Initial Environmental Examination

April 2017

IND: SASEC Road Connectivity Investment Program – Tranche 2

Mechi River Bridge

Prepared by the National Highways and Infrastructure Development Corporation Limited, Ministry of Road Transport and Highways, Government of India for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 25 April 2017)

Currency unit		Indian rupee (Rs)
INR1.00	=	$ 0.01556
$1.00	=	INR 64.273

ABBREVIATIONS

AAQ	-	Ambient Air Quality
ADB	-	Asian Development Bank
AH	-	Asian Highway
BIS	-	Bureau of Indian Standards
BOD	-	Biological Oxygen Demand
CD	-	Cross Drainage
CO	-	Carbon Monoxide
COD	-	Chemical Oxygen Demand
COI	-	Corridor of Impact
CRZ	-	Coastal Regulation Zone
CPCB	-	Central Pollution Control Board
CPR	-	Common Property Resource
CL	-	Centre Line
CTE	-	Consent to Establish
CTO	-	Consent to Operate
dB	-	Decibel
DoR	-	Department of Road
DPR	-	Detailed Project Report
EA	-	Environmental Assessment
EC	-	Environmental Clearance
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
EPR	-	Environment Protection Rule
EROW	-	Existing Right of Way
GoI	-	Government of India
GoN	-	Government of Nepal
GoWB	-	Government of West Bengal
GW	-	Ground Water
HFL		Highest Flood Level
IEE	-	Initial Environmental Examination
IMD	-	India Meteorological Department
IRC	-	Indian Road Congress
IS	-	Indian Standard
IUCN	-	International Union for Conservation of Nature
LHS	-	Left Hand Side
MORTH	-	Ministry of Road Transport & Highways
MoEFCC	-	Ministry of Environment, Forests & Climate Change
NAAQS	-	National Ambient Air Quality Standards
NH	-	National Highway
NHIDCL	-	National Highways and Infrastructure Development Corporation Limited

NOC	-	No Objection Certificate
NOx	-	Oxides of Nitrogen
NQ	-	Noise Quality
PCU		Passenger Car Unit
PIA	-	Project Influence Area
PIU		Project Implementation Unit
PM	-	Particulate Matter
RAP	-	Resettlement Action Plan
RF	-	Reserved Forest
RHS	-	Right Hand Side
ROW	-	Right of Way
ROB	-	Rail over Bridge
SASEC	-	South Asia Subregional Economic Cooperation
SQ	-	Soil Quality
SO_X	-	Sulphur oxide
SPCB	-	State Pollution Control Board
TA	-	Technical Assistance
TDS	-	Total Dissolved Solids
VUP	-	Vehicle Under Pass
WSPCB	-	West Bengal Pollution Control Board
WPA	-	Wildlife Protection Act
WQ	-	Water Quality

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EXECUTIVE SUMMARY

A. The Project

1. The Mechi River separates India and Nepal. There is an existing 2-lane bridge connecting both countries at Kakarbhitta in Nepal and Panitanki in India. The existing two-lane bridge is insufficient to take care of existing traffic. In order to take care of future traffic, a new six-lane bridge 150 m upstream of the existing bridge is planned. This bridge has been planned as a subproject under the SASEC Road Connectivity Investment Program. The bridge project is funded by the Asian Development Bank (ADB). The bridge length is about 675 m and lengths of approaches are about 545 m in Nepal and about 280 m in India. The proposed bridge also has a provision for separate lane on either side of median for slow moving and pedestrian traffic. A Vehicle Under Pass (VUP) has been planned towards the Nepal side to segregate local and international traffic. The approaches are of 4-lane configuration both in India and Nepal. The total cost of the project is over INR 1,585.6 million or $ 23.79 million. The existing traffic on the bridge is around 21,000 Passenger Car Units (PCUs) which is likely to go up to 60,000 PCUs by the horizon year 2045. The Executive Agency (EA) for the project is the Ministry of Road Transport and Highways (MoRT&H) and Implementing Agency (IA) is the National Highways and Infrastructure Development Corporation Limited (NHIDCL) Project Implementation Unit (PIU) Sikkim for India portion in cooperation with PIU at Department of Roads, Damak for Nepal. The project is located in Darjelling district of India and Jhapa district of Nepal.

B. Environmental Sensitivity and Project Categorization

2. There is already an existing bridge just a few meters downstream of the proposed bridge, hence the project bridge will not be the first cross border connection between Nepal and India in the area. The proposed Mechi Bridge and its approaches are not passing through any wildlife sanctuary, national park, bird sanctuary, tiger reserve, protected area or any other similar eco-sensitive areas. The alignment of bridge and approaches are also not located in Reserved/Protected/ Revenue forest. No loss of rare/threatened/endangered species of flora is envisaged. The project site does not have a large congregation of migratory species nor does it have any nationally or internationally important cultural, religious or heritage site. The Mechi river is a seasonal river with some narrow braided channels for most of the year. The project implementation impacts are site-specific and can be addressed through proven mitigation measures. Hence, the project is classified as Category B warranting an initial environmental examination (IEE) consistent with ADB's Safeguard Policy Statement (SPS), 2009.

C. Existing Environment

3. The region falls under the tropical to subtropical climatic region with four distinct seasons; winter, summer, monsoon and post monsoon. The post monsoon season has transition weather. Minimum and maximum temperature varies from as low as 25 ^{0}C in winter and 40 ^{0}C in summer. Average rainfall in the project region is 2,749 mm. Relative humidity is as low as 70% in summer and as high as 97% during monsoon. The topography of bridge and approaches is undulating and elevation varies from 120-139 m above mean sea level. The project area and surroundings are covered by alluvial and deltaic of sub recent and recent times. These are unconsolidated sedimentary deposits of Quaternary period. Project area and surroundings lie in seismic Zone IV, a high damage risk zone. There is swift flow at the location of bridge. No flooding issues have been experienced in the project region. The project area and surroundings are not affected by any other natural hazards. Abutting land use around proposed RoW of bridge and approaches is predominantly built up area followed by Mechi River flood plains and Tea Estate Land.

4. Land use of the study area (10 km radius) largely comprises the river and river bed along with Tea Estate land, fallow/barren/non-agricultural areas followed by arable land. 84 floral and 96 faunal species were found in and around the project site. None of them were found to be critically endangered or endangered. Air quality and noise levels conform to the national standards both in India and Nepal. Ground water largely meets the prescribed limits corresponding to drinking water standards. The project area and surroundings are drained by the Mechi River. The River bank on India side is not well confined and there are soil erosion issues. Mechi River is the only surface water source in the project area and surroundings. Water quality is fit for outdoor bathing and propagation of aquatic life.

D. Anticipated Environmental Impacts and Mitigation Measures

5. Main pre-construction impacts are: (i) loss of livelihood due to acquisition of land and assets (ii) cutting of 116 trees (40 on India portion and 76 on Nepal portion) and (iii) earthworks for construction for embankment construction. Adequate compensation and rehabilitation assistance will be extended as per National Acts of both India and Nepal and resettlement framework of the project. The bridge has been designed considering 100 year return flood period with an anticipated risk of a rarer flood of next higher frequency. Waterway and elevation of most of the bridge are adequately designed considering river hydrology. Retaining walls have been proposed at locations of steep slopes in the bridge approaches to avoid soil erosion. Compensatory plantation of 1:10 ratio has been planned to mitigate tree and vegetation removal from the bridge and approach RoW on the India side and 1:25 at the Nepal side. This compensatory plantation will improve the micro climate of the region in the long term. For earthworks borrow areas have been identified within a lead distance of 6 km. These borrow areas are on non-productive land and have sufficient borrow earth quantities. Religious structures (1 temple in Nepal portion) will be relocated at project cost and in consultation with the community.

6. Significant impacts anticipated during the 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 river water quality due to silt run-off, spillage from vehicles and discharge from labour camps; (iii) impacts on aquatic floral and faunal species due to deterioration in water quality and illegal fishing by contract workers (iv) health impacts from labour camps; (v) disruption to access/traffic; (vi) occupational health and community safety. Mitigation measures includes: (i) utilizing equipment with less noise and regulating time of construction at Panitanki and Kakarbhitta; (ii) sprinkling of water on earthworks, active construction sites, material storage locations and haulage roads; (iii) installation of silt fencing and oil traps at river banks; (iv) slope stabilization to control erosion; (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) implementing 1:10 and 1:25 compensatory plantation to offset impacts from tree cutting; and (ix) avoiding establishment of labour camp, materials storage and hot mix plant in flood plains of Mechi River and its banks and (x) not allowing any fishing or hunting in the project site.

7. Operation stage impacts anticipated are vehicular accidents, accidental spillage, increased air pollution and noise level, survival of compensatory afforestation and side slope shrubs and vegetation. There will be periodic environmental monitoring for initial 2 years for survival rate of plantation and vegetation and a minimum survival rate of 90 % will be maintained and environmental monitoring of river water quality, noise levels and ambient air quality will be reviewed.The implementing agencies on both sides will be responsible for maintaining the infrastructure.

E. Climate Change Screening and Mitigation

8. Total annual emission is estimated to be much less than the 100,000 tons per year threshold set by ADB. The total CO_2 equivalent emission from the Mechi bridge project for the horizon year 2034 based on projected traffic data is 2,031.00 MT. The projected variations in temperature and precipitation the project region indicated vulnerability to flooding (increased storminess). The project takes care of storm water generation and there are less flooding chances as the river has a rolling terrain which helps in swift flow. Further, highest flood level (HFL) from the existing river bottom level is 2 m, whereas clearance from the river bottom to the bridge is about 9.5 m. These inbuilt design features will take care of any unanticipated impact on account of climate change. There are no risks related to forest fire for the project.

F. Public Consultations

9. Extensive consultations were made with the local communities, both in India and Nepal and the Government agencies like Forest Department (India and Nepal), West Bengal State Pollution Control Board, Public Works Department West Bengal Government, Department of Roads Government of Nepal, Mechi Nagar Municipal Corporation (Kakarbhitta, Nepal), Seema Suraksha Bal, Border Security Forces, etc. Local communities strongly support the project. They disseminated many important information and made several suggestions and demands. Main demands include adequate compensation and assistance for loss of land and assets, employment in bridge construction works, provision of safety measures, provisions of water supply and sanitation facilities in their residential area, and proper relocation of affected religious structures. Most of their suggestions and demand have been integrated in the project design.

G. Environmental Management Plan

10. The Mechi bridge project specific Environmental Management Plan (EMP) has been formulated with an intent to set out an action required to avoid or mitigate all impacts and the responsibility for taking each action. Responsibility is made legally binding when actions are subsequently specified in contracts. The Environmental Monitoring Plan has been prepared 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. All costs for implementing the mitigation measures and monitoring plan will be included in the Bill of Quantities (BOQ) by the contractor as implementation of the EMP will be the responsibility of the contractor. The EMP budget for the project life cycle including monitoring costs has been estimated as INR 7.7 million (US$ 128,430 approx.) and this has been included in overall project cost.

11. The project implementation units in India and Nepal will ensure the effective implementation of the environmental management plan. PIUs will be assisted by the Authority's Engineer engaged by NHIDCL. The Authority's Engineer will have an Environmental Specialist in their team. The Environmental Specialist of the Authority Engineer's team will have a continuous interaction with PIUs and will submit periodic environmental monitoring reports through the Team Leader.

H. Conclusion

12. This initial environmental examination (IEE) ascertains that the proposed Mechi Bridge project has minor, localized and temporary impacts and these can be easily mitigated to acceptable levels. If there are any changes in project design and scope or experience of impacts

that were not anticipated in this IEE, the need for updating the IEE or/and EMP will need to be reviewed by the EA and communicated to ADB.

I. INTRODUCTION

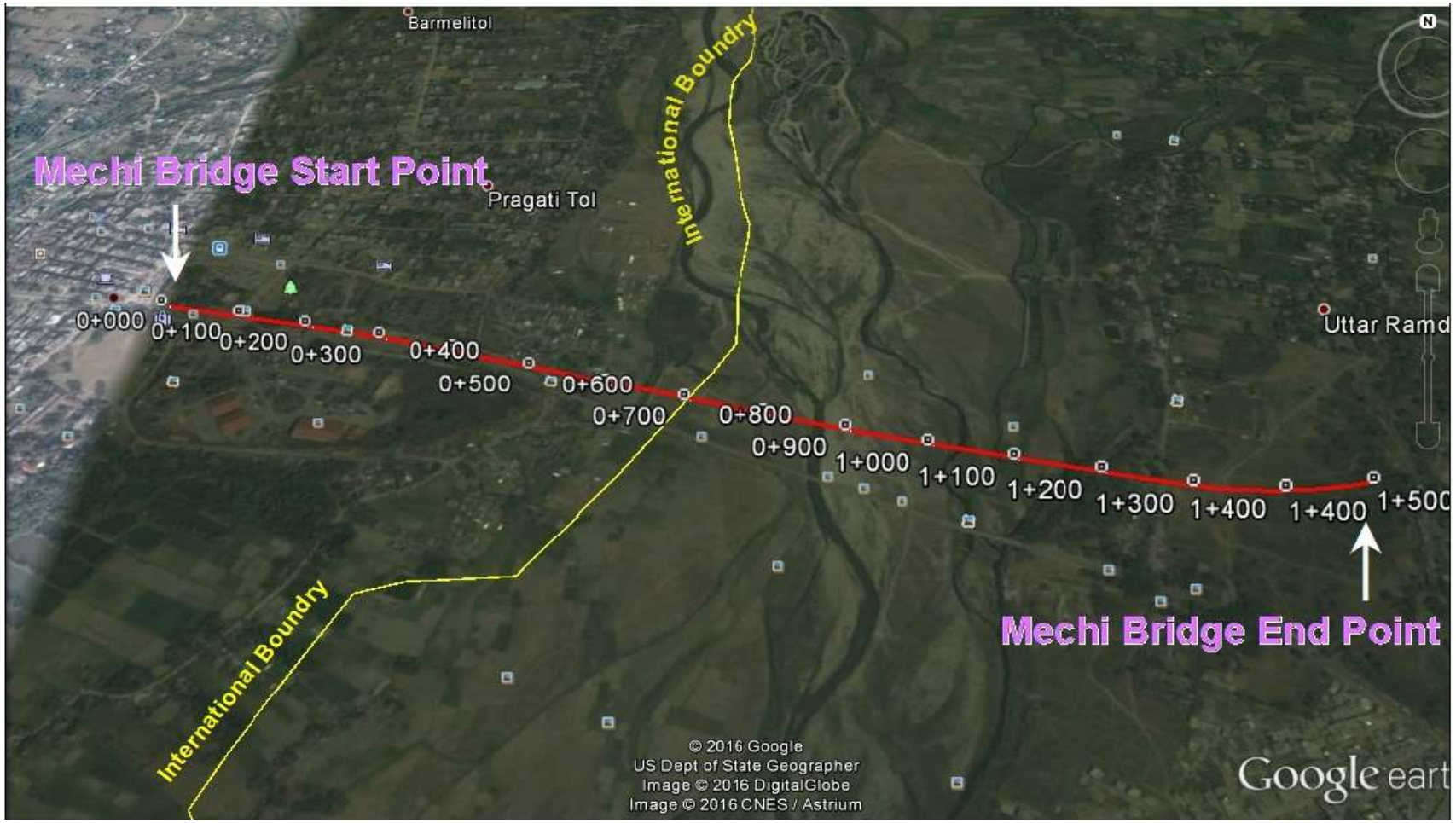
A. Preamble

1. The United Nations Economic and Social Commission for Asia and Pacific (ESCAP) is a regional development arm of the United Nations for Asia and Pacific region. The transport division of ESCAP has initiated development of Asian Highway network in Asia and Pacific region with the aim of promoting the development of international road transport in the region. The regional road connecting Nepal and Bangladesh through India is designated as Asian Highway No.2 (AH-2). The regional road connector between Bhutan and Bangladesh through India has been designated as Asian Highway No. 48 (AH-48). Both of these highways will be in the northern part of West Bengal State. These two Asian Highways are being developed by widening the existing roads to 2 lane/4 lane configuration. The AH-2 currently ends near the Mechi River. This river separates the international boundaries of India and Nepal. The existing bridge on this river is a two lane bridge and this bridge is not sufficient to cater for existing traffic. In order to reduce traffic congestion, a 6 lane bridge is planned on the Mechi River. This bridge and its approaches will be connected to AH-2, which is currently under implementation. This bridge, once developed will promote trade and tourism, local investments and social development in India and Nepal, specially Kakarbhitta in Nepal and Panitanki in India. The bridge on the Mechi River will be constructed with the financial assistance of Asian Development Bank (ADB). The detailed project report preparation for the bridge design, under Technical Assistance (TA) has been awarded by ADB to M/s Sheladia Associates, Inc., USA. This volume of the report covers Initial Environmental Examination (IEE) report of the Mechi Bridge. The project has been endorsed by the South Asia Subregional Economic Cooperation (SASEC) Trade facilitation and Transportation working group meeting in Kolkata on March 05, 2012.

B. Background of the Project

2. Infrastructure development, particularly faster movement and transportation system in a country like India, is a guiding factor for economic development. The regional road connectivity improvement through development of two highway corridors of which the Mechi bridge is a part will bring positive socio-economic changes. While developing these highway networks, there will be some adverse impacts on the surroundings. In order to provide mitigations to the adverse impacts, IEE study has been taken up as part of detailed project report preparation. **Figure 1** shows the alignment of proposed bridge along with its approaches. There were several levels of consultations to finalise the alignment of bridge and its approaches. The implementing agency for the project is National Highways and Infrastructure Development Corporation Limited (NHIDCL) at Sikkim in cooperation with PIU Department of Roads at Damak in Jhapa District of Nepal for Nepal portion.

Figure 1: The Alignment Map of Mechi Bridge and Approaches



1. Executing and Implementing Agency

3. The Ministry of Road Transport and Highways, Government of India is the Executing Agency (EA), and PIU of NHIDCL at Sikkim in cooperation with PIU at Department of Roads at Damak in Nepal is the Implementing Agency.

C. Objectives of the Project

4. The objective of the project is to provide connectivity through a new bridge between Kakarbhitta (Nepal) and Panitanki (India) and to cater to increased traffic. Further, the construction of Mechi bridge will increase the effectiveness of AH-2, which is currently under implementation. The AH-2 provides connectivity between India, Nepal and Bangladesh.

D. Purpose of the Study

1. Objectives

5. The main objective of the IEE study is to identify the impacts of project life cycle of the proposed bridge on the Mechi River on the physical, biological, socioeconomic and cultural environments of the project area. The IEE study objective is also to recommend practical and site specific environmental mitigation and enhancement measures, prepare and implement environmental monitoring plan and make sure that the IEE is sufficient for the proposed bridge project. The IEE has also been prepared to meet guidelines and regulatory requirements of the Government of India (GoI) and the Government of Nepal (GoN).

2. Need

6. The Mechi bridge project has been categorised as 'B' for environment as per ADB SPS 2009, accordingly the IEE is a requirement of ADB for environmental Category B projects. This IEE report conforms to the provisions of the ADB Environment Safeguards Sourcebook; and Safeguard Policy Statement 2009 of ADB.

E. Extent of IEE

7. This IEE covers the proposed Mechi Bridge and approaches construction, including ancillary facilities like camp, quarry, material storage, and plant operations. This IEE Report has been prepared based on the information and data available through the engineering design studies, including socio-economic and resettlement studies; and field visits, public consultations and discussions, collection of primary and secondary information and data. The study has established a core zone of impact for 100 meters on either side of the alignment for direct area of influence and 10 km on either side for the indirect area of influence.

- Consultations with Department of Road (Government of Nepal), Ministry of Road Transport and Highways (Government of India), Forest Department of Government of Nepal and Government of India, and Mechi Nagar Municipal Corporation (Nepal)
- Review of ADB, Government of Nepal and Government of India policies including legal requirements
- Project site visits and consultations with affected people and stakeholders
- Collection of primary and secondary baseline data for the IEE report
- Review of options study report

- Review of relevant documents for secondary information and data collection
- Preparation of IEE Draft Report and submit to ADB and DoR GoN, and Ministry of Road Transport and Highways for comments and feedback
- Preparation of Final IEE Report incorporating ADB and DoR GoN, PIU / NHIDCL and MORTH GoI comments and feedbacks.

F. Structure of the IEE Report

8. This IEE report has been presented as per requirements of TOR specified in the contract document of TA consultants and ADB safeguard requirements.

- **Chapter - I: Introduction**: The present chapter deals with the project objectives, objectives of IEE, extent of IEE and structure of the report.
- **Chapter - II: Policy, Legal and Administrative Framework:** In this chapter policy, legal and administrative framework of GoN and GoI has been described. The description is from the point of view of applicable rules and regulations and clearance requirements for the project in Nepal and India.
- **Chapter - III: Description of Project**: This chapter condensely describes about the project features and broad project benefits.
- **Chapter - IV: Description of the Environment**: This chapter describes the study area and meteorological conditions, the existing baseline environmental scenario in detail. The sections on meteorological baseline, components of the biophysical and natural environment, common property resources along the bridge and approaches alignment and in the project influence area have been described.
- **Chapter - V: Anticipated Environmental Impacts and Mitigation Measures**: This chapter details out environmental impacts, mitigation, avoidance and enhancement measures. CLimate change risks and measures have also been included in this section.
- **Chapter - VI: Analysis of Alternatives**: This chapter covers various alternatives considered in finalisation of the bridge and approaches alignment and with and without project scenario.
- **Chapter - VII: Stakeholder Consultations**: This chapter gives an overview of the Community Consultation carried out during the project preparation stage. It also provides an insight into the processes involved, its importance to project design and methods adopted to document the entire exercise.
- **Chapter - VIII: Environmental Management Plan (EMP)**: This chapter suggests institutional requirements for ease of implementation of the environmental component of the project. It describes the set-up required, a reporting system and Environmental Management Plan. The environmental budget has been estimated in this chapter. This chapter gives the Environmental Monitoring Plan for pre-construction, construction and operation phases to check the effectiveness of EMP implementation. A grievance redress mechanism has also been proposed in this chapter.
- **Chapter - IX: Conclusions and Recommendations**: This chapter covers findings and recommendations based on the IEE study, of which a conclusion has been drawn.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

9. This chapter presents a review of the international agreements and commitments, existing institutions and legislations relevant to the project in Nepal and at the National and State levels in India. The environmental assessment processes are based on environmental regulations and guidelines of Government of India (GoI), Government of Nepal (GoN) and ADB's SPS 2009 requirements.

A. International Agreements and Commitments of Government of India

10. India is party to various international agreements/conventions/treaties for conservation of environment. Important agreements have been briefly described and analysed vis-a-vis the relevance to the project.

1. Ramsar Convention on Wetlands, 1971

11. The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an inter-governmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Out of 19 designated wetlands of International Importance in India, none of them is located in project influence area of the Mechi Bridge and its approaches.

2. Convention on Protection of the World Cultural and Natural Heritage, 1972

12. 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 of the Mechi Bridge and its approaches.

3. Vienna Convention for Protection of the Ozone Layer, 1985 and Montreal Protocol on Substances Depleting the Ozone Layer, 1987

13. 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 such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform, are to be phased out by 2010. The project does not envisage production and consumption of ozone depleting substance (ODS).

