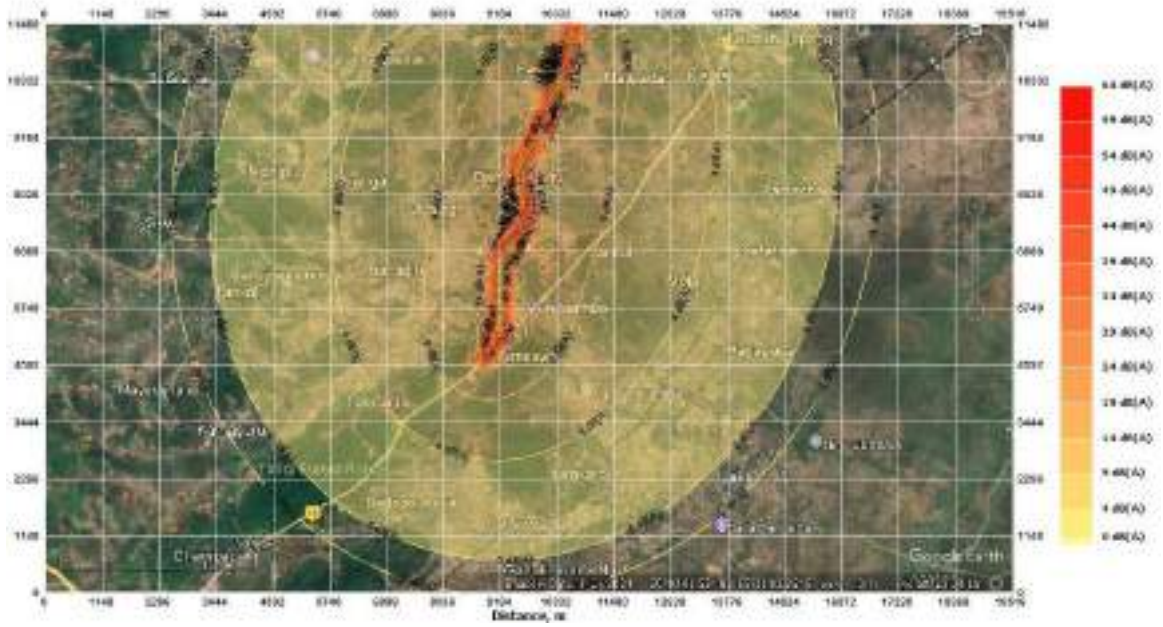


Figure 4-14: Contour map showing noise levels due to total traffic outcome during 2030 year for NL1

From Figure 4-14, it can be observed that the noise levels in 2030 range from a maximum of 64 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL1 location is measured at 57 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL1 site remains within the regulatory standards for environmental noise levels.

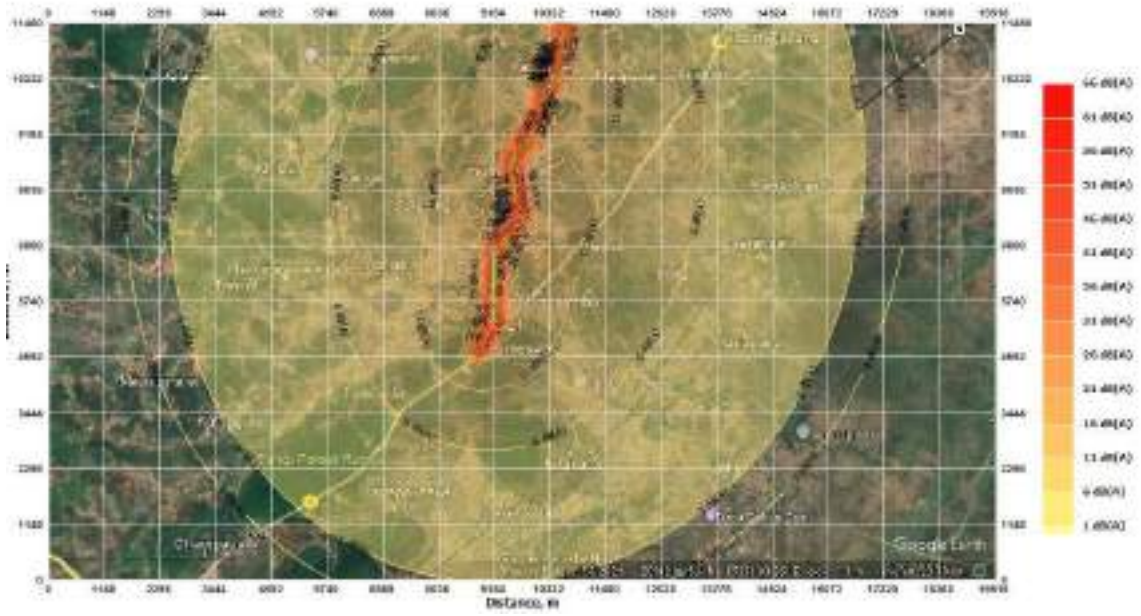


Figure 4-15: Contour map showing noise levels due to total traffic outcome during 2040 year for NL1

From Figure 4-15, it can be observed that the noise levels in 2040 range from a maximum of 66 dB(A) to a minimum of 1 dB(A). Notably, the noise level at the NL1 location is measured at 60 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board

(CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL1 site remains within the regulatory standards for environmental noise levels.

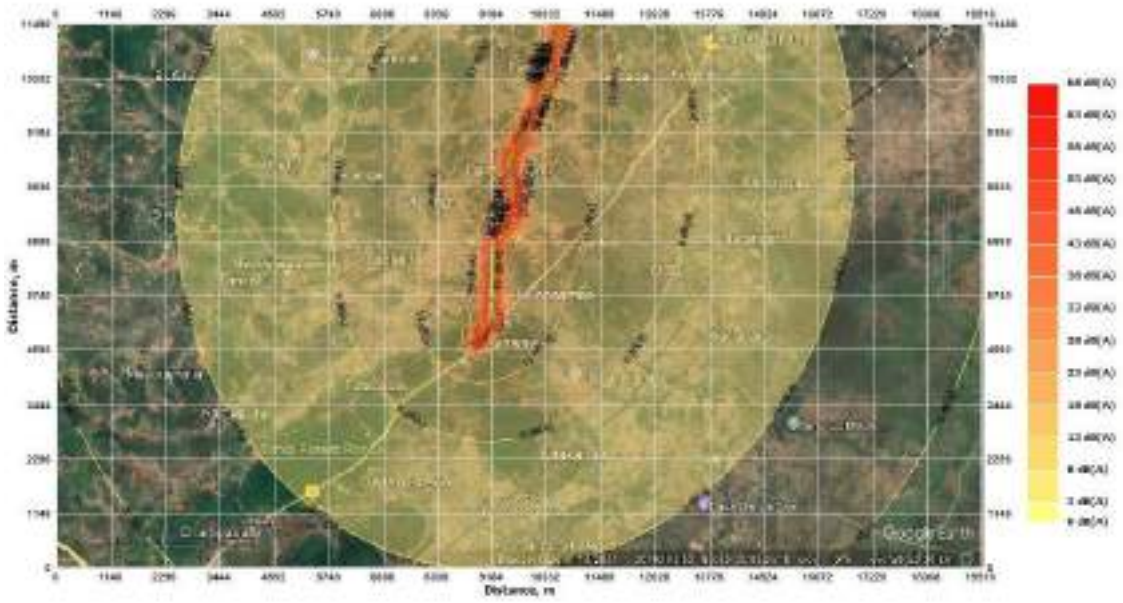


Figure 4-16: Contour map showing noise levels due to total traffic outcome during 2050 year for NL1

From Figure 4-16, it can be observed that the noise levels in 2050 range from a maximum of 68 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL1 location is measured at 62 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL1 site remains within the regulatory standards for environmental noise levels**.**

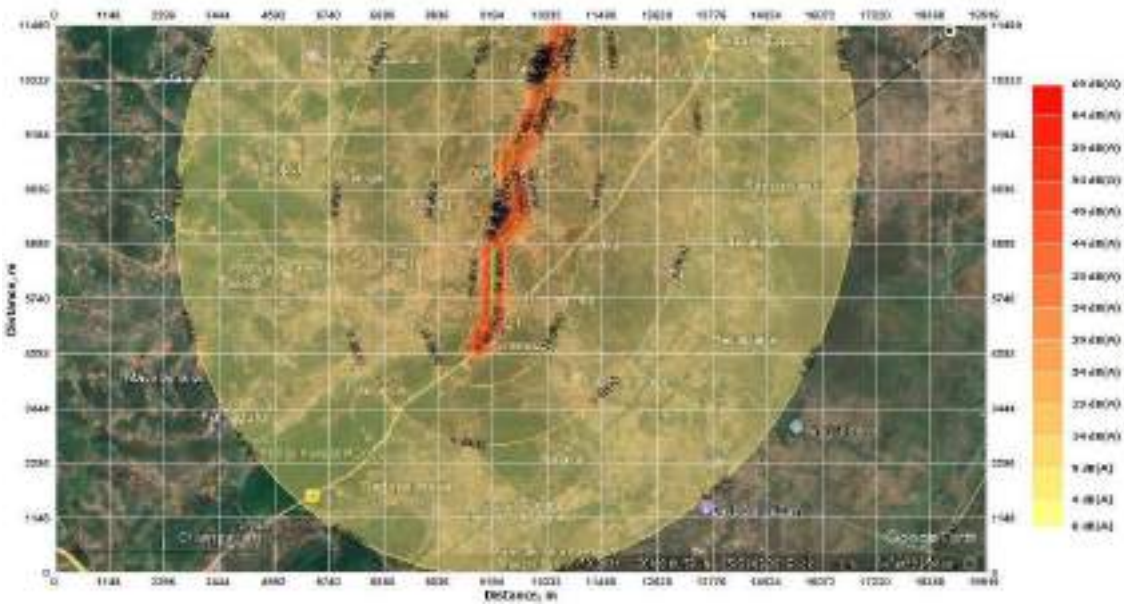


Figure 4-17: Contour map showing noise levels due to total traffic outcome during 2055 year for NL1

From Figure 4-17, it can be observed that the noise levels in 2055 range from a maximum of 69 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL1 location is measured at 63 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board

(CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL1 site remains within the regulatory standards for environmental noise levels.

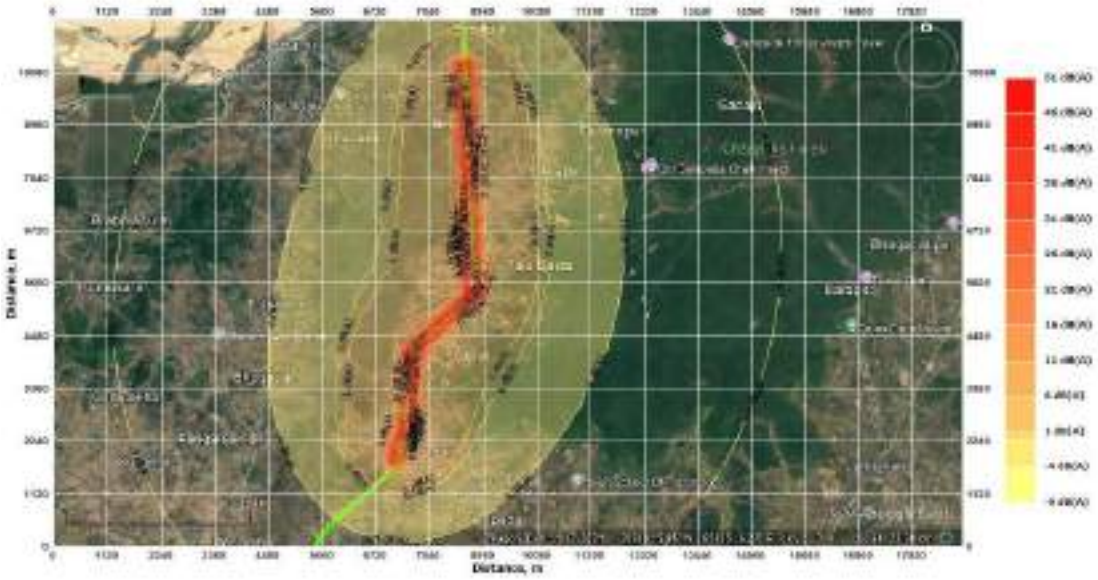


Figure 4-18: Contour map showing noise levels due to total traffic outcome during 2021 year for NL4

From Figure 4-18, it can be observed that the noise levels in 2021 range from a maximum of 51 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL4 location is measured at 49 dB(A), which falls within the permissible limits for residential, commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL4 site remains within the regulatory standards for environmental noise levels.

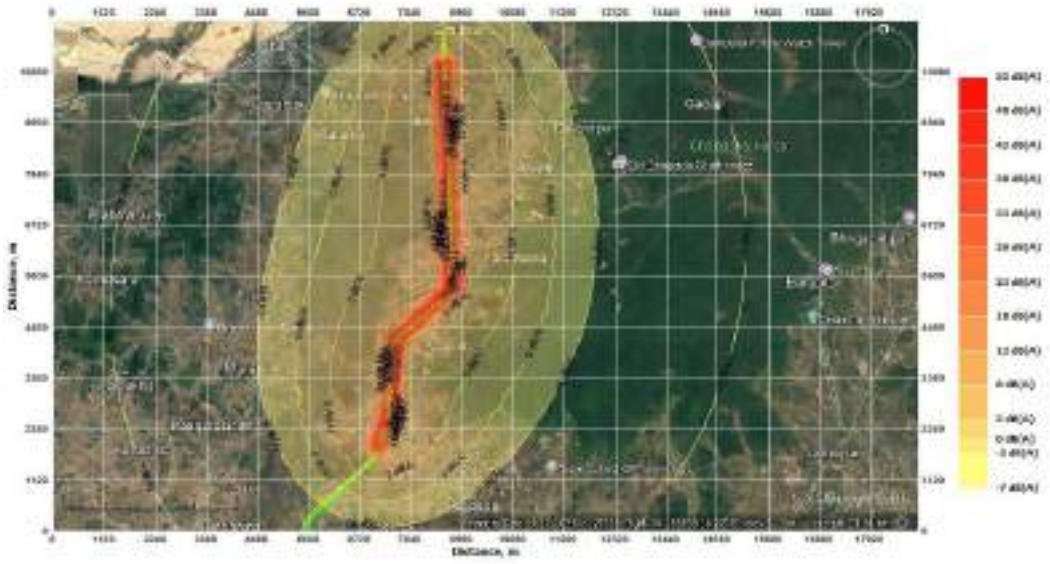


Figure 4-19: Contour map showing noise levels due to total traffic outcome during 2030 year for NL4

From Figure 4-19, it can be observed that the noise levels in 2030 range from a maximum of 53 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL4 location is measured at 51 dB(A), which falls within

the permissible limits for residential, commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL4 site remains within the regulatory standards for environmental noise levels.

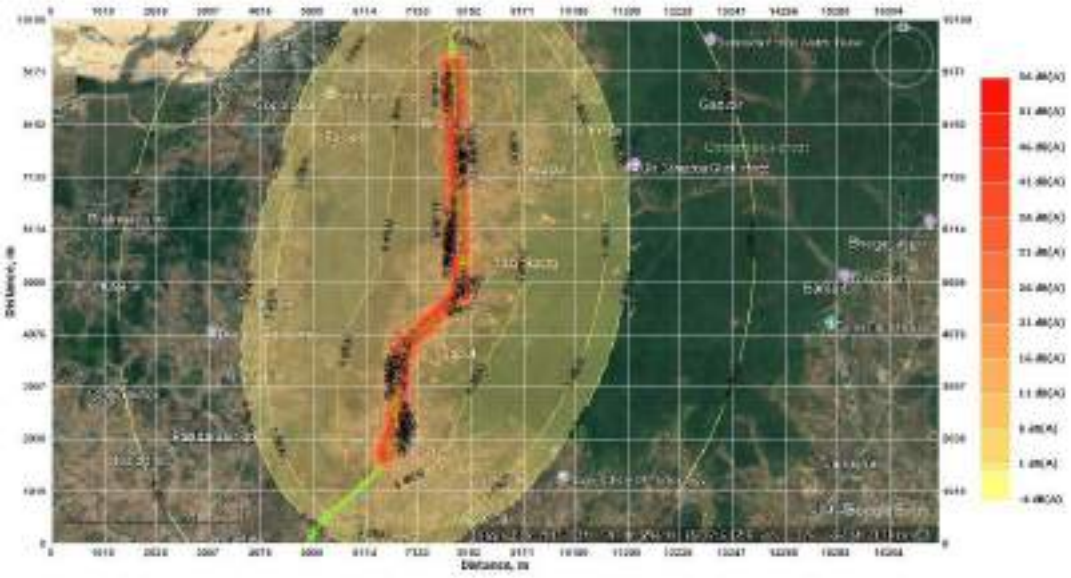


Figure 4-20: Contour map showing noise levels due to total traffic outcome during 2040 year for NL4

From Figure 4-20, it can be observed that the noise levels in 2040 range from a maximum of 56 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL4 location is measured at 53 dB(A), which falls within the permissible limits for residential, commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL4 site remains within the regulatory standards for environmental noise levels.

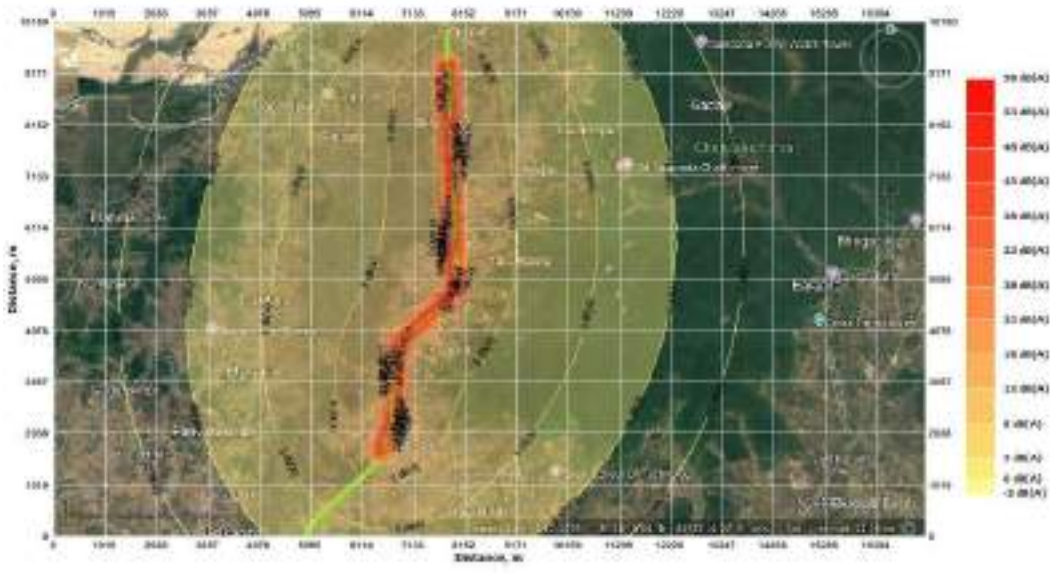


Figure 4-21: Contour map showing noise levels due to total traffic outcome during 2050 year for NL4

From Figure 4-21, it can be observed that the noise levels in 2050 range from a maximum of 58 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL4 location is measured at 55 dB(A), which falls within

the permissible limits for residential, commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL4 site remains within the regulatory standards for environmental noise levels.

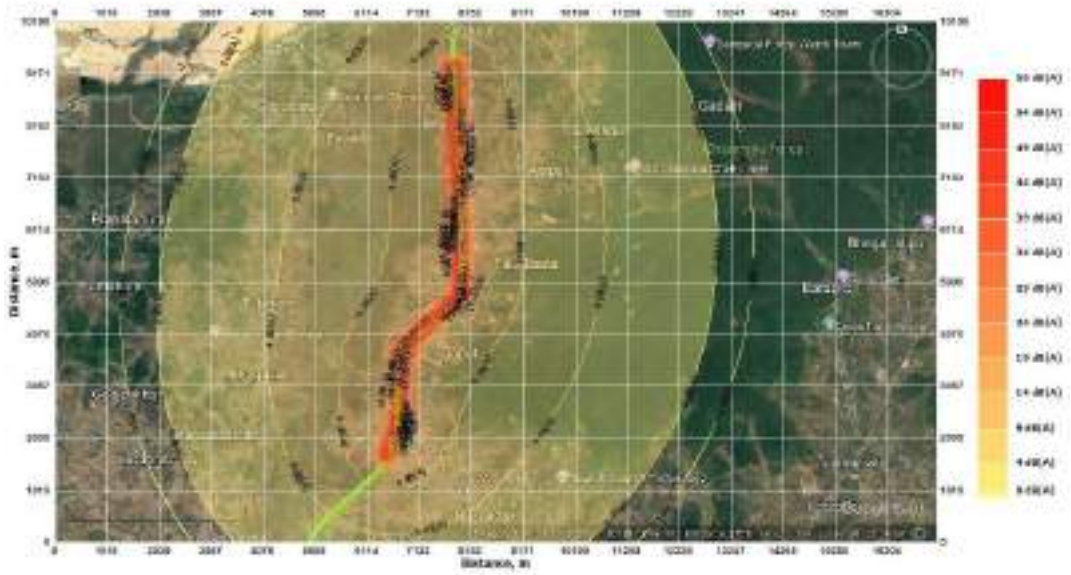


Figure 4-22: Contour map showing noise levels due to total traffic outcome during 2055 year for NL4

From Figure 4-22, it can be observed that the noise levels in 2055 range from a maximum of 59 dB(A) to a minimum of 0 dB(A). Notably, the noise level at the NL4 location is measured at 56 dB(A), which falls within the permissible limits for commercial and industrial areas as set by the Central Pollution Control Board (CPCB). This indicates that while the overall noise range fluctuates significantly, the noise level at the NL4 site remains within the regulatory standards for environmental noise levels.

Mitigation measures to reduce Noise levels

The following are the mitigation measures to reduce noise pollution:

- Noise standards will be strictly enforced for all vehicles, plants, equipment, and construction machinery. All construction equipment used for an 8-hour shift will conform to a standard of less than 90dB (A). If required, high noise producing generators such as concrete mixers, generators, graders, etc. must be provided with noise shields.
- Machinery and vehicles will be maintained regularly, with particular attention to silencers and mufflers, to keep construction noise levels to minimum.
- Workers in the vicinity of high noise levels will be provided earplugs, helmets and will be engaged in diversified activities to prevent prolonged exposure to noise levels of more than 90dB(A) per 8 hour shift.
- The construction camps have to be established at least 1000m away from the nearest habitat or forest area.
- During construction phase, temporary noise barriers will be used to surround the high noise generating construction equipment to build up an acoustic shield around them. Equipment will be maintained appropriately to keep the noise level within prescribed limit.

- Regular monitoring of noise level is necessary, and actions should be taken if noise levels were found to be above the standards.
- All construction related activities shall be performed at specific times and stopped between 9 p.m. and 6 a.m. within 500m of any human settlement.
- Workers will be provided with Personal Protective Equipment (PPE) kits to reduce the effect of noise on their health.
- The project area is passing through some patch of forest area and nearby protected area, hence, sign boards/ Notice Boards at the site like, NO HORN PLEASE, SILENCE ZONE etc. will be fixed at specific sensitive locations.
- Improving quality of pavement may help reduce noise generated from the friction between the vehicle tires and road.
- During construction vibratory compactors will be used sparingly within the urban areas. In case of complaints from roadside residents, the engineer will ask the site engineer to take suitable steps of restricting the work hours even further or use an alternative roller.
- During operation stage, plantation of Bushes as well as Shrubs will absorb some of the noise and help in reduction of noise pollution from vehicular traffic.
- Hot Mix Plant and other noise generating structures shall not be present within 500m from human settlements and forest areas.
- Provision of Noise Barriers need to be made.
- Certain species of plants which act as noise barriers such as *Azadirachta indica, Cinamomum camphora* etc. can be used as sound barriers after construction activities during operation phases.

  Wildlife Disturbance:

  Noise may prevent many animal species from approaching or crossing road corridors because they are afraid. As a result, road corridors become barriers to regular wildlife travel routes, effectively rendering roadside habitat areas inaccessible to some species.

  Such disturbance reduces the success of these species and contributes to ecological alteration.

  Mitigation Measure
- Road side tress and road divider with shrubs considerably reduce noise pollution. Therefore, roadside indigenous tree plantations are recommended.
- Quality of pavement may also be provided to reduce the noise produce due to friction between the road surface and the tyres.
- Creating green belts around potential noise-prone areas.
- The project area is close to open scrub reserve forest and there are occurrences of schedule wild life. Hence, sign boards/ Notice Boards at the site like, NO HORN PLEASE, SILENCE ZONE etc. will be fixed.

4.4 Impacts on the Biological Environment & their Mitigation

The biological environment consists of all the flora and fauna resident of the project area. The anticipated impacts on these species due to the proposed highway are discussed below.

4.4.1 Impacts on Forest Areas

The proposed highway passes through numerous forest patches of the reserved and revenue forest category. The total forest area is around 18.36 ha.

Though the proposed project road bypasses the forest areas as best as possible except at some unavoidable forest areas, the construction activities will potentially have some detrimental effects in places where the forest areas are nearby to the proposed alignment.
The potential impacts and their mitigation measures are listed below.
Pre- construction activities will not have any effect whatsoever on the forest areas.

Construction Phase

- Deforestation spreads outwards from proposed highways. Due to this, the forest areas nearby to the proposed alignment may get degraded, which might in turn hamper the ecological balance of the area.
- Another major impact of concern is the fragmentation of habitat. The construction of the new road may fragment the forest areas and cause disruption to the movement of wildlife, threatening their survival.
- Construction near forest areas may lead to accidents due to human-wildlife conflict, which will result in the loss of life or workers or animals.

No considerable impact is expected to occur in the operation phase of the project.

Mitigation Measures

- Utmost care should be taken to minimize the felling of trees near the forest areas, so as not to disturb the ecological balance. Felling of rare indigenous trees should be avoided.
- Proper continuation should be maintained within the forest so as to minimize habitat fragmentation through the use of proposed structures to allow the movement of animals from one side of the road to the other.
- Construction work should be kept limited to the day time as far as possible to avoid human-wildlife conflict. Construction during night time should have adequate provisions such as proper lighting, fencing to avoid wild animals coming into the construction site.
- Use of firewood from forest areas will not be allowed at site and as far as possible LPG, cook stoves to be provided to workers for cooking.

4.4.2 Impacts on Plantations Within the RoW

Trees within the RoW have to be felled to ease construction activities of the proposed highway, as well as associated structures. Around 13617 trees have to be felled within the Corridor of Impact (CoI) for the proposed alignment. Some of the species of trees to be felled include tree species planted here are Indian Mahogany (*Sweitenia mahogoni),* Coconut (*Cocos nucifera*), Palm (*Phoenix sylvestris*), Mango *(Mengifera indica),* Sal *(Shorea robusta)* and Neem *(Azadirachta indica)* etc., The detailed anticipated impact of felling of plantations is given in the following sections.

No adverse impact is anticipated during the pre-construction phase of the project.

Construction phase

- The felling of trees during the construction stage will have a long term effect on the immediate environment of the alignment, most notable among which is the loss of shade in the area as well as reduction in the AAQ of the immediate area.
- Moreover, the local community may get deprived of valuable sources of tree products such as wood, fruits, leaves, etc.

- The trees support micro-ecosystems comprised of birds, animals and insects which has been present for a long time. These ecosystems will get hampered and cause the overall degradation of the ecological balance of the area if the trees are felled.
- Besides these trees act as noise barrier, dust absorption, pollutant sequester, etc.

No impact is anticipated during the operation phase of the project.

Mitigation Measures

- The number of trees to be felled will be compensated through single row of avenue plantation. Total 11500 Nos. (Avenue + Median plantation) number of plants are proposed to be planted along the alignment. The plantations will consist of a mix of indigenous species, especially which are suited for survival in the area and also the same trees lie in RoW of the proposed alignment.
- As per IRC guidelines (IRC: SP:21-2009) of landscaping and tree plantation and local soil condition, local tree species shall be planted along the extreme edge of the road boundary such as Rosewood, Cashew, Casuarina, Sita Ashoka, and Camphor and Neem etc.
- The plants to be planted on the edges of alignment will act as a hindrance to the wildlife as well as increase the aesthetics of the highway.

4.4.3 Impacts on Wildlife in Project Area

The proposed project alignment does not pass through any national Park, Wildlife Sanctuary or protected area. The project area also does not pass through any Eco-Sensitive Zone of any Wildlife Sanctuary/National Park. However, Chandaka-Dampara and Kapilash wildlife sanctuaries are lies near the project alignment.

Construction activities as well as movement of vehicles through these sections may cause impact on these valuable wildlife species. The details of impacts and the proposed mitigation measures are given in the following sections.

Pre-construction activities will not have any detrimental impacts on wildlife.

Construction phase

- Construction activities, specifically felling down of trees, excavation and loud noise from machinery will affect the ecological balance of the area as well as induce physiological and behavioral changes in wildlife.
- Human-wildlife conflict due to construction activities near forest areas.
- Habitat quality may be degraded further due to mismanagement of harmful chemicals, wastes and other toxic products.
- Canopy may be subjected to discontinuity due to falling down of trees.

Operation Phase

- The wildlife will avoid roads in fear of vehicles and thus may be deprived of essential feeding sites, breeding sites or waterholes.
- Glaring headlights will affect the wildlife during night time.
- The artificial lights may cause temporary blindness, especially in young fauna.
- Human-wildlife conflict due to vehicular traffic through the area.
- Accidents leading to loss of life of wildlife.

Mitigation measures

- Deforestation has to be kept in check and adequate plantations to be done along the sides of the proposed highway to compensate for the number of trees cut, at the rate of minimum 2:1 (new: old) plants.
- Strips of vegetation to be provided on either side of the carriageway to facilitate movement of animals.
- Labour camps will be situated far away from the forest areas.
- Proper precautions to be taken to manage the toxic wastes so that no contamination of habitat occurs due to spillage.
- Dense plantation along the highway to be carried out to reduce the impact of noise on the wildlife.
- Marking of silence zone with the provision of signboards.
- Proper structures such as underpasses/overpasses, culverts shall be use to facilitate the movement of animals across the road.
- Fencing and boundary walls will be provided along the roads to direct the animals away from roads and also to lower the intensity of headlights.
- Artificial waterbodies will be constructed or existing waterbodies improved to provide water for the animals.
- To preserve the canopy, width of the linear clearing may be kept small in areas where fear of habitat fragmentation is there.
- Caution signs will be provided in areas of animal crossing to reduce human-wildlife conflict.
- Speed limit has to be restricted in areas adjacent to habitations.
- Parking will be restricted to reduce contact of humans with wildlife.

4.4.4 Impact on Aquatic Ecology

Temporary sedimentation and water quality deterioration is expected from the project during the construction phase. Construction of structures particularly along waterbodies may increase silt while accidental spill of materials, chemicals, and fuels will deteriorate water quality and affect ecology of aquatic organisms for short term. No significant impact is expected during the operational phase of the project.

Mitigation Measures

- No construction related activities of bridges during breeding season of fish and other aquatic species.
- During construction phase, care would be exercised to control silt so that the water available in the water bodies especially those located very near to the ROW may not be contaminated.
- Siltation shall be avoided by installation of temporary silt traps or sedimentation basins along the drainage leading to the water bodies
- Strict monitoring during construction of bridge over the river as well as during renovation of culvert to avoid contamination of the river and stream water.
- Labour camps shall be minimum 500m away from any type of water bodies.

4.5 Impacts on the Socio-Economic Environment & their Mitigation

Probable positive impacts are expected on the social environment of the area during construction phase. As the migration of workers into the area will probably be very small, the social environment with respect to literacy, health care, transport facilities and cultural aspects will be minimally affected.

4.5.1 Impacts on the Local Community

The proposed alignment shall affect around 3426 families and 15621 persons if the proposed alignment is taken into consideration, as established through the Socio-Economic Survey (SES) and Census survey (Land owner & Structures). In spite of these, the project will also have beneficial impacts as:

- Major part of the alignment is proposed to cross Greenfields, agricultural fields and agroforestry. This will lead to the loss of livelihood for majority of the PAPs.
- The local community will benefit from the proposed project as employment will be generated for the unskilled, semi-skilled and skilled workers during the construction phase of the project.
- Some demographic variables may somewhat 'skew' for a short period of time due to the influx of construction workers from outside the local community, but overall, not much will change.

4.5.2 Impacts on the Economy

- The local economy is expected to have a boost for a short period during the construction phase due to construction workers purchasing daily essentials from the local traders.
- Purchase of construction equipment and payment of wages & salary will be the wider flow-on economic impacts in other sectors.
- Economy of the region may grow further owing to the establishment of wayside hotels, restaurants, hospitals, markets and other facilities at interchanges.
- But the income of the region from agriculture will diminish, which may rise in other sectors, owing to transfer of the working class from agriculture to other sectors.

4.5.3 Impacts on Religious Structures and Cultural Properties

There are 2 religious structures which are falling on the proposed alignment.

4.5.4 Impacts on Traffic Congestion & Road Safety

Being a Greenfield project, traffic congestion will be evident during the construction phase only around those places where the proposed highway meets other roads. Road safety in those intersections will be an issue of utmost importance.

Mitigation Measures

- Detailed traffic management plan will be prepared prior to initiation of construction works, which will contain details about temporary traffic diversions, etc.
- Convenient and safe passage for vehicles, livestock, pedestrians, etc. across roads and to and from properties connecting the roads will have to be designed and implemented.
- The road safety measures to be followed during the construction as well as operation phases are given in table below.

Table 4-11: Potential Traffic Management Impacts and Mitigation Measures

S. No.	Potential Impacts	Construction phase	Operation Phase	Proposed Mitigation measures
1.	Construction may disrupt traffic and cause frustration to drivers	Y	N	Management of traffic flow, proper diversion to minimize traffic congestion
2.	Emergency vehicles or personnel unable to attend to emergency situation	Y	Y	Measures to be undertaken to ensure smooth movement of emergency vehicles
3.	Intermittent speed changes in multiple areas across the project	Y	Y	Speed in construction zone to be restricted to 30 km/h as well as adoption of Construction Traffic Management Plan (CTMP) to minimize impact of construction on traffic
4.	Incompetency in management of break-downs during construction	Y	N	Temporary break-down bays may be designed
5.	Pedestrians unable to cross road	Y	Y	Pedestrian access

*** Y=Yes; N=No**

4.5.5 Impacts Related to Human Health and Safety

There is a possibility of accidents in the project stretch during construction activities to both the traffic as well as workers. The details of impacts on human health and safety during the various stages and their mitigation strategies are given below.

Pre-construction activities will not have any effect on the health and safety of humans.

