Initial Environmental Examination

October 2022

India: Rajasthan State Highway Investment Program – Tranche 3
Volume 1 of 3, Main Document

Prepared by PPP Division, Public Works Department, and Government of Rajasthan for the Asian Development Bank.

CURRENCY EQUIVALENTS
(as of 21 October 2022)

Currency unit	–	Indian Rupee (₹)
INR1.00	=	$0.012
$1.00	=	₹82.83

ABBREVIATIONS

AE	–	Authority Engineer
ADB	–	Asian Development Bank
ASI	–	Archaeological Survey of India
BIS	–	Bureau of Indian Standard
BOQ	–	Bill of Quantities
CBD	–	Convention on Biological Diversity
CCF	–	Chief Conservator Forest
CGM	–	Chief General Manager
CGWA	–	Central Ground Water Authority
CGWB	–	Central Ground Water Board
CPCB		Central Pollution Control Board
CTE	–	Consent to Establish
CTO	–	Consent to Operate
CFO	–	Certificate for Operation
COP 26	-	26TH UN Climate Change Conference of Parties
CSC	–	Construction Supervision Consultant
dBA	–	Decibel
DEIAA	–	District Environment Impact Assessment Authority
DFO	–	Divisional Forest Officer
DGM	–	Deputy General Manager
DPR	–	Detailed Project Report
EA	–	Executing Agency
EAC	–	Expert Appraisal Committee
EARF	–	Environmental Assessment and Review Framework
EFP	–	Environment Focal Person
EIA	–	Environmental Impact Assessment
EMP	–	Environmental management plan
EMOP	–	Environmental monitoring plan
ERDAS	–	Earth Resources Data Analysis System
FGD	–	Focused Group Discussion
FSO	–	Focal Safeguard Officer
FHWA	–	The Federal Highway Administration
GHG	–	Green House Gas
GIS	–	Geographic Information System
GM	–	General Manager
GOR	–	Government of Rajasthan
GOI	–	Government of India
GOR	–	Government of Rajasthan
GRC	–	Grievance Redress Committee
GRM	–	Grievance Redress Mechanism
GSDP	–	Goss State Domestic Product
IS	–	Indian Standard
IEE	–	Initial Environmental Examination
IMD	–	Indian Meteorological Department
IRC	–	Indian Road Congress
IUCN	–	International Union for Conservation of Nature
RPCB	–	Rajasthan Pollution Control Board
MDR	–	Major District Road

Leq	–	Equivalent Continuous Noise Level
MFF	–	Multi-tranche Financing Facility
MoEF&CC	–	Ministry of Environment, Forests and Climate Change
MORTH	–	Ministry of Roads Transport and Highway
NAAQS	–	National Ambient Air Quality Standard
NSDP	–	Net State Domestic Product
NH	–	National Highway
ODR	–	Ordinary District Road
PCR	–	Physical Cultural Resources
PCU	–	Passenger Car Unit
PF	–	Protected Forest
PM	–	Particulate Matter
PD	–	Project Director
PIU	–	Project Implementation Unit
PPP	–	Public-Private Partnership
PWD	-	Public Works Department
REA	–	Rapid Environmental Assessment
RF	–	Reserved Forest
RCD	–	Road Construction Department
ROB	–	Road Over Bridge
ROW	–	Right-of-Way
RR	–	Rural Roads
SE	–	Superintendent Engineer
SEIAA	–	State Environment Impact Assessment Authority
SH	–	State Highway
SOE	–	Safeguard Officer – Environment
SPS	–	ADB Safeguard Policy Statement, 2009
TEEMP	–	Transport Emissions Evaluation Model for Projects
TNM	–	Traffic Noise Model
UNESCO	–	United Nations Educational, Scientific and Cultural Organization
UNFCC	–	United Nations Framework Convention on Climate Change
USEPA		Unite States Environment Protection Agency
WLS	–	Wildlife Sanctuary
WPA	–	Wildlife Protection Act

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Executive Summary

1. **The Project**: Rajasthan State Highway Investment Program Tranche-3 (RSHIP T-3) aims to upgrade four state highways (SH-10A, SH-21, SH-36 and SH-44). The total length of the project aggregates to be 295.2 kilometres and proposed to be executed under 4 civil construction packages and located in 7 districts namely: Jodhpur, Nagaur, Churu, Hanumangarh, Alwar, Bharatpur and Banswara respectively. Public Works Department (PWD), Government of Rajasthan is the implementing agency. Key improvement components involve widening from single/intermediate/two-lane lane to two-lane with the granular shoulder of 2.5 m on either side. Main upgradation components involve improvement in pavement conditions and geometrics, reconstruction and widening of cross-drainage (CD) structures, provision of roadside drains, raising of embankment in water logged sections, junction/intersection improvement, safety provisions for road users, and provision of road facilities like bus bays/bus shelters, and toll plaza/s. Environmental enhancement measures like compensatory plantation and rain water harvesting are also included.

2. **Environmental Sensitivity and Project Categorisation**: None of the sub-projects are located inside or in close proximity to any legally protected and/or eco-sensitive areas. Presence of Nilgai (Blue bull) is reported in most of the projects. This species is under Schedule-III of wildlife act and not assessed as per IUCN. Due to its large population causing heavy crop damage, MOEF& CC has issued an advisory to include it in the Vermin category of Schedule V. None of the project roads involve forest diversion and, hence, no sub-project attracts forest clearance. Sub-project SH-44 falls in Taj trapezium zone (TTZ) as declared by Supreme Court of India.[1] Road projects need to obtain permission for cutting of trees from Tahsildar of the region as per Rajasthan Tenancy Act, 1955. Most of the potential environmental impacts such as use of construction material, its transportation, storage and handling, increase in air pollutants, noise and vibration levels, management of construction and demolition waste, siltation of waterways from silt-laden surface runoff, traffic obstruction near active construction sites, etc. are reversible, co-terminus and concomitant to construction activities/period, consequently localised and short-term in nature. There will be some residual impacts in terms of emissions, road safety issues from generated traffic, and minimal residual impacts due to ground water extraction. Road safety measures have been incorporated in the design while groundwater impacts will be minimized by adopting rainwater harvesting measures. Due to additional tree plantation, there will be positive residual impact in the long term. Therefore, the project has been categorised as **Category 'B'** in accordance with ADB's SPS 2009.

3. **Existing Environment**: The climate of Rajasthan state has varied contrasts and the presence of Aravalli is the greatest influencing factor. The Aravalli Mountains stretching diagonally across the State from the South-West to North-East separate the desert and semi-desert areas to the West from the sub-humid areas in the East. The climate of Rajasthan can be divided into four seasons, summer, monsoon, post-monsoon and winter. The hottest season of summer lasts from April to June. In this season, the day temperature can go up to 48^0C in some parts, though mostly it ranges from 32^0C to 45^0C. Being in the desert, nights are cool. Monsoon lasts from July to September. The temperature becomes more

[1] Supreme Court of India delivered a ruling on December 30, 1996 regarding industries covered under the TTZ, in response to a PIL seeking to protect the Taj Mahal from environmental pollution. It banned the use of coal/ coke in industries located in the TTZ with a mandate for switching over from coal/ coke to natural gas and relocating them outside the TTZ or shutting down. Road projects need to obtain permission for cutting of trees from forest department

comfortable, ranging from 35^0C to 40^0C although there is some humidity to deal with. Post-monsoon from October to December is a pleasant time, with temperature ranging from 18^0C to 20^0C on the lower side to 33^0C to 38^0C on the higher side. Winter lasts from January to March and being in the desert, Rajasthan can be quite cold, especially in the interiors. Places like Churu even experience 0^o(Zero Degree) temperature routinely during winter.

4. The state portrays rolling sand dunes, river-drained plains, rocky terrain, wetlands, plateaus, barren tracks, or land filled with thorny shrubs, wooded regions, and ravines topography. The dry and the parched regions are predominant in the state. The flood-prone regions in the state lie in Bundi, Ganganagar, Jalore, Jodhpur, Nagaur Pali, and Tonk districts. Land use along Dantiwara-Merta City Road, Churu-Taranagar-Nohar Road, Kherli-Nadbai-Kumher Road, and Paloda-Garhi-Anandpuri Road are predominantly agricultural land with waste land with dense plantation coming next. Organized roadside plantation has been done by local inhabitants along most road stretches.

5. Since the project area is characterized mainly by rural/open areas and intermittently traversed by few semi-urban settlements/ built-up areas, sources of air pollution are mainly vehicular emissions, dust from unpaved shoulders/ deteriorated roads, and domestic fuel burning. Monitored parameters of ambient air quality largely meet the prescribed limits of the World Bank (WB), National Ambient Air Quality Standard (NAAQS), and Central Pollution Control Board (CPCB). Noise levels also meet the CPCB prescribed standards and World Bank Environmental, Health, and Safety Guidelines for noise for all land use categories. Ground water sampling collected and analysed, parameters meet the desirable limit of drinking water standard prescribedin IS: 10500:1991.

6. **Anticipated Environmental Impacts and Mitigation Measures:** Main pre-construction impacts are: (i) cutting of a few trees (most of the trees within formation width are likely to be translocated) (ii) waterlogging in built-up areas due to absence/blockage of side drains and (iv) accident risk due to poor horizontal curve along some sub-projects. All cross-drainage (CD) structures have been designed for a 50-year return period, considering climate change impacts. Vent size of CD structures have been proposed for widening to avoid overtopping of road. A free board of 0.6 to 1m has been considered for all bridges. Lined side drains are proposed in market areas/ habitation to prevent waterlogging Additional plantation above regulatory requirement of compensatory plantation will improve the microclimate of the region in the long-term.

7. Significant impacts anticipated during construction phase are: (i) increase of local air pollution and noise level due to construction and site clearance activities, earthworks, borrowing and quarrying, operation of hot mix plants, etc.; (ii) deterioration of surface water quality due to silt run-off, spillage from vehicles and discharge from labour camps; (iii) health impacts from labour camps; (iv) traffic disruption; and (v) occupational health and community safety. Mitigation measures include: (i) utilizing least noisy equipment and regulating time of construction near settlements and sensitive receptors; (ii) sprinkling of water on earthworks, active construction sites, material storage locations, and haulage roads; (iii) installation of silt and oil traps; (iv) slope stabilization to control erosion and protection work for ponds; (v) camp siting and management as per IRC guidelines and best practices; (vi) traffic management to avoid congestion and maintain access of local residents; (vii) implementation of compensatory plantation to offset impacts from tree cutting and additional plantation to curb effects of greenhouse gas emissions and enhancement of micro-climate; (ix) no camp, materials storage, hot mix plant near forest areas/ water bodies/ residential areas; and (x) no construction in the stretches of potential wild animal crossings during night time

8. Anticipated operation stage impacts are increased road accidents, accidental spillage, sub-mergence/ overtopping of CD structures, waterlogging due to blockage of side drains,

increased air pollution and noise levels, poor survival of compensatory and additional plantation. All these are mainly associated with maintenance and monitoring of effectiveness of mitigation measures taken during design and construction stage. Executing agency is mandated to undertake regular maintenance of the road conditions and its appurtenances.

9. **Greenhouse Gas Emissions and Addressing Risk of Climate Change:** The total CO_2 emission as estimated for business-as-usual and with project scenario for all the roads individually is less than ADB's threshold of 100,000 tons per year. Total CO_2 emission at business-as-usual and with project scenarios (over the design life of road) were estimated as 88,350 tons/year, and 22,837 tons/year respectively. It is therefore evident that 'with project scenario' will reduce more than 74% of CO_2 emissions in comparison with the business-as-usual scenario. Within the project lifespan, business-as-usual scenario will continue to have more CO_2 emissions due to the restricted width with increasing traffic. With project scenario will bring wider roads, improved road conditions, ease in traffic movement, and better fuel efficiency. Major reduction comes from the improvement of road carrying capacity, as the traffic volume will reach saturation limit with existing road infrastructure and it would be difficult to sustain design speed with existing 1 or 1.5 lanes during the entire project life. By the same principle, emissions are predicted to go up once the saturation limit is reached beyond project lifespan.

10. **Public Consultations:** Meaningful consultations in line with SPS, 2009 were conducted with local communities and government agencies like Forests and Wildlife, fisheries, etc. Emphasis was made to include women and vulnerable groups in all interactions organized with local community. Focused Group Discussions were organized at 18 locations. Project received strong acceptability among potential beneficiaries. Main demands include provision of road safety measures, upgradation of CD structures and inclusion of side drains in built-up sections, employment in road construction and petty contracts during construction, and avenue plantation. Most of their demands have been integrated in the design.

11. **Environmental Management Plan**: The total budget provided in the civil works contract and PWD budget to implement the environmental management plan (EMP) and (EMoP) is **INR 130 million** comprising a) Mitigation cost which includes dust suppression, installation of noise barriers, connection water harvesting, compensatory plantation, additional plantation; and b) Monitoring cost which includes pollution monitoring for air, water, noise, and soil. PWD, through its Project Implementation Units (PIUs), will ensure the effective implementation of the environmental management plan. To provide regular monitoring information and technical advice to the PIUs a Construction Supervision Consultant/Project Management Authority Engineer will be engaged to examine environmental compliances and suggest corrective actions and guide them to enhance the environmental performance of the project.

12. **Grievance Redressal Mechanism:** A Grievance Redressal Committee (GRC) will be established at PIU level and another already established at PMU level. The GRC will provide an opportunity for affected persons to have their grievances redressed. Depending on the nature and significance of the grievances or complaints, the GRM comprise procedures to address grievances at the project site or PIU level then PMU level. Most serious complaints which cannot be addressed at the PIU level will be forwarded to the PMU.

13. **Conclusion:** This initial environmental examination (IEE) ascertains that upgrading is unlikely to cause any significant environmental impacts. Few impacts were identified attributable to the proposed subproject, all of which are localized and temporary in nature and can be easily mitigated with minor to negligible residual impacts. Need of undertaking

detailed EIA is not envisaged at this stage. The Executing Agency shall ensure that EMP and EMoP are included in Bill of Quantity (BOQ) and forms part of bid document and civil works contract. The same shall be revised if necessary during project implementation or if there is any change in the design with prior approval of ADB.

I. INTRODUCTION

A. Background

1. Rajasthan which is also known as the “Land of Maharajas” is the largest state of India, covering an area of about 342,239 sq. km. It comprises of 33 districts and its largest city is Jaipur, which is also its capital. Being located on the western side of the country, it shares its border with Pakistan to its northwest and to the west it shares its border with Sindh. To its north it has Punjab, Uttar Pradesh and Haryana to its northeast; to its southeast it has Madhya Pradesh and Gujarat to its southwest. Rajasthan's economy is primarily agricultural and pastoral. Wheat and barley are cultivated over large areas, as are pulses, sugarcane, and oilseeds. Cotton and tobacco are the state's cash crops. Rajasthan is among the largest producers of edible oils in India and the second-largest producer of oilseeds. Rajasthan is also the biggest wool-producing state in India and the main opium producer and consumer. Rajasthan connected 100% of its population to electricity power in 2019 (raising the rate of electricity access from 71% of the population in 2015). The renewable energy sector plays the most important role in the increase of generation capacities, with the main focus on solar energy. In 2020, Bhadla Solar Park was recognised as the largest cluster of photovoltaic power plants in a single region in the world, with the installed power exceeding the 2.2 gigawatt peak.

2. The Aravali Range spearheads Rajasthan into two geographical zones. The Mount Abu is the only hill station of the state which houses the loftiest summit of the Aravali ranges-Guru Shikhar Peak. The soil and vegetation of Rajasthan alters with its wide-ranging topography and the availability of water. Rajasthan soils are mostly sandy, saline, alkaline and chalky (calcareous), Clay, loamy and black lava and so on. Only 9.36% of the total geographical region lies under forest vegetation. The flora and fauna are particularly endemic to the arid regions and are specially adapted biologically to survive in the dry, waterless regions of the "Desert State of India". The wildlife consists of 23 species of lizards, 25 species of snakes, various species of the deer family and 450 species of avifauna.

3. Rajasthan is connected by many national highways, the most renowned being NH 8, which is India's first 4–8 lane highway. Rajasthan also has an inter-city surface transport system both in terms of railways and bus network. All chief cities are connected by air, rail, and road. There are 48 National Highways in Rajasthan with total length of 10,599.67 km (31-03-2019) and 170 State Highways with total length of 15517.5 km, 6, 715 km of MDRs, 29, 682 km of other district roads, and 1, 54, 652 km of village/rural roads. Road density in Rajasthan is only about 62.59 km per 100 square km (sq. km), compared to the national average of 166 km as of 31st March 2015. Road Density per lac population in Rajasthan is 313 km corresponding to the national figure of 436 km. Further, nearly 80% of the roads are single lanes. Years of under-investment due to paucity of financial resources and inadequate maintenance have left many of the state highways and MDRs in poor conditions both in terms of riding quality and network.

B. Rajasthan State Highway Improvement Program (RSHIP)

4. Rajasthan State Highway Improvement Program (RSHIP) aims to upgrade four state highways i.e., SH-21, SH-36, SH-44 and SH-10A totalling to 295.2 kilometres under 04 packages **(Table 1)** forming part of the road network in Rajasthan to two-lane standard and performance-based maintenance contracts to maintain the improved road assets for 10 years after construction. Project will improve transport connectivity in 7 districts of the state i.e., Jodhpur, Nagaur, Churu, Hanumangarh, Alwar, Bharatpur and Banswara respectively. It also includes initiatives to build institutional capacity within PWD, Government of Rajasthan, focusing on improved road safety and road asset management.

Table 1: List of RSHIP Sub-project Roads

S.No	Road No.	Road Sections with Civil Construction Packages	Length (km)	Districts
1	SH-21	Dantiwara-Merta City Road **(PKG-01)**	87.700	Jodhpur, Nagaur
2	SH-36	Churu-Taranagar-Nohar Road **(PKG-02)**	115.80	Churu, Hanumangarh
3	SH-44	Kherli-Nadbai-Kumher Road **(PKG-03**)	37.000	Alwar, Bharatpur
4	SH-10A	Paloda-Garhi-Ananapuri Road (**PKG-04)**	54.700	Banswara
		Total	**295.20**	

C. Project Objectives and Outcome

5. The project aims to improve transport efficiency of the state road network, which will contribute to expansion of economic opportunities and poverty reduction. This will be realized through: (i) improving the state highway and major district road network; (ii) facilitating safe and efficient transport services; and (iii) enhancing PWD's capacity for road asset development and management. The project's immediate outcomes will be improved accessibility to social services and markets, increased fuel efficiency, reduced travel time, accidents, vehicle emissions and better employment opportunities outside agriculture, both through improved access to economic centres, and increased industrial activities within the state. This will also help address the regional disparities by promoting trade opportunities to non-urban population.

6. To achieve these objectives, candidate roads will be improved to two-lane with paved and earthen shoulders in consistent with Indian Road Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) guidelines/specifications. Widening and improvement components will include: (i) improvement in pavement conditions and road geometry, (ii) reconstruction/widening and provision of additional CD structures, and (iii) provision of lined drains in built-up sections, construction of ROBs, junction improvement, protection works, bus bays/truck lay-bys and installation of safety measures among others. The sub-projects selected under the program were prioritized (**Table 2**) due to existing deficient conditions at the same time growing traffic with reduced capacity and its importance in economic/ financial viability aside from traffic count.

Table 2: Importance of Sub-project roads

Sub-Project	Importance of Sub-project Roads
SH-21	Jodhpur is the district capital and city is famous for its rich history. It is also referred as the Blue City and "Sun City". The project road connects NH-112 near Dantiwara. Project road in Nagaur district provides connectivity to Nagaur Fort, Tarkeen Dargah, Amar Singh's Cenotaph, Jain Glass Temple, Deepak mahal and Akbar mahal
SH-36	Project road with the long alignment connects to many places such as Fresco Painted Havelies, Sri Shantinath Bhagwan Mandir, Mansa Devi Temple, Sethani Ka Johara in churu district and Bhatner Fort, Kalibangan, Bhadrakali Mata Temple, Pallu, Brahmani Temple, Gurudwara Shree Kabootar Sahib in hanumangarh district.
SH-44	Project road provides connectivity to Keoladeo ghana national park in Bharatpur and Bhangarh fort, Bala Quila Fort in alwar district and Bharatpur palace and museum, Ganga Mandir, Laxman Mandir in Bharatpur district
SH-10A	Project road provides connectivity to Gujarat and Mahi Dam, Shree Tripura Sundari Temple, Kagdi Pick Up Weir, Madareshwar Shiva Temple in Banswara district

7. The project is categorized as category 'B' in accordance with ADB Safeguard Policy Statement (SPS) 2009 warranting an initial environmental examination (IEE). IEE identifies

the environmental issues to be considered at project planning and design stage. The IEE report covers the general environmental profile of the study area and includes an overview of the potential environmental impacts and their magnitude on physical, ecological, economic, and social and cultural resources within the project's influence area during design, construction, and operation stages. An Environmental Management Plan (EMP) for each sub-project forms part of this report which includes mitigation measures for significant environmental impacts during implementation of the project, environmental monitoring program (EMoP), and the responsible entities for mitigation and monitoring. This IEE has four basic objectives; (i) identify the environmental issues that should be taken into account due to project activities; (ii) determine the magnitude of potential environmental concerns and to ensure that environmental considerations are given adequate weight at planning/design stage; (iii) identify need for further environmental studies or Environmental Impact Assessment (EIA); and (iv) suggest enhancement measures, if any.

D. Extent of IEE

8. IEE extent has been decided considering all likely impacts and risks analysed in the context of the project and its area of influence. It encompasses (i) the primary project roads and related facilities; (ii) associated facilities whose viability and existence depend exclusively on the project; (iii) areas and communities potentially affected by cumulative impacts from further planned development of any existing project or condition, and other project-related developments that are realistically defined at the time of assessment; and (iv) areas and communities potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location. After identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction, construction and operation stages of the project was carried out to identify the minor, moderate and major impacts and guide mitigation measures. This includes 100 m on either side studied for direct impacts. Other indirect impact area covers location of quarries; borrow areas, storage area of construction material etc. Baseline data was collected in an area of 10 km on either side of road alignment for larger analysis of ambient air, land use and other environmental sensitivity. Assessment is carried out for all components of environment covering terrestrial and aquatic ecology, soil, water, noise, and socio-economic aspects.

E. Approach and Methodology

9. This IEE report has been prepared on the basis of feasibility report, field investigations and stakeholder consultations to meet the requirements for environmental assessment process and documentation as per ADB SPS 2009. The IEE commenced with the review of legal requirements for the project. Next, technical details were collected and compiled by feasibility consultant. This was followed by a discussion with the implementing agency to reconfirm the technical details. Further steps followed for IEE have been concisely described in the following paragraphs.

1. Reconnaissance Survey and Initial Consultations

10. Reconnaissance survey and initial consultations facilitated in designing the nature of the environmental survey and extent of consultations to be carried out along the road alignment. It helped to identify data gaps, decide valued environment components, key stakeholders and key informants who can further substantiate the collected information. Reconnaissance survey and initial consultations also recognized the need to conduct rapid bio-diversity assessment and wildlife movement study for the stretches where movement of wildlife was reported.

2. Primary Data Collection

11. Environmental resource inventory was carried out from December 2021 to February 2022. It covered environmental features such as terrain, land use, waterways/ water bodies, roadside vegetation, sensitive receptors, common property resources, utilities, drainage, flooding/ water logging, accident prone areas, etc. within the area of interest/core zone. Baseline data for air quality, noise levels, water quality and soil were also collected during this period. Information about wildlife movement such as species, location, reason for crossing the road, potential wildlife accident locations, frequency, season and timing of crossings, etc. were also collected. This was done by trained persons under the supervision of an expert team comprised of wildlife experts. Similarly, floral survey was also carried out.

3. Secondary Data Collection

12. Secondary sources included environmental assessment done by feasibility team, published government reports, government websites, recognized institutions and relevant government departments (forests and wildlife, pollution control board, statistics, Indian Meteorological Department (IMD), etc.) Recent Google images were captured to view environmental features at regional scale. References made to the secondary sources have been mentioned in the text and tables throughout the length of the report.

4. Public Consultations

13. Meaningful consultations were organized from January to February 2022 with the government agencies, and local people/beneficiary and affected population to know the level of project acceptability, understand their concerns, apprehensions, and overall opinion. Details are summarized in Table 43. Information was gathered about existing baseline environmental condition like ambient levels and effects on health, water resources, water logging/ flooding, flora and fauna, wildlife movement, socio-economic standing of local people, impact due to loss of land, other assets, and common property resources, accident risk during construction and operation stage, perceived benefits and losses, etc. Information thus gathered was integrated in project design, mitigation measures, and environmental management plans.

5. Other Tools, Additional Surveys and Studies

14. The Transport Emissions Evaluation Model for Projects (TEEMP)[2] developed by Clean Air Asia[3] was utilized to assess the CO_2 gross emissions. Required input data on road length and configuration, traffic, road roughness, emission factors, etc. were collected from different sources. Remote sensing and GIS technique have been used for assessment of land use/ land cover for the larger area i.e., 10 km on either side of sub-project road, which help in better planning and decision-making before creating any physical infrastructure in the region.

6. Assessment of Potential Impacts

15. The assessment of the type, nature, direct, indirect, cumulative or induced impacts and their significance to the physical, biological, and socio-economic components of the environment has been done to ascertain the project's environmental sustainability. Nature of impacts has been classified as significant, insignificant, short-term, long-term, reversible, irreversible, etc. After identification of nature and extent of impacts, mitigation measures were suggested.

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[2] TEEMP is an excel-based, spreadsheet models to evaluate emissions impacts of transport projects.

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

7. Preparation of the Environment Management Plan

16. The road specific EMPs were formulated with the aim to avoid, reduce, mitigate, or compensate for adverse environmental impacts/risks and propose enhancement measures. These include: (i) mitigation of potentially adverse impacts; (ii) monitoring of impacts and mitigation measures during project implementation and operation; (iii) institutional capacity building and training; (iii) compliance to statutory requirements; and (iv) integration of EMP with project planning, design, construction and operation.

F. Structure of the report

17. The IEE has been structured in accordance with SPS, 2009. An executive summary describing critical facts, significant findings, and recommended actions has been presented in the beginning of the report. The report has been compiled and presented from the description of the project sites and the environment, assessment of impacts, discussion of information disclosure and consultation process, summary of mitigation measures in the EMP and grievance redress mechanism, then culminating with overall conclusions and recommendations.

II. DESCRIPTION OF THE PROJECT

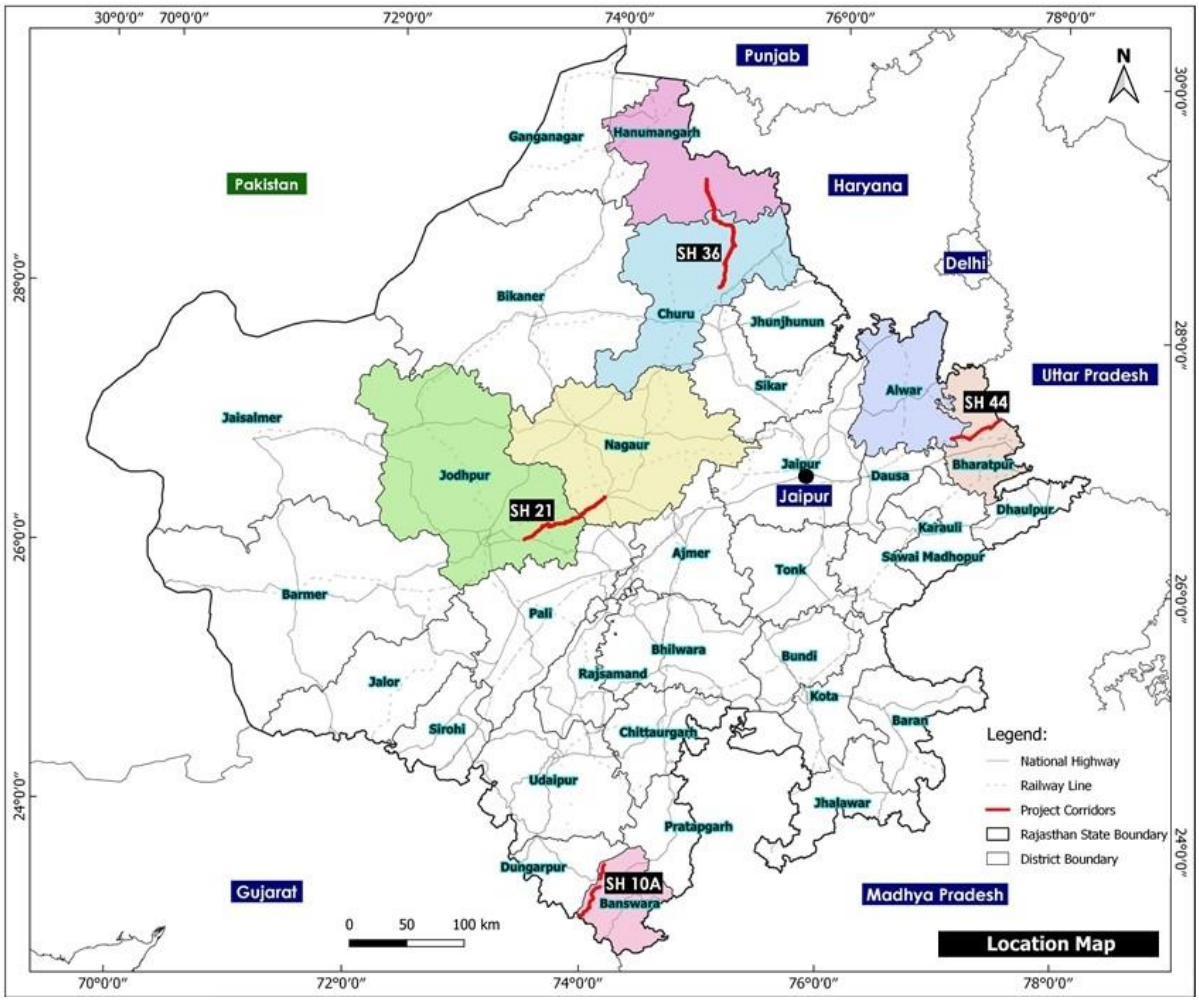
A. Location of the Project

Rajasthan is lying between 23°30' and 30°11'North latitudes and 69° 29' and 78 ° 17' East longitudes in the north western part of India. Rajasthan is edged by Pakistan in the west and northwest, the states of Punjab, Uttar Pradesh and Haryana in the north and northeast. The state of Madhya Pradesh lies in the southeast and Gujrat in the southwest. The four sub-projects are located in 7 districts of Rajasthan namely Jodhpur, Nagaur, Churu, Hanumangarh, Alwar, Bharatpur and Banswara. District-wise locations and other details of the sub-projects are given in

Table 1. Detailed maps are in **Appendix F**.

Figure 1 shows the location of sub-project roads. Detailed maps are in **Appendix F**.

Figure 1: Project Location Map



B. Project Category

18. Project categorization has been done using Rapid Environment Assessment (REA) checklist of ADB for roads and highways (**Appendix 2**) after survey and initial consultations. Project scope is limited to improvement and widening of existing mostly intermediate lane roads to two-lane with earthen/paved shoulders. Hence, it expected that stress on existing natural resources such as land, water, soil, and aggregates is not significant.

19. All the sub-projects are outside and not close to any protected areas as declared under Wildlife Protection Act, Government of India or any internationally recognized key biodiversity areas based on Integrated Biodiversity Assessment Tool screening and through other national biodiversity databases. This was also confirmed through consultations with district forest officers and locals. Erratic and undefined movement of wild animals predominantly the Nilgai (Blue Bulls) were observed in most of the projects areas. No Forest diversion is involved among all sub-projects. 9,606 affected trees have been enumerated within the ROW for all sub-projects combined together. All other impacts are mainly temporary and localized in nature which can be mitigated by effective implementation of Environmental Management Plan (EMP) included in IEE. Hence, the project is classified as environment Category B in accordance with the ADB's SPS 2009.

C. Traffic

20. The average annual daily traffic (AADT) on the project roads is presented in the succeeding table based on the traffic study conducted by detailed design team. The traffic projection on the road consists of normal traffic[4], diverted traffic,[5] and induced/generated traffic.[6] Since the project corridors are not connecting major industrial places and no major activities are planned in the near future, induced or diverted traffic is not expected. Traffic projection has been done assuming 5% growth rate. Existing and projected traffic in different homogenous portions of sub-sections is given in **Table** 3**.**

Table 3: Present and Projected Traffic of Sub-project Roads[7]

Homogenous Sections	2021		2026		2031		2036		2041-42	
	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU	Vehicles	PCU
SH 21: Dantiwara-Merta City Road	7715	7528	9811	9474	12481	11937	15884	15055	20221	19007
	8084	7882	10294	9921	13098	12503	16670	15773	21221	19917
	8492	8252	19802	10390	13745	13096	17494	16525	17351	18219
	8911	8641	11335	10881	14424	13719	18359	17313	18179	19088
	9350	9048	11894	11397	15136	14371	19267	18140	19047	19999
SH 36: Churu-Taranagar-Nohar Road	1676	2312	3630	5103	5016	7642	8620	13950.5	12500	18000
	2179	3032.5	4669	6587	6660	9845.5	11043	16059.5	13000	18500
	2819	3944.5	4700	8704.5	8263	12651.5	11601	16877.5	17721	18607
	2833	5217.	6051	11234	8683	13296.5	12000	17450	18323	19239
SH 44: Kherli-Nadbai-Kumher Road	8856	11572	11303	14769	14426	18850	18411	24057	23498	30704
	9299	12151	11868	15508	15147	19792	19332	25260	24673	32239
	9764	12758	12461	16283	15904	20782	20298	26523	27849	29242
	10252	13396	13085	17097	16700	21821	21313	27850	29243	30705
	10765	14066	13739	17952	17535	22912	22379	29242	30704	32239
SH 10A: Paloda-Garhi-Anandpuri Road	5681	4503	7250	5747	9253	7334	11810	9361	15072	11947
	5965	4728	7613	6034	9716	7701	12400	9829	15826	12544
	6263	4964	7993	6336	10202	8086	13020	10320	10836	11378
	6576	5212	8393	6653	10712	8491	13671	10836	11378	11947
	6905	5473	8813	6985	11247	8915	14355	11378	11947	12544

Source: Traffic Survey and Projection

[4] Normal Traffic is the traffic already plying on the road and continues to use the project road after improvement

[5] Diverted traffic is the traffic which would be diverted to the project road from the alternative routes and also the traffic which might divert away from the project road due to toll..

[6] Induced Traffic represents the new traffic because of new travellers making use of the improved or new facility. The induced traffic is considered in the normal growth rates.

[7] Annual growth is already over estimated, traffic survey was conducted in the year 2015 and 5% growth rate is not anticipated for year 2022 onwards as GDP growth rate was dropped significantly.

D. Characteristics of Existing Roads

21. Existing sub-project roads under RSHIP project have varying width and road conditions. ROW is generally 20-30m in most cases with reduced width in settlements varying from 9 to12 m except in Sarwar(5m). The major part is 2-lane with or without earthen shoulder. Riding condition is mostly poor to fair. Roadside drains are present in some urban stretches but are mostly choked and non-functional. Overtopping of roads is not observed in general but water-logging is very common in built-up areas. Waterways are being crossed only on a few roads. Waterways are mostly non-perennial except few rivers located near or crossed by SH-44 (Kharand River) and SH-10A (Anas river). Major bridges are present only on 2 roads, while 3 roads have minor bridges. All four roads have cross drainage (CD) structures. There is no ROB in in the sub project road proposals. Bus shelters are present in some built-up areas. Most of the roads have inadequate road safety provisions. Horizontal and vertical profiles are incoherent to applicable code provisions. The horizontal curve is mostly insufficient in built-up areas. Vertical curves are deficient to severely deficient throughout the stretches of all sub-projects roads. This is due to the fact that roads are constructed on stabilized sand dunes which normally follow its undulating topography. Abutting land use is mainly agricultural along all sub-project roads. Green mature trees of indigenous species are present along the sub-project roads (refer to Chapter 4 for detail)Habitat portion varies from 5-15% of the total alignment in the subproject roads.

E. Improvement/Strengthening Proposals

22. Project road improvement will mostly follow special codal provisions relevant to state highways prescribed by Indian Road Congress (IRC: SP: 73-2018, Manual of Standard and Specification for two-laning of State Highways) and Ministry of Road Transport and Highways (MORTH) Guidelines. Any compromise or variation has been specifically highlighted with reasons in relevant section of the report.

23. Improvement of the project roads involves its widening from single/intermediate/2-lane lane to 2-lane with the granular shoulder of 2.5 m on either side. Main up-gradation components involve improvement in pavement conditions and geometrics, reconstruction and widening of CD structures, provision of roadside drains, raising of embankment in water logged sections, junctions/intersection improvement, safety provisions for road users, and provision of road facilities like bus bays/bus shelters, and toll plaza. Environmental enhancement measures like compensatory plantation and rainwater harvesting are also included.

24. Asphalt driveway costs much less to construct in comparison to concrete roads. Thus Asphalt is best preferred for most of the average roads and driveways. Moreover, while asphalt pavements have an average lifespan of 15-20 years. Asphalt roads only need to be re-layered over the old layer and they are good to go. Easier and cheaper road repair makes them the preferred choice for low volume roads where maintenance is possible. Concrete roads though are preferred for roads with a heavy volume of traffic like interstate and where quick, regular maintenance is not always feasible.

25. Asphalt driveways are easier to maintain, replace or repair and the process is easy and fast too, unlike concrete roads, which although demands repairs less frequently, but can be costly when it is required. Cement acts as the binder that holds the aggregate together in concrete, thus making it solid and stiff. Whereas, in case of asphalt driveways, bitumen acts as the binder mixed with finer aggregates to keep asphalt together, making it more resistant to water, temperature effects and cracks.

26. Since bitumen driveways are composed of several layers of materials, they are flexible enough to accommodate the imperfections in the surface beneath the roadway. Whereas, if the underlying surface beneath the concrete parking or a driveway is not perfectly smooth or damaged, the concrete road is prone to cracking and the damages would soon reflect on the new layer too.

27. Design speed has been adopted consistent with codal provisions of IRC: SP: 73-2018 (**Table 4**).

Table 4: Design Speed

Nature of Terrain	Cross Slope of the Ground	Design Speed (km/h)	
		Ruling	Minimum
Plain and rolling	Up to 25 percent	100	80
Mountainous and Steep	More than 25 percent	60	40

28. Design speed is reduced where site conditions are restrictive (intersections, bridge approaches, curves, built-up sections, educational and other sensitive receptors, forest and potential wildlife crossing sections, etc.) and adequate land width is not available. In built-up sections, it is generally restricted to 30 kph which is further reduced to 20 kph in exceptional cases. Gradual changes will be introduced by providing successive sections of increasing/ decreasing design speeds so that road users become progressively conditioned to such changes. Warning signs have been proposed at all locations with reduced speed limit.

29. The horizontal curves have been eased to the extent feasible considering the ground constraints/ land availability. Horizontal geometry will be based on IRC: 38-1988: Guidelines for Design of Horizontal Curves for Highways (First Revision) and vertical geometry will be based on IRC: SP 23-1993.

30. Existing roads are largely devoid of side drains. In some urban stretches with drains, these were found to be blocked or choked. Covered lined drains with footpaths have been proposed in all built-up sections. Open unlined earthen drains have been provided to capture surface run off from the main highway for most of the sub-projects.

31. All major and minor junctions are proposed for improvement as per IRC guidelines, mostly at grade. Additional earthen pedestrian walkway of 3m-width is proposed.

32. Since all project highways road will be toll roads, 7 toll plazas are proposed to include a weigh bridge, office building, a traffic aid post, a medical aid post, and a paved yard for parking and unloading of vehicles. Roof top rainwater harvesting proposed at toll plazas for augmentation of groundwater.

33. Gender-friendly bus shelters have been provided at all important habitations. As bus bays have not been designed but an additional paved area of 4.0 m width and 20 m length shall be provided in order to enable a bus to stop without obstructing the flow of traffic. EPC Contractors may shift these locations, if necessary, in consultation with the local people and Authority Engineer/PIU/PMC.

34. Safe crossing facilities for pedestrians are proposed at major intersections and bus bays. These facilities are planned in accordance with relevant provisions in IRC-11,[8] IRC-67,[9]

[8] Recommended Practice for the Design and Layout of Cycle Tracks.
[9] Code of Practice for Road Signs.

and IRC-103.[10] At intersections, controlled form of crossing is achieved through provision of 3 m wide zebra crossing, accompanied by STOP line.

35. The project roads have been provided with all safety features as per IRC: 8,[11] IRC:25,[12] IRC:26,[13] IRC:35,[14] IRC:67,[15] IRC:103,[16] and Section 800 of MORTH.[17] Key features include provision of (i) crash barriers in high embankment areas/black spots, (ii) speed breakers/ rumble strips near built-up areas, educational institutes, health centres and active wildlife crossing areas, delineators, road studs, cat's eye, chevrons, object markers, etc. have been included in the design. For construction stage safety, a proper traffic diversion plan shall be prepared as per IRC: SP: 55-201416. Separate traffic diversion plan shall be prepared for structures and CD works. The execution of the project road should be planned such that inconvenience to road users is minimal. The width of temporary diversion should be equal to the width of existing carriageway. Embankment heights are proposed for raising for grade improvement and locations where overtopping was reported either due to local drainage problem or ponding due to overflow of rivers during monsoons. Existing roads' characteristics and proposal for improvement have been summarized in **Table 5.**

Table 5: RSHIP Sub-project Road's Salient Features and Improvement Proposals

<table>
<tr><th></th><th>Existing Road's Salient Features</th><th>Improvement Proposal</th></tr>
<tr><td>SH-21- Dantiwata-Merta City Road 03</td><td>– Length: 87+ 700Km
– Location: The project road section starts near Dantiwara at Junction of SH 21 (km 0.000) on NH 112 and ends at Junction of SH 21 (km 86.700) with MDR 58 near Merta City. The project road is approximately 87.000 km long. The project road links Dantiwara, Riyan, Pipar, Borunda & Indawar to Merta City.
– Habitations: Chodwas, Benen, Buchkallan, Bankaliya, Riyaan, Pipar, Uchiya Bara, Nanan, Maadaliya, Gadh Sooriya, Borunda, Beetan, Indawar, Satlawas and Merta City.
– ROW: 18 to 30m
– Configuration: Two-lane with 1 m of shoulders is in 00 km to 86+ 700 Km. Pavement condition is mostly good.
– Junction/Intersections: 11 major and 31 minor</td><td>– Project Road Length: 87+ 700 Km
– ROW: 30m
– Configuration: Two-lane of 3.5m with the earthen shoulder of 2.5m on either side
– Bypass: 2, one at Nanan, one at Mandaliya
– Level crossing: One at existing chainage at CH-22+550 broad-gauge railways level crossing.
– 25 gender-friendly bus shelters on both sides
– 11 Junction Improvements
– Rainwater harvesting structures are to be constructed along the complete alignment at 2000 mts on LHS and RHS in a staggered manner.
– 2 toll plazas at km 10+ 200 and at km 66+400 (design chainage)
– Cross Drainage Structures:
<table>
<tr><th>Cross Drains</th><th>New</th><th>Re construction</th><th>Widening &Repair</th><th>Retain with Minor Repair</th><th>Total</th></tr>
<tr><td>Pipe Culvert</td><td>-</td><td>14</td><td>-</td><td>-</td><td>14</td></tr>
<tr><td>Slab/Box Culvert</td><td>-</td><td>34</td><td>-</td><td>-</td><td>34</td></tr>
</table>
</td></tr>
</table>

[10] Guidelines for Pedestrian Facilities.
[11] Type Design for Highway Kilometer Stones.
[12] Type Design for Boundary Stones.
[13] Type Design for 200-meter Stones.
[14] Code of Practice for Road Markings.
[15] Code of Practice for Road Signs.
[16] Guidelines for Pedestrian Facilities.
[17] Specifications for Traffic Signs and other Safety-Related Works.