4. United Nations Framework Convention on Climate Change (UNFCCC), 1994

14. The UNFCCC is an international treaty that was negotiated at the Rio Earth Summit in 1992 and came into force in 1994. The main objective of the treaty is to stabilize Greenhouse Gas (GHG) concentrations in the atmosphere to levels that would prevent dangerous anthropogenic interference with the climate system. Both India and Nepal have ratified the convention.

5. Convention on Biological Diversity (CBD), 1992

15. The Convention on Biological Diversity (CBD) is dedicated to promoting sustainable development and came into force in the 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 levels as a contribution to poverty alleviation and to the benefit of all life on earth.

B. India's Legal Framework and Regulatory Requirements

16. The Government of India has laid out various policy guidelines, acts and regulations for the safeguard and conservation of environment. The Environment (Protection) Act, 1986 provides the umbrella legislation for the protection of the environment. As per this Act, the responsibility to administer the legislation has been jointly entrusted to the Ministry of Environment and Forests and Climate Change (MoEFCC) and the Central Pollution Control Board (CPCB) / West Bengal State Pollution Control Board (WSPCB) in the present context. **Table 1** presents all relevant policies/acts/rules and regulations and its applicability to the project.

Table 1: Applicable National Laws and Regulations in India for the Mechi BridgeProject

S. No	Act /Rules	Purpose	Applicable	Reason for Applicability	Authority
1.	Environment Protection Act-1986	To protect and improve overall environment	Yes	It is umbrella legislation and notifications, rules and schedules are promulgated under this act.	MoEFCC. Gol; West Bengal State Government SPCB
2.	Environmental Impact Assessment Notification,14th Sep-2006 and amendments	To accord environmental Clearance to new development activities listed in schedule of EIA notification.	No	The bridge and approaches are not listed in schedule of EIA Notification 2006.	MoEFCC appraisal committee and SEIAA
3.	Fly Ash Notification, 1999 as amended up to 17th August 2003	Reuse large quantity of fly ash discharged from thermal power plant to minimize land use for	No	No coal based power plant is located within an aerial distance of 100 km.	MoEFCC
4.	Office memorandum dated 18.05.12,by MoEFCC in view of Apex Court order dated 27.2.2012	Conserve top soil, aquatic biodiversity, hydrological regime, etc. by haphazard and unscientific mining of minor minerals	Yes	In case of operation of quarries for sand and aggregates and opening of new borrow areas	SEIAA
5.	National Environment Appellate Authority Act (NEAA) 1997	Address grievances regarding the process of environmental clearance.	Yes	Grievances if any will be dealt with, within this act.	NEAA

S. No	Act /Rules	Purpose	Applicable	Reason for Applicability	Authority
6.	The Forest (Conservation) Act ,1980	To check deforestation by restricting conversion of forested areas into non-forested areas	Yes	There is need for tree cutting permission in the bridge approach on India side	State Forest Department, GoWB
7.	Air (Prevention and Control of Pollution) Act, 1981	To control air pollution by Traffic & Transport controlling Department as per prescribed vehicle emission limits and emissions from other emission sources	Yes	During construction, for construction vehicles and machinery; for obtaining NOC for establishment of hot mix plant, workers' camp, construction camp, wet mix macadam (WMM) plant, concrete batching plant, etc.	SPCB
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, WMM plant, concrete batching plant etc.	SPCB
9.	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 proposed bridge and approaches required to assess for future years and necessary protection measure need to be considered in design.	SPCB
10.	Public Liability and Insurance Act 1991	Protection form hazardous materials and accidents.	Yes	Contractor need to stock hazardous material like diesel, bitumen, emulsions, etc.	----
11.	Explosive Act 1984	Safe transportation, storage and use of explosive material	No	No blasting involved in the project	Chief Controller of Explosives
12.	Minor Mineral and concession Rules	For opening new quarry.	Yes	Regulate use of minor minerals like stone, soil, river sand ,etc.	District Collector, Darjeeling
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 stability through conservation and restoration of biological diversity.	No	Not applicable as no forest land diversion required	Forest Department, GoI and GoWB

S. No	Act /Rules	Purpose	Applicable	Reason for Applicability	Authority
15	The Mining Act	The mining act has been notified for safe and sound mining activity.	Yes	The construction of bridge project will require aggregate through mining from riverbeds and quarries	Department of Mining-GoWB
16.	The Building and Other Construction Workers (Regulation of employment and conditions of service) Act, 1996	To regulate the employment and 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-GoWB

C. Nepal's Legal Framework and Regulatory Requirements

17. In Nepal, various legal instruments are in place to ensure the integration of environmental aspects in development proposals. This IEE reviewed the following legislative provisions, environmental guidelines and policies to ensure compliance of the Project.

1. Policies

a. Constitution of Nepal, 2007 (with latest amendments)

18. The Constitution of Nepal provisions the right for every person to live in a clean environment. Article 35 [5] also provisions that the State shall make necessary arrangements to maintain the natural environment. The State shall give priority to special protection of the environment, and rare wildlife, and prevent further damage due to physical development activities, by increasing awareness of the general public about environmental cleanliness.

b. The Tenth Plan (2002-2007)

19. The Tenth Plan (2002-2007) has identified EIA as a priority area and it emphasizes on environmental monitoring of the projects that are under EIA process (GoN). The Plan focuses on the need for setting-up national environmental standards with the strategy of internalizing environmental management into the development programmes. The Plan has also realized to carry out a Strategic Environmental Assessment (SEA) with the long term policy of promoting environmental governance. The Plan emphasized on the local participation in environmental conservation, according to the Local Self Governance Act 2055, through the local bodies and making them responsible and capable to manage local natural resources.

c. Three Year Interim Plan (20014 - 20016)

20. One of the objectives of the transport sector is to develop the identified eight trades and transit corridors between neighbouring countries India and People's Republic of China. Another objective of the transport sector related to the project is to develop and operate safe roads by suitable road safety and traffic management activities including raising public awareness on such activities.

21. The environmental strategies of the Interim Plan are to launch development programs by internalizing environmental management; mobilize non-government private sector, local agencies and the public in increasing public awareness on the environment; determine and implement additional bylaws on air, water, soil and sound pollution; and by making action plans prioritize and implement Treaties and Conventions on environment, which Nepal has endorsed.

22. One of the policies of the Interim Plan is to institutionalize the environmental monitoring auditing through an effective implementation of approved environmental reports (IEE and EIA).

d. National Transport Policy, 2001/2002

23. The goal of the policy is to develop a reliable, cost effective, safe facility oriented and sustainable transport system that promotes and sustains the economic, social, cultural and tourism development of the Kingdom of Nepal as a whole.

e. Forest Policy

24. The Ministry of Forests and Soil Conservation (2009) also requires that all the costs related to the clearing off the forest, its transportation to the approved location and works related to environmental mitigation shall be borne by the project itself.

2. Acts and Rules

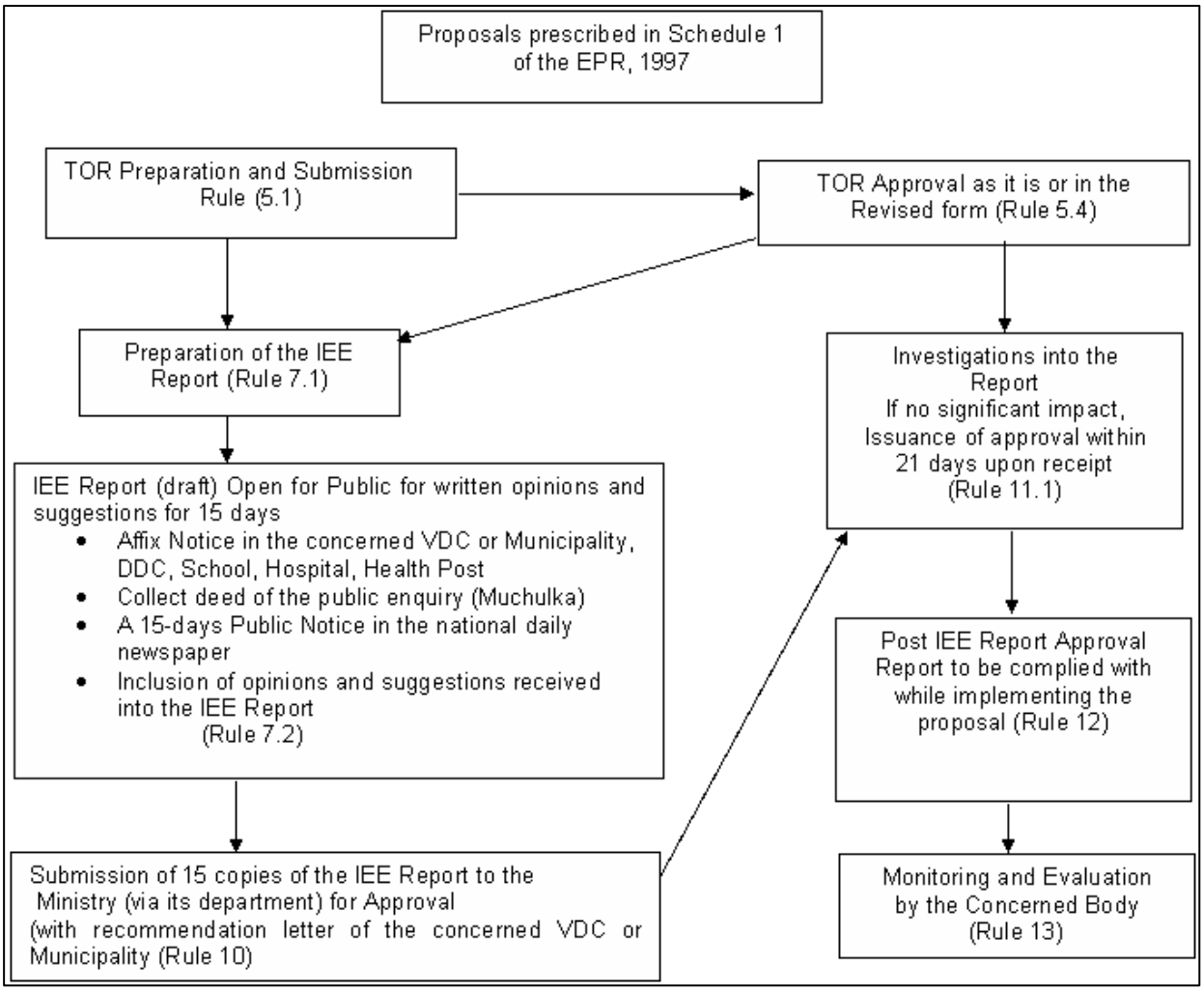
a. Environment Protection Act, 1996

25. The Environment Protection Act, 1996 and Environment Protection Rules, 1997 (as amended) contain several provisions to institutionalize the integration of environmental aspects in development projects including road sector and empowers Ministry of Environment approve the EIA report. Similarly, in case of IEE level study, line Ministry, which is Ministry of Physical Infrastructure and Transport is authorized to approve the Final IEE Report.

26. The Act recognizes the interdependence between development and the environment and shows the concerns for minimizing the impacts of environmental degradation on people, animal, and plant species and their physical surroundings. The Act obliges the proponent to undertake the IEE and EIA of proposal, plans or projects which may cause changes in existing environmental condition and authorizes the Ministry of Environment to clear all EIA and line Ministry for IEE study. The Environmental clearance procedure for category 'B' project has been shown in **Figure 2**.

27. The Act empowers the Ministry of Environment to prohibit the use of any matter, fuel, equipment or plant, which has adverse effects on the environment. The Act has provisions for polluters to compensate affected persons from polluting activities and empowers government to provide additional incentives to any industry, occupation, technology or process, which has positive impacts on environmental conservation. It provides the establishment of an Environmental Protection Fund to be used for environmental protection, pollution control and heritage conservation, and it gives the government authority to declare specific areas as environmentally protected areas.

Figure 2: Environmental Clearance Procedure in Nepal for Category B Project



b. Environment Protection Rules, 1997 (with amendment)

28. In the process of implementing EPA (1996) effectively, the Environment Protection Rule (EPR) came into force in 1997 and was amended in 1999. The EPR contains elaborate provisions for the process to be followed during the preparation and approval of projects requiring EIAs and IEEs including scoping documents, terms of reference, public consultations and hearings, and environmental monitoring and auditing. The environmental legislation empowers the concerned ministry to monitor the environmental activities including mitigation measures and Ministry of Environment for environmental auditing. For IEE, the concerned ministry, which is the Ministry of Physical Infrastructure and Transport in case of the road projects, is authorized to approve the Final IEE Report. The EPR also lists the types of development activities requiring IEE or EIA level Study. It also gives an outline of the content of the terms of reference document, IEE and EIA report.

c. Public Roads Act, 1974

29. The Department of Roads may temporarily acquire the land and other property adopting compensatory measures during the construction, rehabilitation and maintenance of the public roads according to the Act (Article 14 &15). The Act also empowers the DoR to operate quarries,

borrow pits and other facilities during the road construction (Article 17). In sum, the Act facilitates the acquisition of land and property for the extraction of construction materials and development of other facilities as well as to maintain the greenery along the roadside with the adoption of compensatory measures.

d. Forest Act, 1993 (with amendments)

30. The Forest Act, 1993 recognizes the importance of forests in maintaining a healthy environment. The Act requires decision makers to take account of all forest values, including environmental services and biodiversity, not just the production of timber and other commodities. The basis of Act is resource oriented rather than use oriented.

31. The Forest Act, 1993 (with amendment) contains several provisions to ensure the development, conservation, management and sustainable use of forest resources, based on the approved work plan. The work plan should contain a list of activities that should be implemented in the different forest categories - national forests, community forests, leasehold forests, private forests, and religious forests. Section 23 of the Act empowers the government to delineate any part of the national forest, which has “special environmental, scientific or cultural importance", as a protected forest. Section 49 of the Act prohibits reclaiming lands, setting fires, grazing cattle, removing and damaging forest products, felling trees of plants, wildlife hunting and extracting boulders, sand and soil from the National forest without prior approval. However, the government may enforce Section 68 of the Forest Act to provide parts of any type of forest for the implementation of a national priority plan with the assurance that it does not adversely affect the environment significantly. As provisioned under the Act, while clearing the forest on the RoW of road, the implementing authority will coordinate with the District Forest Office. If necessary, the compensatory replantation will also be carried out at the rate of 1:25 under the provision of the Act.

e. Forest Rule, 1995

32. The Forest Rules 1995 (with amendment) further elaborate legal measures for the conservation of forests and wildlife. Based on forest legislation, thirteen plant species are included in the level protection list. Of them, GoN has banned the felling, transportation and export of Champ (*Michelia champaca*), Khayer (*Acacia catechu*) and Sal (*Shorea robusta*). The Rule also stipulates that the entire expenses for cutting and transporting the forest products in a forest area to be used by the approved project shall be borne by the proponent of the project.

f. Forest Products Collection and Sales Distribution Guidelines, 2001

33. Clause 3 to 10 of the Guideline have specified various procedures and formats for getting approvals for vegetation clearance, delineation of lands for vegetation clearance, evaluation of the wood volume etc. and government offices and officials responsible for the approval, delineation and valuation.

g. Local Self-Governance Act, 1999

34. The Local Self-Governance Act, 1999 empowers the local bodies for the conservation of soil, forest, and other natural resources and implementation of environmental conservation activities. The Village Development Committees (VDCs), Municipalities and District Development

Committees (DDCs) are mandated to take up the responsibilities for the formulation and implementation of a programme relating to the protection of the environment and biodiversity, and to give adequate priority for the protection of the environment during the formulation of local level plans and programme.

h. Land Acquisition Act, 1977

35. The Land Acquisition Act (1977, as amended 1993) guides the compulsory acquisition of land. GoN can acquire land at any place and in any quantity by giving compensation pursuant to the Act for the land acquired for any public purpose(s) or for operation of any development project initiated by GoN institutions.

i. Soil and Watershed Conservation Act, 1982

36. Soil and Watershed Conservation Act makes provision to control floods, landslides (watershed conservation rules, 1985). The watershed conservation office is authority and district watershed conservation committee must implement watershed conservation practices and public participation for soil and land protection.

j. Water Resources Act, 1992

37. Water Resources Act (1992) makes provision for the rational use of surface and underground water. The act seeks to prevent environment and hazardous effects from the use of water and prohibit water pollution by chemicals and industries' wastes. Water may only be used in a manner that does not permit soil erosion, landslide or flood. Pollution of drinking water is prohibited under the Nepal drinking water corporation act (1989).

k. The Aquatic Animal Protection Act, 1961 (with amendment)

38. This Act indicates an early recognition of the value of wetlands and aquatic animals. Section 3 renders punishment to any party introducing poisonous, noxious or explosive materials into a water source, or destroying any dam, bridge or water system with the intent of catching or killing aquatic life. Under Section 4 of the Act, Government is empowered to prohibit catching, killing and harming of certain kinds of aquatic animals by notification in the Nepal Gazette.

l. Motor Vehicle and Transportation Management Act, 1993

39. This act sets standard for vehicle emission and mechanical condition for vehicle registration by the Transport Management Office (TMO) and the TMO can deny a permit based on environmental factor. Standard are set for petrol and diesel engine under the Nepal Vehicle Mass Emission Standard, 1999.

m. Guidelines for the Road Sector

40. Guidelines, including the draft EIA Guidelines for Road Sector, 1996, facilitate the proponents to prepare environmental assessment reports. These guidelines have been thoroughly reviewed and all pertinent issues have been incorporated during the preparation of this Report. The DOR Environmental Management Guidelines (EMG), 1997 provides guidance to the proponent to integrate environmental mitigation measures, particularly on the management of quarries, borrow pits, stockpiling of materials and spoil disposal, earthworks and slope stabilization, location of stone crushing plants, etc. The Environmental Guidelines for Local

Development also encourage the proponent to incorporate environmental issues during project design and implementation.

n. Environmental Management Guidelines, GESU/DoR

41. Originally, a Unit was set up in 1988 as the "Environmental Management Coordination Unit" of the DoR to support the Arun Access Road for the proposed Arun-III Hydropower Project and reformed as a permanent cell under Planning & Design Branch with a new name as Geo-Environment Unit (GEU) in the year 1994.

42. In 2005, DoR, in its Master Plan for Strategic Road Network, stressed on the development of road to supplement Poverty Reduction Program. After the initiation of implementation of enhancing poverty reduction impacts in some road projects in 2006, assisted by Asian Development Bank (ADB), the role of GEU was further expanded to incorporate the social aspects of road development projects. Thus DoR has renamed GEU into Geo- Environmental & Social Unit (GESU) to cover the social aspect and render prompt and efficient services with the development & strengthening of the roads.

43. Environmental Management Guidelines, GESU/DOR, July 1999 have been prepared as part of the program undertaken jointly by GoN and the World Bank under the Road Maintenance and Rehabilitation Project. These Guidelines were formally approved by Minister level decision on Kartik 22, 2053 BS (1997). The Guidelines are part of operational practices for all road maintenance, rehabilitation and construction activities under DOR. The guideline consists of environmental mitigation measures to be incorporated into DOR subprojects, procedures for public participation, and socio-economic considerations. The environmental mitigation measures are broken down into twelve categories including (i) quarries; (ii) borrow pits; (iii) spoil and construction waste disposal; (iv) work camp location and operation; (v) labour camp location and operation; (vi) earthwork/slope stabilization; (vii) use of bitumen; (viii) stockpiling of materials; (ix) explosive, combustible and toxic materials management; (x) setting up and operation of stone crushing plants; (xi) water management; and (xii) air and water pollution.

44. Implementation methods for undertaking mitigation measures for each of the activities are also given in the guideline. The guideline suggests methods for determining how and when the public should be included in the environmental analysis. The guidelines also advise on socio-economic impacts and strategies for reducing or avoiding the potential negative impacts and maximizing the beneficial impacts to local residents. The socio-economic impacts include important issues of land acquisition and compensation and other economic impacts with markets for agriculture production, agriculture inputs, nutrition, extraction of natural resources beyond replenishment, migration and influx of migrants, land speculation, illegal logging and mining, pottering, etc. It also includes impacts on cultural heritage.

45. The Environmental and Social Management Framework (ESMF) (DOR/GESU, 2008) was prepared as an overview and guidelines for various safeguards and compliance aspects of environmental and social issues related with the road construction and development.

46. The ESMF intends to provide technical and managerial inputs and guidance into the design of the strategic roads (both designated for rehabilitation and, to a lesser extent, to new construction), through identification of key environmental and social issues related to the foreseen projects, mitigate potential impacts and concerns and, devise opportunities to enhance the benefits. The framework integrates in a step-wise approach the most important environmental

and social considerations into all stages of project preparation, implementation, monitoring and operation.

o. Labor Act 1992 and Labor Rules, 1994

47. Labor Act, 1992 (first amendment 1998) and Labor Rules, 1994 deals with manual labor. Clause 46 under Section 7 deals particularly with construction industry. The Act defines working time as eight hours a day and a weekend leave. A half and hour break should be given as snack and tea break before continuous work of maximum five hours. Attendance Registry should be maintained properly. Clause 27 to 32 under Section 5 gives details for occupational health and safety requirement to be maintained for labors. Child labor (below 14 years) is prohibited, and between 14 to 16 years of age should be given proper training before putting them in work. It calls for insurance and safety management of labors. It also directs to establish camp near temporary working sites with drinking water, food, sanitation and residential facilities of numbers of labors are fifty or more in construction projects. The Labor Rule, 1994 guarantees equal wage for male and female. It also lists the percentage of compensation for different types of accidents during work at site.The Labour Act shall be followed in all the works carried out under the Project.

p. Child-Related Act, 1993 and Child Labour Act, 2001

48. The Child-Related Act 1993 and the Child Labour (abolition and regulation) Act, 2001 are the major acts related to child labour in Nepal. The Article 2 (Ka) of these acts refers"Child" to the children below 16 years of age. The Child Labour (Abolition and Regulation) Act is the most recent and revolutionary decision to overcome the child labour problem in Nepal. Article 3 clause 1 of the act states that any child below the age of 14 years prohibited for labour employment. However, clause 2 states that it is prohibited to engage children below 16 years in works in risk-prone sectors such as public transportation and construction related works. In other words, any employment of children below the age 16 is to be excluded from becoming contracted in any of the SRN subprojects' construction works. Children between 14 and 16 years of age may become engaged in other light and low-risk jobs such as roadside planting and drainage clearing.

3. Other Guidelines and Manuals

49. The following guidelines were reviewed and applied during the preparation of the report:

- Reference Manual for Environmental and Social Aspects of Integrated Road Development; MoPPW/DOR.HMGN,2003
- Environmental Management Guidelines for Roads and Bridges,GEU/DOR,1997
- Public Work Directives, HMGN,2002
- Guide to Road Slope Protection Works, DOR

4. Multilateral and Bilateral Conventions and Treaties Adopted by Nepal

50. Nepal is a signatory to many international agreements, conventions etc. related to environmental conservation:

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989
- The Vienna Convention for Protection of Ozone Layer, 1985
- UN Framework Convention on Climate Change, 1992

- The Agreement on the Network of Aquaculture Centers in Asia and the Pacific, 1988
- The Plant Protection Agreement for the South East Asia and the Pacific (as amended), 1956,
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora, (CITES), 1973
- The Ramsar Convention (Convention on Wetlands of International Importance Especially as Water Fowl Habitat), 1971
- The Convention for Protection of the World Cultural and Natural Heritage, 1972
- The UN Convention to Combat Desertification, 1994
- Convention on Biological Diversity, 1992

51. Relevant regional and bilateral agreements that Nepal is a part of are:

- Kanchenjunga Landscape and Development Initiative – An initiative for transboundary landscape conservation in Bhutan, India and Nepal
- South Asia Cooperative Environment Programme (SACEP – An intergovernmental organization established in 1982 by South Asia governments to promote and support protection, management and enhancement of the environment in the region.