Construction & Operation phases

- Electrical equipment's used in construction activities can be life threatening in the event of a short circuit.
- Malaria, Dengue, COVID or other diseases will spread if not kept in check.
- Workers engaged in mixing of asphaltic materials, cement, etc. or those doing welding works pose health risks to themselves as well as others in their vicinity.
- Unavailability of clean, potable water during construction activities is a major health concern.
- Risk to workers of being hit by traffic during construction.
- Unavailability of safety measures in roads may lead to traffic accidents.

Mitigation measures

- No electrical equipment's or other materials will be kept stacked in such a way as to pose life-threatening to workers or the general public.
- Adequate fencing and lights will be provided during construction activities to minimize the safety hazards.

- All the workers shall be provided with protective gears such as PPE kits, protective footwear, eye goggles, face shields, etc.
- Water from pits dug up for construction work will be drained completely so as stop them from being a breeding ground for mosquitoes or other disease-carrying insects.
- First Aid kits will be made easily available at key points during construction activities.
- Easily accessible and readily available IS-certified potable water will be available. Drinking water obtained from public water supply shall be stored in tanks.
- Provision of safety measures such as safety barriers, proper channelization of junctions, proper acceleration and deceleration lanes on junctions, pedestrian guardrails on separators, etc. will have to be made to minimize traffic accidents.

4.6 Conclusion

On the basis of analysis of possible environmental impacts in the above sections, the table in the following page summarizes the major impacts and their corresponding mitigation measures.

Table 4-12: Summarized Major Environmental Impacts and Mitigation Measures

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
1.	Meteorology	No impact	Little to no impact on the parameters like temperature, humidity, etc.	Normalized temperature, humidity	Plantation along the avenue and other location such as interactions, cross roads etc.
2.	Air Environment	No impact	Increase in particulate matter		Dust suppression through water sprinkling, provision of anti-pollution masks to workers
			High concentrations of harmful gases like SO_2, NOx, CO from machinery		Hot mix plant to be set up at least 1000 m away from settlement, in the downwind location, regular check-up of machinery
				PM generation minimal	Avenue plantation containing pollutant absorbing broad leaved plants
				Harmful gases from vehicular exhaust like CO, HCs, etc.	Regular checks of PUC certificates at important junctions

3.	Land Environment	Soil erosion due to deforestation	Soil erosion prevalent	Erosion minimum	Felling of trees limited to CoI only, Provision of Avenue plantation, embankments.
			Soil compaction	Compaction minimum to non-existent	Limited movement of vehicles, keeping compaction in check in areas other than ROW
			Loss of top soil reducing fertility		Top soil has to be preserved carefully and used for rehabilitation
			Improper waste disposal causing soil contamination	Soil Contamination minimum to non-existent	Storage of harmful chemicals, oils, toxic materials in separate places with RCC surface; septic tanks with soak pit facility;
4.	Water Environment	No impact	Increased runoff due to cut and fill operations		Proper drainage structures, Silt fencing to be provided
			Natural flow of water bodies blocked due to construction		Revision of alignment or compensatory digging for any water body being affected
			Water table depletion due to water requirements		Use of water obtained from the surface water bodies
			Water quality degradation due to seepage of wastes, increased runoff to the surface water bodies, etc.		Storage of harmful wastes in lined pits, management of runoff using cross-drainage structures

5.	Noise Environment	No impact	Noise levels of the areas under construction will increase considerably		Construction activities to be stopped between 9 p.m. and 6 a.m.
			Increased noise from construction activities will affect settlements and also forest areas and wildlife		Construction camps to be situated 1000m from habitat or forest area; provision of temporary sound barriers
				Condition and type of vehicles plying on the road, pavement condition, etc. will affect the noise levels	Increasing the quality of pavement; use of sound absorbing trees in avenue plantation.
6.	Biological Environment (forests, flora and fauna)	Indiscriminate deforestation may cause loss of forest areas			Minimum twice the number of trees cut to be planted as a part of Compensatory Afforestation (CA).
		Habitat fragmentation			Strips of vegetation along the proposed highway to attract animal movement
			Degradation of Habitat Quality		Precautions to avoid leakage of chemicals during construction; Labour camps located far from habitat area
			Noise from construction activities inducing physiological and behavioral changes in the wildlife	Noise from vehicular movement affecting wildlife	Provision of noise barriers, boundary walls along the highway, marking of silence zone, etc.

				Avoidance of road by animals	Animal underpasses/overpasses; Culverts, provision of fences along the sides of highway; plantation and artificial lights to be made less attractive for birds
				Glaring headlights impacting wildlife	Provision of hedges/wall along the sides of highway to lower intensity of light
				Reduced access to waterholes, etc.	Construction of artificial waterholes/improvement of existing waterholes
		Discontinuity of canopy			Width of linear clearing in such areas to be kept small
			Increased Human-Wildlife conflict	Human-Wildlife conflict	Provision of caution signs to alert drivers about presence of wildlife; restriction of speed limit; restriction of parking
7.	Socio-Economic Environment		Temporary 'skew' in demographic profile due to influx of workers		Temporary impact, will normalize after construction completes
			Traffic congestion due to construction activities		Proper traffic management to be followed as per IRC codal provisions
			Human Health & Safety		All safety measures such as provision of PPE to the workers, proper storage

					of electric machinery and instruments so as to minimize the risk of electric shock; availability of IS certified drinking water, water draining from pits to control mosquito breeding, availability of first aid kits, etc.

Table 4-13: Impact Assessment Matrix

Environmental Parameters	Nature of Potential Impact during Construction & Operation phases										
	Local	Regional	Short Term	Long Term	Reversible	Irreversible	Adverse	Beneficial	No Impact	Significant	Insignificant
Meteorology	✓		✓		✓						✓
Topography	✓			✓		✓					
Drainage	✓			✓	✓						✓
Soil	✓				✓						✓
Water Resources	✓		✓		✓						✓
Water Quality	✓				✓						✓
Land Use	✓			✓		✓		✓			✓
Air Quality	✓		✓		✓						✓
Noise	✓		✓	✓	✓						✓
Flora	✓		✓	✓		✓	✓			✓	
Fauna	✓		✓	✓		✓	✓			✓	
Employment	✓		✓	✓		✓		✓		✓	
Aesthetics	✓		✓	✓		✓				✓	

5. ANALYSIS OF ALTERNATIVES

5.1 Introduction

This chapter presents a comparative analysis of the various alternatives considered for alignment selection, to avoid, prevent and minimize the impacts that would be inevitable if technically (based on design speed and geometrics) if best-fit alignment is painstaking. The consideration of alternatives to a proposal is a requirement of the EIA report. During the scoping process, alternatives to a proposal can be generated or refined, either directly or by reference to the key issues identified. A comparative analysis of alternatives will help to determine the best method of achieving project objectives while minimizing environmental impacts. Various alternatives selected for analysis usually includes the 'no project' or 'no action' alternative. The relative impact of each alternative is compared against the baseline environment to select a preferred alternative.

Construction of the Rameswar (Khordha) NH-16 to Gobindpur (Dhenkanal) NH-55, (Capital Region Ring Road (CRRR) -1) for Six Laning with Paved shoulder NH Configuration - in the State of Odisha by NHAI for a total length of 70.995 km was considered after finalization of various options such as realignments, bypasses, State Governments suggestions and different construction material options keeping in view objectives of the project, traffic condition, obligatory points, geometric designs, congestions and socioeconomic viability and environmental safety aspects. The discussion in this chapter includes the project with all the considered alternatives. The objective of this chapter is to highlight some of the salient issues considered for exercising selecting options.

5.2 Selection of Alternatives

The NHAI had carried out preliminary desk studies using satellite imageries and as such an alignment for the proposed highway from Rameswar (Khordha) NH-16 to Gobindpur (Dhenkanal) NH-55, (Capital Region Ring Road (CRRR) -1) for Six Laning with Paved shoulder NH Configuration - in the State of Odisha by NHAI for a total length of 70.995 km was finalized. The detail of this selected alignment was handed over by the NHAI and the DPR Consultant has been assigned the task of preparing the Feasibility and Preliminary Design Report for the proposed Highway. The initial site visits and detailed ground reconnaissance by the consultants revealed that by and large this selected alignment is acceptable.

Three alternative alignments were presented during the grant of ToR meeting and these have been considered for analysis and are as follows:

i. **Option 1**: Option 1 is basically considered as a Green field alignment from existing NH-16 to NH-55 from Rameswar to Gobindpur with a total length of 73.24 km.
ii. **Option 2**: Option 2 is basically considered as a new Green field alignment from Rameswar to Gobindpur, from existing NH-16 to NH-55. With a total length of 70.995 km. (**Proposed alignment)**.

iii. **Option 3:** This option starts from Palatotapada after Khordha town at NH-16 to Near Kuspangi at NH-55 and passes through Greenfield area the alignment is much closer and passes through to the Chandaka WLS in the middle sections.

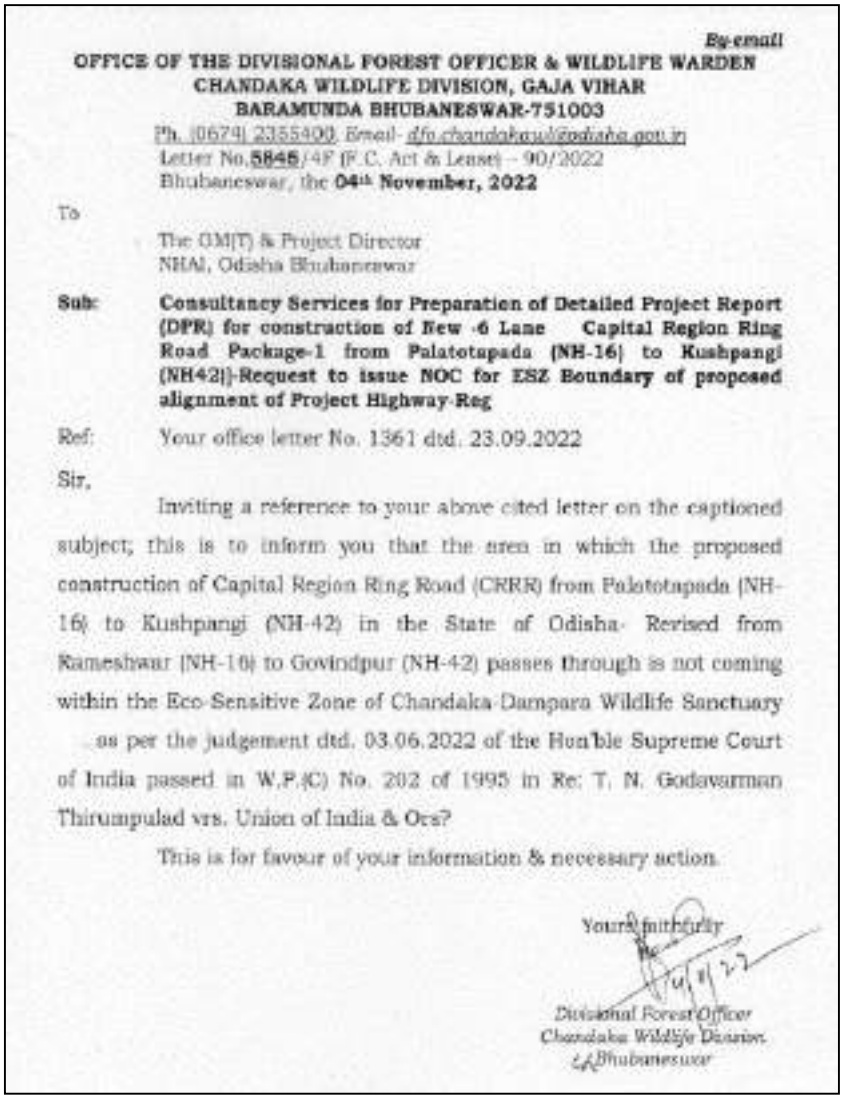
Keeping in view of the selected alignment having less/minor effect on environmental and social components, alignment **Option-2** has been fixed and it seems more feasible as compared to the other options. It also provides better alternative for connection to the existing NH-16 and 55 coming to Tamilnadu and going upto Kolkata and bypassing the major towns of Khordha, Bhubaneshwar and Cuttack. It will lead to less impact on Environment & Social components than other two. The ringroad will further reduce the traffic congestion in the existing cities and reduce urban pollution loads in these cities.

The proposal was heard in the 370th EAC meeting on 23-24th July 2024 and MoEF&CC has granted the ToR for the said project and has approved the proposed NHAI alignment vide its File No. 10/18/2024-IA.III, Proposal No. IA/OR/INFRA1/482782/2024 dated 19/09/2024 and TOR Identification No. TO24A3601OR5956634N.

MoEF&CC in its ToR has instructed and recommended to carry the following study:

"Wildlife conservation / management plan for the area with special emphasis on Elephants management shall be prepared in consultation with State Forest Department, WII or any other nationally reputed institution and implemented at the project cost."

In this regard, NHAI has conducted these studies with the help of reputed institutions and Odisha State Forest Department and DFO Chandaka WLS has approved the mitigation plan and provided NoC for the project in respect to the alignment not passing through the Sanctuary. The detailed biodiversity assessment and conservation and mitigation plan for animal movement has been prepared and enclosed as report in Annexures.



By email

OFFICE OF THE DIVISIONAL FOREST OFFICER & WILDLIFE WARDEN
CHANDAKA WILDLIFE DIVISION, GAJA VIHAR
BARAMUNDA BHUBANESWAR-751003
Ph. (0674) 2355400, Email- dfo.chandakawl@odisha.gov.in
Letter No.5845/4F (F.C. Act & Lease) – 90/2022
Bhubaneswar, the **04th November, 2022**

To

The GM(T) & Project Director
NHAI, Odisha Bhubaneswar

Sub: Consultancy Services for Preparation of Detailed Project Report (DPR) for construction of New 6 Lane Capital Region Ring Road Package-1 from Palatotapada (NH-16) to Kushpangi (NH42)-Request to issue NOC for ESZ Boundary of proposed alignment of Project Highway-Reg

Ref: Your office letter No. 1361 dtd. 23.09.2022

Sir,

Inviting a reference to your above cited letter on the captioned subject, this is to inform you that the area in which the proposed construction of Capital Region Ring Road (CRRR) from Palatotapada (NH-16) to Kushpangi (NH-42) in the State of Odisha- Revised from Rameshwar (NH-16) to Govindpur (NH-42) passes through is not coming within the Eco-Sensitive Zone of Chandaka-Dampara Wildlife Sanctuary as per the judgement dtd. 03.06.2022 of the Hon'ble Supreme Court of India passed in W.P.(C) No. 202 of 1995 in Re: T. N. Godavarman Thirumpulad vrs. Union of India & Ors?

This is for favour of your information & necessary action.

Yours faithfully

Divisional Forest Officer
Chandaka Wildlife Division
Bhubaneswar

NoC from DFO and WLW, Chandaka WLS, Odisha

The details of the three alternatives studied have been described in **Table 5-1**. The SoI toposheet map showing the three alignments has been presented in **Figure 5-1**.

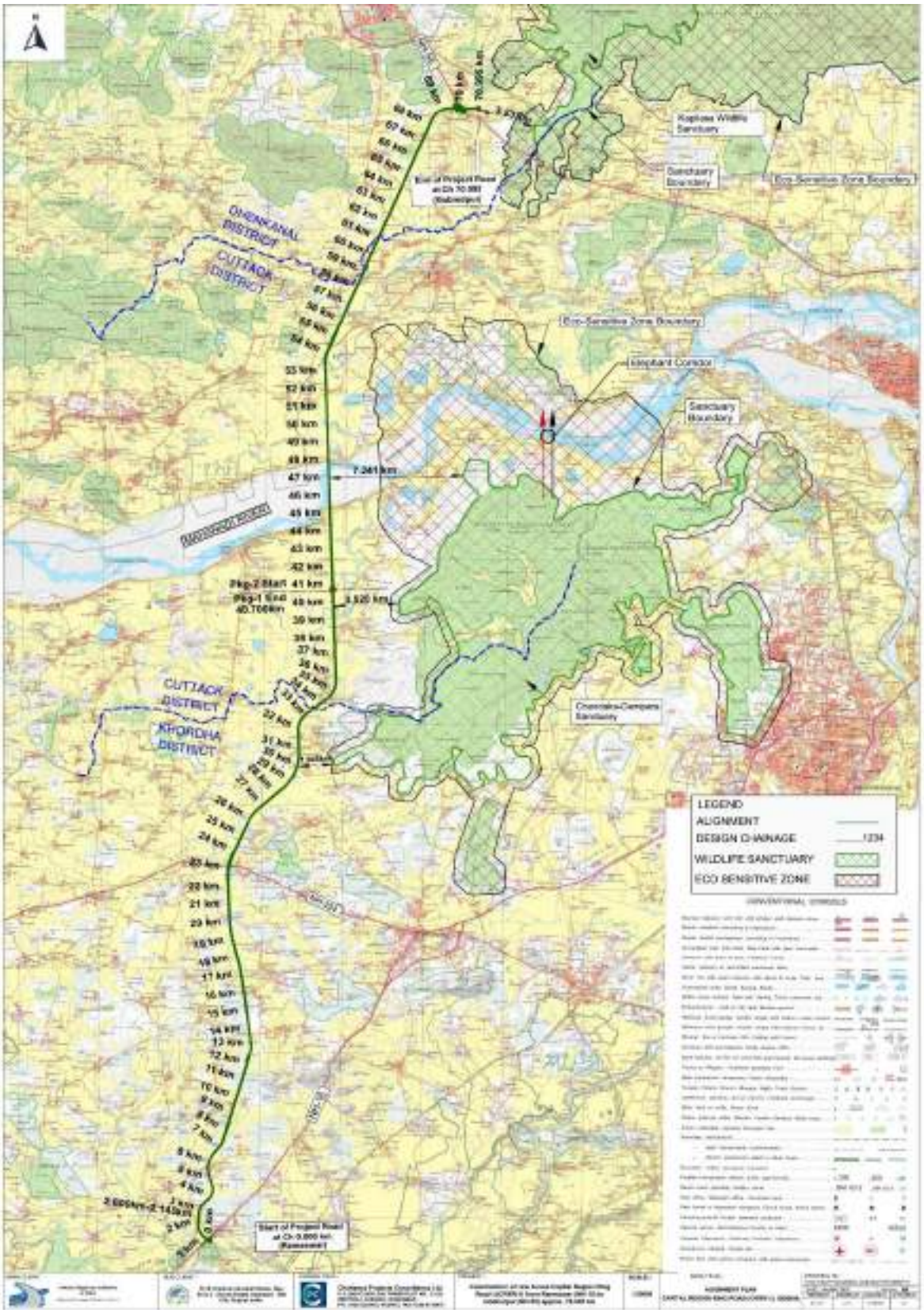


Figure 5-1: Map of alternative alignments

Table 5-1: Details of alternative alignments studied

S. No	Parameters/Issues	Option 1 Existing NH-55 (Green Colour)	Option 2 (Pink Colour) (Proposed alignment)	Option 3 (Blue Colour)
1	Start Point	Rameswar	Rameswar	Palatotapada
2	End Point	Gobindpur	Gobindpur	Near Kuspangi
3	Length (km)	73+240	70+995	61+355
4	Proposed RoW (m)	60 m	60 m	60 m
5	Total land required (ha)	551	547	468.13
6	Forest (RF/PF/Rev. Forest) ha.	16	28	42
7	Area under protected / important or sensitive species of flora or fauna/Wildlife Sanctuary	Around 2.5 km length is passing through various Revenue forest, RF, etc. and passing through the ESZ of Chandaka WLS in around 1.4 ha, with total forest area of approx. 16 ha.	Around 3.0 km length is passing through various Revenue forest, RF, etc. and the alignment is not passing through the ESZ of Chandaka WLS. DFO has issued NOC vide letter no. 5845 dated 4.11.22 regarding proposed alignment is not passing through the Chandaka WLS. (Letter Enclosed).	Around 8.00 km length is passing through the Chandaka WL Sanctuary, 7.5 km length is passing through the ESZ and area encountered is approx. 44 ha. Around 500 m is passing through the core area of Sanctuary and 3 ha area is encountered.
8	No. of trees impacted	32800	13617	37500
9	Impact on flora and fauna	Medium Impact on WL and flora and fauna as forest and WL length is met in ESZ of Chandaka WLS.	Least Impact on WL and flora and fauna as forest area is less and the alignment is not passing through any WLS	Maximum Impact on WL and flora and fauna as maximum forest and WL length is met in ESZ and core of Chandaka WLS.

10	Area under water bodies (ha)*	23	18	20
11	**No of Structures to be provided**			
12	ROBs	01	01	01
13	SVUP	24	10	18
14	LVUP	14	17	15
15	Flyover/ Elevated Viaduct	5	6	5
16	VUP/EUP	12/10	12/10	9/10
17	Interchange	2	2	2
18	Major Bridges	3	3	2
19	Minor Bridges	20	23	28
20	Culvert	245	233	203
21	Tunnel Length	NIL	NIL	NIL
22	No of structures to be affected	152	71	218
23	No of families to be impacted	3437	3426	3525
24	Social Impact	Very high – As the Alignment needs to be constructed in Built-up area involving acquisition & demolition of large number of residential and commercial buildings.	Low - As the Alignment needs to be constructed in less Built-up area involving lesser acquisition & demolition of large number of residential and commercial buildings.	Very high – As the Alignment needs to be constructed in Built-up area involving acquisition & demolition of large number of residential and commercial buildings.
25	Terrain	Plain	Plain	Plain and Rolling
26	Land Use	Heavily Built-up area, forest and agricultural area.	Less Built-up area and agricultural area	Heavily Built-up, forest & Agricultural area
27	Connectivity	Connecting NH-16 (Rameswar) to NH-55 Gobindpur)	Connecting NH-16 (Rameswar) to NH-55 Gobindpur)	Connecting NH-16 Palatotapada with NH-55 at near Kuspangi
28	Civil Cost (Crore Rs.) (Including Utility)	2604	2470	2421
29	LA & Pre-construction cost (Crore Rs.)	848	778	818

30	Tentative Project cost (Crore Rs.) including other expenses.	4607	4541	4584
31	Advantages	1. Forest area affected is slightly less as compared to the other two options.	1. Less no. of families are affected. 2. Less structures are affected. 3. Alignment is not passing through the ESZ of Chandaka WLS. DFO has approved the mitigation plan and given NoC. 4. Less impact on ecology and wild life. 5.Less no. of water bodies affected. 6.Capital cost will be lowest.	1. Total land acquisition is less as compared to other alignment options 2.Length of the alignment is less as compared to the other two alignments.
32	Disadvantages	1. More No. of water bodies affected. 2. Total land acquisition is more as compared to other alignment options 3. Around 2.5 km length is passing through various Revenue forest, RF, etc. and passing through the ESZ of Chandaka WLS in around 1.4 ha. 4. Capital Cost is more than other two options.	1. Some water bodies will be effected. 2. Some forest areas and tree plantation areas will be encountered.	1. Around 8.00 km length is passing through the Chandaka WL Sanctuary, 7.5 km length is passing through the ESZ and area encountered is approx. 44 ha. 2. Around 500 m is passing through the core area of Sanctuary and 3 ha area is encountered. 3. Forest area affected is 42 ha. 4. Most impact on local flora and fauna. 5. More habitations / structures are encountered.

Considering the above analysis **Option II** is selected as it has the least impact on environment, flora, fauna, forest area and hence is the most feasible option from environmental considerations.

5.2.1 Impact Scoring Matrix

An impact scoring matrix encompasses all the variables that may affect the local area through which the alignment passes. Various aspects (5 no.) are analysed in this matrix i.e.: Natural environment, Biological environment, Physical environment, Social environment and engineering considerations. Various micro attributes are further analysed in each of the major 5 aspects. Scores are then allocated to each of the attributes and all the analysed three alignment options. The option with the least score is the one that has the least impact on the local environment.

Table 5-2: Alternative alignments and their impact score

Natural Environment							
Attributes	**Scoring Criteria**		**Score**	**Total Weight of Attribute**	**Option-1**	**Option-2**	**Option-3**
					Score	**Score**	**Score**
Topography	Plains	-	0	**10**	2	1	3
	Rolling terrain	-	5				
	Flood plains/coastal belt	-	10				
	Hilly/mountainous terrain	Upto 100% of Project Length	10	**10**	1	0	2
		Upto 50% of Project Length	5				
		Upto 25% of Project Length	1				
		Nil	0				
	CRZ Area	CRZ-I	10	**10**	0	0	0
		CRZ-III	5				
		CRZ-III/IV	1				

		Nil	0				
Vulnerability to natural hazards (as earthquakes, floods, landslides, Tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes etc.)	Not prone to any Hazard	-	0	**5**	3	3	3
	Rare occurrence	-	1				
	Prone to natural disasters/risks	-	3				
	Highly prone to natural disasters (regular occurrence)	-	5				
Surface water resources	Number (average) of water bodies per Km. (rivers, canals, reservoirs, lakes and ponds) – Crossings as well as water bodies within RoW.	5 or less	1	**5**	3	2	3
		6 to 10	2				
		11 to 15	3				
		16 to 20	4				
		21 or more	5				
Affected Surface Area of Water bodies	Reservoir/Lake/Pond/small water depression	>1 ha.	10	**10**	8	8	8
		Upto 0.5 ha.	5				
		Upto 0.1 ha.	1				
		if No	0				
	Canal/River/Stream	>3 ha.	10	**10**	10	10	10
		Upto 1.5 ha.	5				
		Upto 0.3 ha.	1				
		if No	0				
Drainage Conditions	Over-topping and/or water logging within RoW (average number of such instances per Km.)	2 or less	1	**5**	3	2	3
		3 to 4	2				
		5 to 6	3				
		6 to 7	4				
		7 or more	5				
Ground water resources	Availablity/Grey/Black	Available	1	**5**	1	1	1
		Grey	3				
		Black	5				

Materials Availability	Availability of Boulder/Sand/Earth	Within 50 km.	1	**5**	2	2	2
		50 to 100 km.	2				
		100 to 200 km.	3				
		More than 200 km	5				
Soil Erosion	Is soil erosion an issue in/along the sub-project road?	No Erosion	0	**5**	1	1	1
		To some extent	1				
		Critical	3				
		Very critical	5				
Total	**-**	**-**		**80**	**35**	**32**	**41**

Biological Environment							
Attributes	**Scoring Criteria**		**Score**	**Total Weight of Attribute**	**Option-1**	**Option-2**	**Option-3**
					Score	**Score**	**Score**
Protected Areas (PA) under Wildlife Conservation Act	National Park	-	10	**10**	8	0	8
	Tiger Habitat	-	10				
	Wildlife Sanctuary/Marine Sanctuary	-	8				
	Conservation Reserve/Biosphere, Wetland	-	6				
	Projects Falls within 10 Km. Boundary of PA/Wildlife Corridor in other type of Forests Area	-	2				
	None	-	0				
Forests Area	Reserved Forest	upto 20 ha	1	**10**	2	2	2
		upto 40 ha	2				

		upto 50 ha	4				
		upto 60 ha	6				
		upto 100 ha	8				
		> than 100 ha	10				
	Protected Forest	upto 20 ha	1	**10**	1	1	1
		upto 40 ha	2				
		upto 50 ha	4				
		upto 60 ha	6				
		upto 100 ha	8				
		> than 100 ha	10				
	Forest Type Area (FCA Applicable), Forest Type Area (FCA Applicable), Goverrntment Land Notified under FCA Act as Protected Forest for Management Purpose	upto 20 ha	1	**10**	2	2	2
		upto 40 ha	2				
		upto 50 ha	4				
		upto 60 ha	6				
		upto 100 ha	8				
		> than 100 ha	10				
Trees	Felling of trees from forest area	Upto 100 Trees/km.	1	**10**	8	8	10
		Upto 200 Trees/km.	2				
		Upto 300 Trees/km.	4				
		Upto 400 Trees/km.	6				
		More than 500 Trees/km.	8				

		More than 1000 Trees/km.	10				
	Local Law applicable for felling of trees from Non Forest Land	Upto 100 Trees/km.	1	**10**	8	8	10
		Upto 200 Trees/km.	2				
		Upto 300 Trees/km.	4				
		Upto 400 Trees/km.	6				
		More than 500 Trees/km.	8				
		More than 1000 Trees/km.	10				
Mangroves	Area	No CRZ	0	**10**	0	0	0
		upto 2 ha.	2				
		upto 5 ha.	5				
		> than 10 ha.	10				
	No of Mangroves	upto 50 ha.	2	**10**	0	0	0
		Upto 100 ha.	5				
		> than 200 ha.	10				
Total	**-**	**-**	**-**	**80**	**29**	**21**	**33**

Physical Environment							
Attributes	**Scoring Criteria**		**Score**	**Total Weight of Attribute**	**Option-1**	**Option-2**	**Option-3**
					Score	**Score**	**Score**
Air Quality	Respirable PM 10	More than Permissible limit i.e. 100 µg/m3	5	**5**	2	2	2
		Upto 50 µg/m3	2				
		Upto 20 µg/m3	0				
	Respirable PM 2.5	More than Permissible limit i.e. 60 µg/m3	5	**5**	2	2	3
		Upto 60 µg/m3	4				
		Upto 30 µg/m3	2				
		Upto 10 µg/m3	0				
	SO2/NOx	More than Permissible limit i.e. 80 µg/m3	5	**5**	2	2	2
		Upto 40 µg/m3	2				
		Upto 20 µg/m3	0				
	CO (1 Hr. Monitoring)	More than Permissible limit i.e. 4000 µg/m3	5	**5**	1	1	1
		Upto 2000 µg/m3	2				
		Upto 1000 µg/m3	0				

	CO (8 Hr. Monitoring)	More than Permissible limit i.e. 2000 µg/m3	5	**5**	1	1	1
		Upto 1000 µg/m3	2				
		Upto 250 µg/m3	0				
Ground Water	Limit as per IS 10500:2012	If 4 Parameters are above desirable limit	5	**5**	1	1	1
		If 2 Parameters are above desirable limit	2				
		All within Permissible Limit	0				
Surface Water	Limits as per IS:2296 Class C Limits	If 4 Parameters are above desirable limit	5	**5**	1	1	1
		If 2 Parameters are above desirable limit	2				
		All within Permissible Limit	0				
Noise	Day Time (Ambient Noise) in Residential/Commercial/Silent (*Noise Level in dB (A) for continuous 24 hours at 1 hour interval)*	More than Permissible limit i.e. 65 dB	5	**5**	2	2	2
		Upto 32 db and less than 65 db	4				

		Upto 50% of Permissible Limit i.e.32dB	2				
		Upto less than 50% of Permissible Limit	0				
	Night Time (Ambient Noise) in Residential/Commercial/Silent (Noise Level in dB (A) for continuous 24 hours at 1 hour interval)	More than Permissible limit i.e. 55 dB	5	**5**	2	2	2
		Upto 27 db and less than 65 db	4				
		Upto 50% of Permissible Limit i.e.27 dB	2				
		Upto less than 50% of Permissible Limit	0				
Soil		Saline/Highly Alkaline/Highly Acidic	5	**5**	2	2	2
		Moderate	2				
		Within 50% of Permissible Limit	0				
Total	**-**	**-**	**-**	**50**	**16**	**16**	**17**

Social Environment

Attributes	Scoring Criteria		Score	Total Weight of Attribute	Option-1	Option-2	Option-3
					Score	Score	Score
People	No. of Families Affected/Km.	>25	5	**5**	2	2	2
		Upto 20	4				
		Upto 10	2				
		<5	1				
Agriculture	Affectected Area/Km.	>2 ha.	10	**10**	9	8	8
		Upto 1 ha.	5				
		Upto 0.2 ha.	1				
		if No	0				
Settlements	Total length of settlement sections (both towns and villages) abutting the road corridor	10 km. or less	2	**10**	4	3	5
		10 to 20 km.	4				
		20 to 30 km.	6				
		30 to 40 km.	8				
		40 km. or more	10				
Sensitive Receptors	Number (total) of sensitive receptors within RoW (such as educational and health facilities)	10 or less	1	**5**	2	2	2
		11 to 20	2				
		21 to 30	3				
		31 to 40	4				
		41 or more	5				
Drinking water sources	Total number of drinking water sources (wells, hand pumps, community water points/taps etc.) with in RoW	10 or less	1	**5**	3	3	3
		11 to 20	2				
		21 to 30	3				
		31 to 40	4				
		41 or more	5				
Religious Structures		10 or less	1	**5**	1	1	1

	Number (total) of religious structures (temples, shrines, mosque, church, gurudwara) with in RoW	11 to 20	2				
		21 to 30	3				
		31 to 40	4				
		41 or more	5				
Cultural Heritage Site	Number (total) of cultural properties (protected/ unprotected archeological monuments) within RoW.	2 or less	1	**5**	0	0	0
		3 to 5	2				
		6 to 8	3				
		8 to 10	4				
		More than 10	5				
Market Places	Number (total) of weekly market places/haats; grain/fruit/ vegetable/ fish market; cattle market	5 or less	1	**5**	1	1	1
		6 to 10	2				
		11 to 15	3				
		16 to 20	4				
		21 or more	5				
Common Property Resources	Number (total) of CPRs (such as pastures/gauchar lands; seating areas of the community; cremation/burial grounds etc.) within/along the RoW	5 or less	2	**10**	3	3	3
		6 to 10	4				
		11 to 15	6				
		16 to 20	8				
		21 or more	10				
Total		-	-	**60**	**33**	**25**	**23**

Engineering Aspect							
Attributes	**Scoring Criteria**		**Score**	**Total Weight of Attribute**	**Option-1**	**Option-2**	**Option-3**
					Score	**Score**	**Score**
Road Length, (Km.)	Total length of the Road	50 km. or less	3	**15**	6	6	6
		50 to 100 km.	6				

		100 to 150 km.	9				
		150 to 200 km.	12				
		200 km. or more	15				
Geometrical Elements	Horizontal and Vertical (Curvature)	Nil	0	**15**	15	12	15
		5 or less	3				
		6 to 10	6				
		11 to 15	9				
		16 to 20	12				
		21 or more	15				
Road Safety		High	5	**15**	5	5	7
		Moderate	10				
		Low	15				
Operational	Connectivity / Access	Better	5	**10**	5	5	5
		Moderate	7				
		Low	10				
Construction Time		<30 Months	5	**10**	5	5	7
		up to 36	7				
		>36 Months	10				
Muck/blasting/disposal	Cutting / drilling / blasting / Disposal	Low	1	**5**	1	1	1
		Moderate	3				
		High	5				
Underpass (No.)	VUP/LVUP/SVUP	10 or less	4	**10**	10	8	10
		11 to 20	6				
		21 to 30	8				
		31 or more	10				
Interchange	Number (total) of Road Junctions	10 or less	2	**10**	2	2	2
		11 to 20	4				

		21 to 30	6				
		31 or more	8				
Railway Crossing	Number (total) of RUB/ROB/At Grade	Nil	0	**10**	4	4	4
		2 or less	4				
		3 to 4	6				
		5 to 7	8				
		8 or more	10				
Major Bridge	Number (total) of Bridges incl. bridges on Water Bodies	2 or less	4	**10**	6	6	6
		3 to 5	6				
		6 to 8	8				
		More than 8	10				
Minor Bridge	Number (total) of Bridges incl. bridges on Water Bodies	5 or less	4	**10**	10	10	10
		6 to 10	6				
		11 to 15	8				
		15 or more	10				
Total Cost of Structures	Civil Cost (Crore Rs.)	Upto 300	2	**5**	4	5	5
		300 to 600	3				
		600 to 1000	4				
		1000 or more	5				
Total Construction Cost	Civil +LA Cost (Crores Rs.)	Upto 500	2	**5**	5	5	5
		500 to 1000	3				
		1000 to 1500	4				
		1500 or more	5				
Total	**-**	**-**	**-**	**130**	**78**	**74**	**83**

Table 5-3: Overall Scoring for the three alignments

Scoring Criteria	Total Weight	Option-1	Option-2	Option-3
		Score	Score	Score
Natural Environment	80	35	32	41
Biological Environment	80	29	21	33
Physical Environment	50	16	16	17
Social Environment	60	25	23	25
Engineering	130	78	74	83
Total	**400**	**183**	**166**	**199**

The overall scoring matrix shows that Option-2 has the least score with 166 points followed by Option-1 with 183, and last is Option-3 with 199. Increasing number showing the increasing environmental, social impact due to the said option, hence option-2 has the lowest impact overall and is considered for construction.