<table>
<tr><th></th><th>Existing Road's Salient Features</th><th>Improvement Proposal</th></tr>
<tr><td></td><td>– Cross Drains 1 major bridge, 5 minor bridges, 15 slab culverts, 7 pipe culverts.
– Terrain and Land use: plain. Land use is mainly agricultural and habituated.</td><td><table><tr><td>Minor Bridge</td><td>1</td><td>6</td><td>-</td><td>-</td><td>7</td></tr><tr><td>Major Bridge</td><td>1</td><td>-</td><td>-</td><td>-</td><td>1</td></tr></table></td></tr>
<tr><td>SH-36- Churu-Taranagar-Nohar Road</td><td>– Length: 111+ 940 km
– Location: The project road starts from Stretch 1:Churu-Taranagar from Churu (km 0.000) to Tananagar (km 39.520) section of SH-36. Stretch-2 starts Taranagar-Nohar from Taranagar (km 39.540) to Nohar (km 111.940) section of SH-36.
– Habitations: Gajsar, Sahjoosar, Ginri Patta Lohsana, Bhairoosar, ChalkoiBaneerotan, Anandsinghpura, Taranagar, Bhalau Tal, Bhanin, Dheerwas Bara, Sahwa, Khopran, Meghana, Durjana, Dalpatpura, Nohar.
– ROW: 12 to 20 mts
– Configuration: Single-lane is in 42.00 km. and two-lane in 69+940 km respectively. flexible pavement with moderate conditions except at a few distressed locations.
– Cross Drains 5 nos slab culverts. 8 utility pipes, 1 pipe culvert, 2 canal crossing siphons.
– Level Crossing: nil
– Junction/Intersections: 6 Major junctions, 43 minor junctions.
– Terrain and Land use: plain. Land use is mainly agricultural, Residential and barren land.</td><td>– Project Road Length: 111+940 km
– ROW: 30m
– Configuration: The Project Highway shall be developed into 2-lane with a Granular shoulder of 2.0 mts. Flexible pavement and CC at built-up areas and toll plazas. Remaining 1 km is CC pavement construction, In built-up sections, footpaths shall be provided.
– Bypass: Nil.
– Realignment at CH-000+000 to 002+020.
– 14 gender-friendly bus shelters on both sides
– Junction/Intersections: 6 Major junctions, 71 minor junctions to be improved.
– One level crossing is proposed for improvement
– Rainwater harvesting structures are to be constructed along the complete alignment at 2000 mts on LHS and RHS in a staggered manner.
– 3 toll plazas- one at 19+100, second at 54+100, third at 97+960 (all design chainages).
– Cross Drainage Structures:<table><tr><th>Cross Drains</th><th>New</th><th>Re constructio</th><th>Widening &Repair</th><th>Retain with Minor Repair</th><th>Total</th></tr><tr><td>Pipe Culvert</td><td>20</td><td>-</td><td>-</td><td>-</td><td>20</td></tr><tr><td>Slab/Box Culvert</td><td>-</td><td>5</td><td>-</td><td>-</td><td>05</td></tr><tr><td>Minor Bridge</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr><tr><td>Major Bridge</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr></table></td></tr>
</table>

<table>
<tr><th></th><th>Existing Road's Salient Features</th><th>Improvement Proposal</th></tr>
<tr><td>SH-44- Kherli-Nadbai-Kumher Road</td><td>
– Length : 37+00 km
– Location: The project starts from Km. 61 to Km. 98 of SH-44 comprising the section from Kherli to Nadbai-Kumher (up to UP border).
– Habitations: Akhegarh, Bhikru, Barolichchar, Katara, Nadbai, Gangroulli, Asrawan, Pidi, Kumher
– ROW: 15m to 30m in open areas
– Configuration: Single-lane (34 km) and respectively. The condition of the pavement varies from good to poor. Pavement condition is mostly good (33 km) to fair (22km).
– Junction/Intersections: 6 major, all to be improved.
– Cross Drains 11 slab culverts, 4 pipe culverts, 12 utility pipe repairs.
– Terrain and Land use: The alignment passes through plain terrain, mostly agriculture and stone mining
</td><td>
– Project Road Length: 38+600
– Configuration: Two-lane of 3.5m width with an earthen shoulder of 2.5m on either side
– ROW: 30m
– Level Crossing: nil
– 9 Gender friendly bus shelters
– 1 toll plaza at Km at CH-106+500 (existing chainage, near Peedhi Village)
– Rainwater harvesting structures are to be constructed along the entire alignment at every 2000 mts on LHS and RHS in a staggered manner.
– Cross Drainage Structures:
<table>
<tr><th>Cross Drains</th><th>New</th><th>Re construction</th><th>Widening &Repair</th><th>Retain with Minor Repair</th><th>Total</th></tr>
<tr><td>Pipe Culvert</td><td>-</td><td>4</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Slab/Box Culvert</td><td>-</td><td>7</td><td>4</td><td>-</td><td>11</td></tr>
<tr><td>Minor Bridge</td><td>-</td><td>1</td><td>-</td><td>-</td><td>1</td></tr>
<tr><td>Major Bridge</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>SH-10A- Paloda-Garhi-Anandpuri Road</td><td>
– Length= 54+700 Km
– Location: The project road lies in The Project road Paloda-Garhi-Anandpuri up to Gujarat Border (MDR-22) lies in the district of Banswara.
– Habitations: Paloda, Metwala, Suja Ji Ka Gada, Khodan, Agarpurua, Garhi, Bori, Anjana, Arthoona, Kotra, Chajja, Aanadpuri
– Configuration: The available ROW varied from 10-30m. In the open areas, it is varied 10-15m for 27.6 km length, 15-20m for 25.5m length, 20-25m for 20.4 km length, and 25-30m for km 9.9 lengths. CC pavement sections are observed in village sections totaling to 5.7km. 75% of project road length is in good condition and 20% in fair condition except for isolated patches.
– ROW: 8-30m
– Junction/Intersections: There are 5 nos. major junctions and all major junctions are proposed for junction improvement
– Cross Drains: 1 major bridge, 10 minor bridges, and 165 culverts.
– Terrain and Land use: Plain terrain Land use is mainly agricultural
</td><td>
– Project Road Length: 54+700 Km
– Configuration: Two-lane of 3.5m width with an earthen shoulder of 2.5m on either side
– Bypass: One at Chhajja Proposed. One more was proposed at Garhi.
– ROW: 30m in the open area and minimum 12m to available space in dense habitation areas
– Level Crossing: nil
– 36 Gender friendly bus shelters on RHS and LHS.
– Toll Plaza: 1 at CH-41+000 (existing chainages)
– Rainwater harvesting structures are to be constructed along the complete alignment at 2000 m on LHS and RHS in a staggered manner
– Cross Drainage Structures:
<table>
<tr><th>Cross Drains</th><th>New</th><th>Re constructio</th><th>Widening &Repair</th><th>Retain with Minor Repair</th><th>Total</th></tr>
<tr><td>Pipe Culvert</td><td>5</td><td>99</td><td>35</td><td>8</td><td>147</td></tr>
<tr><td>Slab/Box Culvert</td><td>-</td><td>22</td><td>-</td><td>-</td><td>22</td></tr>
<tr><td>Minor Bridge</td><td>10</td><td>10</td><td>-</td><td>-</td><td>10</td></tr>
<tr><td>Major Bridge</td><td>-</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
</table>
</td></tr>
</table>

F. Construction Material (Quantity and Sourcing)

36. Due to favourable topography and geological conditions, aggregates for the project is available in abundance in most of the project districts with an average lead distance of 40-70 km. Good earth for embankment is also available within 0-5 km lead distance for all projects. Soil for these projects will be transported from nearby upland/foothills located within 15 km of the project road. Sand is also available in plenty in beds of rivers being crossed by the project roads. Water requirements for construction will be met through a combination of groundwater and surface water. Most of the project roads lie within 300 km distance from operational thermal power plants,[18] hence fly-ash utilization is mandatory as per Fly-Ash Notification 2016. However, due to technical constraints, fly-ash utilization is not proposed including the bypass section. Moreover, as confirmed by F/S consultants, all the TPPs are tied up for supply of fly-ash to cement manufacturing and tiles/bricks manufacturing industries. Most of the sub-project roads lie within 300 km distance from operational thermal power plants and hence fly-ash utilization is mandatory as per Fly-Ash Notification 2021. However, as per IRC SP 58 2001, a cushion of 0.5 m between fly-ash and granular material is required. Additionally, 1 to 3 m thick cushion of selected earth cover on embankment slopes is required where fly-ash is to be used. Embankment height of the proposed sub-projects are in general less than desired height for fly-ash utilization. Sources of construction materials and its lead are summarized in **Table 6.** These sources are tentative. Contractor is free to select the sources after securing permissions from competent authority like DEIAA, SPCB, CGWA, mining department etc. and consent from panchayat and concurrence of land owners.

Table 6: Construction Material

Package	Road	Earth, cum	Sand, cum	Cement, bags	Aggregates, cum	Bitumen, tons
01	SH 21	1079179	3406	102195	514835	2495
02	SH 36	667187	4289	129633	559042	2764
03	SH 44	1063257	2320	10970	340902	2084
04	SH 10A	1232706	2425	98665	648136	1496

G. Cost and Implementation Schedule

37. Project construction period will be 24-30 months for sub-project roads followed by 10-year performance-based maintenance. Estimated total project cost is approximately ₹1,230.18 Cr.

[18] Ajmer NTPC is at 70 km, Jaipur TPP is 170 km, , Anta NTPC is 280 km, Kota TPP is 245 km, Nimach TPP is 240 km from SH-21; Ajmer NTPC is at 200 km and Jaipur TPP is 175 km from SH-36; Ajmer NTPC is at 250 km, Jaipur TPP is 140 km, Anta NTPC is 235km, Kota TPP is 260 km from SH-44; Nimach TPP is 100 km, Anta NTPC is 260 km, Kota TPP is 220 km, Ajmer TPP is 280 km from SH-10A.

III. POLICY AND LEGAL FRAMEWORK

38. This chapter presents a review of the international agreements and commitments, existing institutions and legislations relevant to the project at the National and State level. The environmental assessment process needs to adopt environmental regulations and guidelines of Government of India (GoI) and ADB's safeguard requirements.

A. International Agreements and Commitments

39. India is party to various international agreements/conventions/treaties for conservation of environment at global level. The most important among them have been briefly described and analyzed vis- a- vis the project development.

40. **Ramsar Convention on Wetlands, 1971**: The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an inter-governmental treaty, for the conservation and sustainable utilization of wetlands i.e. to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific and recreational value. It provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Out of 25 designated wetlands of international importance in India, none of them is located in project influence area. Activities undertaken in the proximity of these wetlands should follow the guidelines of the convention

41. **Convention on Protection of the World Cultural and Natural Heritage, 1972**: The United Nations Educational, Scientific and Cultural Organization (UNESCO), which seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity has embodied these objectives in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage in 1972. There are Twenty-six world cultural heritage and natural sites in India. None of them is located in project influence area.

42. **Vienna Convention for Protection of the Ozone layer, 1985 and Montreal Protocol on Substances Depleting the Ozone layer, 1987**: The Vienna Convention outlines states' responsibilities for protecting human health and the environment against the adverse effects of ozone depletion, and established the framework under which the Montreal Protocol was negotiated. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere (e.g. chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform) are to be phased out by 2010. The project does not envisage production and consumption of these substances.

43. **United Nations Framework Convention on Climate Change (UNFCCC), 1994**: The UNFCCC is an international environmental treaty with an objective to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. It was adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro in June 1992. It then entered into force on 21 March 1994. India has ratified the second commitment period of the Kyoto Protocol that commits countries to contain the emission of greenhouse gases, reaffirming its stand on climate action. It is the 80th country to do so. The Doha Amendment to the Kyoto Protocol was adopted in Qatar in December 2012. The amendment includes new commitments for parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from January 2013 to December 2020 and a revised list of greenhouse gases to be reported on by Parties in the second commitment period. Also, India, same as the rest of the UN members, has to submit by 2020 its Nationally Determined Contribution (NDC) on its domestic mitigation targets.

44. **Convention on Biological Diversity (CBD) 1992**: The Convention on Biological Diversity (CBD) **is** dedicated to promoting sustainable development and came into force in 1992 Rio Earth Summit. India signed the CBD in 1994. Member Parties have committed themselves to achieve by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth.

B. Country Legal Framework and Regulatory Requirements

45. The implementation of the RSHIP will comply with the environmental acts, policies, rules, and regulations of the Government of India which has a comprehensive coverage of environmental issues and requirements. This environmental legal framework imposes command and controls on certain activities deemed detrimental to the environmental integrity and encompass the conservation of various components of the biological and physical environment and environmental assessment procedures and requirements for public consultation. The policies and requirements which are most relevant in the context of this project are provided in **Table 7** below.

Table 7: Summary of Environmental Legislation Applicable to the Proposed Project

S. No	Act / Rules	Purpose	Applicable	Reason for Applicability	Authority
1	Environment Protection Act-1986	To protect and improve overall environment	Yes	Umbrella legislation notifications, rules and schedules are promulgated under this act.	MOEF&CC GOI; State Govt., SPCB
2	Environmental Impact Assessment Notification,14th Sep-2006 [19]	To accord environmental clearance to new project/ activities listed in schedule of EIA notification.	No	Not applicable	MOEF&CC.
3	Fly Ash Notification, 1999 as amended up to 22nd April 2021	Reuse fly ash discharged from thermal power plant to minimize land requirement for disposal and soil contamination	Yes	Most of the sub-projects are located within 300 km from TPP. Fly ash shall be used by EPC contractor	MOEF&CC
4	MOEF in view of Apex Court order dated 27.2.2012	Conserve top soil, aquatic biodiversity, hydrological regime etc. by haphazard and unscientific mining	Yes	In case of renewal of quarries	DEIAA up to 5 ha and SEIAA > 5ha and upto 25ha
5	National Environment Appellate Authority Act (NEAA) 1997	Address Grievance regarding the process of environmental clearance.	Yes	Grievances if any will be dealt with, within this act.	NEAA
6	The Forest (Conservation) Act 1980 and its amendments	To check deforestation by restricting conversion of forested areas into non-forested areas	Yes	Forest diversion of 125.016 ha of area is required among six sections of two sub-projects namely SH-98, SH-99 and SH-103.	State Forest and MOEFCC RO
7	Air (Prevention and Control of Pollution) Act, 1981	To monitor air pollution due to equipment and machineries potential to emit air pollutants from hot mix plant, crushers,	Yes	Consent for Establishment (CTE) and Consent for Operation (CTO) from SPCB; for establishment of hot mix plant, crushers,	SPCB

[19] All New State Highways; and State Highway expansion projects located in hilly terrain (above 1,000 m mean sea level) and or ecologically sensitive areas require environment clearance as per EIA notification, 2006 (as amended). None of the roads attract EIA notification, 2006 (as amended).

S. No	Act / Rules	Purpose	Applicable	Reason for Applicability	Authority
		DG set and vehicles.		workers/construction camp,	
8	Water Prevention and Control of Pollution) Act1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards	Yes	This act will be applicable during construction for (establishments of hot mix plant, construction camp, workers' camp, etc.	SPCB
9	Permission of Abstraction of Groundwater	To conserve and augment the groundwater resources	Yes	All infrastructure projects abstracting ground water requires prior permission	CGWA
10	Noise Pollution (Regulation and Control Act) 1990	The standards for noise for day and night have been promulgated by the MOEFCC for various land uses.	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 included in design.	SPCB
11	Explosive Act 1984	Safe transportation, storage and use of explosive material	Yes	In case of opening new Quarries	Chief Controller Explosives
12	Mines & Minerals Development Act, 1957 Mineral Conservation and Development Rules, 2017	To regulate excavation, production, storage, collection, distribution, transportation, manufacturing, possession, purchase and sell of any minor mineral including soil	Yes	Project requires sand, aggregates, soil and other minor minerals in large quantity.	District Mineral Foundation (DMF).
13	Central Motor Vehicle Act 1988 and Central Motor Vehicle Rules1989	To check vehicular air and noise pollution.	Yes	These rules will be applicable to road users and construction Machinery.	Motor Vehicle Department
14	National Forest Policy1952 National Forest Policy(Revised) 1988	To maintain ecological balance by conservation and restoration of biological diversity.	Yes	This policy will be applicable as project intervention requires forest land to be acquired.	Forest Dept. GoI and GoB
15	The Building and Other Construction Workers (regulation of employment and conditions of service) Act, 1996	To regulate the employment conditions of construction workers and to provide for their safety, health and welfare measure and for other matter incidental thereto	Yes	A large number of construction workers skilled, semiskilled or unskilled will be employed temporarily during Construction Phase of the project	Ministry of Labor and Employment Government of India
16	Bonded Labor (Abolition) Act,1976 and Rules, 1976	Abolition of bonded labor.	Yes	construction workers skilled, semiskilled or unskilled will be employed temporarily during Construction Phase	Ministry of Labor and Employment Government of India
17	Contract Labor (Regulation and Abolition) Act1970 and rules, 1971	Prevent exploitation of contract labor and introduce better work conditions	Yes	- Do-	- Do-
18	Employees Provident Funds Miscellaneous Provisions Act1952	secure well-being of the employees when contractor employ more than 20 persons	Yes	- Do-	- Do-
19	Minimum Wages Act 1948 along with Central Rules1950	Ensure that workers get at least minimum wages as fixed by the state/central Govt. whichever is higher	Yes	- Do-	- Do-

S. No	Act / Rules	Purpose	Applicable	Reason for Applicability	Authority
20	Public Liability and Insurance Act 1991	Protection form hazardous materials and accidents.	Yes	Contractor need to stock hazardous material like diesel, Bitumen, Emulsions	- Do-
21	Ancient Monuments and Archaeological Sites and Remains Act (1958) and the Ancient Monuments and Archaeological Sites and Remains (Amendment) Bill, 2017	Applicable to subprojects located in proximity with the Protected Monuments/ Sites. No excavation /construction work is allowed within 300 m boundary of the protected monument	Yes	Requires prior permission of Archaeological Survey of India (ASI) for taking works within 500 m of the boundary of the Protected Monuments	Rajasthan Archaeological Dept. GOI
22	Mineral conservation and development Rule of 2017 and the Rajasthan Minor Mineral Concession Rules, 2017	Regulate the quarrying of minor minerals like stone, soil, and river sand	Yes	Sand for construction	District Collector

C. Procedure for Obtaining Key Clearances/Permits

46. **Forest Clearance:** None of the sub projects attracts diversion of forest area, therefore forest clearance is not applicable

47. **Tree Cutting Permission:** Cutting of trees in non-forest land requires a tree cutting permit from the Tehsildars office. All trees cut under a project must be compensated by compensatory afforestation such as two trees per each tree as per Rajasthan Tenancy Act, 1955 by EPC Contractors.

D. Taj Trapezium Zone Notification

48. Taj Trapezium Zone (TTZ) is a defined area of 10,400 sq km around the Taj Mahal to protect the monument from pollution. The Supreme Court of India delivered a ruling on December 30, 1996 regarding industries covered under the TTZ, in response to a PIL seeking to protect the Taj Mahal from environmental pollution. It banned the use of coal/ coke in industries located in the TTZ with a mandate for switching over from coal/ coke to natural gas, and relocating them outside the TTZ or shutting down. The TTZ comprises monuments including three World Heritage Sites the Taj Mahal, Agra Fort and Fatehpur Sikri. TTZ is so named since it is located around the Taj Mahal and is shaped like a trapezoid.

49. A committee was formed to monitor the progress of implementation of various schemes for protection of the Taj Mahal and programmes for protection and improvement of the environment in Taj Trapezium Zone. Take all necessary steps to ensure compliance of specified emission standards by motor vehicles and ensuring compliance of fuel quality standards. Deal with any environmental issue which may be referred to it by the Central Government or the State Governments of Uttar Pradesh and Rajasthan relating to the Taj Trapezium Zone.

50. Sub project SH-44 falls in TTZ and require permission from apex court for tree cutting along the road corridor.

E. Indian Road Congress (IRC) Codes to the Project Road

51. Key IRC guidelines have been summarized in **Table 8** that has a direct/indirect bearing on the environmental management during design and construction stages.

Table 8: Applicable Indian Road Congress (IRC) Codes

S. No	Theme	IRC code
1	Recommended practice for borrow pits for Rural road embankments	IRC: 10 1961
2	Guidelines for Pedestrian Facilities	IRC: 103 -1988
3	Guidelines for EIA of Highway projects	IRC:104-1988
4	Ribbon developments on highways and its prevention	IRC: SP: 1996
5	Manual on Landscaping of road	IRC: SP: 21-1979
6	Report on recommendations of IRC workshops on highway safety	IRC: SP: 27-1984
7	Road safety for Children (5-12 years old)	IRC: SP: 32-1988
8	Guidelines on road drainage	IRC: SP: 42-1994
9	Highway safety code	IRC: SP: 44-1994
10.	Guidelines for safety in construction zones	IRC: SP: 55-2001

F. ADB Safeguard Requirements

52. The Asian Development Bank has defined its environmental safeguard requirements under its Safeguard Policy Statement, 2009 (SPS 2009). The SPS 2009 key requirements include screening for significant impacts and categorization, consultation, and disclosure. Proposed projects are screened according to type, location, scale, and sensitivity and the magnitude of their potential environmental impacts, including direct, indirect, induced, and cumulative impacts. Projects are classified into the following categories:

a. **Category A**. The proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented; impacts may affect an area larger than the sites or facilities subject to physical works. A full-scale environmental impact assessment (EIA) including an environmental management plan (EMP), is required.
b. **Category B**. The proposed project's potential environmental impacts are less adverse and fewer in number than those of category A projects; impacts are site- specific, few if any of them are irreversible, and impacts can be readily addressed through mitigation measures. An initial environmental examination (IEE), including an EMP, is required.
c. **Category C**. The proposed project is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.
d. **Category FI**. The proposed project involves the investment of ADB funds to, or through, a financial intermediary.

53. Project categorization has been done using REA checklist following the guidance provided above and the project is categorized as B. As per SPS 2009, **Category B** projects warrant preparation of an IEE. The SPS includes 11 policy principles on environment safeguards on screening, conduct of environmental assessment, alternative analysis, mitigation hierarchy, need for meaningful consultation, public disclosure, environmental management planning, biodiversity protection and conservation, pollution prevention, occupational health and safety, and conservation of physical cultural resources.

IV. DESCRIPTION OF EXISTING ENVIRONMENT

54. To get familiar with existing phenomena before project implementation and the phenomena which could get impacted due to proposed project activities, it is imperative to assess baseline conditions before projects take off. The entrant roads are sited within West Jodhpur, Nagaur, Churu, Hanumangarh, Alwar, Bharatpur and Banswara district of Rajasthan state. This chapter presents primary and secondary data covering all facts of environment viz. Physical, Biological, social and land environment in the project influence area with respect to the State, corresponding project districts and project corridor.

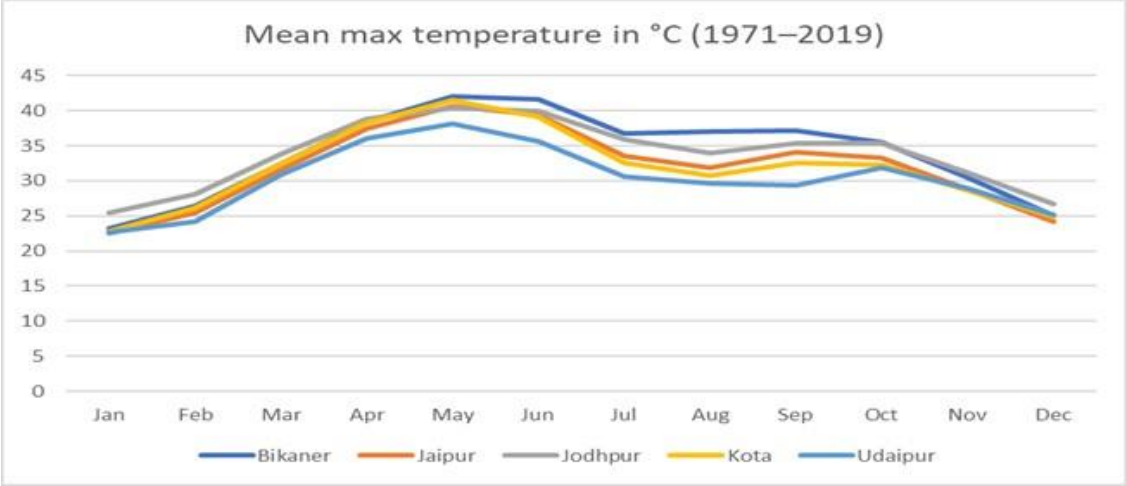
A. Physical Environment:

1. Climate:

55. The climate of Rajasthan state has varied contrasts and the presence of Aravalli is the greatest influencing factor. The Aravalli Mountains stretching diagonally across the State from the South-West to North-East separate the desert and semi-desert areas to the West from the sub-humid areas in the East. The climate of Rajasthan can be divided into four seasons: pre-monsoon (April to June), monsoon (July to Sept), post-monsoon (October to December), and winter (January to March).

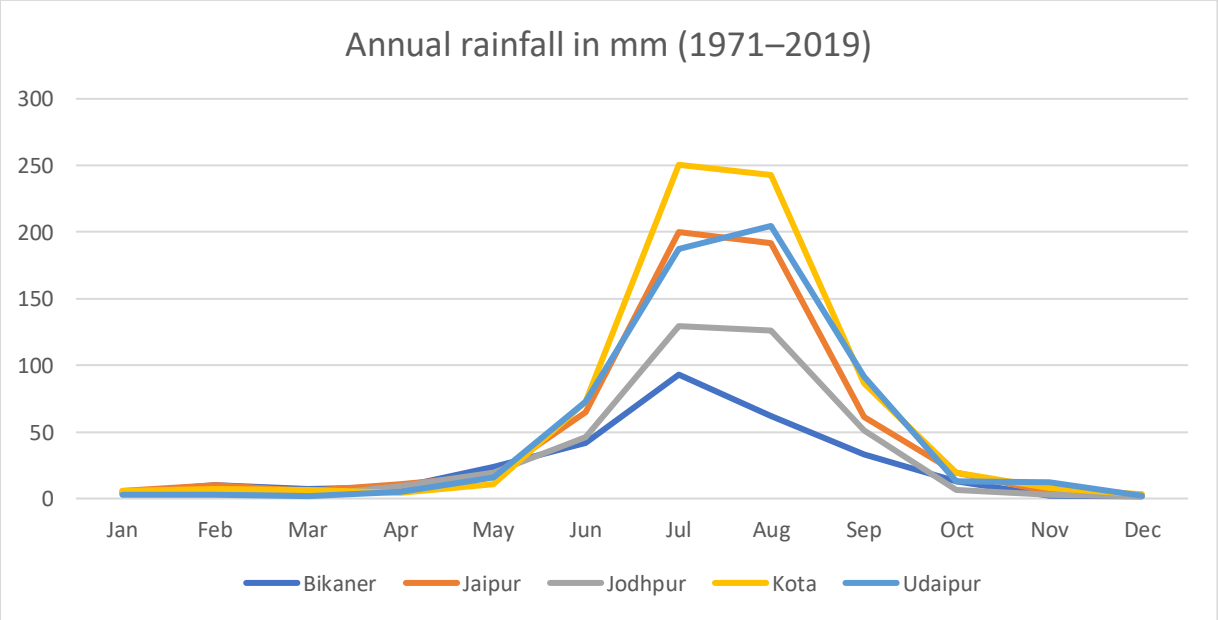
56. **Temperature:** There are distinct temperature range variations diurnal and seasonally throughout the state. The summer begins in March while the temperature keeps rising progressively through April, May, and June. West of Rajasthan and the eastern side of Aravalli Range, in the region of Alwar, and Bharatpur the maximum daily temperature hovers around 40°C to 45°C. Nights of summer see a considerable temperature fall with a minimum daily temperature around 20°C to 29°C. However, Banswara has a more pleasant climate in summers with a relatively lower daily maximum temperature that reaches 38°C and 31.5°C, respectively. The major portion of the state that consists of the arid west and the semi-arid mid-west has an average maximum of 45°C in June. January is the coldest month. The minimum temperatures sometimes fall to -2°C at night at places like Jodhpur, Nagaur Churu, Hanumangarh. Most of the Rajasthan, except the southern Rajasthan comprising Banswara, have an average temperature of more than 10°C. Due to the cold western winds, the whole of Rajasthan sometimes comes under the spell of the cold wave for 2 to 5 days during winters. Mean maximum temperature recorded from 1971 to 2019 in the prime locations of Rajasthan are given in **Figure 2.**

Figure 2: Temperature Profile of Rajasthan



57. **Rainfall:** Rajasthan being predominantly a desert area, its climate varies mostly from arid to sub-humid. To the west of the Aravalli, the climate is marked by low rainfall, extreme diurnal and annual temperature, low humidity, and high-velocity winds. In the east of the Aravalli, the climate is semi-arid to sub-humid marked by lower wind velocity and higher humidity, and better rainfall. The annual rainfall in the state differs significantly. The average annual rainfall ranges from less than 10 cm in the north-west part of the Alwar-Bharatpur region (lowest in the state), to 20 to 30 cm in the regions of Jodhpur, Nagaur, Churu, Hanumangarh Region, 30 to 40 cm in the regions of Nagaur, Jodhpur, Churu and more than 40 cm in the regions of same areas and the western fringes of the Aravalli range. Eastern side of the Aravallis see 55 cm rainfall in Alwar to 102 cm rainfall in Bharatpur, 92 cm and 75 cm in Banswara in the southern region receives the highest rainfall in the state (163.8 cm). The southwest monsoon begins in the last week of June in the eastern parts and may last till mid-September. Winters may also receive a little rainfall with the passing of western distribution. However, Rajasthan receives most of its monthly rainfall during July- September. Mean annual rainfall recorded from1971 to 2019 in the state is illustrated in **Figure 3.**

Figure 3 Annual rainfall (mm) in Rajasthan



58. **Wind:** The winds are light and mainly from northwest to north-east over the state in January, turn gradually anticlockwise and are replaced by light north-westerly to westerly or south-westerly winds in April. With the advance of the summer, the pressure gradient increases and correspondingly the winds from northwest to southwest also strengthen reaching their maximum strength in July. In July, the pressure decreases from west-southwest to east-northeast over the state. October is the month of transition, with weakest pressure gradient. From October onwards, the changeover of the pressure and wind pattern commences and north-north-easterly winds appear.

59. **Relative Humidity** The relative humidity is generally high during the period from July to September. It is about 45%-47% in June rising to a little less than 70% during August in West Rajasthan and to about 76%-77% in East Rajasthan. The diurnal variation in relative humidity is least during monsoon being higher in West Rajasthan. The relative humidity is least during the summer afternoons when it becomes about 20 to 30% in major parts of the state making the summer very dry and hot. The diurnal variation is highest during the period January and February.

B. Topography/Physiography and Landforms

60. The geography of Rajasthan is enriched with variable topographic features. The dry and the parched region are predominant in the major portions of the state. The main features of topography are rolling sand dunes, river-drained plains, rocky terrain, wetlands, plateaus, barren tracks, or land filled with thorny shrubs, wooded regions, and ravines. District wise topography of the project area is summarised in **Table 9**.

Table 9: Topography of the Project Districts

District	Topography	Elevation
Jodhpur	The western and north-western parts of Jodhpur district are characterized by sand dunes. With exception of some parts of Bilara and Osian Tehsil, the land surface of the district is nearly flat and sandy.	231m
Nagaur	Nagaur district is fairly even. The slope of the area is fairly even. The slope of the land surface is towards the west. The south-eastern part of the district comprises small scattered hillocks. The northern, north-western, and north-eastern parts of the district is having sand dunes.	302m
Churu	It is a part of the great Thar Desert. The terrain in general is sloping from south to north. There is no big hill in the district except some hillocks.	292 m
Hanumangarh	The topography of the district is almost plain with some hill formations in the southern part forming part of the Aravalli mountain range. The town is located in the transition zone where Aravalli mountain ranges end and a vast arid plain starts forming part of the Thar Desert characterized by sand dunes and scanty vegetation.	177 m
Alwar	The district lies in the north-easterly part of the Aravalli Range and presents an arch type of folded mountain belt. In the east and south east, the district has undulating topography. The central part of SSW of the district is covered by hill ranges trending from north-east to south-west ranging in heights from 625 to 771 above mean sea level. Hilly areas show ridge topography becomes more prominent in the south-western part of the district.	375m
Bharatpur	Topographically, isolated hillocks are found in the northern part with the vast area occupied by alluvium and windblown sand in the central part of the district. Low ridges are found in the southern and northern parts of the district.	350m
Banswara	Banswara district represents a rugged topography. The Eastern part of the district is occupied by flat-topped hills of the Deccan trap. There are scattered ranges of Aravallis in the eastern part of the district.	550m

C. Geology

61. From the oldest Archaean Metamorphic, represented by Bhilwara Super Group to sub-recent alluvium and wind-blown sand, Rajasthan is endowed with a continuous geological sequence of rocks (Map–2). A vast blanket of young unconsolidated deposits is present in western and north-western parts of the state which include the blown sand of the Thar Desert of western Rajasthan. A wide variety of hard rock which includes various types of metamorphic schist, quartzite, marble, and gneiss of pre-Cambrian age with associated acid and basic intrusive rocks remain exposed in the rest areas of the state**.** The major geological formation of the districts in which proposed roads are sited is summarized in the following **Table 10**.

Table 10: Major Geological Formation of Project Districts

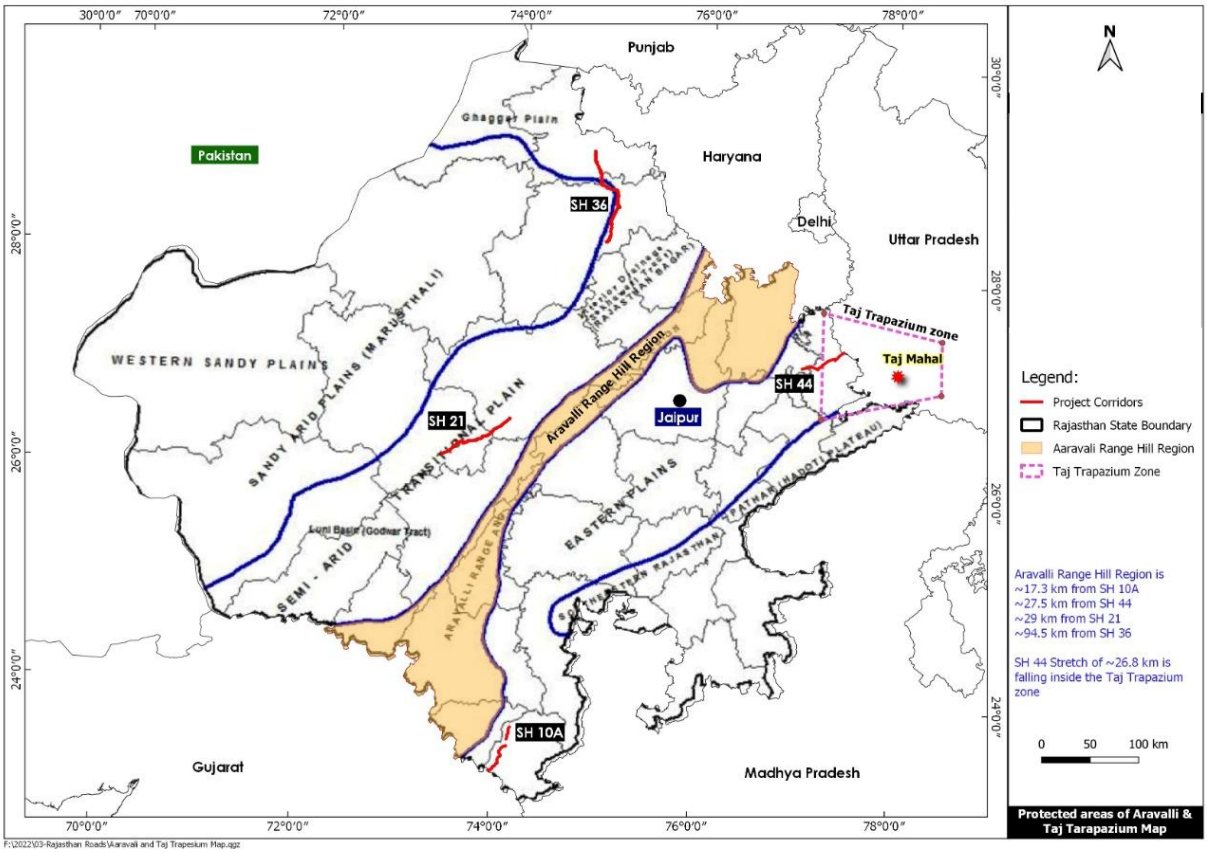
District	Major Geological Formation
Jodhpur	Erinpura granites and Malani igneous rocks cover a large area in the southern part. Marwar Super Group of rocks occupies maximum area covering the central, western, and eastern parts of the district. The rock units of various formations belonging to the Cenozoic era occupy a very small area and lie in the north-western part of the district.
Nagaur	Rocks belonging to Bhilwara Super Group, Delhi Super Group, Marwar Super Group, Palana Formation, and Quaternary alluvium. A few outcrops of gneisses of Bhilwara Supergroup have been exposed north-east of Nawa. The Delhi Super Group includes Alwar, Ajabgarh/ Kumbhalgarh, and Punagarh Group in descending order of antiquity. The rocks of Alwar Group are well exposed in the eastern part and comprise arkose, grit, conglomerate, and schist. The overlying Ajabgarh/ Kumbhalgarh Group of rocks are exposed between Kerikeri and Bijathal. The

District	Major Geological Formation
	overlying Punagarh Group of rocks (quartzite, slate phyllite, marble, etc.) occur as isolated outcrops. The rocks of Bhilwara Super Group and Delhi Super Group are structurally isoclinal and recline fold which is exposed along the south eastern margin (trend NE-SW) of the district adjacent to Ajmer district.
Churu	The longitudinal faults parallel in the NNE-SSW direction divides the district into two distinct geological units. The area lying east of Bandhnaw- Bidasar fault is known as the Sikar basin while the western fault is known as the Bikaner basin. In the eastern part of the district, the Pre-Cambrian crystalline basement has been uplifted, causing erosion of the upper horizon of Marwar Super Group and reduction in thickness of Palana series and Quaternary alluvium. The western part has a considerable thickness of Palana sediments
Hanumangarh	The district is divided into two units i.e. Younger Alluvium and older alluvium. Younger Alluvium covers the maximum area of the district whereas older 5 alluvium occurs only in the southern part of the district.
Alwar	Alluvial plains, Valley fill, Ravine, Flood plain (Fluvial), Pediment and Buried Pediment (Denudational), Sandy plains (Aeolian), Linear ridge, Denudational hill, Structural hills (hills).
Bharatpur	Different formations belong to Bhilwara super group, Delhi super group, Vindhyan group, and Quaternary alluvium from the geological framework of the district. About 85% area of the district is occupied by alluvium and wind blown sand
Banswara	Granites, Gneisses, and Schists of Bhilwara Super group, Phyllites, Schists and Quartzites of Aravalli Super group, and Deccan traps.

Source: District Groundwater Brochures, GWB.

62. Aravalli range is the principal mountain range of Rajasthan which is rich in natural resources including minerals and serve as check to the growth of the western desert. The range runs from Khetri in the northern east to Khedbrahma in southwest within Rajasthan for a length of 550 km. None of the Subproject roads are passing through Aravalli range. Subproject roads map superimposed on Aravalli range hill region is shown **Figure 4**.

Figure 4: Aravalli hill range and location of subproject roads



D. Soils

63. The Aravallis divide Rajasthan state into eastern and western Rajasthan. The soil improves infertility from west and northwest towards east and northeast. In many parts of the state, the soils are saline or alkaline. The soils of the State have been divided into the 7 groups (Map – 2) on the basis of their occurrence, chief characteristics, and suitability for cultivation. These soil types are Desert Soil, Grey and Brown (Desert) Soil, Red and Yellow Soil, Ferruginous Red Soil, Mixed Red and Black Soil, Medium Black Soil, and Alluvial Soils.

64. The soil type varies from district to district in the state of Rajasthan. The soil type of project districts is summarized in the following.