D. International Agreements between India and Nepal

52. India and Nepal are bound by the 1950 Treaty of Peace and Friendship that established a close strategic relationship between the two countries. The treaty, signed on 31 July 1950, allows free movement of people and goods between the two nations and a close relationship and collaboration on matters of defense and foreign policy.

53. Both countries have enhanced cooperation in the areas of investments, hydro power development, technology transfer, and physical infrastructure and education. The most relevant to the project is when India and Nepal signed a Memorandum of Understanding (MOU) for project management consultancy for upgradation / improvement of road infrastructure in Terai region of Nepal. National Highways and Infrastructure Development Corporation Limited (NHIDCL) is currently providing the consultancy services in pursuit of the MOU signing on February 2016.

54. The two countries also signed an agreement in August 2010 to ensure better management of forest areas, many of them key habitat for Tigers and other threatened wildlife, along the 1,752 km Indo-Nepal border. [1] In 2013, the consultative meeting between the two countries stressed on action to move the agenda for cooperation in biodiversity conservation. The said meeting agreed on 11 point resolution that stressed joint monitoring of tigers in the Terai Arc Landscape, strengthening transboundary efforts in curbing poaching and illegal trade of wildlife and forest products, preparing tiger recovery plans for selected trans-boundary sites, pursuing proactive measures to mitigate human-wildlife conflict, promoting smart infrastructure development that does not adversely affect key wildlife habitat, and promote exchange visits to learn best practices in community participation in conservation.[2]

[1] http://www.traffic.org/home/2010/8/4/india-and-nepal-sign-accord-to-protect-wildlife-and-tackle-c.html
[2] http://www.wwfindia.org/news_facts/?uNewsID=8420

E. ADB's Safeguard Requirements

55. 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.

56. Projects are classified into the following categories:

- **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.
- **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.
- **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.
- **Category FI**. The proposed project involves the investment of ADB funds to, or through, a financial intermediary (see section L of this chapter for additional information on safeguard requirements for FI projects).

57. Project categorization has been done using Rapid Environemntal Assessment (REA) checklist (Appendix 1) following the guidance provided above and the project is categorized as B. As per SPS 2009, Category B projects warrants preparation of an IEE.

58. The SPS includes 11 policy principles on environment safeguards as given in the following:

(i) Use a screening process for each proposed project, as early as possible, to determine the appropriate extent and type of environmental assessment so that appropriate studies are undertaken commensurate with the significance of potential impacts and risks.

(ii) Conduct an environmental assessment for each proposed project to identify potential direct, indirect, cumulative, and induced impacts and risks to physical, biological, socioeconomic (including impacts on livelihood through environmental media, health and safety, vulnerable groups, and gender issues), and physical cultural resources in the context of the project’s area of influence. Assess potential transboundary and global impacts, including climate change. Use strategic environmental assessment where appropriate.

(iii) Examine alternatives to the project’s location, design, technology, and components and their potential environmental and social impacts and document the rationale for selecting the particular alternative proposed. Also consider the no project alternative.

(iv) Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts by means of environmental planning and management. Prepare an environmental management plan (EMP) that includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. Key considerations for EMP preparation include mitigation of potential adverse impacts to the level of no significant harm to third parties, and the polluter pays principle.

(v) Carry out meaningful consultation with affected people and facilitate their informed participation. Ensure women's participation in consultation. Involve stakeholders, including affected people and concerned nongovernment organizations, early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and taken into account. Continue consultations with stakeholders throughout project implementation as necessary to address issues related to environmental assessment. Establish a grievance redress mechanism to receive and facilitate resolution of the affected people's concerns and grievances regarding the project's environmental performance.

(vi) Disclose a draft environmental assessment (including the EMP) in a timely manner, before project appraisal, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. Disclose the final environmental assessment, and its updates if any, to affected people and other stakeholders.

(vii) Implement the EMP and monitor its effectiveness. Document monitoring results, including the development and implementation of corrective actions, and disclose monitoring reports.

(viii) Do not implement project activities in areas of critical habitats, unless (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function, (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated. If a project is located within a legally protected area, implement additional programs to promote and enhance the conservation aims of the protected area. In an area of natural habitats, there must be no significant conversion or degradation, unless (i) alternatives are not available, (ii) the overall benefits from the project substantially outweigh the environmental costs, and (iii) any conversion or degradation is appropriately mitigated. Use a precautionary approach to the use, development, and management of renewable natural resources.

(ix) Apply pollution prevention and control technologies and practices consistent with international good practices as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines. Adopt cleaner production processes and good energy efficiency practices. Avoid pollution, or, when avoidance is not possible, minimize or control the intensity or load of pollutant emissions and discharges, including direct and indirect greenhouse gases emissions, waste generation, and release of hazardous materials from their production, transportation, handling, and storage. Avoid the use of hazardous materials subject to international bans or phase outs. Purchase, use, and manage pesticides based on integrated pest management approaches and reduce reliance on synthetic chemical pesticides.

(x) Provide workers with safe and healthy working conditions and prevent accidents, injuries, and disease. Establish preventive and emergency preparedness and

response measures to avoid, and where avoidance is not possible, to minimize, adverse impacts and risks to the health and safety of local communities.

(xi) Conserve physical cultural resources and avoid destroying or damaging them by using field-based surveys that employ qualified and experienced experts during environmental assessment. Provide for the use of "chance find" procedures that include a pre-approved management and conservation approach for materials that may be discovered during project implementation.

F. Permissions and Clearance Required for the project

59. The legal framework of the Nepal and India consists of several acts, notifications, rules, and regulations to protect the environment and wildlife explained above. List of required clearances / permissions related to the environment for the Mechi Bridge project has been summarized in **Table 2** for Nepal and **Table 3** for India below. As can be seen in the table an environmental clearance (IEE approval) is required only under rules of Government of Nepal. Bridges are not listed in the EIA notification under GOI, hence no environmental clearance, hence no IEE or EIA is required GOI requirements.

Table 2: Permissions and Clearance Required in Nepal

S.N.	Clearance	Act/Rule/Notification/Guideline	Concerned Agency	Responsibility
A. Pre-construction Stage				
1	Environmental Clearance (categorized as "B" with IEE requirement)	Environment Protection Act 1996 and Environment Protection Rules, 1997 (with amendments).	Ministry of Physical Infrastructure and Transport	Department of Roads / PD, DOR (ADB)
2	Land Acquisition and Compensation	Land Acquisition Act , 1977(with amendments)	Ministry of Physical Infrastructure and Transport	Department of Roads / PD, DOR (ADB)
3	Forestry clearance for felling of Trees	Forest Act, 1993 (with amendment), Forest Rule, 1995, Forest Products Collection and Sales Distribution Guidelines, 2001 and Local Self- Governance Act, 1999	Ministry of Forest and Soil Conservation	Department of Roads / PD, DOR (ADB)
B. Implementation Stage				
4	Permission for construction material quarrying (stone, cobble, sand, gravel, soil etc)	Local Self-Governance Act, 1999 and Soil and Watershed Conservation Act, 1982 and Watershed Conservation Rule, 1985. EPA,1996 and EPR, 1997 (with amendments)	Concerned Project and Concerned VDC, DDC and Municipality	Contractor
5	Consent to operate Hot mix plant, Crushers, Batching Plant	Local Self-Governance Act, 1999	Concerned Project Authority and Concerned VDC, DDC and Municipality	Contractor
6	Consent for disposal of sewage from labour camps	Water Resource Act, 1992	Concerned Project	Contractor

S.N.	Clearance	Act/Rule/Notification/Guideline	Concerned Agency	Responsibility
7	Pollution Under Control Certificate	Motor Vehicle and Transportation	Department of Transport	Contractor

Table 3: Permissions and Clearance Required in India

S No	Clearances	Acts/Rules/Notifications/Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				
1.	No Objection Certificate	Water (Prevention and Control of Pollution) Act 1974, Air (Prevention and Control of Pollution) Act 1981	State Pollution Control Board	NHIDCL-PIU (Sikkim)/ Consultant
2.	Permission for felling of trees	Forest Conservation Act (1980) Procedural Guidelines developed by the Department of Environment, under the orders of the Hon'ble High Court; Tree removal will be guided as per state government rules.	DFO, Karseong (Darjeeling district)	NHIDCL-PIU (Sikkim)
B. Implementation Stage				
3.	Permission for Withdrawal of Ground Water	Environment Protection Act 1986	Central Ground Water Authority	Contractor
4.	Permission for Withdrawal of Surface Water from River/ Irrigation Canals		Irrigation Department for use of water from Irrigation Canal. River Board / Authorities for withdrawal of water from Rivers	Contractor
5.	Permission for Sand Mining from River Bed	Mines and Minerals (Regulation and Development) Act, 1957 as amended in 1972	River Board Authorities/ Department of Mining, Govt. of West Bengal	Contractor
6.	Permission for Opening of New Quarry	Mines and Minerals (Regulation and Development) Act, 1957 as amended in 1972	Department of Mining Govt. of West Bengal/ State Pollution Control Board	Contractor
7.	Hot mix plant, Crushers, Batching Plant	Air (Prevention and Control of Pollution) Act 1981 and Water (Prevention and Control of Pollution) Act 1974,	State Pollution Control Board	Contractor
8.	Storage of Hazardous Chemicals	Hazardous Waste (Management and Handling) Rules 1989 and Manufacturing Storage and Import of Hazardous Chemicals Rules 1989	State Pollution Control Board	Contractor
9.	Disposal of Hazardous Waste	Hazardous Waste (Management and Handling) Rules 1989	State Pollution Control Board	Contractor
10.	Disposal of Construction	Water (Prevention and Control of Pollution) Act 1974	State Pollution Control Board	Contractor

S No	Clearances	Acts/Rules/Notifications/Guidelines	Concerned Agency	Responsibility
	Waste & liquid effluent from Labour camps			
11.	Use of Fly ash within 100 kms around Thermal Power plants.	Fly Ash Notification, 1999 as amended upto 2009:	MoEFCC	Contractor
12.	Pollution Under Control Certificate	Central Motor and Vehicle Act 1988	Department of Transport, Govt. of West Bengal	Contractor
13.	Employing Labour/workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	District Labour Commissioner	Contractor

III. DESCRIPTION OF PROJECT

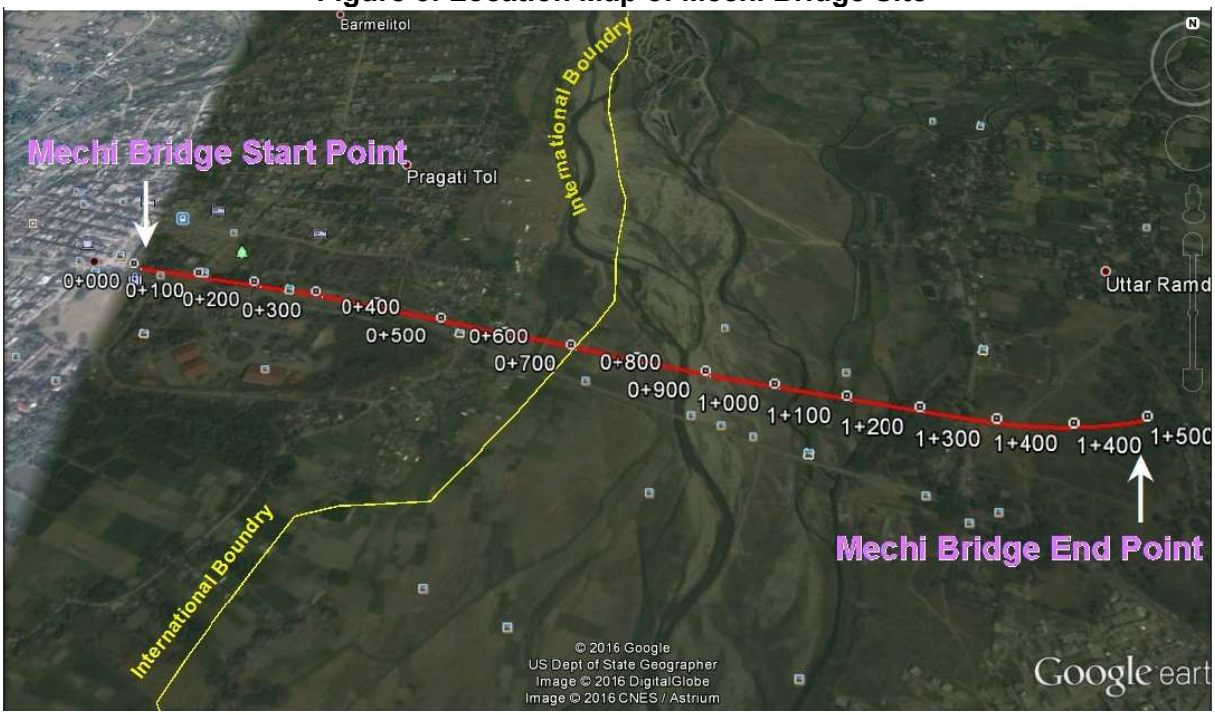
A. Location of Project

60. The Mechi River separates India and Nepal. The bridge is planned at India and Nepal borders at Panitanki town in Darjeeling district of West Bengal in India and Kakarbhitta town in the Jhapa district of Nepal. The bridge and approaches start point and end point latitude and longitude are as follows:

- **Start Point Coordinate**: X: 615007.7737 Y: 2947824.2393
- **End Point Coordinate**: X: 616472.0583 Y: 2947533.6292

61. The bridge location on Google map is shown in **Figure 3.**

Figure 3: Location Map of Mechi Bridge Site



B. Need for the Project

62. The carriageway width of the existing bridge is to cater for 2 lanes loading only, whereas at present there are many slow moving vehicles along with pedestrian traffic plying on the bridge in addition to fast moving / commercial traffic and the capacity of the bridge is insufficient to take care of the present traffic. The projected traffic for future years also demands for a new 6 lane bridge.

C. Project Category

63. Project categorization has been done using the Rapid Environment Assessment (REA) checklist of ADB after visiting the project site and surroundings. The project involves only bridge and its approaches construction. There is already an existing bridge just a few meters downstream of the proposed bridge, hence the project bridge will not be the first cross border

connection between Nepal and India in the area. The bridge and approaches are not located in or near any environmentally sensitive areas such as a wildlife sanctuary, national park, bird sanctuary, tiger reserve, protected area or any other similar eco-sensitive areas. The alignment of bridge and approaches are also not located in Reserved/Protected/ Revenue forest. The approaches are more or less in urban areas on either side. The Mechi River is a seasonal river and has narrow braided channels within the larger riverbed for most of the year. The project impacts are mainly temporary and localized in nature which can be mitigated by effective implementation of Environmental Management Plan (EMP) included with the IEE. No loss of rare/threatened/endangered species of flora is envisaged. The project site does not have have a large congregation of migratory species nor does it have any nationally or internationally important cultural, religious or heritage site. Hence, the project has been categorised as Category 'B' as per SPS, 2009.

D. Existing Bridge

64. The existing Mechi Bridge consists of 20 spans of each 29.3m having PSC Superstructure resting on well foundations. The clear deck width of the bridge is 7.0m and overall deck width is about 8.0m.

65. The bridge was built in the year 1968 (approx.) and is about 47 years old. The bridge is in fair condition as per condition survey with minor distress at some locations. The carriageway width of the bridge is to cater for 2 lane loading only, whereas at present there are many slow moving vehicles along with pedestrian traffic plying on the bridge in addition to fast moving / commercial traffic. The capacity of the bridge is insufficient to take care of the present traffic. Also keeping the projected traffic based on the existing, it is proposed for the construction of a new bridge. The old bridge will not be demolished. It will still be used for slow moving traffic such as cycle rickshaw and for the use of pedestrians crossing the river.

E. Existing and Proposed Traffic

66. The present bridge is catering for completely mixed traffic consisting of pedestrian, slow and fast moving traffic. The current traffic mix on existing bridge is indicated in **Table 4**:

Table 4: Traffic Growth Rates

Vehicle Type / Volume of Vehicles in Year 2014/15																							PCU[3]		
Passenger Vehicles						Slow Moving					Light Commercial			Commercial Vehicle											
Car/Jeep/Van	Taxi	2- Wheeler	3- Wheeler	Mini Bus	Std Bus	Cycle	CRK	AC	HC	Others	3- Tyre	4-Tyre	6-Tyre	2-Axle	3-Axle	4-Axle	5-Axle	6-Axle	7 Axle	Tractor	Trailers	Tractor	Total Fast	Total Slow	Grand Total	Total Fast	Total Slow	Grand Total
1317	1258	4547	325	13	3	5228	5375	0	0	0	176	173	182	104	232	177	51	2	0		0	2	8562	10603	19165	**7957**	13364	21321
Year 2034																												
3494	3338	12065	862	34	8	9351	9614	0	0	0	467	459	483	276	616	470	135	5	0	0	0	5	22718	16066	41868	**21112**	21044	42156

[3] Passenger Car Unit

67. The projections are done on the basis of 5% growth rate per annum for fast moving and 2% for slow moving vehicles. Projections clearly depict the requirement for a 6 Lane Bridge during the analysis period of 30 years (bridges are designed for 50 years on the basis of hydraulics and structurally 100 years based on the recent codal requirements). The slow moving vehicles will continue to use the existing bridge.

F. Proposed Bridge Design Features

68. A six-lane major bridge is proposed connecting Nepal side border to Indian side border and further to Kakarbhitta on Nepal side and Panitanki bypass of Asian Highway AH 02 on Indian side.

69. **Bridge Deck Configuration**. The cross section of 6-lane bridge is 24.2m having 11.0m for each carriageway with 0.5m crash barrier at outer ends and 1.2m central median. The 6 lane major bridge having a total length of 675m consists of 3 Span Continuous Precast PSC Segmental Box Superstructure having a deck width of 24.2m. Fishbelly type superstructure is proposed keeping in view of importance and aesthetics of the structure. The span arrangements for the 3-Span Continuous modules are 5 units of 3 x 45m. One Light Vehicular Underpass (1x12.0x3.5) has been proposed near the abutment A1 in the approach on Nepal for the free movement of slow moving vehicles.

70. **Substructure and Foundation.** Circular RCC piers are proposed considering the possible direction of flow of water and from aesthetics point of view resting on pile foundation. Considering the site condition and the type of soil, pile foundations are proposed.

71. **Drainage Requirements.** Suitably designed drainage arrangement shall be provided for Flyover consists of rigid PVC pipes connecting down spouts below the deck with funnels and along the pier up to ground level and eventually joined to the road drainage system. All carriageways and footpath surfaces shall have anti-skid characteristics.

G. Design Basis and Standards for Structure and Approach Roads

72. **General**. The approach roads and structures are proposed to follow the latest Design Standards specified by the Indian Road Congress, and the Technical Circulars issued by the Ministry of Road Transport and Highways from time to time.

73. Codes and References: The design of various components of the structure, in general are based on provisions of IRC/IS Codes. The list of IRC Codes (latest revisions) given below will serve as a guide for the design of structures.

- IRC: 5-1998: Standard Specifications and Code of Practice for Road Bridges, Section-I – General features of Design.
- IRC: 6-2014: Standard Specifications and Code of Practice for Road Bridges, Section-II – Loads and Stresses.
- IRC: 22-2008: Standard Specifications and Code of Practice for Road Bridges, Section-VI – Composite Construction.
- IRC: 78-2014: Standard Specifications and Code of Practice for Road Bridges, Section-VII – Foundation & Substructure.
- IRC: 83-1987 (PII): Standard Specifications and Code of Practice for Road Bridges, Section-IX – Bearings- Part II: Elastomeric Bearings.
- IRC: 83-2002 (PIII): Standard Specifications and Code of Practice for Road

Bridges, Section-IX –Bearings-Part III: POT, POT-cum-PTPE and Metallic guide Bearings.

- IRC: 112-2011: Code of Practice for Concrete Road Bridges.
- IRC: SP: 13-2004: Guidelines for Design of Minor Bridges & Culverts.
- IRC: SP: 80-2008: Guidelines for Corrosion Prevention, Monitoring and Remedial Measures for Concrete Bridge Structures.
- IRC: SP: 84-2014: Manual of Specifications and Standards for Four Laning of Highways through Public Private Partnership
- IS: 2911:2010: Code of Practice for Design and Construction of Pile (Part I Sec-2) Foundations: Concrete Pile - Bored Cast-in-Situ
- IS: 2911 PIV: Code of Practice for Design and Construction of Pile Foundations: Load test on Piles.

74. Wherever IRC code is silent, following standards will be followed.

- American Association of State Highway and Transport Officials (AAHSTO) Standards
- British Standards
- Any other National or International Standard as considered suitable.

75. **Horizontal Geometry.** The geometry of the Project Highway is designed for the approved alignment option V which is connecting proposed ROB and Proposed Bridge over Mechi river. The ruling design speed is 80Kmph and sight distance is 90m. Stopping sight distance has been adopted for the design of geometry.

76. Most of the existing road is proposed to be reconstructed, the pavement thickness of which has an overall MSA of 50 with 7CBR for a period of 15 years:

- Main Carriageway : BC 40mm, DBM 100mm, WMM 250mm, GSB 230mm and Sub-grade 500mm
- Service Road : BC 40mm, DBM 50mm, WMM 250mm, GSB, 150mm and Subgrade 500mm.

77. **Vertical Profile:**

Gradients	:	A minimum gradient of 0.3% and maximum vertical gradient of 3.0% has been adopted
Vertical Curves:		For Summit curves a K – Value1 8.4, and sag curves K – value 17.4, minimum length of vertical curve shall be 40.0m.
Cross camber	:	2.5%
Super elevation:		5.0%

78. **Width of the Carriageway Element**s:

Main Carriageway	:	3.5m each lane with a kerb shyness of 0.25m
Four Lane road	:	7.0m
Paved Shoulder	:	2.0m
Service Road	:	5.5m
Footpath	:	2.0m

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

79. For safety and operational reasons it will be necessary to provide suitable safety features, road furniture and other facilities along the project road. These features will include safety barriers, road signs, road markings, road lighting, road delineators, and landscaping. Where possible these features will be provided in accordance with relevant IRC or other standards, as detailed below. If no IRC Codes or the MORTH Specifications are available, international standards such as BIS /AASHTO/ ASTM /British Standards will be used in detailed design.

80. **Road Signs**. The colour, configuration, size and location of road signs shall be in accordance with IRC: 67-2001. Standards prescribed by MORTH and IRC: SP-35 shall be followed for overhead signs.