5.3 New Materials and Technologies in Road Construction

The proposed project will use latest construction materials and methodologies to reduce the material usage and reduce the carbon foot print during construction period. Various new guidelines and notifications have been issued by the MoRTH to use new materials, use recycled materials in road construction. The same are highlighted in **Table 5-4.** IRC guidelines are now available for use of Cement Treated Base (CTB), Cement Treated Sub-base (CTSB), Recycling, Fly-ash, Waste Plastic, Geo-Synthetics, modified Bitumen (CRMB, Polymer modified, Natural Rubber), Soil stabilization, etc. in highway construction. It is necessary to promote these materials/technologies in construction and maintenance of National Highways for harnessing potential time and cost savings and reduce the environment impacts.

Table 5-4: New Materials and Technologies in Road construction

S. No.	Material / Technology	Applications	IRC Code / Guidelines / IS Codes
1.	Waste Plastic	Wearing Coat	**IRC:SP-98** "Guidelines for the use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses".
2.	Cement Treated Granular Layer	In Base (CTB); In Sub-base (CTSB)	IRC:37 "Guidelines for the Design of Flexible Pavements".
3.	Geo-Synthetics	i. Reinforcements in pavement ii. Slope-Protection iii. Separation, Filtration, Drainage and erosion control iv. Impermeable barrier / capillary cut off in waterlogged areas	**i. IRC:SP-59** Guidelines for the use of Geo-synthetics in Road Pavements and Associated Works"; **ii. IRC:113**

S. No.	Material / Technology	Applications	IRC Code / Guidelines / IS Codes
		v. Stress relieving membranes and crack retarding layer.	"Guidelines for the Design and Construction of Geo-Synthetic Reinforced Embankments on Soft Sub-soils". **iii. IRC:SP-48** "Hill Road Manual" **iv. IRC:56** "Recommended Practices for Treatment of Embankment and Roadside Slopes for Erosion control". **v. IRC:SP-106** "Engineering Guidelines on Landslide Mitigation for Indian Roads".
4.	Recycling	i. Wearing Coat ii. Crust building	**IRC:120** "Recommended Practice for Recycling of Bituminous Pavements".
5.	Fly-ash	i. Embankment ii. Cement Concrete iii. Stabilization	**i. IRC:SP-58** "Guidelines for Use of Fly Ash in Road Embankments"; **ii. IRC:44** "Guidelines for Cement Concrete Mix Design for Pavements"; **iii. IRC:SP:89** "Guidelines for Soil and Granular Material Stabilization Using Cement, Lime and Fly Ash".
6.	Modified Bitumen (CRMB, Polymer modified, Natural Rubber)	Wearing Coat	**i. IRC:SP:53** "Guidelines on Use of Modified Bitumen in Road Construction"; **ii. IRC:SP:107** "Guidelines for Gap Graded Wearing Course with Rubberised Bitumen - (Bitumen Rubber)".
7.	Soil stabilization	Chemical Stabilization	**IRC:SP-89 (Part II)** "Guidelines for the Design and Stabilized Pavements (Part-II)".

S. No.	Material / Technology	Applications	IRC Code / Guidelines / IS Codes
8.	Jute	Slope Stabilization	**IRC:SP-56** "Recommended Practices for Treatment of Embankment and Roadside Slopes for Erosion Control"
9.	Coir	Slope Stabilization	**IRC:SP-56** "Recommended Practices for Treatment of Embankment and Roadside Slopes for Erosion Control"
10.	Construction & Demolition Waste	i. Embankment ii. Granular Layer in flexible pavement iii. Concrete Pavement	**IRC:SP-121** "Guidelines for Use of Construction and Demolition Waste in Road Sector"
11.	Recycled Aggregate / Slag Aggregate / Bottom Fly Ash	i. Concrete ii. Granular Layer	**IS-383** "Coarse and Fine Aggregate for Concrete Specifications"
12.	Stone Matrix Asphalt	Wearing Coat	**IRC:SP-79** "Tentative Specifications for Stone Matrix Asphalt"
13.	Fibre reinforced concrete pavement	Road crust	**IRC:SP-46** "Guidelines for Design and Construction of Fibre Reinforced Concrete Pavements"
14.	Cold Mix Technologies	Wearing Coat	**IRC:SP-100** "Use of Cold Mix Technology in Construction and Maintenance of Roads Using Bitumen Emulsion"
15.	Open Graded Friction Courses	Wearing Coat for high rainfall areas	**IRC:SP-129** "Specifications for Open-Graded Friction Course"
16.	Thin White Topping	Wearing Coat	**IRC:SP-76** "Guidelines for Conventional and Thin White-topping"
17.	Precast Pre-tensioned girders for bridges, Integral Bridges	Bridges	**IRC:SP-71** "Guidelines for Design and Construction of Precast Pre-tensioned Girders for Bridges"

5.4 With and Without Project Scenario

The proposed project will not only develop the surrounding area but will also provide smooth movement of traffic and linking with other roads of the country. It will provide better amenities to the surrounding areas, will bypass the traffic congestions in the major cities of Khordha, Bhubaneshwar and Cuttack, reduce travel times between Chennai and Kolkata, etc. Keeping in view, the site conditions and the scope of development of the area, the 'With' and 'Without' project scenarios has been studied. The details of the "With" and "Without" Project has been presented in **Table 5-5.**

Table 5-5: 'With' and 'Without' Project Scenario

With Project		Without Project	
Positive Impacts	**Negative Impacts**	**Positive Impacts**	**Negative Impacts**
• The construction of new highway will reduce the traffic congestion and wastage of fuel. • Flourish in trade and Commerce. • Providing better level of service in terms of improved riding quality and smooth traffic flow. • Reduction in accident rate. • Access to new Employment Opportunities • Employment of local workers for the execution of project. • Better access to health care and other social services. • Improved quality of life of the local people • Better way side amenities and other facilities like bus bays/shelters, truck lay byes and service roads. • Adequate underpasses flyovers, culverts for cross over and hydrogeology • Better movement of goods transport to ports.	• Approx. 519 ha. of land shall be acquired • Around 64500 trees will be cut down due to development of green field alignment. However twice the number would be replanted. • Increase of traffic will lead to slight air and noise pollutions in the vicinity. However proper PUC checks would be in place. • Removal of trees and vegetation due to construction of proposed project • Changes in land use pattern along the new green field alignment. • Increase in dust pollution and noise Pollution during construction period. However, this will be for short term only.	• No acquisition of land or properties and hence no displacement of families. • No felling of existing trees and vegetation	• Travel time and fuel consumption level will be more due to bottlenecks of major cities in the old alignment • Increased air pollution in the close proximity of the existing roads due to slow moving traffic and congestion. • Rise in noise levels due to more traffic congestion on the existing roads. • Chances of accidents on existing transport infrastructure will be more in absence of the planned Highway. • Further deterioration of project road • Lot of habitations on both sides of the road may lead to fatal accidents.

Therefore, 'with' project scenario, with its insignificant adverse impacts is more acceptable than the 'without' project scenario, which would mean an aggravation of the existing problems. The potential

benefits of the planned are substantial and far reaching both in terms of the geographical spread and time. Hence, it is clear that the implementation of the project will be a definite advantage to Tamilnadu, Andhra Pradesh, Odisha, West Bengal and especially in the districts of Khordha, Dhenkanal, Cuttack and Puri districts of Odisha state in order to achieve all-round development of their economy and progress for their people.

The potential impacts on different environmental components would be avoided through good engineering design practices. Appropriate mitigation measures have been suggested where avoidances are not possible in various sections of the environmental assessment report.

Based on the above studies following are the observations:

i. **Option 1**: Option 1 is basically considered as a Green field alignment from existing NH-16 to NH-55 from Rameswar to Gobindpur with a total length of 73.24 km. Closer and passes through the Chandaka WLS.
ii. **Option 2**: Option 2 is basically considered as a new Green field alignment from Rameswar to Gobindpur, from existing NH-16 to NH-55. With a total length of 70.995 km. (**Proposed alignment)**. This alignment avoids the Candaka WLS.
iii. **Option 3:** This option starts from Palatotapada after Khordha town at NH-16 to Near Kuspangi at NH-55 and passes through Greenfield area the alignment is much closer and passes through to the Chandaka WLS in the middle sections.

Hence Option 2 is found to have the least impact on environmental and social component, and hence it is followed as the proposed alignment.

6. ENVIRONMENTAL MONITORING PROGRAMME

6.1 Introduction

The environmental monitoring program is a vital process of any Environmental Management Plan (EMP) of a development project for review of indicators and to take immediate preventive action. This helps in signalling the potential issues resulting from the proposed project activities and will allow for prompt implementation of corrective measures. NHAI has keen interest in environmental monitoring as it is an integral part towards better environmental management of air, noise, water, soil, etc., during construction and operation phase.

6.2 Monitoring Schedule

The proposed project's main activity envisages construction of road. Construction phase of the project is likely to be completed within approx. 2.5 years. The environment measures that need to be undertaken during project construction stage are given in table below.

Table 6-1: Environmental Monitoring - Project Construction & Operation Stage

S. No.	Attribute	Stage	Parameter	Frequency of Monitoring
1	Air	Construction	PM_{10}, $PM_{2.5}$, SO_2 NO_2, NH_3, CO, C_6H_6, O_3	Thrice in a year excluding monsoon season (continuous 24 hours/ or 1 full working day)
		Operation	PM_{10}, $PM_{2.5}$, SO_2, NO_2, NH_3, CO, C_6H_6, O_3	Thrice in a year excluding monsoon season (continuous 24 hours / or 1 full working day)
2	Noise	Construction	Noise level Day Time Leq-6.00 am to 10.00 pm Night time Leq-10.00 pm to 6.00 am	Thrice in a year excluding monsoon season (continuous 24 hours/ or 1 full working day)
		Operation	Noise level Day Time Leq-6.00 am to 10.00 pm Night time Leq-10.00 pm to 6.00 am	Thrice in a year excluding monsoon season (continuous 24 hours/ or 1 full working day)
3	Soil	Construction	pH, Electrical conductivity, WR, Pb, SAR, Oil & Grease, Soil type	Thrice in a year excluding monsoon season (pre monsoon and post monsoon
		Operation	Pb, SAR, Oil & Grease	Thrice in a year excluding monsoon season (pre monsoon and post monsoon)

4	Water	Construction	Surface water- pH, BOD, COD, TDS, Pb, Oil & Grease and detergent, F, metals. Ground water- pH, TDS, Total Hardness, Sulphate, Chloride, F, Fe, Pb.	Thrice in a year excluding monsoon season (pre monsoon and post monsoon)
		Operation	Surface water- pH, BOD, COD, TDS, Pb, Oil & Grease and detergent. Ground water- pH, TDS, Total Hardness, Sulphate, Chloride, Fe, Pb.	Thrice in a year excluding monsoon season (pre monsoon and post monsoon)
5	Ecology & Biodiversity	Construction	Planting of local indigenous plant species. Wildlife conservation and management plan.	Regular upkeep and monitoring of planted materials. Upkeep of WL mitigation measures.
		Operation	Animal Mortality	Regular monitoring
6	Health & Safety	Construction	All relevant parameter including Malaria, Chikungunya, HIV, COVID, etc.	Monthly and as per requirements.
		Operation	All relevant parameter including Malaria, Chikungunya, HIV, COVID, etc.	Monthly and as per requirements.
7	Environment management Cell	Construction Operation	Responsibilities and roles will be decided before the commencement of work.	The environment management cell / unit is to ensure implementation and monitoring of environment safeguard during construction and operation phase.

6.3 Monitoring Indicators

The monitoring programme contains monitoring plan for all performance indicators, reporting formats and necessary budgetary provisions. Physical, Biological and Environmental Management components identified as being particularly significant in affecting the environment at critical locations have been suggested as Performance Indicators. The Performance Indicators shall be evaluated under three heads as:

- Environmental condition indicators to determine efficacy of environmental management measures in control of air, noise, water and soil pollution.
- Environmental management indicators to determine compliance with the suggested environmental management measures.

- Operational performance indicators have also been devised to determine efficacy and utility of the mitigation/enhancement designs proposed.

For each of the environmental condition indicator, the monitoring plan specifies the parameters to be monitored, location of the monitoring sites, frequency and duration of monitoring. The monitoring plan also specifies the applicable standards, implementation and supervising responsibilities.

The Environmental Monitoring Plan and Environmental Monitoring Cost has been detailed out in subsequent clauses along with stipulated standards.

6.4 Monitoring During Construction Phase

During construction stage, environmental monitoring will be carried out for air quality, noise level, water quality, and soil quality. Environmental monitoring should be carried out at the locations where baseline monitoring was carried out. These numbers could be modified based on need when the construction commences. The contractor shall ensure daily, weekly, six monthly environmental monitoring, mitigation & management measures for preparing monthly report and PMC personnel would consist of a dedicated Environmental Specialist to monitor the compliance throughout the construction phase of the project and report the same to the General Manager/Project Director of NHAI. The monitoring program shall also be conducted by Project Management Consultant/third party on a random sample basis covering 20% of sampling requirements and some tests need to be carried out by the contractor in addition as specified in the EMP under the supervision of General Manager/Project Director of NHAI.

6.5 Water Quality Monitoring

Since water contamination leads to various water related diseases, the project authorities shall establish a procedure for water quality surveillance and ensure safe water for all consumers. Water quality parameters have to be monitored during the entire period of project construction. Monitoring should be carried out by NABL certified private or government agency/laboratory. Water quality should be analyzed strictly following the procedures given in standard methods. Parameters for surface water quality monitoring will be as per IS: 2296 and for groundwater quality, monitoring will be as per IS: 10500.

Table 6-2: National Drinking Water Quality Standards

Group	National Standards for Drinking Water [a, b]		
	Parameter	Unit	Max. Concentration Limit
Physical	Turbidity	NTU	1 (5)
	pH	-	6.5 – 8.5
	Colour	Hazen Units	5 (15)
	Taste and Odour	-	Agreeable
	TDS	mg/l	500 (2,000)
	Iron	mg/l	0.3
	Manganese	mg/l	0.1 (0.3)
	Arsenic	mg/l	0.01 (0.05)
	Cadmium	mg/l	0.003

	Chromium	mg/l	0.05
	Cyanide	mg/l	0.05
	Fluoride	mg/l	1 (1.5)
	Lead	mg/l	0.01
	Ammonia	mg/l	0.5
Chemical	Chloride	mg/l	250 (1,000)
	Barium	mg/l	0.7
	Sulphate	mg/l	200 (400)
	Nitrate	mg/l	45
	Copper	mg/l	0.05 (1.5)
	Total Hardness	mg/l	200 (600)
	Calcium	mg/l	75 (200)
	Zinc	mg/l	5 (15)
	Mercury	mg/l	0.001
	Aluminium	mg/l	0.1 (0.3)
	Anionic Detergents	mg/l	0.2 (1.0)
	Phenolic Compounds	mg/l	0.001(0.002)
	Residual Chlorine	mg/l	0.2
Microbial indicator	E-coli	MPN/100ml	Must not be detectable in any 100 ml sample
	Total Coliform	MPN/100ml	

Source- [a] http://cgwb.gov.in/Documents/WQ-standards.pdf.

[b] Bureau of India Standard 10500: 2012 [Indian Standard, Drinking Water — Specification (Second Revision)]

6.5.1 Air Quality Monitoring

The air quality monitoring should be carried out by the NABL approved agency. The monitoring of air sampling should be conducted at the location of Crusher plant, HMP, Stockyards Batching plant, Haul roads and DG sets. In addition to these, air quality should also be monitored near the storage sites having aggregates, sands etc. The contractor will be responsible for carrying out air monitoring. Any other sensitive location as suggested by the Environment Engineer In-charge.

Table 6-3: National Ambient Air Quality Standards

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and other area	Ecologically Sensitive Area (Notified by Central Government)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual	50	20
		24 hrs	80	80
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual	40	30
		24 hrs	80	80
3	Particulate Matter (PM_{10}), µg/m^3	Annual	60	60
		24 hrs	100	100
4	Particulate Matter ($PM_{2.5}$), µg/m^3	Annual	40	40
		24 hrs	60	60

5	Ozone (O3), µg/m^3	8 hrs	100	100
		1 hrs	180	180
6	Lead (Pb), µg/m^3	Annual	0.5	0.5
		24 hrs	1	1
7	Carbon Monoxide (CO), mg/m^3	8 hrs	2	2
		1 hrs	4	4
8	Ammonia (NH^3), µg/m^3	Annual	100	100
		24 hrs	400	400
9	Benzene (C6H6), µg/m^3	Annual	5	5
10	Benzo(a)Pyrene (BaP)- particulate phase only, ng/m3	Annual	1	1
11	Arsenic (As), ng/m3	Annual	6	6
12	Nickel (Ni), ng/m3	Annual	20	20

(Source: CPCB NAAQS, 2009)

The parameters recommended for monitoring during construction are:

- Particulate Matter: PM_{10}, $PM_{2.5}$
- Sulphur Dioxide,
- Nitrogen Dioxide, and
- Carbon Monoxide

6.5.2 Noise Level Monitoring

The monitoring of noise sampling should be conducted at the location of plant sites i.e. crusher plant, HMP and construction sites, etc. In addition to these, noise quality should also be monitored near any school, hospital, other sensitive sites and residential areas that exist along the 40 meter to 50-meter distance of project road or at the designated locations fixed –up by the environmental expert. The noise levels will be monitored using the Integrating/logging sound level meter from 6.00 am to 10.00 pm (Day Time Leq) and night noise levels (Night Time Leq), from 10.00 pm to 6.00 am. Weighted equivalent has to be estimated for the recorded sound level in decibels. Monitoring should be carried out by a NABL certified private or government agency/Laboratory. The contractor will be responsible for carrying out noise level monitoring during entire construction and operation phase under the supervision of NHAI.

Table 6-4: National Ambient Noise Quality Standards

Receptor/ Source	Noise Level Standards [a] (dBA)	
	Day	Night
Industrial area	75	70
Commercial area	65	55

Residential Area	55	45
Silent Zone	50	40

Source- Noise Pollution (Regulation and Control) Rules, 2002 as amended up to 2010, CPCB)

6.5.3 Soil Quality Monitoring

Soil quality tests should be undertaken to assess the soil conditions in and around the project area during the construction of the project. The sample will be collected by ramming a core-cutter into the soil up to 90-cm depth. Soil samples are to be collected and analyzed for relevant physical and chemical characteristics in order to assess the impact of the proposed project on soil. Monitoring should be carried out by NABL certified private or government agency. The contractor will be responsible for carrying out soil quality monitoring during entire construction phase under the supervision of NHAI.

Table 6-5: National Soil Quality Standards

Sl. No.	Parameters	Unit	Method of Testing
1.	pH	----	IS: 2720 (P-26): 1987
2.	Electrical Conductivity	µmhos /cm	IS: 14767 (2000): 2001
3.	Moisture	%	IS: 2720 (P-22): 1983
4.	Clay	%	IS: 2720 (P-4)
5.	Silt	%	IS: 2720 (P-4)
6.	Sand	%	IS: 2720 (P-4)
7.	Bulk density	gm/cm^3	IS: 2720 (P-6): 1962
8.	Porosity	%	IS: 2720 (P-6): 1962
9.	Nitrogen as N	mg/kg	IS: 2720 (P-47): 1962
10.	Phosphorus	mg/kg	IS: 14684: (1999): 2019
11.	Potassium as K	mg/kg	IS: 2720 (P-47): 1962
12.	Organic Carbon	%	IS: 2720 (P-23): 1982
13.	Sodium	mg/kg	IS: 9497:1980 (2020)
14.	Calcium	mg/kg	IS: 2720 (P-27): 1983
15.	Magnesium	mg/kg	USDA Method, 1968
16.	Total Alkalinity	mg/kg	USDA Method, 1968
17.	Chloride	mg/kg	-
18.	Sulphur Content	mg/kg	-

6.5.4 Workers Health and Safety Monitoring

Monitoring of health issues that may arise throughout the project life time will be done through contractor. Epidemiological studies at construction sites and workers camp will be performed to monitor the potential spread of diseases. Regular inspection and medical check-ups shall be carried out and any reoccurring incidents such as irritations, rashes, respiratory problems, ongoing epidemics/pandemics, (HIV, COVID), etc. shall be recorded and appropriate mitigation measures shall be taken. Contractor will be the responsible person to take care of health and safety of workers during the entire period of the construction and project proponent shall review/audit the health and safety measures/plans. However, supervision agency for workers' health and safety is the project proponent,

NHAI which will conduct site representation, compliance monitoring, training and incident management.

6.5.5 Monitoring Schedule

Number of monitoring locations of air, noise, water and soil and during the construction stage of Package 1 & 2 of the project are presented in table below. Monitoring locations and increase or reduce based upon the Environment in-charge at site locations of sensitive locations.

Table 6-6: Monitoring locations during construction phase

Parameter	Frequency	No. of locations	Duration (Years)
Air	Thrice in a year excluding monsoon season	12	2.5
Noise	Thrice in a year excluding monsoon season	12	2.5
Surface Water	Thrice in a year excluding monsoon season	12	2.5
Ground Water	Thrice in a year excluding monsoon season	12	2.5
Soil	Thrice in a year excluding monsoon season	12	2.5

6.6 Monitoring During Operation Phase

Even though the environmental hazards during operation phase of the project are minimal, environmental monitoring will be carried out for air, noise, water and soil. The parameters monitored for air quality during operation phase will be PM10, PM2.5, CO, NO2 & SO2. Surface & groundwater quality parameters will be monitored as per IS 2296 & IS 10500. The monitoring program shall be conducted by Project Management Consultant/third party on a random sample basis covering 20% of sampling requirements and some tests need to be carried out by the contractor in addition as specified in the EMP under the supervision of General Manager/Project Director of NHAI.
Numbers of monitoring locations of air, noise, water and soil during operation phase for Package 1& 2 are presented in below table.

Table 6-7: Monitoring locations during operation phase

Parameter	Frequency	No. of locations	Duration (Years)
Air	Thrice in a year excluding monsoon season	8	5
Noise	Thrice in a year excluding monsoon season	8	5
Water (GW+SW)	Thrice in a year excluding monsoon season	16	5
Soil	Thrice in a year excluding monsoon season	8	5

The results of air, noise, water and soil monitoring will be submitted to the management quarterly during construction phase and semi-annually during operation phase. Monitoring is carried out at all baseline locations, wherever not mentioned follow the directions of the Environmental Expert/Engineer in-charge.

6.7 Establishment of Environmental Management Cell

It is recommended that NHAI establishes an Environment Management Cell (EMC) at the initial stage of the project itself. The division should be staffed with an Environmental Engineer/Officer and a

Technical Assistant (Environment background). The task of the division will be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to General Manager/Project Director of NHAI. The Hierarchical structure of EMC is shown in the figure below.

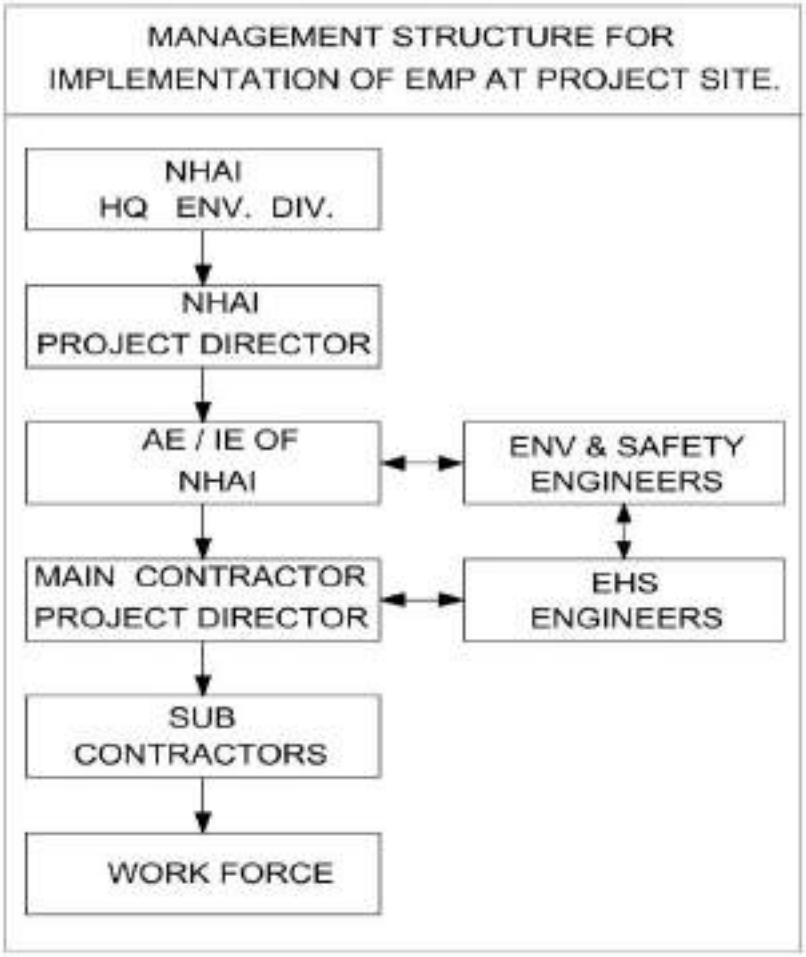


Figure 6-1: Hierarchical structure of Environment Management Cell

Table 6-8: Environmental Monitoring Plan

Environmental Components	Monitoring			Location	Frequency	Institutional Responsibility	
	Parameters	Special Guidance	Standards			Implementation	Supervision
Air Quality	$PM_{2.5}$, PM_{10}, SO_2, NOX, CO	As per CPCB guidelines	The Air (Prevention and Control of Pollution) Rules, CPCB, 1982	At sites where hot mix plant / batching plant is located	Once in a season till end of construction	Contractor through approved monitoring agency	PD, NHAI- PIU Bhubaneswar, AE
Ground and Surface Water Quality	pH, BOD, temperature, Total Hardness, COD, TDS, TSS, DO, Total coliform, Conductivity, Oil & Grease	Grab sample collected from source and analyzed as per standard methods for examination of water and wastewater	Water quality standards by CPCB	River tributaries, roadside ponds and ground water at construction camp sites	Once in a season till end of construction	Contractor through approved monitoring agency	PD, NHAI- PIU Bhubaneswar, AE
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.	Once in a season till end of construction	Contractor through approved monitoring agency	PD, NHAI- PIU Bhubaneswar, AE
Soil quality	Monitoring of NPK & heavy metals and grease	At any sensitive locations	As per IRC code of practice	Ad-hoc if accident /spill locations involving bulk transport of carrying hazardous material	Once in a season till end of construction	Contractor through approved monitoring agency	PD, NHAI- PIU Bhubaneswar, AE
Road side plantation	Monitoring of felling of trees	It should be ensured that	As given in the Detailed	All along the corridor	During the felling of trees	Forest department or	Developer to assist in co-

Environmental Components	Monitoring			Location	Frequency	Institutional Responsibility	
	Parameters	Special Guidance	Standards			Implementation	Supervision
		only marked trees are felled	Design for the project			Competent Agency	ordination with NHAI, AE
	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, avenue and median plantation	Every year for 3 years or as per contract	Contractor through approved horticulture agency.	Developer & Forest Department, NHAI, A.E.

6.8 Environmental Monitoring Cost

The environmental monitoring cost is estimated on the basis of the length and existing environmental scenario of the proposed project. Environmental monitoring cost of **Rs. 32,28,750/-** has been allocated for construction and operation stages. The details have been presented in table below.

Table 6-9: Environment Monitoring Cost

S. No.	Parameters / Components	Particular	Guidelines	Unit Cost/Sample (Rs.)	Total Cost (Rs.)
1	**Ambient Air Monitoring: At construction Stage:** At 7 locations for three seasons in a year for 2.5 years	Monitoring at Construction sites	PM2.5 and Respirable dust samplers to be used and located 50 m from the construction site	5,000	2,62,500
	At Operation Stage: At 7 locations for three seasons a year for 5 years	Ambient Air Quality Monitoring	-	5,000	5,25,000
2	**Ground Water Sampling:** At Construction Stage**:** At 7 locations for three season in a year for 2.5years	Ground water bodies	Analyze as per the standard methods for examination of water and waste water	4,500	2,36,250

S. No.	Parameters / Components	Particular	Guidelines	Unit Cost/Sample (Rs.)	Total Cost (Rs.)
	At Operation Stage: At 7 locations for three seasons a year for 5 years	Ground water bodies	Analyze as per the standard methods for examination of water and waste water	4,500	4,72,500
3	**Surface Water Sampling**: At Construction Stage: At 7 locations for three season in a year for 2.5 years	Surface water resources	Analyze as per the standard methods for examination of water and waste water	5,000	2,62,500
	At Operation Stage: At 7 locations for three seasons a year for 5 years	Surface water resources	Analyze as per the standard methods for examination of water and waste water	5,000	5,25,000
4	**Noise Monitoring:** At Construction Stage: At 7 locations for three seasons a year for 2.5 years	At equipment yards'/construction sites identified by IC	Using an integrated noise level meter kept at a distance of 15 m from the construction site	1,500	78,750
	At Operation Stage: At 7 locations for three seasons a year for 5 years	As directed by the Engineer	-	1,500	157,500
5	**Soil Monitoring:** At Construction Stage: At 7 locations for three season in a year for 2.5 years	At productive agricultural land	-	4,500	2,36,250
	At Operation Stage: At 7 locations for three season for 5 years	At productive agricultural land	-	4,500	4,72,500
	Total Monitoring Cost (A)				**32,28,750**

7. ADDITIONAL STUDIES

7.1 Public Consultation

7.1.1 Introduction

As a part of the project preparation and to ensure that the community support is obtained and the project supports the needs of the people; public consultations were carried out as an integral component. A continuous involvement of the stakeholders and the affected community was obtained. The information gathered in the consultation process has led to substantial inputs for the project preparation including, influencing designs. Consultations involve soliciting people's views on proposed actions and engaging them in a dialogue. It is a two-way information flow, from project authorities to people and, from people to project authorities. While decision making authority would be retained by the project authority, interaction with people and eliciting feedback allows affected populations to influence the decision-making process by raising issues that should be considered in designing, mitigation, monitoring and management plans and the analysis of alternatives. Public Consultation Meetings (PCM) can lead to reduced financial risks of time and cost over-run, legal disputes, and negative publicity, direct cost savings, increased market share through good public image, and enhanced social benefits to the affected local communities. It provides an opportunity for the general public, private and community bodies to know the environmental and social impacts as a result of project implementation. Major purpose of the public consultation of environmental issues in the EIA study is to appraise the stakeholders on potential environmental impacts and collect their feedback so that adequate safeguards can be considered during the planning phases. The objectives of consultation sessions, the procedure adopted and the outputs of the consultation conducted have been described in the following sections.

7.1.2 Objectives

The main objective of the consultation process is to minimize negative impacts of the project and to maximize the benefits from the project to the local populace. The objectives of public consultation as part of this project are:

- To obtain the information on baseline scenario;
- Promote public awareness and improve understanding of the potential impacts of proposed project;
- Identify alternative designs, and mitigation measures;
- Solicit the views of affected communities / individuals on environmental and socio-economic aspects;
- Improve environmental and social soundness;
- Identify contentious local issues which might jeopardize the implementation of the project;
- Establish transparent procedures for carrying out proposed works;
- Inform the affected populace about the entitlement framework and to settle problems with mutual consent; and
- Create accountability and sense of local ownership during project implementation.

7.1.3 Stakeholders

For the project, following major groups of stakeholders were identified for consultations at screening stage:

Primary Stakeholders: are the local people including project affected people, farmers, local residents, shopkeepers, *etc*.; and

Institutional Stakeholders: such as concerned Government departments and local authorities.

The stakeholder consultation included community meetings and in-depth interviews with individual and institutional stakeholders. Consultations were done using various tools including, interviews with government officials, dialogues were set-up with the community through structured questionnaire and general environment, social and economic aspect related questions. The public consultation carried out at the various stages of the study has been summarized in this section.

7.1.4 Methodology

Arrangement: Major project affected village settlements located close to proposed highway were selected for conducting public consultation. Affected communities and potential stakeholders such as local residents, panchayat members, youth, women and teachers, *etc*. were invited to attend the meeting. Effort was made to make the gathering representative of the local population directly or indirectly affected by the potential impacts. During the meetings, no person is prevented from entering and /or leaving the PCM as he / she shall so desire.

Discussions, Questions and Answers: During consultation meeting, the participants were explained the proposed improvement proposal and potential environmental impacts due to the proposed green field highway. Thereafter, a session for question and answer was kept to facilitate interaction with the stakeholders, exchange of information, & direct communication and collect their opinion on the environmental and social-economic issues. The issues broadly covered in questionnaire included the following topics.

- Disturbance due to present traffic scenario with respect to environmental pollution and road safety.
- Anticipation of disturbance due to the proposed green field highway with respect to environmental pollution and road safety.
- Expectation on road safety measures in the improvement proposal.
- Accidents and conflicts involving wildlife, if any
- Preference of avenue trees, if any
- Forest, Wildlife and Environmental Sensitive Area.
- Historical and Archaeological sites.
- Flora & Fauna of the area.

7.1.5 Consultations with Institutional Stakeholders

The institutional level consultations were held with representatives of institutions having stakes in implementation of the project. The institutions namely field officials of State Forest and Wildlife department, Revenue department, Railways, Irrigation, were consulted. Meetings were held with State Forest and Wildlife Officials and their inputs have been incorporated in the reports. Details of consultations with Institutional stakeholders are given in the table below.