Table 11: Soil Formation of Project Districts

Jodhpur: Mainly red desertic soils in the central, eastern, and southern parts of the district. These are loose, well-drained and texture varies from sandy loam to sandy clay loam. Desert soils occupy northern and western parts of the district. These are mainly wind-blown sand and soils of interdunal depressions. Sand dunes occupy a small part in the northern and north-western margins. These are sandy to loamy sand and well-drained. Lithosols and regosols soils are found in hills and hill slopes of central and western parts. These are shallow, light-textured, fairly drained, and reddish-brown to grayish-brown in colour.
Nagaur: The general texture of the soil in the area is sandy loam to clayey loam which is further classified into “Barani” or un-irrigated and “Chahi” or irrigated soil. A part of Nagaur Tehsil and the south-eastern part of Merta tehsil have deep sandy loam, while red loamy soil exists elsewhere in Merta tehsil except on the banks of river Luni. Light loamy soil occurs in Parbatsar tehsil away from hill ranges. A longitudinal belt from Didwana to Nawa extending up to Sambhar Lake has the characteristics of alkaline soil.
Churu: The northern part of the district is covered with sand dunes while the southern part is occupied by desert soils. The desert soils are usually light yellowish-brown to yellowish-brown, calcareous sands with little clay. Their hydraulic conductivity goes up to 13.6 km/h, while the minimum available moisture recorded was 1.1 percent. The large fine sand fraction reflects their being mainly of aeolian origin.
Hanumangarh: The northern part of the district is covered by arid soils which are characterized by alluvial soils. These soils are loamy in character. The central part of the district is characterized by entisols, i.e., desert soils which are loamy along the Ghaggar river course. The southern part of the district is characterized by arid soils i.e. non-calcic brown desert
Alwar: Lithosol & regosol of hills (Red Grey valley Soil), Older alluvium (Older Alluvial, Soils), Recent alluvium (Red Sandy Soils).
Bharatpur: Greyish brown and yellowish-brown with wide variation in texture from sandy loam to clayey loam. The soils at some places are affected by salinity/ alkalinity. The soils of Bharatpur, Bayana, and Deeg subdivisions are fertile. In the north-eastern part of the district, the soils are compact and have low permeability, which causes water to stagnate on the surface during the rainy season.
Banswara: Black soil is found predominantly in the district mostly in northern, southern, central, and eastern parts. Red soil is mostly found in the western portion of the district from north to south

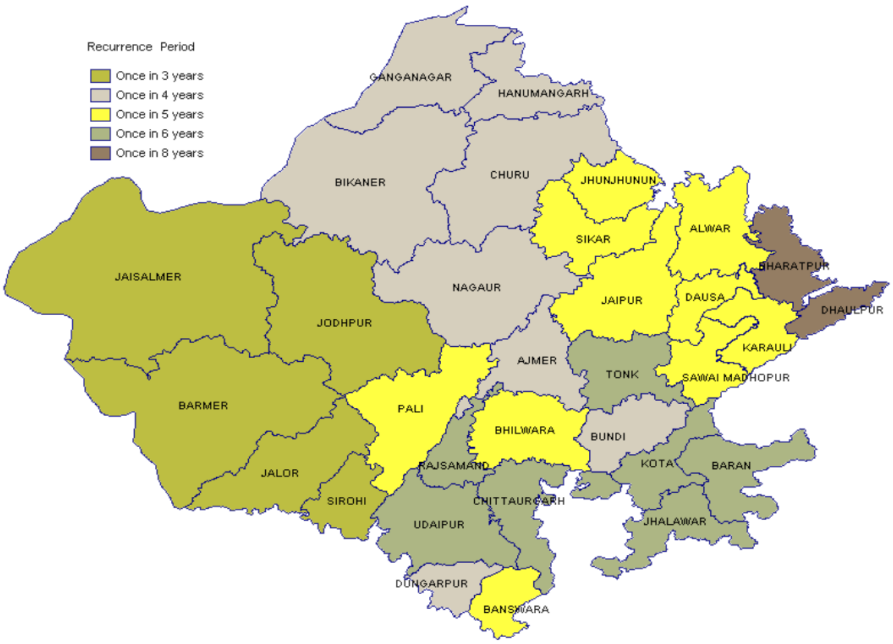
E. Natural Hazard

65. **Earthquake:** As per the seismic zone classification of India, the State of Rajasthan lies in Zone II i.e. least active zone. As per the BIS classification, the project road area is majorly classified as Zone II (least to moderate) except Bikaner, Barmer, and Jalore districts which are classified as Zone III (Moderate damage risk zone). **Figure 5** shows the earthquake zone of Rajasthan.

Figure 5: Earthquake Zone of Rajasthan

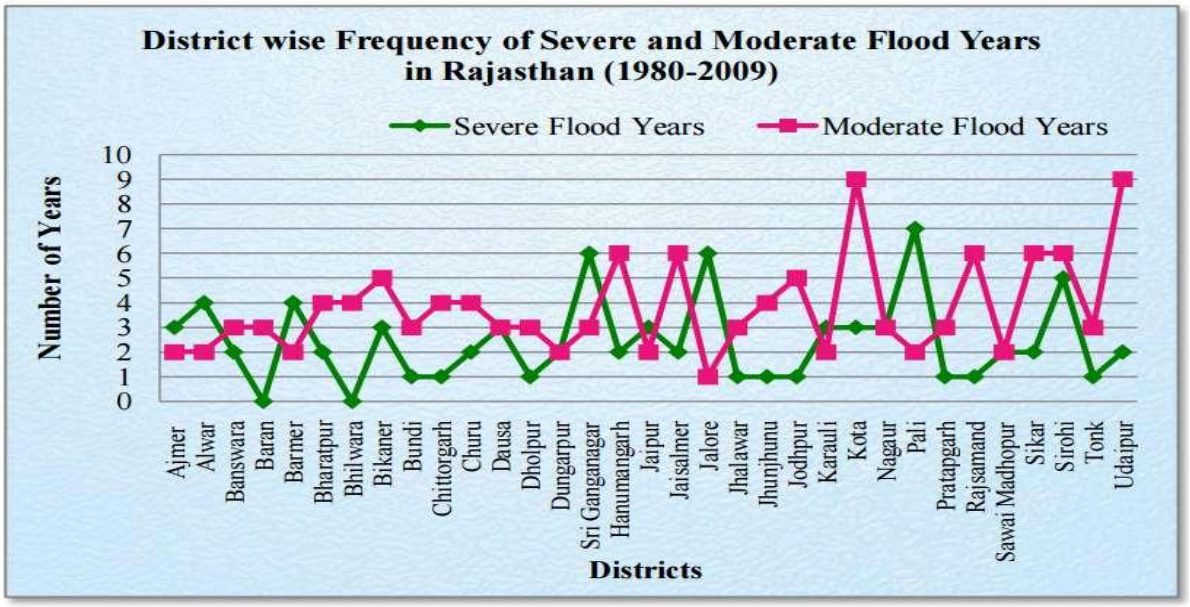
66. **Drought:** The state of Rajasthan has the maximum probability of occurrence of drought in India, with recurring droughts in 3–4 years in a cycle of 5 years (Mall et al., 2006) and this condition may deteriorate in terms of severity of droughts in Rajasthan (RPCB, GoR, 2010). Low rainfall coupled with the erratic behaviour of the monsoon in the state makes Rajasthan the most vulnerable to drought. In Rajasthan, there have been 48 drought years of varied intensity in the period 2001-2021, which means that the chance of occurrence of meteorological drought in the state is 47% (Rathore, 2004). The frequency of drought occurrence in the project districts is given in **Figure 6**.

Figure 6: Drought Frequency of various Districts in Rajasthan



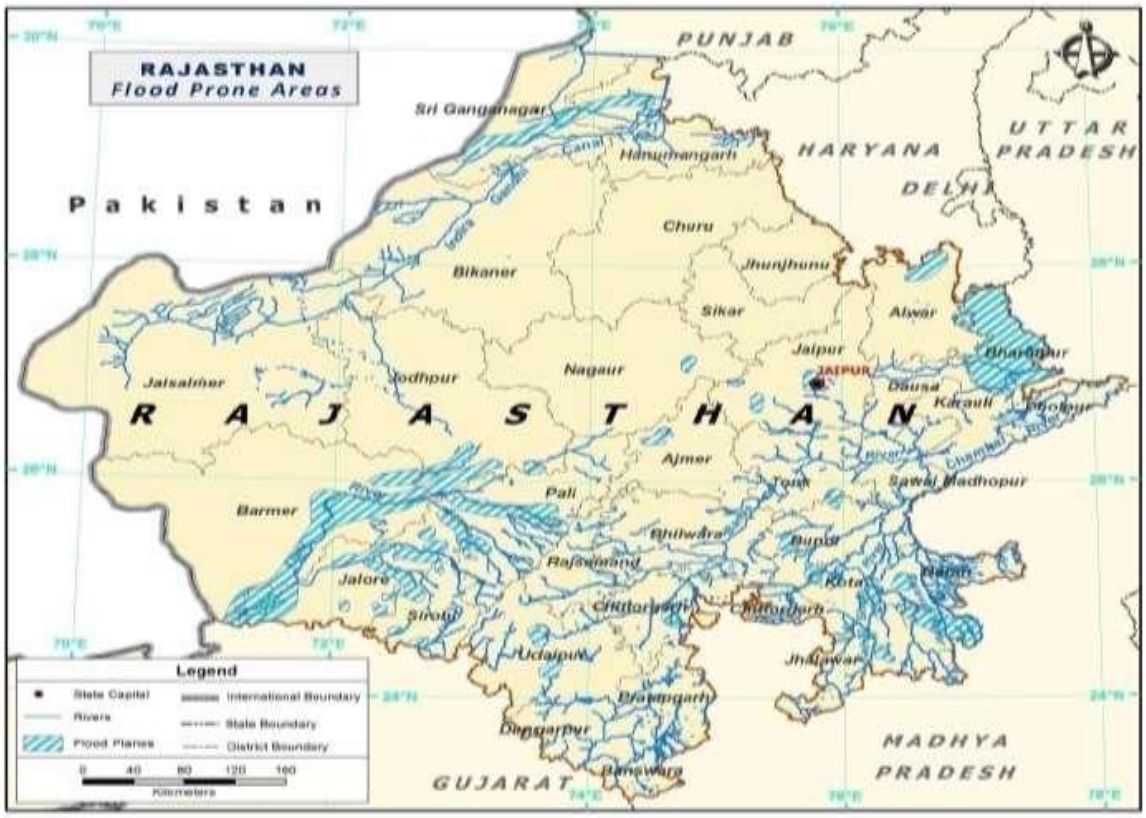
67. **Flood:** The state of Rajasthan is popularly known as the Desert State of India is largely water deficit yet there are incidents of flood in that state and there are flood-prone regions as well. The flood-prone regions in the state lie in Bundi, Ganganagar, Jalore, Jodhpur, Nagaur Pali, and Tonk districts. These regions spread across the Basins and Sub-Basins of the rivers Banas, Ghaggar, Luni, Banas. Graph–1 depicts the district-wise frequency of "Moderate Flood" and "Severe Flood" years in the state.

Figure 7: District wise frequency of "Moderate Flood"



Source: Flood Manual, Rajasthan (Disaster Management and Relief Department)

Figure 8: Flood-prone area map



Source: Flood Manual, Rajasthan (Disaster Management and Relief Department)

F. Land Use Land Cover

68. **Study Area and Influence Zone:** Land use of the study area and 10 km buffer zone majorly imitate the land use of the state. However, abutting land use of the sub-project corridors varies with each other. Land use along the 4 project roads was predominantly agricultural and wasteland with plantation. Organized roadside plantation has been done by local communities along most of its stretches. Detailed project-wise Land use and Land cover summary and maps are given in **Table 12** and **Figure 9** to **Figure 12**.

Table 12: Summary of Land use/ Land Cover in %

LULC	SH-21	SH-36	SH-44	SH-10A
Forest Deciduous	51.86	84.47	10.66	9.44
Agriculture Fallow	41.02	10.03	85.22	62.33
Forest Plantation	2.49	1.92	0.38	9.89
Grass / Grazing land	1.79	1.38	1.67	1.29
Built up Mining	1.07	0.83	0.46	0.19
River / Stream / Canals	0.90	0.70	0.63	2.81
Built up Rural	0.56	0.43	0.09	0.84
Barren/Uncultivable Salt affected land	0.08	0.06	0.04	6.54
Barren/Uncultivable Wastelands, Sandy area	0.07	0.05	0.00	0.00
Scrub Forest	0.07	0.05	0.43	2.32
Barren/Uncultivable Wastelands, Scrub land	0.05	0.04	0.16	4.13
Built up Urban	0.02	0.02	0.08	0.00
Water bodies/Reservoirs/Lakes/Ponds	0.01	0.01	0.00	0.00
Agriculture Crop Land	0.00	0.00	0.03	0.07
Barren rocky	0.00	0.00	0.13	0.14
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**

Figure 9: LU/LC-Dantiwara-Merta City Road

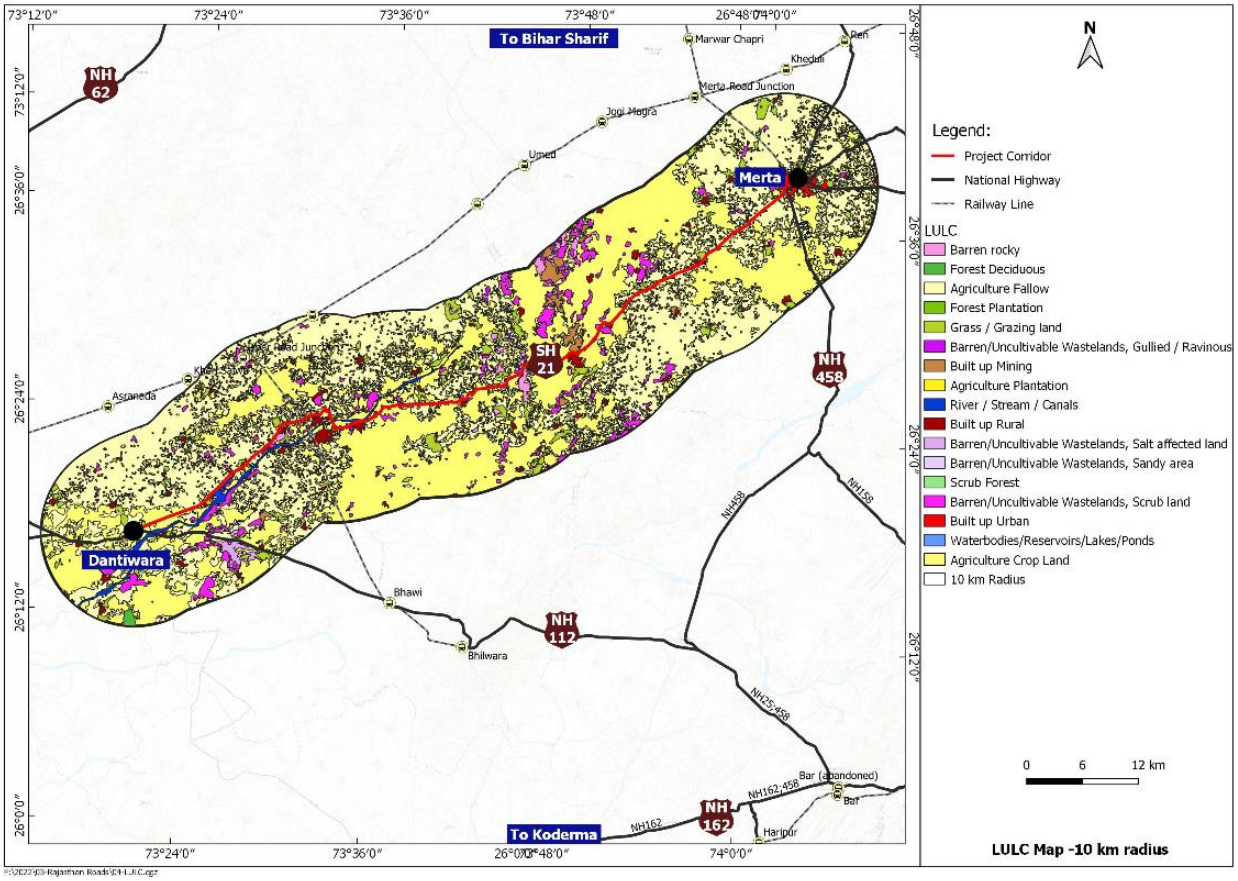


Figure 10: LU/LC-Churu-Taranagar-Nohar Road

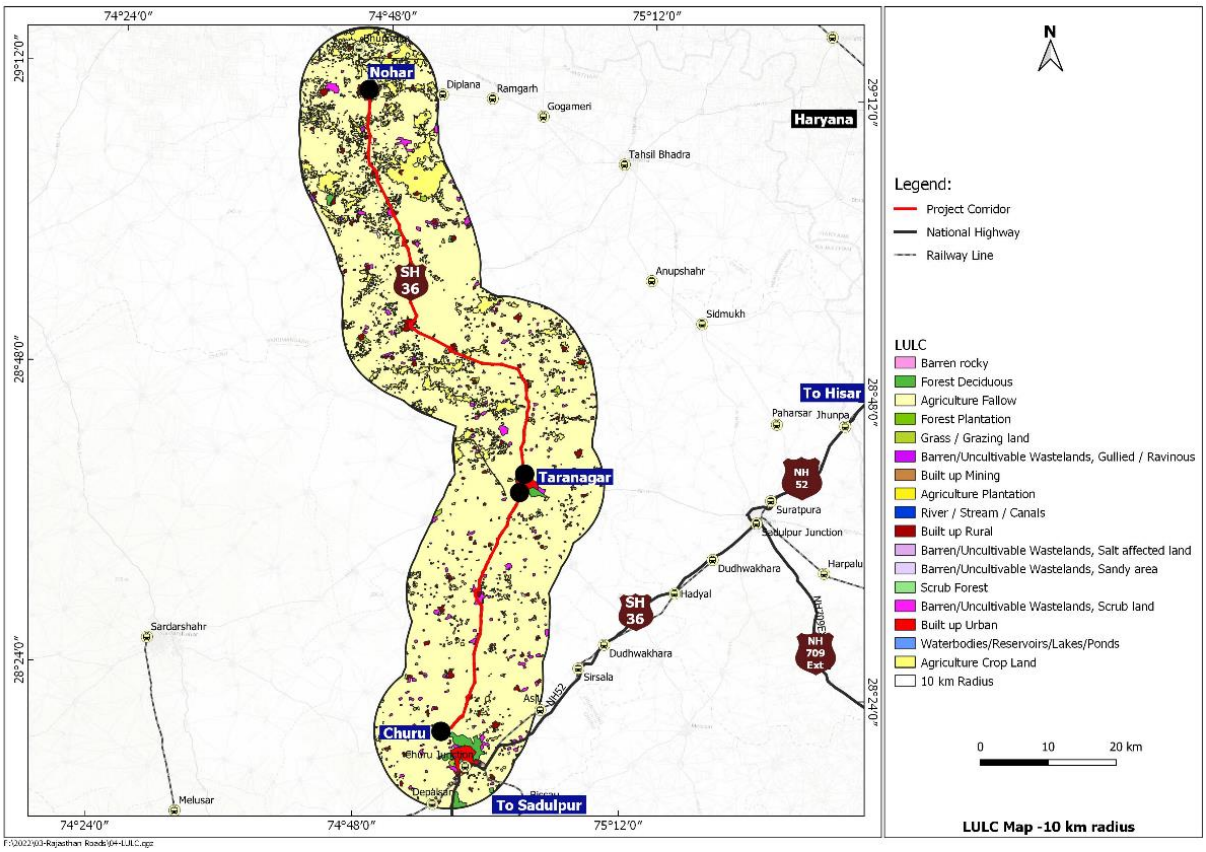


Figure 11: LU/LC Kherli-Nadbai-Kumher Road

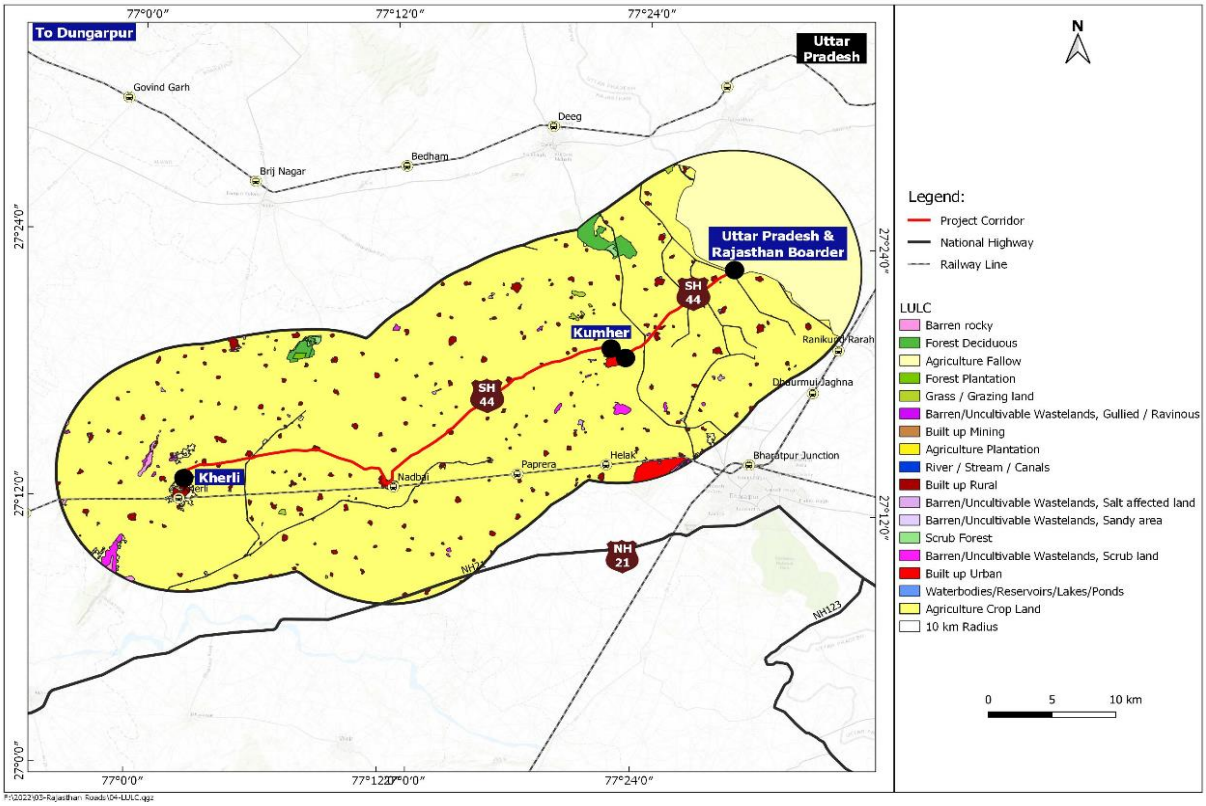
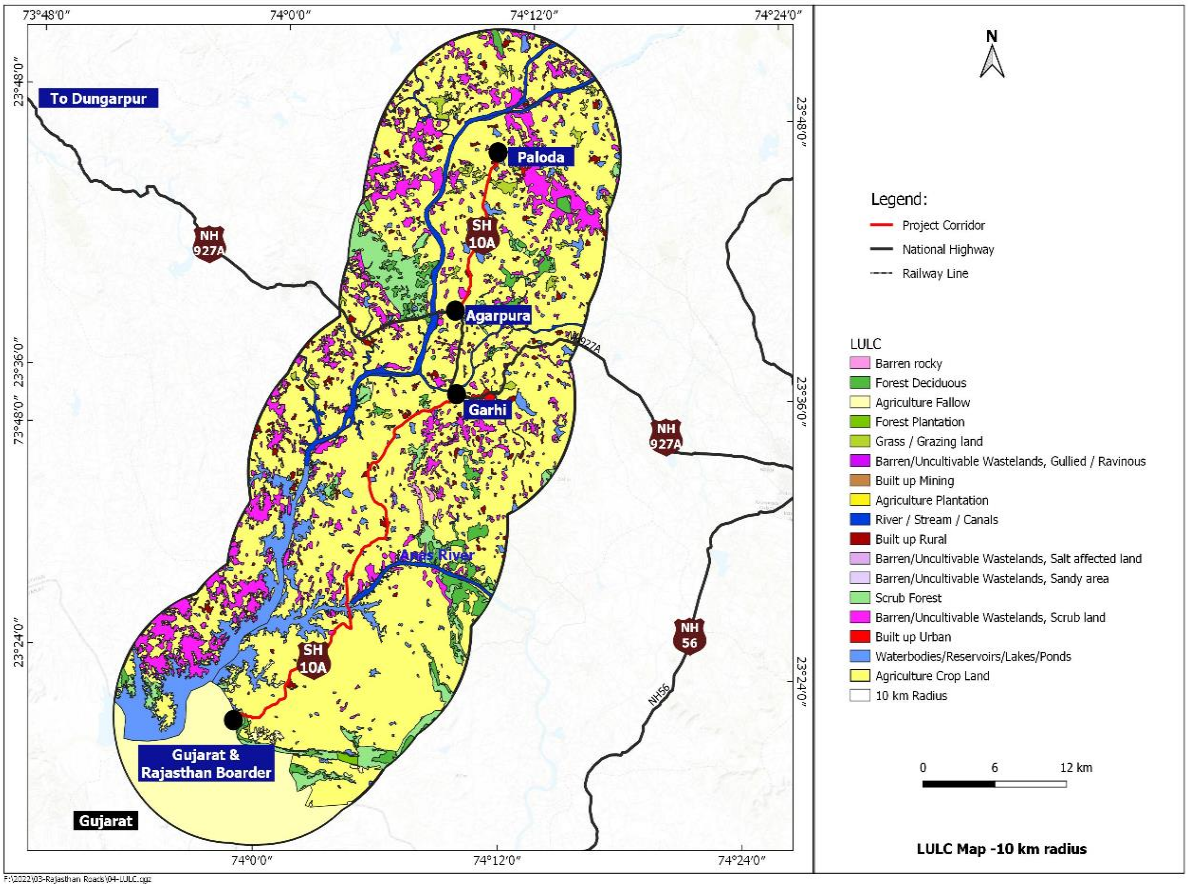


Figure 12: LU/LC Paloda-Garhi-Ananapuri Road



G. Air Quality

69. Projects areas are characterized mainly by rural/open areas and intermittently traversed by a few semi-urban settlements/built-up areas. Sources of air pollution in projects areas are mainly vehicular emission, dust emanation due to use of unpaved shoulders/deteriorated roads by vehicles, and domestic fuel burning as the project area is rich in vegetation, all such emissions will be very well dissipated.

70. Monitored parameters of ambient air quality largely meet the prescribed limit (Appendix B) of World Bank (WB), National Ambient Air Quality Standard (NAAQS), and Central Pollution Control Board (CPCB) except particulate matter (PM10) and Carbon Mono oxide (CO). At no project site, Particulate matter (PM10) has been found higher than the permissible limit. Increased levels in these areas may be attributed due to poor road conditions and high traffic density. Detailed 24 hourly data is appended as **Appendix B**. Compliance status of Air quality data is presented in **Table 13**.

Table 13: Status of AAQ in the Project Areas

S. No.	Particulars	WB EHS (in µg/m^3)	GOI NAAQS (in µg/m^3)	Remarks
1	Dantiwara-Merta City Road	✓	✓	All parameters are meeting WB interim target GOI limits.
2	Churu-Taranagar-Nohar Road	✓	✓	
3	Kherli-Nadbai-Kumher Road	✓	✓	
4	Paloda-Garhi-Ananapuri Road	✓	✓	

Note: ✓ within limits X- above limits

H. Noise Level

71. Traffic noise is the principal source of noise in the project area. The area mostly includes rural open areas with a good vegetation cover and therefore the noise levels are relatively low. Noise level monitoring indicates that the noise level mostly meets the prescribed noise standards (Appendix C) for all land use categories viz. commercial, industrial as well as residential zones. There is no continuous sound frequency of impulsive nature near industries. It is anticipated that noise levels will decrease significantly after road expansion and improvement work enabling decongestion at existing built-up areas. The noise level in the projects areas has been appended as Appendix C. Compliance status of Noise quality data is presented in **Table 14**.

Table 14: Compliance Status of NAAQ around the project area

S.No	PARTICULARS	WB EHS					GOI NAANS							
		Res		Inst		Indl	Res		Indl		Comm.		Sensitive	
		D	N	D	N	D/N	D	N	D	N	D	N	D	N
1	Dantiwara-Merta City	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Churu-Taranagar-Nohar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Kherli-Nadbai-Kumher	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Paloda-Garhi-Ananapuri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: ✓ within limits X- above limits, Res: Residential, Instl: Institutional, Indl: Industrial

I. Groundwater

72. Rajasthan covers 10.5% of the country's geographical area but shares only 1.16% of its water resources. It is the driest state with nearly 70 percent of the area classified as an arid and semi-arid region. Rajasthan has always been a water deficit area. Water resources in the state are not only scarce but have a highly uneven distribution both in time and space with most of the available water resources being confined to the south and south-eastern part of the State. The condition has deteriorated very fast in the last two decades. The stage of groundwater exploitation, which was just 35% in the year 1984, has reached a level of 150% in 2021. At present, Rajasthan has 248 water blocks, out of which 44 are in the safe category, 28 (semi-critical), 9 (critical), and 164 are over-exploited. Only Churu district out of all project districts is completely notified by Central Ground Water Authority (CGWA).

Table 15: District-wise Groundwater Details

District	Water Bearing Formation
Jodhpur	Unconfined to semi-confined conditions in rocks of Delhi Super Group, Jodhpur sandstone, Bilara limestone, Nagaur sandstone, Lathi sandstone, and unconsolidated sediments. These form the chief source of ground water. Confined condition is also met at deeper levels in the north-western part
Nagaur	The consolidated formations comprise metamorphics of Precambrian age and limestone & sandstone of Marwar Super Group. Metamorphic are normally impervious except in the presence of a few weak planes, joints, weathered zones, and kinks which contain limited quantity of ground water.
Churu	Unconsolidated alluvium to semi consolidated sandstones and consolidated schistose rocks. Aquifer of Quaternary alluvium and Aeolian sand. The major part is covered with Aeolian sand and alluvium which forms the chief source of ground water. The alluvium comprises fine to coarse-grained sand, with gravel and pebbles, silt and clay with Kankar.
Hanumangarh	Quaternary Alluvium overlain by windblown sand in the central part and by high dunes in the Southern Part. In the northern part and the Ghaggar flood plain, alluvium is without any sand cover. Alluvium is mostly fluvial and consists of an alternating sequence of sand, silt, and clay. The thickness varies from 100m in the southern part to over 400m in the northern part.
Alwar	Confined conditions in phreatic zones, semi-confined conditions in deeper zones, and weathered & fractured portions of the hard rocks.
Bharatpur	Shallow depths ranging from 25 – 30 m to less than 5 m and at places almost at ground level after the rainy season. In most of the area, groundwater is phreatic, but semi-confined conditions occur in the central and eastern parts of the district. Groundwater is mainly found in the Quaternary, unconsolidated beds. Weathered zones, fractures, joints in hard rocks also yield a good amount of groundwater.
Banswara	Unconfined condition in the saturated zone of rock formation. The movement of groundwater in hard rock areas is governed by size, openness, interconnection, and continuity of structurally weak planes. In alluvium, ground water occurs in interstitial pore spaces among the grains.

J. Groundwater Quality

73. Monitored parameters largely conform to the drinking water standards (IS:10500-1991) prescribed by the Bureau of Indian Standard. This was also ascertained by the study done by Central Ground Water Board (CGWB) in the project districts. Project site-specific compliance of the permissible and desirable limit is tabulated as under.

Table 16: Compliance Status of Ground Water Quality around the project area

Road	GOI LIMITS		REMARKS
	Desirable	Permissible	
SH-21	✓	✓	Monitoring reports suggest All parameters in desirable as well as in permissible limits as per IS-10500:2012.
SH-36	✓	✓	
SH-44	✓	✓	
SH-10A	✓	✓	

Source: Baseline Monitoring conducted at project sites.

K. Surface water Quality

74. Surface water resources in the state are in a precarious situation. Except in the canal command area in the north, surface water potential is very low in the central, western, and southern parts of the state (CAZRI, 2009).

75. The total surface water available in the state is 21.71 BCM, out of which 16.05 BCM is economically utilizable. The state has so far harnessed 11.84 BCM which is 72% of an economically utilizable portion (State Water Policy, 2010).

76. Constant drinking water supply is available in the project district by Government supply. Jodhpur and Nagaur, Churu, Hanumangarh, Alwar, Bharatpur, Banswara, are getting constant water supply from Apni Yojna of the Government of Rajasthan. Surface water is not used for drinking or domestic purpose in the project area except for outdoor bathing, cattle feeding, and irrigation at some places. Although surface water samples from rivers and ponds have been analyzed to confirm its suitability for different classes prescribed for freshwater classification by CPCB. Analyzed samples are summarized in **Table 17** for compliance with the prescribed limits.

Table 17: Compliance Status of Surface Water Quality around the project area

Road	GOI (CPCB)			REMARKS
	Drinking-Water Source without conventional treatment but after disinfection	Outdoor bathing (Organised)	Irrigation	
SH-21	✓	✓	✓	As per monitoring reports water is fit for all usage
SH-36	✓	✓	✓	
SH-44	✓	✓	✓	As per monitoring reports water is fit for all usage
SH-10A	✓	✓	✓	As per monitoring reports water is fit for all usage

L. Waterways and Water Bodies

77. Projects roads are crossing one river and there are a number of ponds/stagnant water bodies. All waterways and water bodies have been listed in **Table 18**.

Table 18: List of waterways/ Water Bodies

Road	Ch. Km	Side	Water Body/Waterway	Type
SH-21	25.605	LHS	Pond	Non-Perennial

Road	Ch. Km	Side	Water Body/Waterway	Type
	25.856		Pond	
	26.520		Nallah	
	27.124		Pond	
	30.954		Pond	
	41.050		Pond	
	42.900 to km 43.250 (B/S)		Nallah	
	45.831		Pond	
	47.042	RHS	Pond	
	47.603	RHS	Pond	
	52.710 to km 52.910	RHS	Pond	
SH-36	89+100	LHS	Pond	Non-Perennial
SH-44	4+450	LHS	Kharand River	Non Perennial
			Pond	Perennial
	11+400	Crossing	Canal	
SH-10A	Mor	RHS	Ponds	perennial river
	Metwala			
	Garhi		Nallah	
	34+00	LHS	Ponds	
	36+900			
	52+700			
	55+600	Crossing	Anans River	

M. Ecological Resources

State Profile

78. **Forest:** Rajasthan state is largely arid for the most part. Only 9.5 % of the state's total geographical area is recorded as forest. The forests of Rajasthan are spread unequally in the northern, southern, eastern, and southeastern parts. The total reserved and protected forest areas are 12, 453.92 and 17, 415.00 sq. Km respectively and the unclassified forest constitutes about 2, 768.86 sq.km. The extent of Natural Forests in Rajasthan is not only one of the lowest in the country but also low in terms of forest productivity. On the contrary, the State is endowed with the largest expanse of wasteland, which is about 20% of the total wastelands of the country.

79. **Forest in the Project Districts**: All Project districts have very less forest cover compared to state (9.67%) Proportion of open area forest is highest followed by moderately dense forest and very dense forests. Forest cover in different canopy classes of the project districts is given **in Table 19**.

Table 19: Forest Cover in Project Districts

S. No	Name of District	GA in Sq. Km	Very Dense Forest	Moderately Dense Forest	Open Forest	Forest area in Sq. Km	% in GA
1	Jodhpur	22, 850	0.00	4.55	103.23	107.78	0.47
2.	Nagaur	17, 718	0.00	15.00	132.04	147.04	0.83
3.	Churu	16, 830	0.00	3.00	79.00	82.00	0.59
4.	Hanumangarh	9, 656	1.00	7.00	81.96	89.96	0.93
5.	Alwar	8, 380	59.00	334.96	802.70	1, 196.66	14.28
6.	Bharatpur	5, 066	0.00	22.00	208.27	230.27	4.55
7.	Banswara	4, 522	0.00	38.57	229.85	268.42	5.94

Source: Forest Survey of India 2019-20

80. **Forest along the Project Roads**: Project road is not passing through any reserve forest; protected forest. Hence project road does not require forest clearance.

N. Trees within Right of Way

81. The road side plantation is the mixed type and natural regeneration is seen. A total of 5, 904 trees have been enumerated within the right of way. The predominant species in the project district are Neem, Babul, Khejri, and Ardu. The majority of trees are of girth size is between 60-90 cm. All efforts will be made to restrict the tree cutting to toe line of the formation width considering the safety issue. Details of the trees enumerated in the project district are given in **Table 20**.

82. **Flora:** The study area is mostly open, followed by agricultural crops interspersed with few trees between cultivated crops, on the bunds of the fields and distributed with shrubs and seasonal herbs. Trees such as *Acacia nilotica* subsp. *Indica* (Kikar), *Acacia tortilis* (Israeli Kikar), *Tamarindus indica* (Imli) are distributed all along the site. Due to the semi-arid climatic conditions, the study area is mostly open, dry with few standing trees, common shrubs such as *Calotropis procera* (Aak) *Carissa spinarum*, *Tephrosia purpurea* and *Agave americana* are commonly sighted and herbaceous flora dominated with *Tridax procumbens*, *Tribulus terrestris*, *Cyperus rotundus* & *Cymbopogon martini* in the monsoon seasons.

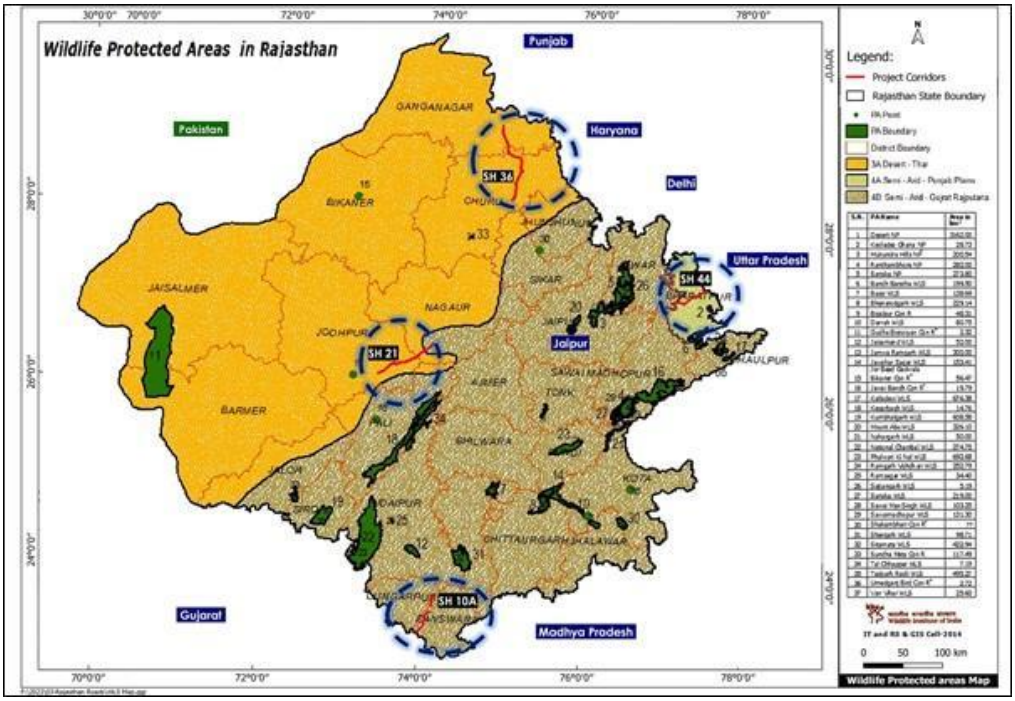
Table 20: Affected Trees due to Project Development

Road Section	Girth Size of Affected Trees (in cm)					
	30-60	60-90	90-120	120-180	>180	Total
SH-21	247	128	325		475	1075
SH-36	122	278	175	425	2014	3014
SH-44	162	158	136	234	592	1192
SH-10A	325	400	1050	550	2050	4325
Total						9606

O. Eco-sensitive Zones, Key Biodiversity/Protected Areas, and Wildlife

83. **Protected area Network:** In Rajasthan there are 5 National Parks, 25 Wildlife Sanctuaries, 11 Conservation reserves. & 3 Biological reserves. None of the sub projects roads are passing through any PA or its Buffer areas/Eco sensitive Zones (ESZ). No Biosphere Reserves are present as notified by UNESCO. protected areas in Rajasthan and subproject roads superimposed on Protected Area Network of Rajasthan are shown below.

Figure 13: Sub project roads superimposed on Protected Areas



84. **Fauna**: Common mammals include Blacknaped hare (*Lepus nigricollis*), Common Indian Mongoose (*Herpestes j*avanicus), Hanuman langur (*Macaca radiata*), Nilgai (*Boselaphus tragocamelus*), Little Indian and Bandicoot rat (*Bandicota indica*) are the common species. The common bird species of the area include Spotted Dove (*Streptopelia chinensis*), Rose ringed Parakeet (*Psittacula krameri*), Red vented bulbul (*Pycnonotus cafer*), Black drongo (*Dicrurus macrocercus*) and Small green bee-eater (*Merops orientalis*).

85. Except for erratic and undefined movement of wild animals, mainly that of Nilgai (Blue, bull, *Boselaphus tragocamelus*) which is reported in most of the projects, no other IWPA schedule or IUCN listed threatened species are reported in the subproject roads. This species is under Schedule-III of wildlife act and not assessed as per IUCN. Due to its large population causing heavy crop damage, MOEF& CC has issued an advisory to include it in the Vermin category of Schedule V so that killing/hunting of such animals is the outside purview of regulations. State Government has nominated Tehsildar, Ranger officers, and other officers of the same level to be the competent authority for the killing of such animals. No other species under threatened category are recorded in the subproject roads.

86. Subproject SH 10A passing through perennial Anas River, which is a tributary of Mahi River. Most of the fishes recorded in Mahi River are commonly found in the inland water bodies of India. As per IUCN (2015) status of different fish species recorded from the Mahi River is concerned *Tor khudree* (Sykes, 1839) is Endangered (EN), *Ompok bimaculatus* (Bloch, 1794), *Wallago attu* (Bloch and Schneider, 1801) and *Chitala chitala* (Hamilton, 1822) in Near Threatened (NT) and remaining fish species are included in Least Concerned (LC) category http://recordsofzsi.com/index.php/zsoi/article/view/141307 /101112. In the present proposal no interventions are proposed over the river since already 2-lane bridges are available.

87. Since the Sub project Roads are not passing through any reserve forest, no wildlife movement is recorded/observed during the site investigation. All the subproject roads fall in the climatic region of semi-arid, where winters are dry and even in summers there is not enough rainfall. Most of the roads are passing through the agricultural lands predominantly cultivated by wheat as main crop, mostly restricted to single crop per season.

P. Critical Habitat Assessment

88. Guidance on critical habitat assessment is provided in the ADB SPS as well as under the International Finance Corporation (IFC) Performance Standard (PS) 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources. The ADB SPS includes 6 criteria and the IFC PS6 includes 5 criteria for critical habitat assessment. The ADB SPS includes 6 criteria and the IFC PS6 includes 5 criteria for critical habitat are assessed.

89. Integrated Biodiversity Assessment Tool (IBAT) was used to screen the presence of key biodiversity areas (KBA) within the project area, particularly for subproject SH 10A which is passing through perennial Anas River, a tributary of mahi river. It was determined through the screening that no KBA or Protected Areas (PA) were noted at least 30 km radius distance from the subproject road. None of the other criteria are triggered in the present assessment. Remaining subproject roads are in the agricultural and open lands, no protected areas are located. Hence, the project influence area does not trigger critical habitat for both ADB SPS and IFC PS6. Therefore, it is concluded that the project area is not a critical habitat for any Endangered/Endemic species. Moreover, Tranche 3 roads are located within modified habitats such that there will be no natural habitat loss.