81. **Road Markings**. Road markings shall be as per IRC: 35-2015 (second revision). These markings shall be applied to road centre lines, edge line, continuity line, stop lines, give-way lines, diagonal/chevron markings, and zebra crossing areas by means of an approved self propelled machine which has a satisfactory cut-off value capable of applying broken lines automatically. The approach noses of the traffic islands will be marked for additional guidance of traffic by means of diagonal markings and chevrons. The design and location for road delineators shall be as per IRC: 79.

82. **Strengthening of existing pavement**. Strengthening of existing pavement shall be done in accordance with IRC: 81-1997. Before laying the overlays, profile corrective course shall be carried out with DBM/BM/WMM as the case may be based on detailed vertical design.

83. **Roadside Drainage**. An effective drainage system shall be planned for the drainage of roadway as per stipulations or IRC SP: 42-1994 and IRC SP: 50-1999 for maintaining structural soundness and functionality of the project road. Covered RCC drains are proposed at the outer edge road in urban area.

84. **Specifications.** The General Technical Specifications shall be as per MORTH Specifications for Road and Bridge works (Fifth Revision) issued by the Ministry of Road Transport and Highways, Government of India and published by the Indian Roads Congress along with its updating/amendments/ addendum issued from time to time.

85. **Quarries and Crusher Plant.** Pakuru quarry has been identified for subgrade and Narsing crusher at Matigara for sand stone. The sand requirement is estimated at 20,000 m^3. The sand quarries have been identified at the Mechi River, Mahanada and Balasone .

86. **Construction camp, asphalt mix plant, and handling and storage of aggregates.** There are no details yet on the construction camp site, asphalt mix plant and area for handling and storage of aggregates.

I. Natural factors considered for the bridge design

87. **Temperature Forces (Temperature Gradient):** Temperature forces considered for calculation of bearing movement and for the design of expansion joint shall be as per clause 215 of IRC: 6. The design is based on the range of effective bridge temperature at the site location of the structure. The temperature gradient considered for stress calculations of all structure members are as per the clause 215.3 of IRC: 6.

Minimum temperature = 0°C

Maximum temperature = 40°C

Mean temperature = (0 + 40) / 2 = 20°C

88. Mean temperature +100°C or 100°C shall be considered as the Bridge temperature when the structure is effectively restrained.

Temperature increase/ Decrease = 40 - (20-10) = 30° C

Coefficient of Thermal expansion = 12 x 10^{-6} /° C (Cl. 215.4 IRC 6)

89. For the calculation of shrinkage effect, the shrinkage strain of 2 x 10^{-4} has been converted into equivalent temperature fall as shown below:

Total temperature fall due to shrinkage = 2 x 10^{-4} / 117 x 10^{-7} = 17/° C

90. While considering the forces due to these strains, Young's modulus of elasticity of concrete can be reduced to 50% of the original value to consider the long term effect.

91. **Wind Forces.** Wind Forces shall be considered as per clause 209 of IRC: 6. Drag Coefficient, Gust factor and Lift Coefficient shall be calculated as per the above clauses.

92. **Water Current Forces.** Water Current Forces shall be considered as per Clause 210 of IRC: 6. The pier and abutment of the structures shall be designed for a variation of 20 deg with respect to orientation of pier depending upon the location of abutment / pier.

93. **Buoyancy.** Buoyancy shall be considered as per Clause 213 of IRC: 6 in the design of submerged components of structures, the buoyancy effect through pore pressure shall be limited to 15% of full buoyancy.

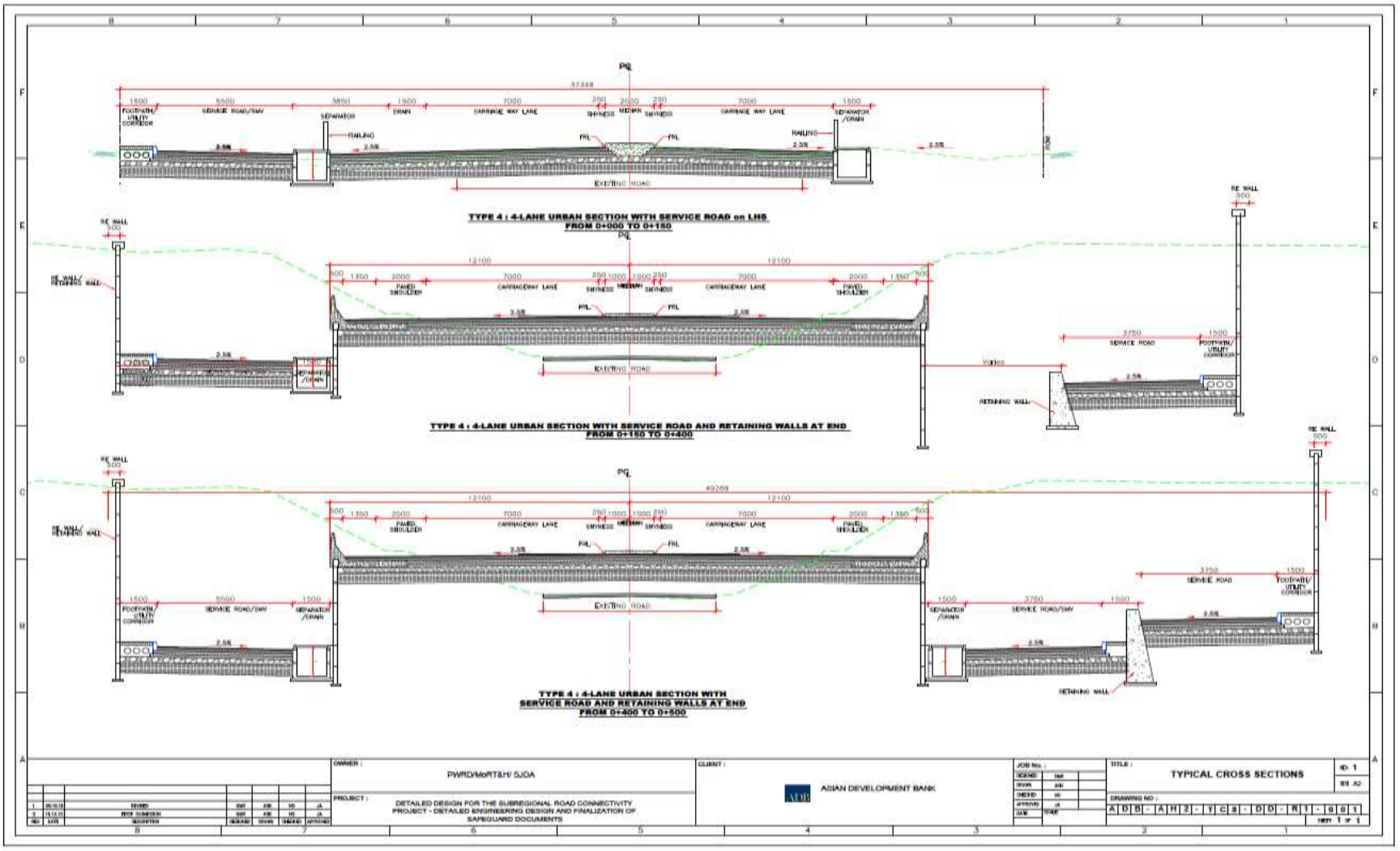
94. **Earth Pressure.** Active pressure due to filling behind the retaining/abutment shall be evaluated by Coulomb's formula. The Coefficient of active pressure (horizontal): Ka = Following soil properties for filling behind abutment and between return walls shall be considered in the design.

(i) Angle of Internal friction (_) : 30°
(ii) Angle of Wall friction (_) : 20°
(iii) Angle of cohesion, c : 0°
(iv) Dry density of backfill material : 2.0 T/m^3

95. The value for coefficient of active earth pressure, Ka is calculated using the above formula and design parameters, case by case. Surcharge live load, equivalent to 1.2m of earth fill shall be considered in the design.

96. **Seismic Forces.** The project stretch falls under Seismic Zone IV as per clause 219 of IRC: 6. The seismic coefficient is calculated considering the Importance factor (I) of 1.5 as no alternative alignment is available except the existing bridge. Seismic reduction factor (R) is considered as 3 for Piers/Columns with POT bearings/STU for the design of substructure & foundation. Seismic reduction factor shall be 1.0 for bearings.

Figure 4: Typical Cross Section



Source: DPR Volume VIII - Drawings (August 2016)

J. Construction Material Sources

97. For meeting the earthworks requirement, borrow areas have been identified close to the bridge location near Panitanki (borrow areas are at a distance of 0.500 and 1.5 km distance) and quarries for sandstone and aggregate that have been identified are Pakuru (at about 15 km) and for sand, Balason/Mahananda rivers at a distance of about 25 km).

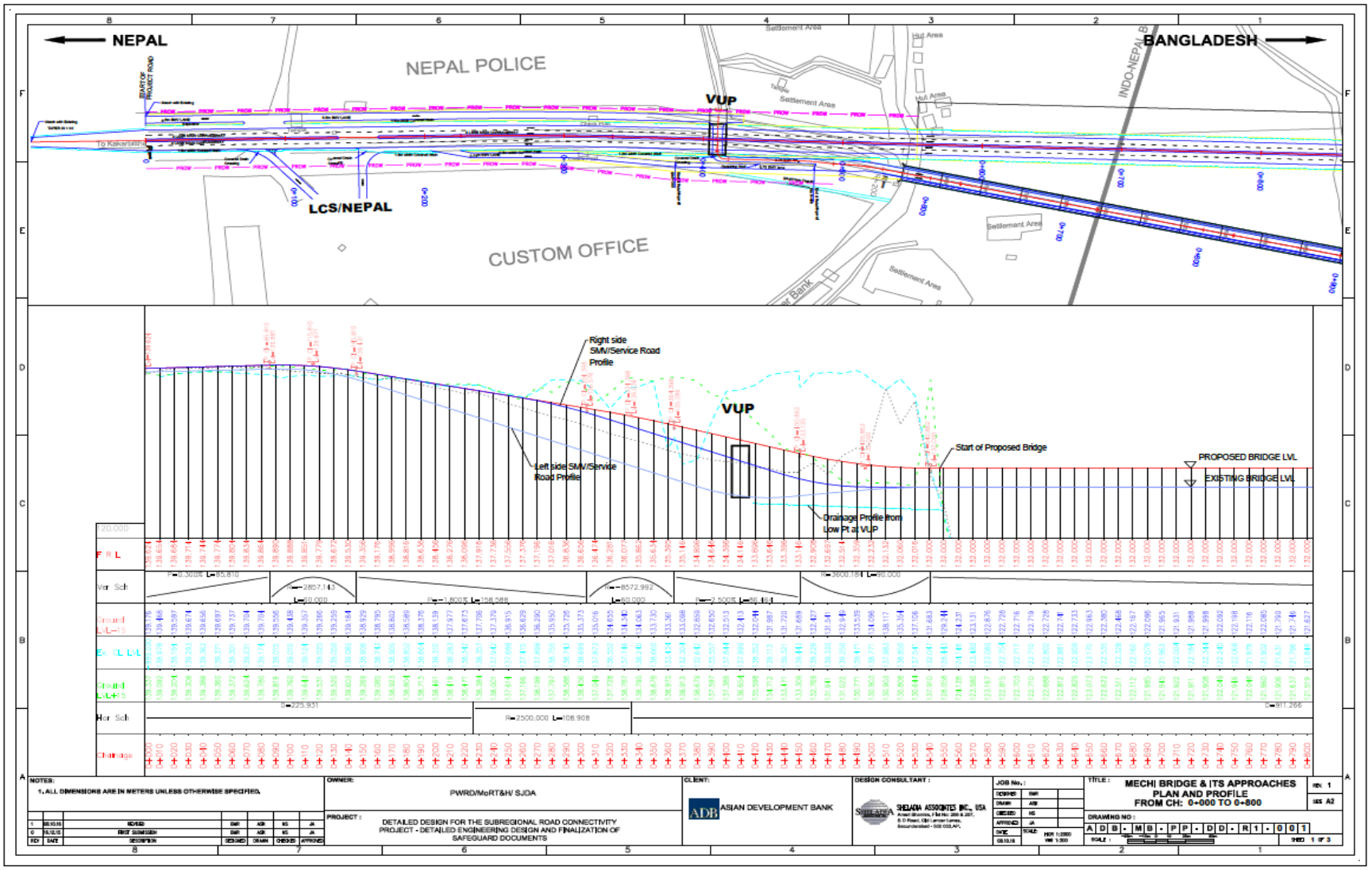
K. Plan and Profile for the Mechi Bridge and Approaches

98. The plan and profile of the Mechi Bridge and its approaches is given in **Figures 5** and **6** below.

L. Cost of the Project

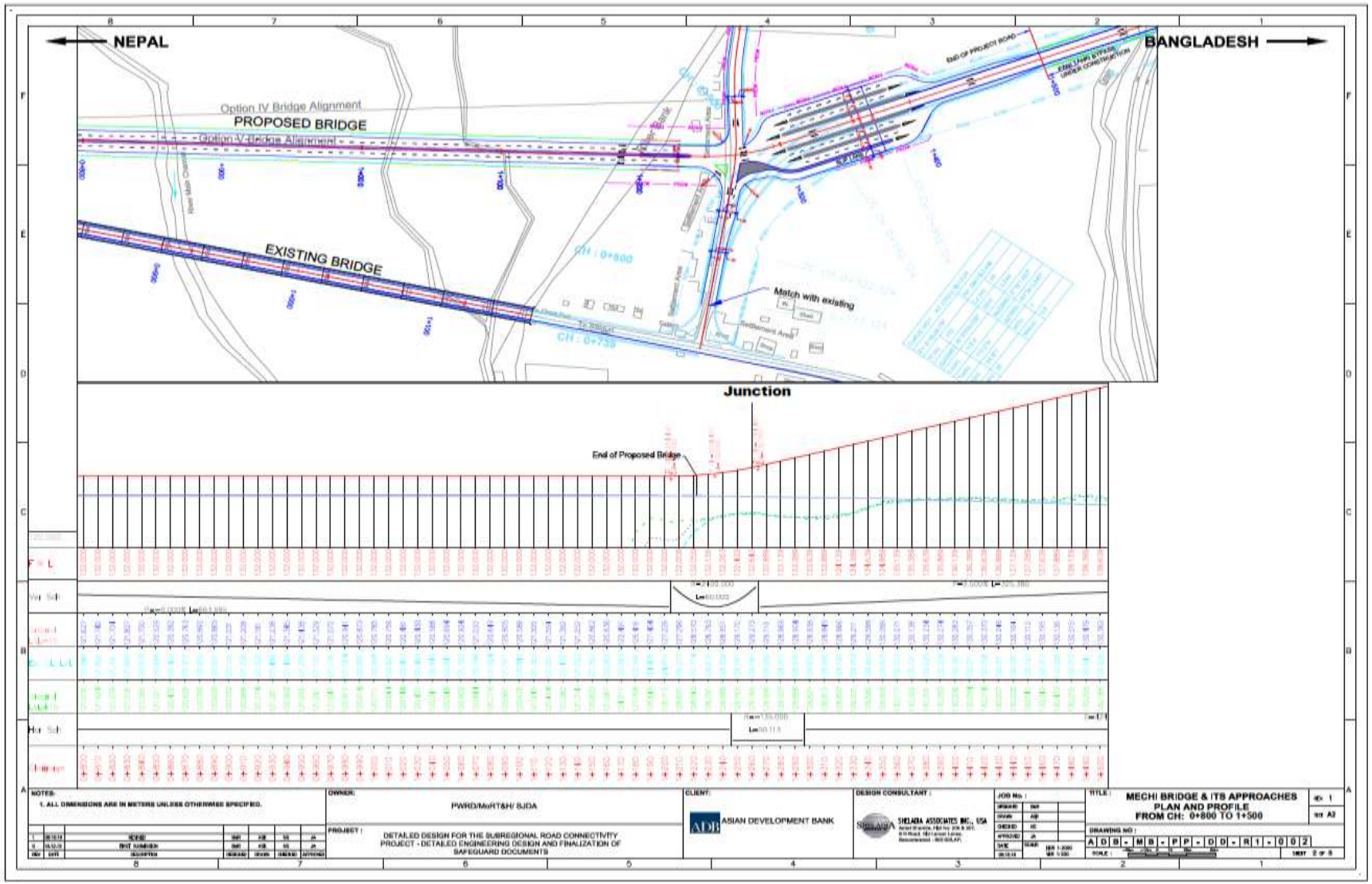
99. The cost of the project is INR 159 Crores or approximately $ 23.8 million.

Figure 5: Plan and profile for Bridge Approach (Nepal Side)



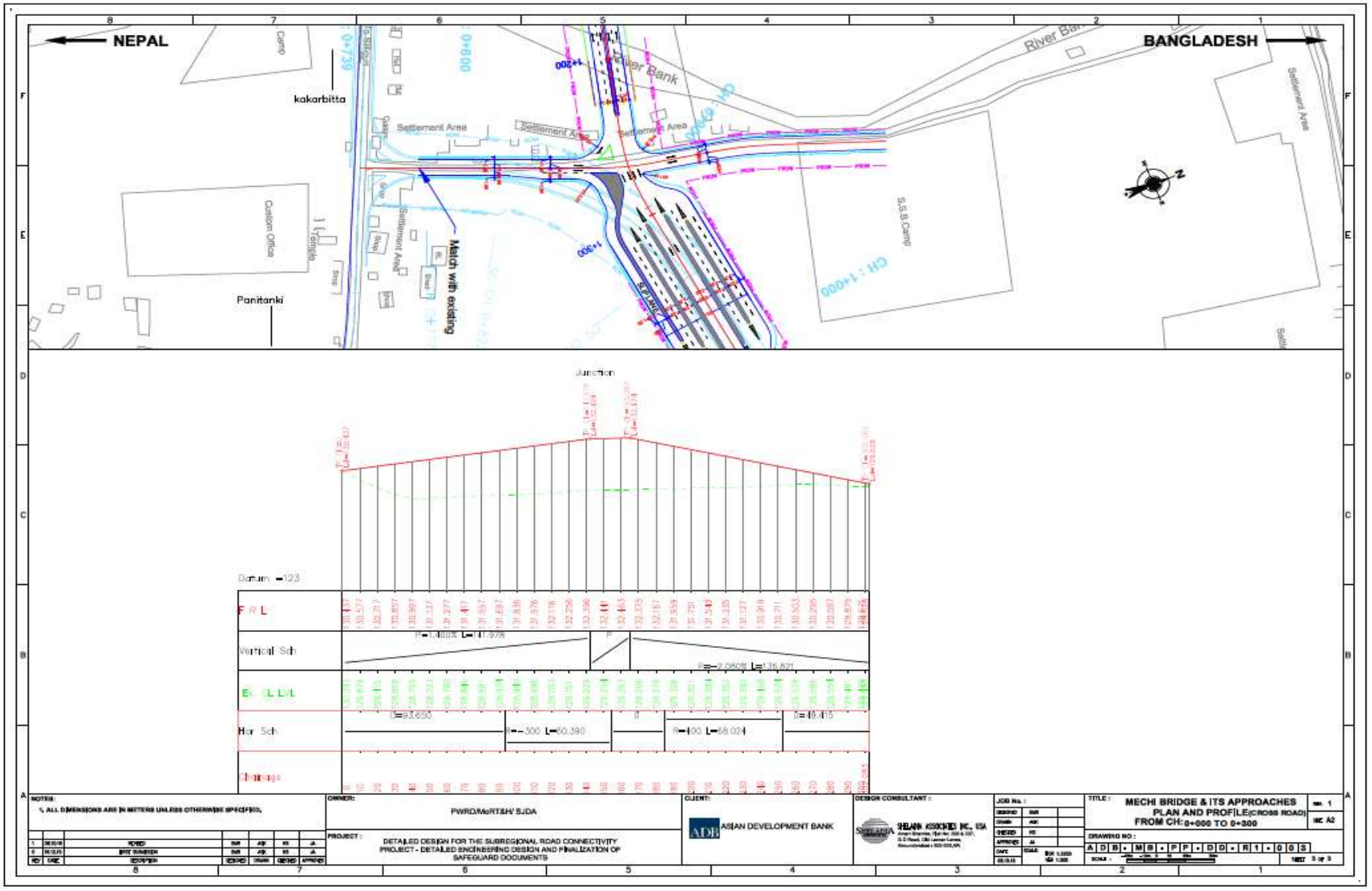
Source: DPR Volume VIII - Drawings (August 2016)

Figure 6: Plan and profile for Bridge



Source: DPR Volume VIII - Drawings (August 2016)

Figure 7: Plan and profile for Bridge Approach (India Side)



Source: DPR Volume VIII - Drawings (August 2016)

IV. DESCRIPTION OF THE ENVIRONMENT

A. Introduction

100. Environment encompasses all the three components like the physical, biological and the socioeconomic environment. The environmental assessment encompasses the development of mitigation measures to address these impacts and suggested approaches for implementation of mitigation and monitoring measures. As a precursor for the prediction of various types of environmental impacts likely to arise due to implementation of the project, it is essential to establish the baseline environmental status of the physical and biological parameters in the Direct and Indirect Area of Influence. Details of baseline environment parameters are required for decision making for the project.

101. **Period of Study:** The IEE study has been carried out by generating baseline data in the summer months of the year 2013 as part of DPR work on AH-2. In addition to this, data collected from the secondary sources have also been included in the IEE report.

B. Site Setting and Study Area

102. The present IEE report is for the Mechi Bridge on the AH-2 (connecting Kakarbhitta-Panitanki-Fulbari-Banglabandha road). Major habitations in the surroundings of the Mechi bridge and approaches are Kakarbhitta on Nepal side and Panitanki on India side.

103. The surroundings of the proposed bridge have the existing Mechi Bridge and Mechi River. The Nepal side approach surroundings include Nepal land custom station (LCS), residential and commercial areas. The bridge approach on India side has a river bank with scattered trees, Panitanki town and some residential houses of Tea estate workers. The end point of bridge approach is near Tea Estate. The study area encompasses 10 km aerial distance from the edge of the RoW of bridge and approaches.

104. The direct project influence area has been considered as the Right of Way (RoW) of bridge and approaches and 100 m on either side from the edge of the RoW. The proposed RoW varies from 25-45 m. The indirect influence extends from the boundary of the proposed RoW and up to 10 km aerial distance

C. Establishment of Baseline

105. The environmental baseline has been established for components of valued ecosystem. The environment setting has been established by a collection of secondary data from various sources and filling of data gaps by generation of primary data wherever secondary data was not available. The primary baseline data were collected during the baseline data collection for AH-2 EIA study. The baseline has been established for physical environment, biological environment and socioeconomic environment.