Table 7-1: Consultations with Institutional Stakeholders

S. No.	Contacted officials	Points Discussed
1.	DFO, Cuttack	• Wildlife/eco sensitive protected area within 10 km radius of the proposed project. • Information on presence of forest land along the road and Flora of the area. • Presence of Notified Protected Area (covered under Wildlife Protection Act, 1972). • Record of sighting of Endangered / Migratory species in the vicinity of Project Area. • Forest Map showing the alignment. • Wildlife crossing/ corridor crossing the project area. • Endemic / Keystone Species Project impact. • DGPS maps of forest areas.
2.	DFO, Dhenkanal	
3.	DFO, Khordha	
4.	DFO, Chandaka-Dampara wls	
5.	PCCF and Nodal Officer, Bhubaneswar, CWLW, Forest Department, Govt. of Odisha, ORSAC.	
6.	MSME, DIC, DIO, PHED, Irrigation Department, Department of Mines and Minerals, Department of Economics and Statistics and other departments of Govt. of Odisha., Office of the Registrar General and Census Commissioner, Govt. of India.	• Details of industries and Micro, Small & Medium Enterprises in the project area. • Details of water Supply systems of all Urban Local Bodies in the project area. • Details of irrigation water courses, major and minor irrigation tanks in the project area. • Details of geology and important mineral resources in the project area. • Number of skilled/unskilled workers in the project area. • Socio-economic data of the project area. • Census data for state and districts
7.	Revenue Department, Govt. of Odisha	• Details of tehsils, villages, plot-wise land holders.

7.1.6 Consultations with Community/Primary Stakeholders

The extent or the likely level of adverse impacts was one of the major criteria in deciding locations for public consultation sessions. Consultations were held with the affected population and community residing in the affected villages near the vicinity of the project.

7.1.7 Outcomes of Consultations

The suggestion / observation of the public was recorded and is summarized in the table below. Proposed project activities and further impact on social and environment aspects were discussed during consultation. Probable Management plan to avoid or minimize the anticipated impacts were also discussed during consultation.

Table 7-2: Outcome of the Consultations with Community/Primary Stakeholders

Outcome of the Discussion	
Details of some of the consulted villages	**Issues and suggestions raised by the stakeholders**
	• Majority of the PAP do not have any problem with the proposed highway, though their only demand was getting monetary compensation at the correct time as well as provision of proper service roads for maintaining connectivity between the village and fields. • Majority of the people were not concerned about the environmental issues that will be caused by the construction of the proposed highway but did show some mention for the same. • The remaining members of the community stakeholders had concerns over felling of trees and suggested that felling should be kept to a minimum. Another concern raised was the matter of noise and dust pollution during the construction activities, and suggestions were made to provide noise barriers and dust suppression measures to mitigate the same. • The stakeholders suggested provision of jobs for the persons whose livelihood are to be affected due to the construction of the proposed highway.

7.1.8 Key Findings and Recommendations

Major findings related to key issues such as general perception about the project, suggestions to mitigate issues resulting from relocation and loss of livelihood are presented below:

- It was observed that people are not only aware of the project, but also welcomed the project in general.
- The average water table of the region is around 2-5 m below the ground level.
- Affected people suggested that proper connectivity should be maintained between the agricultural fields and the habitation areas through the provision of vehicular underpasses at important locations and service roads wherever possible.
- The stakeholders demanded the relocation of the bore wells that will be demolished due to the construction of the proposed highway.
- Environmental pollution was not a major concern, but dust generation and noise pollution due to construction and subsequent plying of traffic is supposed to cause problems to the immediate roadside inhabitants.
- People suggested that adequate safety measures should be provided to prevent accidents and pollution. In brief, it was felt during consultation that regular meeting with the local population / community could easily resolve any dispute between the community people and implementing agency settlements.
- The potential PAPs in general were very much concerned about the mode of compensation and employment.
- Green Belt development along the highway.
- Site specific EMP has been designed to address environmental and socio-economic related issues.

7.1.9 Conclusion

The Public Consultation is an ongoing process which starts from the inception stage and continues throughout the construction; till completion of the project. All the above feasible suggestions have been addressed in DPR and Environment Management Plan. Public Consultation has been conducted in all the districts through which proposed highway is passing, in accordance with the EIA Notification, 2006 and its subsequent amendments for obtaining the prior environmental clearance for the project.

7.2 Public Hearing

Public hearing would be carried out in each district of the project after submitting the draft report to Member Secretary, OSPCB and District Collectors of three districts viz. Khordha, Dhenkanal and Cuttack. Dates for the public hearing would be taken one month after the announcement of the dates in local newspaper. Announcement for the public hearing will be made in the affected villages and PH notice will be put up on Panchayat notice boards and intimated to the Sarpanch of each village.

Presentation of the project, its issues and anticipated impacts will be discussed and views and observations of the local stakeholders will be put up for discussion and their concerns addressed in the hearing. Attendance of all the attendees would be taken and Minutes of Meeting prepared for incorporating in the final EIA report.

7.3 Social Impact Assessment Study

The Social Impact Assessment study of the project expressway has been carried out as per Terms of Reference of MoEF&CC, NHAI and guidelines given by the Govt. of India. The study methodology employs a holistic approach in which the important receptors were identified. Based on the identification of various socio-economic parameters, secondary baseline data were collected and then analyzed to predict the impacts and quantify them. A detailed Social Assessment has been carried out to identify nature and characteristics of impacts to individuals and local communities because of the proposed project interventions. The report prepared which gives detailed impacts of the project. A Census survey of Project-Affected Persons (PAPs) was carried out along with the land resource survey of the project area. To establish impacts on people and community a resource mapping on strip map and consultation with individuals, communities and other stakeholders were done. Based on the findings of this survey and consultation with project affected persons and other stakeholders a social impact assessment report is prepared.

7.3.1 Methodology

Screening is the first step in the social assessment process. Social analysis of the project area is made at this stage and steps are taken from the beginning so that plans / designs / alignments are decided in such a way that to the extent possible, incompatible influences are evaded / reduced at the design stage itself to make these roads social and environment friendly. In case avoidance/reduction of adverse impacts are not feasible, the affected people shall have to be properly and adequately compensated, resettled or rehabilitated by implementing proper mitigation measures so that the living conditions can be improved.

The main steps followed for social impact assessment are as follows:

- Avoidance/reduction of adverse social impacts during the planning and design stage.
- Mitigation of the unavoidable adverse impacts during planning, construction and implementation stages.
- Providing adequate compensation to the affected people and common properties at replacement costs and adopting appropriate rehabilitation and resettlement measures.

For the study of this project, the scope of work defined in the Terms of Reference (ToR) submitted by the NHAI, Government of India and as detailed by MoEF&CC, has been taken into consideration. The scope identifies some major issues and items, viz.:

- Study of Background information on project and related policy and legal issues;
- Collection of data from secondary sources;
- Reconnaissance survey of the project impact zone, and
- Analysis of data and Screening exercise

7.3.2 Policy, Legal and Administrative Framework

The project has been initiated and is being implemented out by the National Highways Authority of India (NHAI). The SIA report of the proposed construction of 6 lane National Highway under NH (O) from Rameswar (NH-16) to Gobindpur (NH-55) of approx. 70.995 km in Odisha state has been prepared considering the Guidelines of NH Act (1956).

7.3.3 Project Profile

❖ **Right of Way**

This is a proposed alignment is a greenfield project with a RoW of 60 m.

❖ **Terrain and Land Use**

The proposed highway will traverse through mainly plain terrain. The land use pattern along the proposed alignment is mainly agricultural land and revenue forests with some built up areas in some patches.

❖ **Settlement Section**

The proposed project highway passes through 65 villages and some built-up area within the Corridor of Impact (CoI). This will potentially result in the displacement of families, loss of livelihood and impact on other resources.

The proposed expressway passes through rural area and the local people have to access their fields. There would be a need of provision of service roads, VUP, SVUP, LVUP, culverts at every 1-2 km which will have impact on people as well as property. The project is so designed so that it will have minimum impact on movement of local population with more than two openings per kilometer are being designed.

7.3.4 Project Affected Households/Families (PAHs/PAFs) & Project Affected Population (PAP)

Project affected households and total project affected population is around 3426 and 15621 respectively in the proposed alignment.

7.3.5 Land Acquisition

Based on the land area survey conducted and information obtained on PRoW, about 547.51 land is to be acquired for the construction of the highway to provide a 60 m wide RoW for the proposed alignment. The land that will be acquired includes agricultural, revenue forest (Sabik/Hal) and built-up land.

7.3.6 Public Consultation

The public consultations were undertaken by environmental and social teams along with the subject experts in the villages along the project corridor.

Interactions were done with the impacted persons to understand their views and apprehensions about the project. Concerns of the impacted persons about safety, road widening, potential impacts to properties and other expected impacts were also addressed through detailed interactions. The major concerns of any titleholder were regarding the design of the PRoW, loss of structure, as well as compensation norms to affected persons.

Extensive public consultations were undertaken with major focus on the environmental and socio-economic aspects. This revealed that majority of the PAPs are primarily dependent on agriculture as their livelihood, and the quality and availability of water was also not satisfactory along the entire stretch especially in the lean months.

The affected persons were in general supportive of the construction of the new highway, with suggestions about provision of vehicular underpasses at every 500 m and service roads to maintain the

connectivity among the village and the agricultural fields. Adequate compensation was also desired by the PAPs.

The concerns raised by the villagers have been addressed in the project design. Mitigation measures shall be undertaken as per EMP to mitigate environmental impacts in the area. The compensation to project affected persons will be paid as per NH Act, 1956.

The main purpose of public consultation process is to know the community's reaction to the perceived impact of proposed project on the people at individual and village settlement level. The issues of the most concern are related to rehabilitation and resettlements. It is also generally felt that most of the people are aware about the project. The other prime concern is road safety. The issues have been duly incorporated in project design.

7.3.7 Potential Impacts

❖ **Impact of Land Acquisition**

The impacts on acquisition of land can be subdivided into the following impacts:

➢ **Loss of Land**

The proposed project will require the acquisition of about 547.51 ha. of land for the proposed alignment, which includes majorly agricultural land, residential land with residential structures, public utilities, community structures, and others. This will have a direct impact on the village communities as well as other neighboring villages. Moreover, the land use pattern of the area will change from agricultural to road construction activity. As the livelihood of most of the affected people depend on agriculture, the loss of agricultural land to the construction of the road will impact the community to an extent.

➢ **Loss of Farm Produce**

The stretch has relatively fertile agricultural land. Acquisition of land will result in loss of cropping areas and crops. As land will be acquired in a phased manner, the owners will be able to cultivate some part of their land till construction time permits. They will be allowed to harvest produce and cash compensation will be paid for crops acquired at a price fixed by the Government.

➢ **Loss of Residential and Commercial Structures**

The project requires the demolition of residential houses and commercial properties. These will be acquired and compensation will be paid before the start of project.

➢ **Loss of Public Infrastructure**

Construction of proposed expressway would entail shifting of public infrastructure. These include places of culture, places of worships, some village roads, piped water lines, electricity grid lines, etc. These will be relocated at new sites as per the community's/departments' requirement, subject to allotment of land by authorities before actual demolition begins.

➢ **Loss of Income**

Those losing agricultural lands will lose income opportunity. However, this will be a permanent setback, unless provided with adequate compensation amount and / or training facilities for new trades with sufficient seed capital.

➢ **Increase in Employment Opportunities**

Commencement of expressway will benefit the community through generation of direct and indirect employment within the project areas due to construction activity, minor repairs and maintenance works. The project will require a good number of unskilled workers and they can form a cooperative, which will supply labourers to contractors whenever required. Up gradation of roads and community development programs in the project plan will benefit the communities at large.

7.3.8 Mitigation and Enhancement Measures

Most of the mitigation measures can be incorporated as good engineering practice during the design phase itself thus ensuring the mainstreaming of social concerns early in the project. Adherence to design drawing and specifications will reduce; to within acceptable levels, the adverse impacts during construction.

7.3.9 R&R Budget (Compensation)

It has already been stated that the list of affected properties is yet to be firmed up. However, a tentative estimate of cost for Rehabilitation & Resettlement has been worked out to INR. 800 Cr. for the proposed alignment, which covers all components of compensation, assistance and entitlements.

7.3.10 Project Impact Zone

The road users and the population benefited / affected by the project roads are mainly the people, who generally pass through or use the existing road / proposed alignment for their daily needs. The majority of the direct beneficiaries of the project reside in the vicinity of the road alignment, within approximately 1 km radius from the road alignment.

In order to carry out Socio-Economic Survey (SES) and conduct Focus Group Discussions (FGD's) for preparing Social Analysis, the project impact zone has been defined as:

- Direct impact involves the habitations and fields existing on the project road and
- Indirect impacted habitations will involve those within 1 km on either of the project road.

❖ **Socio-economic profiling**

The majority of the potentially affected / benefited persons living in the project influence zone frequently travel down the existing roads or proposed alignment of the project. Their purpose of visit brings them generally to the prominent market places by the roadside or transport boarding points either side of the road. Other beneficiaries also pass through the important junctions of the feeder roads connecting the project roads / proposed alignment. These junction points served as the clusters from where sample households and meetings were selected. Besides, administrative offices, places of worship, community structures, such as Anganwadi centers, schools, commercial establishments in the major settlements within the project impact zone were also taken into considerations for holding FGD / Key Informant Interview (KII).

The project influence area (PIA) of expressway covers parts of three districts of Odisha i.e. Khordha, Dhenkanal and Cuttack. The district and tehsil-wise influenced villages falling under the direct influence zone is presented in the following table**.**

Table 7-3: Villages falling under direct influence zone of the proposed alignment

District	Tehsil	Project Affected Villages under Impact Zone
Khordha	Tangi	Bagheiput, Balarampur, Rameswar, Ambabi, Damanbhumi, Kuanrakalipatna, Nayakot, Gayabandha
	Khordha	Jankia, Madhapur, Kaipadar, Bhatapara, Kankadahad, Mangalpur, Radhakantapur, Bangida, Kumbhilo, Adhakhandia, Balisahi, Basanta, Brahmanabereni, Hatasahi, Kuaput
	Begunia	Parichhal, Dalak, Goda, Masania, Ramasinghprasad, Phulachhanchuni, Karadagadia, Botalama, Kesarada, Sarua, Lokanathpur, Kathakhuntia, Patanibar
Cuttack	Damapada	Talabasta, Bilipada Saradhapur, Badapadanpur, Simil Pur Makundapur Charigharia
	Banki	Kantapahara, Patugadadharpur, Sahanga gopalpur, Gholpur
	Athagarh	Mahidharpur, Gopiballav Pur, Nuabandha, Chirigunipat Khuntakata, Gudupada, Samsarpur, Amrutamanohipatana Jagannath Pur, Kuanal, Koranga
Dhenkanal	Dhenkanal	Shankarpur, Jenasahupatana, Padmalabhapur, Patarabhaga, Manipur, Talabarkote, Siaria, Baladiabandha, Gobindapur

7.3.11 Conclusions

The construction of the proposed new 6-lane Capital Region Ring Road (CRRR-1) from Rameswar (NH-16) to Gobindpur (NH-55) of approx. 70.995 km in Odisha state will have an overall positive impact on the region which is being impacted by the project. Major impacts of the project involved land acquisition as well as some environmental impacts as it is majorly a greenfield project. These temporary and short-lived anticipated environmental impacts have been identified and their proper mitigation measures have been formulated. Green belt development along the road at specific vacant places such as toll plaza areas and wayside amenity areas have been envisioned with an objective of environmental enhancement. Adequate vehicular underpasses have been proposed to facilitate the smooth movement of villagers and cattle as well as their vehicles from the village to the agricultural farmlands which may be bifurcated at places due to the proposed project. The social impacts due to the proposed project may be mitigated effectively by implementing the measures stated in the current report. Road connectivity and overall economic development of the region, especially at interchange locations, has been visualized. Moreover, this proposed highway will serve as a faster route connecting the existing NH-16 and NH 55 Kolkata -Chennai Highway at Rameswar in Odisha. With the above approach to design, construction and operation the project will be socially feasible.

7.4 Census and Socio-Economic Survey

- The objective of the census and socio-economic survey was to prepare the list of the project affected households and prepare the socio-economic profile of the project affected persons for evolving the entitlement framework.
- The cut-off date for eligibility for entitlements for non-title holders is the date of the commencement of census surveys for the three project districts of Odisha i.e. Khordha,

Cuttack and Dhenkanal. The date of publication of Notification under section 3A(I) of NH Act will be the cut-off date for the legal titleholders.

- The study time frame can be broadly divided into two phases comprising of Phase I to include secondary data search, Reconnaissance survey, Social strip mapping; and Phase II to include census and socio-economic surveys for titleholders.
- The analysis of the data has been presented in the following sections for the titleholders separately.

7.4.1 Socio-Economic Characteristics of Project Affected Family

The socio-economic characteristics of the titleholder PAFs have been analyzed with respect to the following characteristics:

- Project Affected Families
- Type of Family
- Educational Status
- Sex Ratio
- Religious status
- Marital Status
- Occupational Pattern
- Income Categories
- Social Vulnerability

❖ Project affected families

The distribution of Project Affected Families (PAFs) and Project Affected Population (PAPs) as per the number of persons affected using the definition of family as per the R&R policy is given in the following table. Total number of PAFs are 3426 and PAPs are 15621.

Table 7-4: Number of (PAFs) and (PAPs)

S. No.	Particulars	Khordha	Cuttack	Dhenkanal	Total
1	Number of PAFs	1553	1382	491	3426
2	Number of PAPs	7761	6015	1845	15621

(Source: Primary survey, 2024)

❖ Type of Family

Being a country having a huge population, some families in India often constitute siblings' families also living together in one household, in other words, they live in a joint family. The project affected families were surveyed and classified based upon the type of the family, viz. nuclear or joint. The cumulative details of the type of project affected families are given in the table below.

Table 7-5: Type of project affected family

S. No.	Type of Family	Khordha	Cuttack	Dhenkanal	Total
1	Joint	1422	1306	460	3188
2	Nuclear	131	76	31	238
Total		**1553**	**1382**	**491**	**3426**

(Source: Primary survey, 2024)

The survey data indicates that 93.05% are joint families and 6.95 % are nuclear families.

❖ Education status

Overall, most of the PAPs are found to have some basic level of education. The distribution of total PAPs with respect to their educational status is given in the table below.

Table 7-6: Educational status of the PAPs

S. No.	Parameters	Khordha	Cuttack	Dhenkanal	Total
1	Illiterate	731	537	170	1438
2	Up to 5th	1911	1611	442	3964
3	Up to 8th	2980	2256	697	5933
4	Up to 12th	973	859	236	2068
5	Graduate or Higher	1166	753	300	2219
Total		**7761**	**6015**	**1845**	**15621**

(Source: Primary survey, 2024)

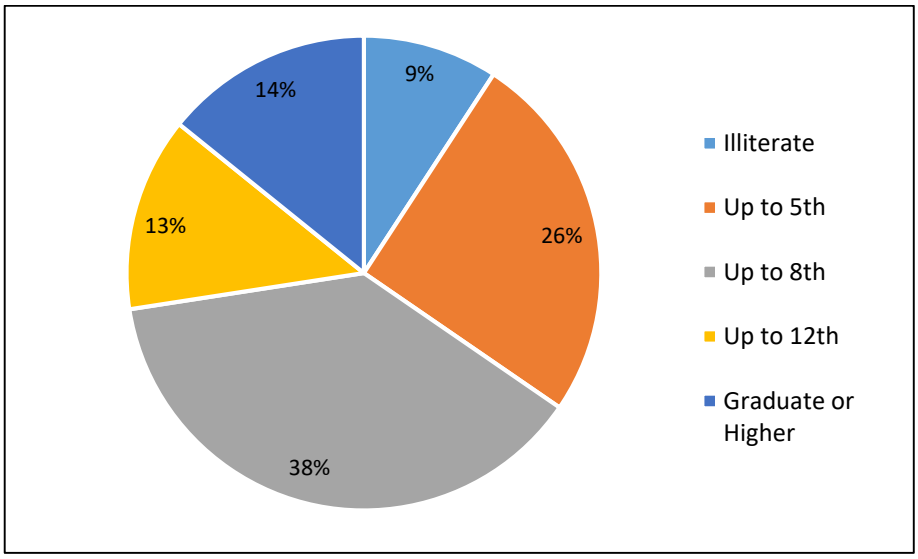


Figure 7-1: Education level of the PAPs of proposed alignment

37.98% of the PAPs in the proposed alignment were found to have an education up to 8th level, followed by 25.38%. PAPs up to 5th standards, 14.20% of the PAPs having graduate or higher qualification, 13.24% of the PAPs are upto 12th standard. 9.21% of PAPs of the proposed alignment were found to be illiterates.

❖ Sex Ratio

The sex ratio of the PAPs comes out to be around 954 in the proposed alignment. The detailed structure of the sex ratio is given in the following table.

Table 7-7: Sex Ratio of the PAPs

S. No.	Parameters	Khordha	Cuttack	Dhenkanal
1.	Total Population	**7761**	**6015**	**1845**
2.	Male	4007	3075	937
3.	Female	3754	2940	908
4.	Sex ratio	937	956	968

(Source: Primary survey, 2024)

The sex ratio of the PAPs in project districts viz. Khordha, Cuttack and Dhenkanal are 937, 956 and 968 respectively, which closely aligns with the rural sex ratios of Khordha, Cuttack and Dhenkanal districts, recorded at 929, 940 and 947 respectively, according to the 2011 Census data.

❖ Religious Status

India is a secular country, with different religions living in harmony with each other. In order to assess the religious status of the PAFs, a survey was carried out.

Table 7-8: Religious status of the PAFs

S. No.	Religion	Khordha	Cuttack	Dhenkanal	Total
1.	Hindu	1497	1308	488	3293
2.	Muslim	42	61	2	105
3.	Christian	9	6	0	15
4.	Sikh	1	1	0	2
5.	Others	4	6	1	11
Total		**1553**	**1382**	**491**	**3426**

(Source: Primary survey, 2024)

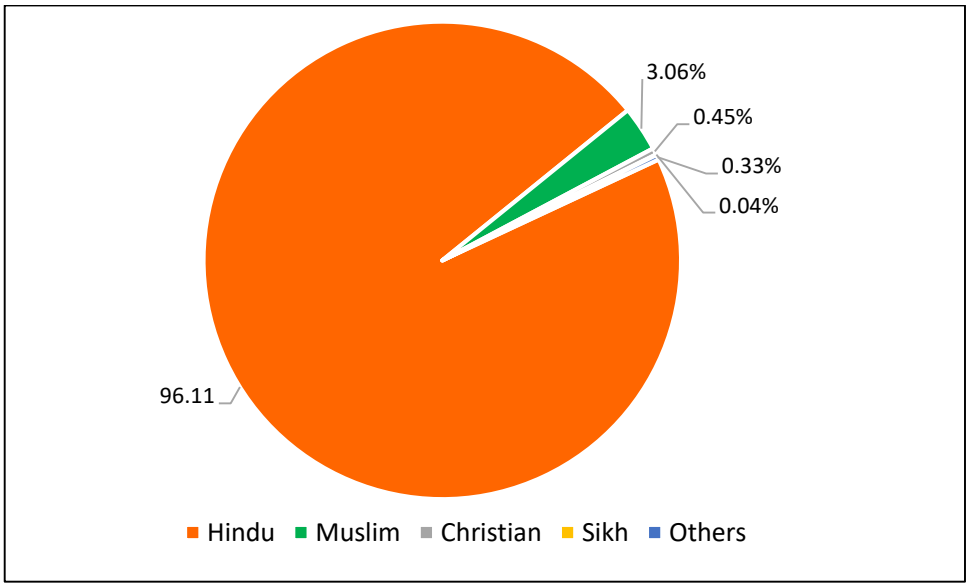


Figure 7-2: Religious status of PAFs of proposed alignment

The majority of the PAFs of proposed alignment were found to be Hindus i.e. 96.11%, followed by 3.06% are Muslim, 0.45% Christians, 0.04% are Sikh and 0.33% of the PAFs in the proposed alignment were found to be in following others religions. The class “Others” constitute people from other religions such as Jains and Buddhists as well as those who did not wish to state their religion.

❖ Marital Status

The PAPs were surveyed to understand the status of their relationships with one another. Classifications were made as ‘married’, ‘unmarried’, ‘widow’, ‘widower’ and ‘others’. The relationship status of the PAPs of the alignment options are given in the following table.

Table 7-9: Marital Status of PAPs

S. No.	Marital Status	Khordha (%)	Cuttack (%)	Dhenkanal (%)
1.	Married	32.78	31.84	33.45
2.	Unmarried	22.60	21.46	23.57
3.	Widow	0.40	0.36	0.31
4.	Widower	0.20	0.10	0.12
5.	Others	44.02	46.24	42.55
Total		**100.00**	**100.00**	**100.00**

(Source: Primary survey, 2024)

As per marital status of the PAPs, maximum PAPs are found others categories (44.27%), followed by Married (32.69%), Unmarried (22.54%), Widow (0.36%) and Widower (0.14%).

❖ Age Structure of the PAPs

The PAPs were surveyed and grouped according to the following age classes in order to understand the age structure of the PAPs:

Young age	0-10	11-20	21-30
Middle age	31-40	41-50	51-60
Old age	61-70	71-80	80+

Table 7-10: Age groups of PAPs

S. No.	Age Class	Khordha	Cuttack	Dhenkanal	Total
1	0-10	1285	941	318	2544
2	11-20	1472	1118	355	2945
3	21-30	1431	1092	325	2849
4	31-40	1200	920	281	2400
5	41-50	917	747	220	1884
6	51-60	629	508	154	1291
7	61-70	479	387	118	985
8	71-80	248	221	55	524
9	80+	98	81	18	198
Total		**7761**	**6051**	**1845**	**15621**

(Source: Primary survey, 2024)

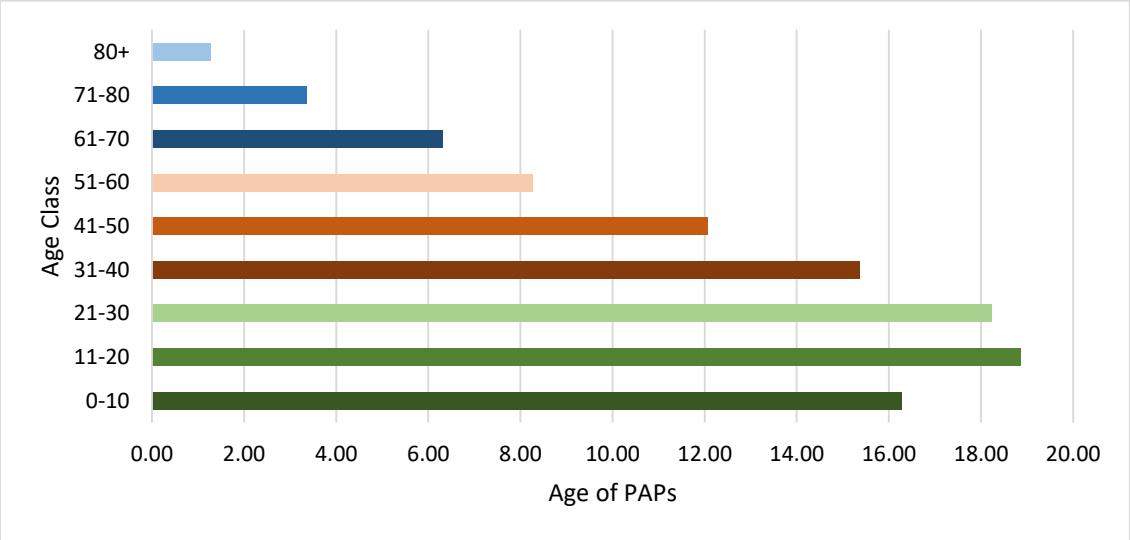


Figure 7-3: Age structure of the proposed alignment

A detailed survey about the age structure reveals whether the populations is a young population (where number of children and adolescents are more than the adults) or old (where number of adults and old persons are more than the number of children). The details of age structure of the PAPs are given in the table 7-10.

Majority of the PAPs of the proposed alignment fall in the age group '11-20' (18.85%), followed by the age group '21-30' (18.24%) whereas the age group '80+' constitute least and have only 1.27% PAPs.

❖ Occupational Pattern

The majority of the PAPs were found to be housewives, followed by agriculture workers, students, labourers as well as some working in government service. Students fall in the age group of below 21 years of age, some of them also help in the agricultural work. The break-up of occupational pattern is given in the table below.

Table 7-11: Occupational status of PAPs

S. No.	Occupation	Khordha	Cuttack	Dhenkanal	Total
1.	Service	276	190	55	521
2.	Business	371	295	70	735
3.	Agriculture	2689	1964	529	5182
4.	Student	542	357	121	1020
5.	Housewife	2534	2074	656	5264
6.	Labour	722	649	266	1637
7.	Unemployed	585	454	139	1178
8.	Professional	42	32	10	84
Total		**7761**	**6015**	**1845**	**15621**

(Source: Primary survey, 2024)

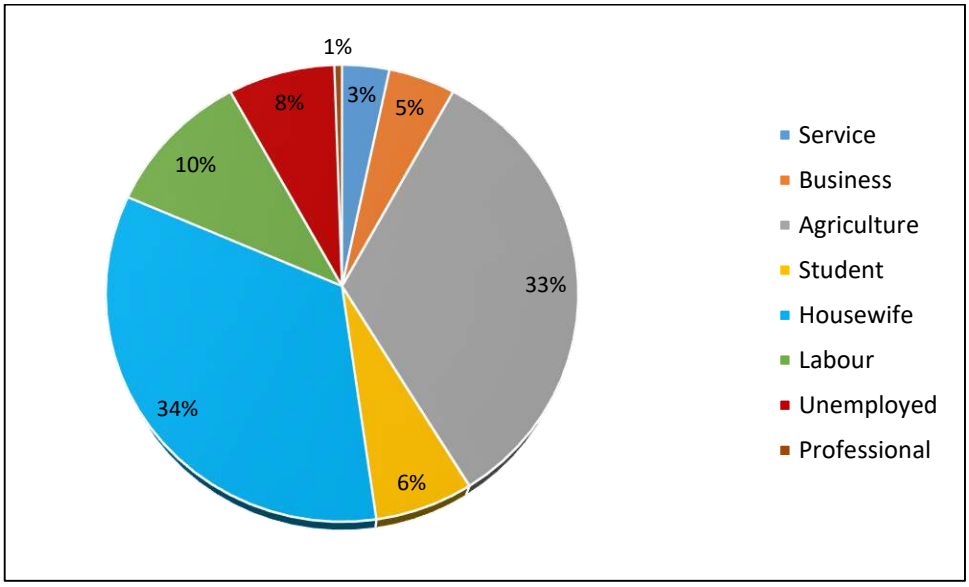


Figure 7-4: Occupational pattern of the PAPs of the proposed alignment

In the proposed alignment, 34% of the PAPs are housewives, followed by 33% of agricultural workers, 10% are laborers, 6% are students in various institutions such as schools, colleges or ITIs. The percentage of unemployed persons is 10%.

❖ Income Category

The PAFs were further divided into classes based on the income category that they fall into. A total of 6 income categories were selected for the purpose. The details of the same are given in the following table.

Table 7-12: Distribution of PAFs as per income slab

S. No.	Annual income slab (INR)	Khordha	Cuttack	Dhenkanal	Total
1.	<= 50000	5940	4363	1384	11688
2.	50001-100000	612	498	164	1274
3.	100001-500000	473	419	125	1017
4.	500001-1000000	372	353	73	798
5.	1000001-2000000	268	227	59	554
6.	>2000000	95	154	39	289
Total		**7761**	**6015**	**1845**	**15621**

(Source: Primary survey, 2024)

The majority of the PAFs of the proposed alignment fall in the <= 50000 income slab (74.82%), followed by 50001-100000 and 100001-500000 income slab, which constitute 8.16% and 6.51% of the PAFs respectively. This may also be attributed to the fact that villagers tend not to disclose this aspect and mention lesser annual incomes.

❖ Common Property Resources

The common property resources such as ponds, wells, etc. are used by all the villagers for various agricultural and social activities. The same are detailed in the following table.

Table 7-13: Common Property details

S. No.	Common Property Resource by type	Numbers
1	Ponds	15
2	Wells	0
3	Religious Structures	2
4	Community Structures	4
	Total	**21**

(Source: Primary survey, 2024)

15 ponds, 4 community structures and 2 religious structures were observed in the proposed alignment area during the survey of common property resources. No wells were encountered.

❖ Social Stratification

The PAFs were divided into different classes based on their individual social structure viz. General, SC, ST or OBC. The social stratification details are given in the following table 7-14. Overall, the proposed alignment majorly consists of people falling in the general category (42.23%) followed by OBC (32.19%), SC category (17.28%) and ST category (8.30%).

Table 7-14: Social Structure of PAFs

S. No.	Social Classes	Khordha (%)	Cuttack (%)	Dhenkanal (%)
1.	General	46.42	46.97	33.30
2.	Scheduled Caste (SC)	13.21	19.00	19.62
3.	Scheduled Tribe (ST)	7.73	3.57	13.59
4.	Other Backward Caste (OBC)	32.63	30.46	33.49
	Total	**100.00**	**100.00**	**100.00**

(Source: Primary survey, 2024)

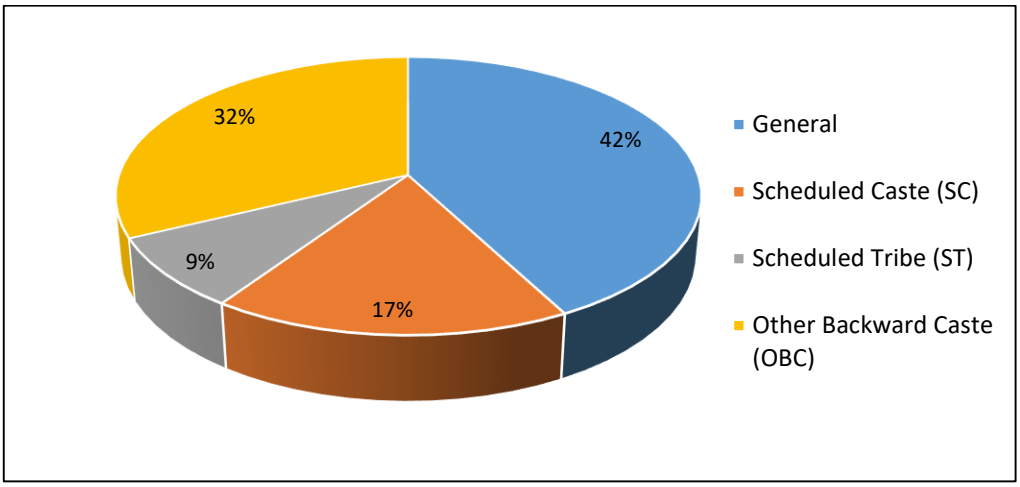


Figure 7-5: Social structure of PAFs of proposed alignment

❖ Project Affected Structures

The proposed alignment will impact a number of structures falling within the RoW, which will directly influence the life of the PAPs. The survey for those structures has been carried out under four categories namely household, commercial, religious and community. The details of the total project affected structures are given in the table below.