Q. Economic Development

90. Rajasthan's economy is predominantly agricultural and rural with fluctuations in the growth rate of the NSDP (Net State Domestic Product) because of the uncertainties in agriculture as it is almost entirely dependent on rainfall. The Gross State Domestic Product (GSDP), Net State Domestic Product (NSDP), and Per Capita Income (PCI) are key parameters to assess the economic performance of the state during a specific period of time. The trend of the past few years (2015-20) indicates an upward trend in the GSDP/NSDP and PCI both at current and constant prices in the state (State Economic Review, 2019-20). The State GSDP estimates at current price and constant prices for the year 2019-20 show an increase of 8.97% and 2.51% respectively over the previous year. For NSDP, these increases turn out to be 8.80% and 2.21% respectively. The PCI estimates at Rs 28, 885 at the current price (2019-20) also show an increase of 6.98% over the previous years (State Economic Review, 2019-20).

R. Agriculture and allied sector

91. The Agriculture and allied sectors play a significant role in the State economy. It includes the agriculture, animal husbandry, forestry, and fishing sectors, which contribute about 20 to 34% to the State's economy (State Economic Review, 2019-20). Agriculture in Rajasthan is mostly dependent on rainfall that mostly remains scanty, low, and irregular. Despite low rainfall, Rajasthan is among the largest producers of edible oils in the country and the second-largest producer of oilseeds. Rajasthan is also the biggest wool-producing state in the country. The main food grain crops of the state are maize, wheat, rice, jawar, bajra, and pulses. The other main agricultural products include oilseeds, groundnut, and vegetables. Rajasthan is known for its spice production. The chili of Mathania is famous throughout India. The Pushkar region of Rajasthan is renowned for its horticulture and produces Rose flowers. The state also produces herbs and aromatic products.

S. Industries and Mineral Resources

92. Industries: The Industrial sector also plays a significant role in the State economy. It includes mining, quarrying, manufacturing, utilities such as electricity, gas and water supply, and the construction sector. Together these sectors contribute about 26 to 30 % to the State's economy (State Economic Review, 2019-20). The mineral-rich state is fast emerging as a prominent industrial destination in the country. Major industries are textiles and wool, sugar, cement, glass, sodium plants, dyes, pesticides, zinc, fertilizers, railway wagons, ball bearings, water and electricity meters, television sets, synthetic yarn, and insulating bricks.

93. Minerals: The State is geologically a veritable repository of minerals. There are about 64 different kinds of major and minor minerals produced in the State, contributing an annual revenue of more than Rs. 600 crores. Rajasthan is the sole producer of garnet (gem variety), jasper, and wollastonite. Almost the entire production of zinc (concentrate), calcite, asbestos, and gypsum in the country was reported from Rajasthan. Besides, Rajasthan is the leading producer of ball clay (40%), feldspar (70%), fluorite (graded) (59%), Kaolin (44%), lead concentrate (80%), ochre (72%), phosphorite (79%), silver (54%), steatite (85%), barites (53%), copper (34%), quartzite (33%) and silica sand (21%).

T. Infrastructure Facility

94. Roads: The total road length in the state of Rajasthan is 1, 86, 086 km out of which 1, 12, 717 km is with PWD, Rajasthan. This includes National Highways, State Highways, major district roads, other district roads, and village roads. There are 20 National Highways passing through the state of Rajasthan. The total length of these is 5, 722 km, out of which for the present 1, 447 km has been transferred to NHAI.

95. **Railway:** Rajasthan has a good railway network with a total length of about 5911 km, out of which 3842.15 km (65 %) is under broad gauge. During the year 2008, the total length of railways was 5683.01 km, out of which almost 3885.47 km (68.37%) was covered under broad gauge, 1, 710.78 km (30.10%) under meter gauge and 86.76 km (1.53%) under narrow gauge. The national average railway route length per 1000 sq. km. of geographical is 19.23 km. The same in Rajasthan is 17.05 km. One of the most important means that contributes significantly to the state's revenue collection and the economy is the super luxurious train-Palace on Wheels.

96. **Aviation**: Rajasthan has full-fledged airports at Jaipur, Bikaner, Kota, Jodhpur, Udaipur, and Jaisalmer. Jaipur has recently been designated as an international airport at Sanganer.

97. **Power:** The total installed generation capacity in the State is 7, 716.63 MW of which the state generates about 4, 820.30 MW; 3, 847 MW from state sector projects (RVUN), and 972.95 MW from partnership projects. The state also gets 1, 878.18 MW of power from the central government. Apart from conventional power generation, the state also generates 883.145 MW of power from non-conventional sources like the wind (851.84 MW) and Biomass (31.30 MW) respectively.

U. Social and Cultural Resources

98. Demography: According to the 2011 census the total population of the state is about 68.5 million. The population density of the state is 201 per sq. km. (compared to the country's average of 436 sq. Km). The decadal growth rate recorded during the previous decade at 28.41% is higher than the national level of 21.5 %. Over 76% of the population resides in rural areas. The number of females per 1000 males (sex ratio) in Rajasthan was 951 in 2011 and had shown an increase as compared to that in 2001 at 931. The future demographic projections suggest a further increase. Facts and figures about the demography of the project districts are summarized in **Table 21**.

Table 21: Demography of the Project Districts

Indicators	Jodhpur	Nagaur	Churu	Hanumangarh	Alwar	Bharatpur	Banswara
Area Sq. Km	22, 850	17, 718	13, 835	9, 656	8, 380	5, 066	4, 522
Population	3.68	3.3	2.03	1.42	3.45	2.54	1.79
Male	1.92	1.69	1.05	0.75	1.82	1.35	0.9
Female	1.76	1.61	0.98	0.67	1.63	1.19	0.89

Population Growth (%)	27.74	19.20	6.1	16.91%	22.78	21.29	26.53
Density/km2	161	187	147	184	438	503	397
Sex Ratio	916	950	940	906	895	880	980
Child Sex Ratio	891	897	902	878	865	869	934
Average Literacy	65.94	62.80	66.75	67.13	70.72	70.11	56.33
Male Literacy	78.95	77.17	78.78	77.41	83.75	84.10	69.48
Female Literacy	51.83	47.82	54.04	55.84	56.25	54.24	43.06
Child proportion (%)	16.45	15.33	15.58	13.20	16.00	17.11	18.10
Boys proportion (%)	16.67	15.76	15.89	13.20	16.26	17.21	18.53
Girls Proportion (%)	16.21	14.88	15.25	12.98	15.72	17.01	17.65

Source: Census Survey, 2011

99. **Educational Facility**: There has been a leap in the literacy rate in the last ten years. The literacy rate has grown from 61% in 2001 to over 67% in 2011. Primary education is free and mandatory for all children in the state. At present, the state has nine universities and more than 250 colleges, 55, 000 primary and 7, 400 secondary schools. 41 engineering colleges at present. There are 23 polytechnics and 152 Industrial Training Institutes (ITIs) that impart vocational training. The state has 10 medical colleges, 8 dental colleges, and 28 pharmacy institutes. Rajasthan also has 26 Management Institutes.

100. **Health Infrastructure:** Rajasthan has 108 hospitals, 1612 primary health centres(PHCs) in the rural areas and 37 in the urban area, 12, 701 sub-centres, 428 CHCs, 195 dispensaries, 118 Maternity and Child welfare centres, and 37, 417 inpatient beds. The broad objectives of the state's Department of Health include enhancing maternal and child healthcare, stabilizing population growth, and improving nutritional status.

101. **Tourism:** Rajasthan is a land of great beauty and diversity. From the Thar Desert in the west to the fertile South-eastern plains enhances the beauty of the state. The main cities in Rajasthan enjoying the benefit of tourist attraction are Jaipur, Jodhpur, Udaipur, Mount Abu, Bikaner, Churu, Hanumangarh, Jaisalmer, Chittor, Bharatpur. Alwar and Banswara. The customs and traditions, fairs and festivals, handicrafts, art, and music reflect the very broad spectrum of the Rajasthani culture where much of the Rajasthani thought, philosophy, and culture is being reflected all over the state.

102. **Archaeological and Historical Monuments and Sensitive Receptors**: There are no archaeological or historical monuments along the project's roads. However, there are a number of religious structures and other community property resources (CPR)20 including sensitive receptors like schools and health centres. List of all sensitive receptors have been listed in road-specific EMPs. In addition to the specific sensitive structures enlisted in the tables above, there are a few residential areas or towns (residential cum commercial areas) along the project's roads.

Table 22: Noise Sensitive Structures along Sub-Project Roads

S. No	Chainage (km)	Type of receptor	Boundary wall from c/l (m)	Distance from classrooms	Side
Dantiwara-Merta City Road					
1	8.200	School	15	30	LHS
2	8.900	School	20	200	RHS
3	13.800	School	10	30	RHS

20 In India CPRs are structures or facilities that belong to a community such as hand pumps, wells, schools, health centers, temples, grave yards etc. Some Physical Cultural Resources (PCR) such as temples can also be a CPR if it belongs to the community

S. No	Chainage (km)	Type of receptor	Boundary wall from c/l (m)	Distance from classrooms	Side
4	13.900	School	20	40	RHS
5	14.200	School	50	150-200	RHS
6	14.900	School	15	50	LHS
7	17.100	School	20	120	RHS
8	20.100	School	15	150	LHS
9	27.600	School	15	60	RHS
10	29.200	School	5	150	LHS
11	31.800	School	7	45	LHS
12	41.900	School	No compound wall	35	RHS
13	42.300	School	5	30	RHS
14	43.400	School	3	10	RHS
15	47.350	School	5	50	RHS
16	47.650	Health Centre	8	50	RHS
17	51.325	School	15	30	RHS
18	55.100	School	3	15	LHS
19	56.400	College	15	80	LHS
20	62.230	School	10	30	RHS
21	63.700	School	12	40	LHS
22	74.050	Health Center	10	20	RHS
23	74.200	School	50	250	RHS
24	84.600	School	20	50	LHS
25	85.800	School	15	50	LHS
Churu-Taranagar-Nohar Road					
1	9+400	School	20	120	LHS
2	26+200	School	8	40	LHS
3	3+.970	School	00	60	LHS
4	40+600	School	1.5	60	RHS
5	42+300	School	8	90	LHS
6	46+050	School	2	80	RHS
7	54+200	School	50	150	RHS
8	71+500	School	2	70	LHS
9	72+500	School	5	90	RHS
10	72+600	School	15	90	RHS
11	78+600	School	5	50	LHS
12	78+700	School	5	100	LHS
13	96+100	School	5	80	RHS
14	109+300	School	12	100	LHS
15	113+100	School	00	90	LHS
16	113+700	School	5	150	LHS
Kherli-Nadbai-Kumher Road					
17	4+700	School	5	200	LHS
18	10+010	School	5	100	LHS
19	15+300	School	40	60	RHS
20	15+600	School	5	50	RHS
21	16+600	School	00	5	RHS
22	18+500	School	00	12	LHS
23	18+700	School	04	15	LHS
24	19+300	School	05	120	LHS
25	33+500	School	5	20	LHS
26	35+400	Primary Heath Center	5	5	LHS
Garhi-Anandpuri Section of Road					
1	00+200	School	3	10	RHS
2	00+550	Hostel	5	8	LHS
3	1+820	School	00	10	LHS

S. No	Chainage (km)	Type of receptor	Boundary wall from c/l (m)	Distance from classrooms	Side
4	2+400	School	00	50-60	LHS
5	4+300	School	00	5	LHS
6	9+800	School	3	5	LHS
7	13+400	School	3	30	LHS
8	20+400	School	5	5	LHS
9	24+900	School	00	15	LHS
10	25+400	Hospital	10	10	RHS
11	32+100	Hostel	7	7	RHS
12	33+200	School	2	10	LHS
13	33+600	Hostel	3	15	LHS
Garhi-Paloda Section					
1	13+300	School	5	5	LHS
2	10+000	School	1	3	RHS
3	9+500	School	2	100	RHS
4	5+600	School	2	12-50	RHS
5	5+500	School	2	8	RHS
6	2+700	School	5	50	LHS
7	0+350	School	5	50	LHS

V. IMPACT ASSESSMENT AND MITIGATION MEASURES

103. Road improvement projects are likely to bring several changes in the local environment both beneficial and adverse. This section of IEE identifies nature, extent and magnitude of all such likely changes vis-a-vis project activities for all stages of the project cycle, i.e., pre-construction, construction and operation. Beneficial impacts are mostly long-term and permanent whereas adverse impacts are localized and temporary in nature and are likely to occur mostly during construction stage.

A. Methodology

104. The methodology of assessing environmental impacts from the project entailed clearly identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction, construction and operation stages of the project was carried out to identify the minor, moderate and major impacts to guide development of mitigation measures and ensure that there are no or minimal residual impacts.

105. **Identification of impacts**. This includes identifying the valued environmental components (VEC) of the physical, biological, and human environments that are at risk of being impacted by the project. The VECs for this project which are based on the environmental baseline and are:

a. Physical environment – air quality and greenhouse gas emissions, land and soil, and groundwater quality and quantity; land use in 10 km radius
b. Biological environment – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important/sensitive areas in 10 km radius
c. Human environment – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural/heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

106. **Area of impact assessment.** The area covered for assessing **direct impacts** include:

a. An average of 30m corridor (ROW) along the sub-project sections. This includes 100 m on either side studied for direct impacts.
b. Other indirect impact area covers location of quarries; borrow areas, storage area of construction material etc.

107. **Type of impact on the VECs:** The type of impact can be described as:

a. Positive: Improvement in the quality of the VECs because of the project
b. Negative: Degradation or reduction in the quality of the VECs because of the project
c. Neutral: No noticeable change in VECs

108. **Duration of the impact:** Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-loved are used to describe the duration of impact:

(a) **Short-lived:** The impact disappears promptly
(b) **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project
(c) **Permanent:** The impacts are felt throughout the life of the infrastructure

109. **Extent of impact:** The extent of impact entails the spatial scale of impact on one or more of the VECs. The terms regional, local and limited are used to describe the area of impact:

(a) Limited: The impact is felt within the direct impact zone
(b) Local: The impact is felt within the indirect impact zone
(c) Regional: The impact is felt beyond the indirect impact zone

110. **Severity of impact**. The severity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criterion, which is defined as high, medium or low as below:

(a) **High**: The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project

(b) **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues; some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project

(c) **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project or activity.

111. **Significance of impacts**. The assessment of the significance of the impacts on the VECs requires understanding on the rating of type of impact, duration, extent and severity of impact as demonstrated in **Table 23** which described above the overall significance of each impact as major, moderate or minor.

Table 23: Criteria for rating the significance of impacts

Type of Impact	Duration	Extent	Severity	Significance
+ve	Short lived	Limited	Low	Minor
-ve	Temporary	Local	Medium	Moderate
Neutral	Permanent	Regional	High	Major

B. Screening of Impacts

112. Based on the rating criteria provided in Error! Reference source not found., e nvironmental impacts anticipated during the project design and pre-construction stage, construction stage and operation stage were screened for their level of significance as demonstrated in Error! Reference source not found. below. The screening was carried out for i mpacts that are expected without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant/major negative impacts that need to be prioritized for mitigation.

113. The significance of each environmental impact or project activity is indicated by the colours of the cells in the last column of the table. Red indicates major impact, orange indicates moderate impact, yellow indicates minor impact and green indicates positive impact. The

following section discusses the details of impacts on each of the VECs in line with identification of major, moderate, minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that there are minimal or no residual impacts.

Table 24: Screening of Environmental Impacts

VEC	Impact/ Activity	Project stage	Type of Impact	Duration	Area	Severity	Significance of impact	Residual Impacts
1.	**Physical environment**							
1.1 Air quality	Location of project roads alignment	D	+ve	permanent	Local	medium	+ve Minor	Nil
	Dust, PM, emissions from construction equipment and vehicles, Transport and storage of construction materials,	C	-ve	temporary	limited	medium	-ve moderate	-ve minimal
	Emissions from road traffic	O	-ve	permanent	regional	low	-ve Moderate	-ve minimal
1.2 GHG emissions	Emissions from construction equipment and vehicles	C	-ve	temporary	limited	medium	-ve Minor	minimal -ve impact after adequate mitigation measures
	Emissions from road traffic	O	-ve	permanent	regional	low	-ve Moderate	-ve moderate due to increase traffic load
1.3 Surface water quality	Pollution from liquid and solid waste from camps and construction activities leakage from vehicles Siltation in water bodies due to construction activities /earthwork Extraction of water for construction works and use in camps Alteration of rivers/ streams for construction of cross drains	C	N	N	N	N	N	Nil
	accidental oil spillage	O	-ve	permanent	limited	low	-ve Moderate	Nil
1.4 Ground water quality	Pollution from liquid and solid waste from camps and construction activities;	C	-ve	temporary	limited	low	-ve minor	Nil after mitigation measures
1.5 Ground water quantity	Location of site in already groundwater scarce region	D	-ve	temporary	limited	medium	-ve moderate	minimal -ve impact after adequate mitigation measures

VEC	Impact/ Activity	Project stage	Type of Impact	Duration	Area	Severity	Significance of impact	Residual Impacts
	Extraction of ground water for construction works and use in camps	C	-ve	temporary	limited	medium	-ve moderate	minimal -ve impact after adequate mitigation measures
1.6 Land degradation/ pollution	Opening of borrow area and quarries	C	-ve	permanent	limited	medium	-ve Moderate	
	Solid waste from construction works and camps, muck disposal	C	-ve	temporary	local	medium	-ve Moderate	
	Contamination of soil due to leakage/ spillage of oil, bituminous and non-bituminous debris generated from demolition and road construction	C	-ve	permanent	limited	low	-ve minor	
2.	**Biological environment**							
2.1 Trees/Forest/ terrestrial vegetation	Location of project alignment through forest area-no forest area is involved	D	+ve	permanent	Local	Low	+ve Minor	Nil
	Removal of trees, shrubs and grasses	C	-ve	permanent	local	medium	-ve Moderate	-ve minimal after compensatory and additional plantation
	Growth of the compensated trees and additional plantation.	O	+ve	permanent	local	medium	+ve Moderate	+ve residual impact
2.2 Terrestrial fauna (mammals, birds, insects)	Accidents involving mammals/ birds/ insects.	D	-ve	permanent	limited	low	-ve Minor	-ve minimal
		C	-ve	permanent	limited	low	-ve Minor	-ve minimal
		O	-ve	permanent	limited	low	-ve Minor	-ve minimal
2.3 Migratory birds and ecologically important areas	None of the Sub-projects are located within Wildlife Sanctuary respectively.	D	+ve	permanent	limited	low	+ve minor	Nil
	Habitat Loss and disturbance in feeding, breeding and migration of birds.	C	-ve	temporary	limited	medium	-ve moderate	-ve minimal
2.4 Aquatic Fauna	None of the sub-project have sightings of REET species of aquatic fauna	C	N	N	N	N	N	N
3.	**Social environment**							**4.**
3.1 Private land and buildings	Location requiring removal of private structures/ buildings	D	-ve	permanent	limited	medium	-ve moderate	-ve moderate
	Acquisition of private land. Demolition of	C	-ve	permanent	limited	medium	-ve moderate	-ve moderate

VEC	Impact/ Activity	Project stage	Type of Impact	Duration	Area	Severity	Significance of impact	Residual Impacts
	private structures. Possible complaints, opposition from disgruntled or unhappy affected persons							
	Increase in value of land and property. Easier access to some areas and property.	O	+ve	permanent	local	high	+ve major	+ve high
3.2 Public property/infrastructure/ utility structures	Location removal of public structures/buildings and utility structures	D	-ve	permanent	limited	medium	-ve Moderate	-ve moderate
	Demolition of public structures. Removal and shifting of utility structures. Possible complaints from local public due to disruption of utility services	C	-ve	permanent	local	high	-ve Moderate	-ve minimal
	none	O	N	N	N	N	N	
3.3 Noise	Location near residential areas, sensitive receptors (places of worship, hospitals, educational institutes, cultural/ heritage sites etc.)	D	-ve	permanent	limited	medium	-ve moderate	-ve minimal
	Disturbance caused to local residents from noise generated from construction activities, campsite activities using heavy equipment, movement of trucks during day and night time. Noise levels exceeding standards. Complaints from local residents near construction sites.	C	-ve	temporary	local	medium	-ve moderate	-ve minimal
	Noise levels exceeding baseline levels by more than 3dBA and causing disturbance to residents and sensitive receptors near project alignment	O	-ve	permanent	limited	low	-ve minor	-ve minimal
3.4 Vibration	Location near residential areas, sensitive receptors (places of worship, hospitals, educational institutes, cultural/heritage sites etc.)	D	-ve	permanent	limited	low	-ve minor	-ve minimal
	Vibration disturbance felt by local residents	C	-ve	temporary	limited	low	-ve minor	-ve minimal

VEC	Impact/ Activity	Project stage	Type of Impact	Duration	Area	Severity	Significance of impact	Residual Impacts
	due to construction activities using heavy equipment and movement of heavy-duty trucks during day and night							
3.5 Occupational health and safety	Death, accident or injury of construction workers, due to poor safety standards. Illness of construction workers due to poor hygiene, health and sanitary facilities at the construction sites and camp	C	-ve	temporary	limited	high	-ve major	-ve high
	Accidents, injuries to operational staff	O	N	N	N	N	N	
3.6 Public health and safety	Design of road safety features	D	+ve	permanent	limited	medium	+ve Major	+ve high
	Accident or injury or death of local public living or moving near construction/camp sites due to poor safety standards, mosquito breeding due to poor camp management, excessive dust/air pollution caused by project activities. Traffic jams and accidents caused by project related activities.	C	-ve	temporary	limited	high	-ve major	-ve high
	Accident, injury or death of public using the road. Health problems caused to people residing near road due to increased noise and air pollution	O	-ve	permanent	limited	High	-ve minor	-ve minimal

Note: +ve = positive impact; -ve = negative impact; AG = above ground; C = construction stage; D = design & pre-construction stage; N = neutral; O = operation stage; PC = pre-construction; UG = underground; VEC = valued environmental component

C. Assessment of Alternatives (Alignment Options)

114. Project scope includes widening and Improvement of roads along existing alignments. However, due to restricted ROW in some built up sections, two bypasses are proposed for SH-21 and for SH-10A each. Bypasses along SH-21 are (i) at Nanan km 29+700 to km 31+300 (1.60 km) and (ii) bypass at Mandaliya from km 42+000 to km 42+900 (900 m length). Along SH-10A, bypasses are proposed at (i) Garhi from km 28+120 to km 28+420 (300 m length) and (ii) Chhajja Bypass from km 25+860 to km 27+240 (1.38 km length). Different alternatives examined and further assessed to finalise most preferred alignments apropos technical, social and environmental parameters have been described in following paras. The environmental set-up along the proposed bypass are mostly similar and hence technical, cost and social

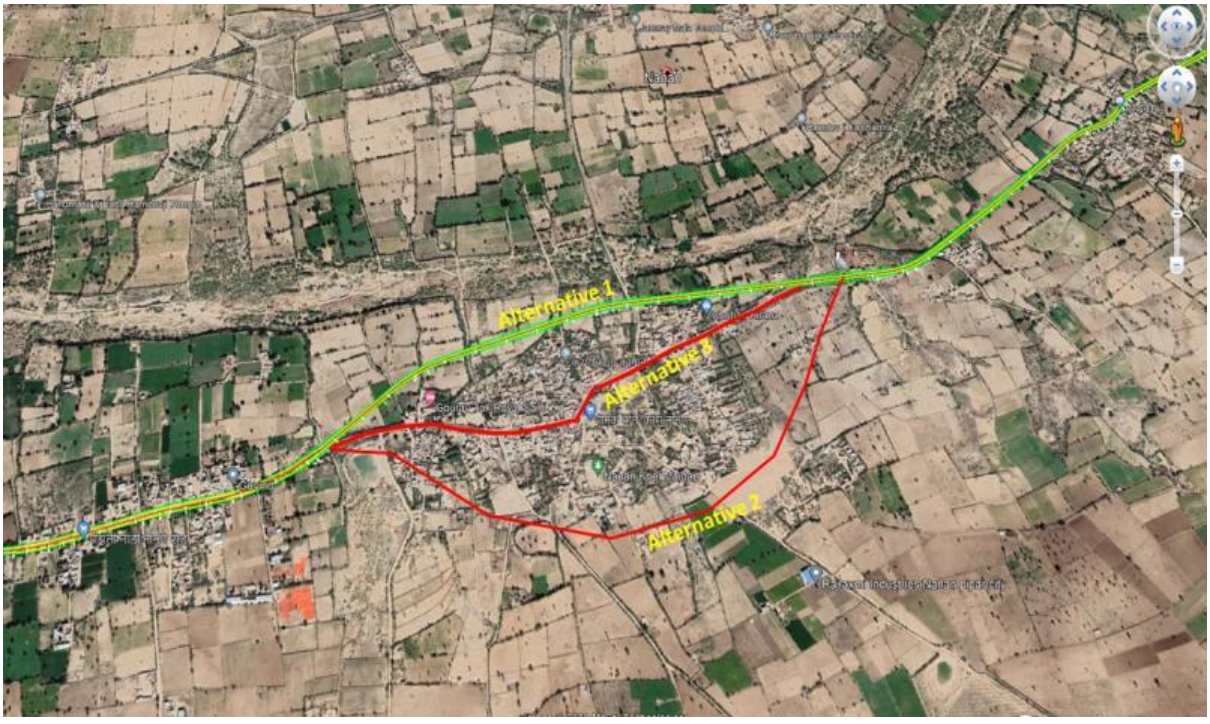
parameters evidenced more pertinent for decision making. Moreover, social parameters taken into account inter-alia assimilates the environmental concerns viz increased length will reason more adverse impacts both on social/human and physical environment.

115. **Nanan Bypass:** Based on the different alternatives analysed, option-1 was recommended based on the merits and demerits of different parameters as summarised below in **Table 25** and shown in **Figure 14.**

Table 25: SH-21: Alternative assessment for Nanan Bypass

S.no.	Description	Alternative 1	Alternative 2	Alternative 3 (Existing Alignment)
1	Design Length	1.6 km	2.7 km	1.850
2	Length of existing alignment Bypassed	1.6	2.375 km	
3	Speed	100 Km/hr	80 Km/hr	40 Km/hr
4	Geometrics	Possible	Possible	Possible with less speed
5	Land use pattern	Barren	Barren	Residential and Commercial
6	No of Proposed Structures	2 MNB	2 MNB	2 MNB
7	Service Road	-	-	Service Road Required
8	Junctions	2	2	5
9	Area Required, Hectares	8.1	12.15	1
10	Resettlement & Rehabilitation	Minimal	> Alternative 2	Large-scale
11	Approx. Cost	8.0 crores / Km	10.0 crores / Km	14.0 crores /km
12	**Recommendation**	**Recommended**	**Not recommended**	**Not recommended**

Figure 14: SH-21- Nanan Bypass Alternatives



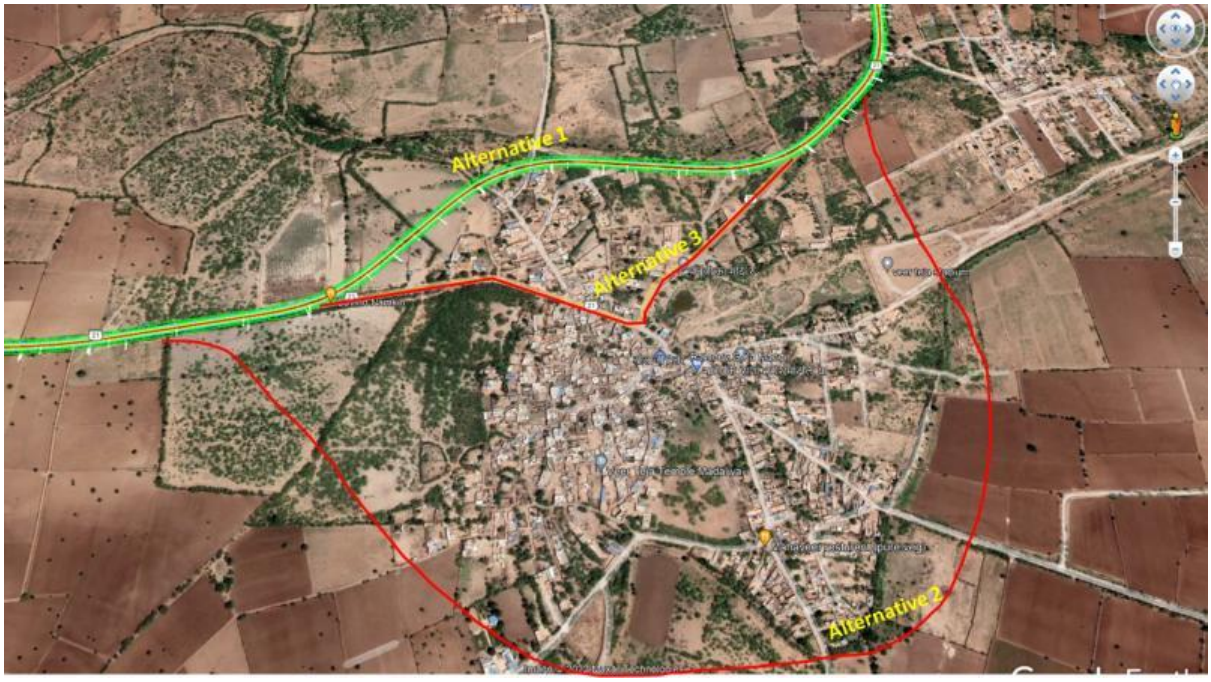
116. The alternative assessment for Mandaliya Bypass considering three options as shown in

117. **Figure** 15 and **Table 26**. Alternative 1 at km Mandaliya km 42+000 to km 42+900 (900 m length) at Mandaliya is recommended considering low R&R.

Table 26: SH-21: Alternative assessment for Mandaliya Bypass

S. No.	Description	Alternative 1	Alternative 2	Alternative 3 (Existing Alignment)
1	Design Length	900 m	2.970 km	1.060
2	Length of existing alignment Bypassed	1.060	1.82	-
3	Speed	100 Km/hr	80 Km/hr	40 Km/hr
4	Smooth Geometrics	Possible	Possible	Possible with lesspeed
5	Land use pattern	Barren	Barren	Residential, Commercial
6	CD Structures	2 Culverts	1 –Major Bridge,2-Culverts	2-Culverts
7	Service Road	-	-	Service road required
8	Junctions	-	2	5
9	Land Acquisition (Ha)	4.5	13.365	1
10	Approx Cost	3.0 crores/Km	3.0 crore/Km	4.0 crores/km
11	Merits	Length is less	Speed is Comparatively less	Less LA
12	Demerits		Length more than Alternative 1	High R&R issues
	Recommendation	***Recommended***	**Not recommended**	**Not recommended**

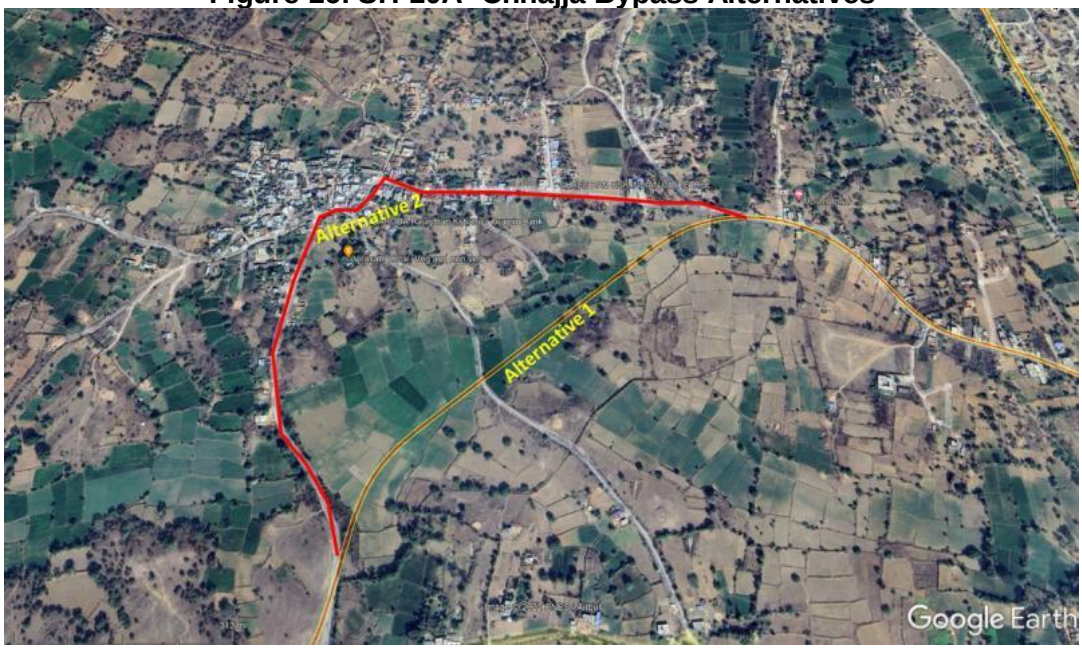
Figure 15: SH-21- Mandaliya Bypass Alternatives



118. **Chajja Bypass:** The alternative assessment for Chhajja Bypass was carried out by considering two alternatives as shown in
119. Figure 16. Alternative 1, from km 25+860 to km 27+240 (1.38 km length) is recommended considering low R&R.

120. Exiting road has restricted ROW along Chajja Town (from 25+860 Km to Km 27+360) and also forming a sub-standard curve for a length of more than 2 km causing frequent traffic congestion. This obviously will further deteriorate with projected annual traffic growth and therefore necessitates a bypass.

Figure 16: SH-10A- Chhajja Bypass Alternatives



121. The alternative assessment for Garhi Bypass is carried out by considering two alternatives as shown in
122.
123.

124. Figure 17. Alternative 1, from km 28+120 to km 28+420 (300 m length) is recommended considering low R&R. Exiting Road has restricted ROW along Garhi Town (from 28+120 Km to Km 27+430) and also forming a sub-standard curve for a length of more than 690 m causing frequent traffic congestion. Any bypass on RHS (

125. Figure 167) of existing road will significantly increase the road length. This consequently entails more land requirement and its induced impacts including environment. Realigning the bypass on LHS as finalised will not only reduce the road length but also improve the road geometry.

Figure 17: SH-10A- Garhi Bypass Alternatives

D. Typical Potential Beneficial Impacts

126. The immediate benefits of road construction and improvement will come in the form of direct employment opportunities during construction for the roadside communities engaged as wage labourer, petty contractors and suppliers of raw materials. During operation stage, road-side economic activities supporting transport like gasoline stations, automotive repair shops, lodging, and restaurants will increase due to increased number of vehicles. Increase in agro-industrial activities are also expected to take advantage of improved access to urban centres where there are higher demands and better prices for agricultural products. Project will accelerate the economic opportunities resulting in reduced migration. Other benefits of project road improvement are: (i) reduction in travel time, (ii) better mode and frequency of transport, (iii) access to quality health care, educational, and other infrastructural facilities (iv) improved quality of life of rural population, (v) reduced accidents, and (vi) better investment

climate for industries creating more employment opportunities for local people. Furthermore, the project is designed with bituminous pavement which has various benefits as described in chapter-2.

E. Typical Potential Adverse Impacts

127. Major anticipated impacts arising from the improvement of sub-project roads are: (i) economic displacement of some households, (ii) cutting of few trees (iv) adverse impacts due to borrowing and quarrying, (v) increased risk of accident due to faster vehicular movement, and (iv) increased air and noise pollution due to increased traffic. Most of the impacts are reversible, temporary, localized in nature, and can be easily mitigated/ minimized/ avoided by effective implementation of EMP.

F. Pre-construction Phase Impacts and Mitigations

1. Terrestrial Vegetation/ Trees, Forest

128. **Trees:** A total of 9606 trees (approx. 33 trees/km) have been enumerated in proposed ROW. Most of them are indigenous and none of them are of rare, endangered, or threatened category. Tree cutting permission shall be obtained from forest department and TTZ authority and mitigation measures compensatory plantation need to be carried out. Trees which are valuable, shady and ecologically important, will be specially marked and need to be translocated to an appropriate relocation site identified jointly with forest department. In case the trees are completely dry and survival is doubtful after relocation, size and condition of the trees are such that their replacement is not technically and practically possible, felling of such trees need to be proposed.

129. Geometric adjustment till final design by the contractors will be made to minimize affected trees. Further, tree cutting will be restricted to toe line of the formation width without compromising road safety elements. The mandatory compensatory plantation will be done on 1:3 basis by the Forestry Department. Additional plantation will be done as a strategy to minimize GHG emissions from increased traffic due to road upgrading. No tree will be uprooted without prior approval of competent authority.

130. **Forest:** No Forest diversion is involved in any of sub project, hence no forest clearance is applicable.

2. Community Safety

131. With increased traffic volume, communities including road users may be at risk due to road crashes in absence of adequate safety provisions such as crash barriers at accident prone areas. Safety provisions in accordance with IRC guidelines which include provision of (i) speed breakers in habitat areas to regulate speed, (ii) retro-reflective warning signboards near schools, hospitals, and religious places, (iii) proper sidewalks/pedestrian zones along the road near habitat areas, schools, hospitals, and religious places are included in preliminary design which will be further reviewed during detailed design by EPC contractor, and (iv) compliance with IRC codal provisions of state highway for curvature and grading. Provision of safety kerb at all bridges is also proposed. The design should attempt to equalize cut and fill.

3. Flooding/Over-topping

132. Few isolated sections are vulnerable to flooding. To avoid overtopping of pavement all low-lying sections are proposed for raising of embankment height above the HFL, provision of adequate CD structures with increased vent size/waterways and provision of side drains.

4. **Worker's Camp Siting**

133. Poor siting and layout of workers camp may cause (i) loss of agricultural produce if sited on cultivable land, (ii) health hazard to workers and nearby community, (iii) surface water pollution in case sited near water bodies, (iv) local drainage problem (v) wear and tear to haul routes if material is transported via village roads, and (vi), fire, electrical and other safety risks.

134. The location, layout and basic facility provision of each labour camp will be submitted to Authority Engineer (AE) and PIU prior to their construction. All camps should maintain minimum distance from habitation, water bodies, and through traffic routes as prescribed by BSPCB and other applicable local guidelines. The construction shall commence only after approval of AE and PWD. Contractors shall prepare solid waste management plan that includes collection, storage, and disposal subject to the review and approval of the AE.

5. **Utility Shifting, Aesthetic and Visual Impacts**

135. Delayed and unplanned shifting of public utilities like telephone and electrical poles, water pipelines, and OFC cables causes disruption of utility services to local community. Digging, shifting, and re- establishment of poles may also impair the view of community areas. All efforts shall be made to reduce the duration of utility shifting impact and restore the disturbed areas. All utilities should be shifted before start of construction. Necessary permission and payments should be made to relevant utility service agencies to allow quick shifting and restoration of utility services. Visual barriers are to be provided, as necessary, on active construction zones. Consultation with affected people prior to the start of utility shifting, presentation of construction timelines and guidelines should be conducted. Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services, if any.

6. **Heritage and archaeology**

136. None of the sub-projects have heritage and archaeology important monuments either within the alignment or 100m on either side. However, digging for various road construction purposes may unearth chance artifacts. A rapid response procedure to protect chance finds while minimizing disruption to project activities must be in place. Relevant provisions of Ancient Monuments and Archaeological Sites and Remains Act (1958) should be implemented, to include: i) consultation with the Rajasthan Archaeology Department, ii), demarcation of the discovery site, iii) chance finds report, iv) arrival and actions of cultural authority, and v) suspension/non- suspension/ further suspension of work.