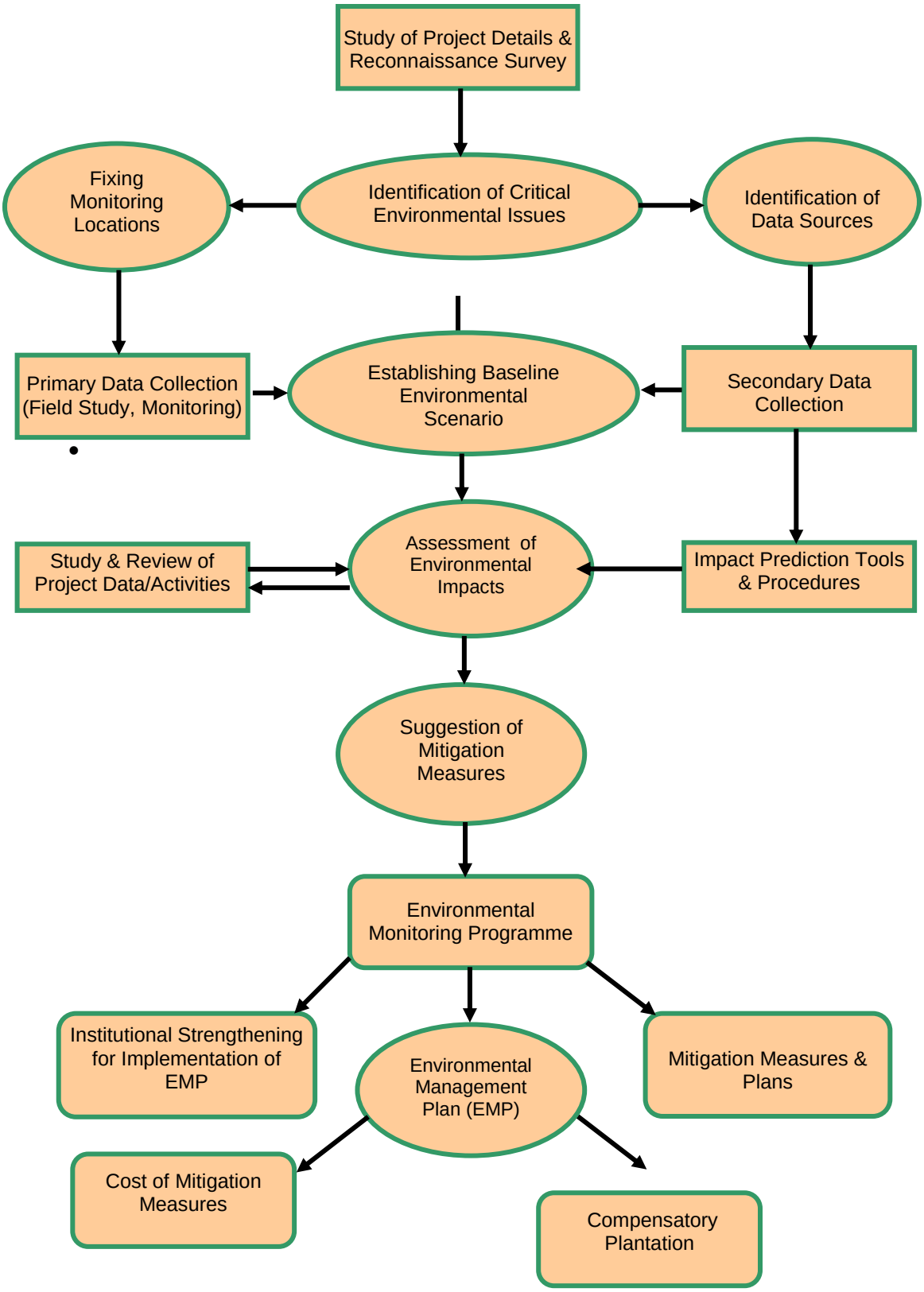
D. IEE Methodology

106. The IEE study proceeded simultaneously with the design of the bridge and approaches. The methodology adopted for IEE is shown in **Figure 8**. The important findings of the assessment gave important feedback to the design team, especially in terms of the sensitive receptor utilities /facilities to be impacted and locations of religious properties. It helped modify the designs at locations where impacts had to be avoided and incorporate mitigation measures wherever the

impacts were unavoidable due to other constraints. The steps covered in the preparation of IEE are as follows:

- **Review of Documents**: the documents of Rules, Guidelines, Acts of Government of India, Government of Nepal, Asian Development Bank and Government of West Bengal, and Prototype studies were reviewed viz a viz the proposed project.
- **Reconnaissance Surveys**: the team of professionals took the reconnaissance of the site to have a feel of the area and to identify the likely environment issues associated with the project.
- **Collection of Primary and Secondary Data**: The secondary data was collected from different sources about components of valued eco-system like climate, physiography, soil type, ecology including aquatic ecology, flora and fauna including aquatic flora and fauna of the area. The gaps in secondary data have been filled by generating primary data like ambient air quality, water quality, noise levels, surface hydrology, etc.
- **Assessment of Potential Impacts**: The potential impacts on components of Valued Ecosystem have been assessed based on previous prototype studies, different prediction models and past experiences. The predictions are both qualitative and quantitative for each component of environment viz. physical, biological and socioeconomic.
- **Identification of Mitigation and Enhancement Measures**: Requisite mitigation measures are ideitified for potential adverse environmental impacts from the project.
- **Analysis of Alternatives:** All alternatives were considered and adverse impacts of each alternative were studied before selecting the proposed alignment.
- **Stakeholder Consultations**: The stakeholder consultations have been carried out various stakeholders in India and Nepal. These have been documented.
- **Preparation of the Environmental Management Plan**: Environment Management Programme has been developed suggesting mitigative measures for various impacts on components of Valued Ecosystems to offset the adverse impacts or to mitigate the adverse impacts and bring them to acceptable levels. The monitoring programme specifies the monitoring mechanism, frequency, etc. A detailed budget has also been prepared for implementation of Environment Management and Monitoring Programme.

Figure 8: Methodology of IEE



E. Physical Environment

1. Topography

107. The topography of bridge and approaches on both Indian and Nepal sides is undulating. The elevation of bridge and approaches varies from 120.649 to 139.737 m above mean sea level.

2. Geology

108. The project area and surroundings are covered by alluvial and deltaic of sub recent and recent time. These are unconsolidated sedimentary deposits of Quaternary period. In the project area Pre–Cambarian is represented by Darjeeling Gneiss, Lingtse Gneissand Daling group of rocks. Apart from cambarian formations, there are some sedimentary rocks of Gondwana period and also of Siwalik formations of the late tertiary period. A belt of alluvial detritus of tertiary age occurs in the Terai region of the northern part of Darjeeling district. This area consists of alluvium terrain underlain by lithified and quaternary formation comprising of sand, silt and clay with fine texture flood plain deposits are noticed in and around the meander belt of different rivers.

109. The geology on the Nepal side is also of similar nature as described for India.

3. Physiography

110. The physiography of the project area and surroundings is overlain by alluvium. The approaches of the bridge on both sides are undulating terrain. The bridge portion is in river bed.

4. Soils

111. The soils in the study area of proposed bridge are mainly mixed sandy loam and loamy. These consist of older alluvial soils, red gravel soils, red sandy soils, and red loamy and mixed red black soils. Soils are partly developed and are mainly formed of young alluvium. These are moderately deep and at some places medium to fine texture. These soils are moderately fertile and mostly support tea and horticultural plantations. In order to charaterise soil quality in the project area and surroundings soil samples were collected from Panitanki (km 0.650) and Naxal Bari (at about 6.0 km from bridge site). The soil quality analysis results have been given in Table 5**.**

Table 5: Soil Quality Monitoring Results

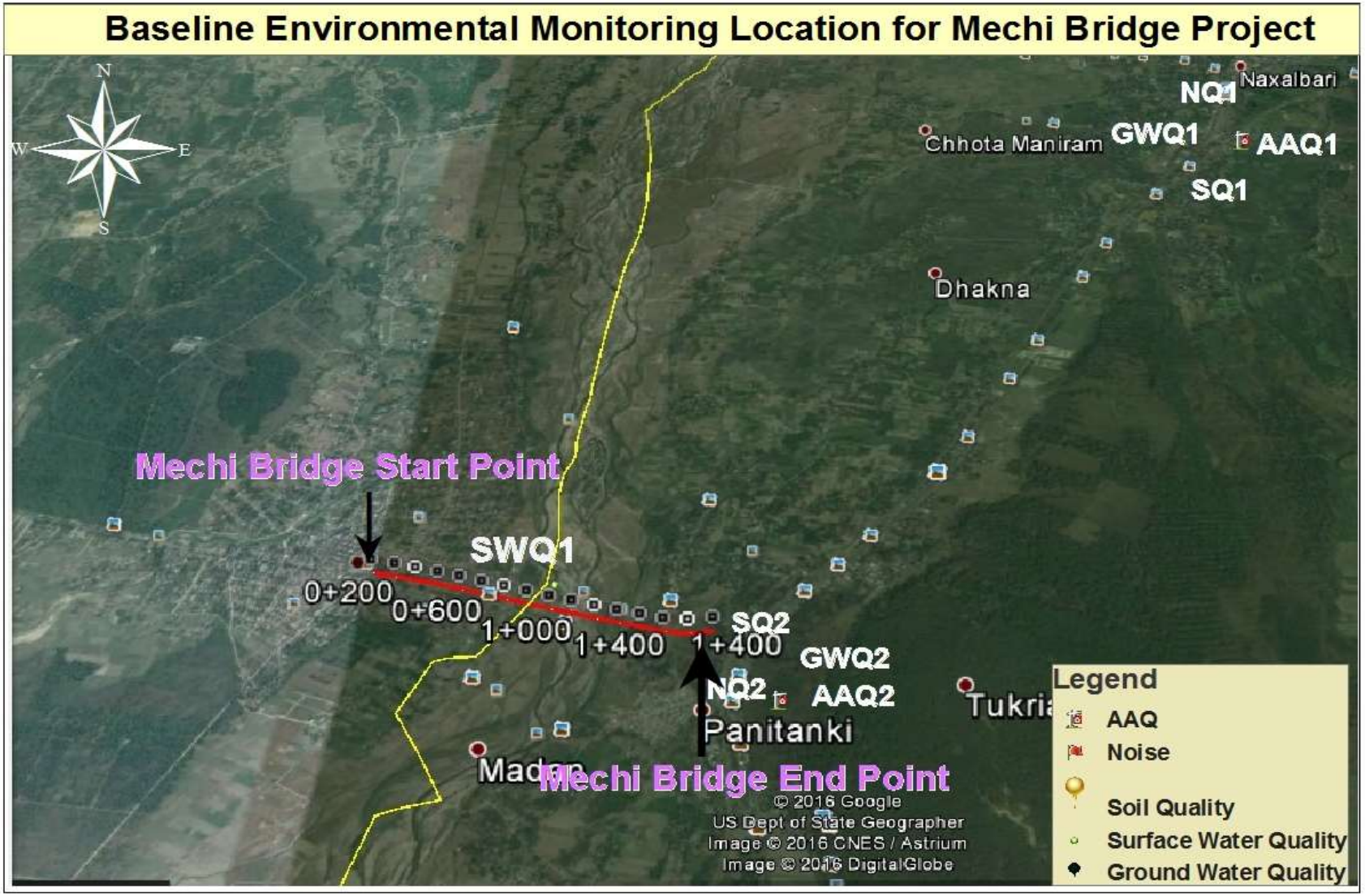
Parameter	Agriculture Field near km 0.650 (LHS)	Agriculture Field near Naxal Bari	Indian Quality Standards	
Colour	**Brownish**	**Brownish**	***Normal***	***High***
pH	7.02	7.10	6.3	>8.3
Textural Class	Sandy (Loamy soil – silt loam)	Sandy (Loamy soil – silt loam)	Class B[4]	-
Sand (%)	54.12	53.96	25-75%	-
Silt (%)	32.82	33.16	25-50%	-
Clay (%)	13.06	12.88	0-26%	-
Bulk density (gm/cc)	1.841	1.886		-
Water Holding Capacity (%)	36	34	90-120 mm[5]	-
Nitrogen (%)	0.41	0.43	-	-
Phosphorus (%)	0.02	0.09	9 to 22	>22
Potassium available (mg/100 gm.)	0.54	0.62	50 to 120	>120
Organic Carbon (%)	0.98	0.95	0.5 to 0.75	>0.75
Lead as Pb (mg/kg.)	ND	ND	-	-
Arsenic (mg/l)	ND	ND	-	-
Sulphate (kg/hec)	115.80	131.20	-	-
Chloride (mg/kg)	84.3	88.25	-	-
Calcium (meq/100gm)	0.84	0.80	-	-
Copper (mg/kg)	<0.01	<0.01	-	-
Sodium (meq/100gm)	0.03	0.04	-	-
Magnesium (meq/100gm)	0.12	0.10	-	-
Sulphate as SO4 (%)	0.42	0.38	-	-
Sodium Sulphate as Na_2SO_4(%)	0.42	0.38	-	-
Calcium Sulphate as CaSO4 (%)	0.56	0.60	-	-

Source: Consultants' Field Monitoring During May 2013

112. No soil sample was collected on Nepal side as there is no open space and land under agriculture. It is clear from the results that soils are not contaminated with pollutants and heavy metals. Since project influence area is good rain fed area, therefore, it has good potential for vegetation growth. The locations of soil monitoring have been shown in **Figure 9**.

[4] Guide for Evaluation of Soil Properties Relevant to Irrigation
[5] Available water holding capacity to depth of 90 cm.

Figure 9: Baseline Monitoring Stations



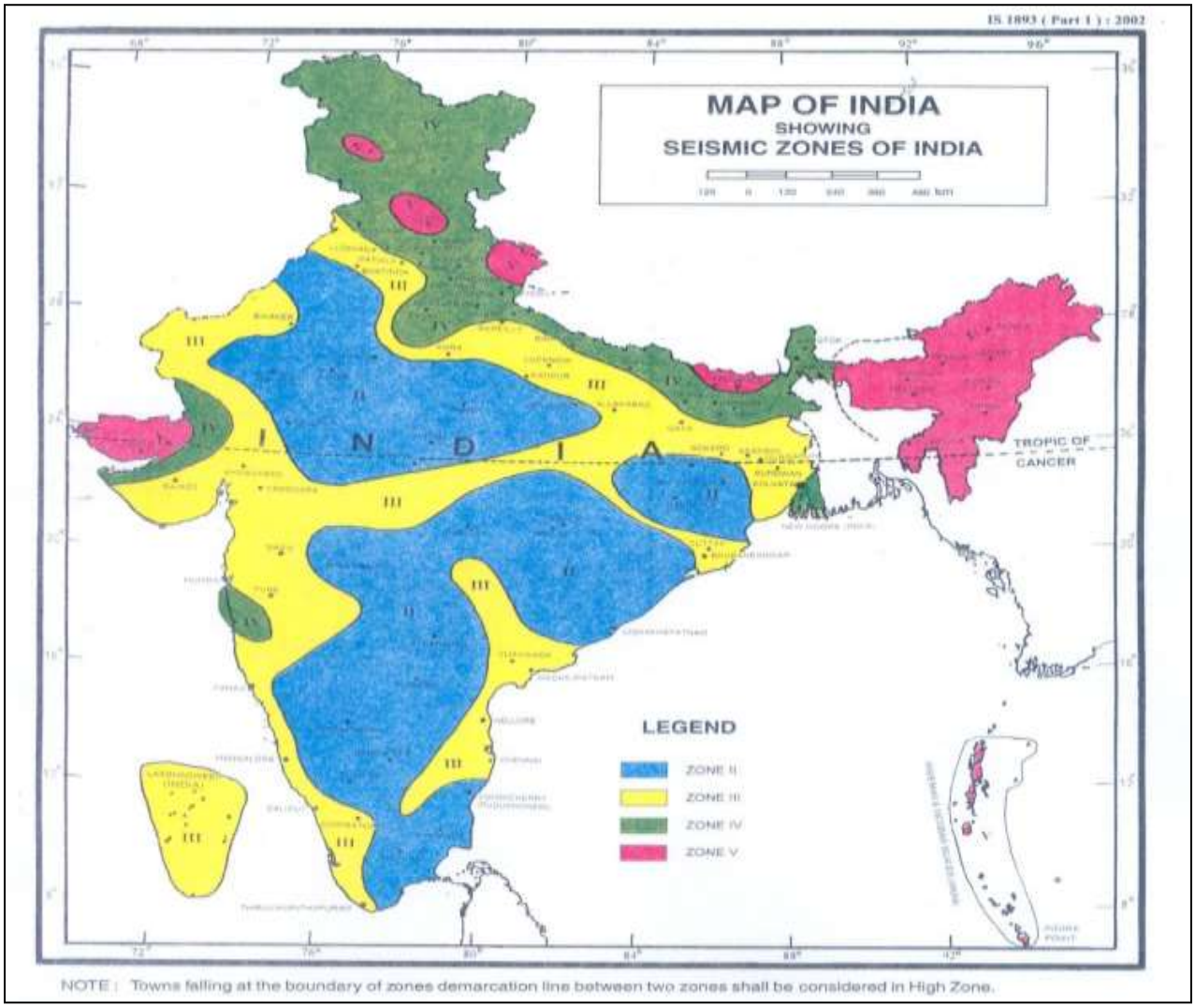
5. Mineral Resources

113. The only mineral source in the project corridor and surroundings is sand from the bed of the Mechi River.

6. Earthquake Zone / Sensitivity

114. The Bureau of Indian Standards has categorised the entire India into zones depending upon degree of the proneness of earthquakes. The entire country has been divided into five zones named as I to V, Zone I being less prone and Zone V having maximum severity. The proposed Mechi Bridge and its approaches falls under Zone IV as per Clause 219 of IRC: 6. Accordingly all project related structures have been designed considering earthquake coefficient corresponding to Zone IV. The earthquake zone map for the country is shown in **Figure 10**. The UN Office for Coordination of Humanitarian Affairs (OCHA) Regional Office for Asia Pacific categorised the area in Nepal side as Degree VIII in the Modified Mercalli Scale, equivalent to Zone IV category of India.

Figure 10: Earthquake Map of India



7. Borrow Areas

115. There will be requirements for earthworks at the approaches of the bridge. The suitable borrow areas have been identified by the design team through soil testing and suitability to use. The list of borrow areas, available quantity of borrow material at each borrows area and lead distance from the project site has been given below in **Figure 11**.

Figure 11: Detail of Borrow Area

S.No	Material Charactristic Description				BA-1	BA-2
					0+500 (Dulail Jote (vill) Manjai jote area	7+500 (Naxl bari (vill)
	Lab Description	MORTH Specification Requirement				
1	Density	Emb up 3mt Height	<3	1.52 g/cc	1.92	1.72
		Emb above 3mt Height	3 to 6	1.60 g/cc		
		Subgrade/ Shoulder	>6	1.75 g/cc		
2	Liquid Limit			70 Per cent	37.90	32.26
3	Plasticity Index			45 Per cent		
4	Free Sweel Index			50 Per cent		
5	CBR	Embankement				
6		Subgrade (Natural)	8 Per Cent CBR as per IRC:37-2012: Clause 5.1.		16.37 Suitable	10.02 Suitable
7		Subgrade (20 per cent Course Sand)			17.86	11.91
8		Subgrade (Cement Stabilization)		2 Per cent Cement	17.11	11.91
				3 Per cent Cement	23.81	15.63

116. There will be requirements for the stone dust, and sand for preparation of concrete and other works. The stone dust will be obtained from the licensed quarries and crushers. The stone dust is already being procured from these quarries for the requirements of construction related works. The list of sand quarries and stone dust are given below in **Figure12**.

Figure 12: List of sand quarries and stone dust

Road Name	Source	Geological Name	Apparent Specific Gravity	Water Absorption (%)		Combined Flakiness and Elongation		Aggregate Impact Value (%)				Suitability for Various Layers
				MORTH Specifications	Laboratory Test Results	MORTH Specifications	Laboratory Test Results	MORTH Specifications			Laboratory Test Results	
				All Pavement Layers (GSB/WMM/DBM/SC)		All Pavement Layers (GSB/WMM/DBM/BC)		Aggregate Base & Sub-base	Dense Bituminous Macadam	Bituminous Concrete		
AH02	Pekuru	Basalt	2.88	2	0.58	30		30	27	24	14.92	1. Crusher set-up has to be adjusted to meet the Gradation requirements. 2. Suitable for all the layers
	Nursing Crushing Machine (Matigara)	Sand Stone	2.58	2	0.47	30	27.58	30	27	24	31.96	1. Crusher set-up has to be adjusted to meet the Gradation requirements. 2. Not Suitable for Any Layers

117. It is clear that one sand quarry and one stone dust quarry has been identified for the material requirements for the bridge project.

8. Climate and Meteorology

118. Regional meteorological conditions and the project site air basin are of high significance in the development of transport projects, because the transportation and diffusion of all ambient air pollutants generated during project implementation and/or operational phase. This data plays a significant role in the location of hot mix plants and other construction activities that lead fugitive emissions.

119. The climate of the region in which project corridor is located is subtropical. There are four major seasons. The winter season commences from December and ends in February; summer season extends from March and ends in May. The monsoon period starts from June and ends in September. The months of October and November are transition months.

120. In order to characterize the meteorological conditions of the project region the data from the Darjeeling IMD Observatory has been obtained. Since Kakarbhitta climate is similar to Panitanki, so same data on climate is assumed to be valid for the Nepal portion of the bridge project.

9. Temperature

121. The minimum temperature varies from 21 to 24 degree Celsius in winter months. In summer months,the temperature varies from 4 to 37 degree Celsius. In the monsoon months the temperature rises as high as 25 degree Celsius. The data obtained from IMD observatory is given below for the Darjeeling district where the project site is located.

Table 6: Minimum Temperature

Month	Darjeeling	
	Max	Min
January	9	1
February	19	3
March	23	4
April	24	5
May	21	8
June	22	11
July	22	13
August	25	13
September	21	9
October	21	9
November	22	0
December	16	2

Source: India Meteorological Department

10. Rainfall

122. The average annual rainfall in the project area is around 2750 mm. The maximum rainfall occurs during the monsoon months. The monthly rainfall is given below:

Table 7: Average Annual Rainfall

Month	Rainfall (in mm)
January	17.5

Month	Rainfall (in mm)
February	16.1
March	36.3
April	111.2
May	256.5
June	264.2
July	865.8
August	647.8
September	368.3
October	146.3
November	9.7
December	10
	2,749.7

Source: India Meteorological Department

11. Wind Speed and Wind Direction

123. The predominant wind direction in the project area is southerly during both morning (22%) and evening (24%). The calm period prevails for 5.1 % during morning hours and 61 % during evening hours. The mean speed range is 2.6-9 kmph. The maximum wind speed prevails in summer months as in other parts of the country. The project region has a clear visibility even more than 20 km over 250 days in a year.

12. Relative Humidity

124. Normally, May to October months are humid and January to April months are dry. The relative humidity ranges from 70-88 % in the winter months and 81-97% in the monsoon months. During the transition weather relative humidity range lies between winter and monsoon period.

13. Land Use Pattern

125. The land use in project area affected by the road right of way is given in Tables 8 and 9. Most of the affected lands in Indian side comprised government and tea garden lands. In Nepal side, most lands are owned by the government, while two plots are privately owned.