Table 7-15: Distribution of usage of structures

S. No.	Category	Number
1	Houses	43
2	Commercial	22
3	Religious	2
4	Community	4
	Total	**71**

(Source: Primary survey, 2024)

Maximum number of structures that will be potentially impacted due to the construction of the proposed highway falls in the 'household' category, followed by commercial and community structures.

Type of Project Affected Household Structures

Residential structures that are falling within the RoW can be further classified into three main types based on the type of roof and walls. The project affected household structures have been surveyed

and classified as being one of three types, viz. kutcha, semi-pucca and pucca, the details of which are given in table below.

Table 7-16: Classification of Project affected Residential structures

S. No.	Type of structure	Khordha (%)	Cuttack (%)	Dhenkanal (%)
1	Kutcha	13.43	11.78	17.83
2	Semi-pucca	68.64	58.74	65.72
3	Pucca	17.93	29.48	16.45
Total		**100**	**100**	**100**

(Source: Primary survey, 2024)

Out of the total household structures surveyed coming in the RoW of the proposed alignment, majority 64.37% were found to be semi-pucca type houses, 21.29 % were pucca houses and the rest 14.35% were kutcha houses.

❖ **Ownership Category**

The PAFs were also surveyed to know the status of ownership of the households. They were classified under 4 types, viz. rented, owner, encroacher, squatter. The following table details the ownership category of the households of PAFs of the proposed alignment.

Table 7-17: Classification of project affected households based on ownership type

Sl. No.	Type of Family	Khordha (%)	Cuttack (%)	Dhenkanal (%)
1	Rented	12.64	13.48	15.32
2	Owner	86.44	86.06	83.96
3	Encroacher/Squatter	0.92	0.46	0.72
Total		**100**	**100**	**100**

(Source: Primary Survey, 2024)

Maximum affected households (85.49 %) of the proposed alignment are found in the Owner category followed by Rented category (11.36 %) and Encroacher/Squatter category (0.70%). According to the 2011 census of India, in the rural part of the project districts, approximately 97 % of the households were in the owner category and approximately 3 % of the households in the rented category.

7.5 Land Acquisition

7.5.1 Introduction

This chapter assesses the nature, type and magnitude of the potential social impacts likely along the project corridor. For the assessment of impacts, the baseline information based on the field visits and the primary surveys were carried out.

This section identifies and assesses the probable impacts on different social issues due to the proposed development. After studying the existing scenario, reviewing the process and related statutory norms, the major impacts can be identified and shall be mitigated in the forthcoming phases. Most of the impacts though shall be perceived during construction and operation phase.

7.5.2 Land Acquisition: Legal Framework

The first attempt to legally acquire land was made in 1824, through Regulation 1 of 1824 applicable to immediate subject of presidency of Fort William. The rules empowered government to acquire immovable property for public purposes.

- Provisions of 1824 were extended to Calcutta through Act I of 1850. Act XLII was brought to enable the provisions of regulation I of 1824 to be used for acquiring land for construction of railways.
- Building Act XXVII of 1839, Act XX of 1852 was introduced to obviate the difficulties to particular cities of Bombay and Madras.
- Act VI of 1857 was the first full enactment, which had application to the whole of British India. It repealed all previous enactment relating to acquisition and its object.
- Principle of Arbitration was introduced for the first time through Act VI of 1857, but procedure for making a reference to the arbitrator was found unsatisfactory and then came Act X of 1870. For the first time a detailed procedure for the acquisition of land were provided in 1870 Act. Rules were also framed for the determination of an amount of compensation.

The provisions of the 1870 Act did not satisfy the needs of the day and eventually the Land Acquisition Act, 1894 (I of 1894) was enacted repealing the 1870 Act. In India, the land acquisition and its compensation are generally governed by the Land Acquisition Act (1894), which has been amended from time to time. However, for the purpose of maintenance, sustenance and management of National Highways, a Special act, The National Highways Act (NH Act), 1956 has been promulgated. This Act provides for acquiring the land through "competent authority" which means any person or authority authorized by the Central Govt. by notification in the official Gazette to perform functions of the competent authority for such areas as may be specified in the notifications. For LA, the Act defines the various procedures as follows: (I) section 3A – intention of Central Govt. to acquire land, (ii) 3B - power to enter for survey, (iii) 3C - hearing of objections (iv) 3D - declaration of acquisition, (v) 3E - power to take possession, (vi) 3F - power to enter into the land where land has vested in the central government, (vii) 3G - determination of compensation and (viii) 3F - deposit and payment of the amount.

The act requires that the processes must be completed within a year from 3A to 3D. Although NH act significantly reduces the timeframe for acquisition, the rules and principles of compensation have been derived from the LA Act of 1894. The Act covers only legal titleholders and provides for (i) market value of the land; (ii) additional amount for trees, crops, houses or other immovable.

Provision of direct purchase of land from landowners in case where additional land requirement is very less (minimal) may also be considered. However, resettlement and rehabilitation benefit available to affected persons whose land would be acquired under the statute shall also be available to those affected persons whose land would be acquired through direct purchase. Properties; (iii) damage due to severing of land, residence, place of business.

7.5.3 Land Acquisition Planning for the Project

Based on outcome of the Feasibility Study as well as Social and Environmental Screening Exercise, the proposed alignment was finalized and geometric design of highway was completed accordingly. Initially, the numbers of affected villages were identified as per the alignment. All the village (revenue) maps were collected from the local revenue offices. The village maps were thoroughly reviewed and verified in the field. The stacked alignment was then transferred on revenue maps with respect to

ground survey by land acquisition team and rechecked for correctness. The Land Acquisition Plan (LAP) was prepared accordingly. Based on the identified land plots by land acquisition team, local revenue officials were consulted to collect the names of owners of each plot. The details are available under the LA Plan prepared for the purpose of this project as a separate document.

7.5.4 Impact on Structures

Based on socio-economic survey, a total of 71 structures of the proposed alignment fall within the RoW. The structures are residential, commercial, religious and community structures in their nature.

7.5.5 Type of Land Being Acquired for the Project

The land being acquired for the subproject is of various types such as Government land, Private land and Revenue Forest land which comes to 547.51 ha. No reserve forest is encountered in the proposed alignment. Total Revenue Forest land to be diverted is around 28.32 ha. The area details of Land Acquisition are presented in the following table.

Table 7-18: Type of Land being acquired for the project

S. No.	District	Type of Land	Area in ha
1	Khordha	Govt. Land	52.69
		Pvt. Land	186.55
		Revenue Forest Land	9.29
		Total	**248.53**
2	Cuttack	Govt. Land	31.71
		Pvt. Land	167.72
		Revenue Forest Land	0.05
		Total	**199.48**
3	Dhenkanal	Govt. Land	12.32
		Pvt. Land	68.19
		Revenue Forest Land	18.98
		Total	**99.49**
G. Total			**547.51**

(Source: CALA/Tehsildar/ORSAC authenticated land schedule, 3D of project's villages)

7.5.6 Impact of Land Acquisition

The analysis of the impact of land acquisition can be categorized into following subheads:

- Loss of Land (Private and Government)
- Loss of farm produces (standing crops)
- Loss of Structures

❖ Loss of Land (Private and Government)

The project will involve the acquisition of agriculture land and other lands in the boundary of different villages of the project area. The initiation of the project will have direct impact on village communities and other neighboring villages. The land to be acquired for the proposed project consists of agricultural land, trees and community land under village panchayats, various structures of public interest, residential structures and residential plots, public utilities and others. Further, there would be change in the land use pattern, as land use will be diverted from agricultural land to road construction activity. Quite a number of families would lose settled agricultural land. The livelihood of these families in most cases depends on the produce of their land.

❖ **Loss of Farm Produce**

The stretch has relatively fertile agricultural land on either side of the highway. Acquisition of land will result in loss of crops. As land will be acquired in a phased manner, the owners will be able to cultivate some part of their land till construction time permits. They will be allowed to harvest produce and cash compensation will be paid for crops acquired at a price fixed by the Government.

❖ **Loss of Residential Houses**

The project requires the demolition of residential houses and commercial properties. These will be acquired and compensation paid before the start of project.

❖ **Loss of Income**

Those losing agricultural lands will lose income opportunity. However, this will be a permanent setback, unless provided with adequate compensation amount and / or training facilities for new trades with sufficient seed capital.

7.6 Mitigation and Enhancement Measures

7.6.1 Introduction

Mitigation measures mostly can be incorporated as good engineering practice during the design phase itself, which will ensure mainstreaming of social concerns early in the project. The adverse impacts during construction will be reduced to acceptable levels if design drawing and specifications are adhered to.

7.6.2 Proposed Mitigation Measures

Based on the survey conducted and information on RoW obtained so far, the land required to provide a 60 m wide RoW for the project shall include agricultural lands, revenue forest lands, built up areas as well as some government and other lands under private ownership. Due to the ribbon development almost all throughout the area, care shall be taken to minimize land acquisition. In order to mitigate the ensuing negative impacts of the land acquisition a Resettlement and Rehabilitation (R&R) policy shall be prepared based on the RFCTLARR-2013. The salient features of the mitigation measures are:

- Where displacement is unavoidable, those displaced will have their living standard improved.
- PAPs will be compensated, at replacement cost, for assets lost. Adequate social and physical infrastructure will be provided.
- PAPs and lost community would be encouraged to participate in the implementation of RAP.

Apart from the above-mentioned measures, some other measures have also been envisaged such as:

- Construction and up gradation of approach roads to the highway.
- Up gradation of the existing road.
- Ambulance service to transport serious cases to district hospital in case of accidents.
- VUPs have been proposed for approximately every 2 km so the farmers can assess their field frequent.
- Wherever possible, displacement shall be reduced or avoided altogether by sensitive design of civil works (e.g. alternative designs or modification to the design).

7.6.3 Enhancement Opportunities

Enhancements are the positive actions that are proposed to be taken up during the implementation of the project which will benefit the road users as well as the communities living nearby to the proposed project alignment. The following are some of the enhancement opportunities envisioned for the project:

- Wayside amenities.
- Introduction of ambulance services to transport serious accident cases.
- Slip roads/service roads for easy connectivity to the local community.

7.6.4 Implementation of RAP

The implementation of Resettlement Action Plan (RAP) is primarily envisaged, as a participatory exercise where the consulting NGO is responsible for the implementation of RAP and is expected to play a role of secondary stakeholder or in other words the implementing agency would be a partner in the whole exercise.

The role of the implementing NGO would be to mitigate the adverse effects of the project, both, from the NHAI perspective, to ensure timely completion of the road construction, and, from the perspective of affected people, to ensure that their rehabilitation process is taken up in a right spirit with a comprehensive livelihood system and these people are able to take advantages of the options available. The prime responsibility of the implementing agency is to ensure that each and every eligible project affected person receive appropriate and due entitlement within the overall framework of R&R policy and entitlement matrix and the PAPs have improved (or at least restored) their previous standard of living by the end of the RAP implementation process.

❖ Stages of RAP Implementation: A Methodological Framework

The objective of the project is to construct the new highway aimed at economic and social development of the region. One of the key activities in the project cycle is the implementation of Resettlement Action Plan with an objective of minimizing the adverse impact of the project implementation on the lives of people living in the project area. The R&R policy envisages that the project-affected families (PAFs) are to be resettled and rehabilitated so that the adverse impact due to proposed improvement of the road gets minimized.

❖ Training and Capacity Building of Project Staff

As a first step, it is essential to build the capacity of our staff i.e. Team Leader, Supervisors, Engineers, Village level workers etc. The aspects of training to be imparted would include social impact assessment survey, conducting focus group discussions, community participation, PRA/RRA, relocation of common property resources etc.

❖ Focus Group Discussion, Awareness Campaign and Dissemination of Information

In order to make the RAP implementation process transparent as per NHAI guidelines, a series of FGDs/ meetings etc. would be organized with all stakeholders for dissemination of information regarding rehabilitation process and entitlement framework. The RAP policy will be printed in Hindi language as well as English and the same will be distributed to the PAFs in order to make the process transparent.

❖ **Rehabilitation of Affected Families and Restoration of Income and Livelihood**

Rehabilitation of all the PAFs is one of the critical tasks of the project implementation process in order to help the communities derive the maximum benefits out of the project without losing their livelihoods and the least impact on socio-cultural aspects of their lives. It includes livelihood analysis, preparation and implementation of a comprehensive livelihood support plan and development of a comprehensive livelihood support system. This process must result in improved or at least restored living standards, earning capacity or improve the quality of life of the people affected by the project. Accordingly, rehabilitation will be conceived and shall be implemented as a development programme with particular attention to the needs of women headed households and vulnerable groups.

Organizing the economic activities would be according to the skills possessed by the affected families and in case such options are not economically viable, the corresponding skill up gradation support for the economic activities would be facilitated. The PAP will be free to choose to act as individuals or as informal groups like SHGs for accessing credit, Milk Producer Groups (MPGs), Agriculture Commodities (like vegetable, pulse, wheat) Processing Groups etc. or as co-operatives, with their overall operating efficiency and viability of the livelihood options chosen by them.

In context of the socio-economic profile of the region, their existing activity base and the skills, efforts should also be made to ensure that the groups are resettled in a manner so that their backward and forward linkages in the activities performed by them are maintained and they are provided support in improving their income through support of other government sponsored programs also.

7.7 Institutional Framework and Grievance Redressal Mechanism

7.7.1 Introduction

The institutional mechanism for the effective implementation of the project in general and R&R activities in particular is envisaged on partnership model whereby each and every agency/ institution proposed at various levels supplement and complement each other efforts. The key elements in designing these institutional mechanisms are transparency in operation, collaboration/ sharing of responsibilities with clearly defined roles, involvement of key stakeholders and vertical and horizontal linkages amongst various institutions/ agencies, as given in Figure 7-6.

The proposed Institutional arrangements will be set up at three levels viz., Central (Government) Level, State Level and Sub-Project Level.

7.7.2 Central Level Institutional Arrangement

At Central Level, the Chief General Manager (LA) will be overall responsible for the implementation of RAP. CGM (LA) will have all delegated administrative and financial decisions with regard to implementation of the project as well as land acquisition, RAP implementation Institutional arrangement at Central Level will include augmenting the capacity of NHAI with regard to resettlement and rehabilitation. A team comprising of Regional Office of the state, concerned Project Director, CALA, site managers and engineers and DPR Consultant staff designated as Social Development Specialist (SDS) and Land Acquisition Experts will assist CGM (LA) in Land Acquisition. The designated persons will be directly involved in the implementation of RAP. The officials will ensure that all resettlement and rehabilitation issues are complied with as per the RPF.

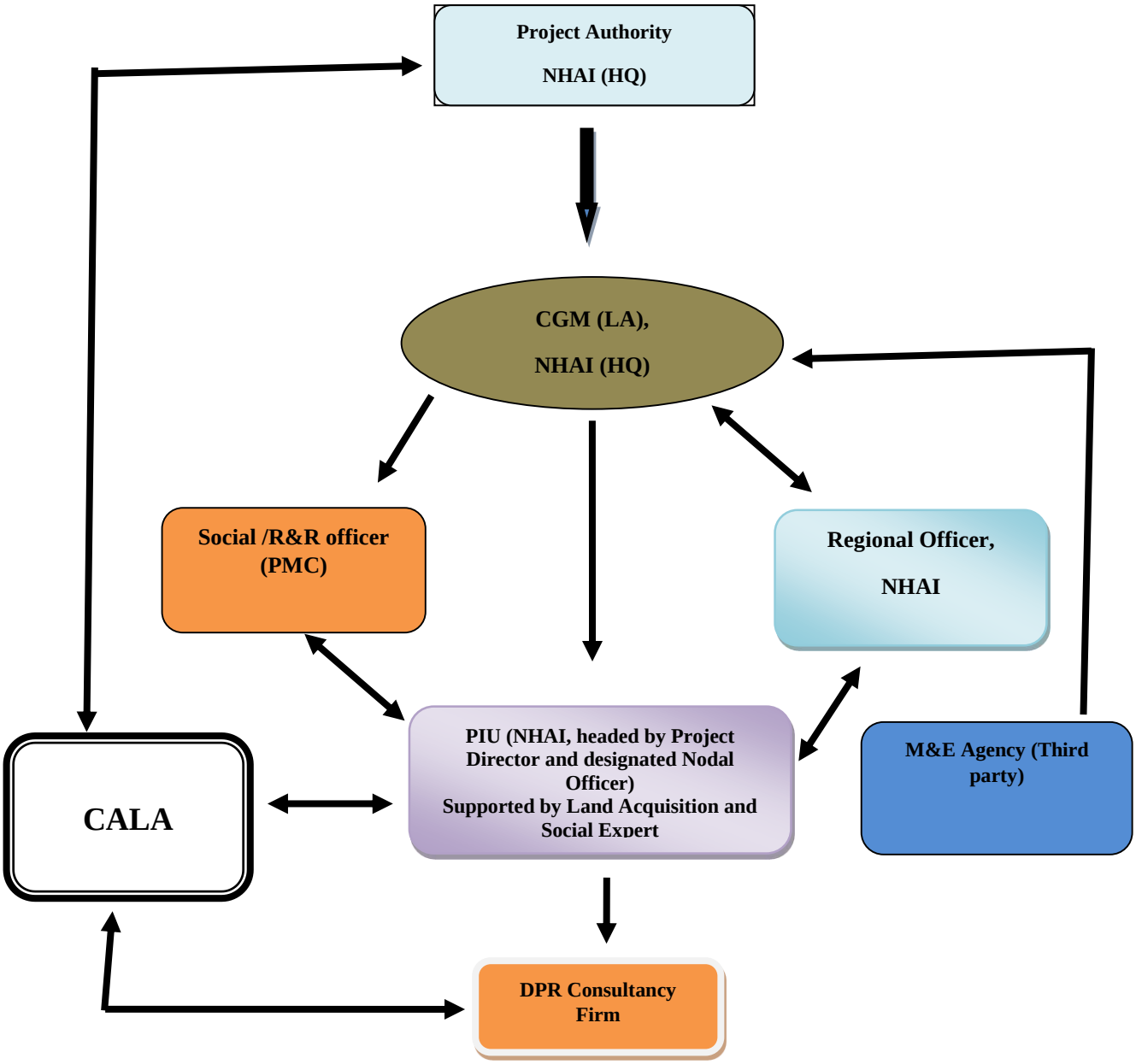


Figure 7-6: Institutional Arrangement for Land Acquisition

The roles and responsibility of the concerned officials would broadly include the following:

- Assist technical team at Central Level in finalizing the RAP and Land Acquisition Plan.
- Guide and supervise in matters related to resettlement and rehabilitation to state and subproject level offices.
- Compile data related to resettlement and rehabilitation activities received from field offices and update reporting officer and suggest suitable measures to be taken.
- Interact with Land Acquisition agency on a regular basis.
- Undertake field visits as and when required.
- Facilitate necessary help needed at site with regard to LA and R&R issues.
- Co-ordinate with state government department/CALA in matters related to implementation of R&R.

- Ensure budgetary provision for resettlement and rehabilitation of EPs and relocation, rehabilitation and reconstruction of common property resources (CPRs) and implementation of RAP.
- Monitor implementation of RAP carried out by the agency through RRO.
- Perform other roles and responsibilities related to implementation of RAP as assigned by the CGM (LA) or PD (PIU) from time to time.
- Ensure free, prior and informed consultation with Tribal families along the project and also ensure that sufficient supporting documentation is maintained.

7.7.3 State Level Institutional Arrangement

At State Level, a Land Acquisition cum Social Development Officer will be appointed to provide assistance to the designated Nodal Officer of PIU, NHAI, and Government of Odisha. The roles and responsibility of the CALA cum SDO would broadly include the following:

- Facilitate land acquisition and RAP implementation,
- Guide and supervise RAP implementation at sub-project level,
- Interact with RAP implementation agency and undertake field visits for first-hand information,
- Compile data on LA progress and resettlement and rehabilitation activities received from field offices and update reporting officer and suggest suitable measures to be taken,
- Co-ordinate with various government departments in matters related to implementation of RAP,
- Check implementation of RAP carried out by the agency from time to time by undertaking site visits and consultations with PAPs,
- Perform other roles and responsibilities related to implementation of RAP as assigned by the Reporting Officer from time to time.

7.7.4 Project Level Institutional Arrangement

A Project Implementation Unit (PIU) comprising officials of NHAI will be constituted at subproject level headed by the General Manager (Technical) designated as Project Director. The PIU will be responsible for the project execution and LA issues. There will be a designated or appointed PD/Manager at respective PIUs who will be responsible only for the LA issues at site. No other roles and responsibilities will be assigned to the officers other than provision of compensation to the affected stakeholders. CALA will assist Project Director in all matters related to compensation and other LA issues.

The roles and responsibilities of the Land Acquisition Officer are as under:

- Ensure proper compensation with assistance from implementation agency as per the time line agreed upon.
- Interact with implementation agency on a regular basis.
- Undertake field visits with implementation agency from time to time.
- Facilitate necessary help needed at site with regard to LA issues to implementation agency.
- Ensure and attend meetings organized by implementation agency on related to awareness and dissemination of information on LA issues and entitlements.
- Ensure inclusion of PAPs who could not be enumerated during census but have documentary evidence to be included in the list of EPs.

- Ensure timely preparation of micro-plan from implementation agency and approval from Head Office.
- Ensure preparation of identity cards and distribution of the same to the affected stakeholders.
- Ensure disbursement of compensation assistance in a transparent manner.
- Participate in meetings related to resettlement and rehabilitation issues.
- Facilitate in opening of joint account of affected stakeholders.
- Prepare monthly progress report related to physical and financial progress of implementation of LA & submit to Head Office.
- Ensure release of compensation and assistance before taking over the possession of land for start of construction work.
- Assist and facilitate aggrieved PAPs (for compensation and assistance) by bringing their cases to GRC.
- Facilitate in opening of joint account of PAPs.
- Generate awareness about the alternative economic livelihood and enable PAPs to make informed choice.
- Consultations with PAPs regarding the choice of resettlement (i.e. self or assisted), development of resettlement site, participation of women, etc.
- Consultations with local people and Panchayati Raj Institutions with regard to relocation, rehabilitation, reconstruction of affected CPRs as well as availability of new facilities under the project.
- Participate in various meetings.
- Submit monthly progress report.
- Any other activities that may be required for the implementation of the project.

7.7.5 Coordination with other Agencies and Organizations

LA Cell will establish important networking relationships with many departments and organizations. The Revenue Department has an influencing role in Land Acquisition proceedings, and initiation of resettlement process. Unless the compensation process is prompt and efficient, implementation process will get delayed. LA Cell will coordinate with the Project Land Acquisition Officer to expedite the land acquisition process.

Restoration of community assets such as hand pumps, bore wells, drainage facilities will require help from Department of Water Resource. Where schools are affected, coordination will be required from the District Offices of Education Department.

Considering the above, NHAI will extensively work on developing lateral linkages for mobilization of resources to benefit the PAPs and to achieve the desired results expected from implementation of RAP.

7.7.6 Role of Other Agencies

Various government department and public agencies, particularly the Revenue Department, Rural Development and Financial Institutions, have an important role in implementing the RAP. The Revenue Department is responsible for providing land records, acquiring land and other properties and handing them over to the proper authorities. The District Rural Development Agency (DRDA) will extend the RD and other developmental schemes to include the PAPs. The representative of these

departments/agencies will be in contact with the LA Cell, which will facilitate the integration of the various agencies, involved in the LA process.

7.7.7 Grievance Redressal Mechanism (GRM)

The RAP provides for a mechanism to ensure that the benefits are effectively transferred to the beneficiaries. However, need also exists for an efficient grievance redressal mechanism which will assist the APs in resolving queries and complaints. Land Acquisition will take place according to NH Act 1956 (Amended 1988). Compensation and entitlements will be paid according to NPRR (2007). Any disputes or grievances will be addressed through the grievance redressal mechanism proposed here. Detailed Investigation will be undertaken which may involve field investigation with the concerned APs. The Grievance Redressal Committee (GRC) is expected to resolve the grievances of the eligible persons within a stipulated time. The decision of the GRC is binding, unless vacated by court of law.
The GRC will be constituted by the Project Authority with the aim to settle as many disputes as possible through consultations. There will be one GRC for each PIU. The GRC will comprise five members headed by a retired Magistrate not below the rank of SDM. Other members of the GRC will include a NHAI Officer (not below the rank of Project Director), Revenue Officer, representative of PAPs and Sarpanch (Elected Head of Village) of the concerned village. Grievances of affected persons in writing will be brought to GRC for redressal by the concerned officials of NHAI. The officials will provide all necessary help to PAPs in presenting his/her case before the GRC. The GRC will respond to the grievance within 15 days. The GRC will normally meet once in a month but may meet more frequently, if the situation so demands. A time period of 45 days will be available for redressing the grievance of affected persons. The decision of the GRC will not be binding to affected persons. This means the decision of the GRC does not debar the stakeholders taking recourse to court of law, if he/she so desires. Broad functions of GRC are as under.

- Record the grievances of affected persons, categorize and prioritize them and provide solution to their grievances related to resettlement and rehabilitation assistance.
- The GRC may undertake site visit, ask for relevant information from Project Authority and other government and non-government agencies, etc. in order to resolve the grievances of affected persons.
- Fix a time frame within the stipulated time period of 45 days for resolving the grievance.
- Inform affected persons through implementation agency about the status of their case and their decision to affected persons and Project Authority for compliance.

The GRC will be constituted within 3 months by an executive order from competent authority (center/ state) from the date of mobilization of RAP implementation agency. The LA Officer will persuade the matter with assistance from implementation agency in identifying the suitable persons from the nearby area for the constitution of GRC. Secretarial assistance will be provided by the PIU as and when required. GRM is shown in Figure 7-7.

7.7.8 Suggestions and Complaint Handling Mechanism (SCHM)

Being a greenfield project involving several tehsils and large scale of civil works along with R&R and Environment issues, the project is likely to receive many suggestions, complaints, inquiries, etc. through the project implementation period. The NHAI recognizes the importance of this and hence intends to establish a SCHM for the NH.

Though the Right to Information Act, 2005 an Act of the Parliament of India provides for setting out the practical regime of right to information for citizens. The Act applies to all States and Union Territories of India except the State of Jammu and Kashmir. Under the provisions of the Act, any citizen may request information from a "public authority" (a body of Government or "instrumentality of State") which is required to reply expeditiously or within thirty days. The Act also requires every public authority to computerize their records for wide dissemination and to pro-actively publish certain categories of information so that the citizens need minimum recourse to request for information formally.

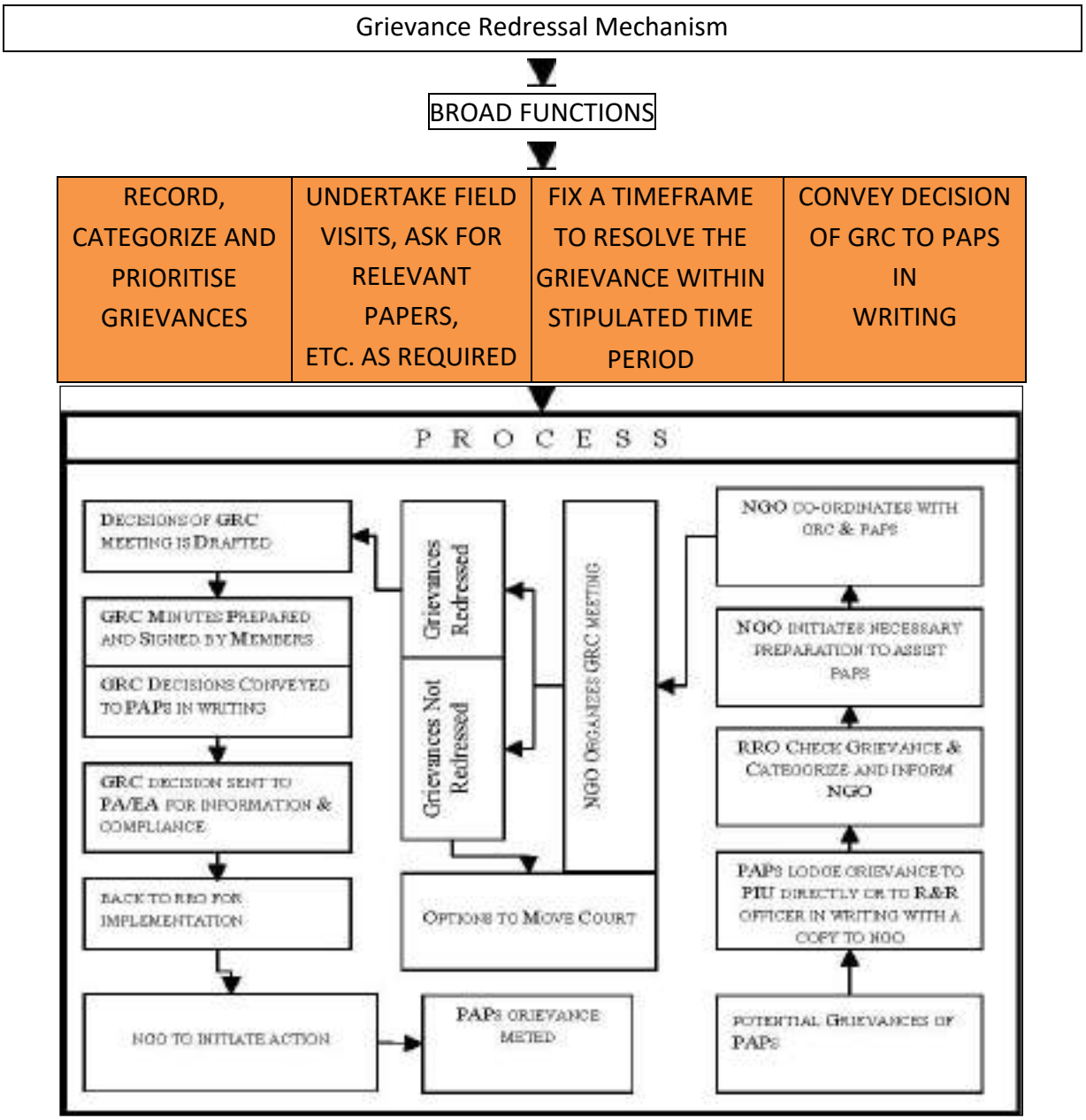


Figure 7-7: Grievance Redressal Mechanism

In other words, under the Act, citizens have right to seek information from concerned agencies by following the set procedures. However, it is quite likely that many people may not use the provisions of this Act, only in limited cases covering serious concerns. Therefore, NHAI has agreed to establish SCHM as a good practice to address public concerns pertaining to various issues. Several

communication channels viz., toll free phone number, dedicated email, mechanism for on line submission of suggestions/complaints/inquiries, provision of suggestion/complaint box (at site and project office), post and other suitable means shall be set up for suggestion and complaint handling.
Right from beginning of project implementation, the appointed consultancy firm shall disseminate the information regarding establishment of Suggestions and Complaint Handling Mechanism for this project among the Project affected / benefited peoples. The appointed consultancy firm will explain the process through various applicable mode to be followed / adopted by the people for filing complaints & suggestions.

7.7.9 Information Campaign

Attention of the PAPs will be invited to the proposed redressal system for a quick, inexpensive and amicable settlement of claims for enhanced compensation. They will also be advised to get their records of rights updated. All possible efforts will be put forth to motivate the affected landowners and structure owners for a voluntary and amicable settlement of their claims outside the court.
Most of the issues will be settled out of court as far as possible. Hand-outs will be distributed among all the affected persons highlighting the prospects of amicable settlement of dispute in question, outside the court, speedy and at lesser expense along with the timetable of inquiries and spots inspections of the committee. Besides, public announcements will be made in affected areas. Press notes will be released in local newspapers to aid publicity.

7.8 Disaster Management, Risk Assessment & Mitigation Procedures

7.8.1 General

The Disaster Management is aimed to ensure safety of life, to protect environment, to safeguard construction and installations and rescue operations in order of priorities. The objective of a Disaster management plan is to localize a Disaster and contain its effect to the greatest extent, so as to minimize its impact on life, environment and property. Response to Disaster, in the absence of a well-defined plan, would be arbitrary, leading to overemphasis of actions of some actions and absence of other critical actions. A formal plan for managing Disaster is, therefore, necessary. The purpose of the disaster management plan is to identify potential probable accidents/ emergency situations, establish and maintain procedures to address or prevent such situations, as well as to test the effectiveness/ review/ revise such procedures periodically. Generally, most of the accidents will be confined within the construction camp boundaries, borrow areas and road RoW during construction phase and within the RoW of Highways during operation phase. This section of the report presents an outline of disaster management plan for the proposed Rameswar-Gobindpur (CRRR-1) project stretch in the State of Odisha.

7.8.2 Objective of Disaster Management Plan

The purpose of the DMP (Disaster Management Plan) is to identify the roles, responsibilities, and tasks/functions to be performed in all disaster recovery operations. Thus the objectives are –

- To increase awareness among of officials of the project on the issues involved in disaster recovery,
- To provide explanations of roles and responsibilities and
- To provide guidelines for disaster recovery operations.

- To localize the emergency and, if possible eliminate it; and
- To minimize the effects of the accidents on people and property.

Elimination will require prompt action by operators and works emergency staff using, for example, fire-fighting equipment, emergency due to collision and submergence etc. Minimizing the effects may include rescue, first aid, evacuation, rehabilitation and giving information promptly to people living nearby.

7.8.3 Risk assessment and analysis

Risk (either health, safety or economic), is inherent in all activities. In order to control, prevent or minimize loss of life or injury, damage to property or impact on environment, risk must be analysed and managed. Risk Assessment (RA) is a step-by-step process to identify the probability of extent of adverse consequences resulting from a specific activity, quantify risk and compare the same with known risk criteria so as to prepare and implement appropriate risk reduction measures. RA is a method that has proven its value as an all-round tool for improving the safety standards prevalent in every hazardous industry. With advancements in, in-built and inherent safety systems, accidents rates have come down, but still persist at an un-acceptable level for newer technology and new process plants. RA is a structured safety assessment tools designed for high hazard industries such as chemical, petrochemical, pesticides, pharmaceuticals, etc., supplementing other safety systems tools such as HAZOP, safety audit, and regular incident analysis to identify the potential for incidents (near-misses, unsafe conditions) and to evaluate the necessary control measures.