G. Construction Phase Impacts and Mitigations

1. Topography and Geology

137. Project scope is limited to expansion of existing roads with widening of 7-8m on either side and will be confined within available ROW majorly except in the bypasses of SH-21 and SH-10A sub-projects. Abutting topography is predominantly plain rolling terrain. Cut-and-fill operations are confined to ROW to improve/ maintain the vertical profile of road. The surplus soil from cut operations, which is unsuitable for selected sub grade, will be used to reinstate the borrow areas. Therefore, overall impact on the topography of the project area is unlikely. Likely impact on the geological resources may occur from the extraction of materials (borrow of earth, granular sub-base and aggregates for base courses and bridges). Rajasthan being naturally endowed with rock/ mineral deposits, a large number of licensed/ approved quarries under operation are readily available. All construction material such as aggregates, sand and boulder material are to be procured only after requisite permission from mining department

like requisite valid consent from RPCB is available for operating the existing Crusher and environmental clearance from SEIAA have been obtained. Specific measures are:

a. Sources/ sites of construction material sites have been identified within the immediate vicinity of the road. No new quarry has been proposed for the project. Only licensed quarries will be used as sources of coarse and fine aggregates.
b. The AEs will ensure that the quarries have environmental clearance from SEIAA and all appropriate licenses, and are being operated as per conditions of mine lease and CPCB norms.
c. Cut slopes should be re-vegetated immediately after widening activities
d. Borrow areas should be rehabilitated and brought back as far as possible to their previous appearance. Some borrow areas will be converted into ponds to compensate loss of water bodies. This will also enhance the local aesthetics
e. Cut materials should be used to widen the road or disposed of at proper sites

2. Air Quality

138. The specific locations affected by the air pollutants during construction are working areas, construction plant sites, quarries, and construction machinery and construction vehicles. Activities which generate air pollutants are: (i) dust generation from the construction zone during different stages of the construction such as clearing and grubbing, materials dumping, drying of materials, brushing of surfaces; (ii) dust generation from the access roads to the soil borrow areas, aggregate quarries, construction plants, and construction camp sites; (iv) operation of the construction plants such as hot mix plants, crushers, WMM plants, and concrete batching plants; and (iv) material storage, transportation and handling (loading/unloading) of different construction materials such as sand and earth from borrow pits and aggregates. Some of the pollution control measures have been incorporated in the design stage by relieving congestion in built-up stretches at critical sections, improving road geometry, and widening of road to smoothen the traffic flow. The specific measures to control air pollution during construction are:

a. Vehicles delivering loose and fine materials are covered.
b. Loading and unloading of construction materials in covered area or provisions of water fogging around these locations
c. Storage areas are located downwind of the habitation area.
d. Water will be sprayed on earthworks periodically
e. Regular maintenance of machinery and equipment. Vehicular pollution check will be made mandatory.
f. Hot mix plants to be located at a suitable distance from the nearest habitation, school, hospital, forest, rivers, ponds, and national highway, from state highway, prescribed by RPCB and other applicable national laws, unless otherwise required by statutory requirements after securing a No-Objection Certificate (NOC) from the RPCB. Hot mix plant will be fitted with stack of adequate height as prescribed by SPCB to ensure dispersion of exit gases.
g. Bitumen emulsion and bitumen heaters should be used to extent feasible.
h. Only crushers licensed by PCB will be used.
i. LPG should be used as fuel source in construction camps instead of wood.
j. Regular water sprinkling of unpaved haulage roads.
k. Mask and other PPE will be provided to the construction workers
l. DG sets will be fitted with adequate height as per CPCB/ MoEF&CC guidelines.
m. Contractor should submit a dust suppression and control program to the PWD
n. Additional plantation proposed to improve the micro-climate

139. **Air Modelling for 2021:** Air dispersion modelling is conducted to assess the impact of air pollutant dispersion as a result of vehicular traffic emissions on the sensitive receptors during construction period (baseline period). The impact on air quality depends upon traffic volume, traffic fleet including fuel type and prevailing atmospheric conditions. An unstable atmospheric condition disperses pollutants more while stable atmospheric conditions traps pollutants resulting in increased pollution concentrations. To assess the likely impacts on the ambient air quality due to the proposed highway project, the prediction of the particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), Nitrogen di oxide (NO_2) and Sulphur di-oxide (SO_2) have been carried out using AERMOD View (line source) dispersion model, based on Gaussian equation. AERMOD dispersion modelling is conducted considering homogenous sections of the four sub-project roads and Traffic Volume for the year 2021 as shown in **Table 27.**

Table 27: Four Sub-project Road sections considered in the Modelling Study

Section	Proposed Length (m)	Vehicles per day
		2021
SH-21	87.7	9,350
SH-36	115.8	2,833
SH-44	37.00	10,765
SH-10A	54.7	6,905

Source: Air Dispersion Modelling of Project, 2021

140. The emission factors for different categories of vehicles in India ARAI, 2007 and CPCB, 2010 are used for the vehicular dispersion modelling. These emission factors are used to calculate the weighted or composite emission factor for all types of vehicles. The model is initialised to predict the 24-hourly incremental ground level concentration of $PM_{2.5}$, and PM_{10}, NO_2 and Sulphur-di-oxide (SO_2) and 8-hourly incremental ground level concentration of CO due to vehicle plying on the project for the baseline year of 2021. Composite emission factors for pollutants (CO, $PM_{2.5}$, PM_{10}, NO_2, SO_2) for different categories of vehicles for homogenous road sections are calculated based on weightage on the percentage share of different category of vehicles and respective emission factor[21] and shown in **Table 28.**

Table 28: Calculation of Composite Emission Factor

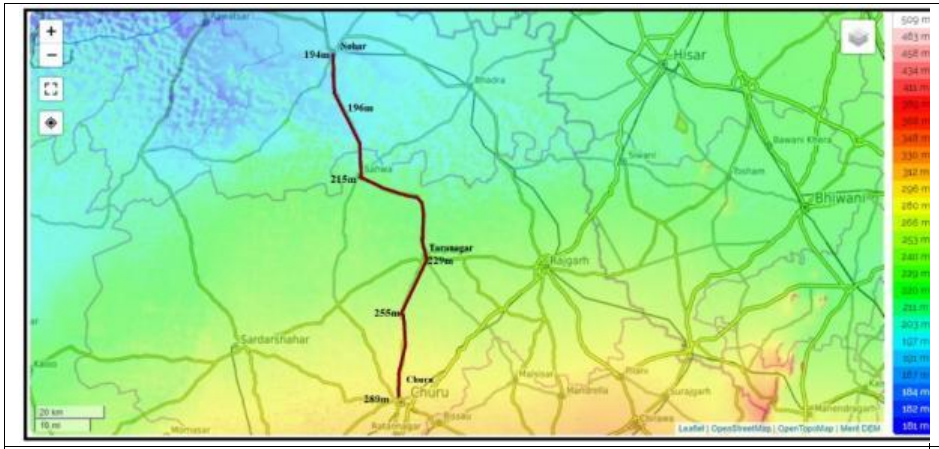
Pollutants	Distance (km)		Composite Emission Factor (g/s/m^2)
	Existing	Improved	2021
SH-21 Dantiwara-Merta City Road			
CO	87.7	87.7	0.0000489
$PM_{2.5}$	87.7	87.7	0.00000153
PM_{10}	87.7	87.7	0.00000361
NO_2	87.7	87.7	0.00000126
SO_2	87.7	87.7	0.000000698
SH-36 Churu-Taranagar-Nohar Road			
CO	115.8	115.8	0.000107

[21] ARAI (Automotive Research Association of India), 2007. Emission factor development for Indian vehicles. Project report no. AEF/2006-07/IOCL/Emission Factor Project. Automotive Research Association of India, Pune, India, 94 pages.

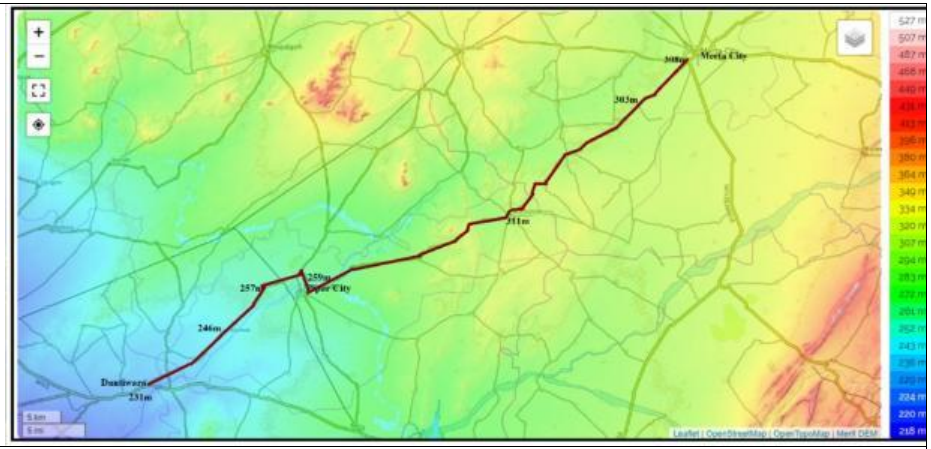
Pollutants	Distance (km)		Composite Emission Factor (g/s/m^2)
	Existing	Improved	2021
$PM_{2.5}$	115.8	115.8	0.00000113
PM_{10}	115.8	115.8	0.0000018
NO2	115.8	115.8	0.000000515
SO_2	115.8	115.8	0.00000022
SH-44 Kherli-Nadbai-Kumher Road			
CO	37.00	37.00	0.0000501
$PM_{2.5}$	37.00	37.00	0.00000253
PM_{10}	37.00	37.00	0.00000412
NO2	37.00	37.00	0.000001305
SO_2	37.00	37.00	0.000000820
SH-10A Paloda-Garhi-Ananapuri Road			
CO	54.7	54.7	0.000126
$PM_{2.5}$	54.7	54.7	0.00000114
PM_{10}	54.7	54.7	0.00000175
NO2	54.7	54.7	0.000000496
SO_2	54.7	54.7	0.000000218

141. **Meteorology:** In this model, AERMET module is used for meteorological processing of 168 hours of meteorological data for 7 days in the month of January 2021. The wind rose shows that the predominant wind flows from N -NNE to S-SSW. Highest wind speed range between 2.1-3.6 m/s with 8.33.6% calm and average wind speed over the study area is 2.05 m/s. **Topography:** Shape files were prepared for all road sections and the data is directly transposed on Google Imagery. **Figure 18** shows the Digital elevation map of Sub-Project Roads. **Receptor setting:** Cartesian grid receptor settings are specified for all receptors adjacent to the sub-project roads as shown **Figure 19**. **Table 29** gives the total ground level value at the location of Field Monitoring for the year 2021.

Figure 18: Digital Elevation Map of Sub project Roads

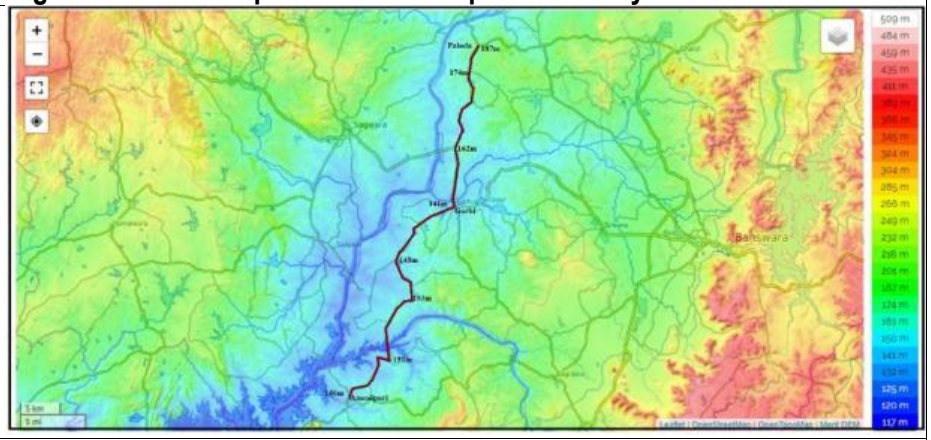


Digital Elevation Map of Churu-Taranagar-Nohar Road



Digital Elevation Map of Dantiwara-Pipar-Merta City Road

Digital Elevation Map of Kherli Nadbai Kumher Road



Digital Elevation Map of Paloda-Garhi-Anandpuri Rajya Seema Tak

Source: https://en-gb.topographic-map.com/maps

Table 29: Ground Level concentration with incremental values (2021) at field Monitoring Locations

F-Field; PI-Predicted incremental Values, T- Total

Sl. No.	Name of Location	Particulate Matter ($PM_{2.5}$)			Particulate Matter (PM_{10})			Nitrogen Oxide (As NO_2)			Sulfur Dioxide (SO_2)			Carbon monoxide (CO)		
		$\mu g/m^3$														
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
1	0+13Km Near IOCL Vill. Indwar	48.12	0.6	48.72	90.53	1.0	91.53	25.47	0.8	26.27	10.65	0.5	11.15	0.62	0.005	0.625
2	0+38 Km Near Village Beetan	42.55	0.5	43.05	88.62	0.8	89.42	23.46	0.5	23.96	9.87	0.2	10.07	0.60	0.05	0.65
3	0+44Km Near Hotel Karni Place	40.58	0.6	41.18	90.36	2.0	92.36	23.8	0.2	24	9.9	0.2	10.1	0.63	0.07	0.7
4	0+60 Km Near Vill Naman	44.6	0.6	45.2	91.7	0.9	92.6	25.6	1.0	26.6	10.6	0.5	11.1	0.62	0.01	0.63
5	0+75 Km Near Village Bankaliya	39.45	1.0	40.45	87.21	0.8	88.01	22.55	0.3	22.85	10.48	0.3	10.78	0.61	0.06	0.67
6	0+91 Km Near Village Dantiwara	45.61	1.0	46.61	86.95	0.8	87.75	24.56	0.5	25.06	10.67	0.1	10.77	0.66	0.01	0.67
Churu-Taranagar-Nohar Road (Nohar To Taranagar)																
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
1	0 to 12 Km ESSAR Petrol Pump	49.2	0.2	49.4	92.48	0.4	92.88	26.16	0.1	26.26	9.08	0.2	9.28	0.63	0.02	0.65
2	0 to 23 Km Village Meghana	40.2	0.1	40.3	90.62	0.2	90.82	23.36	0.05	23.41	8.74	0.1	8.84	0.67	0.01	0.68
3	0 to 34 Km Near Sri Shiv Gorakha Bhojanalya	38.29	1	39.29	86.48	0.1	86.58	22.06	0.08	22.14	9.92	0.06	9.98	0.6	0.006	0.606
4	0 to 46 Village Dhriwas Bada	36.12	0.2	36.32	86.29	0.1	86.39	24.48	0.05	24.53	8.26	0.03	8.29	0.62	0.01	0.63
5	0 to 60 Nr. Baaichara Hotel	32.24	0.6	32.84	83.48	0.8	84.28	20.27	0.1	20.37	9.1	0.1	9.2	0.6	0.02	0.62
6	0 to 71 Km HP Petrol Pump	41.26	0.1	41.36	94.2	0.2	94.4	28.49	0.08	28.57	9.92	0.01	9.93	0.66	0.01	0.67
Churu-Taranagar-Nohar Road (Churau to Taranagar)																
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
1	0+9.5 Km Near Achanak Family Restaurant	46.3	0.1	46.4	89.5	0.1	89.6	23.2	0.2	23.4	8.12	0.4	8.52	0.59	0.04	0.63
2	0+15 Km Nr. Temple	36.4	0.3	36.7	87.2	0.2	87.4	21.5	0.06	21.56	7.68	0.2	7.88	0.56	0.03	0.59
3	0+23 Near ESSAR Petrol Pump	37.32	0.4	37.72	81.1	0.7	81.8	20.54	0.07	20.61	9.42	0.08	9.5	0.63	0.006	0.636
4	0+34 Khatiya Dhani	34.2	0.2	34.4	81.71	0.2	81.91	22.63	0.06	22.69	7.94	0.05	7.99	0.6	0.01	0.61
5	0+41 Nr Raghav Hotal	28.98	0.5	29.48	79.23	0.5	79.73	18.96	0.1	19.06	8.75	0.2	8.95	0.62	0.02	0.64

Sl. No.	Name of Location	Particulate Matter ($PM_{2.5}$)			Particulate Matter (PM_{10})			Nitrogen Oxide (As NO_2)			Sulfur Dioxide (SO_2)			Carbon monoxide (CO)		
		$\mu g/m^3$														
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
6	0+46 Nr. Taranagar	35.31	0.3	35.61	78.9	0.4	79.3	20.61	0.07	20.68	7.44	0.04	7.48	0.56	0.01	0.57
Kherli Nadbai Kumher Road																
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
1	0+7 Km	51.26	0.5	51.76	94.8	0.8	95.6	27.72	0.2	27.92	10.16	0.3	10.46	0.64	0.01	0.65
2	0+15 Km Nr. IOCL Petrol Pump	44.16	0.5	44.66	94.28	0.6	94.88	26.19	0.3	26.49	9.16	0.1	9.26	0.62	0.01	0.63
3	0+19 Km Nr. ESSAR Petrol Pump	42.06	0.3	42.36	91.28	0.9	92.18	24.06	0.4	24.46	10.14	0.2	10.34	0.64	0.007	0.647
4	0+25Km Nr. ESSAR Petrol Pump	38.31	0.1	38.41	92.28	0.5	92.78	26.16	0.14	26.3	9.42	0.1	9.52	0.67	0.005	0.675
5	0+32 Km Nr. Baboraa Passion	36.28	1	37.28	85.62	0.7	86.32	22.44	0.34	22.78	10.16	0.1	10.26	0.62	0.01	0.63
6	0+39 Km Nr. Village Kumher	47.92	0.5	48.42	96.16	0.8	96.96	29.14	0.2	29.34	10.92	0.1	11.02	0.68	0.007	0.687
Paloda-Garhi-Anandpuri Rajya Seema Tak																
		F	PI	T	F	PI	T	F	PI	T	F	PI	T	F	PI	T
1	0+9 Km	44.24	0.08	44.32	90.16	0.1	90.26	25.48	0.1	25.58	10.93	0.06	10.99	0.61	0.03	0.64
2	0+18 Km	48.29	0.08	48.37	93.42	0.1	93.52	27.56	0.1	27.66	10.14	/0.05	10.14	0.64	0.05	0.69
3	0+23 Km	51.06	0.09	51.15	96.48	0.1	96.58	29.34	0.1	29.44	11.57	0.1	11.67	0.66	0.07	0.73
4	0+34 Km	52.16	0.2	52.36	89.22	0.5	89.72	23.14	0.05	23.19	9.97	0.04	10.01	0.69	0.03	0.72
5	0+43 Km	39.18	0.2	39.38	90.26	0.5	90.76	26.07	0.1	26.17	11.34	0.1	11.44	0.65	0.07	0.72
6	0+51 Km	49.2	0.3	49.5	94.08	1	95.08	26.44	0.1	26.54	11.2	0.1	11.3	0.66	0.1	0.76

Figure 19 gives isopleths of Air pollutants and their dispersion for four sub-Roads. The spread of pollutants is more in downwind direction and the magnitude of concentration is also low.

Figure 19: Isopleths of Air Pollutants for 2021

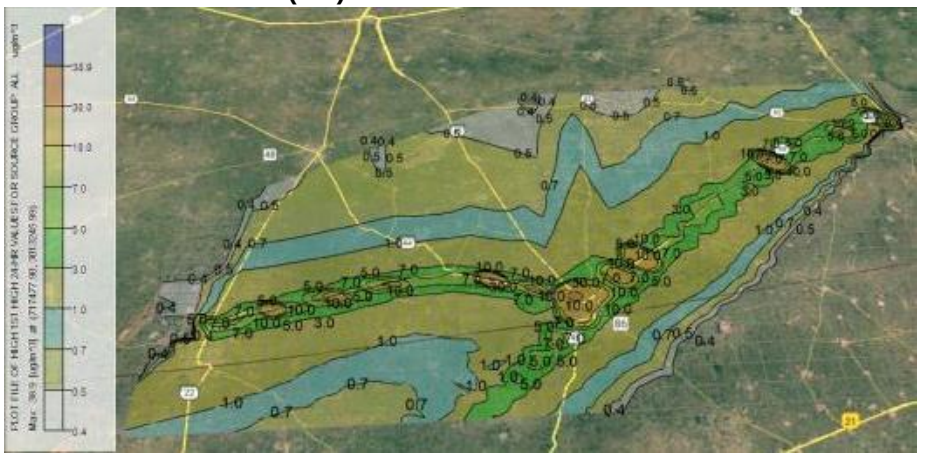
SH-44 ($PM_{2.5}$) Kherli-Nadbai-Kumher Road

SH-44 (PM_{10}) Kherli-Nadbai-Kumher Road

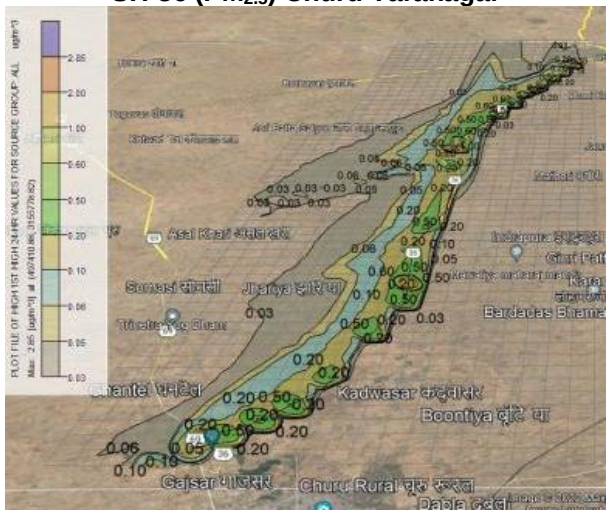
SH-44 (NO_2) Kherli-Nadbai-Kumher Road

SH-44 (SO_2) Kherli-Nadbai-Kumher Road

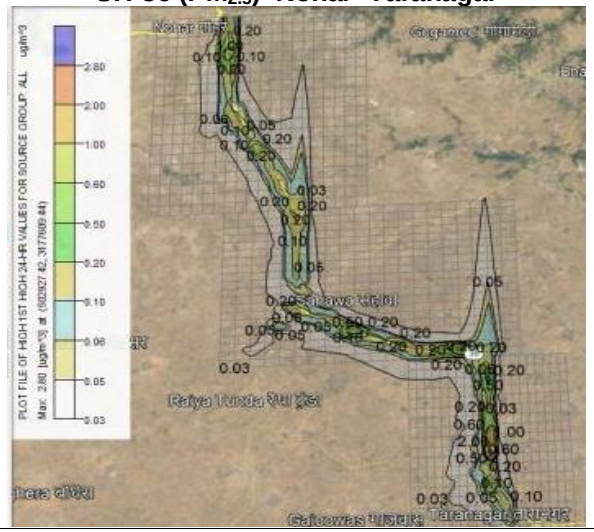
SH-44(CO) Kherli-Nadbai-Kumher Road



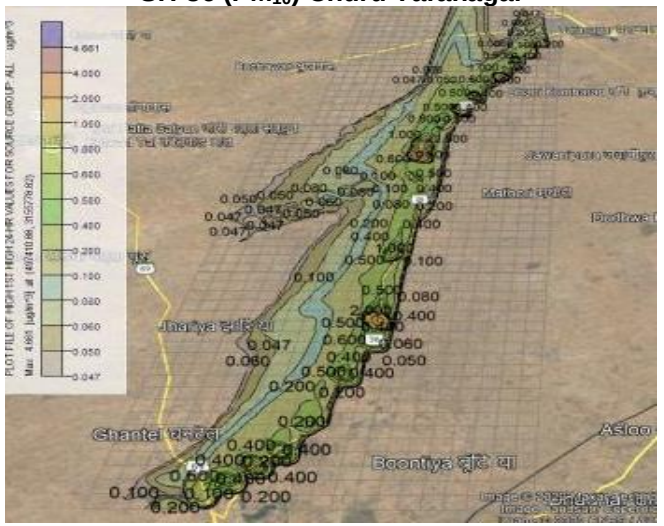
SH-36 ($PM_{2.5}$) Churu-Taranagar



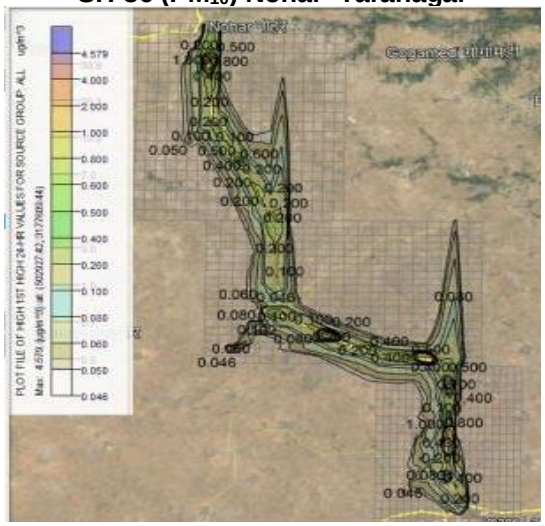
SH-36 ($PM_{2.5}$) Nohar -Taranagar



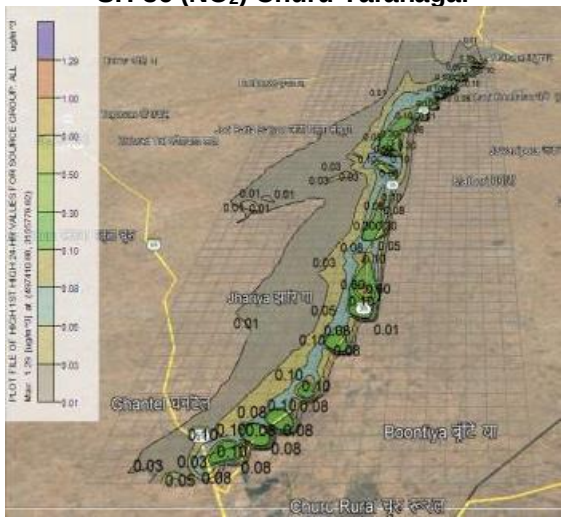
SH-36 (PM_{10}) Churu-Taranagar



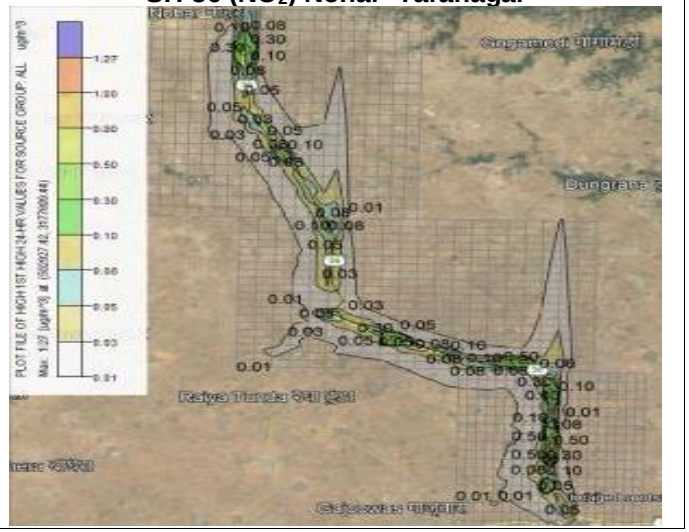
SH-36 (PM_{10}) Nohar- Taranagar



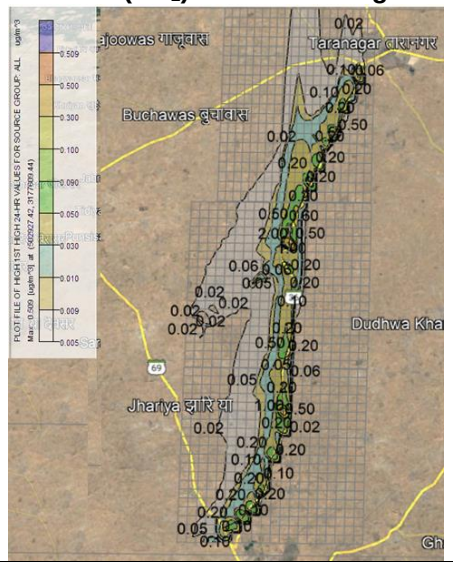
SH-36 (NO_2) Churu-Taranagar



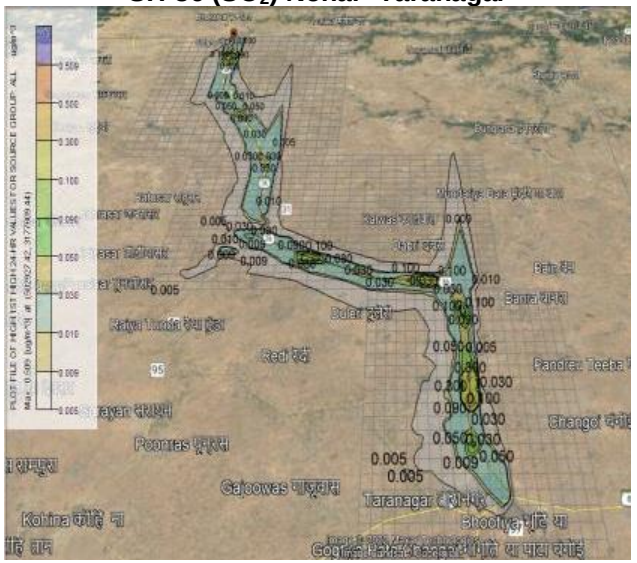
SH-36 (NO_2) Nohar -Taranagar



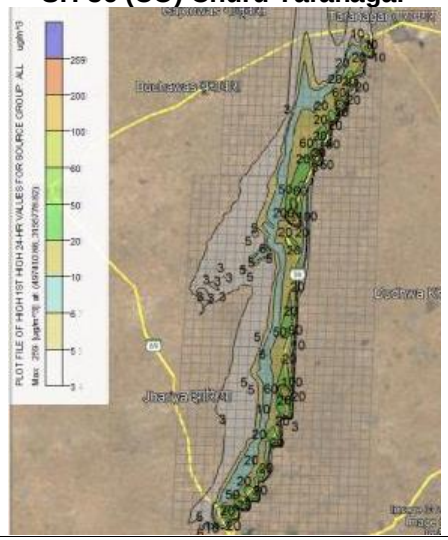
SH-36 (SO_2) Churu-Taranagar



SH-36 (SO_2) Nohar -Taranagar

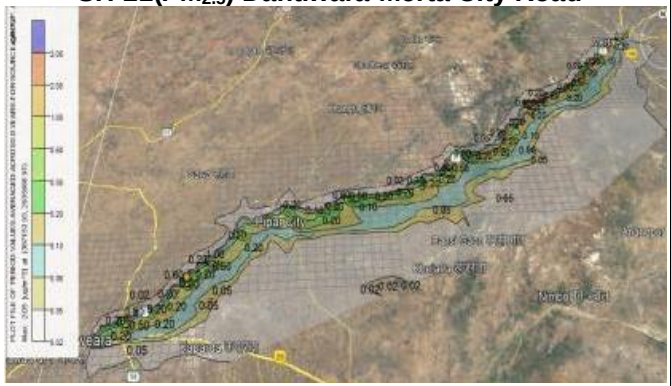


SH-36 (CO) Churu-Taranagar

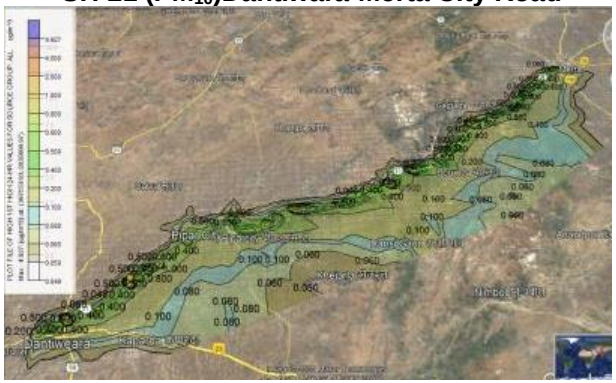


SH-36 (CO) Nohar -Taranagar

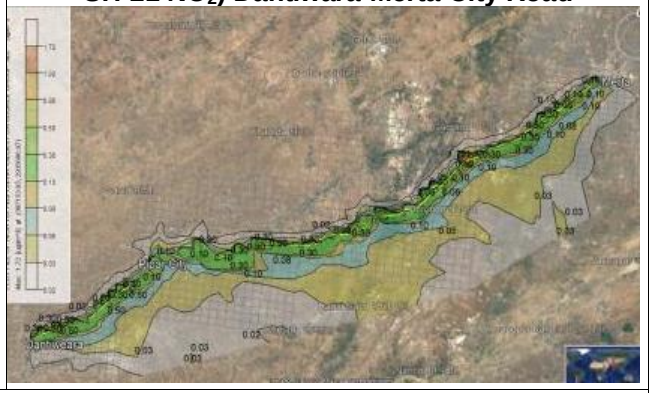
SH-21($PM_{2.5}$) Dantiwara-Merta City Road



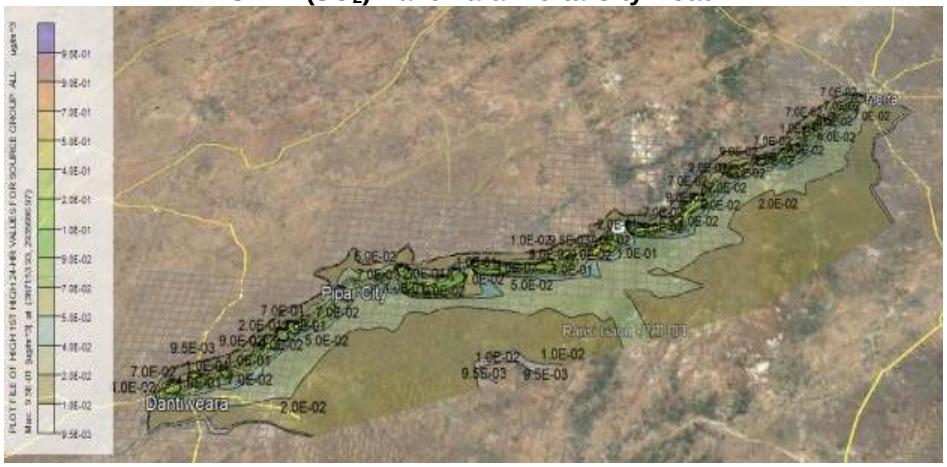
SH-21 (PM_{10})Dantiwara-Merta City Road



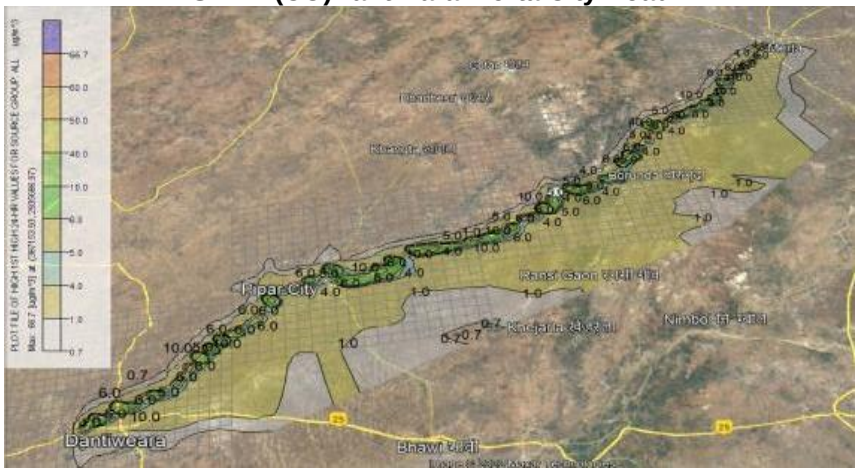
SH-21 NO_2) Dantiwara-Merta City Road



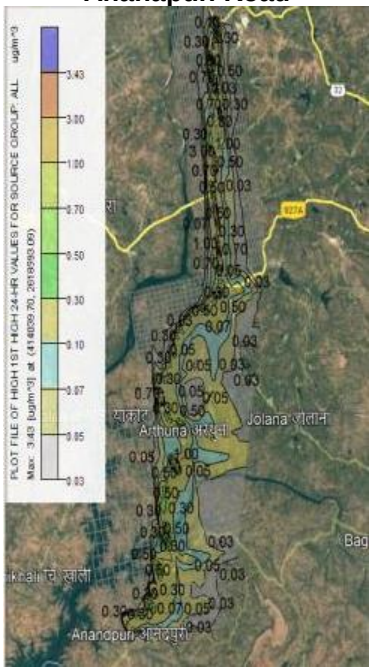
SH-21(SO_2) Dantiwara-Merta City Road



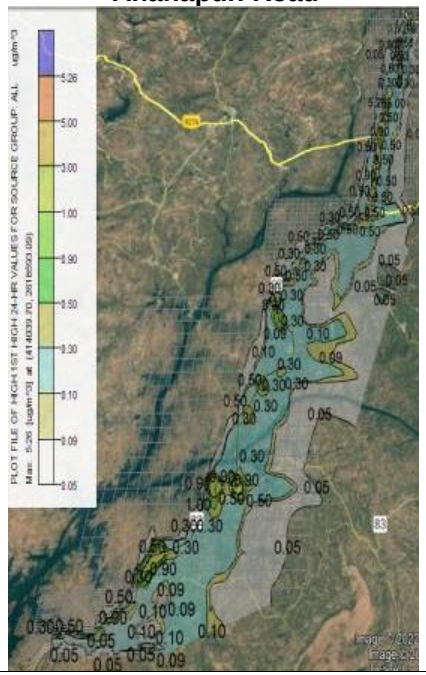
SH-21 (CO)Dantiwara-Merta City Road



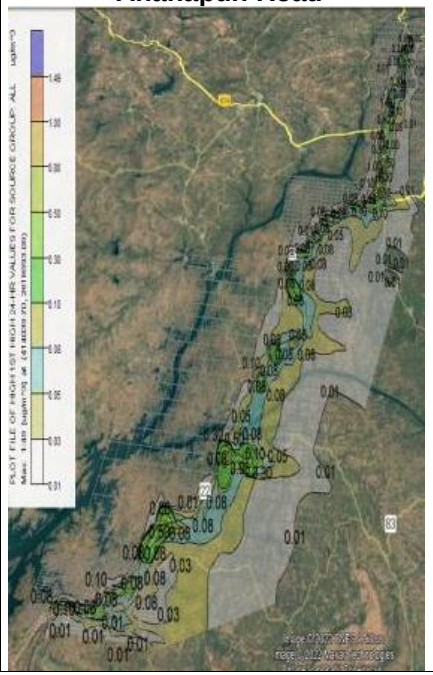
SH-10A($PM_{2.5}$) Paloda-Garhi-Ananapuri Road



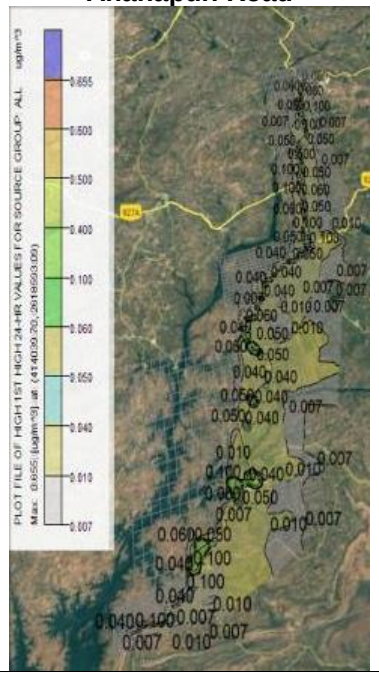
SH-10A(PM_{10}) Paloda-Garhi-Ananapuri Road



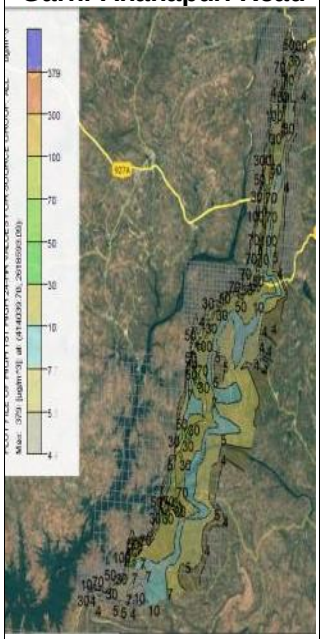
SH-10A(NO_2) Paloda-Garhi-Ananapuri Road



SH-10A(SO_2) Paloda-Garhi-Ananapuri Road



SH-10A(CO) Paloda-Garhi-Ananapuri Road



7. **Results and Analysis:** The incremental ground level concentration at various receptors locations is predicted for different road sections for the year 2021 (Base-case simulation to quantify the contribution from traffic volume on the background concentration on various receptors along the road length to assess the overall impact on the airshed. The dispersion has been carried out for 8-hourly and 24-hourly averaged incremental ground level concentrations (GLC) for CO, $PM_{2.5}$ and $PM_{10,}$ NO_2 and SO_2. The predicted 8-hourly and 24-hourly averaged incremental ground level concentrations of CO, $PM_{2.5}$ and PM_{10}, NO2 and SO_2 at receptor locations are presented in the isopleths in **Figure 19** and GLC predicted at specific distances from the road edge are provided **Table 30**

Table 30: Distance-wise Predicted Incremental Values of GLCs from edge of project road (2021)

Pollutants	Year	Pollution Concentration (µg/m^3)																			
		Distance from the edge of the road, m. (Left side)										Distance from the edge of the road, m. (Right side)									
		-1000	-900	-800	-700	-600	-500	-400	-300	-200	-100	100	200	300	400	500	600	700	800	900	1000
SH-44 ($PM_{2.5}$) Kherli-Nadbai-Kumher Road																					
CO	2021	6	6	6	6	6	6	10	10	10	10	10	10	10	10	6	6	6	5	2.5	2.5
PM2.5	2021	0.1	0.3	0.3	0.4	0.5	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3
PM10	2021	0.08	0.08	0.08	0.1	0.5	0.5	0.5	0.6	0.8	1.0	1.0	1.0	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5
NO2	2021	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.07	0.5	0.5	0.08	0.06	0.05	0.03	0.01	0.01	0.01	0.01	0.01
SO2	2021	0.01	0.01	0.01	0.01	0.01	0.06	0.06	0.06	0.1	0.3	0.3	0.2	0.2	0.08	0.08	0.08	0.04	0.04	0.04	0.04
SH-36 ($PM_{2.5}$) Churu-Taranagar																					
CO	2021	5	5	5	5	6	6	7	7	20	60	70	20	20	10	8	7	6	5	5	5
PM2.5	2021	0.06	0.06	0.1	0.1	0.3	0.5	0.6	0.6	1.0	1.0	1.0	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.2
PM10	2021	0.01	0.05	0.05	0.08	0.1	0.3	0.5	0.6	0.8	2.0	2.0	1.0	0.8	0.7	0.6	0.5	0.5	0.3	0.3	0.3
NO2	2021	0.001	0.001	0.001	0.07	0.07	0.1	0.1	0.3	0.5	0.9	0.8	0.3	0.3	0.01	0.01	0.01	0.006	0.003	0.003	0.003
SO2	2021	0.008	0.03	0.01	0.01	0.03	0.03	0.05	0.05	0.05	0.5	0.5	0.5	0.4	0.2	0.08	0.06	0.03	0.03	0.02	0.02
SH-36 (NO_2) Taranagar- Nohar																					
CO	2021	3	3	3	5	5	6	6	7	10	40	50	10	10	10	7	6	6	4	3	3
PM2.5	2021	0.04	0.04	0.04	0.1	0.1	0.4	0.4	0.4	0.9	0.9	0.9	0.8	0.8	0.4	0.4	0.4	0.2	0.2	0.2	0.2
PM10	2021	0.08	0.1	0.1	0.4	0.4	0.8	0.8	0.8	1.0	3.0	1.0	0.9	0.8	0.8	0.7	0.6	0.3	0.1	0.1	0.08
NO2	2021	0.002	0.003	0.005	0.08	0.1	0.3	0.3	0.4	0.5	1.0	0.9	0.5	0.5	0.3	0.1	0.08	0.05	0.003	0.005	0.005
SO2	2021	0.005	0.01	0.03	0.03	0.07	0.07	0.1	0.2	0.2	0.4	0.5	0.3	0.2	0.1	0.06	0.06	0.04	0.02	0.02	0.01
SH-21($PM_{2.5}$) Dantiwara-Merta City Road																					
CO	2021	1	2	5	5	6	6	10	10	20	30	40	30	20	10	8	8	6	6	5	4
PM2.5	2021	0.02	0.02	0.07	0.1	0.3	0.3	0.3	0.5	0.8	0.8	0.7	0.6	0.6	0.3	0.2	0.2	0.1	0.1	0.05	0.05
PM10	2021	0.05	0.05	0.09	0.1	0.1	0.2	0.6	0.7	1.0	2.0	2.0	0.8	0.7	0.7	0.6	0.5	0.2	0.2	0.1	0.1
NO2	2021	0.02	0.02	0.05	0.08	0.2	0.2	0.4	0.4	0.5	0.9	0.8	0.7	0.5	0.5	0.2	0.08	0.05	0.08	0.05	0.05
SO2	2021	0.01	0.02	0.02	0.05	0.05	0.08	0.1	0.3	0.4	0.5	0.5	0.4	0.3	0.2	0.08	0.04	0.03	0.02	0.02	0.02
SH-10A($PM_{2.5}$) Paloda-Garhi-Ananapuri Road																					
CO	2021	6	6	7	8	8	9	9	10	30	90	100	50	30	20	10	10	8	8	4	4
PM2.5	2021	0.05	0.05	0.09	0.1	0.3	0.6	0.6	0.9	1.0	2.0	2.0	0.9	0.9	0.6	0.6	0.4	0.4	0.3	0.1	0.03
PM10	2021	0.1	0.1	0.2	0.3	0.5	0.6	0.6	0.8	2.0	4.0	3.0	1.0	0.9	0.9	0.6	0.5	0.5	0.3	0.3	0.3
NO2	2021	0.03	0.05	0. 06	0.09	0.2	0.3	0.3	0.3	0.5	0.9	1.0	0.5	0.5	0.3	0.1	0.09	0.08	0.08	0.05	0.05
SO2	2021	0.006	0.01	0.01	0.02	0.05	0.07	0.09	0.2	0.3	0.4	0.5	0.2	0.1	0.08	0.06	0.05	0.03	0.01	0.009	0.009

142. **Summary of Analysis:** The modelling shows the predicted maximum incremental pollutant concentration and the incremental GLC over a distance of 1 km on either side of the project road at all receptor points in the form of isopleths; **CO (2021)**: The predicted 8-hourly ground level concentration of CO within 1km of receptors are found in the range from 5 – 100.0 µg/m^3 at all sub-project roads. The maximum GLC of CO was found of 100.0 µg/m^3 for SH-10A. Overall, 24-hourly incremental CO concentrations in different receptors of four road sections of airshed and are found below the national ambient air quality standard (2000 µg/m^3) at all locations.**$PM_{2.5}$: (2021)** The predicted 24-hourly ground level concentration of PM2.5 within 1km of receptors are found in the range from 0.1 – 2.0 µg/m^3 at all sub-project roads. The maximum GLC of $PM_{2.5}$ was found of 2.0 µg/m^3 for SH-10A. Overall, 24-hourly incremental $PM_{2.5}$ concentrations at different receptors of four road sections airshed and are found below the IFC standards (75 µg/m^3) at all locations. The 24-hourly incremental of $PM_{2.5}$ concentrations do not exceed the national ambient air quality standard (60 µg/m^3). **PM_{10}: (2021)**The predicted 24-hourly ground level concentration of PM_{10} within 1km of receptors are found in the range from 0.1 – 4.0 µg/m^3 at all sub-project roads. The maximum GLC of PM_{10} was found of 4.0 µg/m^3 for SH-10A. Overall, 24-hourly incremental PM_{10} concentrations at different receptors of six road sections airshed and are found below the IFC standards (150 µg/m^3) at all locations. Nowhere the, 24-hourly incremental of $PM_{2.5}$ concentrations are found to exceed the national ambient air quality standard (100 µg/m^3) at any locations for the four road. **NO_2(2021)** The predicted 24-hourly ground level concentration of NO_2 within 1km of receptors are found in the range from 0.001 – 1.0 µg/m^3 at all sub-project roads. The maximum GLC of NO_2 was found of 1.0 µg/m^3 for SH-10A. Overall, 24-hourly incremental NO_2 concentrations at different receptors of four road sections airshed and are found to within the national ambient air quality standard (80 µg/m3) at all locations. **SO_2: (2021)**The predicted 24-hourly ground level concentration of SO_2 within 1km of receptors are found in the range from 0.005 – 0.5 µg/m^3 at all sub-project roads. The maximum GLC of SO_2 was found of 0.5 µg/m^3 for SH-10A. Overall, 24-hourly incremental SO_2 concentrations at different receptors of four road sections airshed and are found to within the national ambient air quality standard (80 µg/m^3) at all locations.