Table 8: Land Use of Land Affected by Mechi Bridge Construction (India side)

Subproject Component	Extent of Land (in hectares)				Number of owners Private Land
	Private Land	Government Land	Tea garden Land	Total	
Bridge of 675m	-	2.0191	-	2.0191	-
Approach Road in Indian Side	-	0.0558	1.0024	1.0582	-
Total	**-**	**2.0749**	**1.0024**	**3.0773**	**Nil**

Source: Census and Social Survey, December 2015

Table 9: Land Use of Land Affected by Mechi Bridge Construction (Nepal side)

Subproject Component	Extent of Land (in hectares)			Number of owners in Private Land
	Private Land	Government Land	Total	
Approach Road in Nepal Side	0.0246	0.7603	0.7849	2
Total	**0.0246**	**0.7603**	**0.7849**	**2**

Source: Census and Social Survey, December 2015

14. Water Resources

126. The water resources in the project corridor surrounding can be divided into two parts (a) ground water and (b) surface water. Ground water is used mainly for domestic purposes of cooking and cleaning, while surface water is used for bathing and washing. The description of ground water resources is given below:

127. According to the Central Ground Water Board (CGWB), net annual ground water availability in Darjeeling district is 30.36 Billion Cubic meters (BCM). The total annual estimated ground water extraction is of the order of 2.98 BCM. The stage of ground water development is 42%. The project region is not critical or subcritical in respect of ground water development and management. There is no salinity, Fluoride or Arsenic problem in the project area and surroundings.

128. Hence, overall in the project region net ground water availability is more than the extracted quantity. This is due to good ground water potential because of the Mechi River in the project area. The ground water depth in project region is 3-4 m.

129. On the Nepal side also water resources are of similar nature as described above for Darjeeling district.

15. River Hydrology

130. The Mechi river is part of the Mahandi River System. It originates at the Mahabarat Range in Nepal and flows south forming the border between Nepal and India.

131. Mechi is a typical Himalayan river. The bridge crosses the river in its sub-mountainous reach. This reach is known as the Duars and the Terai region which is relatively flat with respect to the immediate upper reach of Mechi. As shown in the picture below the river is characterized by its braided and interlaced system of independent channels/ branches. These braided channels are meandering between relatively large khadir (plain area surrounding a river including the flood plains of the river) of the Mechi River. The braided channels generally carry perennial flow. Three distinct braided channels are located upstream of the bridge location with a mean width of flow of 10 to 20m concentrated drainage path meandering between the khadir. These channels meander and are separated by shallow sandy beaches that are parts of the river bed of Mechi river. Each of these channels have the potential of getting ferocious and combining to form one big channel during peak flow during the monsoon season. The channels have a fairly high velocity. Hence, it is necessary to avoid obstructing them or blocking partially as it may result in problems of deep scouring and even outflanking. These streams join together at little downstream of the existing bridge and the combined flow found to be quite mighty with high current, not less than 2.0 to 2.5m/sec even during ordinary flow situation.

Figure 13: View of Mechi river bank (north of existing bridge)

Figure 14: View of river at the existing bridge

132. The river has a sharp bend at existing bridge location and further downstream. As it hugs the bank on the Indian side, deep erosion and a high natural bank exists all along the sharp bend downstream. The bank is protected by series of spurs which are in fair to good condition and

found to be serving well and can be retained with minor repair. But on the Nepal side, it is quite undefined downstream.

133. During high flood which is never more than 2.0m from the low bed the river flow widens from almost bank to bank. The rest of the year the flow of Mechi remains divided and restricted within the shallow braided channels. Flash floods are characterized by high velocity and contribute to concave Indian side of the bank and silting on Nepal side.

16. Water Quality

134. In order to characterise water quality in the surroundings of the bridge project site ground and surface water quality samples were drawn as part of baseline environmental monitoring. The brief description and locations of surface and ground water quality is given below:

Table 10: Water Sampling Location

Location Code	Distance from Project (km)	Source	Distance From Project Site (km)	Justifications For Selection	Environmental Setting Representation
Surface Water Sampling Location					
SWQ- 1	0.000	Mechi River	Near existing Mechi river bridge	To establish baseline scenario of surface water source being crossed by bridge project	Rural and open
Ground Water Sampling Location					
Panitanki (GWQ-1)	0.00	Hand Pump near Start of bridge approach at Kakarbhitta	0.70	To establish baseline scenario for ground water quality at start point of bridge approach in built up area.	Semi Urban
Naxalbari (GWQ-2)	7.000	Hand pump Close to RoW at Satbhaya mode on AH-2	6.0	To establish baseline scenario for ground water in open and rural area	Rural

Table 11: Analytical Results of Surface Water Quality Monitoring

Parameter	Mechi River	Limits IS: 10500	Indian Water Quality Standards[6]	Nepal Water Quality Standards[7]
pH	6.83	6.6 to 8.5	8.5	6.5-8.5
Colour	5	-	300	100 Pt-Co units
Electrical Conductivity (umhos/cm)	224.0	-	-	
Turbidity (mmhos/cm)	3	-		0.5
Total Suspended Solids (mg/l)	11.24	-		
Total Dissolve solids (mg/l)	136	500		
Chlorides as Cl (mg/l)	13.23	250	-	
Sulphates as SO_4 (mg/l)	32.40	200	1000	
Calcium as Ca (mg/l)	16.0	75	-	
Manganese as Mn (mg/l)	<0.02	-	-	
Magnesium as Mg (mg/l)	6.0	30	-	
T. Hardness (mg/l)	61.0	300	-	
Nitrate as NO_3 (mg/l)	0.162	45	-	
Oil & Grease (mg/l)	2.6	-	-	
Ammonical Nitrogen as N (mg/l)	0.06	-	-	
Total Phosphate (mg/l)	0.38	-		
Chemical Oxygen Demand (mg/l)	18	-		
Biological Oxygen Demand (3 days at 27°C (mg/l)	<5.0	-	3	
Dissolve Oxygen (mg/l)	4.16	-	5	
Total Iron (mg/l)	<0.05	0.3	-	
Lead Pb (mg/l)	<0.05	.05	-	
Copper as Cu (mg/l)	<0.02	-	-	
Zinc as Zn (mg/l)	0.18	-	-	
Nickel as Ni (mg/l)	<0.03	-		
Total Chromium as Cr+6	< 0.05	-	0.05	
Arsenic (mg/l)	<0.01	0.05	0.2	
Fluorides as F (mg/l)	0.18	1	1.5	
Total Coliform MPN/100 ml	1.2		500	0
T.Alkalinity (mg/l)	12.16	200		

Source: Consultants' Field Monitoring, 2012
ND- Not Detected

[6] Based on IS:2296, Class B – Water for outdoor bathing.
[7] Nepal Water Quality Guidelines for Recreation

Table 12: Analytical Results of Ground Water Quality Monitoring

Parameter	GWQ-1	GWQ-2	Desirable Limit as per BIS 10500	Permissible limit as per BIS 10500 in absence of alternate source	National Drinking Water Quality Standards for Nepal[8]
pH	7.9	7.1	6.5-8.5	No Relaxation	6.5-8.5
Colour	5	5	-	-	5 (15)
Odour	Odourless	Odourless	-	-	
Turbidity (NTU)	3	4	5.0	10.0	5 (10)
TSS	5.32	6.12	-	-	
Total Dissolve solids (mg/l)	186	165	500	2000	1000
Conductivity (m mhos/cm)	312	270			1500
Total Hardness (mg/l)	139.0	154.0	300.0	600	500
Total Alkalinity(mg/l)	8.48	9.56	200	600	
Total Iron (mg/l)	4.55	4.02	0.30	1.00	0.3 (3.0)
Chlorides as Cl(mg/l)	12.0	18.0	250.0	1000	250
Sulphates as SO_4 (mg/l)	34.0	42.0	200.0	400	250
Nitrate as NO_3 (mg/l)	8	13.0	45.0	100	50
Nitrite as NO_2 (mg/l)	ND	ND	-	-	
Fluorides as F (mg/l)	0.72	0.81	1.0	1.50	0.5-1.5
Phosphate as PO_4 (mg/l)	0.78	0.92	-	-	
Magnesium as Mg (mg/l)	17.0	16.0	30	100	
Calcium as Ca (mg/l)	42.0	29.0			200
Lead as Pb (mg/l)	<0.05	<0.05	0.05	No Relaxation	0.01
Zinc as Zn (mg/l)	0.18	0.15	5.0	15.00	3.0
Chromium as Cr (mg/l)	<0.05	<0.05	0.05	No Relaxation	0.05
Arsenic (mg/l)	<0.001	<0.001	-	-	0.05
Copper as Cu(mg/l)	<0.02	<0.02	-	-	1
Nickel as Ni (mg/l)	<0.03	<0.03	-	-	
Total Coli/100ml)	<1.0	<1.1	-	-	0
B.O.D. (mg/l)	<5.0	<5.0	-	-	
C.O.D (mg/l)	12	14	-	-	
Dissolved Oxygen (mg/l)	6.8	7.2	-	-	
Manganese as Mn (mg/l)	<0.02	<0.02	-	-	0.2
Oil and Grease (mg/l)	1.0	1.2	-	-	
Ammonical Nitrogen (mg/l)	0.05	0.046	-	-	

Source: Consultants' Field Monitoring, 2012
ND- Not Detected

135. It is clear from the above results that all parameters of surface and ground water quality are within the permissible limits specified in BIS10500 and the National Drinking Water Quality Standards for Nepal. The surface water requires disinfection before making it amenable for drinking. The surface water quality of the Mechi river is good for propagation of aquatic life and outdoor bathing. The ground and surface water quality monitoring stations have been shown in **Figure 9**.

[8] Environment Statistics of Nepal 2008, Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal.

17. Air Quality

136. The ambient air quality has been monitored as part of baseline data collection in the month of May 2013. The relevant parameters identified are sulphur dioxide, oxides of nitrogen, particulate matter (PM_{10} and $PM_{2.5}$) and CO.

137. The ambient air quality monitoring location description has been given below in **Table 13.**

Table 13: Ambient Air Quality Monitoring Locations

Location Code	Distance from site	Location Name	Category As per AAQ Standards	Environmental Setting and Justification for Selection
AAQ-1	100 m	Panitanki	Semi Urban Residential	The monitoring instruments were put on one platform at about 2 m height near existing custom office. The monitoring at this location will characterise baseline of semi urban area. The new land custom station is planned near the existing custom station, therefore baseline at this location is important as there will be increased activity after new bridge and custom station become operational.
AAQ - 2	6.0 km	Naxalbari	Rural Area	The monitoring station is located in a rural area. The location is justified as this will characterise AAQ in rural area close to rail line where RoB is planned.

138. The summary of ambient air quality results is presented below in **Table 14.**

Table 14: Summary of Ambient Air Quality Results

S. No.	Location	Range of Measured Concentration (µg/m3)				
		SO_2 (24hr ave)	NO_x (24hr ave)	PM_{10} (24hr ave)	$PM_{2.5}$ (24hr ave)	CO (8 hr ave)
1	Panitanki	9.6-14.6	23.6-33.1	54-81	26-43	367 -526
2	Naxalbari	6-9	18-29	24-38	37- 64	286 -465
GON standards		70	80	120	none	10,000
GOI standards		80	80	100	60	2000
WB-EHS guideline value		20	none	50	25	None

Source: Consultants' Field Monitoring

Note: The relevant environmental zone under GOI and WB-EHS standard is "industrial, residential, rural and other areas"; under GON is and "high traffic zone"

139. The results presented in the table above shows that concentrations of SO_2, NOx PM_{10}, and CO are well within the limits of the GOI and GON standards. The $PM_{2.5}$ level is higher than the GOI standard in Naxalbari (one of the two sampling locations). When compared against the WB-EHS standards the baseline SO_2 levels are within the limits. However, the $PM_{2.5}$ level is higher than the WB-EHS limits for both locations and the PM_{10} level for one of the two sampling locations. The monitoring locations have been shown in **Figure 9**. The detailed date wise ambient air quality results are presented in **Appendix 2**. Baseline data for Kakarbhitta is not available but Ambient Air Quality is expected in the same range as at Panitanki.

18. Noise Quality

140. The noise is an important environmental attribute in the transport projects. As part of baseline data generation, noise monitoring has been carried out at two locations in study area. The description of environmental settings of noise monitoring is given in **Table 15** and the results of monitoring are given in **Table 16**.

Table 15: Ambient Noise Level Monitoring Locations

Location Code	Distance from site	Noise Level Measurement Location	Environmental Setting as per Standards	Reason for Selection
NL-1	100 m	Panitanki	Semi Urban and Commercial	To establish baseline in Semi Urban and commercial area and near proposed Land Custom Station
NL - 2	6.0 km	Naxalbari	Rural and Residential	To establish baseline in Rural and Residential area

141. The above monitoring locations have been selected to cover all types of land use in the project area. These all locations are of true representative of the study area. The noise level measurements were carried out in May 2013. The hourly noise levels were computed from 5 minutes values recorded by the instruments. These hourly values were then used to arrive at 'Day' and 'Night' average values.

Table 16: Ambient Noise Level Monitoring Results

S. No.	Monitoring Locations	Leq dB (A) Day	Leq dB (A) Night
NL1	Panitanki	61.2	46.5
NL 2	Naxalbari	53	43.8
GON standards (24 hour average)		74.36	
GOI standards		65	55
WB-EHS guideline value		70	70

Source: Consultants' Field Monitoring

Note: The relevant noise zone under the GON is High Traffic Area and Commercial zone for both WB-EHS and GOI

142. It is clear from the results that noise levels are well within the stipulated limits of respective land uses of monitoring locations. The noise level data for Kakarbhitta is not available. But levels are expected to same as prevailing in Panitanki.

F. Ecological Resources

143. An ecological survey of the project area and surroundings was conducted, particularly with reference to listing of species and assessment of the existing baseline ecological conditions in the study area. Considering the bio-diversity of organisms and their role in productivity and their importance in human livelihood, it is vital to protect and safeguard these dynamic ecosystems. The main objective of the ecological survey is aimed to assess the existing flora and fauna components in the study area.

1. Ecology and Habitat Type

144. The forest area in Darjeeling district is 124,576 ha. The forest area in Jhapa district is 25.9% of the total district area. The Jhapa district has agriculture base. The proposed Mechi Bridge and its approaches do not pass through any reserved or protected forest.

145. Primary data on flora and fauna was collected through ocular surveys by the Project Team and discussions with Forestry and Wild Life officials and local community people in 2012.

146. The landuse type at the bridge location comprises the Mechi river bed with small channels of the river spread across the river bed and mainly agricultural fields along the approach roads. Hence the bridge location comprises natural riverine habitat while the approach roads pass through modified habitat. A large number of floral and faunal species have been recorded in the project area. None of them are endangered or critically endangered. The project area is not a known area for large numbers of species such as migratory birds.

147. Darjeeling, located in the north western district of West Bengal, is full of rivers, canals and jhoras. Major rivers in the district include Mechi, Balason, Mahananda and Teesta. The district is thickly interspersed with many hill streams which are potential sources of fish supply. Recorded explorations of ichthyofaunal resources include that conducted by Shaw and Shebbeare (1937), where 131 species of fishes from different water bodies of Darjeeling and Jalpaiguri were recorded; and the survey done by the Department of Zoology of the University of Calcutta in 2009.[9]

148. The 2009 survey result shows that among the total fish species collected, majority of the district's fish fauna is of the Order Cypriniformes. The most abundant is from the Family Cyprinidae (39% of the total fish species), followed by the Family Balitoridae (11%). The study also revealed that, compared to the 1937 survey, the percentage of fishes under threatened category increased by 30%, 11% became endangered species, and 20% became vulnerable. Although the survey is preliminary in nature, the decline in the number of fish species can be attributed to the series of floods that occur particularly in River Teesta, which resulted in the destruction of breeding ground of many fish species; siltation due to combination of factors such as soil erosion and waste dumping, excessive harvesting of fishes such as Boroli (*Barilius* sp).; and domestic and industrial pollution.[10]

149. A systematic and detailed study was carried out by then Ministry of Environment and Forest[11] on the Teesta River, a river similar to the Mechi river, located about 50 km away from Teesta. The study of the biological components of Teesta River comprised micro and macro-organisms in the form of plankton, benthos and nektons. The phytoplankton and phytobenthos are the producers while zooplankton and macro- invertebrates are the primary or secondary consumers. The fish community is at the top trophic level in this aquatic ecosystem.

150. In Teesta river, phytoplankton community was comprised of Chlorophyceae, Bacillariophyceae, Myxophyceae, etc. But Bacillariophyceae (diatoms) was most important group, contributing more than 85% of total density. The density of phytoplankton was observed to

[9] Paul, Moumita; Gupta, Sandipan; and Banerjee, Samir. Aquaculture Research Unit, Department of Zoology. University of Calcutta, Kolkata, 2009.
[10] Ibid.
[11] Biological Environment – Terrestrial and Aquatic Resources. Carrying Capacity Study of Teesta Basin in Sikkim. Ministry of Environment and Forest. Government of India.

increase from lower to upper stretches of Teesta (Lachen) in pre-monsoon and post-monsoon seasons. Rainfall that triggers fluctuations in water discharge and turbidity, seems to be the determining factor for the seasonal variation in the phytoplankton density while temperature and velocity determine the spatial variation (Berner, 1951). Among the phytoplankton, around 70 species of non- filamentous algae (diatoms) were recorded, 48 from the lower stretch and 44 from upper stretch of Teesta.

151. The phytobenthos, which is important for the bottom dwellers and herbivorous fishes in the aquatic ecosystem, is dominated by non-filamentous form diatoms, which account for more than 90% of total density. This is a feature in most Himalayan rivers such as Mechi River. In general, low densities of phytobenthos were observed in lower stretch of Teesta river which can be attributed to higher temperatures. Lowest densities were recorded during monsoon season at all the sites, which might be due to higher discharge and turbidity that distributed and washed out the substrate. About 80 species of phyobenthic community were observed from river Teesta and its tributary.

152. Zooplankton in river Teesta accounted for zero to 4.5 % of total density of plankton. In upper reaches they were absent at most of the sampling sites.

153. Macro-invertebrates are found to be attached on the bottom. In this category, the organisms included are oligochaeta, mollusca and nymph of aquatic insects. Macro-invertebrates are secondary consumers of aquatic ecosystem. They generally feed upon microscopic algae and zooplankton and form the food for carnivorous fish. In river Teesta, water discharge and scarcity of food in monsoon season, reduces the density of macro-invertebrates greatly. The density further decreased in the lower stretches. Among macro-invertebrates, total of more than 21 families were recorded from Teesta river.

154. The terrestrial flora present in the study area is presented in **Table 17** and aquatic flora in **Table 18** and list of fauna is provided in **Table 19**.

Table 17: List of Terrestrial Flora in the Project Area

S. No.	Botanical Name	Use/Yield	S.No.	Botanical Name	Use/Yield
1	Acacia catechu	Timber & Tanin	28	Ficus infectoria	-
2	Acacia nilotica	Medicine	29	Ficus religiosa	-
3	Acacia auriculiformis	Timber & Saponin	30	Ghricidia sepium	Ornamental
4	Adina cardifolia	Timber	31	Gmelina arborea	Timber
5	Aeci mermelos	Fruits & Medicine	32	Guazoma tomentosa	Fruits
6	Alangium salvifolium	-	33	Lagerstroemia speciosa	Ornamental
7	Albizzialebbek	Timber	34	Leucaena leucocephala	Fodder
8	Alsrtonia scholans	Medicine	35	Mangifera indica	Fruits & Timber
9	Anthocepalus Chinensi	Ornamental & Timber	36	Melia azadarach	Timber
10	Azadirachta indica	Timber & Medicine	37	Mumusops chengi	-
11	Artocarpus Integrifolia	Fruits & Timber	38	Mytragyna perviflora	Timber
12	Bayhinia variegata	Ornamental	39	Odina wodier	Saponin

S. No.	Botanical Name	Use/Yield	S.No.	Botanical Name	Use/Yield
13	Bombax cieba	Ornamental & Fiber	40	Oroxvlum indicum	Medicine
14	Boswellia serrata	Timber	41	Peltphorum pterocarpu	Ornamental
15	Cassia fistula	Medicine	42	Pithecolobium dulee	Timber & Fruits
16	Cassia seamea	Ornamental	43	Phoenixsylyestris	Fruits
17	Casuarina equisetifolia	Ornamental	44	Pongamia pinnata	Timber Medicine
18	Ceiba pentandra	Ornamental	45	Polvathia longifolia	Timber
19	Cordia mvxa	-	46	Samanea saman	Timber & Ornamental
20	Dalbergia sissoo	Timber & Medicine	47	Stereulia foetida	Fruits & Timber
21	Delonix regia	Ornamental	48	Sweitenia mahagoni	Timber
22	Dipterocarpus tarbinat	Medicine & Timber	49	Sweitenia macrophyila	Timber & Medicine
23	Dyospyros malaberica	Fruits	50	Syzygium cumini	Fruits & Timber
24	Erythrina strieta	Ornamental	51	Tectone grandis	Timber
25	Eucalyptus globossus	Timber & Medicine	52	Terminalia ariuna	Timber & Medicine
26	Ficus benghalensis	-	53	Terminalia catappa	Fruits
27	Ficus glomerata	-			

Source: Information collection during field visits

Table 18: List of Aquatic flora in Project area

Scientific Name	IUCN Status
(A) Free Floating	
1. Eichomia crassipes	Not listed
2. Lemna perpusilla	Least concern
3. Azolla pinnata	Least concern
4. Pista stratiotes	Least concern
5. Wolffia arrhiza	Least concern
(B)Suspended	
6. Cerataphyllum demersum	Least concern
7. Utrieularia species	
(C) Anchorded (submerged)	
8. Hydrilla verticilliate	Least concern
9. Alisma plantago	Least concern
10. Bergia capenis	Not listed
11. Myriophyllum tufereuitan	
12. Vallisneria spiralis	Least concern
13. Potamogeton species	Not listed
14. Hygrophilla spinosa	Not listed
15. Najar species	
16. Ottelia aides	
(D) Rooted Floating	
17. Hygrorhiyza aristata	Not listed
18. Limnophila heterophylla	Least concern

Scientific Name	IUCN Status
19. Marsilea minuta	Least concern
(E) Marginal Plants	
20. Alternanthera philaxeroides	Not listed
21. Juessiea repens	Not listed
22. Elipta alba	Not listed
23. Ipomoea aquatica	Least concern
24. Luduigia adseendern	Not listed
25. Phragmites karka	Least concern
26. Typha angustata	Not listed
27. Commelina species	
28. Colaeasia eseuianta	
29. Polyganum plebegurn	Least concern
30. P.hydropiper	Least concern
31. Rumex dentaters	Least concern