Provision and plan for risks has been made at various stages. The risk may be due to accident, Vehicles crossing barriers of road, fire, sabotage, earthquake, spillage of oil and chemicals on the road. This would, depending upon the type and intensity, involve disasters in terms of loss of life and damage to the road apart from disruption of traffic. Therefore, to avoid and minimize this, disaster and emergency management plays a very important role.

7.8.4 Objectives of Risk Assessment

The objectives of the Risk Assessment can be summarized as follows:

- Assessing risk levels due to the operations of the facility.
- Identification of the risk mitigation measures to bring the potential risk within acceptable range.
- To suggest general safety improvement measures.
- To help generate accident-free hours.
- To identify emergency scenarios and suggest mitigation measures.

Risk is the unwanted consequence of an event or series of events. Risk occurs when multiple risk causing factors occur at the same time causing an accident manifesting in an event like a fire or explosion. Certain risks are generally accepted as part of the industrial operations, while other low-frequency, high consequence risks attract statutory attention and are regarded unacceptable to local public.

7.8.5 Factors Influencing Public Perception

Factors influencing public perception of risk depends upon various factors as described in table 7-19 below.

A Risk Assessment should therefore, be seen as an important component of any or all on-going preventive actions aimed at minimising and thus hopefully, avoiding accidents. Re-assessments should therefore follow at regular intervals, and/or after any changes that could alter the hazard, so contributing to the overall prevention programme and disaster management plan of the project.

Table 7-19: Factors influencing public perception

S. No.	Factors influencing public perception	Description
1.	Control	People are more willing to accept risks they impose upon themselves than to have risks imposed upon them.
2.	Dread and scale of impact	Fear is greatest where the consequences of risks are likely to be catastrophic rather than spread over time.
3.	Familiarity	People appear to be far more willing to accept risks that are familiar rather than new risks.
4.	Timing	Risks are more acceptable if the risk consequences are immediate or short-term, rather than delayed consequences.
5.	Social amplification & attenuation	Concerns are increased if media coverage or graphic depiction of events is there, reduced if there is economic hardship.
6.	Trust	If public trusts policy makers, public trusts regulators or industry as being honest, admit mistakes and limitations and one who take into account different views, then public is more likely to place credibility in them.

7.8.6 Disaster Management Cell

The Disaster Management Cell (DMC) will be the apex planning body and will play a major role in preparedness and mitigation of any disaster. The cell will have the following key functions:

- Preparation of comprehensive Disaster Management Plan.
- Setting up of Emergency Control Centre during emergency situations.
- Coordination with District Disaster Control Room.
- To supervise emergency response measures in case of any emergency.
- Keep track of predictable natural hazard events such as floods, drought, fire and earthquakes etc.
- Periodic monitoring of Emergency Response Plans and the corresponding procedures of individual establishment.
- Organize post-Disaster evaluation and update DMP accordingly.
- Prepare reports and document on Disaster events of road section and surrounding areas and submit the same to District Control Room The documents shall include:
  - Source & Cause of Disaster
  - Description of the response efforts.
  - Recommendation for preventive & mitigation measures.

- Plan for upgrading emergency preparedness and response plan

The Disaster Management Cell will have the following departments/ teams:

7.8.7 Disaster Tracking Unit

The primary function of this unit shall be to keep track of predictable natural hazards such as floods, drought, fire and earthquakes, etc. The unit shall continuously coordinate with the Regional Meteorological Centre (RMC) and Indian Meteorological Department (IMD), in order to monitor disaster warnings and weather conditions in the region. On account of any extreme event predictions, the unit shall communicate the same to the DMC which will issue warnings in the entire Investment Region.

❖ **Disaster/ Emergency Response Team**

The Disaster/ Emergency Response Team shall perform the following functions:

- Advise the DMC as to whether the declaration of an emergency is recommended;
- Advise the DMC on the need to designate all or part of road section as an emergency area;
- Appoint an Emergency Control Centre;
- Determine if the location and composition of the Emergency Control Centre are appropriate;
- The Emergency Response Team shall form an Emergency Control Centre in case of any emergency situations. The Team shall coordinate with other agencies such as:
  - Fire Brigade
  - Police Department
  - Hospitals / Ambulance
  - Technical Departments such as Factory Inspectorate, Pollution Control Board etc.
  - Local Authorities/ District Administration

❖ **Training Centre**

The training centre shall be responsible for the following activities:

- Dissemination of information about the Comprehensive Disaster Management Plan.
- Organize capacity building workshops for the personnel of Disaster Management Cell.
- Organize training programs such as mock drills, emergency evacuation procedures in schools, offices, residential colonies and industrial areas.
- Work in association with Residential Welfare Associations and Industrial Groups for creating awareness about the disaster preparedness.

Apart from the above teams, information dissemination between Disaster Control Room and Disaster Management Committee will be there.

❖ **Disaster Control Room**

In order to control the disaster more effectively a Disaster Control Room will be established at construction camps of contractor. During operation phase, it will be established as far as possible at midway of road length. The planned facilities at Disaster Control Room are as follows:

❖ During Construction Phase

- Layout of construction camp showing all areas specially oil storages, transfer locations, oil dispensers, etc.
- Alignment Map of Project road and access roads.
- Hazard identification chart, names of personnel working in each shift, assembly points at construction camp other project sites within RoW.
- List of habitations and industrial installations and their population in the vicinity of construction camp in a radius of 3 km.
- Mobile Telephone numbers of all key personnel.
- External telephone connections.
- Public address system.
- Rechargeable and battery-operated torch lights and invertors.
- List of Medical Facilities available within 10 km of the construction camp.
- Muster Roll of employees.
- Note pads and ball pens to record message received and instructions to be passed through runners through designated persons.
- The blow-up copy of Layout plan showing areas where accident could occur.
- Accident mock drill is to be made part of routine exercise.

❖ During Operation Phase

- List of all employees of concessionaire working in the project with telephone numbers
- Map showing Project roads and surroundings in a radius of 3.0 km
- List of medical Facilities in a radius of 10 km around 'Emergency Control Centre'
- Public address system
- Rechargeable and battery-operated torch lights and invertors
- Note /Pads and pens to record message received and instruction be passed through runners
- First Aid kits in 5-10 numbers
- One ambulance at each 'Emergency Control Centre'
- Tie up with the neighbouring hospitals for referring any accidental victims to the hospital
- Portable fire extinguishers carry to accidental site.
- Accidental drill is to be made part of routing exercise

❖ Traffic Surveillance Monitoring and Control System

Traffic surveillance shall be carried out on the by-pass road. The project has built in sophisticated state of the art traffic management and control system. Signals will be used for controlling traffic on reversible lanes during emergency such as accidents, fire etc. lane use signals consisting of red, amber and green lights for permitting or prohibiting the use of specific lanes or to alert the impeding prohibition of lane use will also be used. All road signs shall be of retro reflector type and made of high intensity grade sheets with encapsulated lens type reflective sheets. Mainly air pollution is contributed by vehicular emission. It is necessary to establish vehicular emission check centre, in order to estimate contribution of vehicular pollution load and to identify the polluting vehicles.

7.8.8 Emergency Response

Effective command and control start with a clear definition of the overall command and control structure, and description of the duties of key personnel with specific responsibilities for emergency response. The control of emergencies will consider the minimum number of persons required to provide an adequate response to emergencies.

- All emergencies occurring as a result of project activities shall be managed as per following order of priorities:
- Preservation of Life (self, team, community)
- Protection of the Environment
- Protection or Property/ assets
- Preservation of Evidence

ROLES & RESPONSIBILITIES

The roles and the responsibilities of various departments during emergency situations as defined in Section have been discussed in the following paragraphs below.

Emergency Control Centre (ECC)

The emergency control centre shall be formulated in case of emergency situations by the Disaster Management Committee. The ECC shall be chaired by the head of Regional Development Authority head and will have representatives from Police, Fire Department, Hospitals, Factory Inspectorate and District Administration. The ECC shall perform the following functions:

- Co-ordinate the acquisition, distribution and scheduling of various modes of transport (i.e. public transit, school buses, trains and trucks) for the purpose of transporting persons and/or supplies, as required;
- Determine if additional transport is required for evacuation or transport of persons and/or supplies;
- Discontinue utilities or services provided by public or private concerns without reference to any consumers in the region, or when continuation of such utilities or services constitutes a hazard to public safety within an emergency area;
- Disperse people not directly connected with the operations who by their presence are considered to be in danger or whose presence hinders in any way the efficient functioning of emergency operations;
- Authorize the evacuation of those buildings or sections within an emergency area which are themselves considered to be dangerous or in which the occupants are considered to be in danger from some other source;
- Authorize casualty collection and evacuation in support of emergency health care authorities;
- Coordinate with other departments such as Police, Fire Department, Medical, etc.
- Arrange for services and equipment from local agencies not such as private contractors, volunteer agencies etc.;
- Arrange for accommodation and welfare, on a temporary basis, of any residents who need assistance due to displacement as a result of the emergency;
- Arrange assistance from senior levels of Government as per requirements

The following information and equipment shall be available at ECC:

- Intercom, telephone
- P and T telephone
- Breathing apparatus
- Fire suit/ gas tight goggles/ gloves/ helmets
- Hand tools, wind direction/ velocities indications
- Public address megaphone, hand bell, telephone directories (internal, P and T)
- Emergency lamp/ torch light/ batteries
- Emergency shut-down procedures
- List of key personnel and list of Emergency Co-coordinators
- Duties of key personnel
- Address with telephone numbers and key personnel, emergency coordinator, essential employees.
- Important address and telephone numbers including Government agencies, neighbouring industries and sources of help, outside experts, chemical fact sheets population details.

Police Department

The Police Department shall perform the following actions:

- The overall responsibility of police shall be to maintain law and order during and post disaster situation in the context of disaster management.
- Prepare a departmental disaster response plan and Standard Operating Procedure in which roles and responsibilities are clearly defined. The plan and SOP shall be submitted to the DMC;
- Prepare a database of nodal person at State, District and Taluka level and share with DMC;
- Police personnel shall be trained in search and rescue (flood rescue, collapse structure, rope rescue, etc.) during normal time and database of such trained personnel shall be shared with the DMC;
- Overall traffic management (access roads to disaster site, roads to be made one-way, to be blocked, alternate routes, etc.) and patrolling;
- Provide security in transit and relief camps, affected areas, hospitals and medical centres and identify areas to be cordoned off;
- Establish communication with the ECC, District Control Room and nearest Police station to the disasters site;
- Additional deployment of police, if required, to inquire into and record of deaths;
- Provide convoys for relief materials;
- A public information system to be activated for passing information related to injured, dead, missing persons, etc.
- Regularly conduct mock drill by simulating different disasters to check preparedness, coordination and scope of improvement and a report shall be submitted to the DMC;
- Assist DMC and ECC in evacuation of people from the vulnerable areas.

Fire Department

The Fire Department shall perform the following actions:

- The overall responsibility of fire department shall be to undertake the emergency fire evacuation procedures effectively and efficiently;
- Prepare a departmental disaster response plan and Standard Operating Procedure in which roles and responsibilities are clearly defined. The plan and SOP shall be submitted to the DMC;
- Prepare a database of nodal person at State, District and Taluka level and share with DMC;
- Fire personnel shall be trained in fire evacuation procedures during normal time and database of such trained personnel shall be shared with the DMC;
- Establish communication with the ECC, District Control Room and nearest Fire station to the disasters site;
- Additional deployment of fire safety personnel, if required, to inquire into and record of deaths;
- Regularly conduct mock drill by simulating different disasters to check preparedness, coordination and scope of improvement and a report shall be submitted to the DMC;
- Assist DMC and ECC in evacuation of people from the vulnerable areas;

Health Department

The Health Department shall perform the following actions:

- The overall responsibility of health department is to undertake the emergency heath activities in the aftermath of disasters and take measures to check the outbreak of epidemic in the post disasters situation effectively and efficiently;
- Prepare a departmental Emergency Health Management Plan including, hospital specific plan shall also be prepared. Apart from plan, SOP shall be prepared which clearly delineates the roles and responsibilities;
- The plan shall cover mass casualty management, triage (prioritization of patients), trauma counselling, mobile team which may be deployed at sites, procedure for coordinating with private hospitals and availing its services, etc.
- A database of nodal officer at State, district and hospital specific shall be prepared for emergency health services and shared with the DMC;
- Periodic review of the stock emergency medicines and equipment required during the disasters; The epidemic surveillance and water quality monitoring shall be done at transit camps, relief camps, affected areas and feeding centres;
- The central warehouse shall be kept informed for dispatch of supplies likely to be needed, to hospitals, on an emergency priority basis;
- Establish communication with the ECC District Control Room, Police and the medical team at the disasters site;
- A public information system to be activated for passing information related to patients admitted at the hospital;
- Mock drill on mass casualty management at hospital level shall be organized twice in year. The mock drill shall check the activation and response time of emergency medical teams, coordination with other agencies, areas of improvement, etc. The report shall be submitted to the DMC;
- The medical officers and staffs shall be trained in triage (system for prioritization of patients).

EMERGENCY CONTROL PROCEDURE

Possible Type of Disaster

In roads & highways project, during construction and operation phases, disaster may occur due to the following aspects:

- Floods
- Earthquake
- Biological Disaster or Epidemic of Human/ livestock/ crops
- Fire
- Explosion
- Fuel Oil spillage
- Electrocution
- Hazardous materials releases
- Transportation accidents
- Terrorism / War
- Some of the hazards will be dealt with Government procedure for Natural hazards and calamities.

For Natural Calamity

In the event of occurrence of natural calamity during the construction phase, all work will be suspended and all construction material will be shifted to the safer location. In order to minimize losses/ damages to pavement, incomplete CD structures during the heavy rains the inventory of material storage at site will be kept to a minimum during rainy period i.e. May to September. During the operation phase, in the event occurrence of Natural Calamity the concessionaire will stop traffic on the highway and will guide the traffic at time of closure for follow up of safer route. The traffic will be regulated right from receiving of warning. The emergency control centre will be in direct contact with the district administration for their advice for the steps taken for the traffic control and other assistance.

For Hazard

The onset of emergency will in all probability commences with a major fire or explosion and shall be detected by the member of staff on duty at construction camp/on Highways. If located by a staff member on duty, he (as per site emergency procedure of which he is adequately briefed) will go to the nearest fire alarm call point, break glass and trigger off the fire alarms. He will also try to inform about location and nature of fire/ accident to the Site Main Controller on mobile phone.

In accordance with work emergency procedure, the following key activities will immediately take place to intercept and take control of emergency:

- The fire group will arrive at the site of incident with firefighting controls
- Site Main Controller will commence his role from the Control Centre
- The First Aid Group will take care of injured
- Site Main Controller will be directing and deciding a wide range of desperate issues. In particular, DMC has to decide and direct:
- Whether firefighting and first aid groups require reinforcement of man power and facilities
- Whether the facility is to be shut down or more importantly kept running

- Respond to any large size complaints from outside public and to assess an offsite impact arising out of the onsite emergency.
- When the incident has eventually been brought under control as declared by the firefighting group, the Site Main Controller shall visit himself personally for:
  - An assessment of total damage and prevailing conditions with particular attention to possibility of re escalation of emergency, which might of the time being, be under control.
  - Inspection of other facilities, which might have been affected by impact of incident.
  - Based on visit, Site Main Controller will finally declare and communicate termination of emergency and authorize step by step restoration of normal operation of the refuelling and storage facility. The fire siren will be sounded with all CLEAR SIGNAL.

During entire period of emergency, the site will remain out of bounds to external visitors except:

- External Fire Personnel;
- External hospital ambulance staff;
- Local Government;
- Insurance authorities;

.

Alarm System to be followed during Disaster

Suitable alarms will be developed after establishment of construction camp/opening of Highways for traffic and these will be explained to each personnel working at the Highways. The alarm will also be displayed at office for the information of visitors.

Actions to be Taken on Hearing the Warning Signal

On receiving the disaster message following actions will be taken: Fire Fighting group, first aid group shall reach the ECC Team members will remain ready in their respective sections for further instructions.

For Petroleum Product Leakage

In the event of massive spillage of HSD/ Gasoline/ Kerosene/ Furnace oil the spilled quantity should be reclaimed from the storm drainage channels/ rain water harvesting pits. The traces of the products may be absorbed in sand or cotton rags. The spilled area at main carriageway/ service road should be thoroughly washed with water or any neutral solvent to avoid any slippage or skidding. All effect should be made that spilled oil does not enter surface water body.

Head-on Collision / Vehicle Accident on the road

The major risk involved in this type of Disaster fatal or high degree of injury. Early response will be in terms of well-equipped ambulance with paramedical team reaching on the site. This will help in rescue of passengers from the accident site and will be taken to the nearest hospital. If need so arises the patient can be taken to one of the major and super specialty hospitals in the area.

Spillage and Leakages of Oil on the road

This Disaster can occur during a leak or spillages of oil or fuel carrying tankers met with an accident on the road. The various risks involved in this is danger of skidding of other vehicles due to spillages. Risk of catching fire depends upon the flash point of the material. The early response in this case will be stoppage of vehicular movement immediately by using communication system and towing the

damaged vehicle in order to make traffic easier. It is important to carry out mopping operations to collect oil spilled on the road. The clean- up procedure is of immense importance in order to avoid further hazards and consequences.

7.9 Land Acquisition (LA) Budget

7.9.1 Introduction

A consolidated overview of the budget is provided and the cost estimates given below shall be viewed accordingly. The cost estimates for land and structures based on data collected during the survey and contingency provisions have been made to take into account variations from this data.

The compensation amount for the acquisition of land and structures will be determined by the competent Authority appointed under NH Act 1956. Over and above, the PAF will be entitled for LA assistance as per the entitlement framework (for Acquisition of long stretches of land) of the Right to Fair Compensation and Transparency in Land Acquisition on Resettlement & Rehabilitation 2013 for project affected Families.

7.9.2 Cost of Land and other Replacement Value

The project requires about 422.47 ha of private land for construction of road, junction improvement, curve improvements, lanes taking into the account of revenue rate, market rate and stake holder's estimation, the market value of the land has been assumed during the primary survey. The cost of land, which includes compensation amount, Multiplier Factor 1.3-times, solatium of 100%, which become 2.6-times as per RFCTLARR-2013 Schedule-1 on Land acquisition including other compensations is estimated to be INR. 800 Cr.

7.9.3 Compensation for Structures

For the loss of building structures, like commercial, residential, tube well house, borewells, wells, etc., the titleholder will be compensated at replacement cost. A government approved value has been used to assess the replacement cost.

It is premature here to estimate the cost of structures at this stage when census of the properties in land acquisition area is in progress however; compensation for the structures has been calculated during the structure identification survey in the project area. The Replacement cost for the structure will be based on the updated Basic Schedule of Rates.

7.9.4 Provision for Development of Community Structures

A total of 2 community structures (govt. schools, community toilet, etc.) are coming in the way of the proposed alignment. All these structures shall be considered for relocation or reconstruction at another place depending on the valuation of the said structures.

7.9.5 Budget

It has already been stated that the list of affected properties is yet to be firmed up. However, estimated of land Acquisition and cost for Rehabilitation & Resettlement has been worked out to INR. 800 Cr. for the proposed alignment. This covers all components of compensation, assistance and entitlements. The broad break up of LA budget is given in the following table. The budget is based on assessment conducted by the consultant on the market value of land through interviewing Patwaris (Local Revenue Officer) and PAPs. The detailed LA budget is presented below.

Table 7-20: LA Budget of proposed alignment

S. No.	Particulars	Unit	Quantity	Rate per unit	INR (Cr.)
1	**Land Acquisition**				
1.1	Compensation for private land	ha.	422.47	5,12,000	216.30
1.2	Multiplier Factor (1.3 -times Rural)				281.19
1.3	Solatium (100%)				281.19
Sub Total Land Acquisition Cost					**778.69**
2	**Replacement of Structures**				
2.1	Residential area (Approx. 12m x 12m)	Sq. m	6,192	14,800	9.16
2.2	Commercial Area (Approx. 6m x 6m)	Sq. m	792	12800	1.01
2.3	Sub-Total cost for replacement of structures				10.18
2.5	Solatium (100%)				10.18
Sub Total Cost for Replacement of Structures					**20.36**
3	**Assistance for PAFs**				
3.1	Resettlement Allowance	Family	43	60,000	0.26
3.2	Assistance Allowance	Family	43	45,000	0.19
3.3	Financial Assistance	Family	43	60,000	0.26
3.4	Shifting Allowance	Family	43	60,000	0.26
Sub Total cost for Assistance to PAFs					**0.97**
Total Cost					**800.01**
Contingency (10% of the total cost)					**80.00**
Grand Total					**880.01**
Say					**880**

Source: Calculated as per Project DPR costing, GDRPL

7.10 Additional Studies as per ToR

7.10.1 Additional Wildlife Study

The specific condition no. '2' of the ToR (File No: 10/18/2024-IA.III) granted by the MoEF&CC dated 19/09/2024 states the following:

"Wildlife conservation/management plan for the area with special emphasis on elephants management shall be prepared in consultation with State Forest Department, WII or any other nationally reputed institution and implemented at the project cost.".

As per the specific condition 2' of the ToR (File No: 10/18/2024-IA.III) granted by the MoEF&CC dated 19/09/2024, a wildlife study in the proposed project area is carried out to understand the biodiversity of the proposed project area as well as to prepare a detailed Conservation Plan/management plan. The report is presented to State Forest Department for the various mitigation measures required for proper animal movement at the project site. Elephant underpasses have been proposed at 10 locations after consultation with Forest department. Apart from these, 233 culverts have also been proposed for movement of smaller animals. Detail wildlife conservation/management plan is attached as **Annexure 3-5.**

8. PROJECT BENEFITS

8.1. Introduction

Access control Highway, are constructed to higher design standards than is customary on ordinary roads. Outstanding features include the separation of highway and railway grades, thus eliminating all stops not required for fuel, full lanes of pavement in each direction separated by a medial safety zone, easy grades, sweeping curves, and adequate shoulders. On a highway of this type where stops will be unnecessary except for fuel, it will be possible to obtain a high average speed in comparison with the top speed. It provides the option for movement of men and material at a faster pace, establishing linkages between distant cities and towns and improve earning and thereby enhancing the quality of life. This in turn enhances the demand for transport.

This two-way interaction works through a host of inter-sectoral forward and backward linkages effects and dynamic externalities, tend to relocate industries, services and labour and thus helps to shape the economic geography of the region. The developments of highways have also resulted in the development of the entire region located all along the stretch. In a way, the highways are becoming symbols of growth and prosperity.

The benefits of proposed highway which is starting from Rameswar at NH-16, traverses in a Ring Road fashion by passing cities of Khordha, Bhubaneshwar and Cuttack and ends at Gobindpur at NH-55 in Dhenkanal district in the State of Odisha may also be seen from a different angle, viz., the local benefit and the wider regional or national level benefit. The entire regional and national economy lying beyond this neighbourhood will also be benefited from the development. Such effect may be called as the regional or national level benefits. Further the benefit may be direct or indirect in nature.

All these should have a bearing on the level of well-being of the households, although some of them may not themselves necessarily use most of the highway facility created. These would in turn lead to positive changes in the level of well-being and human development, through their benefit on consumption level, educational attainment, health status, better freight and agricultural commodities movement etc.
In general, the project will have the following benefits at the regional & national level.

8.2. Improvement in Physical Infrastructure

As the proposed project is a greenfield project, it is aimed towards the overall development of the physical infrastructure of the region such as:

- Creation of new road surface with superior quality, safety features and other facilities.
- Further development of the built up area of the region.
- The Highway has been designed to best of International Standards and will thus facilitate safe travel at high speeds with State of the art Automated Traffic Management system, Access Control, World class way- side amenities such as truck parking/ servicing areas, fuel stations etc.

- **High-speed connectivity and access**: The projected corridor is a proposed for 6 lane, access controlled highway. This will avoid traffic congestion and speed-up the freight and passenger movement. It is expected that overall the proposed corridor will reduce the travel time between the two economic hubs/highways by around 20%. The proposed highway will start from NH-16

near Rameswar village, Khordha and terminating at its junction at Gobindpur, NH-55 in Dhenkanal district in the State of Odisha.

- **Aiding economic growth:** The seamless connectivity will provide better access to vehicles as a link to the National Highways. The Project will reduce travel time and provide boost to trade and commerce linked to the regions connected through this highway. It provides improved connectivity to major industrial areas along NH-53 with Angul, Sambalpur, Khordha, Bhubaneswar, Paradip port and Cuttack. The reduction in traffic from NH-16 between Khordha, Bhubaneswar, and Cuttack will be achieved after the construction of the project stretch. Development of new parallel connectivity of NH-16 bypassing Khordha, Bhubaneswar and Cuttack will enhance the economic development of the influence area.

- **Usage shift:** Long-distance traffic will shift from existing National Highways to the proposed highway, resulting in lesser congestion leading to higher fuel savings and reduced travel time on these highways.

- **Improved safety:** Due to access control, the Roadway & Travel Safety of the traffic connecting the cities will be enhanced as there will be minimum distractions & conflict zones.

- **Support to Industry:** Different types of industries like Manufacturing, Tourism, warehousing facilities etc. along the proposed corridor will be facilitated in their business operation and reachability.

8.3. Improvement in Social Infrastructure

There is a potential of immense socio-economic improvement of the region due to creation of the new highway through the previously untapped region. These have been detailed below:

- This proposed highway will act as the primary artery for economic flow through the region.
- It will facilitate increased connectivity between the rural as well as urban populations as the proposed highway passes through villages as well as adjacent to important towns. This will help people from all strata of society.
- This road will promote the buildup of educational as well as health infrastructure.
- The rural and urban economies will be strengthened, which in turn will increase the country's economy as a whole.
- Strengthening of tourist development in the area is another improvement to the social structure of the area.
- The increase in economy will promote the growth of employment in the area.
- Growth of backward areas: The biggest strength of the alignment is that it plans to cover two important districts of Odisha. As a result of connectivity and access to other parts of the country, these areas will be aided to integrate with other part of India. Further, freight and passenger traffic on the highway will help promoting ancillary economy of these regions.

8.4. Employment Generation (Skilled, Semi-skilled & Unskilled)

The proposed highway will generate employment opportunities for the skilled, semi-skilled as well as unskilled persons in the following ways:

- During construction, the local people will be employed for various activities related to construction such as pillar fixing, tree felling, asphalt mixing, etc.

- Skilled persons such as engineers or other experienced persons will also be employed for the smoothening of operations during project construction.
- During operation phase, toll plazas will be constructed at various places, creating employment opportunities for semi-skilled people.
- Other activities from time to time like plantation management, fencing near forest areas, improvement of the damaged roads, etc. will also generate employment.
- The construction of the highway will help the farmers in getting good prices of their produce by way of quick and fast transportation of perishable goods to the market places. The highway connectivity will also help in import of new techniques of agriculture to the backward areas.
- Around 30 permanent work force will be employed during construction (around 2.5 years) and during operation (10 years) at toll plaza, way side amenities and safety personnel. During the construction phase around 500 skilled and semi-skilled persons will be employed for 2.5 years generating total working man days of 455000.

8.5. Other Tangible Benefits

The proposed highway is a connecting highway between the existing NH-16 at Rameswar by passes cities Khordha, Bhubaneshwar, and Cuttack and ends at Gobindpur at NH-55 in Dhenkanal district in the State of Odisha. Other benefits of this proposed highway are:

- This highway will reduce the traffic load on the existing NH 16, thereby reducing the deterioration of the environmental parameters such as AAQ, Noise, biological environment, etc. Around 30-40% of the heavy vehicular traffic will then bypass the cities of Khordha, Bhubaneshwar and Cuttack in long term entire through traffic will use the ring road.
- The development of tourism industry will help in the establishment of hotels and lodges, as well as other businesses related to tourism.
- Promoting local traditional art and craft of the region.
- This project will help in the growth of businesses like construction equipment and materials suppliers, etc.

8.6. Environmental and Health Benefits along the Existing Routes

Reductions in adverse environmental impacts of transportations i.e. reduced emissions; decrease in Respirable Suspended Particulate Matter and Suspended Particulate Matter, reduced Noise and other impacts thereof improving the health conditions of the people residing in the settlements along the proposed alignment as proposed highway will provide fast uninterrupted free flow of traffic. With the bypassing of the traffic to the ring road the AQI of the cities of Cuttack and Bhubaneshwar will improve gradually.

9. Environmental Cost Benefit Analysis

This chapter is not included in this EIA report because EAC did not recommend this chapter at the scoping stage and meeting for approval of ToR (File No: 10/18/2024-IA.III for proposal no. IA/OR/INFRA1/482782/2024 in Agenda No.-9 of 370th meeting held on 23rd to 24th July, 2024).

10. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

10.1. Introduction

Environmental Management Plan (EMP) is a necessary part of any developmental project to ensure that environmental impacts are kept well below the acceptable limits, as well as to improve environmental conditions of the project area at pre-construction, construction as well as operation phases, through comprehensive mitigation measures.

In general, NHAI, with assistance from Contractor and Monitoring Consultant, is responsible for carrying out mitigation measures as and when required. The PIU/Independent Engineer has to ensure, through periodic audits and monitoring, so that all EMP requirements and mitigation measures are being implemented correctly by the contractor during various stages of the project.

The main components of EMP are:

- EMP Implementing Agency
- Monitoring the Implementation of EMP
- Training for correct implementation of EMP
- Budgetary provisions for EMP implementation

The Project Proponent (PP) is responsible for creation of an Environment Management Cell (EMC) which will supervise the implementation of mitigation measures as laid down in EMP. The PP shall collaborate with the various governing bodies in the central as well as the state governments for smooth operation of the EMP.

The EMP to be implemented at various stages of the project i.e. Pre-construction, Construction and Operation are given in details in individual sections.

The estimated budgetary provisions for implementing the EMP is given in this chapter.

10.2. Checklist of Statutory Obligations

Project Proponent is required to attain a number of statutes as well as obey the provisions laid down by the Acts, Rules, Notifications and Orders relevant to the project. Some important National Acts which aim at prevention and control of industrial and urban pollution are:

- Water (Prevention and Control of Pollution) Act, 1974, amended 1988
- Air (Prevention and Control of Pollution) Act, 1981, amended 1987
- Environment (Protection) Act, 1986, (EPA)
- The Wildlife (Protection) Act, 1972
- The Forest (Conservation) Act, 1980 (With Amendments made in 1988)
- Forest (Conservation) Rules, 2003 (With Amendments made in 2004)
- National Environment Tribunal Act, 1995
- Ozone Depleting Substances Regulation and Control Rules, 2000
- Fly Ash Notification, 2009
- EIA Notification, 2006 and further amendments
- Public Liability Insurance Act, 1991
- Ancient Monuments and Archaeological Sites and Remains Rules, 1959
- Quarry Lease deeds and license under the Mines Act, 1958

The Air and Water Acts are medium-specific regulations which help the Central and state pollution control authorities to keep in check the pollution emanating from industries through their emissions and discharge of effluents into air and water by setting respective standards.

Environment (Protection) Act, 1986 is considered as the 'umbrella act' as it authorizes the government authorities to make and amend rules related to air, water, noise, soil pollution; hazardous substances handling; waste management; manufacture, storage, sampling and analysis by environmental laboratories, etc.

Some other acts/rules/notifications which are relevant to the highway projects are:

- National Highways Authority of India (Amendment) Act, 2013
- Motor Vehicles Act, 1988
- Central Motor Vehicle Rules, 1989
- Control of National Highways (Land and Traffic) Act, 2002
- National Highways Act, 1956
- National Highways Rules, 1957
- National Highways Authority of India Act, 1998
- Road Transport Corporations Act, 1950
- Carriage by Road Act and Rules
- Notifications under Motor Vehicle Legislation

10.3. Environment Management Action Plan

The Environmental Management Action Plan is the synthesis of all proposed mitigation and monitoring actions, to be implemented within a time frame with specific responsibility assigned and follow-up actions defined. It contains all the information for the project proponents, the contractors and the regulatory agency to implement the project within a specified time frame.

- The EMP is a plan of action for avoidance, mitigation and management of the negative impacts of the project. The Environmental Enhancement is also an important component of EMP.
- The EMP refers to all implementable task at different stages of project, namely,
  i. Pre-Construction Phase
  ii. Construction Phase, and
  iii. Operation Phase
- The EMP includes a list of all project-related activities and impacts and a clear reporting schedule.

The EMP is divided into two broad components,

(i) dealing with natural environment, and
(ii) dealing with action plan for resettlement and rehabilitation (RAP).

While the mitigation measures of the natural environment and their management have been incorporated in the present volume, the management of issues related with resettlement and rehabilitation of human communities has been provided in Resettlement Action Plan.

10.3.1 Pre-Construction Stage

The pre-construction stage involves various technicalities such as:

- Obtaining all necessary clearances/NOC's/consents from concerned regulatory authorities such as Environmental Clearance, Forest Clearance, Wildlife Clearance, etc.
- Identifying and selecting the sources of gathering materials for construction such as quarry, water, sand, etc.
- Fulfilling the conditions laid down by the respective NOCs.

10.3.2 Construction Stage

The construction stage involves various technicalities such as:

- Stone crushing and screening plants, hot mix plants, concrete batching plants etc. shall be located sufficiently away from habitation, agricultural operations.
- Precaution shall be taken to reduce the levels of noise, vibration, dust and emissions from plants.
- The contractor shall not use or generate any materials in the works which are hazardous to the health of person, animals or vegetation.
- Provision of protective clothing or appliances to workers
- Provision of drinking water for workers shall be made available.
- The use of firewood shall not be permitted.
- All equipment shall be provided with proven efficiency.
- Plants, equipment and instruments provided shall have adequate sensitivity facility for calibration to desired level and shall be robust.

10.3.3 Operation stage

The operation stage involves various technicalities such as:

- Road development may lead to establishment of petty shops and other commercial pursuits by the local people. The project proponent should prevent development of squatter settlements and encroachments on the vacant portions of the RoW of the road.
- There is possibility of accidents in the project stretch as a greater number of vehicles are expected in this road stretch. In the event of spillage of hazardous chemicals, a spillage containment mechanism will be developed along with the participation of police and the fire department.
- Avenue and median plantations along the stretch will improve the aesthetics of the project corridor. Public amenities and parking places are proposed in project design for long distance travelers.
- Traffic noise significantly affects human health, especially for people living in the vicinity to major roads/highways. There will be significant noise impact due to traffic which include different categories like small private vehicles to large goods vehicles.

10.4. Enhancement of Natural Environment

The natural environment can be improved by plantation of ornamental and shade providing avenue trees on the roadside, the shrubs and some important herbs besides developing ponds and providing bore wells along the roadside.