143. Analysis of modelling results shows that the predicted incremental concentration levels of CO, $PM_{2.5}$, PM_{10} NO_2 and SO_2 at all the receptors along the project road will moderately contribute to the overall background concentration as a result of vehicular emissions during the construction stage however, the pollution concentration will be well within the permissible limit of national ambient air quality standards and IFC/WHO standards for the year 2021. It is anticipated that pollution concentration will decrease with distance on either side of the road due to dispersion and assimilation process.

3. Noise and Vibration

144. Increases in noise due to construction activities (land clearing, site preparation, material, equipment, machinery movement, establishment of camps/site offices) are expected. The impacts of noise exposure on the community residing near the work zones will be significant and intensity of the exposure to different receptors will also vary widely. These impacts are temporary in nature as the construction site moves along different road stretches. For these operations, the noise levels will increase during the construction period. The machinery involved in the construction operation (dozer, roller, grader, paver, tractors, brooms/rotary brushing, tippers, generators, excavators, etc.) produce noise levels in the range of 80 – 95 dB(A) (at a distance of about 5 m from the source). Although this level of noise is higher than permissible limit, it will occur intermittently and temporarily. This noise level will attenuate fast with increase in distance from noise source. There is a number of noise sensitive receptors, especially schools, close to the alignment. Adequate mitigations have been proposed for the remaining structures near the road. Since hill cutting in ghat section is

not envisaged noise and/or vibration impact due to blasting is not expected. Specific measures are:

a. All equipment will be timely serviced and properly maintained to minimize its operational noise. Noise level will be one of the considerations in equipment selection which will favour lower sound power levels. Construction equipment and machinery will be fitted with silencers and maintained properly.
b. Stationary noise making equipment will be placed along un-inhabited stretches.
c. Timing of noisy construction activities will be regulated near residential areas and sensitive receptors. Maximum construction activities will be undertaken during night time and weekends when sensitive receptors such as schools are not functioning. Alternatively, construction work will be executed during daytime near residential areas. The health centres along the project roads are of primary level with first aid outdoor treatment facility and are anticipated not to require any permanent noise barriers.
d. Noisy operations will be separated to reduce the total noise generated, and, where feasible, traffic will be re-routed during construction to avoid the accumulation of noise beyond standards.
e. If the abovementioned schemes prove to be inadequate, temporary noise barrier will be provided near identified sensitive locations or near the noise source during construction.
f. Protection devices (ear plugs or earmuffs) will be provided to the workers operating in the vicinity of high noise generating machines.
g. Noise monitoring will be carried out to ensure the effectiveness of mitigation
h. Complaints on noise from local community will be received and addressed through the grievance redress mechanism system discussed in chapter VI.

145. **Vibration:** Vibration can be felt during construction due to equipment movement, pile driving, compaction, hammering, operation of batching plant and generators, etc. Vibration can cause general annoyance, sleep disturbance, architectural and structural damage to properties.

146. In general, structural damage to the building caused by vibration phenomena are extremely rare and generally generated by the contribution of other factors. Other forms of damage defined “threshold level," is the one that, without compromising the structural safety of the buildings, can cause a reduction of the value or the use. The damage threshold takes the form of cracks in the plaster, enhancements of existing cracks, damage of architectural elements.

147. It is recommended that the Contractor undertakes condition surveys of all properties within 25 meters from road edge as well as vibration monitoring during heavy machinery/equipment operation. If there are any claims or reports of damage the affected house will be surveyed against the pre-project survey and repairs will be undertaken as appropriate by the Contractor. There are several technical standards, which can serve as reference for the evaluation of the disturbance and damages caused by vibration phenomena. For damage to the buildings the main references are: UNI 9916 "Criteria for measuring and assessing the effects of vibration on buildings", DIN 4150 and BS 7385. These standards provide a guide for the selection of appropriate methods of measurement, data processing and evaluation of the vibratory phenomena for the evaluation of the effects of vibration on buildings (risk of structural damage), with reference to their structural response and architectural integrity.

4. Land and Soil

148. **Loss of Productive Soil and Change in Land use:** Topsoil from borrow areas shall not be used for embankment formation as it is very fertile and shall be used for closure of disturbed are as after the completion of construction work. Loss of topsoil is envisaged during construction stage if construction plant, offices, workers camps, stockyards, and borrow areas are located on fertile areas and if haul roads and traffic detours during construction are routed through agricultural land. Change in land use is insignificant since widening and improvement is mostly within available ROW. Hence, no specific mitigation proposed for land use change. Specific measures for topsoil preservation are:

a. The topsoil will be stripped to a maximum of 1.5 m depth and stored in stockpiles. At least 10% of the temporarily acquired area will be earmarked for storing topsoil.
b. The stockpile will be designed such that the slope does not exceed 1:2 (vertical to horizontal), and the height of the pile will be restricted to 2 m.
c. Stockpiles will not be surcharged, or otherwise loaded and multiple handling will be kept to a minimum and stockpile will be covered with gunny bags or tarpaulin.
d. It will be ensured that the topsoil will not be trafficked either before stripping or when in stockpiles.
e. To prevent any compaction of soil in the adjoining productive lands, the movement of construction vehicles, machinery and equipment will be restricted to project corridor as much as possible.
f. The stored topsoil will be utilized for covering disturbed areas including redevelopment of borrow areas after filling dressing of the slopes of embankment.

149. **Soil Erosion/ Silt Runoff:** Slopes of the project roads are relatively stable as the embankments of the roads are not high compared to the adjacent lands. Soil erosion may take place near cutting areas, at steep and un-compacted embankment slope, bridge locations and wherever vegetation is cleared. Soil erosion may have cumulative effect like siltation, embankment damage, drainage problem, etc. Loss of soil due to runoff from earth stockpiles may also lead to siltation. Specific measures are:

a. Bank protection measures will be taken at erosion prone areas.
b. Provision of side drains to guide the water to natural outfalls.
c. Retaining walls and breast walls have been included in the design to check erosion.
d. Covering the slope surface with grass and bushes, by simple planting of grass roots and saplings;
e. In conditions where simple planting and seeding is not effective, the slopes are covered with open mesh of natural fibres such as coir or jute, or of geo-synthetics, followed by planting of grass and bushes. This is often termed slope reinforcement method of vegetation; and,
f. Where slopes are of highly erodible materials or other adverse conditions prevail, the vulnerable slope surface is covered with protective surfacing. Stone or brick pitching are most commonly used in India for this purpose.
g. Side slopes of the embankment will not be steeper than 2H: 1V. Turfing of embankment slopes will be done along the stretch.
h. IRC: 56 -1974 recommended practice for treatment of embankment slopes for erosion control will be taken into consideration.

150. **Borrow Areas and Quarries:** Extraction of the soil from borrow area and boulders/ aggregates/ granular sub-base from the riverbeds can result in some direct and indirect impacts on the local and regional environment. Impacts may be positive or negative and vary from case to case. Borrow areas may cause some adverse impacts if left un-rehabilitated. It may pose risk to people, particularly children, and animals of accidentally falling into it as well as become potential breeding ground for mosquitoes and vector-borne diseases. Illegal quarrying may lead to unstable soil condition; destroy the landscape of the terrain, and cause air and noise pollution. The following specific provisions should be followed:

a. Borrow areas will not be located near habitation. The edges of borrow sites will be no closer than 3 m from any fence line or boundary.
b. Adequate clearance will be provided for the construction of catch drains. Borrow sites will have adequate drainage outlets unless the relevant landowner has agreed that the borrow area is to create a permanent tank or dam. Written clearance from the landowner/village head will be obtained before leaving a site
c. Borrow pits will be selected from barren land/wasteland to the extent possible. The topsoil will be preserved, and depth will be restricted to 1.5 m to comply with IRC guidelines.
d. Borrow areas should be excavated as per the intended end use by the owner. IRC:10-1961 guideline should be used for selection of borrow pits and amount that can be borrowed.
e. The depths in borrow pits are to be regulated as per IRC guidelines. Borrow areas will be levelled with salvaged material or other filling materials which do not pose contamination of soil.
f. Transportation of fine aggregates and earth material by covered trucks.
g. Sprinkling of water near loading/downloading and stockpile locations.
h. The contractor will evolve site-specific redevelopment plans for each borrow area, which will be implemented after the approval of the Supervision Consultant.
i. If necessary, opening of new quarries only after environmental clearance from SEIAA, NOC from SPCB and permission from state mines department.

151. **Compaction and Contamination of Soil:** Soil of the haulage roads and construction camp area may be compacted due to movement of construction vehicles, machineries and equipment, and due to siting of construction camps and workshops. Soil may get contaminated due to inappropriate disposal of liquid waste, (lubricant and fuel spills, vehicle/equipment washing effluent) and solid waste (fuel filters, oily rags) likely to be generated from repair and maintenance of transport vehicles, construction equipment and machinery. Soil may also get contaminated due to inappropriate disposal of domestic solid waste and sewage from construction camps. Sub-soil contamination may also be attributed to: scarified bitumen wastes, operation of the emulsion sprayer and laying of hot mix, storage and stockyards of bitumen and emulsion, excess production of hot mix and rejected materials. As such, the following specific measures are proposed:

a. Fuel and lubricants will be stored at the pre-defined storage location. The storage area will be paved with gentle slope to a corner and connected with a chamber to collect any spills of the oils.
b. Unavoidable waste will be stored at the designated place prior to disposal. To avoid soil contamination at the wash-down and re-fuelling areas, oil interceptors will be provided. Oil and grease spill and oil-soaked materials are to be collected and stored in labelled containers and sold off to SPCB/MoEF&CC authorized re-refiners.

c. Movement of construction vehicles, machinery and equipment will be restricted to the designated haulage route.
d. Approach roads will be designed along the barren and hard soil area to reduce the compaction induced impact on soil.
e. The productive land will be reclaimed after construction activity.
f. Septic tank/mobile toilets fitted with anaerobic treatment will be provided at camp.
g. Domestic waste at construction camp will be segregated into biodegradable and non-biodegradable waste. Non-biodegradable waste will be given or sold to relevant agents for recycling or disposed in the nearest dumping site following environmentally friendly practices.

5. Groundwater and Loss of Water Sources

152. Rajasthan has always been a water deficit area. Water resources in the state are not only scarce but have a highly uneven distribution both in time and space with most of the available water resources being confined to the south and south-eastern part of the State. The ground water condition of the state is quite alarming. The condition has deteriorated very fast in the last two decades. The stage of groundwater exploitation, which was just 35% in the year 1984, has reached a level of 150% in 2021. At present, Rajasthan has 248 water blocks, out of which 44 are in the safe category, 28 (semi-critical), 9 (critical), and 164 are over-exploited. Churu district has been notified by the Central Groundwater Authority. In notified areas, abstraction of ground water is not permissible for any purpose other than drinking and domestic use. However, prior permission/ NOC is mandatory for abstracting groundwater for project purposes including road infrastructure. Uncontrolled abstraction may hamper water need of communities along the road. Other than these, specific measures are:

a. All efforts have been taken while finalizing the alignment to minimize the impact on ponds and other water sources.
b. Rainwater harvesting pits are proposed in all sub-projects. It is also recommended to convert some of the borrow areas into ponds. These measures will significantly augment the groundwater conditions in the project areas.
c. All hand pumps and wells proposed for relocation at suitable locations in consultation with local community.
d. In view of the recent order by the National Green Tribunal, it is a pre-condition to recharge groundwater while granting permission for abstraction of groundwater by CGWA for any infrastructure project.
e. The contractor will make arrangements for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.
f. No change in groundwater regime is envisaged hence no mitigation is proposed.

6. Siltation and Deterioration in Surface Water Quality

153. Construction activities may increase turbidity level increasing the sediment load. Sometimes contamination of surface water may take place due to accidental spills of construction materials, oil, grease, fuel, and paint. Degradation of water quality is also possible due to accidental discharges into water courses from drainage of workers camps and from spillages from vehicle parking and/or fuel and lubricant storage areas. During construction phase, care would be exercised to control silt so that the water available in the ponds and wells, especially those located very near to the ROW may not be contaminated.

154. Extraction of sand from the riverbed may increase turbidity and affect propagation of fishes and other aquatic life mainly benthic organisms. The macro-benthic life which remains attached to the riverbed material may get dislodged and carried away downstream by turbulent flow. Mining and dredging activities, poorly planned stockpiling and uncontrolled dumping of overburden, and chemical/fuel spills from equipment and machinery involved in dredging may cause deterioration of water quality for downstream users and poisoning of aquatic life. However, the riverbed sand quarries identified for the project have no density and diversity of benthic fauna. No fishing was observed or reported. This is mainly because all riverbeds are dry for most part of the year. Moreover, any extraction of riverbed material is regulated by different authorities like State Environmental Impact Assessment Authority (SEIAA), State Pollution Control Board (SPCB), and State Mining Department with an objective to conserve topsoil, avoid impact on aquatic biodiversity, hydrological regime, etc. by haphazard and unscientific mining of minor minerals. The project will utilize riverbed materials from existing licensed quarries with all stipulated conditions of abovementioned authorities. Moreover, specifically:

a. Construction works near waterways/water bodies will not be undertaken during the monsoon season
b. Retaining walls, stone pitching and toe walls have been proposed to prevent erosion
c. Contractors will install temporary silt traps or sedimentation basins along the drainage leading to the water bodies,
d. No construction camp will be located within 500 m of any water body.
e. All parking, repair and fuel and hazardous material storage areas will be located away from any water body. Vehicle parking and maintenance areas will have waterproof floors from which drainage is collected and treated to legal standards.
f. Vehicles will be refuelled only in dedicated areas with waterproof floors from which drainage flows to an oil/water separator before discharge
g. All waste oil will be collected and stored in sealed damage-proof containers and disposed to recyclers.
h. All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual cleanup.
i. Temporary retention ponds, interception drains, and silt traps will be installed to prevent silt laden water from entering adjacent water bodies/waterways.
j. The slopes of embankments leading to water bodies will be modified and rechanneled to prevent entry of contaminants.
k. Contractors will comply with requirements of the clearance issued by the relevant state authority for mining in rivers

7. Hydrology and Drainage

155. A number of rivers, streams, and nallahs drain the project area. Although most of them are seasonal in nature, waterlogging/ flood situation may arise due to construction of road embankment which may act as impediment to flow of water without adequate cross drainage/ side drains. Water logging along the road will also have ill effects on the stability of embankment especially in shallow water table areas. Diversion of water channels during construction of cross drainage structures or otherwise is not envisaged. Sub-structure construction should be limited to the dry season. The following have also been taken or should be taken to mitigate these impacts:

a. Adequate cross drainage structures have been provided to avoid impediment to natural flow of water. Additional balancing culverts have been provided. The embankment height has been designed consistent with the existing topography of the region.
b. Effective drainage system will be provided to drain the storm water from the roadway and embankment and to ensure minimum disturbance to natural drainage of surface and subsurface water of the area.
c. Drainage system design such as surface and sub-surface drainage will be carried out as per IRC: SP: 42 and IRC: SP: 50. Surface runoff from the main highway, embankment slopes, and service roads will be discharged through longitudinal drains, designed for adequate cross section, bed slopes, invert levels, and outfalls. If necessary, the walls of the drains will be designed to retain the adjoining earth.
d. In the absence of sufficient guidance materials on how a (Representative Concentration Pathways) RCP scenario can be used with confidence in actual engineering practice, a shift to a higher design frequency, 50-year return period instead of 10-15 year, was considered to cope with climate change uncertainties.
e. All existing causeways are proposed to be reconstructed as minor bridge or slab/box culverts.

8. Construction Debris/ Waste

156. Debris can be generated by dismantling of pavement. Depending on the type and place of recycling asphalt pavements, the most frequently used methods are plant (hot-mix asphalt) recycling, cold in-place recycling, and hot in-place recycling. Although hot-mix plant recycling has been widely used, both cold and hot in-place recycling are recommended only for low-traffic roads. Nevertheless, asphalt can be recycled numerous times.

157. Debris generated due to the dismantling of the existing road need to be suitably reused in the road construction, subject to the suitability of materials and as follows;

f. Sub grade of the existing pavement shall be used as embankment fill material.
g. Existing base and sub-base material shall be recycled as sub-base of the haul road or access roads
h. Existing bitumen surface may be utilized for the paving of cross roads, access roads and paving works in construction sites and campus, temporary traffic diversions, haulage routes etc.
i. Contractor will suitably dispose unutilized debris materials at pre-designated disposal locations as per Construction Waste Management Rules, 2016
j. At locations identified for disposal of residual bituminous wastes, the disposal will be carried out over a 60 mm thick layer of rammed clay so as to eliminate the possibility of leaching of wastes into the ground water. The concessionaire will ensure that the surface area of such disposal pits is covered with a layer of soil.

158. Quarry dust and unused iron bars or damaged support structures constitute significant wastes. Mitigation for solid waste from construction camp has been given in construction camp section. However, other specific mitigation measures are as follows:

a. Unusable debris material should be suitably disposed at pre-designated disposal locations to the satisfaction of AE.

b. Unusable and surplus materials, as determined by the Project Engineer, will be removed and disposed off-site.
c. Following considerations will be made during selection of dumping sites.
    - 1.5 km from habitation and forest areas and 500 m from ponds.
    - Dumping sites do not contaminate any water sources, rivers etc., and
    - Consent from the village council has to be obtained before finalizing the location.
    - Form works will be re-used to the extent possible. All stripped formworks will be examined for any damage and rectified in the workshop for re-use.

9. Ecological Resources

159. **Terrestrial Vegetation/ Trees**: The total number of trees will be affected are 9,606 trees spread over a vast geographical area is unlikely to cause any change in microclimate. The roads are also passing through largely modified habitats and removal of trees will be done only along the existing alignment except in bypasses and will therefore not cause significant ecological impact. Compensatory plantation at 1:3 ratio will improve the local climate in the long term. No loss of any rare/endangered species is envisaged. Detailed measures to be taken are as follows:

a. Avoid or minimize the number of trees to be cleared through minor geometric realignment or eccentric widening.
b. Requisite permission from Forest Department will be secured for cutting of roadside trees.
c. Ensure timely commencement of compensatory plantation. Roadside Plantation Strategy as per IRC including manuring and controlled use of pesticides/ fertilizers
d. Additional plantation/avenue plantation is also proposed subject to availability of land.
e. Provision of LPG in construction camp as fuel source to avoid tree cutting for firewood, wherever possible.
f. For safe traffic operation, vertical clearance between the crown of the carriageway and lowest part of overhang of the tree available across the roadway will conform to IRC: SP: 21-2009. The pit size, fencing, watering, and manuring requirements will also conform to the above standard. Use of pesticides will be restricted.
g. In the event of design changes during the construction stages, additional assessments including the possibility to save trees shall be made by the EA

160. **Invasive Species:** Soil brought into the project area from outside may contain seeds of alien invasive species. Also, the construction machinery and vehicles can accidentally introduce seeds of such plants if used without proper cleaning. Temporary facilities such as labor camps, dumping sites, soil storage sites are potential locations where invasive plant species can get established in quick succession. This will negatively affect both the natural and manmade habitats. Securing soil from locations close to the project area will reduce the chances of transporting any seeds of alien invasive species to the project area. Land area of labor camps, dumping sites and soil storage sites should be frequently checked for any growth of invasive plant species. If found, they should be burned and destroyed within the premises in which they were found. Information on invasive plant species will be provided in camps.

161. **Aquatic Ecology:** Temporary sedimentation and water quality deterioration is expected during the construction stage. Increase in turbidity due to erosion will lead to

reduction of light penetration and make it an undesirable place for aquatic fauna and flora. Further due to the reduced light penetration to the water body, the primary productivity of the biota in the water body will be reduced resulting in increased mortality. In addition, when these particles settle on the bottom it will affect the breeding ground of aquatic animals. Improvement of existing embankments particularly along the waterways may increase silt while accidental spill of materials, chemicals, and fuels will deteriorate receiving water quality. The impact is insignificant since most of the waterways are non-perennial and construction of bridges will be mostly during summer. Siltation will be avoided by measures suggested above in impact on surface water resource section.

10. Construction Camp and Immigration of Workers

162. Poor siting and improper management of construction camp may lead to several adverse impacts on environment like: (i) loss of vegetation due to use of wood as fuel source for cooking, (ii) deterioration in nearby surface water bodies' quality, (iii) compaction and contamination of soil due to uncontrolled disposal of solid waste, and (iv) poor sanitation may result to transmission of communicable diseases among the workers and the host communities. This includes the possible spread of sexually transmitted disease, diseases from improper handling and supply of food, poor water supply, insect-borne diseases, and alcohol and drug abuse. The following specific measures should be taken to avoid/minimize negative effects:

a. No productive land will be utilized for camp. All sites must be graded and rendered free from depressions to avoid water stagnation. Accommodation and ancillary facilities will be erected and maintained to standards and scales approved by the resident engineer. All camps will be sited at the SPCB prescribed distance from habitation and water bodies.
b. All construction camps will be provided with sanitary toilet with septic tanks attached with soak pits. Storm water drains will be provided for the flow of used water outside the camp. Drains and ditches will be treated with bleaching powder on a regular basis. Garbage bins must be provided in the camp and regularly emptied and disposed in a hygienic manner. LPG cylinders will be provided as fuel source for cooking to avoid any tree cutting.
c. At every workplace, the Contractor will ensure that a first-aid unit is readily available. Workplaces away from regular hospitals will have indoor health units. Suitable transport will be provided to reach the nearest hospital. An ambulance containing the prescribed equipment and nursing staff will be provided, as appropriate
d. The Contractor will ensure the good health and hygiene of all workers to prevent sickness and epidemics. These measures include the HIV/AIDS prevention program to reduce the risk and transfer of HIV. Activities under the program include regular information, education, and communication campaigns to workers, drivers, delivery crew, and communities on the risk.
e. The Contractor will provide adequate and safe water supply for workers. No alcoholic liquor or prohibited drugs will be imported to, sell, give, and barter to the workers of host community.
f. Migrant workers may be the potential carriers of various diseases. Regular health check-up and immunization camps will also be organized for the workers and nearby population.
g. In the event of any unanticipated, conditions one like COVID-19 pandemic situations, Government protocols must be followed and precautions shall be taken.

11. Workers and Community Health and Safety

163. The following safety aspects will be observed: (i) safety of construction workers, (ii) safety of road users including pedestrians, (iii) safety to cattle, (iv) safety of local community, (iv) unsafe/ hazardous traffic conditions due to construction vehicle movement to be considered during design and construction stage, and (v) conduct of safety audit. Impact and mitigations due to construction activities have already been detailed in Noise and Vibration section but specific safety measures are outlined below:

a. During the construction phase, contractors will be required to adopt and maintain safe working practices. Internationally accepted and widely used safety procedures should be followed during: (i) road works, (ii) handling of large construction equipment and machineries, (iii) handling of chemicals and hazardous materials and inflammable substances, (iii) welding, and(iv) electrical works among others.
b. Contractor will arrange all PPE for workers, first aid and fire-fighting equipment at construction sites. An emergency plan will be prepared duly approved by engineer in charge to respond to safety hazards.
c. To avoid disruption of the existing traffic due to construction activities, comprehensive traffic management plan will be drawn up by the contractor. Traffic in construction zones will be managed as per the provisions of IRC SP 55.
d. After construction is completed in a particular zone, it will be opened for normal operation. All diversions should be closed before start of normal operation.
e. Use of retro-reflectorized traffic signs, and cantilever/gantry type overhead signs, thermoplastic road marking paints, delineators, traffic cones, empty bitumen drums, barricades, and flagmen will be used to ensure traffic management and safety. Conduct of regular safety audit on safety measures will be adopted during construction.

12. Obstruction and Disruption of Traffic

164. Disruption of access to infrastructure or social resource due to construction activity will cause nuisance and additional cost to the public in terms of longer travel period due to diversion or heavier traffic. It will also pose risk of accident to motorist at night if these blockage and disruption are not clearly demarcated. As such, specific measures outlined below should be followed:

a. The contractor will submit a traffic plan to the Project Engineer before the construction. This Plan will recommend for approval, the safe and convenient temporary diversion of traffic during construction, design of barricades, delineators, signs, markings, lights, and flagmen, among others.
b. For widening of existing carriageway and part of it will be used for passage of traffic, paved shoulder will be provided on one side of the existing road by the contractor
c. At least one 3.5 m lane to remain open to traffic at all times
d. The surface used by the through traffic will be firm bituminous compacted surface free of defect
e. The maximum continuous length over which construction under traffic may take place should be limited to 750 meters as much as practicable.
f. Construction activity will be restricted to only one side of the existing road.
g. On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed.
h. Transportation of quarry material to the construction sites through heavy vehicles will be done through existing major roads to the extent possible. This will restrict wear and tear to the village/ minor roads. Small vehicles/ un-

motorized vehicle can also be used for its further transportation to the construction sites from temporary storage areas.

13. Transport and Storage of Materials

165. The construction material primarily will consist of aggregate, sand, cement, bitumen, and lubricating oil and fuel for vehicle and construction equipment. These will be primarily stored temporarily at construction camps. The oils, fuels and chemicals will be stored on concreted platform with spills collection pits. The cement will be stored under cover. All these temporary storage areas will be located at least 150m away from the habitat. The likely impacts due to transportation and storage including fugitive emission have already been covered under different sections above.

H. Post Construction and Operational Phase

166. Road aesthetics will be improved after tree plantation, landscaping of embankment slopes, improving the road cross sections, more bus bays, side drains, installation of safety signages, crash barriers, and road markings. The aesthetics will further be improved due to the enhancements/ creation of new ponds as a rehabilitation measure for borrow areas. However, due to lack of proper maintenance the road condition may deteriorate over the years resulting into numerous problems such as rise in accidents, disruption of transportation services, tree survival, and functioning of side drains. PWD will allocate adequate resources and logistics to ensure that the road and its furniture are being maintained and intended benefits are generated thereof.

1. Site Restoration

167. Contractor will prepare site restoration plans, which will be approved by the AE. The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. All construction zones including riverbeds, culverts, roadside areas, camps, hot mix plant sites, crushers, batching plant sites, and any other area used/ affected by the project will be left clean and tidy, at the contractor's expense, to the satisfaction of the Environmental Officer of the AE. All the opened borrow areas will be rehabilitated and AE will certify it.

2. Road Repair/Maintenance Work and Increase in Traffic

168. Emissions from hot patch work, fumes from pavement marking works, dust from concrete grinding, and dust demolition debris may deteriorate local air quality. Mitigation measures recommended are:

a. Provision of PPE to workers
b. Water sprinkling to control dust
c. Covered haul trucks
d. Maintain an adequate vehicle road capacity as congestion decreases vehicle speed, deteriorates fuel efficiency, and increases emission per kilometer travel.
e. Maintain optimum range of vehicle speed. CO_2 emissions drastically increase when vehicles are travelling less than 30 kph and faster than 70 kph.
f. Maintain good riding quality of the toll road, expressed in roughness

3. Soil Erosion and its Cumulative Impacts:

169. The consequences of soil erosions are far wider than repair and maintenance of the road. Along the project road, the inflow of water into ponds during rains causes erosion of the embankment besides seepage of water into embankment and sub-grade resulting in softening and possible, pavement failure. This may also increase siltation in water bodies. Project design includes provisions of retaining walls for the protection. Regular checks will be made to check its effectiveness.

4. Water Resources

170. Improvements to the road drainage will result in improved storm water flows and reduce the tendency of blockages to occur in roadside drains. Risks to the public health caused by such stagnant water bodies by acting as disease vector breeding places will be reduced. Designing the drains to withstand appropriate storm events, adjusted to climate change projections, and implementing regular maintenance will further reduce the chances of drainage system failure. Accidental oil spillage, washing of vehicles, used engine oils, paints used in maintenance can contaminate the water bodies. Proper handling of such chemicals under strict supervision will help to minimize the water pollution during the maintenance period. Rejuvenation of the drainage system by removing encroachments/congestions should be regularly conducted

5. Pedestrian and Commuter Safety

171. Improvements to the road surface will be conducive to safe vehicle travel at higher speeds. Such speeds may increase the incidences of accidents. Incorporating the following measures could offset this negative impact;

a. Provision of centerline road marking where possible, edge delineation, etc.
b. Provision of clearly marked signing at townships, sensitive areas such as potential wildlife crossings, schools, temples, etc.
c. Enforcement of speed limits and other traffic rules, especially near potential wildlife crossings and built-up sections.
d. Safety of road users could be ensured during repair of carriageway and hydraulic structures by placing standard sign boards, barricading of the repair site, etc.

6. Air Quality

172. Air emissions due to vehicular movement are one of the prime sources of air pollution in the study area. The project roads are currently having 1.5 or 2-lanes without shoulders. Based on the traffic estimation for the next few years, widening and upgradation is proposed for all the sub-projects. This will result in better road condition and will ease the traffic movement which will result in less congestion. In the existing scenario, due to lesser width and higher roughness, the average vehicle speed is low, which results in more exhaust gas emissions. In the sub-projects, proposed road construction with concrete material and periodic maintenance will result in reduction of gas emissions from the traffic flow. Also, currently the land use is majorly agriculture along the sub-projects. Therefore, improved road conditions and congestion-free traffic movement will reduce emissions and air quality in the sub-project region will be improved.

173. **Air Modelling for Predictions for 2041:** Air dispersion modelling is conducted to assess the impact of air pollutant dispersion because of vehicular traffic emissions on the sensitive receptors during operation period for 20 years. The impact on air quality depends upon traffic volume, traffic fleet including fuel type and prevailing atmospheric conditions. An unstable atmospheric condition disperses pollutants more while stable atmospheric conditions traps pollutants resulting in increased pollution concentrations. To assess the likely impacts on the ambient air quality due to the proposed highway project, the prediction of the particulate matter (PM2.5 and PM10), carbon monoxide (CO), Nitrogen di oxide (NO2) and Sulphur di-oxide (SO2) have been carried out using AERMOD View (line source) dispersion model, based on Gaussian equation. AERMOD dispersion modelling is conducted considering homogenous sections of the four sub-project roads for the forecasted using project traffic data for 2041 as shown in **Table 31.** GLC predicted at specific distances from the road edge are provided in **Table 32.**

Table 31: Calculation of Composite Emission Factor for 2041

Pollutants	Distance (km)		Composite Emission Factor (g/s/m^2)
	Existing	Improved	2041
SH-21 Dantiwara-Merta City Road			
CO	87.7	87.7	0.000154
$PM_{2.5}$	87.7	87.7	0.00000453
PM_{10}	87.7	87.7	0.00000823
NO_2	87.7	87.7	0.00000294
SO_2	87.7	87.7	0.00000208
SH-36 Churu-Taranagar-Nohar Road			
CO	115.8	115.8	0.000253
$PM_{2.5}$	115.8	115.8	0.00000743
PM_{10}	115.8	115.8	0.0000126
NO2	115.8	115.8	0.00000337
SO_2	115.8	115.8	0.00000143
SH-44 Kherli-Nadbai-Kumher Road			
CO	37.00	37.00	0.000086
$PM_{2.5}$	37.00	37.00	0.00000685
PM_{10}	37.00	37.00	0.0000115
NO2	37.00	37.00	0.00000386
SO_2	37.00	37.00	0.00000226
SH-10A Paloda-Garhi-Ananapuri Road			
CO	54.7	54.7	0.000252
$PM_{2.5}$	54.7	54.7	0.0000029
PM_{10}	54.7	54.7	0.00000491
NO2	54.7	54.7	0.00000103
SO_2	54.7	54.7	0.000000836

Table 32 Ground Level Incremental Concentration values (2041) at field Monitoring Locations

F-Field; PI-Predicted incremental Values, T- Total

S. No.	Name of Location	Particulate Matter ($PM_{2.5}$)	Particulate Matter (PM_{10})	Nitrogen Oxide (As NO_2)	Sulphur Dioxide (As SO_2)	Carbon monoxide (as CO)
Unit		**$\mu g/m^3$**				
	Dantiwara-Pipar-Merta City Road					
1	0+13Km Near IOCL Vill. Inadwar	0.5	2.0	1.0	0.6	70
2	0+38 Km Near Village Beetan	0.8	10.0	3.0	1.0	100
3	0+44Km Near Hotel Karni Place	0.3	1.0	0.8	0.5	70
4	0+60 Km Near Vill Naman	0.6	7.0	2.0	0.5	50
5	0+75 Km Near Village Bankaliya	0.5	3.0	1.0	1.0	30
6	0+91 Km Near Village Dantiwara	0.6	1.0	2.0	0.5	100
	Kherli Nadbai Kumher Road					
1	0+7 Km	30	50	18.0	10	30
2	0+15 Km Nr. IOCL Petrol Pump	3.0	3.0	1.0	1.0	100
3	0+19 Km Nr. ESSAR Petrol Pump	10.0	30.0	10.0	8.0	30
4	0+25Km Nr. ESSAR Petrol Pump	5.0	10.0	3.0	1.0	100
5	0+32 Km Nr. Baboraa Passion	1.0	1.0	0.8	0.5	30
6	0+39 Km Nr. Village Kumher	1.0	3.0	1.0	0.5	10
	Paloda-Garhi-Anandpuri Rajya Seema Tak					
1	0+9 Km	2.0	2.0	1.0	0.5	200
2	0+18 Km	1.0	2.0	0.5	0.5	100
3	0+23 Km	1.0	1.0	1.6	0.7	200
4	0+34 Km	0.8	1.0	0.8	0.6	200
5	0+43 Km	0.2	1.0	1.0	0.5	200
6	0+51 Km	1.0	0.8	0.3	0.3	200
	Churu-Taranagar-Nohar Road (Nohar To Taranagar)					
1	0 to 12 Km ESSAR Petrol Pump	1.0	3.0	1.0	0.1	100
2	0 to 23 Km Village Meghana	1.0	1.0	0.6	0.1	100

S. No.	Name of Location	Particulate Matter ($PM_{2.5}$)	Particulate Matter (PM_{10})	Nitrogen Oxide (As NO_2)	Sulphur Dioxide (As SO_2)	Carbon monoxide (as CO)
3	0 to 34 Km Near Sri Shiv Gorakha Bhojanalya	0.5	0.7	0.6	0.1	100
4	0 to 46 Village Dhriwas Bada	5.0	10.0	3.0	1.0	500
5	0 to 60 Nr. Baaichara Hotel	10.0	32.1	8.57	3.64	1000
6	0 to 71 Km HP Petrol Pump	0.8	7.0	1.0	0.7	300
Churu-Taranagar-Nohar Road (Churau To Taranagar)						
1	0+9.5 Km Near Achanak Family Restaurant	8	10	5	1.0	1395
2	0+15 Km Nr. Temple	3.0	7.0	1.0	0.7	100
3	0+23 Near ESSAR Petrol Pump	19.2	32.6	8.73	3.0	1000
4	0+34 Khatiya Dhani	3.0	10	3.0	1.0	500
5	0+41 Nr Raghav Hotal	1.0	10	5.0	1.0	100
6	0+46 Nr. Taranagar	8	7	0.8	0.8	100

175. **Figure 20** gives isopleths of Air pollutants (incremental values) and their dispersion for four sub project roads for the year 2041. The concentration of pollutants is higher and will impact air quality adversely in case of no project scenario.