Source: Interactions with locals during field visits

Table 19: Fauna in the Project Area

Name	Scientific Name	IUCN status	Status under GOI The Indian Wildlife (Protection) Act 1972	Status under GON National Parks and Wildlife Conservation Act, 1973
Domestic Animals				
1. Pig	*Sus cristatus*	N/A	N/A	N/A
2. Dog	*Canis familiris*	N/A	N/A	N/A
3. Cow	*Bos indicus*	N/A	N/A	N/A
4. Buffalo	*Bubalus indicus*	N/A	N/A	N/A
5. Cat	*Felis domesticus*	N/A	N/A	N/A
6. Goat	*Capra hircus*	N/A	N/A	N/A
Reptiles (Snake)				
7. Rat Snake	*Ptyas mucasus*	Not assessed	Not listed	Not listed
8. Indian spectacled Cobra	*Naja Naja Naja*	Not assessed	Schedule II	Not listed
9. Indian moncocled Cobra	*Naja naja Kouthia*	Not assessed	Not listed	Not listed
10. Common sand boa	*Eryx johnii*	Not assessed	Not listed	Not listed
11. Flying Snake	*Chrysapelea ornate*	Not assessed	Not listed	Not listed
12. Python	*Python moluris*	Not assessed	Schedule I	Schedule I
13. Comman Krait	*Bungarus caerulenas*	Not assessed	Not listed	Not listed
14. Banded Krait	*Bungarus fasciatus*	Least Concern	Not listed	Not listed
Reptiles (Lizard)				
15. Comman Monitor lizard	*Calotes versicolor*	Least Concern	Not listed	Not listed
16. Comman house gecko	*Hemidactylus frenatus*	Least Concern	Not listed	Not listed
17. Yellow Monitor	*Varanus flavescens*	Low risk/Least Concern	Not listed	Schedule I
18. Snake lizard	*Acanthodactylus cantoris*	Least Concern	Not listed	Not listed
Amphibians				
19. Asian Common Toad	*Bufo melanostictus*	Least Concern	Not listed	Not listed
20. Frog	*Hylarana taipehensis*	Least Concern	Not listed	Not listed
21. Skipper frog	*Euphlyctis cyanophlyctis*	Least Concern	Not listed	Not listed
22. Frog	*Feihyla vittatus*	Least Concern	Not listed	Not listed
23. Indian Marbled Toad	*Bufo stomaticus*	Least Concern	Not listed	Not listed
24. Indian Globular Frog	*Uperodon globulosus*	Least Concern	Not listed	Not listed
25. Jerdons Bull Frog	*Hoplobatrachus crassus*	Least Concern	Not listed	Not listed
26. Green Mountain Frog	*Odorrana livida*	Data deficient	Not listed	Not listed
Rodents				
27. Comman house rat	*Rattus rattus*	Least Concern	Not listed	Not listed
28. Indian field mouse	*Mus booduga*	Least Concern	Not listed	Not listed
29. Indian bush rat	*Golunda ellioti*	Least Concern	Not listed	Not listed

Name	Scientific Name	IUCN status	Status under GOI The Indian Wildlife (Protection) Act 1972	Status under GON National Parks and Wildlife Conservation Act, 1973
30. House mouse	*Mus museulus*	Least Concern	Not listed	Not listed
Fishes				
31. Rohu	*Labeo rohita*	Least Concern	Not listed	Not listed
32. Catla	*Catla catla*	Least Concern	Not listed	Not listed
33. Mrigala	*Cirrhinus mrigala*	Least Concern	Not listed	Not listed
34. Magur (Walking catfish)	*Clarias batrachus*	Least Concern	Not listed	Not listed
35. Chingiri (Giant freshwater prawn)	*Macronbrachium rosenbeigie*	Least Concern	Not listed	Not listed
36. Lata (Spotted 37. Snakehead)	*Channa punctatus*	Least Concern	Not listed	Not listed
37. Puthi (Dwarf Barb)	*Puntius Phuntunio*	Low Risk/Least Concern	Not listed	Not listed
38. Bhangar	*Liza tade*	Data deficient	Not listed	Not listed
39. Sole (Snakehead murrel)	*Chana striatus*	Least Concern	Not listed	Not listed
40. Koi (Climbing perch)	*Anabas tesludineus*	Data deficient	Not listed	Not listed
Birds				
41. Catle Egret	*Bubulcas ibis*	Least Concern	Not listed	Not listed
42. Large Egret	*Ardea alba*	Least Concern	Not listed	Not listed
43. Little Egret	*Egretta garzetta*	Least Concern	Not listed	Not listed
44. Little Bittern	*Ixobrychus minutus*	Least Concern	Not listed	Not listed
45. Chestnut Bittern	*Ixobrychus cinnamomeus*	Least Concern	Not listed	Not listed
46. Little Cormorant	*Microcarbo niger*	Least Concern	Not listed	Not listed
47. Great Bittern	*Botaunus stellaris*	Least Concern	Not listed	Not listed
48. Brahminy Kite	*Halistur indus*	Least Concern	Not listed	Not listed
49. Common sand piper	*Actitis hypoleucos*	Least Concern	Not listed	Not listed
50. Spotted Dove	*Spilopelia chinensis*	Least Concern	Not listed	Not listed
51. Rose ringed parakeet	*Psittacula krameri*	Least Concern	Not listed	Not listed
52. Indian plaintive Cuckoo	*Cacomantis passerinus*	Least Concern	Not listed	Not listed
53. Spotted Owlet	*Athene brama*	Least Concern	Not listed	Not listed
54. Brown fish owl	*Bubo zeylonensis*	Least Concern	Not listed	Not listed
55. Common Kingfisher	*Alcedo atthis*	Least Concern	Not listed	Not listed
56. White breasted Kingfisher	*Halcyon smyr nensis*	Least Concern	Not listed	Not listed
57. Green Bee -eater	*Merops orientalis*	Least Concern	Not listed	Not listed
58. Indian roller	*Caracias benghalensis*	Least Concern	Not listed	Not listed
59. Hoopoe	*Upupa epops*	Least Concern	Not listed	Not listed

Name	Scientific Name	IUCN status	Status under GOI The Indian Wildlife (Protection) Act 1972	Status under GON National Parks and Wildlife Conservation Act, 1973
60. Lesser Golden Backed 61. Wood-Pecker	*Dinopium benghalense*	Least Concern	Not listed	Not listed
62. Stripe breasted Wood – pecker	*Picoides acticus*	Least Concern	Not listed	Not listed
63. Copper smith Barbet	*Megalaima haemacephala*	Least Concern	Not listed	Not listed
64. Large green Barbet	*Megalaima zeylanica*	Least Concern	Not listed	Not listed
65. Blue throated Barbet	*Megalaima asiatica*	Least Concern	Not listed	Not listed
66. Great grey Shrike	*Lanius excubitor*	Least Concern	Not listed	Not listed
67. Black-hooded Oriole	*Oriolus xanthornus*	Least Concern	Not listed	Not listed
68. Black Drongo	*Dicrurus macrocercus*	Least Concern	Not listed	Not listed
69. Lesser Racked -tailed Drongo	*Dicrurus remifer*	Least Concern	Not listed	Not listed
70. Common Myna	*Acridotheres tristis*	Least Concern	Not listed	Not listed
71. House Crow	*Corvus splendens*	Least Concern	Not listed	Not listed
72. Red vented Bulbul	*Pycnonotus cafer*	Least Concern	Not listed	Not listed
73. White-rumfed Shama	*Copsychus malabaricus*	Least Concern	Not listed	Not listed
74. Grey Tit	*Parus major*	Least Concern	Not listed	Not listed
75. White Wagtail	*Motacilla alba*	Least Concern	Not listed	Not listed
76. Purple Sunbird	*Nectarinia asiatica*	Least Concern	Not listed	Not listed
77. House Sparrow	*Passer domesticus*	Least Concern	Not listed	Not listed
78. Tree Sparrow	*Passer montanus*	Least Concern	Not listed	Not listed
79. Spotted Munia	*Lonchura punctulata*	Least Concern	Not listed	Not listed
80. Lesser Whistling Duck	*Dendrocygna javanica*	Least Concern	Not listed	Not listed
81. Asian Openbill Stork	*Anastomus oscitans*	Least Concern	Not listed	Not listed
82. Pariah Kite	*Milvus migrans govinda*	Least Concern	Not listed	Not listed
83. Pin-tailed Snipe	*Capela stenuras*	Least Concern	Not listed	Not listed
84. Common Sandpiper	*Actitis hypoleucos*	Least Concern	Not listed	Not listed
85. Common Teal	*Anas crecca*	Least Concern	Not listed	Not listed
86. Cotton Teal	*Nettapus coromandelianus*	Least Concern	Not listed	Not listed
87. Lesser Whistling Teal	*Dendrocygna javanica*	Least Concern	Not listed	Not listed
88. Little Cormorant	*Microcarbo niger*	Least Concern	Not listed	Not listed
89. Painted Snipe	*Rostratula benghalensis*	Least Concern	Not listed	Not listed
90. Northern Pintail	*Anas acuta*	Least Concern	Not listed	Not listed
91. Pheasant Tailed Jacana	*Hydrophasianus chirurgus*	Least Concern	Not listed	Not listed
92. Purple Swamphen	*Porphyrio porphyrio*	Least Concern	Not listed	Not listed
93. Spot-Billed Duck	*Anas poecilorhyncha*	Least Concern	Not listed	Not listed

Name	Scientific Name	IUCN status	Status under GOI The Indian Wildlife (Protection) Act 1972	Status under GON National Parks and Wildlife Conservation Act, 1973
94. Tufted Duck	*Aythya fuligula*	Least Concern	Not listed	Not listed
95. White-breasted Waterhen	*Amaurornis phoenicurus*	Least Concern	Not listed	Not listed
96. White Eyed Pochard	*Aythya nyroca*	Near threatened	Not listed	Not listed

4. Trees to be cut

155. The tree enumeration has been done in the RoW as per proposed RoW of the bridge. The total numbers of trees that need to be cut are 116. The tree list is presented below:

Table 20: Trees to be cut in the Right of Way (RoW)

(a) Tree Data Nepal (km 0+600) RHS

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C. L in m	Natural/ planted	Physical condition
1	1	0-100	Mango	3.5	110	17.4	Planted	Green Standing
2	2	100-200	Paikor	3.5	500	14	Planted	Green Standing
3	3	100-200	Bait	7	160	9	Planted	Dry Stand
4	4	200-300	Pitali	1	100	12	Planted	Green Standing
5	5	200-300	Ashoka	2.5	35	12	Planted	Green Standing
6	6	300-400	Sisu	0.5	40	15	Planted	Green Standing
7	7	300-400	Pitali	5	130	16	Planted	Green Standing
8	8	300-400	Sisu	4.5	130	1.3	Planted	Green Standing
9	9	300-400	Sisu	3	100	12.5	Planted	Green Standing
10	10	300-400	Pitali	3	110	17	Planted	Green Standing
11	11	400-500	Sisu	3	45	1.8	Planted	Green Standing
12	12	400-500	Pitali	4	70	18.5	Planted	Green Standing
13	13	400-500	Pitali	4.5	70	19.5	Planted	Green Standing
14	14	400-500	Pitali	3.5	125	19	Planted	Green Standing
15	15	400-500	Pitali	15	80	21	Planted	Green Standing
16	16	400-500	Pitali	3	80	20.5	Planted	Green Standing
17	17	400-500	Pitali	6	85	19.5	Planted	Green Standing
18	18	400-500	Sisu	2	100	22	Planted	Green Standing
19	19	400-500	Sisu	5	90	22.5	Planted	Green Standing
20	20	400-500	Sisu	3.5	70	15	Planted	Green Standing
21	21	400-500	Sisu	2.5	70	15	Planted	Green Standing
22	22	500-600	Bat	3	150	1.5	Planted	Green Standing
23	23	500-600	Kadam	15	80	0.02	Planted	Green Standing
24	24	500-600	Kadam	18	120	5.5	Planted	Green Standing
25	25	500-600	Kadam	15	90	5	Planted	Green Standing
26	26	500-600	Neem	10	70	9	Planted	Green Standing
27	27	500-600	Neem	10	70	4.5	Planted	Green Standing
28	28	500-600	Gamavi	4	60	2	Planted	Green Standing
29	29	500-600	Gamavi	2.5	50	6	Planted	Green Standing
30	30	500-600	Gamavi	7	70	4	Planted	Green Standing
31	31	500-600	Gamavi	2	60	1	Planted	Green Standing
32	32	500-600	Sisu	3	110	19.5	Planted	Green Standing
33	33	500-600	Sisu	20	110	20.5	Planted	Green Standing

Source: Tree Enumeration by the Consultants

(b) Tree Data Nepal (km 0+600) LHS

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C.L in m	Natural/ planted	Physical condition
1	1	0-0.100	Ashoka	2.5	65	2.1	Planted	Green Standing
2	2	0-100	Kmgbrich	3.5	140	14.5	Planted	Green Standing
3	3	0-100	Ashoka	9	97	13	Planted	Green Standing
4	4	0-100	Ashoka	5	89	12.5	Planted	Green Standing

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C.L in m	Natural/ planted	Physical condition
5	5	0-100	Ashoka	13	90	12	Planted	Green Standing
6	6	0-100	Bait	2	145	22.5	Planted	Green Standing
7	7	0-100	Segun	9	220	22.5	Planted	Green Standing
8	8	0-100	Segun	6	90	22.5	Planted	Green Standing
9	9	0-100	Segun	10	150	22.5	Planted	Green Standing
10	10	0-100	Paikor	3.5	260	12	Planted	Green Standing
11	11	0-100	Ashoka	3.5	65	12	Planted	Green Standing
12	12	100-200	Kadam	5	65	17.5	Planted	Green Standing
13	13	100-200	Paikor	11	380	8.5	Planted	Green Standing
14	14	100-200	Bat	3.5	520	8.5	Planted	Green Standing
15	15	100-200	Paikor	7	420	8.5	Planted	Green Standing
16	16	100-200	Kadam	12	260	8.5	Planted	Green Standing
17	17	100-200	Mango	2	35	8.5	Planted	Green Standing
18	18	200-300	Mango	3	130	8	Planted	Green Standing
19	19	200-300	Kathal	2	100	9.2	Planted	Green Standing
20	20	200-300	Partal	10	160	9.2	Planted	Green Standing
21	21	200-300	Mango	5	130	9	Planted	Green Standing
22	22	200-300	Mango	7	180	4.5	Planted	Green Standing
23	23	300-400	Sisu	5	100	5	Planted	Green Standing
24	24	300-400	Sisu	5	100	5	Planted	Green Standing
25	25	400-500	Pitali	10	290	12	Planted	Green Standing
26	26	400-500	Kadam	5	65	7	Planted	Green Standing
27	27	500-600	Sajna	3	35	7	Planted	Green Standing
28	28	500-600	Paikor	4	120	140	Planted	Green Standing
29	29	500-600	Kadam	18	90	1.5	Planted	Green Standing
30	30	500-600	Kadam	18	90	0.5	Planted	Green Standing
31	31	500-600	Neem	2.5	70	9	Planted	Green Standing
32	32	500-600	Pitavi	15	96	21	Planted	Dry Standing
33	33	500-600	Mango	3	100	6.5	Planted	Green Standing
34	34	500-600	Gamavi	1.5	55	1	Planted	Green Standing
35	35	500-600	Mango	1	90	5	Planted	Green Standing
36	36	500-600	Gamavi	3	50	9	Planted	Green Standing
37	37	500-600	Gamavi	3.5	65	14	Planted	Green Standing
38	38	500-600	Pitali	1.5	50	1.5	Planted	Green Standing
39	39	500-600	Gamavi	4.5	55	1.6	Planted	Green Standing
40	40	500-600	Gamavi	3	55	19.5	Planted	Green Standing
41	41	500-600	Kadam	8	65	21.5	Planted	Green Standing
42	42	500-600	kadam	15	75	22.5	Planted	Green Standing
43	43	500-600	Paikor	9	100	5	Planted	Green Standing

Source: Tree Enumeration by the Consultants

(c) Tree Data India (km1+100 to 1+300) LHS

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C.L in m	Natural or planted	Physical condition
1	1	1+100 - 1+200	Gamavi	3.5	110	18	Natural	Green Standing
2	2	1+200 - 1+300	Gamavi	4	65	18	Natural	Green Standing
3	3		Gamavi	4.5	100	21.5	Natural	Green Standing
4	4		Gamavi	9	90.5	21.5	Natural	Green Standing
5	5		Gamavi	1	32	21	Natural	Green Standing
6	6		Gamavi	5	40	4	Natural	Green Standing

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C.L in m	Natural or planted	Physical condition
7	7		Gamavi	4	85	3	Natural	Green Standing
8	8		Sajna	1.5	110	3.5	Natural	Green Standing
9	9		Kadam	5	39	3	Natural	Green Standing
10	10		Sajna	3.5	1	12	Natural	Green Standing
11	11		Ata	2	35	12	Natural	Green Standing
12	12		Kathal	3	150	13.5	Natural	Green Standing
13	13		Ata	2	45	2	Natural	Green Standing

Source: Tree Enumeration by the Consultants

(d) Tree Data India (1+100-1+300 km) RHS

S. No	Tree no	Km	Tree Name	Height (in m)	Width in cm	D.F.C.L in m	Natural or planted	Physical condition
1	1	1+100-1+200	Jeebom	3	50	22	Natural	Dry Stand
2	2		Gamavi	6	110	17.5	Natural	Green Standing
3	3		Bat	2	70	16.5	Natural	Green Standing
4	4		Gular	1.5	50	10	Natural	Green Standing
5	5		Gamavi	3.5	39	12	Natural	Green Standing
6	6		Gamavi	3	35	18	Natural	Green Standing
7	7		Gamavi	3	35	18	Natural	Green Standing
8	8		Gamavi	2.5	32	11	Natural	Green Standing
9	9		Gamavi	3.5	35	3	Natural	Green Standing
10	10		Gamavi	3	30	21.5	Natural	Green Standing
11	11	1+200-1+300	Gamavi	1.5	65	3.5	Natural	Green Standing
12	12		Gamavi	7	60	3.5	Natural	Green Standing
13	13		Gular	2	30	4	Natural	Green Standing
14	14		Gamavi	3.5	75	6	Natural	Green Standing
15	15		Gamavi	4	35	9.5	Natural	Green Standing
16	16		Gamavi	4	35	3	Natural	Green Standing
17	17		Kathal	1.5	100	3.5	Planted	Green Standing
18	18		Gamavi	4	50	19.5	Natural	Green Standing
19	19		Gamavi	8	65	20.5	Natural	Green Standing
20	20		Gamavi	4.5	4.5	7	Natural	Green Standing
21	21		Gamavi	3	39	7	Natural	Green Standing
22	22		Pitali	2.5	35	10	Natural	Green Standing
23	23		Sajna	2	42	22.5	Natural	Green Standing
24	24		Segun	10	140	22.5	Natural	Green Standing
25	25		Kathal	2	40	12	Natural	Green Standing
26	26		Sajna	2	60	1	Natural	Green Standing
27	27		Ata	4	55	1	Natural	Green Standing

Source: Tree Enumeration by the Consultants

5. Ecologically Sensitive Area within Study Area

156. There are no IUCN declared protected areas at the national level, as well as protected areas at the regional and international levels within a distance of 10 km radius from the bridge site and approaches. The site is about 15 km from the edge of important bird and biodiversity area in Mai Valley Forest. [12]

[12] Integrated Biodiversity Assessment Tool (IBAT) Map for the proposed Mechi Bridge (https://www.ibatforbusiness.org/mapviewerol213).

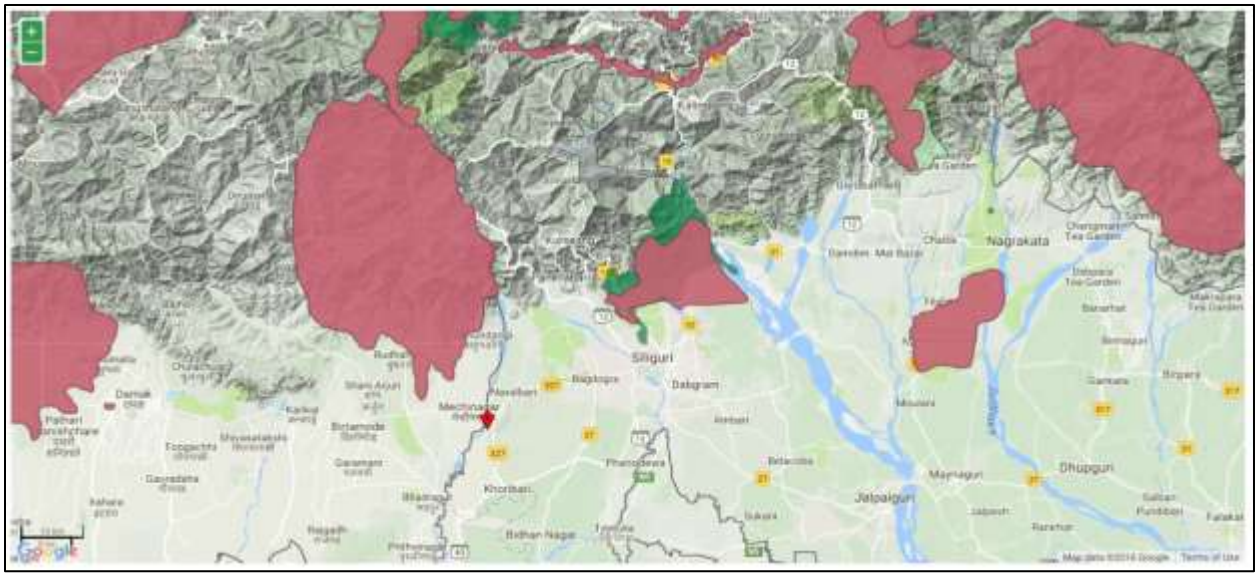


Figure 15: Integrated Biodiversity Assessment Tool (IBAT) Map of the Project Area.

G. Socioeconomic Environment

157. The Mechi Bridge and surroundings are located in Darjeeling district of India and Jhapa district of Nepal. The impacts related to social and socioeconomic data of project region have been elaborated in a separately bound volume of Resettlement Action Plan (RAP).

158. There is a growing recognition that people, communities and institutions are crucial to development outcomes. The social safeguard policies form the basis for social development. This agenda emphasizes a broader view of development, stronger ownership by stakeholders, and wider partnerships among the private sector, civil society and multilateral funding agencies. Considering the neglect of road infrastructure, backlog and growing recognition of its tremendous impact on economic development within the globalizing environment, the ADB has taken new initiatives in the road sector development in the form of Asian Highway network for providing international connectivity.

159. Districtwise, the total population as per 2011 Census is given below:

District	Approaches Length (km)	No. of Sub Divisions	Population		
			Male	Female	Total
Darjeeling (India)	0.545	01	830644	778528	1842034
Jhapa District (Nepal)	0.280	01	385096	427554	812650

Source: Census of India 2011 and Census of Nepal 2011

160. Social issues and accompanied impacts of small projects like the bridge and approaches are less discussed in resettlement literature and dialogue in comparison to fairly well known big development projects like dams, new towns and mining that acquire large land and cause huge displacement of families. The linear nature of road projects and the impacts confined largely within few meters of RoW/ Corridor of Impacts (CoI) did not attract much attention of resettlement experts and other citizen groups. In the current project, the people affected are found to have lost land, houses, roadside shops/businesses, employment, income, and sources of livelihoods. Some of the affected people are encroachers and squatters. There are no indigenous/Tribal communities residing in the corridor of impacts.

161. Developing and enhancing the human capital of the area is the underlying aim of all development projects undertaken including road construction and enhancement. Quality of life is based on health care, status of women, basic infrastructure and amenities available to people and the presence of indigenous people or Scheduled Tribes in the project area. There is no prevalence of Indigenous people or ethnic minorities in the study area of the bridge project.

1. Settlement and Properties

162. The current project connects India and Nepal and connects Kakarbhitta in Nepal and Panitanki in India. The details of the properties being impacted and project affected persons is covered in the Resettlement Action Plan report under a separate cover.