10.4.1. Plantation of Trees, Shrubs and Herbs along the proposed Highway

The plantation of trees can be done in different densities depending on:

- Habitat and soil type
- Water table depth
- Availability of indigenous species
- Survival rate of plants and
- People's choice

The physical growth characteristics like the form and shape of canopy types, branching patterns, growth rate, colour of flowers, foliage and root characteristics were also the major criteria in the selection of plantation type and densities.

Since the natural forests of desired density are lacking in the region, the ecological importance of the roadside plantation becomes increasingly significant. But, what kind of tree species should be selected for such plantation has been a debated issue. The acute shortage of forest products provided support to the view point that the strip plantation along the highway should be managed primarily to meet the requirement of the local people and industries for various forest products. However, the consideration of comfort to travelers was given the top priority.

10.4.2. Enhancement of Water Bodies

The proposed project alignment crossing one major rivers viz. Mahanadi. Various structures are being proposed so as to not to disturbed the drainage pattern of the water bodies. In order to make these water bodies more accessible and enhance the waterfront landscape following measures has been suggested.

The water bodies are used for various purposes including bathing, washing, fishing, growing water-fruits, livestock drinking and often irrigating the agricultural fields. The landscape treatment includes

- Provision of stepped access to the edge of water
- Providing flat boulders for washing
- Stone pitching for slope for high embankment stabilization
- Plantation of trees and shrubs for stabilization of pond edge

10.4.3. Conservation Status and Biodiversity Management

The proposed project alignment does not pass through any national Park, Wildlife Sanctuary or protected area. The project area also does not pass through any Eco-Sensitive Zone of any Wildlife Sanctuary/National Park. Chandaka-Dampara and Kapilash wildlife sanctuaries lie at some distance from the project alignment.

10.4.4. Threats to Biodiversity in the Project Site

The major threats are enumerated as follows:

- Gradual shrinkage of wildlife habitat due to economic development activities
- Environmental pollution and habitat destruction due to economic development activities, tourism.
- Major anthropogenic direct drivers of ecosystem degradation and destruction include habitat conversion to other forms of land use
- Overexploitation of species and associated destructive harvesting practices, spread of invasive alien species
- Gradual increase in human and livestock population
- Unusual soil erosion around wetlands
- Human and livestock activities, such as, open grazing and seasonal flooding in the low-lying areas
- Exposure to diseases in case of wildlife (least at present) due to exposure to domestic cattle.

10.5. Physical Environment

10.5.1. Construction of Bus Stops

- No bus shelters are provided.

10.5.2. Developing Truck Stoppage Complex and Way Side Amenities (WSA's)

In view of the heavy truck parking activities in midsections, truck stoppage sites/ truck lay byes/WSA's are suggested at the appropriate locations along the highway.

The requirements of truck stoppage complexes/WSA's are:

- Acquisition of land for developing the complex
- Each complex should have some shops covering the repair shops, medicine shops, restaurants, and recreation
- The location of petrol pumps should be close to such complexes
- Ornamental and shade trees and shrubs to be planted in order to develop the area aesthetically.

10.5.3. Enhancement of Major Road Intersections

The road intersections are the main nodal spaces along the corridor. Proper landscaping of these areas by flowering trees and shrubs will improve the area aesthetically.

10.5.4. Enhancement of Cultural Properties

The cultural properties should be viewed as assets contributing towards meaningful and pleasurable traveling experience. These are the sites of community and individual sentiments. The landscape and design improvements include:

- Providing and improving access to cultural properties.
- The precincts of such properties should be defined or redefined.
- Provision of parking should be made to avoid haphazard parking activities.
- Seating space and rest areas around the cultural properties to be developed.
- Plantation of trees and shrubs for shade and aesthetics.

10.5.5. Enhancement of Quarries and Borrow Areas

The following enhancement measures will be undertaken for quarries: -

Construction Stage

Development of site: To minimize the adverse impact during excavation of material following measures are need to be undertaken:

i) Adequate drainage system shall be provided to prevent the flooding of the excavated area

ii) At the stockpiling locations, the Contractor shall construct sediment barriers to prevent the erosion of excavated material due to runoff

iii) Construction of offices, laboratory, workshop and rest places shall be done in the up-wind of the plant to minimize the adverse impact due to dust and noise.

iv) The access road to the plant shall be constructed taking into consideration the location of units and also slope of the ground to regulate the vehicle movement within the plant.

v) In case of storage of blasting material, all precautions shall be taken as per The Explosive Rules, 1983.

Quarry Operations Including Safety

i) Overburden shall be removed and disposed on designated site

ii) During excavation, slopes shall be flatter than 20 degrees to prevent their sliding. In cases where quarry strata are good and where chances of sliding are less this restriction can be ignored.

iii) In case of blasting, procedure and safety measures shall be taken as per The Explosive Rules, 1983.

iv) The contractor shall ensure that all workers related safety measures shall be done as per guidelines for Workers and Safety.

v) The Contractor shall ensure maintenance of crushers regularly as per manufacturer's recommendation.

Topsoil will be excavated and preserved during transportation of the material. Measures shall be taken to minimize the generation of dust and prevent accidents.

Borrow Areas Management

Borrow areas will be finalized either form the list of locations recommended during EIA stage or new areas identified by contractor. The finalization of locations identified during EIA identified and may be finalized by contractor depends upon the formal agreement between landowners and contractor and

its suitability from civil engineering as well as environmental consideration. Meeting the guidelines/notifications as stipulated from time to time by the Ministry of Environment, Forest and Climate Change, Government of India, and local bodies, as applicable shall be the sole responsibility of the contractor.

Besides this, certain precautions have to be taken to restrict unauthorized borrowing by the contractor. No borrow area shall be opened without permission of the Engineer/AE. The engineer in addition to the established practices, rules and regulation will also consider following criteria before approving the Borrow areas.

To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Engineer. Redevelopment of the borrow areas to mitigate the impacts will be the responsibility of the contractor. The contractor shall evolve site-specific redevelopment plans for each borrow area location, which shall be implemented after the approval of the Supervision Consultant.

To ensure that the spills, which might result from the transport of borrow and quarry materials do not impact the settlements, it will be ensured that the excavation and carrying of earth will be done during day-time only. The unpaved surfaces used for the haulage of borrow materials will be maintained properly.

Borrowing of earth shall be carried out at locations recommended as follows:

Non-Cultivable Lands: Borrowing of earth will be carried out upto a depth of 2.0 m from the existing ground level. Borrowing of earth shall not be done continuously. Ridges of not less than 8m width shall be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges, if necessary, to facilitate drainage. Borrow pits shall have slopes not steeper than 1 vertical in 4 horizontals.

Productive Lands: Borrowing of earth shall be avoided on productive lands. However, in the event of borrowing from productive lands, under circumstances as described above, topsoil shall be preserved in stockpiles. The conservation of topsoil shall be carried out as described in section of this chapter. At such locations, the depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside.

Elevated Lands: At locations where private owners desire their fields to be levelled, the borrowing shall be done to a depth of not more than 2 m or up to the level of surrounding fields.

Borrow pits along Roadside: Borrow pits shall be located at least 5m away from the toe of the embankment or 4 times the height of the embankment plus 5 m from the toe of the embankment. Depth of the pit should be such that the bottom of the pit shall not fall within an imaginary line of slope 1 vertical to 2 horizontal projected from the edge of the final section of the bank. Borrow pits should not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains should be cut through the ridges to facilitate drainage.

Borrow pits on the riverside: The borrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood.

Community / Private Ponds: Borrowing can be carried out at locations, where the private owners (or in some cases, the community) desire to develop lands (mostly low-lying areas) for pisciculture purposes and for use as fishponds.

Borrow Areas near Settlements: Borrow pit location shall be located at least 1.0 km from villages and settlements. If unavoidable, they should not be dug for more than 30 cm and should be drained.

After identification of borrow areas based on guidelines. Contractor will fill reporting format as under and submit the same for approval to the "Engineer" Once approved the contractor will adhere to the recommendation for borrow area to the satisfaction of Engineer.

(1) In no case the depth of borrow area should exceed 2m from the existing ground level or as approved by the Concerned Government department.

(2) Borrow pits slope should be maintained, no steeper than 1 Vertical: 2 Horizontal.

(3) Water pooling to be avoided/managed so that NO disease spread due to water stagnation.

(4) Precautionary measures as the covering of vehicles will be taken to avoid spillage during transportation of borrow area.

(5) The unpaved surfaces used for the haulage of borrow materials should be maintained properly for dust suppression.

(6) Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction facility is operating at the place of deposition, to minimize dust pollution.

(7) During rains appropriate measures to be taken to minimize soil erosion, silt fencing to be provided as directed by Engineer/EO.

The Contractor will keep record of photographs of various stages i.e., before using materials from the location (pre-project), for the period borrowing activities (construction Phase) and after rehabilitation (post development), to ascertain the pre and post borrowing status of the area.

Table 10-1: Environmental Management Action Plan

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
PRE-CONSTRUCTION/DESIGN PHASE					
1. Pre-construction Activities					
Tree Cutting	• Tree Cutting Permission	• Approximately 13617 trees are likely to felled for construction of the highway. All efforts will be made to minimise cutting of trees. • Prior permission will be obtained for cutting trees.	Corridor of Impact.	PIU, Forest Department	PMU, NHAI PD-PIU, A.E.
Preservation of Trees	• Preservation of Trees	• All efforts will be made to preserve trees including evaluation of minor design adjustments/alternatives (as applicable) to save trees. • In the event of design changes, additional assessments including the possibility to save trees shall be made. Stacking, transport and storage of the wood will be done as per the relevant norms Systematic corridor level documentation for the trees cut and those saved will be maintained by the PIU.	Corridor of Impact.	PIU, Forest Department	PMU, NHAI PD-PIU, A.E.
Utility Shifting	• Utility Shifting	• Prior permission will be taken from line department offices of Electricity (PDD), Telecommunications (for OFC underground cables etc), water Pipeline (PHE) etc. Utility shifting required to be undertaken by PIU.	Corridor of Impact.	PIU, Concerned Utility Department	PMU, NHAI PD-PIU, A.E.
Statutory Clearance	• Obtaining Clearance, Permission and Consents	• Prior permission will be obtained from concerned Department for any works related to culverts, embankment construction,	Corridor of Impact.	Contractor, NHAI PIU	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		protective works etc. along or near natural streams. • Labour license from Department of Labour. • If contractors open new stone quarry or borrow areas, prior • Environmental Clearance will be obtained from MoEF&CC. • For setting–up of Stone Crusher Plant, HMM Plants, Batching Plant, D.G Sets- Consent to Establish and Consent to Operate will be obtained from Odisha Pollution Control Board (OSPCB)			
Common Property Resources (CPR's)	• Common Property Resources (CPR's)	• All common property resources shall be relocated and restored before the commencement of the road improvement activities. • Before commencement of works, a joint field Monitoring will be conducted by the Contactor and PIU to map out the alignments, to check if any CPR is being impacted due to construction works. While relocating these utilities and facilities all concerned agencies including PIU shall take necessary precautions and shall provide barricades/delineation of such sites to prevent accidental fall of pedestrian and other road users into pits, drains both during demolition and construction/ relocation of sum facilities.	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
Procurement of Machinery, Crushers, Batching Plants etc.	• Procurement of Machinery, Crushers, Batching Plants etc.	• Specifications of Machinery, crushers, and batching plants shall comply with the requirements of the relevant environmental legislations. Crusher, batching plants and hot mix plant shall be located 250m away from settlements/ commercial establishments, preferably in the downwind direction. • No plants should be set-up within 250m from the residential/settlement locations. The Contractor shall submit a detailed layout plan for such sites and seek prior approval of PIU before entering into formal agreement with a land owner for setting-up such sites. • Actions by PIU/PMU against any non-compliance shall be borne by the Contractor at his own cost. Arrangements to minimize dust pollution through provision of water spray shall have to be provided at such sites.	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.
Construction Camp Selection,	Construction Camp Selection,	• If contractor decides to establish labour camp, siting of the camp, layout of camp will be approved by PIU. • Labour camp will not be established within 250 m from the nearest Settlement to avoid conflicts and stress with the local community.	250 m from the nearest Settlement	Contractor	PMU, NHAI PD-PIU, A.E.
Construction Vehicles, Equipment and Machinery	Construction Vehicles, Equipment and Machinery	• All vehicles and equipment to be procured for the proposed upgradation works of project road will conform to the relevant Bureau of Indian Standard (BIS) norms. The	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		discharge standards promulgated under the Environment Protection Act, 1986 and Motor Vehicles Act, 2019 will be strictly adhered to. • The silent/quiet equipment like DG set as per regulations will be used at the construction site or labour camp. • The contractor will maintain records of Pollution Under Control (PUC) certificates for all vehicles used during the contract period, which will be produced to PIU for Monitoring and whenever required.			
Arrangement For Construction Water	Arrangement For Construction Water	• The contractor shall source construction water preferentially from surface water bodies in the project area. Boring of any tube wells shall be drilled only after obtaining necessary permission from Central Ground Water Authority. • To avoid disruption/disturbance to other water users, the contractor shall extract water from fixed locations. The contractor shall consult the local people before finalization the locations. • Contractor can extract ground water only in case surface water sources are not available and that too only after proper permission from Central Ground Water Authority	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.
Labour Requirement	Labour Requirement	• The contractor preferably will use unskilled/semiskilled labour from local areas to give the maximum benefit to the local	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		community to avoid any additional stress on the existing facilities. On an average 150 labours will be required during construction stage depending upon extent of construction work. • All applicable labour regulation will be complied by the contractor. • Necessary facilities will be provided to workers as per The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996			
Traffic Management Plan- Planning for Traffic Diversions and Detours	Traffic Management Plan- Planning for Traffic Diversions and Detours	• Detailed traffic control plan shall be prepared by the contractor and same shall be submitted to the PIU for approval. The traffic control plans shall contain details of temporary diversions, traffic safety arrangements including night time safety measures, details of traffic arrangement after cessation of work each day, safety measures undertaken for transport of hazardous materials and arrangement of flagmen etc. to regulate traffic congestion	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.
CONSTRUCTION PHASE					
1.LAND					
Utility Shifting	• Utility Relocation and Common Property Resources (CPRs)	• All community utilities and common property resources such as stand posts bore wells, wells, water supply lines, toilets, sewage lines, drainage systems, optical fibre	Corridor of Impact.	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		cables, electric power supply lines, transformers, irrigation pump houses, telephone, and television cables shall be relocated and restored before the commencement of the road improvement activity.			
Land Acquisition	• Land will be acquired	• The land will be acquired following the provisions of NH Act, 1956 and the compensation will be determined following India's Land Acquisition and Rehabilitation and Resettlement Act, (RFCTLARR Act, 2013)	Corridor of Impact.	PIU, Revenue Dept.,	PMU, NHAI PD-PIU, A.E.
Embankment slopes	• Some degree of soil erosion on newly constructed embankment	• Turfing of the slopes to check soil erosion with grasses, geo-mats, geo-cells, etc.	Corridor of Impact.	Contractor, PIU, Revenue Dept.	PMU, NHAI PD-PIU, A.E.
Borrow areas	• Soil and land use will be changed	• Borrow pits shall not be dug continuously. The location, shape and size of the designated borrow areas shall be as approved by the Engineer. No borrow area shall be opened without permission of the engineer. • If borrow pits along the highway is permitted by the Engineer, these shall not be dug continuously and shall confirm to MORTH specifications. • Borrow pits shall be redeveloped as per MoEF&CC/IRC guidelines. Spoils shall be dumped with an overlay of stockpiled topsoil in accordance with compliance requirements with respect to MoEFCC/IRC guidelines.	Ecologically sensitive area	Contractor and Environmental Officer	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• No borrow areas shall be opened within 500m of wildlife movement zones and forest areas. The borrow areas shall be at least 300m from schools and village access roads. • Borrow area should be located at a minimum distance of 300m from the residential/ settlement area. Proper fencing should be provided and access to the borrow areas should be restricted for the locals • The Contractor shall not borrow the earth from the selected borrow area until a formal agreement is signed between landowner and Contractor and a copy of the agreement is to be submitted to the Engineer – In-charge of the Supervision Consultant. The Supervision Consultant shall report these facts to the PIU along with the remarks in the prescribed format with documentary proofs. • Planning of haul roads for accessing borrows materials shall be undertaken during this stage. The haul roads shall be routed to avoid agricultural areas. In case agricultural land is disturbed, • the Contractor shall rehabilitate it as per Borrow Area guideline given in the Environmental Management Framework (EMF) or as approved by the Engineer – In-charge of Supervision Consultant.			

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• Haul roads shall be maintained throughout the operation period of the borrow areas by undertaking the required maintenance and repair works, which may include strengthening, pothole repairing, and diversions. Improvements shall be done to reduce inconvenience to users of these roads, residents living along the haul roads and minimize air and water pollution. Such measures shall include, but not limited to, frequent			
2. WATER					
Water source	• No appreciable impact on underground water sources • No loss of surface water bodies or canals	• The Contractor shall source the requirement of water preferentially from surface water bodies, as rivers and tanks in the project area. The Contractor shall be allowed to pump only from the surface water bodies. Boring of any tube wells shall be prohibited. • Only at locations where surface water sources are not available, the Contractor can contemplate the extraction of groundwater. Consent from the Engineer that "no surface water resource is available in the immediate area for the project" is a pre- requisite before extraction of groundwater.	All rivers/surface water bodies that can be used in the project	Contractor	Environment Officer, PMU, NHAI PD-PIU, A.E.
Drainage	• No significant impact as sufficient nos. of CD works are available	• Raising the road level • Provision for drainage on the side of highway	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.
3. FLORA AND FAUNA					

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
Clearing and Grubbing	• Site clearance including clearance of marked trees for felling and removal has to be carried out much before the actual road construction takes place • Structures and utilities (cabins, commercial properties, hoardings, overhead power transmission lines, cable connections, telephone lines, bore wells, stand posts, wells, statues, temples, etc.) shall be compensated/relocated as per RAP and EMP provisions before tree felling; clearing or grubbing activities are to be undertaken as these activities may damage structures (private and govt.) and essential facilities/utilities of public use.	• All works shall be carried out in a manner such that the damage or disruption to flora is minimum. Only ground cover/shrubs that impinge directly on the permanent works or necessary temporary works shall be removed with prior approval from Engineer – In charge of Supervision Consultant	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
Tree Felling and Transplantation	The total number of trees to be affected for the project is 13617.	• As far as possible maximum efforts shall be made to minimize the number of trees proposed to be felled by adopting suitable on the spot adjustment of engineering designs. • Trees shall be removed from the Corridor of Impact (CoI) and construction sites before the commencement of construction. • Prior Permission shall be obtained from the Revenue Department for the avenue trees and the Forest Department for the trees located within the Forest areas • The trees cut shall be disposed of through auction (inclusive of tree stumps). This disposal shall be done immediately to ensure that the traffic movement is not disrupted. Progress of tree cutting shall be reported to the PIU.	Corridor of Impact.	PIU, Revenue Department and Forest Department. Tree Felling, Contractor	PMU, NHAI PD-PIU, A.E.
Wildlife	• Loss of Habitat and Defragmentation	• Plantation will be done along the proposed highway to compensate the loss of vegetation • The strips of vegetation will be planted on either side of the linear clearing to provide attractive corridors for animal movement.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.
	• Degradation of Habitat Quality	• Precautions will be taken to avoid leakage of chemicals, any hazardous materials due to construction activities. • Labour camps will be located far from habitat of any fauna	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• Invasive alien species will be removed from time to time			
	• Noise Induced physiological and behavioural Changes	• Dense vegetation along the road side may be provided for attenuation of noise. • Silence zone will be marked and provided with sign boards to alert drivers • Noise buffers using diversity of tree species, with a range of foliage shapes and sizes, combination of shrubs and trees and evergreen species will be provided. • Noise barriers will be provided as required.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E
	• Impacts of Headlights Glare on Wildlife	• Hedges along both sides of highway will be provided to lower the intensity of lights. Light mitigation measures will be provided	Corridor of Impact	Contractor	NHAI PD-PIU, A.E.
	• Avoidance of Road by Animals • To avoid Injury and Mortality of animals	• Various structure is proposed to be constructed for animals to cross the highway. • Different types of underpasses like Box culverts, pipe culverts, and culverts with furniture will be constructed for passage of herpeto fauna, amphibians etc. • Fences will be provided in combination with underpasses to direct animals away from the highway. • Vegetation or other habitat features (rocks, fallen timber) will be placed, planted or allowed to regrow so that animals are directed to preferred crossing locations.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• The plantation and lighting systems along the highway should be made less attractive to birds to avoid collision of birds with vehicles.			
	• Reduce access to saltlicks and waterholes	• Creation or improvement of water bodies will be done so that the animals have access to water. • Plantation along the water body will be done to attract the animals towards it. • The saltlicks areas will be protected from reach of human beings.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.
	• Discontinuity of Canopy	• The width of the linear clearing may be kept small in the area having dense canopy to maintain the continuity above the clearing.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.
	• Disruption of Processes that maintain regional wildlife populations	• The breeding sites of animals/amphibians, nesting sites of birds, thermoregulation surface sites of snakes will be avoided for any type of construction. • Construction/modification of ponds will be done to provide breeding sites to amphibians. • The construction of strips of surfaces (next to road where high mortality of snakes is reported) that may attract snakes for thermoregulation will be done.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.
	• Increased Human Pressure and Human-Wildlife Conflict	• Caution signs will be provided to alert drivers about wildlife • Parking shall be restricted to avoid any encounter of humans with animals.	Corridor of Impact	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• Temporary warning signs may be provided to warn drivers during specific time like breeding periods of animals or animal movement. • Animal Detection Systems may be provided for detection of any animal near the highway. • Poachers will be warned through sign boards. • Wild life movement and mitigation measures and structures will be planned			
Private plantation	• Loss of trees leading to increase in air and noise pollution; the loss of ecological and economic activities	• Trees will be removed as per design with prior approval	All along the project corridor	Contractor	PMU, NHAI PD-PIU, A.E.
***4.* ENVIRONMENTAL QUALITY**					
Air quality	• There will be increase in the Dust pollution level of the air in a few places	• The Contractor shall take every precaution to reduce the level of dust (PM10 and PM 2.5) from crushers, material storage yards, haul roads and construction sites (including earthwork, dismantling, scarification and material mixing sites) by sprinkling of water, mist spray, encapsulation of dust source and erection of screen /barriers. • Hot mix plant and batch mix plant shall be fitted with dust extraction units and mist spray to keep down the dust emission levels. The PM10 value at a distance of 40m from a unit located in such a cluster should be less	Construction camps, Materials Loading/unloading facilities	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		than 500 µg/m^3. The Contractor shall provide necessary certificates to confirm that all crushers used in the project conform to relevant dust emission control legislation. Air pollution monitoring shall be conducted as per the Environmental Monitoring Plan and results shall be used to strengthen/rectify problematic areas. If other existing crushers are used, such units need to have a valid license from the OSPCB.			
	• Emission from Construction Vehicles, Equipment and Machineries	• The contractor shall ensure that all vehicles, equipment, and machinery used for construction are regularly maintained and conform to the emission standards specified by the OPCB. Certification issued for such contrivances obtained from designated/approved authority shall be submitted along with the specified reporting format. • The contractor shall maintain a separate file and submit Pollution under Control (PUC) certificates for all vehicles/equipment/machinery used for the project. Monitoring results shall also be submitted to Supervision Consultant.	Construction camps, Materials Loading/ unloading facilities	Contractor	PMU, NHAI PD-PIU, A.E.
Noise level	• The noise level might be increased slightly in area due to machinery activities	• All plants and equipment used in construction shall strictly conform to the MoEF&CC/ OSPCB noise standards.	Sensitive locations including Schools, Hospitals, and	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• All vehicles and equipment used in construction shall be fitted with exhaust silencers. • Servicing of all construction vehicles and machinery shall be done regularly and during routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found defective shall `be replaced. • Limits for construction equipment used in the project such as compactors, rollers, front loaders, concrete mixers, cranes (moveable), vibrators and saws shall not exceed 75 dB (A) (measured at one-meter distance from the edge of equipment in the free field), as specified in the Environment (Protection) Rules, 1986. • At the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing, batching shall `be stopped during the night time between 9.00 pm to 6.00 am. • No noisy construction activities shall be permitted around educational institutes/health centers (silence zones) up to distance of 100 m from the sensitive receptors	Temples		
5. UTILITIES					

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
Relocation of utility lines/community utilities	• Short time negative impact during transitory phase of shifting of utility lines • No impact on shifting wells, hand-pumps etc.	• All utilities to be relocated with prior approval of the concerned agencies • All community utilities such as sources of water to be relocated to suitable places	All along the project corridor	Contractor	PMU, NHAI PD-PIU, A.E.
6. CULTURAL HERITAGE					
Relocation of cultural properties	• Most of the temples being small the issue is not a sensitive one	• Community meetings to be held before relocation or shifting • Provision of enhancement of religious structures, and access road	All along the project corridor	Contractor	PMU, NHAI PD-PIU, A.E.
7. ENVIRONMENTAL SAFETY					
Accidents	• Moving of fast moving & slow moving vehicles in market places will enhance chances of accidents • Poor visibility causes more accidents	• Segregating the slow moving traffic in the market places by developing the service lanes • Provision of wider median in rural stretches and plantation of shrubs/under trees in it to avoid the gear of vehicles moving in opposite direction • Signals to be erected to reduce speed • Proper light arrangement to be made	All along the project corridor	Contractor	PMU, NHAI PD-PIU, A.E.
Personal Safety	Personal Safety Measures for Labour Material handling, Painting, etc.	• The contractor shall provide all necessary safety appliances such as safety goggles (high visibility), helmets, safety belts, earplugs, masks, vests, boots, etc. to workers and staff. • Protective footwear and protective goggles to all workers employed on mixing asphalt materials, cement, lime mortars, concrete, etc.	All along the project corridor	Contractor	PMU, NHAI PD-PIU, A.E.

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
		• Welder's protective eye-shields to workers engaged in welding works • Protective goggles and clothing to workers engaged in stone breaking activities and workers shall be seated at sufficiently safe intervals • Earplugs to workers exposed to loud noise (above 75dB (A)), and workers working in crushing compaction, or concrete mixing operation. • Adequate safety measures for workers during the handling of materials at the site are taken up. • The Contractor shall comply with all regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress. • The Contractor shall not employ any person below the age of 14 years for any work and no woman shall be employed for the work of painting with products containing lead in any form. • The Contractor shall also ensure that no paint containing lead or lead products is used except in the form of paste or readymade paint.			

Environmental Issue/Component	Impact Description	Remedial Measure	Location	Responsibility	
				Planning and Execution	Supervision & Monitoring
Traffic and Safety & Pedestrian Safety	• Traffic and Safety & Pedestrian Safety	• The Contractor shall take all necessary measures for the safety of traffic during construction and shall provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as proposed in the Traffic Control Plan/Drawings and as required by the Engineer – In charge for the information and protection of traffic approaching or passing through the section of any existing crossroads. • The Contractor shall ensure that all signs, barricades, pavement markings are provided as per the MoRTH specifications. • Pedestrian Safety shall be ensured. Pedestrian circulation shall be demarcated before start & unsafe areas shall be cordoned off	All along the project corridor and all haul roads	Contractor	PMU, NHAI PD-PIU, A.E.
First Aid	• In case of any accident happened at construction site.	The contractor shall arrange for - • A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone • Availability of suitable transport at all times to take an injured or sick person(s) to the nearest hospital • Equipment and trained nursing staff at the construction camp.	All construction equipment	Contractor	PMU, NHAI PD-PIU, A.E.

10.6. Traffic Management Plan

The proposed road stretch is passing from Khordha, Cuttack and Dhenkanal districts of Odisha state. Site specific traffic management plan shall be done by the contractor during construction phase of the sub-project, duly adopting the following key components of traffic management plan.

10.6.1. Purpose of Overall Traffic Management Plan

The overall traffic management plan is designed and intended to provide adequate safety measures in advance against identified hazards and stipulated implementation of the said safety measures to ensure safe movement of traffic during the construction period of the proposed road stretch. The objective of safety standards is to provide safe travel to the drivers of vehicles plying along the roads during day and night time, throughout the year and provide protection to the project workers when they are on the work. This overall traffic management plan delineates the safety standards in terms of construction zones, signs and safety measures in work zones.

10.6.2. Construction Zone

Construction zones are the integral part of any road construction system. Safety measures will be aimed at avoiding hazardous conditions especially in work sub-zones where major construction activities are going on. For these purposes, the entire stretch will be treated as work sub-zone.

Signages

There are three major categories of signs i.e., regulatory, warning and guiding and also other traffic signs as per (Ref: IRC 67 2001, code of practice for road signs). These signs will be placed on the left-hand side of the road. Some other signboards will also be used to regulate the traffic, which have not been standardized (Ref: IRC SP 55 2014, Guidelines on traffic management in work zones). However, they confirm with the general requirement of shape & colour and their message should be brief, legible and clearly understandable i.e., “CAUTION-Men and Machinery at Work Go Slow”, “CAUTION-Work in Progress Go Slow”, etc. The location, frequency and type of signboards will be governed by the kind of traffic situations arising during the construction. Signboards of the type ‘Men at Work’ and ‘Speed Limit’ will be provided at locations wherever required on a case-to-case basis. Some of the warning signs are shown in Figure below.

10.6.3. Traffic Management Practices

The traffic management strategies include the following fundamental principles:

- Making traffic safety as an integral and high priority element of the project.
- Avoid inhibiting traffic as much as possible.
- Guide drivers in a clear and positive way.
- Routine inspection of traffic control element and traffic operations.
- Protection to project workers on work site

10.6.4. Traffic Control Devices

Warning Signs:

The advance warning for the construction operations ahead will be provided by the warning sign ‘Men at Work’ about 100 m before the work zone. It will be followed by ‘Over Taking Prohibited’ signboard. These signs will be placed on the left-hand side of the road. ‘Men at Work’ and ‘Overtaking Prohibited’ signboards will be as per IRC 67 2001.

Barricading:

Barricade using the Corrugated Galvanized Iron (CGI) sheets would be on vertical steel post. The horizontal members of barricades would be made of metal. These should be 200 – 300 mm wide and

should be painted in alternate yellow and black stripes of 150 mm width. The stripes should slope at an angle of 45° in the direction of traffic. The main intention of the barricading is to restrict the entering of the traffic into work area and protecting main carriageway traffic from falling in excavated or lower-level area. These barricading will be provided at a regular interval of 3 m. Height of barricade would be 1.5 m.

Flagman:

To avoid collision between construction vehicles and traffic, flagmen with flags will be effectively used at the exit/entry points of working stretch. The flags for signalling will be of 0.60m x 0.60m size, made of good red cloth and fastened to a staff of approximately 1 m length.

10.6.5. Safety of Work Men at Site

- Safety of at site workers during duty hours will be ensured. Appropriate safety measures as per project safety plan will be adopted.
- The job specific Personal Protection Equipment's (PPEs) i.e., helmets, safety jackets, gumboots etc., will be provided to at site workmen and it will be compulsory for them to wear the same.
- Site engineers will have to ensure the use of PPEs by workmen.
- Use of safety jacket will be compulsory for the workmen engaged in roadwork.
- Use of safety helmet will be compulsory for all workmen including the staffs.
- Labour laws in force will be followed.

10.6.6. Maintenance of Traffic Control Devices

For the maintenance of installed traffic control devices, a separate team shall be engaged. They will be provided with two vehicles for transportation of materials and labour. This team will periodically check for disturbed devices and maintain them accordingly.

10.6.7. Permanent Barricade

Permanent barricades provided along the construction areas of road will channelize the vehicles along the existing road. Main intention of this barricade is to make traffic aware about the construction work in progress. This is a psychological barrier preventing vehicles from going astray into the construction area. Permanent barricade will be made of properly anchored Galvanized Iron (GI) sheets. GI wire will be used to fasten the sheets for better stability. These sheets will be painted with alternate yellow and black inclined strips or red and white vertical strips. For night visibility, red reflective sheets will be fixed on barricades.

10.6.8. Pavement Barricade

The finished kerb on the median side of the carriageway will be pavement barricade preventing he vehicles from entering into the area under construction. The portion of kerb above the finished asphalt top will prevent vehicles from crossing the median under construction, and its further entry into

construction area. In eccentric and concentric widening situations, kerb will be the pavement barricade wherever its casting has been completed.

10.6.9. Delineators

Delineators will be of cylindrical shape and will be made of concrete. They will be painted with black and white circumferential strips. Red coloured reflectors or retro-reflective sheet will be fixed to the delineator so as to make it visible to the traffic from either direction during night time. These delineators will be placed at suitable spacing to guide drivers along safe path and control the flow of traffic.

10.6.10. Construction Entry/Exit Points

Construction entry/exit points will be clearly identified and marked. Construction traffic will be allowed to enter/exit the construction area through these openings only. This will be marked with signboards or red coloured flag. The table below gives potential risks due to the road construction work, their impacts and mitigation measures.

Table 10-2: Traffic Management - Potential Risks, Impacts and Mitigation Measures

Potential Risks	Potential Impacts	Proposed Mitigation Measures
Construction methods may cause disruption to traffic	Traffic delays will cause frustration to drivers	• Consider methods of construction at design stage itself to reflect community needs and reduce delay times therefore minimizing the impact on traffic.
Traffic management, inadequate anticipation and communication of issues	Potential community issues causing dissatisfaction and frustration	• Confirm pre-existing conditions. • Consider the need for night assessment. • Identify any short-term corrective actions.
Access for emergency services restricted	Emergency vehicles and personnel unable to attend to an emergency situation	• Liaise with emergency services at an early stage to establish requirements and measures to be adopted in the Vehicle Movement Plan (VMP)
Major traffic incident	Local disrupted traffic upsetting locals	• Regular checking for the implementation of traffic management plan. • Ensure rapid recovery of traffic system, keep locals informed.
Severe delays to traffic perceived by the community as a direct result of the construction activities	Community dissatisfaction, claims for loss in trade, time delays	• Establish good public relations from the outset. • Erect early warning information signs through Variable Message Signs (VMS). • Early engagement of affected property/business owners to explain processes and ascertain needs and potential effects of changed access.

Access to site for deliveries	Traffic disruption or interference	• Development of this plan in conjunction with community • Communication strategy- access points will be high risk locations and will need detailed consideration. • Simplification of traffic staging will simplify access arrangements or minimize impacts. • Signage and pre-delivery notifications for delivery routes to make it clear and simple as per the VMP.
Traffic speed	Works in multiple areas across the project and may result in intermittent speed changes that may frustrate road users.	• Speed of the traffic in construction zone is restricted to 30 km/h. • Adoption of Construction Traffic Management Plan (CTMP) to minimize impact of construction zone on traffic.
Pedestrian access	Potential disruption to progress causing pedestrians to not comply with pedestrian provisions	• From early stages, pedestrian access provisions are adequately addressed, well established and maintained.
Inadequate provisions for break-downs during construction	Traffic delay	• Design temporary break down bays. Consider temporary verges during design of traffic staging.
Dangerous entry and exit to sites and properties	Traffic Incident	• Entries and exits are designed to cater for expected traffic volumes, acceleration & deceleration provision and clear advanced warning signage.
Reduced allowable movements	Traffic delay, confusion to commuters that may lead to an incident.	• Implement effective community engagement strategies that will consider businesses and property owner's requirements.
Damage to local roads due to heavy vehicular movements	Road damage and accidents. Poor community and Panchayat relationship	• Give access to existing/temporary alignments which are suitable during the construction period. • Carry out road dilapidation surveys and immediate repairs to damaged roads.
Impact of construction traffic on haulage roads	Increased traffic on haulage roads and excessive damages to the local roads	• Monitor road safety on haulage roads during construction period

		• Implement safety measures in consultation with all villages of the area.