Figure 20: Isopleths of Air Pollutants for 2041

SH-44 ($PM_{2.5}$) Kherli-Nadbai-Kumher Road

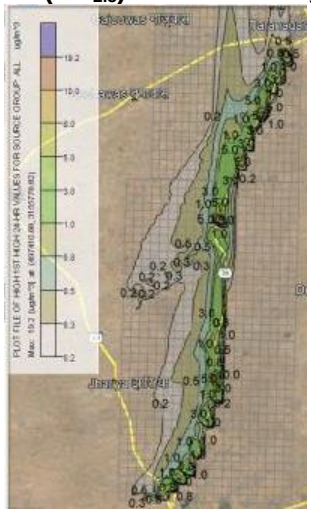
SH-44 (PM_{10}) Kherli-Nadbai-Kumher Road

SH-44 (NO_2) Kherli-Nadbai-Kumher Road

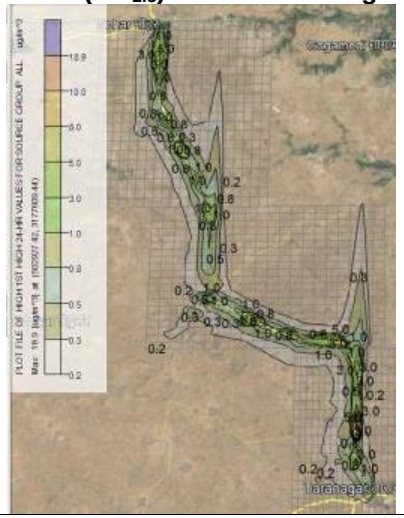
SH-44 (SO_2) Kherli-Nadbai-Kumher Road

SH-44(CO) Kherli-Nadbai-Kumher Road

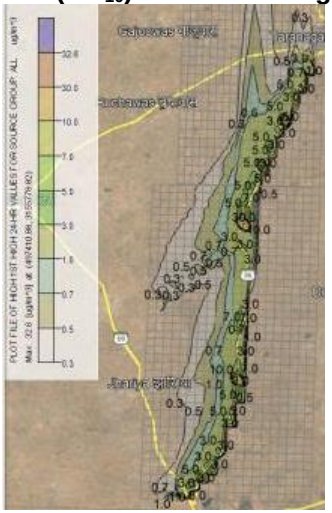
SH-36 ($PM_{2.5}$) Churu-Taranagar



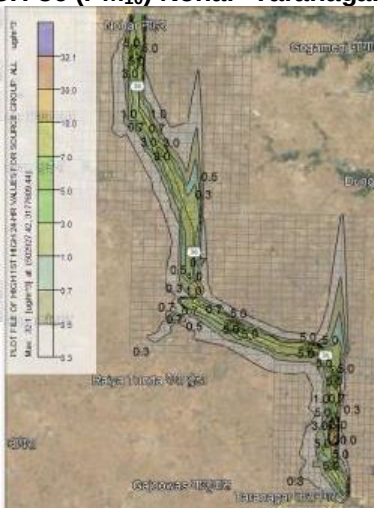
SH-36 ($PM_{2.5}$) Nohar -Taranagar



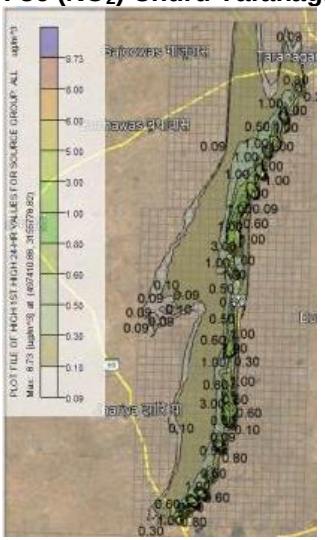
SH-36 (PM_{10}) Churu-Taranagar



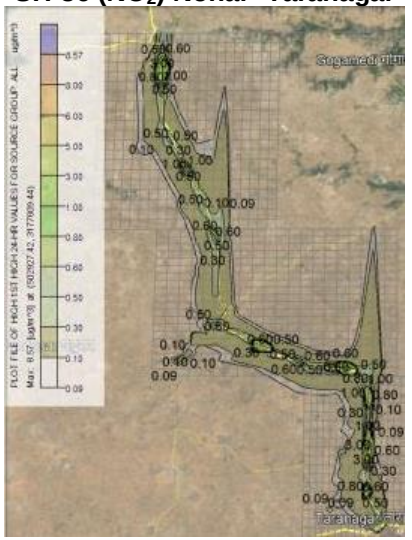
SH-36 (PM_{10}) Nohar- Taranagar



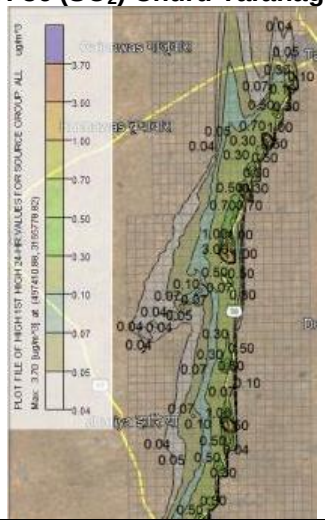
SH-36 (NO_2) Churu-Taranagar



SH-36 (NO_2) Nohar -Taranagar



SH-36 (SO_2) Churu-Taranagar



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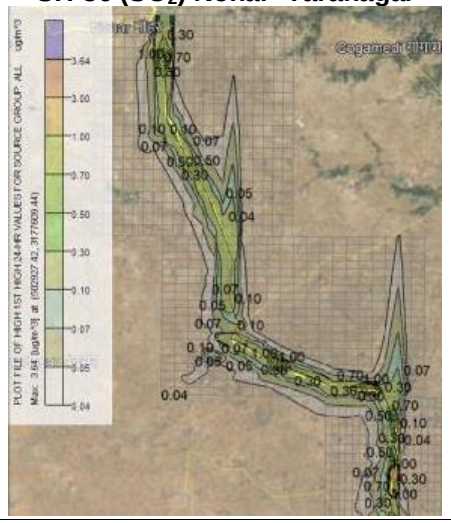
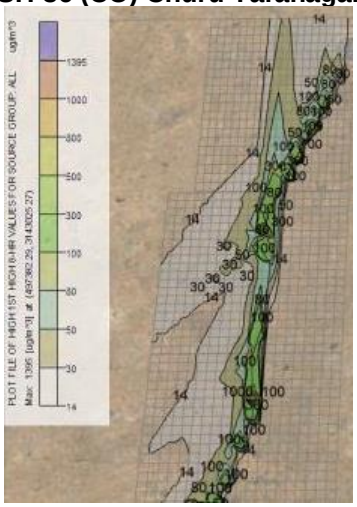
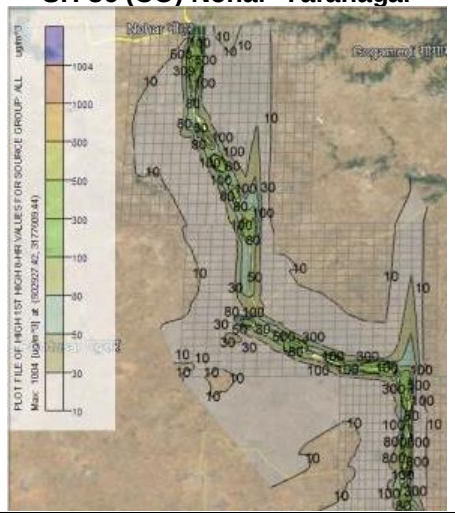


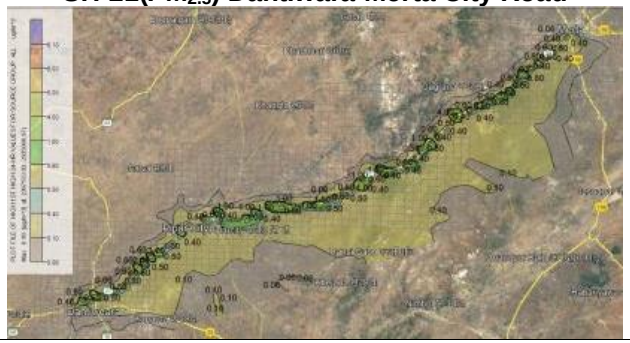
SH-36 (CO) Churu-Taranagar



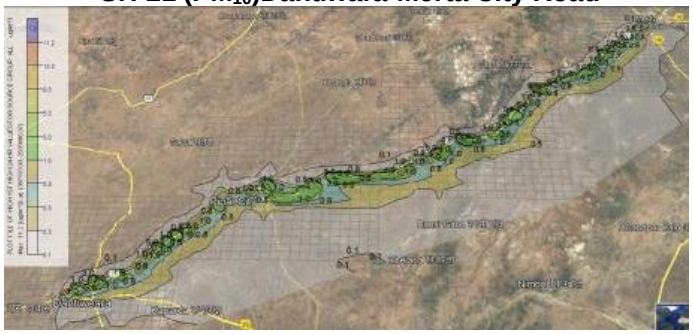
SH-36 (CO) Nohar -Taranagar



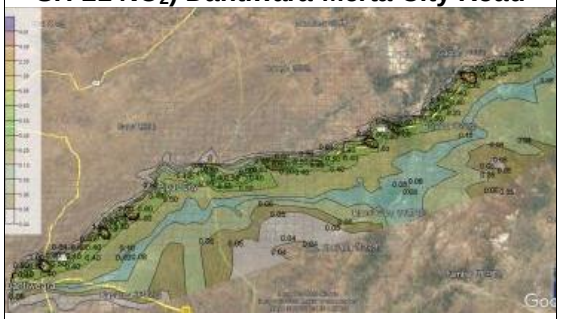
SH-21($PM_{2.5}$) Dantiwara-Merta City Road



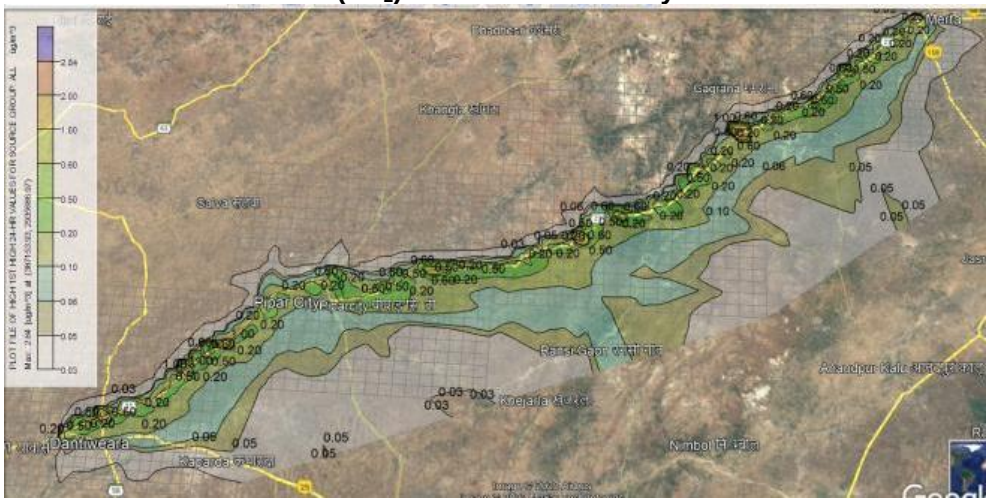
SH-21 (PM_{10})Dantiwara-Merta City Road



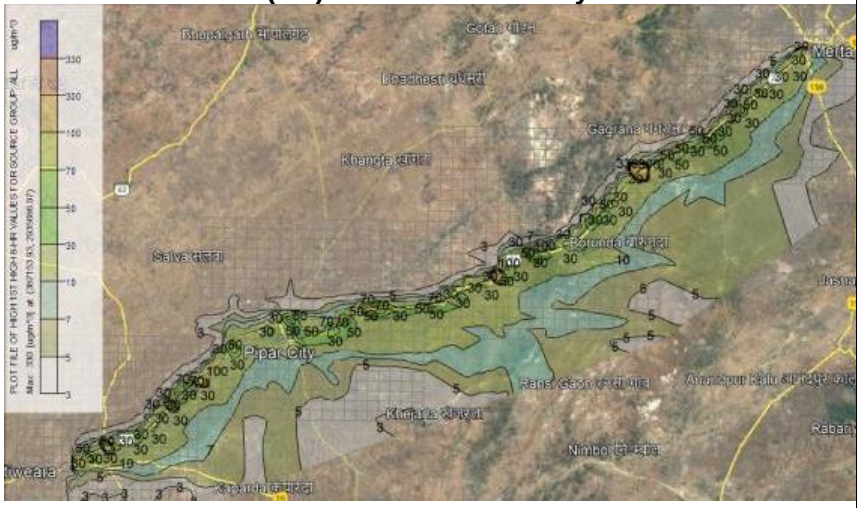
SH-21 NO_2) Dantiwara-Merta City Road

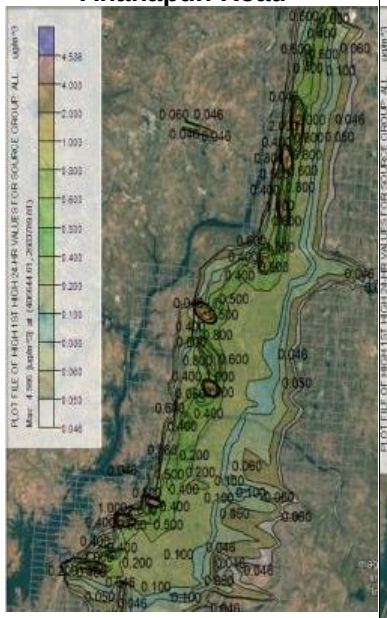
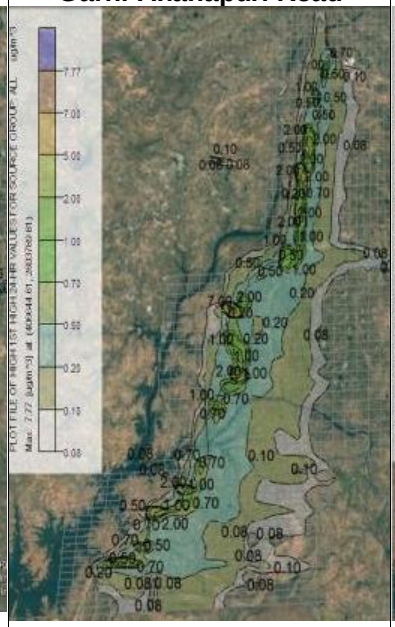
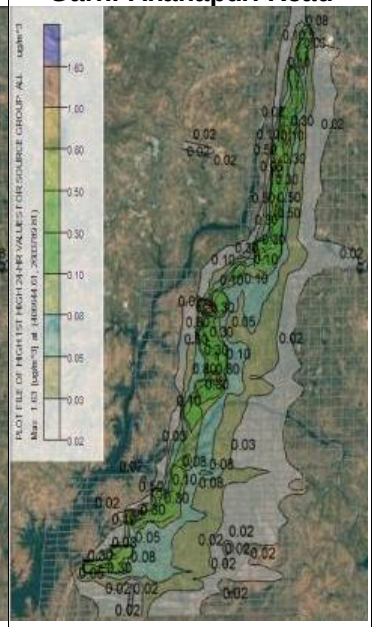
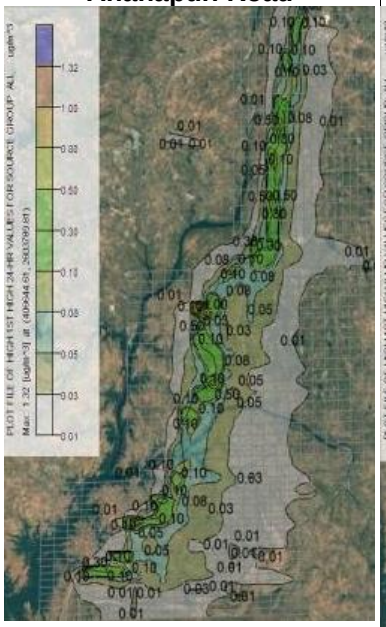
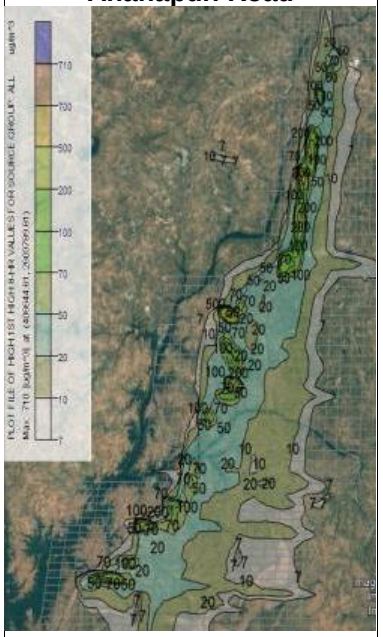


SH-21(SO_2) Dantiwara-Merta City Road



SH-21 (CO)Dantiwara-Merta City Road



SH-10A($PM_{2.5}$) Paloda-Garhi-Ananapuri Road	SH-10A(PM_{10}) Paloda-Garhi-Ananapuri Road	SH-10A(NO_2) Paloda-Garhi-Ananapuri Road	SH-10A(SO_2) Paloda-Garhi-Ananapuri Road	SH-10A(CO) Paloda-Garhi-Ananapuri Road
				

176. **Results and Analysis:** The incremental ground level concentration at various receptors locations is predicted for different road sections for the 2041 to quantify the contribution from traffic volume on the background concentration on various receptors along the road length to assess the overall impact on the airshed. The dispersion has been carried out for 8-hourly and 24-hourly averaged incremental ground level concentrations (GLC) for CO, $PM_{2.5}$ and $PM_{10,}$ NO_2 and SO_2. The predicted 8-hourly and 24-hourly averaged incremental ground level concentrations of CO, $PM_{2.5}$ and PM_{10}, NO2 and SO_2 at receptor locations are presented in the isopleths in Error! Reference source not found. G LC predicted at specific distances from the road edge are provided **Table 33.**

Table 33 Distance-wise Predicted Incremental Values of GLCs from edge of project road (2041)

Pollutants	Year	Pollution Concentration (µg/m^3)																			
		Distance from the edge of the road, m. (Left side)										Distance from the edge of the road, m. (Right side)									
		-1000	-900	-800	-700	-600	-500	-400	-300	-200	-100	100	200	300	400	500	600	700	800	900	1000
SH-44 ($PM_{2.5}$) Kherli-Nadbai-Kumher Road																					
CO	2041	10	50	60	80	100	300	500	600	600	600	600	600	600	600	500	500	300	80	50	10
PM2.5	2041	0.1	0.3	0.8	1	2	5	10	10	10	10	10	10	10	5	2	2	1.0	0.8	0.3	0.1
PM10	2041	0.5	0.7	1.0	3	3	7	10	30	30	30	30	30	30	30	30	10	7	3	1	07
NO2	2041	0.5	1.0	3	5	5	8	10	10	10	10	10	10	10	10	10	8	5	5	3	1.0
SO2	2041	0.5	1	2	3	5	8	8	8	8	8	8	8	8	8	8	5	3	1	1.0	0.5
SH-36 ($PM_{2.5}$) Churu-Taranagar																					
CO	2041	10	20	50	100	300	500	500	1000	1000	1000	1000	1000	1000	1000	500	500	300	100	50	20
PM2.5	2041	0.5	1.0	3	3	5	5	5	8	8	10	10	8	8	5	5	5.0	5	3	1.0	0.5
PM10	2041	3	5	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	10	5	3
NO2	2041	0.1	0.5	1.0	2.0	2.0	5.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	7.0	5.0	3	2	1.0	0.5	1.0
SO2	2021	0.1	0.5	0.6	0.8	3	3	3	3	3	3	3	3	3	3	3	0.8	0.6	0.5	0.4	0.1
SH-36 (NO_2) Taranagar- Nohar																					
CO	2041	20	50	100	100	300	500	500	800	800	800	800	800	800	800	500	500	300	100	100	50
PM2.5	2041	1.0	2.0	3	3	5	5	5	8	8	10	10	8	8	5	5	5	3	3	2.0	1.0
PM10	2041	1.0	2.0	3	3	5	7	8	10	10	30	30	10	10	8	7	5	3	3	2.0	1.0
NO2	2041	0.8	1.0	3	3	3	3	5	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	5	4	3	1.0	1.0
SO2	2041	0.5	0.1	0.3	0.5	1.0	1.0	3	3	3	3	3	3	3	3	3	1.0	1.0	0.5	0.3	0.1
SH-21($PM_{2.5}$) Dantiwara-Merta City Road																					
CO	2041	5	7	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	10	7	5
PM2.5	2041	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0	5.0	6.0	6.0	0.6	5.0	4.0	1.0	1.0	1.0	1.0	1.0	1.0

Pollutants	Year	Pollution Concentration (µg/m^3)																			
		Distance from the edge of the road, m. (Left side)										Distance from the edge of the road, m. (Right side)									
		-1000	-900	-800	-700	-600	-500	-400	-300	-200	-100	100	200	300	400	500	600	700	800	900	1000
PM10	2041	1.0	1.0	3	3	5	5	5	8	8	10	10	8	8	5	5	0.5	5	3	1.0	1.0
NO2	2041	0.1	0.5	0.6	0.8	2	2	2	2	2	2	2	2	2	2	0.2	0.8	0.6	0.5	0.4	0.1
SO2	2041	0.1	0.2	0.2	0.5	0.5	0.5	1.0	1.0	2	2	2	2	1.0	1.0	0.5	0.5	0.2	0.2	0.1	0.1
SH-10A($PM_{2.5}$) Paloda-Garhi-Ananapuri Road																					
CO	2041	10	30	50	70	100	300	300	300	300	300	300	300	300	300	300	300	300	100	70	50
PM2.5	2041	0.5	1.0	3	3	5	5	5	6	6	6	6	6	5	5	5	0.5	5	3	1.0	0.5
PM10	2041	0.5	1	3	3	5	5	8	8	10	10	10	8	8	5	5	3.0	3.0	1	0.5	0.3
NO2	2041	0.5	0.8	1.0	1.0	2	2	2	2	2	2	2	2	2	1	1.0	0.8	0.5	0.3	0.2	0.1
SO2	2041	0.1	0.5	0.6	0.8	1	1	2	2	2	2	2	1	1	0.8	0.8	0.8	0.6	0.5	0.4	0.1

177. **Summary of Analysis:** The modelling shows the predicted maximum incremental pollutant concentration and the incremental GLC over a distance of 1 km on either side of the project road at all receptor points in the form of isopleths **CO (2041)**: The predicted 8-hourly ground level concentration of CO within 1km of receptors are found in the range from 5 – 1000.0 µg/m3 at all sub-project roads. The maximum GLC of CO was found of 1000.0 µg/m^3 for SH-36. Overall, 24-hourly incremental CO concentrations in different receptors of four road sections of airshed and are found below the national ambient air quality standard (2000 µg/m3) at all locations. **$PM_{2.5}$: (2041)**The predicted 24-hourly ground level concentration of $PM_{2.5}$ within 1km of receptors are found in the range from 0.1 – 10 µg/m^3 at all sub-project roads. The maximum GLC of $PM_{2.5}$ was found of 10.0 µg/m^3 for SH-44. **PM_{10}: (2041)** The predicted 24-hourly ground level concentration of PM_{10} within 1km of receptors are found in the range from 0.1 – 30.0 µg/m^3 at all sub-project roads. The maximum GLC of PM_{10} was found of 30.0 µg/m^3 for SH-36 and SH-44. **NO_2(2041)** The predicted 24-hourly ground level concentration of NO2 within 1km of receptors are found in the range from 0.1 – 10.0 µg/m3 at all sub-project roads. The maximum GLC of NO2 was found of 10.0 µg/m3 for SH-44. Overall, 24-hourly incremental NO2 concentrations at different receptors of four road sections airshed and are found to within the national ambient air quality standard (80 µg/m3) at all locations. **SO_2 (2041)** The predicted 24-hourly ground level concentration of SO_2 within 1km of receptors are found in the range from 0.1 – 8.0 µg/m^3 at all sub-project roads. The maximum GLC of SO_2 was found of 8.0 µg/m^3 for SH-44. Overall, 24-hourly incremental SO_2 concentrations at different receptors of four road sections airshed and are found to within the national ambient air quality standard (80 µg/m^3) at all locations.

178. Analysis of modelling results shows that the predicted incremental concentration levels of CO, $PM_{2.5}$, PM_{10} NO_2 and SO_2 at all the receptors along the project road will moderately contribute to the overall background concentration as a result of vehicular emissions during the operation stage however, the pollution concentration will be well within the permissible limit of national ambient air quality standards and IFC/WHO standards for the year 2024. It is anticipated that pollution concentration will decrease with distance on either side of the road due to dispersion and assimilation process.

7. Noise

179. During the operational phase, movement of traffic, traffic congestion, pedestrian interferences, and increased use of horns due to interface between local/slow moving traffic with through traffic will be the prime source of noise. The noise levels at nearby schools, religious place may cause nuisance and irritation. Noise modelling has been carried out for the all sub-projects (SH-21, SH-36, SH-44, SH-10A) by using noise prediction tool DHWANIPRO to predict the noise generation due to the traffic movement as well as its propagation on the surrounding environment. The road is divided various sections/lines, traffic generated and projected for each horizon year is taken and noise levels were calculated. Assumptions considered in the modelling study include:

- Meteorological data of sub-project road is taken in base map creation.
- Cartesian Grid with an interval of 500mX500m or 1000mX1000m is considered based on the length of each sub-project.
- Various receptors such as residential, commercial and silence zones have been identified along the road
- Height of sources is 0.6 m above the carriageway.
- Background noise at receptors is considered as baseline noise levels present in the sub-project alignment.

- Though the design speed of the project road is 100 kmph, however as a conservative approach and speed restrictions in built-up areas, forest areas, bridges approaches, etc. average speed for modelling has been considered as 65 Kmph
- Traffic forecast data provided in the DPR (also summarized in **Table 3** of this report) has been used to generate different scenarios of noise propagation during the project lifecycle
- Model does not take into account background noise such as noise generated due to anthropogenic activities, industrial activities, movement/ operation of other noise generating sources, such as trains, aero planes, etc.
- Model consider the topography and terrain effect.
- Since segregated data for traffic is not available for daytime and night time, prediction has been done for entire 24 hr.

180. Scenarios modelled by considering receptors at various distances The prediction of noise propagation had considered following five assessment years based on the traffic projections provided in the DPR:

- 1st Prediction (Start Year after construction)
- 2nd Prediction - Year 2026
- 3rd Prediction Year 2031
- 4th Prediction Year 2036
- 5th Prediction Year 2041-42

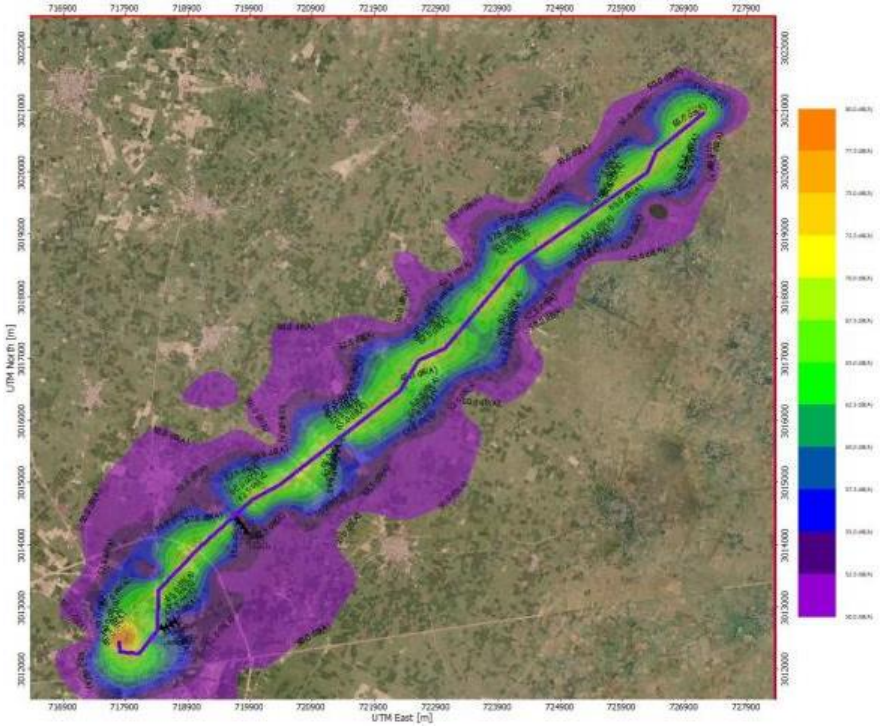
181. For all the five assessment years, prediction of noise has been carried out all along the project road with a grid size of 500 m x 500 m as part of grid noise assessment. It can be seen that without mitigation measures the noise levels are slightly exceeding with respect to applicable ambient noise standards for sensitive land use locations as well as in some of the residential receptors. Furthermore, additional traffic density in the project roads with better speed due to widening and strengthening of the road will result into further exceedances in the noise levels. However, implementation of the mitigation measures will significantly help to reduce the noise levels and infect help to even lower the noise levels in comparison to the baseline conditions in the initial 10 years of project operation. Error! Reference source not f ound. provides noise predicted levels for five traffic horizon years and the distance wise noise levels were measured at 15m, 30m, 50m and 100m from the noise contours generated. A sample noise propagation contour for SH-44 sub-project is shown in Error! Reference source n ot found.. Representative scenarios predicted for all sub-projects is given as **Appendix G**.

Table 34: Results of Predicted Noise Level in dB along Sub-Projects

Road Number	Start of operation				2026				2031			
	Predicted Noise from Road Edge (m)											
	15	30	50	100	15	30	50	100	15	30	50	100
SH-21	50.8	49.1	47.1	46	51.8	49.9	47.8	46.6	52.1	50.2	48.1	46.8
SH-36	50.4	49.4	48.9	48.5	50.1	48.6	47.6	47.3	51.1	48.6	47.1	46.1
SH-44	53.1	52.4	51.7	50.3	54.6	53.6	52.7	52.1	55.1	54	53.5	53
SH-10A	52	51.5	50	49	53	52	51	49.5	53.5	52.5	51.5	50

Road Number	2036				2041-42			
	Predicted Noise from Road Edge (m)							
	15	30	50	100	15	30	50	100
SH-21	52.8	50.8	48.6	47.3	52.7	51	49	47.5
SH-36	51.3	50.5	49.4	48.3	52	51	50	49
SH-44	55.9	54.6	54	54.5	56	55	54	53
SH-10A	54	53	52	51	54.5	53.5	52.5	51.5

Figure 21: Sample Contour Map showing Noise Levels along SH-44 sub-project



182. Results summarized in above table are without mitigation measures and impacts on sensitive receptors including residential areas are of vital concern and needs mitigation. Speed limits imposed in built-up sections to 30 kph can reduce noise by 3 dB. Most of the residential structures along the road are of concrete wall. The wall of a house (for a resident inside the house) can cause a reduction of noise of at least 3 dB. Therefore, these two factors combined together will easily attenuate noise by 6 dB thereby confirming the limits of residential areas. Solid noise barrier can reduce noise by 8- 9 db. Calculations made with this assumption show that noise barriers will be very effective in lowering noise levels. In fact, the noise levels will remain below baseline levels even with the traffic increases during daytime. Despite any exceedance of noise level during night, it would not affect the receptor, considering that the schools are occupied only during the daytime.

183. Sensitive Receptors Necessitating Noise Barrier: Noise barriers are proposed at all sensitive receptor locations where predicted noise level exceeds WHO guideline values for community noise. Various literatures and case studies establish that regardless of its material type, noise barrier with density of 20 kilograms/square meter can achieve a 5dB noise level reduction when it is tall enough to break the line-of-sight from the highway to the home or receiver. After it breaks the line-of-sight, it can achieve approximately 1.5dB of additional noise level reduction for each meter of barrier height. Assuming line of sight at 1.5 m, a noise barrier of 3.5 m proposed in this case can attenuate noise level by 8 dB. Further, the speed limit of 30 kmph and wall of existing receptors can reduce noise by 3 dB each. Project envisages multilayered plantation near sensitive location which can reduce noise by another 2 dB. All measures together can offset noise level by 16dB. The predicted values at sensitive receptors indicate that noise levels exceed WHO Guidelines at several locations. However, with mitigation values are already below baseline values and meet the GOI NAAQS limit at all locations.

184. Error! Reference source not found. provides the noise levels without mitigation and w ith mitigation with varied distance from road edge. The location of noise barriers at sensitive receptors is given in Table 36.

Table 35: Predicted Noise Levels (without mitigation and with mitigation)

Road Number	Start of Operation								2026							
	Predicted Noise from Road Edge (m)															
	15	WM	30	WM	50	WM	100	WM	15	WM	30	WM	50	WM	100	WM
SH-21	50.8	34.8	49.1	33.1	47.1	31.1	46	30	51.8	35.8	49.9	33.9	48.1	32.1	46.8	30.8
SH-36	50.4	34.4	49.4	33.4	48.9	32.9	48.5	32.5	50.1	34.1	48.6	32.6	47.1	31.1	46.1	30.1
SH-44	53.1	37.1	52.4	36.4	51.7	35.7	50.3	34.3	54.6	38.6	53.6	37.6	53.5	37.5	53	37
SH-10A	52	36	51.5	35.5	50	34	49	33	53	37	52	36	51.5	35.5	50	34
Road Number	**2031**								**2036**							
	15	**WM**	**30**	**WM**	**50**	**WM**	**100**	**WM**	**15**	**WM**	**30**	**WM**	**50**	**WM**	**100**	**WM**
SH-21	52.1	36.1	50.2	34.2	48.1	32.1	46.8	30.8	52.8	36.8	50.8	34.8	48.6	32.6	47.3	31.3
SH-36	51.1	35.1	48.6	32.6	47.1	31.1	46.1	30.1	51.3	35.3	50.5	34.5	49.4	33.4	48.3	32.3
SH-44	55.1	39.1	54	38	53.5	37.5	53	37	55.9	39.9	54.6	38.6	54	38	54.5	38.5
SH-10A	53.5	37.5	52.5	36.5	51.5	35.5	50	34	54	38	53	37	52	36	51	35

Road Number	2041-42							
	Predicted Noise from Road Edge (m)							
	15	WM	30	WM	50	WM	100	WM
SH-21	52.7	36.7	51	35	49	34	47.5	31.5
SH-36	52	36	51	35	50	35	49	33
SH-44	56	40	55	39	54	39	53	37
SH-10A	54.5	38.5	53.5	37.5	52.5	37.5	51.5	35.5

WM: With Mitigation

Table 36: Location of Noise Barriers along Sub-Project Roads

S. No	Chainage (km)	Type of receptor	Noise Barrier Length (m)	Barrier height (m)	Side
Dantiwara-Merta City Road					
1	8.200	School	15	3.5	LHS
2	8.900	School	20	3.5	RHS
3	13.800	School	10	3.5	RHS
4	13.900	School	20	3.5	RHS
5	14.200	School	50	3.5	RHS
6	14.900	School	15	3.5	LHS
7	17.100	School	20	3.5	RHS
8	20.100	School	15	3.5	LHS
9	27.600	School	15	3.5	RHS
10	29.200	School	5	3.5	LHS
11	31.800	School	7	3.5	LHS
12	41.900	School	No compound wall	3.5	RHS
13	42.300	School	5	3.5	RHS
14	43.400	School	3	3.5	RHS
15	47.350	School	5	3.5	RHS
16	47.650	Health Centre	8	3.5	RHS
17	51.325	School	15	3.5	RHS
18	55.100	School	3	3.5	LHS
19	56.400	College	15	3.5	LHS
20	62.230	School	10	3.5	RHS
21	63.700	School	12	3.5	LHS
22	74.050	Health Center	10	3.5	RHS
23	74.200	School	50	3.5	RHS
24	84.600	School	20	3.5	LHS
25	85.800	School	15	3.5	LHS

S. No	Chainage (km)	Type of receptor	Noise Barrier Length (m)	Barrier height (m)	Side
Churu-Taranagar-Nohar Road					
1	9+400	School	20	3.5	LHS
2	26+200	School	8	3.5	LHS
3	3+.970	School	5	3.5	LHS
4	40+600	School	1.5	3.5	RHS
5	42+300	School	8	3.5	LHS
6	46+050	School	2	3.5	RHS
7	54+200	School	50	3.5	RHS
8	71+500	School	2	3.5	LHS
9	72+500	School	5	3.5	RHS
10	72+600	School	15	3.5	RHS
11	78+600	School	5	3.5	LHS
12	78+700	School	5	3.5	LHS
13	96+100	School	5	3.5	RHS
14	109+300	School	12	3.5	LHS
15	113+100	School	5	3.5	LHS
16	113+700	School	5	3.5	LHS
Kherli-Nadbai-Kumher Road					
17	4+700	School	5	3.5	LHS
18	10+010	School	5	3.5	LHS
19	15+300	School	40	3.5	RHS
20	15+600	School	5	3.5	RHS
21	16+600	School	5	3.5	RHS
22	18+500	School	5	3.5	LHS
23	18+700	School	04	3.5	LHS
24	19+300	School	05	3.5	LHS
25	33+500	School	5	3.5	LHS
26	35+400	Primary Heath Center	5	3.5	LHS
Garhi-Anandpuri Section of Road					
1	00+200	School	3	3.5	RHS
2	00+550	Hostel	5	3.5	LHS
3	1+820	School	5	3.5	LHS
4	2+400	School	5	3.5	LHS
5	4+300	School	5	3.5	LHS
6	9+800	School	3	3.5	LHS
7	13+400	School	3	3.5	LHS
8	20+400	School	5	3.5	LHS
9	24+900	School	5	3.5	LHS
10	25+400	Hospital	10	3.5	RHS
11	32+100	Hostel	7	3.5	RHS
12	33+200	School	2	3.5	LHS
13	33+600	Hostel	3	3.5	LHS
Garhi-Paloda Section					
1	13+300	School	5	3.5	LHS
2	10+000	School	1	3.5	RHS
3	9+500	School	2	3.5	RHS
4	5+600	School	2	3.5	RHS
5	5+500	School	2	3.5	RHS
6	2+700	School	5	3.5	LHS
7	0+350	School	5	3.5	LHS

185. **Conclusions**: It is evident from the above tables that there will be significant increase in the noise levels due to increase in traffic intensity as well as average speed of vehicles over

the road's design life. However, with appropriate mitigation measures such as lowering of speed from 80km/hour to 30km/hour in residential and commercial areas which has already been included in the project design, the natural barrier effect from the wall of houses, and the provision for noise barriers near sensitive receptors the noise levels will be kept even below the baseline levels

186. **Vibration:** Highway traffic is not likely to have any measurable impact on the structures or on comfort. The Federal Highway Administration of the USA has determined that "all studies the highway agencies have done to assess the impact of operational traffic induced vibrations have shown that both measured and predicted vibration levels are less than any known criteria for structural damage to buildings. In fact, normal living activities (e.g., closing doors, walking across floors, operating appliances) within a building have been shown to create greater levels of vibration than highway traffic.

VI. GREEN HOUSE GAS EMISSION

A. Climate Change Mitigation

One of the main triggering factors for climate change is increase in greenhouse gas emissions. Transportation sector in India contributes to around 7.5% of the total GHG emission, of which road transportation alone has a significant share of 87%[22]. Road construction accounts for 5% of its total life cycle in GHG emission whereas operational traffic accounts for rest 95%[23]. GHG emissions likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)[24] developed by Clean Air Asia[25] to assess the CO_2 gross emissions with and without the project.

187. The main improvements of the sub-project road that was considered for the model are better surface roughness with less than 2m/km and widening of roads from 1.0 or 1.5 lanes to 2-lane standard. These changes were translated into increase in traffic speed and smooth movement of traffic and, hence, reduction in fuel consumption during the operation after upgradation and improvements. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting data on the traffic numbers, lane width, number of lanes and volume/capacity saturation limit. Information that was used for projecting the CO_2 emissions were:
    a. The project will rehabilitate and widen 4 rural roads (SH-21, SH-36, SH-44 and SH-10A) with total road length of 295.2 km
    b. The road configuration will change from 1.0 or 1.5 lanes to uniform 2.0 lanes with carriageway width of 7 m that will have mostly bituminous surface.
    c. Existing road roughness is mostly 6.0 to 7.0 m/km and will be improved to less than 2.0m/km and will be maintained within this limit in the future;
    d. Construction will take place over a period of 24 months in 2022-24 and road operations will begin in 2024.
    e. Other improvements include the repair or reconstruction of damaged culverts, introduction of lined longitudinal and cross drains for road and removal of irregularities on the existing vertical profile and road safety appurtenances.
    f. Traffic studies suggest that the project roads do not connect to major corridor and, therefore, induced traffic is only least expected.
    g. Traffic forecasts were taken from the design report, which has assumed increase in traffic over the project life as 5%.

188. Since the project roads are located in different terrains, the maximum PCU for existing 1/1.5 lanes as well as upgraded 2 lanes have been aligned with the IRC guidelines **(**Table 37**).**

Table 37: Maximum PCU based on Terrain Considered in the TEEMP

Number of Lanes	Maximum PCU		
	Plain Terrain [1]	Rolling Terrain [2]	Hilly Terrain [3]
1	2,000	1,800	1,400
1.5	6,000	5,700	4,500
2	18,000	13,000	9,000

Source: [1] & [2] IRC: SP-64:1990; [3] IRC: SP-73:2015

[22] Emissions from fuel combustion highlights (2012 Edition) by International Energy Agency.
[23] Indian Network for Climate Change Assessment, MoEFCC, 2010.
[24] TEEMP is an excel-based spreadsheet models to evaluate emissions impacts of transport projects.
[25] A network of 250 organizations in 31 countries established by the Asian Development Bank, World Bank, and USAID to promote better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors.

189. It has been noted that fuel types in the transportation sector are constantly moving towards use of cleaner fuel and have already started in metropolitan cities. Considering this, it has been assumed that predominantly petrol and diesel driven vehicles will be operated, there will be a least share of LPG/ CNG and electric vehicles in the modal share. Assumptions made for fuel type from year 2021 to 2040 is given in **Table 38**.

Table 38: Fuel Type Scenario Considered in the TEEMP (Year 2021 and Year 2040)

	2021					
Fuel Type (%)	**Gasoline**	**Diesel**	**LPG**	**Electric**	**Other**	**Sum**
2-wheeler	100.00%					100%
3-wheeler	10.00%	85.00%	5.00%			100%
Car	55.00%	40.00%	0.00%			100%
Multi Axle		100.00%				100%
Bus		100.00%				100%
2 Axle		100.00%				100%
	2040					
Fuel Type (%)	**Gasoline**	**Diesel**	**LPG**	**Electric**	**Other**	**Sum**
2-wheeler	50.00%			50.00%		100%
3-wheeler	10.00%	40.00%	30.00%	20.00%		100%
Car	40.00%	30.00%	10.00%	20.00%		100%
Multi Axle		100.00%				100%
Bus		75.00%	5.00%	20.00%		100%
2 Axle		100.00%				100%

190. Emission factors were taken from a variety of sources including CPCB, MoEF&CC, Automotive Research Association of India (ARAI) and other published reports, considering different types of vehicles and fuel. It has also been assumed that the emission factors will be improved over a period of time due to improved fuel efficiency as well as changes in regulations and use of cleaner fuels. Emission factors referred for different type of vehicles and fuel is given in **Table 39**.

Table 39: CO_2 Emission Factors for Different Vehicle Types (Year 2021 and 2040)

	2021				2040			
Fuel	**Gasoline**	**Diesel**	**LPG**	**Electric**	**Gasoline**	**Diesel**	**LPG**	**Electric**
Unit	**kg/liters**	**kg/liters**	**kg/kg**	**kg/kwh**	**kg/liters**	**kg/liters**	**kg/kg**	**kg/kwh**
2-wheeler	1.78			0.82	1.51	-	-	0.41
3-wheeler	3.41	3.97	3.23	0.82	2.89	3.37	2.75	0.41
Car	2.10	2.63	2.40	0.82	1.79	2.23	2.04	0.41
Multi Axle		2.21		0.82	-	1.88	-	-
Bus		2.37	2.10	0.82	-	2.02	1.79	0.41
2 Axle		2.37			-	2.02	-	-

191. The model demands information on length of road or section, lane configuration, mode-wise count of AADT in vehicles, average trip length, share or local traffic, trip length of local traffic, fleet characteristics i.e., breakdown of fleet based on fuel type, percentage breakdown of vehicle-fuel type based on Euro standard. Input parameters as considered for all the sub-project roads are given in succeeding tables. Design period is considered to be 20 years and volume capacity saturation limit is considered based on the current traffic velocity and hence varies in each project road. Traffic forecasts were taken from the traffic surveys, which are assumed as 5% per annum for each of the project road.

Table 40: Input Parameters for TEEMP

Road Section	Length (km)	Business as Usual (BAU)			With Project Scenario (WPS)		
		Lanes	Lane width (m)	Roughness (m/km)	Lanes	Lane width (m)	Roughness (m/km)
SH-21	86.700	1.5	3.75	6	2	3.5	2
SH-36	115.80	1.5	3.75	6	2	3.5	2
SH-44	37.000	1.5	3.75	6	2	3.5	2
SH-10A	54.700	1.5	3.75	6	2	3.5	2

1. Carbon emissions from road construction were estimated by using the emission factor for rural/ urban roads, by using ADB - Carbon footprint 1), which is equivalent to 48,400 kg CO_2/km of road construction.

Table 41: Estimated Total CO2 Emission during Road Construction

Road Section	Length (km)	Emission factor (kg CO_2/km)	CO_2 emission (kg)
SH-21	87.700	48,400	42,44,680
SH-36	115.80		56,04,720
SH-44	37.000		17,90,800
SH-10A	54.700		26,47,480
Total	**295.2 km**		**1,42,87,680 (14288 tons)**

192. The road upgradation brings about changes in surface roughness value and road capacity value which on improvements have implications in CO_2 emissions. Improved roughness (lower value) results in higher speed and lesser emissions while increase road usages increases emissions. These are further affected by traffic congestion once reach the volume/capacity saturation limit. On the other hand, CO_2 emissions are also generated as a result from the processing and manufacturing of raw materials needed to upgrade the project road and in this case of project, to upgrade and strengthen the road length of approximately 295.2 km. Thus, the total CO_2 emissions that is likely to be generated as a result of the road construction will be of the order of approximately 14,288 tons, which will be mostly generated during the first 2 years of road construction period (as the total construction period is mostly to 2 years).

193. The design life of road is considered to 20 years. Emission of CO_2 as estimated in scenarios as Business-As-Usual BAU and With Project Scenario (WPS) for all the project roads individually is estimated and found to be below 100,000 tons per year threshold set by ADB. The total CO_2 emission at BAU and WPS (over the design life of road) were estimated as 2,20,097 tons/ year and 27,521 tons/ year (with induced traffic) respectively.

Table 42: Overall Project CO2 Emissions Intensity Indicators

Road Sections	Road Length (km)	Particular	CO_2 Emission		
			Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
SH-21	**87.700**	tons/km	9683	2721	3098
		tons/year	36313	11930	13585
		tons/km/year	484	136	155
		g/pkm	1127	226	224
		g/tkm	187	38	37
SH-36	**39.520**	tons/km	9471	1295	1521

Road Sections	Road Length (km)	Particular	CO_2 Emission		
			Business-As-Usual	Project (without Induced Traffic)	Project (with Induced Traffic)
(Churu to Taranagar)		tons/year	19178	2622	3081
		tons/km/year	474	65	76
		g/pkm	2592	214	211
		g/tkm	652	54	53
SH-36 (Taranagar to Nohar)	76.28	tons/km	12946	992	1178
		tons/year	25245	3744	4447
		tons/km/year	647	50	59
		g/pkm	1873	167	167
		g/tkm	588	53	53
SH-44	37.0	tons/km	438	257	297
		tons/year	845	496	573
		tons/km/year	22	13	15
		g/pkm	264	135	130
		g/tkm	182	93	90
SH-10A	54.7	tons/km	3351	486	569
		tons/year	6769	981	1150
		tons/km/year	168	24	28
		g/pkm	2051	180	176
		g/tkm	741	65	64
Total	**295.2**	tons/year	**88,350**	**19,774**	**22,837**

194. It is therefore evident that 'with project scenario' will reduce more than 74% of CO_2 emissions relative to the business-as-usual scenario. Business-as-usual scenario will continue to have more CO_2 emissions due to the poor road conditions with increasing traffic. With project scenario will bring wider roads, improved road conditions, ease in traffic movement, and better fuel efficiency. Major reduction comes from the improvement of road carrying capacity, as the traffic volume will reach saturation limit with existing road infrastructure, and it would be difficult to sustain 60 km/hr speed with existing 1 or 1.5 lanes during the entire project life.

VII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Meaningful Consultation

195. Meaningful consultations[26] as prescribed in SPS 2009 were carried out in the project area during IEE preparation. All the five principles of information dissemination, information solicitation, integration, co-ordination, and engagement into dialogue were incorporated in the consultation process. A framework of mitigating the project's different environmental impacts was strengthened and modified based on inputs of all those consulted, especially at the micro level by setting up a dialogue with the village people from whom information on site facts and prevailing conditions were collected. Focussed group discussion **(**Table 43**)** were held with affected families, local communities residing along highways, shop/kiosk owners, farmers, commuters, drivers, village panchayat member, school teachers, local elected representatives key informants. Rapport building done to make the consultations gender inclusive. Locations selected are residential and commercial areas abutting the roads, schools and other educational institutes, sections with prior records of flooding/water logging, accident hot spots, near forest areas, proposed bypasses etc.

Table 43: Summary of Public Consultations

Roads	Date/Month	FGD	Location	Participant	
				Male	Female
SH-21	Jan-Feb 2022	03	Benan	15	11
			Borunda	20	06
			Merta City	15	07
SH-36	Jan-Feb 2022	05	Meghana	20	09
			Bhalau tal	12	06
			Sahwa	14	07
			Bhanin	30	10
			Chalkoi	20	09
SH-44	Jan-Feb 2022	05	Akegarh	23	09
			Katara	10	05
			Barolichha	30	17
			Bhikru	10	04
			Nadbai-Kumher triple junction	18	08
SH-10A	Jan-Feb 2022	05	Anandpuri	18	05
			Chhaja	20	08
			Bori	10	20
			Garhi circle	20	08
			Paloda circle	20	05
TOTAL				325	154

[26] A process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

B. Objectives of the Public Consultations

196. Public consultations were held to allow the incorporation of relevant views of the stakeholders in the final project design, mitigation measures, implementation issues, and enhancement of the distribution of benefits. Stakeholder consultations were held with intent to understand their concerns, apprehensions, overall opinion and solicit recommendations to improve project design and implementation. Informal meetings and interviews were done during the entire project design stage. Consultations provide affected people a platform to ensure incorporation of their concerns in the decision-making process and foster co-operation among officers of PWD, the community, and other stakeholders to achieve a cordial working relationship for smooth implementation of the project. It inculcates the sense of belongingness in the public about the project.

197. The discussions were designed to receive maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the sub-project. They were given the brief outline of the project and the proposed improvements and road works in their respective stretches. Their opinions were sought particularly in identifying and mitigating any potential adverse impact.

C. Methodology

198. Consultation with the stakeholders, beneficiaries, and community leaders were carried out using standard structured questionnaires as well as unstructured questions. Questionnaire survey/discussions were designed to obtain background information and details of general environmental issues that concern people in the project area. In addition, environmental issues were discussed with relevant organizations, government officials, beneficiaries, community leaders, and experts. Personal discussions with officials, on site discussion with affected stakeholders, and reconnaissance visits have also been made to the project areas.

D. Project Stakeholders

199. All types of stakeholders were identified to ensure as wide coverage as possible such as residents, shopkeepers, and businesspeople who live and work along the road, especially the project affected persons, road users/commuters, executing agency, government institutions whose remit includes areas or issues affected by the project, and, most importantly, the beneficiary community in general.

E. Consultations with Government Agencies

200. The first round of meetings was held with officers of the executing agency at the regional/PIU level to get familiar with sub-project roads' characteristics. This helped to identify the consultation needs with other government departments. Since most of the secondary information relevant to the study are available on official websites, and road specific information other than forest and wildlife are available with executing agency, physical interaction was focused on conducting meetings with forest and wildlife officials. The list of officials from various government departments contacted during IEE preparation and issues discussed are summarized in the **Table 44**.

Table 44: Summary of Consultation Held with Government Departments

S. No	Designation	Issues Discussed and Information Obtained
1	Chief Conservator of Forests, Jodhpur, Churu, Banswara, Bharatpur	Information was collected about forest stretches falling along Dantiwara-Merta City Road, Churu-Taranagar-Nohar Road and
2	Deputy Conservator of Forests, Tonk	

S. No	Designation	Issues Discussed and Information Obtained
3	Deputy Conservator of Forests, Bundi	Kherli-Nadbai-Kumher. They confirmed that no revered or protect areas fall under any one of these Tranche-3 roads. All help was extended for Biodiversity studies.
4	Range Forest Officer, Merta City, Bharatpur, Churu, Hanumangarh,	No movement of wildlife is recorded across these project's roads.
5	Deputy Conservator of Forests, Hanumangarh	
6	Divisional Forest Officer, Jalore	
7	Divisional Forest Officer, Jodhpur	
8	Divisional Forest Officer, Sikar	Information was collected about forest stretches falling along with Dantiwara-Merta City, Churu-Taranagar-Nohar, Kherli-Nadbai-Kumher, Paloda-Garhi-Anandpuri roads. The officers cross-checked and confirmed that no forest stretch was falling along these project roads and encouraged for road side and avenue plantation. Detailed information was also sought about eco-sensitive wet-land. They confirmed that the projects were not crossing any eco-sensitive location, wet land, or migratory route.
9	Deputy Conservator of Forests, Jodhpur, Nagaur, Churu, Hanumangarh, Bharatpur, Garhi, Anandpur.	
10	Divisional Forest Officer, Jodhpur	
11	Divisional Forest Officer, Nagaur	
12	Divisional Forest Officer, Hanumangarh	
13	Deputy Conservator of Forests, Churu	
14.	Deputy Conservator of Forests, Bharatpur	
15.	Deputy Conservator of Forests, Garhi	
16.	Deputy Conservator of Forests, Anandpuri	
17.	Member Secretary, Rajasthan Pollution Control Board	Informed the authorities about the coming up Tranche-3 state highway projects and the permits/ approvals from RPCB. The authorities assured cooperation and support from their side.
18.	Chief Engineer Rajasthan Pollution Control Board	
19.	Regional Engineers of PHED at Merta City, Hanumangarh, Churu, Bharatpur, and Banswara	Informed about drinking water supplies to projects affected areas.
20.	Regional Engineers of Irrigation Department Merta City, Hanumangarh, Churu, Bharatpur, and Banswara	Informed about irrigation facilities being provided to the public.

Dy. Deputy, DFO: Divisional Forest Officer, RFO: Range Forest Office, CF, Conservator of Forests, CCF: Chief Conservator of Forests Divn: Division

F. Consultations with Local People/ Beneficiaries

201. The informal consultation generally started with explaining the project, followed by an explanation of potential impacts. Participants' views were gathered regarding all aspects of the environment which may have direct or indirect impacts on local people. **Table 45** summarizes the details of consultation with local people. Key issues discussed were:

a. Awareness and extent of the project and development components;
b. Benefits of the project for the economic and social upliftment of community;
c. Waterlogging and drainage problem, if any;
d. Environment and health;
e. Flora and fauna of the project area;
f. Socio-economic standing of the local people

202. Consultations were held along all sub-projects. Local communities welcomed the decision of road widening and improvement proposals. They perceived several benefits like faster and cheaper connectivity, improved accessibility to better infrastructure facilities,

reduction in migration, increased economic activities and appreciation in value of land and many others. But at the same time, they apprehended that the risk of accident, air and noise pollution will increase due to high traffic density after widening. Main request/ suggestions made by the participants are:

a. Adequate compensation and rehabilitation assistance to affected households
b. Preference to locals in employment and petty contracts during construction
c. Active role of gram-panchayats in road development activities
d. Labor availability in the project area or requirement of outside labor;
e. Minimization of local disturbances due to project construction work;
f. Improvement in vertical profile of the roads
g. Provision of side drains, culverts, safety measures, avenue plantation, bus shelters, parking and lighting in markets/ built-up areas
h. Creation of new ponds/ water harvesting structures assisted by project
i. Water sprinkling in built-up areas.
j. Signage and speed restriction near schools and active animal crossing
k. Protection of water bodies
l. Restriction on honking near built-up areas and sensitive receptors
m. Extensive plantation
n. Lighting in built-up areas and sensitive receptors
o. Measures to minimize air and noise pollution

203. Design considerations have been made to incorporate most of the suggestions and demands of the local people except those which are beyond the scope of the project like improvement of already deteriorated water quality, drinking water facility and reconstruction of link roads, etc.

G. Consultations with Women and Vulnerable Groups

204. Focused group discussions were held with women and vulnerable groups. The purpose of these exclusive discussions was to ensure women were aware about the project and to understand their unique concerns and expected benefits out of the project. The women expressed a number of both key benefits and concerns that they perceive out of sub-projects. The improvement of the road network will have positive impacts as it will increase the frequency and quality of the transportation. It will not only improve accessibility but also increase the value of land. They also opined that the augmentation of the road network will help in creating employment opportunities for the local people. However, the women participants voiced their concerns regarding their safety of their children as they foresee that the widening of the road would increase the frequency of the vehicles, leading to increased risk of accidents. They were informed that adequate provisions for road safety have been integrated in the road design to address these risks. Necessary measures to reduce noise levels such as speed control, tree plantation, and noise barriers will also be installed in locations with sensitive receptors. Further details on the discussions held with women are provided in the RPs.

H. Disclosure of Information

205. Pertinent project information has been disclosed with affected people and communities during consultations. The IEE report will be made available at the gram panchayat offices, PWD and respective PIUs. The same will be posted on PWD's website. Based on ADB disclosure requirements, it will also be posted on its website. Annual environmental monitoring reports, corrective action plans and any updated IEE if required during the course of project implementation, will be disclosed in accordance with ADB's SPS and Access to Information Policy.

Table 45: Outcome of Consultations Held in the Project Area

<table>
<tr><th>Location and No. of Participants</th><th>Information/Demands/Suggestions of Participants</th></tr>
<tr><td colspan="2">SH-21 (Dantiwara-Merta City Road)</td></tr>
<tr><td>
<table>
<tr><th>Location</th><th>Male</th><th>Female</th></tr>
<tr><td>Benan</td><td>15</td><td>11</td></tr>
<tr><td>Borunda</td><td>20</td><td>06</td></tr>
<tr><td>Merta City</td><td>15</td><td>07</td></tr>
</table>
</td><td>Demands/Suggestions: Improvement of the sharp curves to reduce road accidents. Requirement of Bus Shelters near Y Junctions near all villages. A cross drainage structure is required for overflow of pond water near the Y junction in Borunda village. A safety barrier should be provided near the Schools along the alignment
Response of Authorities: Curve improvement and safety measures like reflectors and crash barriers are proposed at these curve locations. Gender-friendly bus shelters near villages are proposed. A Box culvert and increasing embankment height are proposed at this locality of Borunda..</td></tr>
<tr><td colspan="2"> 


</td></tr>
<tr><td colspan="2">SH-36 (Churu-Taranagar-Nohar Road)</td></tr>
<tr><td>
<table>
<tr><th>Location</th><th>Male</th><th>Female</th></tr>
<tr><td>Meghana 20</td><td>09</td><td></td></tr>
<tr><td>Bhalau Tal</td><td>12</td><td>06</td></tr>
<tr><td>Sahwa</td><td>14</td><td>07</td></tr>
<tr><td>Bhanin</td><td>30</td><td>10</td></tr>
<tr><td>Chalkoi</td><td>20</td><td>09</td></tr>
</table>
</td><td>Demands/Suggestions: Local people informed that in some sections road submerges during normal rainfall. Participants suggested viz., Minimal loss of structures. Adequate safety provisions to be made particularly at locations of the school, provision of gender-friendly bus stops.
Response of Authorities: The widening will be accommodated within available ROW and in case Land Acquisition cannot be avoided Proper Rehabilitation and resettlement, measures will be taken up. All road safety features and road furniture are included in design.</td></tr>
<tr><td colspan="2"> 


</td></tr>
</table>

<table>
<tr><th>Location and No. of Participants</th><th>Information/Demands/Suggestions of Participants</th></tr>
<tr><td colspan="2">SH-44 (Kherli-Nadbai-Kumher Road)</td></tr>
<tr><td>
Location Male Female
Akegarh 23 09
Katara 10 05
Barolichha 30 17
Bhikru 10 04
Nadbai-Kumher 18 08
Triple Junction
</td><td>
Demands/Suggestions: Local communities, wherever, consulted, were found under stress due to extreme weather-induced severely damaged road pavements, long-standing waterlogging, poor cross-drainage, deep potholes, and completely unsafe driving conditions on road. All these issues are leading to serious difficulties in all life affairs such as more than required time in reaching out to nearby destinations, especially during medical emergencies, proper organization of family and social events such as marriages, cultural festival events, etc, as well as serious traffic injuries such as body ache etc.
Road slopes should be properly designed and implemented, in order, to properly discharge monsoon rainfall generated excessive rainfall.

Women teachers at Barolichhar (CH-05+800), emphatically expressed that women teachers are not able to reach out to school by driving scooties. We have to hire a cab which is raising our expenses. Besides growing expenses it is causing health related problems due to big potholes. Hence, affecting academic responsibilities. All women teachers collectively requested to fill up these deep potholes. PD (PIU) and ES (PMC) assured that PIU Engineers looking after ongoing works of potholes filling will be reminded of the quickest possible actions for filling potholes in all these villages.Safety measures like rumble strips and sign boards have been included in the design. Women members voiced their concern regarding the safety of their children going to school. Informatory sign boards indicating village name and other relevant information.
Response of Authorities: All Cement Concrete Roads in each village should be dismantled and should be constructed as a new CC road. A longitudinal covered drainage system should be constructed on both sides LHS and RHS of the road in each village/built-up area. Good quality construction materials should be used for road construction.
</td></tr>
<tr><td colspan="2">


</td></tr>
<tr><td colspan="2">SH-10A (Paloda-Garhi-Anandpuri)</td></tr>
<tr><td>
Location Male Female
Anandpuri 18 5
Chhaja 20 8
Bori 10 20
Garhi Circle 20 08
Paloda Circle 20 05
</td><td>
Demands/suggestions: The proposed ROW width in the Chhajja village should be kept bypass is to be provided, due to less ROW. Sign boards should be provided near all schools along the proposed road for safety. Proper compensation should be given to non-titleholders also. Bypass for Garhi village should be provided because lesser ROW well width of 7 mts even. Proper cross drainage structures are to be provided to avoid soil cutting.
Response of Authorities: In the Habitation area where available ROW is insufficient, a minimum of 12m to Available space will be proposed for PROW. Near Every Govt.School and other main private schools, sign boards are provided. In the Garhi village, 15-20m ROW is not available. On the Anas river, bridge repair works sufficient stone pitching is proposed to control soil erosion.
</td></tr>
</table>

VIII. GRIEVANCE AND REDRESS MECHANISM

206. All the three parties involved in this project implementation i.e. Contractor, CSC and executing agency will maintain complaint registers at their following respective offices:

f. Contractor's main site offices i.e. office of the Project Manager;
g. CSC's/PMAE main site office i.e. office of the Engineer's Representative; and
h. PIU DGM office i.e. Employer's field office

207. **Level 1 – PIU level**: All public complaints regarding environmental issues received by any of the above mentioned offices will be entered into the register with specific details such as name and address of the person or representative of the community registering a complaint, the details of complaint, and time. DGM/Project Director (PIU) and CSC/PMAE representative will immediately communicate the details of the complaint to the Contractor. The environment and safety officer of the contractor will promptly investigate and review the environmental complaint and implement appropriate corrective actions to arrest or mitigate the cause of the complaints within 3 days' time of receiving the complaint. The contractor will report to CSC environment expert about the action taken on the complaint, also within 3 days' time of receiving the complaint, for his further intimation to DGM PIU. The person making the complaint will also be intimated by the complaint receiving person or his representative, about the action taken, within 3 days.

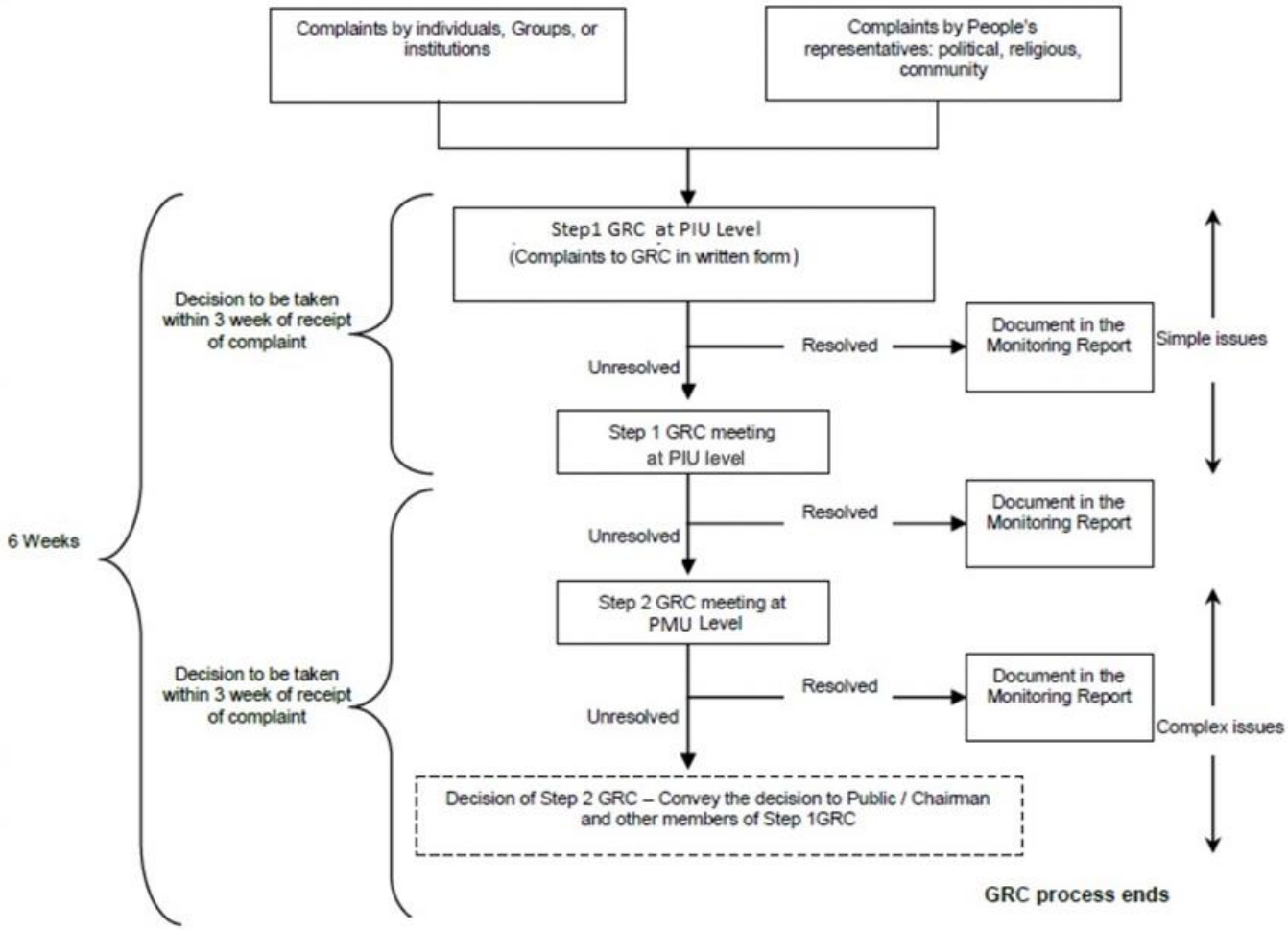
208. **Level 2 – State level:** Grievances not redressed by the PIU level will be brought to the State level Grievance Redress Committee (GRC). The State level GRC will be headed and chaired by General Manager (Projects) and will comprise of the following:

i) General Manager (Projects), PWD
ii) Environmental Specialist, CSC/PMAE
iii) A representative from the respective local community
iv) Representative of concerned agency such as Forestry Department or State Pollution Control Board depending on the nature of the complaint/issue

209. The main responsibilities of the GRC will be to: (i) record grievances, categorize, and prioritize grievances and resolve them as soon as possible; (ii) immediately inform the EA of serious cases; and (iii) report to complainants on decisions made regarding their grievances within three weeks of receiving the grievance from the PIU level. The decision must include the agreed timeline for addressing the grievance. Grievances related to resettlement benefits, compensation, relocation, replacement cost and other assistance will be addressed by following the grievance redress system provided in the RP.

210. The Grievance Redress Mechanism has also been illustrated through a flow chart given as Figure **12**.

Figure 22: Grievance Redress Mechanism



IX. ENVIRONMENTAL MANAGEMENT PLAN AND INSTITUTIONAL ARRANGEMENT

A. Environment Management Plan

1. Environmental Management Plan (EMP) is intended to set out clearly and unambiguously the likely negative impacts of construction and/or operation of the project, the action that is required to avoid or mitigate each impact and the responsibility for taking each action. Responsibility is made legally binding when actions are subsequently specified in contracts.

2. The EMP has been prepared based on all foreseen impacts at the time of preparing this IEE. Mitigation measures were identified to reduce the significant adverse impacts including residual effects. As six of the project will be implemented based on engineering, procurement, and construction (EPC) modality a number of construction alternatives like location of camp and plant sites, borrow area, source quarries, and even minor geometric realignments to minimize the number of remains to be decided and from which a host of impacts may be generated and warrants updating of the EMP under the supervision of the PMC and ADB.

3. Should unanticipated environmental impacts arise during project implementation or in cases of changes in project design that would warrant it, the EMP and/or the IEE must be updated. In cases of non-compliance to the EMP or any environmental safeguards measures in the IEE, PAM, or in the loan covenants and applicable national requirements/regulations, a corrective action plan including timeline for compliance and responsibilities must be prepared and agreed between ADB and RPWD.

B. Environment Monitoring Program

4. The monitoring and evaluation are critical activities in implementation of the project. Monitoring involves periodic checking to ascertain whether activities are going according to plan or not. It provides the necessary feedback for project management to ensure project objectives are met and on schedule. The reporting system is based on accountability to ensure that the environmental mitigation measures are implemented. Environmental monitoring program has the underlying objective to ensure that the intended environmental mitigations are realized and these results in desired benefits to the target population causing minimal deterioration to the environmental parameters. Such program targets proper implementation of the EMP. The broad objectives are:

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

C. Organizational Set-up to Implement the EMP

5. The Government of Rajasthan (GOR) through RPWD is the Executing Agency (EA) for the project. The PMU in RPWD will be responsible for ensuring that all components of this EARF are complied with. Under the PMU there will be a number of Project Implementation Units (PIUs) to manage individual road packages or groups of packages

under the project. The PIU will be headed by a Project Director (PD). The PMU will have a Safeguard Officer-Environment (SOE) with a rank of Executive Engineer to coordinate with the PD-PIUs to ensure project implementation complies with the EARF and EMP.

6. The Project Management Consultants (PMC) will support the PMU to implement the project and supervise the contractor including environment safeguards. The PMC's team will include one Environmental Specialist to supervise and guide the contractor on implementation of the EMP and EMOP and will assign relevant staff on site per package to oversee day to day implementation of the EMP. The AE for contract packages following EPC modality and IE for contract packages following annuity modality will include an environmental specialist to carry out day to day and on-site supervision and monitoring of environment safeguards. The contractor's team will include health and safety officers and/or environmental focal persons to ensure implementation of the EMP and EMOP. The responsibilities of various agencies and parties for implementing environment safeguards are provided below.

7. Description of key responsibilities of various agencies and parties for implementing environment safeguards are provided below.

(i) **PPP Division of Rajasthan PWD** will be the project management unit and responsible for the overall compliance of ADB Safeguard Policy Statement 2009 and the applicable laws and rules under the Ministry of Environment, Forest and Climate Change. The PMU will have a safeguard officer-environment (SOE) with a rank of executive engineer to coordinate with the project directors for PIUs to ensure that project implementation complies with the environmental assessment review framework and environmental management plan. The safeguard officer-environment is responsible for:

- Environmental screening and proposed categorization to reflect the significance of potential impacts or risks that a proposed road might present, and advise feasibility for inclusion and identify the needed level of assessment;
- Reviewing and approving all environment safeguards related documents such as IEE, monitoring reports, and due diligence prepared under the investment program with recommendations and clarifications from the PIUs and PMC where necessary;
- Continued employment of environmental specialist consultant (recruited under tranche 1) to provide support in preparing IEE reports, processing environmental statutory clearances, permits such as forestry clearances and others on behalf of PMC for roads under tranche 2 and subsequent tranches
- Timely endorsement and signing of key documents and forwarding to the respective agency required for processing of forestry clearance, tree cutting permit, permission for groundwater extraction, etc., and disclosure on ADB and PWD websites;
- Ensure all contractors obtain permits, licenses, etc. for activities such as operation of asphalt plants, quarries, borrow areas, etc., before the implementation of the respective construction activity; and
- Taking proactive and timely measures to address any environment safeguards related challenges at the national or state level such as delays in processing of clearances during pre-construction stage and significant grievances (during construction stage).
- Review sanctions proposed by the PIU and agree with the

contractor/concessionaire on actions to be taken on the sanction

- Ensure that annual monitoring reports are submitted to ADB for review and disclosure within 3 months from the end of the monitoring period, both for construction and operation, until the project completion report is prepared by ADB.

(ii) **Project implementation units (PIU).** The project implementation unit through the PD will be responsible for supervising implementation of the environmental management plan (EMP) and environmental monitoring plan (EMOP) by the contractor/concessionaire through the following:

- Review all sub-plans identified in the EMP to be prepared by the Contractor to include camp layout, waste/debris management plan, borrow area management plan, traffic management plan with guidance from the PMC;
- Review monthly/quarterly/annual environmental monitoring reports prepared by the Contractor/concessionaire-Environmental Focal Person (EFP);
- Conduct monthly site and follow-up inspection to ensure the veracity of the submitted monitoring reports and enforce the EMP and EMOP;
- Conduct compliance conference with the Contractor/Concessionaire to discuss non-compliance and agree on corrective measures with guidance from the PMC and PMU; and
- Recommend sanctions to the PMU-SOE in case of recalcitrant contractors/concessionaires.

(iii) **Project Management Consultant (PMC).** The main objective of Project Management Consultant is to support the project management unit (PMU) implements the environmental requirements of the Project by providing assistance in the monitoring of the EMP implementation by:

- Conduct environmental site induction training workshops to all contractors/concessionaires, IE/AE and PIUs to ensure understanding of the EMP and domestic environmental laws and regulations requirements particularly on the required clearances and permits, training on occupational and community health and safety,
- Ensure timely mobilization of the Contractor's/concessionaire's EFP
- Review and verify revised EMPs, sub-plans submitted by the contractor/concessionaire and advise the PMU on adequacy;[27]
- Conduct monthly site inspections to check the contractor's/concessionaire's compliance with the EMP and EMOP
- Participate in public consultations on issues concerning the project and facilitate addressing environment related grievances that maybe submitted to the project GRM
- Ensure contractors/concessionaires secure necessary permits and

[27] Site induction training includes but not limited to: i) discussion and review of EMP and EMoP detailing how specific environmental risks associated with their Scope of Work will be managed legal compliance, inspection and audits, and progress tracking and reporting; ii) environmental training and awareness needs shall be determined and documented via a training needs analysis prior to commencement; iii) Health and Safety Awareness Course, which details general environmental awareness and specific performance requirements expected on site; and iv) GRM.

clearances;

- Prepare environmental due diligence reports on EMP implementation needed for the processing of subsequent tranches;
- Prepare an environmental monitoring report template for contractors/concessionaires self-monitoring reports;
- Design monthly compliance assessment checklists for PIU/PMU to be used for monitoring EMP implementation during pre-construction stage, construction stage, post construction stage and status of statutory clearances and permits
- Prepare summary monthly, quarterly, and annual environmental monitoring reports based on the monthly environmental self-monitoring reports prepared by the Contractor's/concessionaire's EFP and site observations for the review and of PIUs/PMU and approval by PMU;
- Prepare annual environmental monitoring reports for approval by PMU (copy to PIU, IE/AE) and further submission to ADB for public disclosure;
- Advise the Contractor/concessionaire through the PMU and PIUs on how to comply with requirements and address non-compliances; and
- Report apparent unanticipated impacts and recommend mitigation measures to the PMU for advising IE/AE to issue necessary instructions to the respective contractor/concessionaire
- Update the IEE report in situations of unanticipated impacts when deemed necessary

(iv) **Authority/ Engineer.**[28]The AE will have a dedicated Environment Specialist to monitor the implementation of safeguards standards. The following are the responsibilities of the AE and IE:

- Review the IEE and EMP to understand the background environmental issues of the respective subproject
- Review and approve the revised EMP and other required sub-plans such as traffic management plan, health and safety plan, waste management plan etc. prepared by the contractor/concessionaire
- Conduct regular (at least monthly) site inspections and monitor implementation of the EMP and EMOP by the contractor/concessionaire
- Provide on-site training and technical guidance to the contractor/concessionaire workers as necessary
- Review the monthly/quarterly/annual reports prepared and submitted by the contractor/concessionaire
- Prepare monthly reports on monitoring activities, training and other environment safeguard activities implemented
- Where necessary, identify the need for corrective actions and issue official notices to the contractor/concessionaire to implement the corrective actions with clear timeline
- If there are any complaints or grievances, facilitate consultations with

[28] The AE is the supervising authority for contractors that follow the EPC modality. They are also responsible for reviewing and approving the detailed engineering design prepared by the EPC contractor.

the respective complainant and ensure the grievances are addressed in accordance with the GRM system as given in the section D;

- Regularly convene meetings to discuss progress or issues on environment safeguards to ensure that all parties (contractor/concessionaire, PMC, PIU, RPWD) are on the same page on requirements and milestones for environment safeguards
- Based on the site inspections and review of reports submitted by the contractor/concessionaire, assist the PMC in preparing annual Environmental Monitoring Reports for review and approval by the RPWD. These reports will be further forwarded to ADB for disclosure on their website.

(v) **Contractor:** The Contractor/Concessionaire is the principal agent to implement the EMP and EMOP during the pre-construction, construction and operation stage. Specifically, the contractor/concessionaire will:

- Appoint the contractor's/concessionaire's environment focal person and attend the site induction workshop to be organized by the PMC;
- Obtain necessary environmental license(s), permits etc., from relevant agencies as specified by EARF for associated facilities for project road works, quarries, hot-mix plant etc. prior to commencement of civil works contracts;
- Implement all mitigation measures in the EMP and activities in the EMOP; Pollution monitoring will be done on a quarterly basis through NABL/MOEFCC[29] accredited testing laboratories. Other EMOP items will be monitored on a monthly basis
- Submit monthly, quarterly, and annual self-monitoring reports to for approval to the IE/AE and further submission to PIU and PMC for final submission to PMU;
- Ensure that all workers, site agents, including site supervisors and management participate in training sessions delivered by PMC;
- Acquire all environmental statutory requirements (permits, NOCs etc.) and fulfil contractual obligations;
- Collect the baseline data on environmental quality before the start of physical works and continue collection as given in the EMOP during construction and operation;
- Participate in resolving issues as a member of the GRC;
- Respond promptly to grievances raised by the local community or any stakeholder and implement environmental corrective actions or additional environmental mitigation measures as necessary; and
- Based on the results of EMP monitoring, cooperate with the PMC, IE/AE and PIU to implement environmental corrective actions and corrective action plans, as necessary.

(vi) **ADB:** ADB is responsible for the following:

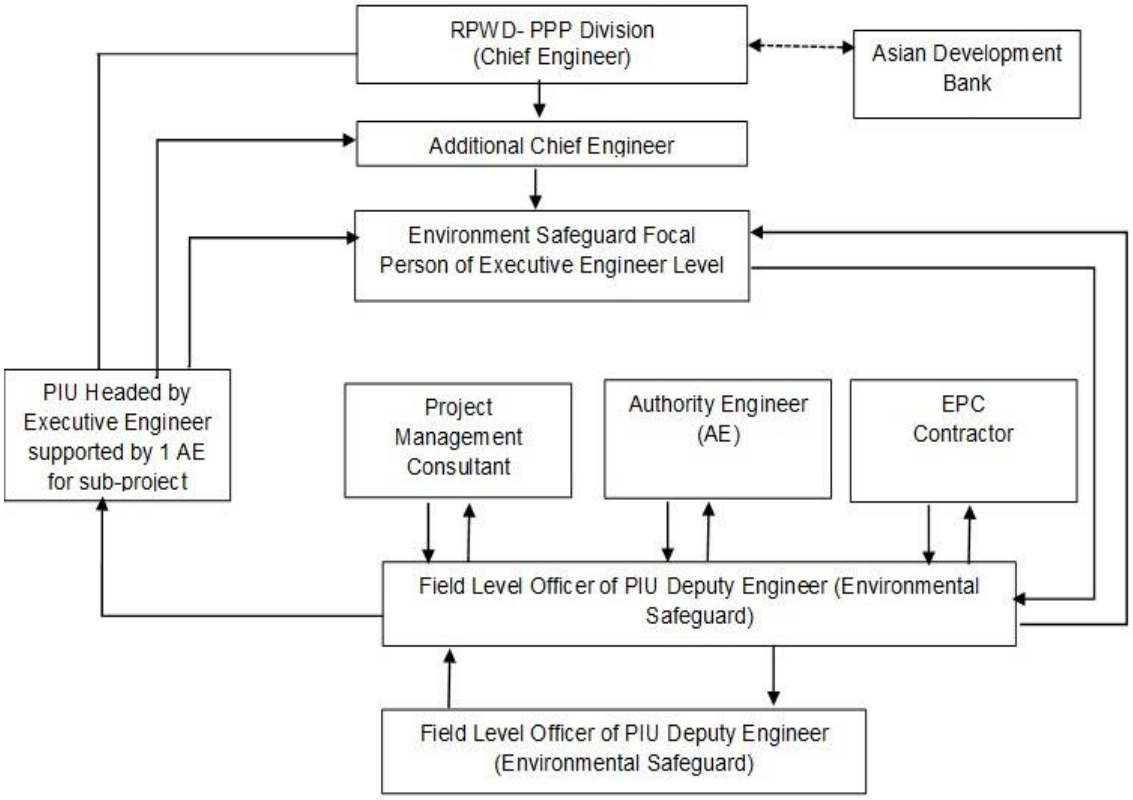
- Review REA checklist and endorse or modify the tranche classification proposed by the PMU

[29] NABL = National Accreditation Board for Testing and Calibration Laboratories; MOEFCC = Ministry of Environment Forests and Climate Change.

- Review IEE report and disclose the final reports on the ADB website as required;
- Issue tranche/subproject's approval based IEE report;
- Monitor implementation of the EMP through due diligence missions;
- Provide assistance to the RPWD, if required, in carrying out its responsibilities and for building capacity for safeguard compliance;
- Monitor overall compliance of the subprojects to this EARF; and
- If necessary provide further guidance to the RPWD on the format, content, and scope of the IEE report and annual monitoring reports for submission to ADB.

211. The main budgetary need for implementing this EARF is costs for screening and categorization and preparation of IEE reports including EMP and EMOP for subprojects under subsequent tranches. As done for tranche 1 and 2 the RPWD will use their own budgetary resources to recruit Detailed Project Report (DPR) consultants to prepare the subproject specific IEE reports and EMPs. ADB TA resources or staff consultant budget will be used to provide additional support to RPWD for finalizing the IEE and EMP to meet the requirements of ADB's SPS if required.

Figure 23: Institutional Arrangement to Implement Environmental Management Plan



D. Institutional / Capacity Building

212. Several trainings and capacity building programmes have been conducted in past by PWD to enhance the capacity of its officials related to implementation of environment safeguards in ADB's assisted projects. However, since the officers are not permanently positioned and there is periodic transfers within or outside the department and vice-versa so it is imperative to devise a training program to acquaint the freshly joined officers about safeguard requirements, including EMP implementation and monitoring the resultant effects, Training module is also aimed to create awareness among workers and local

community. The institutions/agencies like regional office of MoEF, SPCB/CPCB, Indian Institute of Technologies and forestry institutions, can be consulted for such trainings. Independent subject's experts/consultants (e.g., for the environmental awareness program, impact assessment specialist will be the resource person) can also be the resource persons to impart trainings. These experts /agencies shall be appointed based on specific need for the training. A separate budget for training has been allocated under the PMC budget.

E. Environment Management Budget

213. The succeeding Table presents the total budget provided in the civil works contract and RPWD budget to implement the EMP including COSHP and EMoP. The total cost of Tranche-3 is about INR 973.61 Crore is broken down into the following items:

a) Mitigation cost as "Included in Project Costs" which includes dust suppression[29], installation of movable noise barriers[30], the connection of side drains to nearby ponds/tanks for water harvesting[31], toll booth water harvesting[32], compensatory plantation[33], is included in Project costs.
b) Monitoring cost which includes air, water, noise, and soil quality

Table 33: Estimated Environment Management Cost as Part of Civil Works

S.No	Road	Design Length (km)	Project Cost (Rs in Cr.)	Remedial & Mitigation Measures Given In EMPs including COSHP	Monitoring /training (Rs.1000000.00 added to each package)
1	SH-21	87.7	336.94	Included in the project cost	2,032,000
2	SH-36	115.8	361.95	Included in the project cost	3,061,000
3	SH-44	37	143.69	Included in the project cost	2,330,000
4	SH-10A	54.7	131.03	Included in the project cost	2,336,000
	Grand Total	**295.2**	**973.61**	Included in the project cost	**9,759,000**

[29] Estimated based on the total length of built-up areas traversed by the road which needs to be sprinkled with water for 30 days, 2 passes per day using a 5.25m^3 truck at a cost of INR1, 000/truck load
[30] 3mx3m movable noise barrier, metal with foam insulation @ INR 20, 000. Total length of barrier is estimates at 30% of the longest continuous built-up area.
[31] Estimated at INR1.5M/100 km
[32] Estimated at INR300, 000/booth
[33] Cost borne by RPWD part of utility shifting cost

X. CONCLUSION AND RECOMMENDATION

214. Rajasthan State Highway Investment Program Tranche 3 (RSHIP-T3) aims to upgrade four state highways (SH-10A, SH-21, SH-36 and SH-44). The total length of the project aggregates to be 295.2 kilometres and proposed to be executed under 4 civil construction packages and located in 7 districts namely: Jodhpur, Nagaur, Churu, Hanumangarh, Alwar, Bharatpur and Banswara respectively. Public Works Department (PWD), Government of Rajasthan is the implementing agency. Key improvement components involves its widening from single/intermediate/2-lane lane to 2-lane with the granular shoulder of 2.5 m on either side. Main up-gradation components involve improvement in pavement conditions and geometrics, reconstruction and widening of CD structures, provision of roadside drains, raising of embankment in water logged sections, junctions/intersection improvement, safety provisions for road users, and provision of road facilities like bus bays/bus shelters, and toll plaza. Environmental enhancement measures like compensatory plantation and rain water harvesting are also included.

215. None of the sub-projects are either located inside or in close proximity to any legally protected and/or eco-sensitive areas. Presence of Nilgai (Blue bull) is reported in most of the projects. This species is under Schedule-III of wildlife act and not assessed as per IUCN. Due to its large population causing heavy crop damage, MOEF& CC has issued an advisory to include it in the Vermin category of Schedule V. None of the project roads involve forest diversion and hence no sub-project attracts forest clearance. Sub-project SH-44 falls in Taj trapezium zone (TTZ) declared by Supreme Court of India. Road projects need to obtain permission for cutting of trees apex court of India.

216. Most of the potential environmental impacts viz. use of construction material, its transportation, storage and handling, increase in air pollutants, noise and vibration level, management of construction and demolition waste, siltation of waterways from silt-laden surface runoff, traffic obstruction near active construction sites etc. are reversible, co-terminus and concomitant to construction activities/period, consequently localised and short-term in nature. There will be some residual impacts in terms of emissions, road safety issues from generated traffic, and minimal residual impacts due to ground water extraction. Road safety measures have been incorporated in the design while groundwater impacts will be minimized by adopting rainwater harvesting measures. Due to additional tree plantation, there will be positive residual impact in the long term. Therefore, the project has been categorised as **Category 'B'** in accordance with ADB's SPS 2009.

217. Meaningful consultations were conducted during the project preparation stage and all concerns of the affected persons and stakeholders have been incorporated in the IEE and the EMPs. These consultations were represented by key informants, roadside communities, and related government organizations. A Grievance Redress Mechanism has been formed to receive, feedback, suggestions and complaints, if any, from affected parties and addressing them during the construction stage and operation stage.

218. During construction phase, adequate guidance and resources will be provided by executing agency to the Contractor to comply with the borrow area management requirements, suppress dust, control noise, and implement proper closure. Authority Engineers/Independent Engineers will be engaged by the PWD to ensure that mitigation and monitoring measures are implemented.

219. This consolidated IEE based on feasibility studies and contract package specific EMPs accompanying EMOPs covering monitoring of relevant physical, biological and health and safety parameters have been prepared. It is unlikely that changes in the alignment and design

would be needed that would require an IEE update but PWD should inform ADB of such changes and update the IEE as needed. PWD shall ensure that EMPs and EMOPs are included in Bill of Quantity (BOQ) and forms part of bid document and civil works contract. The same shall be revised if necessary during project implementation. IEE shall also be updated if there is any change in the project design/scope with prior approval of ADB.