10.6.11. Accident, Health and Safety

Construction activities will cause hindrance to existing traffic flow. Thus, short-term impact in terms of accident is anticipated during construction phase of the project. So, adequate safety measures need to be considered.

10.6.12. Mitigation Measures

- Reduce speed of the traffic in construction zones.
- Construction of bridges/culverts shall be carried out prior to construction of the new corridor.
- Proper cautionary signs shall be displayed at construction sites.
- Diversion roads will be provided wherever needed.

10.7. Green Belt Development Plan

Certain species are listed in the table above for developing green belt with the objective of pollution control, carbon sequestration and for stabilization of soil. Depending upon the suitability, availability and desirability, other local species should also be considered. The work of green belt development should be taken up by the project proponents with guidance from the Forest Department of the Government of Odisha. Minimum 1 no. of row, (@5-8 m spacing) of trees on either side of the proposed highway shall be planted and approx. 11500 Nos. of avenue tree and median plantation will be planted as per site conditions. It is stated that the indigenous species of local economic and ecological (soil and water conservation) importance need be given priority over commercial and non-native species. The detailed tree plantation scheme is attached as **Annexure 10-1**.

10.7.1. Plantation operations and practices for Green-belt development

The plantation strategy should include operations, such as, Development of seedlings/saplings of the tree and shrub species, Land/site preparation for transplanting/seeding, Transplanting, and Post-transplanting maintenance under the guidance of a field -oriented botanist or agriculture professional or field staff of the Forest Department.

Table 10-3: Suitable plant species for green belt along the project as per IRC: SP: 21-2009

S. No.	Scientific Name	Common Name
Trees		
1.	*Acacia nilotica*	Babul
2.	*Aegle marmelos*	Bael
3.	*Alstonia scholaris*	Scholar Tree
4.	*Anogeissus latifolia*	Axlewood
5.	*Anthocephalus cadamba*	Kadam
6.	*Azadirachta indica*	Neem
7.	*Bauhinia vahlii*	Maloo Creeper
8.	*Bombax ceiba*	Cotton-Tree
9.	*Bombax malabaricum*	Malabar Silk-Cotton
10.	*Boswellia serrata*	Salai
11.	*Bridelia retusa*	Spinous Kino Tree
12.	*Cassia fistula*	Amaltas

13.	*Cleistanthus collinus*	Toxic Gooseberry
14.	*Cocos nucifera*	Coconut
15.	*Combretum roxburghii*	White Combretum
16.	*Dalbergia latifolia*	Rosewood
17.	*Dalbergia paniculata*	Passi
18.	*Dalbergia sissoo*	Shisham
19.	*Ficus benghalensis*	Banyan
20.	*Ficus racemosa*	Cluster Fig
21.	*Ficus religiosa*	Pipal
22.	*Lagerstroemia speciosa*	Crepe Myrtle
23.	*Lannea coromandelica*	Indian Ash Tree
24.	*Madhuca longifolia*	Mahua
25.	*Mallotus nudiflorus*	False White Teak
26.	*Mangifera indica*	Mango
27.	*Mimusops elengi*	Maulsari
28.	*Mitragyna parviflora*	Kaim
29.	*Moringa oleifera*	Drumstick
30.	*Phyllanthus emblica*	Amla
31.	*Polyathia longifolia*	False Ashoka
32.	*Pongamia pinnata*	Pongam
33.	*Pterocarpus marsupium*	Indian Kino
34.	*Schleichera oleosa*	Kusum
35.	*Sesbania grandiflora*	Agati
36.	*Shorea robusta*	Sal
37.	*Stereospermum suaveolens*	Patala
38.	*Syzygium cuminii*	Jamun
39.	*Tamarindus indica*	Tamarind
40.	*Terminalia arjuna*	Arjun
41.	*Terminalia bellerica*	Bhenda
42.	*Terminalia tomentosa*	Indian Laurel
43.	*Zizyphus mauritiana*	Ber
Shrubs and Herbs		
44.	*Ageratum conyzoides*	Goat Weed
45.	*Argemone mexicana*	Mexican Prickly Poppy
46.	*Boerhavia diffusa*	Red Spiderling
47.	*Calotropis gigantea*	Crown Flower
48.	*Capparis sepiaria*	Wild Caper Bush
49.	*Carissa spinarum*	Wild Karanda
50.	*Celastrus paniculatus*	Black Oil Plant
51.	*Chenopodium album*	Baconweed
52.	*Cissus quadrangularis*	Cactus Vine
53.	*Datura stramonium*	Thorn Apple

54.	*Desmodium gangeticums*	Salparni
55.	*Euphorbia hirta*	Asthma-Plant
56.	*Glycosmis pentaphylla*	Orangeberry
57.	*Hyptis suaveolens*	American Mint
58.	*Jatropha gossypiifolia*	Bellyache Bush
59.	*Justicia adhatoda*	Malabar Nut
60.	*Lantana camara*	Lantana
61.	*Mimosa pudica*	Touch Me Not
62.	*Mucuna pruriens*	Velvet Bean
63.	*Murraya koenigii*	Curry Leaf
64.	*Nyctanthes arbor-tristis*	Night-Blooming Jasmine
65.	*Phoenix sylvestris*	Wild Date Palm
66.	*Phyllanthus niruri*	Bhui Amla
67.	*Ricinus communis*	Castor Bean
68.	*Sida cordifolia*	Heart-Leaf Sida
69.	*Solanum indicum*	Indian Nightshade
70.	*Tephrosia purpurea*	Common Tephrosia
71.	*Tribulus terrestris*	Gokharu
72.	*Tridax procumbens*	Tridax Daisy
73.	*Triumfetta rhomboidea*	Chinese Bur
74.	*Vernonia cinerea*	Little Ironweed
75.	*Vitex negundo*	Nirgundi
76.	*Ziziphus oenoplia*	Jackal Jujube

(a) Development of planting material

For tree and shrub species, the seedlings and saplings could be raised in nursery in poly bags of standard size or root trainer trays. The healthy certified seed material should be used for this purpose. These materials can also be arranged on demand from the nurseries owned by Forest Department or private organizations. Healthy and disease-free planting material is pre-requisite for success of the plantation**.**

(b) Site preparation

This activity need be undertaken well in advance before monsoon for rainy season species and during October -November for winter species. Thorny bushes and weeds need to be removed completely from the site. It should be followed by soil and water conservation work using physical measures, such as, surface rain water harvesting, trenches, stone bunds; engineering structures, such as, small check dams; and biological devices, such as, planting of fast spreading grass and leguminous species and bushy materials**.**

For planting seedling/sapling, pits of appropriate size (1×1×1m for tree species, 0.5×0.5×0.5 m for shrub species) need be prepared well in advance. The top soil of 30 cm depth need be kept aside for mixing with FYM to promote microbial growth for nutrient recycling.

After digging, the pit must be kept unfilled and uncovered so that sterilization through sun rays could occur. It should follow by filling stone -free soil (3 part) and well-decomposed weed-free compost or dump manure (1 part). For improving soil fertility, neem/castor/ground cake can be used. The basal

dressing of urea, ammonium phosphate, potassium sulphate or DAP could be applied in morning hours at appropriate interval.

(c) Seeding and Transplanting

This operation must be done after rain showers. In case of grass and leguminous species, direct seeding could be practiced to establish a surface cover to check soil loss and grass growth for herbivores and nesting sites for birds.

The plantation should be done in rows following 5×5 spacing both row to row and plant to plant using healthy seedling/sapling. While planting, the poly bag should be moistened first. The poly bag should not be removed completely, only the bottom part of it should be removed by cutting it with a sharp blade without disturbing planting material. The planted material should be watered slowly to avoid soil disturbances.

(d) Post-planting maintenance

The transplanted material needs attentive care for complete one year at least, followed by care during stressful seasons particularly. The maintenance operations include watering, removal of weeds, prevention and control of diseases and pests using bio-pesticides preferably, and trimming, and fertilization. No specific amount could be mentioned for watering, etc., as it is selective to species, hence, based on field conditions, the maintenance activities should be done. The fertilization could be carried out at an interval of 30 days avoiding occurrence of rains. The gaps caused on account of mortality, should be filled by replanting the same species.

Above all, the development of green space must get value similar to Highway development.

10.8. Environmental Management Plan Budget

The cost of environmental protection measures has been estimated at Rs. 16.48 Cr. as per the following details. Total cost estimate for the EMP for this alignment has been presented in the following table.

Table 10-4: Environmental Management Plan Budget

Component	Stage	Items	Estimated Rate	Total Cost (Rs)
Environmental Training	Construction	Training of project staff	Lump Sum	20,00,000
Environmental Monitoring	Construction and Operation Period	Monitoring of air, water, soil, noise and Soil (Refer Table 6.2)	As per environmental monitoring plan	32,28,750
Air	Construction	Dust Suppression at the project site @ Rs 1800/trip x 2 trips/day x 365 days x 2.5 years	70.995 km (2 packages)	66,00,000
Solid waste	Construction	Demolition wastes and bituminous scrap disposal as per C& D rules 2016	Lump Sum	20,00,000
Soil	Construction	Provision for providing Oil Interceptors	2 Nos	4,50,000
Surface water	Construction	Silt Fencing for water bodies (4000m)	1500 Rs/mt	60,00,000
Noise Barrier	Construction	Provision of Noise Barrier (5000m)	7,500 Rs/mt	3,75,00,000

Flora	Construction	Plantation of trees along the proposed highway i.e. 22000 trees to be planted	Rs 2000/tree including tree guard	4,40,00,000
		Maintenance period of 2.5 years including causality replacement of tree	Lump Sum	30,00,000
		Ornamental Plantation on Inter Sections.	Lump Sum	40,00,000
		Shrub Plantation and grass carpeting in median	Lump Sum	30,00,000
Wildlife	Construction	Signage for wildlife	Lump Sum	3,00,000
	Operation	Proposed wildlife management plan (As per approval/Approx.)	Lump Sum	3,00,00,000
Safety	Construction	Demarcation of borrow areas clearly, using fencing if needed.	Lump Sum	30,00,000
		Provision of Hoarding /Posters at construction camps and provision of health checks at construction sites	Lump Sum	10,00,000
		Provision for helmet, gumboots, jackets, goggles etc. to labours	Lump Sum	15,00,000
Construction Camps	Construction	Sanitary Facilities (Bio-Toilet, Septic Tank, Soak pit, etc.	Lump Sum	10,00,000
Rain Water Harvesting	Construction and operation	Construction of RWH Structures as per site Geological condition	Approx. 70	40,00,000
		Maintenance of Rainwater Harvesting Structures during defect liability period	Lump Sum	4,00,000
Renewable energy	Construction	Installation of Solar Panel, and LED bulbs at project site (Camp area)	Lump Sum	40,00,000
Total				**15,69,78,750**
Contingency @ 5%				**78,48,938**
Total				**16,48,27,688**

11. CONCLUSION AND RECOMMENDATIONS

11.1 Background

Highway projects are undertaken to improve the socio-economic life of the people through the areas which they pass. At the same time, they may also create impacts on the surrounding environment. People and property in the direct path of the alignment are largely affected due to this. The environmental impact of road projects includes issues to sensitive ecosystems, soil erosion, changes to drainage pattern and thereby groundwater, interference with animal and plant life, loss of productive agricultural lands, resettlement of people, disruption of local economic activities, demographic changes, accelerated urbanization and increase in air pollution. To minimize these adverse effects that may be created by highway development projects, the techniques of Environmental Impact Assessment (EIA) become necessary. EIA is a technique which is necessary for identification, quantification and assessment of potential environmental impacts. The National Highways Authority of India (NHAI) is responsible for the development and improvement of the project roads for the connectivity of National Highways under the new NH (O) scheme.

NHAI has entrusted the work to M/s. Geo Design & Research Pvt. Ltd to carry out the Feasibility study and the Detailed Project Report for 6-laning NH configuration under NH(O) Scheme from Rameswar in Khordha district to Gobindpur in Dhenkanal district in Odisha state to augment capacity of the highway. M/s. Geo Design & Research Pvt. Ltd has appointed M/s. Chaitanya Projects Consultancy Ltd. for carrying out the EIA study

The new highway starts from its junction with NH-16 near Rameswar in Khordha district and terminating at its junction with NH-55 at Gobindpur in Dhenkanal district in the State of Odisha. The length of the proposed alignment is approx. 70.995 km. As per the EIA Notification issued on 14th September, 2006 by the MoEF&CC, GoI and amended Notification on 22nd August, 2013 on Highway projects, the proposed new highway project between Rameswar to Gobindpur falls under Category - A Project (Schedule -7f of Notification). The above proposal was considered by the Expert Appraisal Committee (EAC) for Infra-I Sector, in its 370th Expert Appraisal Committee during 23rd-24th July, 2024, recommended the project for grant of Terms of Reference (ToR). The EIA & EMP report is prepared in accordance to the Terms of Reference (ToR) issued by MoEFCC, New Delhi, vide letter no. F. No. 10/18/2024-IA.III, and Proposal No. IA/OR/INFRA1/482782/2024 dated 09th September 2024.

11.2 Need for the Project and Project features

The proposed project is the construction of new Six Lane NH configuration under NHO/Bharatmala Scheme from Rameswar in Khordha District to Gobindpur in Dhenkanal district in Odisha state to augment capacity of the highway, with enhanced safety features & efficient freight movement and bypass the traffic from the major cities of Cuttack, Bhubaneshwar and Khordha. The proposed alignment of the project covers three districts viz.Khordha, Cuttack and Dhenkanal in the state of Odisha.

The project will provide better geometry and quicker travel times between the existing NH-16 (Chennai-Kolkata Highway) and remove traffic congestion in the three major cities of the state. The proposed alignment is not passing through any Wildlife Sanctuaries.

The proposed highway is of a 6 lane Configuration. This is a complete greenfield alignment, the entire alignment has a 60m RoW and 45m of proposed ROW in forest area. The alignment runs through plain terrain with Agricultural land at most locations. The project road is divided into two construction packages. The adopted design speed is 100 kmph throughout the stretch. The project is designed for a traffic of 113614 vehicles upto 2059-60.

A total of 312 structures are proposed to be provided in the entire length of the proposed project which includes major bridges, minor bridges, ROBs, VUP, LVUPs, SVUPs, EUPs, Interchanges and Culverts for smooth passage of people, vehicles, hydrogeology and animals. The summary of proposed structure details is given below.

Table 11-1: Summary of proposed structures

Sl. No.	Name of the Structure	Package I	Package II	Total
1	Box Culvert	134	81	215
2	Minor Bridge	10	11	21
3	Major Bridge	Nil	3	3
4	ROB	1	-	1
5	Fly over	2	3	5
6	Viaduct	1	-	1
7	VUP	8	3	11
8	LVUP	8	6	14
9	SVUP	7	3	10
10	EUP	7	3	10
	Total	**178**	**113**	**291**

11.2.1 Project Cost

The base Civil cost works out to be **INR. 2899 Cr.** and **INR. 4541 Cr**. including taxes, Centages, LA. The total EPC Cost includes GST, Contingencies, Supervision Charge and Agency Charge as per MoRT&H circular. Details of Project cost are mentioned in Chapter-2 of this report.

11.2.2 Project Facilities

Various facilities are proposed to be constructed for the project include Truck Lay Byes at various locations to serve as vehicular and passenger users rest areas, refreshment areas etc. There will also be Toll Plazas and Wayside Amenities provided alongside the proposed highway.

11.2.3 Project Benefits

As the proposed project is a greenfield project in mostly rural area, it's aimed towards the overall development of the physical infrastructure of the region with creation of new road surface with superior quality, advanced safety features, high speed connectivity, reduction in travel times, access controlled and other facilities. Highway will further lead to the socio-economic development of the region with potential for increase in tourism, industry, port connectivity and agriculture activity. The highway will also lead to enhanced local employment generation during the project period and during

operation. Improved highway geometrics, avenue plantations along the highway will further improve the local environment and add to enhancing the local environment and green cover.

11.3 Baseline Environment

Construction and operation of a highway may have impacts both adverse and beneficial on the physical environment of an area it passes through viz. topography, micro climate, drainage pattern, floral and faunal habitats. The estimation of the Baseline Environment status of the proposed project is important to ascertain the present conditions of the environmental parameters such as air quality, water quality, noise, soil, as well as the biological environment (flora and faunal details including forest details) and socio-economic environment. A total of approx. 28 ha of revenue forest will be used for the project. The alignment is not crossing any wildlife sanctuaries.

Primary data has been collected within 500 meters on either side of the proposed alignment. Primary baseline environment monitoring was carried out for the period of one season from October, 2024 to December, 2024.

Secondary data such as meteorological data and census data were collected from the various departments of the Central and State government as well as published literature. Primary data was obtained through field sampling of environmental parameters such as air, water, noise, soil, etc. Field surveys were also conducted to get primary information on the major environmental features such as settlements, water bodies, forest areas, trees within the RoW, etc.

Cropping pattern of all the three districts, Khordha, Cuttack and Dhenkanal districts shows that rice is cultivated in majority of the area, followed by potato, rapeseed and mustard, sesame and maize.

11.4 Anticipated Impacts and Mitigation Measures Environment

The impacts of the proposed project and their probable mitigation measures, wherever required have been studied for ease in construction of the road. The impacts have been categorised regarding four main environmental parameters, viz. air, water, soil and noise. Impacts during construction as well as operation phase and their corresponding mitigation measures have been discussed in this section.

a. Impacts on Air Quality

Air Quality of the project area may be impacted due to various construction activities such as removal of old structures, use of heavy machinery, mixing of road materials and transport of raw materials from quarry to site, earth filling on alignment, thereby increasing the amount of particulate matter (PM_{10} & $PM_{2.5}$). The movement of heavy machinery, oil tankers will most probably generate exhaust gases. High concentrations of harmful gases like SO_2, NO_2 as well as HCs likely to be generated from hot mix plant operations.

A mathematical air pollution dispersion modelling was performed using AERMOD software and CALINE-4, to assess the spread of the various pollutants during the construction phase as well as during the operation phase to better mitigate the effects of air pollution.

Mitigation measures include water sprinkling on haul roads to manage dust, regular pollution checks, plantation of broad-leaved trees which may absorb high concentration of pollutants and others.

b. Impacts on Water Resources and Water Quality

The water resources (surface and ground) may be affected due to various factors such as increased runoff due to deforestation, blocking of natural flow of water bodies, contamination of groundwater by seepage of harmful chemicals, etc. Mitigation measures include proper design of the proposed highway, proper management of solid and liquid wastes, provision of slit fencing, provision of adequate drainage systems, etc.

c. Impacts on Soil Quality

The soil quality of the proposed project area may be degraded following excavation of earth for construction of the road, removal of large numbers of trees, soil compaction due to movement of large vehicles, soil contamination due to improper waste disposal, etc. Mitigation measures include proper handling of the top soil after excavation, limited number of tree felling, proper management of wastes, etc.

d. Impacts on Noise Quality

The ambient noise levels will increase due to the various construction activities as well as movement of vehicles both during the construction phase as well as the operation phase. Mitigation measures such as provision of adequate noise barriers, proper maintenance of vehicles, etc. is absolutely necessary for effective control of noise pollution due to the construction of the road.

e. Impacts on Biological Environment

The flora and fauna as well as the plantations or forest area falling in the project area will be affected due to the felling of trees to make way for the construction of the road. This will cause tree cover to come down in the short term. Some impact on local flora and fauna would be there during the construction period. These impacts can be effectively mitigated through avoidance of the animals wandering into the construction site, felling of minimum number of trees, provision of adequate number of culverts/cattle/animal underpasses so as to minimise the habitat fragmentation, etc. In areas near to Chandaka WLS proper mitigation measures with provision of EUPs, noise and sound mitigation measures would be provided. Chandaka DFO has already provided NoC in this regard.

11.5 Impacts on Socio-Economic Environment

The proposed project will impact around 3426 families and 15621 persons for proposed alignment. Due to major part of the proposed alignment passing through agricultural fields, some people will lose their livelihood in the short term. But the proposed project will also have many beneficial effects in the socio-economic characteristics of the region such as increase in income of small businesses, establishment of hotels, restaurants, hospitals, markets and others in the interchange locations, etc.

Traffic may get congested on the pre-existing roads that the proposed highway is supposed to cut through only during construction phase.

All these beneficial impacts are very much welcome for the betterment of the local community. As for the other non-beneficial impacts, some mitigation measures need to be put in such as proper compensation for the persons affected, provision of adequate service roads to maintain connectivity, provision of safety measures and traffic management systems, etc.

Consultations with the individual villagers and village headmen provided an insight into the view of the affected villagers with respect to the proposed project. A total of 547.51 ha. of land will have to be acquired for the proposed alignment. Preliminary survey indicates that a total of 71 number of structures will be impacted due to the construction of the proposed alignment. Most of these structures are semi-pucca structures and are mainly owned by individual owners, majority of whom have joint families.

An LA budget has been worked out which comes out to be around Rs.778 Cr. for the proposed alignment. This budget includes the compensatory cost for land to be acquired, cost for replacement of structures as well as cost for assistance to PAFs. The detailed break-up of the LA budget has been presented in Chapter 7 of the EIA report. A comprehensive action plan to mitigate the impacts on physical and environmental aspects is presented below.

11.6 Environmental Monitoring Programme

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of a development project for review of important indicators and to take immediate preventive actions in case of deviation from stipulated norms. Environmental monitoring as an integral part towards better environmental management comprises of monitoring of air, noise, water (surface and ground), soil, ecology, health and other parameters during construction and operation phase.

For Air important monitoring parameters like $PM_{10,}$ $PM_{2.5,}$ SO_X, NO_X, NH_3, CO, etc. are to be monitored during construction and operation phase. For noise the sound decibel in dB is to be monitored for day and night time values. For soil various parameters like pH, water content, NPK values, various organic and inorganic chemicals are to be monitored. For water (surface and ground water) important parameters like pH, BOD, COD, TDS, Pb, Oil & Grease, Total Hardness, Sulphate, Chloride, Fe, Fl, etc. are to be monitored as per the sample.

Other aspects like local management of Ecology & Biodiversity, comprising of knowledge of indigenous plant species, local flora and fauna is to be monitored. Management of compensatory avenue and median plantation is to be followed. Proper adherence to local Disaster management, Health & Safety laws, protocols and procedures have also to be followed at project site.

Formation of an Environment Management Cell with role and responsibilities will be decided before the commencement of work. The environment management cell / unit will ensure implementation and monitoring of environment safeguard during construction. All the monitoring parameters will be carried out by NABL certified private or government agency/laboratory. Prior finalising the sensitive locations of the project site the construction camps, Hot mix plants, crusher plant, batching plants, construction site, haul roads, borrow areas, sensitive ecology and environmental locations like forest areas, river/streams, wells, habitations, etc. where monitoring has to take place. The total Environmental monitoring budget is estimated at RS.32.29 lakhs

Table 11-2: Summarized Major Environmental Impacts and Mitigation Measures

S. No.	Parameters	Potential Major Impacts			Suggested Mitigation Measures
		Pre-construction	Construction	Operation	
1.	Meteorology	No impact	Little to no impact on the parameters like temperature, humidity, etc.	Normalized temperature, humidity	Afforestation along the avenue within proposed RoW.
2.	Air Environment	No impact	Increase in particulate matter		Dust suppression through water sprinkling, provision of anti-pollution masks to workers
			High concentrations of harmful gases like SO_2, NOx, CO from machinery		Hot mix plant to be set up at least 1000 m away from settlement, in the downwind location, regular check-up of machinery
				PM generation minimal	Avenue plantation containing pollutant absorbing broad leaved plants
				Harmful gases from vehicular exhaust like CO, HCs, etc.	Regular checks of PUC certificates at important junctions
3.	Land Environment	Soil erosion due to deforestation	Soil erosion prevalent	Erosion minimum	Felling of trees limited to CoI only, Provision of Avenue plantation, embankments
			Soil compaction	Compaction minimum to non-existent	Limited movement of vehicles, keeping compaction in check in areas other than ROW
			Loss of top soil reducing fertility		Top soil has to be preserved carefully and used for rehabilitation

			Improper waste disposal causing soil contamination	Soil Contamination minimum to non-existent	Storage of harmful chemicals, oils, toxic materials in separate places with RCC surface; septic tanks with soak pit facility;
4.	Water Environment	No impact	Increased runoff due to cut and fill operations		Proper drainage structures, slit fencing
			Natural flow of water bodies blocked due to construction		Revision of alignment or compensatory digging for any water body being affected
			Water table depletion due to water requirements		Use of water obtained from the surface water bodies only.
			Water quality degradation due to seepage of wastes, increased runoff to the surface water bodies, etc.		Storage of harmful wastes in lined pits, management of runoff using cross-drainage structures
5.	Noise Environment	No impact	Noise levels of the areas under construction will increase considerably		Construction activities to be stopped between 9 p.m. and 6 a.m.
			Increased noise from construction activities will affect settlements and also forest areas and wildlife		Construction camps to be situated 1000m from habitat or forest area; provision of temporary sound barriers
				Condition and type of vehicles plying on the road, pavement	Increasing the quality of pavement; use of shrubs in median; use of sound absorbing trees in avenue plantation.

				condition, etc. will affect the noise levels	
6.	Biological Environment (forests, flora and fauna)	Indiscriminate deforestation may cause loss of forest areas	Forest diversion as per State and MoEFCC guidelines only		Minimum twice the number of trees cut to be planted as a part of CA.
		Habitat fragmentation	No Wildlife is encountered		Strips of vegetation along the proposed highway to attract animal movement
			Degradation of Habitat Quality		Precautions to avoid leakage of chemicals during construction; Labour camps located far from habitat area
			Noise from construction activities inducing physiological and behavioral changes in the wildlife	Noise from vehicular movement affecting wildlife	Provision of noise barriers, dense vegetation along the highway, marking of silence zone, etc.
				Avoidance of road by animals	Proposed structures such as underpasses, Bridges, Culverts, provision of fences and boundary wall along the sides of highway; plantation and artificial lights to be made less attractive for birds
				Glaring headlights impacting wildlife	Provision of hedges along the sides of highway to lower intensity of light
				Reduced access to waterholes, etc.	Construction of artificial waterholes/improvement of existing waterholes
		Discontinuity of canopy			Width of linear clearing in such areas to be kept small

			Increased Human-Wildlife conflict	Human-Wildlife conflict	Provision of caution signs to alert drivers about presence of wildlife; restriction of speed limit; restriction of parking as applicable
7.	Socio-Economic Environment		Temporary 'skew' in demographic profile due to influx of workers		Temporary impact, will normalize after construction completes
			Traffic congestion due to construction activities		Proper traffic management to be followed as per IRC codal provisions
			Human Health & Safety		All safety measures such as provision of PPE to the workers, proper storage of electric machinery and instruments so as to minimize the risk of electric shock; availability of IS certified drinking water, water draining from pits to control mosquito breeding, availability of first aid kits, etc.

11.7 Environment Management Plan

Environmental Management Plan (EMP) is an important part of any developmental project to ensure that environmental impacts are kept well below the acceptable limits, as well as to improve environmental conditions of the project area at pre-construction, construction as well as operation phases, through comprehensive mitigation measures.

NHAI, with assistance from Authority Engineer, Contractor and Monitoring Consultant, is responsible for carrying out mitigation measures as and when required. The Project Proponent (PP) is responsible for creation of an Environment Management Cell (EMC) which will supervise the implementation of mitigation measures as laid down in EMP.

All the important National and State Acts and Statutory clearances required which aim at prevention and control of industrial and urban pollution will be followed and implemented at the project site. The detailed environmental management action plan during construction and operation phase is presented in Chapter-10. Various aspects covered include Land, Water, Flora and Fauna, Environmental quality, Utilities, Cultural heritage, Environment safety, Monitoring of Air, Noise, Water and Soil, Health and safety issues. Disaster and risk mitigation, Traffic management during construction, plantation and green belt development, etc. are covered in detail. The cost of environmental protection measures has been estimated at Rs. 16.48 Cr tentatively subject to final approvals.

New Materials and Technologies in Road Construction

The proposed project will use latest construction materials and methodologies to reduce the material usage and reduce the carbon foot print during construction period. Various new guidelines and notifications have been issued by the MoRTH to use new materials, use recycled materials in road construction. The same are detailed in **Table 5-4.** IRC guidelines are now available for use of Cement Treated Base (CTB), Cement Treated Sub-base (CTSB), Recycling, Fly-ash, Waste Plastic, Geo-Synthetics, modified Bitumen (CRMB, Polymer modified, Natural Rubber), Soil stabilization, etc. in highway construction. It is necessary to promote these materials/technologies in construction and maintenance of National Highways for harnessing potential time and cost savings and reduce the environment impacts.

11.8 Recommendations

This section provides a comparative analysis of the 3 alignment alternatives considered for the project and the final recommended alignment option. A comparative analysis of alternatives to determine the best alignment with least environmental and social impacts was undertaken. The details of the three alternative alignments that have been considered and analysed are presented below.

i. **Option 1**: Option 1 is basically considered as a Green field alignment from existing NH-16 to NH-55 from Rameswar to Gobindpur with a total length of 73.24 km.
ii. **Option 2**: Option 2 is basically considered as a new Green field alignment from Rameswar to Gobindpur, from existing NH-16 to NH-55. With a total length of 70.995 km. (**Proposed alignment)**.

iii. **Option 3:** This option starts from Palatotapada after Khordha town at NH-16 to Near Kuspangi at NH-55 and passes through Greenfield area the alignment is much closer and passes through to the Chandaka WLS in the middle sections.

Keeping in view of the selected alignment having less/minor effect on environmental and social components, alignment **Option-2** has been fixed and it appears more feasible as compared to the other options. It also provides better alternative for connection to the existing NH-16 and NH-55 coming to Tamilnadu and going upto Kolkata and bypassing the major towns of Khordha, Bhubaneshwar and Cuttack. It will lead to less impact on Environment & Social components than other two. The ringroad will further reduce the traffic congestion in the existing cities and reduce urban pollution loads in these cities.

Impact Scoring Matrix

An impact scoring matrix encompasses all the variables that may affect the local area through which the alignment passes. Various aspects (5 no.) are analysed in this matrix i.e.: Natural environment, Biological environment, Physical environment, Social environment and engineering considerations. Various micro attributes are further analysed in each of the major 5 aspects. Scores are then allocated to each of the attributes and all the analysed three alignment options. The option with the least score is the one that has the least impact on the local environment.

Alternative alignments and their impact score

Scoring Criteria	Total Weight	Option-1	Option-2	Option-3
		Score	Score	Score
Natural Environment	80	35	32	41
Biological Environment	80	29	21	33
Physical Environment	50	16	16	17
Social Environment	60	25	23	25
Engineering	130	78	74	83
Total	**400**	**183**	**166**	**199**

The overall scoring matrix shows that Option-2 has the least score with 166 points followed by Option-1 with 183, and last is Option-3 with 199. Increasing number showing the increasing environmental, social impact due to the said option, hence option-2 has the lowest impact overall and is considered for construction.

12. DISCLOSURE OF CONSULTANT ENGAGED

12.1. Introduction to Firm

The consultant **Chaitanya Projects Consultancy Pvt. Ltd.** (Now **M/s. Chaitanya Projects Consultancy Ltd.)** is a Quality Council of India (QCI) accredited consultant for carrying out EIA/ EMP studies from the Highways sector (category A). Geo designs & research pvt. ltd (GDRPL) is the design consultant for the project. GDRPL head office is at Vadodara Gujarat and are geographically well spread seven branches, across Gujarat & Rajasthan with a state-of-art facility for material testing.

This study has been carried out by duly accredited EIA co-coordinator and Functional Area Experts by QCI. This study entails the Construction of Rameswar to Gobindpur (Capital Region Ring Road-1) for Six Laning with Paved shoulder NH Configuration - in the State of Odisha (Lot 3/Odisha & Jharkhand-Package - 3) by NHAI for total length: 70.995 km. The details of EIA Coordinator, FAEs and other team members involved are as given in the beginning of the report.

Chaitanya Projects Consultancy Pvt. Ltd. (CPCPL), established in 2004, is an ISO 9001:2015 certified company that provides various Civil Engineering Consultancy Services Pan-India. The company is proud to have completed more than 100 projects in various areas in the civil engineering sector spanning all over India over a span of nearly two decades. Headquartered in Noida, CPCPL has regional offices at Kolkata, Bhubaneswar, Patna and Hyderabad to name a few. Besides, the company maintains and operates site offices at the various project locations.

Chaitanya Projects Consultancy Pvt. Ltd., Noida, Uttar Pradesh, has been accredited by QCI-NABET in them vide Certificate No.-**NABET/EIA/2023/SA 0205** dated: November 20, 2023 and valid up to January 29, 2025 for carrying out EIA and EMP studies in the Highway sectors.

12.2. Brief About the Laboratory

Chaitanya Projects Consultancy Pvt. Ltd. had entrusted QCI-NABL accredited laboratories, Analytical and Research Lab Pvt. Ltd. (AGSS), Delhi for baseline monitoring of proposed alignment.

AGSS is a QCI-NABL accredited laboratory for carrying out measurement of various environmental parameters such as Ambient Air Quality, Noise, Water Quality of Surface and Ground water resources, Micro Metrological data collection and Soil testing.

AGSS is well equipped with sophisticated & versatile analytical instruments & having updated technology for various analytical applications in the field of environment. AGSS provides a wide range of services including-

- Monitoring and Analysis of Environmental Samples & Environmental Compliances Reports.
- Sample Collection of Water Soil/ Sludge and Solid Waste.
- Field monitoring for ambient air, Indoor Air, stack, noise etc.
- Meteorological Monitoring.
- Water, Waste water, Ground Water, Raw Water, Drinking Water, Mineral Water, Construction Water, Boiler Water & Domestic Effluent etc. testing as per CPCB Guidelines, EPA Act.
- Ambient & Work Zone Noise Monitoring.
- Facilities for bioassay of industrial effluents. Micro Biological analysis of water.
- Characterization of soil and its Fertility.
- Solid Waste Characterization, Identification & analysis.

The copies of the QCI-NABL, AGSS have been attached in **Annexure 12-1.**