2. Quality of Life

163. The **physical quality-of-life index (PQLI)** is an attempt to measure the quality of life or well-being of a country. The value is the average of three statistics: basic literacy rate, infant mortality, and life expectancy at age one, all equally weighted on a 0 to 100 scale. It was developed for the Overseas Development Council in the mid-1970s by Morris David Morris, as one of a number of measures created due to dissatisfaction with the use of GNP as an indicator of development. PQLI might be regarded as an improvement, but shares the general problems of measuring quality of life in a quantitative way. It has also been criticized, because there is considerable overlap between infant mortality and life expectancy.

164. The Planning Commission of India has constructed the quality of life index **(coefficients of quality of life)** for different districts of India. The Darjeeling district (being the tourist and tea producing district) shows a value of an index of 0.743. The PQLI coefficient for the Jhapa district is not available. The Human Development Index (HDI) is another parameter used for indication of quality of life. The HDI index for the Darjeeling district is 0.468. The HDI index for the Jhapa district of Nepal is not available. It may be mentioned that quality of life in the Jhapa district of Nepal is similar to Panitanki in India.

3. Health Status

165. **Infant and Child Mortality.** In the State of West Bengal, health parameters are as follows: "The infant mortality rate (44) is lower than the average performance of the country (81.40)." The infant mortality rate is highest in Uttar Pradesh and lowest in Kerala. After the first month of life and before completing five years of age, girls face a higher risk of mortality than boys; consequently the under-five mortality rates for girls are higher than that of boys." As regards project district is concerned, there are no figures available exclusively, hence the state level figures are assumed to be district level figures.

166. In the Jhapa district infant mortality rate data is not available but infant mortality rate for Nepal as a whole country is 46.

4. Disease Pattern

167. **Anemia among Children**: Based on international standards, 43.5 % of children under the age of three years in West Bengal are underweight, 33 % are stunted and 19 % are wasted. The national figure for underweight, stunted and wasted are 42.50, 48 and 19.80 % respectively. This shows that children's health on these parameters is better than national level figure and other states. The anemia in children (6-35 months) in West Bengal is 69.4 %. The national level for

anemia is 54.7%. Hence on anemic front children are low. As regards project district is concerned, there are no figures available exclusively hence the state level figures are assumed to be district level figures.

168. In Nepal, about 46 % children in 6-59 months age are anemic. The district wise data is not available.

169. **HIV Prevalence:** The HIV prevalence is on the rise in West Bengal. There were 304 cases in 1996 and current figure exceeds 9000. According to West Bengal AIDS Prevention and Control Society (WBAP&CS), the epidemic has spread to the general public and no longer restricted to most at risk population. The project region is frequented by international community to trade and tourism, hence is more prone to AIDS/HIV exposure.

170. Because of limited work opportunities in Nepal and the open-border provision between Nepal and India, 1.5 to 2 million Nepalis have been estimated to migrate to India for seasonal and long-term work. The proposed project will allow Nepalese workers to frequently cross the border that may lead to unhealthy lifestyles such as alcohol drinking and unsafe sexual activities. This can lead to HIV transmission to their wives or to other women. There are approximately 27,495 cases of HIV in Nepal as of December 2015.

5. Status of Women

171. After an overview of the health status of people of West Bengal and project district, two important indicators need to be highlighted. They are sex ratio of the population and sex ratio of the 0-6 year age group. Both are important indicators of health status of women, their position in the society and also hints at the social attitudes towards them. Ideally, all populations should have almost equal numbers of males and females in their population, but it is rarely so especially in a patriarchcal society like India.

Table 21: Sex ratio and under six sex ratio

	Sex ratio (No. of females per 1,000 males)	Under six sex ratio (No. of females per 1,000 males in the age group 0-6 years)
India	**933**	**927**
Darjeeling	970	953
Nepal	**944**	**935**
Jhapa district Nepal	907	923

Source: Census of India 2011 and Census of Nepal 2011

172. This is clear from the table that the Darjeeling district shows a sex ratio higher than the national average. In Jhapa district, the sex ratio is much lower than neighboring Darjeeling district. During the project implementation and resettlement, it has to be ensured that women are given due consideration for empowerment. These all aspects have been considered in the Resettlement Action Plan report. More importantly, the child sex ratio of the project area shows that girl child needs special attention both in health care and education facilities so that the road to their empowerment is strengthened. Lower sex ratio is also an indication of more female mortality at the time of birth.

6. State Scenario

173. In the state of West Bengal, only 20.9% of the households live in pucca houses, 37.5% of the households have electricity. About 56.30% of the households have no toilet facility, 100% of

the households get drinking water from a borehole or tubewell, tap, river, canal and get water from the Government supplied source. About 20% of the households use solid fuels for cooking.

7. Project Area Scenario:

174. **Housing Characteristics**: There are three types of houses available to people: permanent, semi-permanent and temporary. Housing conditions available to people are to a large extent defined by urban or rural nature of the settlement. The housing characteristics in the surroundings of project are permanent. But, having permanence of housing is a basic human right and goes a long way in determining their social well being and protection. Access to semi-permanent (one of the roof, wall or floor is temporary in nature) and temporary structure for living results in deprivation and is a threat to safety.

Table 22: Project Area: Housing Characteristics

District	Permanent	Semi-Permanent	Temporary
Darjeeling	51.90	32.6	15.50

Source: Census of India, 2011

175. In Nepal portion of the project housing structures are permanent and semi permanent in nature.

176. **Drinking Water Supply**: In the project corridor surroundings population (both in India and Nepal) has access to safe drinking water supply as they are urban centres and hence covered by the urban water supply scheme. Ground water resources are also used for other domestic/household purposes.

177. **Medical Facility**: The percentage of villages having access to sub centre, primary health centre and community health centre in Darjeeling district are 5.21, 15.82 and 70.97 %, respectively. The Darjeeling district has 21 allopathic hospitals (2481 beds), Jalpaiguri district has 11 allopthatic hospitals (3197 beds), 38 primary health centres, 8 dispensaries and 54 private hospitals. The project area surroundings have good medical facilities because Kakarbhitta and Panitanki are urban centers.

178. **Education Infrastructure**: Access to Education is a human right and a precondition for improving the quality of life in an area. Elementary Education for all is a fundamental right in India. In the project area, this basic amenity is also not available to many people. It is found that 90.10% villages have Primary schools within the village, 17.50 % villages have middle schools. There is availability of college within 5 km for 10.30 % habitations, within 5-9 km for 25.1 % habitations and within 10 km and beyond for 62.9 % habitations. The Darjeeling district has 1233 primary schools, 126 middle schools, 85 secondary and senior secondary schools and 3 colleges.

179. There are schools and colleges available in Kakarbhitta.

180. **Post, Telegraph and Telephone facility**: In terms of other important services like post, telegraph and telephone facility, the project area performs well. All villages and habitations have access to communication facilities as there is a good mobile telephone network. Internet services are also available.

8. Religious Structure

181. There are some religious structures close to RoW or falling the RoW of bridge and approaches. The details of these have been given below:

Table 23: Religious Structures

S.No.	Type of Religious Structure	LHS/RHS	Distance (m) from Center Line	Chainage
1	Temple (in Nepal)	LHS	9	0+120
2	No religious structure falling in RoW or close to RoW in India Portion of project			

Source: Consultants' Field Survey

9. Agriculture and Forestry

182. The cultivable land in Darjeeling district of India and Jhapa district of Nepal are 160,140 and 89,400 ha respectively. The forest area in Darjeeling and Jhapa districts are 124,500 and 41,594 ha respectively. It is clear that both districts have considerable forest area. Both districts have a considerable area under Government leased Tea estate plantation.

10. Transportation

183. The state of West Bengal is served by 92,023 km of roads within which the National Highways (NH) cover a span of 2,578 km and State Highways (SH) 2,393 km. The road density is 1.04 per sq km, which is considerably higher than the national average of 0.75 km. There is availability of good road network in the project region also. Darjeeling district has 111 km NH length, 191 km SH length and 79 km major district roads (MDR).

184. The Jhapa district of Nepal has significant road length. Exact statistics of different types of roads is not available.

11. Archaeological and Cultural Sites

185. There are no protected archaeological or cultural sites in the project influence area.

12. Industries

186. There are tea processing industries in both project districts (Jhapa in Nepal and Darjeeling in India) in which proposed bridge is located. In the bridge project surroundings, there are no such industries.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Background

187. This chapter assesses the nature, type and magnitude of the potential impacts likely to occur on the various relevant physical, biological and cultural environmental components on the surroundings of the Mechi Bridge and its approaches. The description of the impacts on the individual components has been structured as per the discussion in Chapter 4: (Description of Environment) of this report.

188. Project implementation related impacts occur during the following three stages:

- Planning and Design
- Construction
- Operation

189. Planning and Design covers the alignment finalisation for the bridge and approaches, detailed design, identification of construction material sources, statutory clearances, etc. that ultimately decides the impact during later phases. Most of the impacts are during pre construction, construction and operation phases. While some of the construction phase impacts are temporary, some Operation phase impacts are continuous in nature.

190. Other important criterion for identification of impact is the identification of the impact zone. For the present project, the direct project influence area has been considered the Right of Way (RoW) of the proposed bridge and its approaches and 100 m on either side from the edge of the Right of way (RoW). The Proposed Right of Way varies from 25-100 m. The indirect influence area (study area) extends from boundary of the RoW and up to 10 km distance on either side.

191. Environmental parameters are broadly classified into three groups.

- Physical Environment
- Biological Environment
- Human Environment

192. Physical environment includes water resources, water quality, air quality, noise and land environment, Biological environment includes, flora, terrestrial fauna, avifauna, aquatic flora, fauna and plantations. Human environment includes the social environmental rehabilitation, employment, agriculture, housing, culture, etc. Social impact has been covered in detail in the Resettlement Action Plan prepared separately.

193. The chapter also gives mitigation measures for the adverse impacts. The considerations in design for mitigations adopted have also been highlighted.

B. Physical Environment

1. Topography

a. Impacts

194. **Construction Stage.** During the construction works of the bridge and approaches, the topography will change due to excavation of borrow areas, construction of approaches,

interchange, VUP and new six lane bridge. Establishment of construction camp for material handling will also alter the existing topography temporarily. The quantity of earthworks in the proposed bridge project has been estimated as 6,966 m^3.

195. **Operation Stage.** In the operation phase, change in topography is not anticipated as the bridge project is near habitation and crosses the Mechi River and scope of induced development is not much due to already existing habitations.

b. Mitigation Measures

196. **Construction Stage.** The borrow areas, will be opened, operated and closed as per clause no 305.2.2 of Specifications for Road and Bridge Works of Ministry of Road Transport and Highways (MORTH). The 2 borrow areas have been identified near the bridge site. The borrow areas are to be filled with the rejected waste and then finally a layer of top soil is to be spread over it before carrying out plantation, turfing, etc. The borrow area rehabilitation plan will be prepared before the exploitation of borrow area.

197. **Operation Stage.** During the operation stage, maintenance of the embankment will be carried out, so that the embankment is not affected due to soil erosion. The locations of the embankment are on either side of the bridge. The side slopes, if damaged due to soil erosion or other reasons will be repaired promptly. The side slopes will also established through plantation of shrubs and vegetation.

2. Geology

a. Impacts

198. **Construction.** The impact on geology may be from extraction of sand and stone dust for subgrade; however, the quantity of material required is not much to impact the geology of the project region. About 1720.50 m^3 of aggregates will be required for construction. The quantity of material required is not much to impact the geology of the project region. Pakuru quarry has been identified for subgrade and Narsing crusher at Matigara for sand stone. The sand requirement has been worked out about 20,000 m^3. The sand quarries have been identified at the Mechi River, Mahanada and Balasone and these have been given a lead chart in Chapter-3.

199. **Operation Stage.** The project area is not passing through mining area and during the operation phase of the project no impact is anticipated on geology of the area. Any materials required for the maintenance of the road will be procured from the licensed quarries only.

b. Mitigation Measures

200. **Construction Stage.** No new quarries are proposed to be opened for this bridge project. The quarries identified are Pakuru for subgrade and Narsing crusher at Matigara for sand stone. Both are licensed with valid permits and which are presently in operation.

201. **Operation Stage.** Since no impacts have been identified, therefore, no mitigation measures are warranted.

3. Seismicity

a. Impacts

202. **During Construction.** The Mechi Bridge and its approaches fall in Seismic Zone IV. This zone is most severe from earthquake occurrence point of view. The bridge construction will not have any impact on its overall earthquake potential since no blasting is envisaged at the construction site. Since Zone IV is the most hazardous zone and earthquake of severe intensity may be felt. Hence all project related structures are subjected to damage during an earthquake if a proper earthquake coefficient is not considered in the design. During the construction shuttering and other support structure need to bear the effects of severe earthquake.

203. **During Operations.** No impact on seismicity is anticipated during the operation phase unless there is an occurrence of an earthquake and damage to the Structures Bridge and VUP. Should this occur, it would be disastrous.

b. Mitigation Measures

204. **Construction Stage.** All the project related structures have been designed to make these as earthquake resistant, for this necessary design factor has been taken into the project design. While constructing the structure for the project related structures necessary support will be provided strong enough so that there is no damage to the structure.

205. **Operation Stage.** In the event of occurrence of the earthquake and damage to the road surface or its structures, necessary mitigation measures will be taken to repair damages. PIU managing the maintenance (in NHIDCL) will also prepare an emergency plan to handle such situation in the event of occurrence of such mishaps.

4. Physiography

a. Impacts

206. **During Construction.** The change in physiography will be limited within the RoW of the project. The temporary physiographic changes may be felt at locations of construction camps.

207. **During Operation**. No impact on physiography is anticipated during the operation phase.

b. Mitigation Measures

208. The change in physiography will not be pinching to the eyes, as side slopes will be properly vegetated through turfing and plantation, therefore, no mitigation measures are warranted. All the locations of construction camps and material storages in the open areas close to project site will be reinstated to original shape after completion of construction works. This will be ensured by the Authority Engineer.

209. **Operation Stage.** During operation stage plantation will be taken up in vacant space in RoW and on side slopes of approaches.

5. Soil Erosion

a. Impacts

210. The soils in the study area are fertile and have sandy loam and with fine silt, sand and humus. These soils are prone to erosion during the monsoon months.

211. **Pre-Construction.** The soil erosion takes place due to the following:

212. Site preparation may involve demolition of building, clearing of brushwood, tree removal and temporary rerouting of utilities. This brings risks of erosion to the exposed ground or stored topsoil.

213. Setting up of workers camp near habitations or in the agriculture fields may lead to loss of productive soils and impact the soil productivity especially at micro level.

214. **During Construction.** The soil erosion may take place on the side slopes of bridge approaches due to rains, at borrow areas and at construction sites which has been exposed during monsoon.

215. **During Operation.** During the operation phase soil erosion is possible on the side slopes of bridge approaches in the initial years till side slopes are stabilized.

b. Mitigation Measures

216. **Design Stage.** The RE walls have been proposed at the locations of steep slopes in the bridge approaches. This will avoid slope failures. To check soil erosion of side slopes turfing with grasses and shrubs will be carried out, in accordance with the recommended practice for treatment for erosion control, IRC: 56-1974.

217. **Construction Stage.** Prior to the start of the relevant construction, the contractor shall submit to the Authority's Engineer for approval of his schedules for carrying out temporary and permanent erosion / sedimentation control works as are applicable to the items of clearing and grubbing, drainage excavation, etc. Contractor shall also submit for approval his proposed method of erosion control at borrow areas and his plans for disposal of waste materials. Work shall start only when the Authority's Engineer has approved the erosion / sedimentation control schedules and methods of operations for the applicable construction.

218. The surface area of erodible earth material exposed by clearing and grubbing and, excavation, borrow and fill material operations shall be limited to the extent practicable. The contractor will provide immediate permanent or temporary erosion control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties or cause contamination of the Mechi river water course.

219. **Operation Stage.** The turfing and maintenance of retaining wall shall be monitored regularly and in case of any sign of damage of retaining wall immediate action will be taken to restore. Any loss of grass and shrubs on side slopes will also be made up before the onset of monsoon season.

6. Compaction of Soil

a. Impacts

220. **Pre-Construction Stage.** Compaction of soil will occur in the pre-construction phase due to movement of the construction equipment and machinery and during the setting up of construction camp. The compaction has little significance in the present case as the existing road has to be widened and construction machinery equipment will follow existing road network.

221. **Construction Stage.** The chances of compaction are there within the proposed RoW (especially in the Mechi river bed) due to the movement of vehicles and machinery. Movement of vehicles on haul roads may lead to compaction if construction camps are located in an open area. The compaction issue is not much in the project as bridge approaches are in the already existing compacted surface in the most portions. Similarly, if borrow areas are operated then during the cartage of borrow material there will be compaction. The impact will be felt within the RoW.

222. **Operation Stage.** During operation, there will be no compaction as all vehicles will ply on constructed bridge and approach.

b. Mitigation Measures

223. **Pre-Construction Stage.** During the pre-construction stage, establishment of construction camp and installation of plants and machinery at the campsite, machinery and equipment will be unloaded and kept at the campsite only. All construction vehicles will move and be parked at the designated locations only. All haul roads shall be constructed and maintained in good condition. Construction as far as possible will be planned on waste and unproductive land.

224. **Construction Stage.** During construction phase all construction vehicles will ply within the RoW and identified routes. In no case these shall ply through open land or agriculture fields.

225. **Operation Stage.** No mitigation measures are warranted as no impacts have been identified.

7. Contamination of Soil

a. Impacts

226. **Pre-Construction Stage.** Contamination of soil in the pre-construction stage may be considered as a short-term residual negative impact. Soil contamination may take place due to solid waste contamination from the labour camp set up during pre-construction stage. This impact is significant at locations of construction camps; stockyards, concrete batching plants, etc. as these will come up in this stage.

227. **Construction Stage.** Contamination of soil during the construction stage is primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Pollution of soil can also occur in hot-mix plants from leakage or spillage of asphalt or bitumen. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoils and debris will add to soil contamination. This contamination is likely to be carried over to the Mechi River if construction wastes are left at the bank.

228. **Operation Stage.** During operation phase soil contamination may take place due to accidental spillage of fuel/lubricants or chemicals due to the overturning of vehicles. The occurrence of such scenario is rare but it will be disastrous.

8. Contamination of Soil from Fuel and Lubricants

229. **Construction Stage**. At construction camp and bridge site vehicle and machinery will not go under maintenance to avoid spillage of discarded lubricants. The refuelling will also be avoided

at the camp site. It will be ensured that the fuel storage and refuelling sites are kept away from the Mechi river bank. At the wash down and refuelling areas, “Oil Water Separators” shall be provided. All spills and discarded petroleum products shall be disposed off in accordance to the West Bengal Pollution Control Board Guidelines. Fuel storage and refuelling areas will be located at least 500 m from the Mechi river bank.

230. In all fuel storage and refuelling areas located on agricultural lands or productive lands, the topsoil preservation shall be carried out.

231. **Operation Stage.** There are chances of contamination of soil from the road runoff and accidental spillage. The accidental spillage will be contained as per emergency procedure. This procedure will be developed by the respective PIUs in India and Nepal for the operation phase. The road runoff will be directed into the Mechi River through well-designed drains.

9. Contamination of Soil from Construction Wastes and Quarry Materials

232. **Construction Stage.** It will be required that earth works are carried out strictly in accordance with the design drawings. Unsuitable and excess earth, if required, will be disposed in approved areas. The spoils will be used to reclaim borrow pits and quarries, low-lying areas in barren lands and in settlements along the project corridor. All spoils will be disposed off and the site will be fully cleaned before handing over. The construction wastes will be dumped at selected approved disposal facilities. Waste disposal sites will be developed in consultation with West Bengal Pollution Control Board.

233. **Operation Stage.** During operation stage no impact is anticipated from construction waste and quarry materials.

10. Loss of Productive Soil

a. Impacts

234. **Design Stage.** The loss of productive top soil in the project is not likely as bridge and approaches are not in the agriculture area. Most portion in Nepal side approach is an urban area and towards the Panitanki side habitation area. This habitation area is occupied by the tea estate workers.

235. **Pre-construction stage.** Loss of productive soil, albeit during the construction stage only, is envisaged at locations of workers’ camp, stockyards, storage godowns, etc. if these are located on fertile areas.

236. **Construction stage** . In the construction stage loss of productive soil may take place at locations of borrow areas and in bridge approach portions (falling on Tea estate land India side) if the topsoil is not properly stored.

237. **Operation Stage.** No Impact is anticipated in the operation phase.

b. Mitigation Measures

238. **Design Stage.** The borrow areas will be operated as per IRC guidelines and topsoil will be preserved.

239. Temporary acquisition of productive agriculture land will be avoided. No borrow areas planned on the Nepal side.

240. **Pre Construction Stage.** The camp will be sited on unproductive land only unless unavoidable. Topsoil in case of productive land will be stripped to a depth of 150mm and stored as per IRC guidelines. After completion of work these areas shall be restored and top soil shall be utilised in the restoration of borrow areas.

241. **Construction Stage.** At the location of Tea estate land, at construction camps, and borrow areas in productive lands and all areas likely to be permanently covered, the top soil will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m. The stockpiling will be done in slopes of 2:1, to reduce surface runoff and enhance percolation through the mass of stored soil. The locations of top soil storage will be identified by the Authority's Engineer.

242. The stored topsoil will be spread back to maintain the physico-chemical and biological activity of the soil. The stored topsoil will be utilized for:

- Covering all disturbed areas including for the redevelopment of borrow areas;
- Top dressing of the embankments and fill slopes;
- Filling up of tree pits, proposed as part of compensatory afforestation and avenue plantation;
- Filling up of the median for shrub plantation; and
- To prevent any compaction of soil in the adjoining productive lands, the movement of construction vehicles, machinery and equipment will be restricted to RoW/ Construction Camps.

10. Borrow Pits for the Project

a. Impacts

243. The total estimated quantity of earthworks for the project is 6,966 m^3. The lead distance of borrow areas varies from 0.50 to 6 km. The design team has identified 2 borrow areas after assessing suitability. The impacts due to borrow area operations are summarised in the sections to follow:

244. Construction Stage. Cartage of the borrow materials to the construction sites is of significance, as almost all such areas are accessible through dirt tracks only and therefore, spillage and compaction of soil along these tracks will be a significant impact. Proper protection measures need to be worked out for minimising such impacts during the haulage of borrow materials.

245. Rehabilitation of borrow areas from which earth has been excavated, is a potential problem which needs to be addressed. In addition to visual blight, safety issues shall also be considered. Opening of borrow areas may result in loss of productive soil. Moreover, the borrow area pits, if not treated properly after the borrowing is complete, can form stagnant pools and pose health hazards. To prevent such occurrences, redevelopment of borrow areas needs to be worked out. Additionally, they can also act as a breeding ground for vectors like mosquitoes especially just after monsoon.

246. **Operation Stage.** During operation stage there will be no requirement for the operation of borrows areas. But it may be required to repair the damages to the embankment or side slopes due to rain cuts. For this earth will be procured from the approved sources.

b. Mitigation Measures

247. **Design Stage.** Following precautions will be taken to restrict unauthorised borrowing by the contractors

- No borrow area shall be opened without permission of the Authority's Engineer. The borrowing shall not be carried out on cultivable lands, unless and until, it shall be agreed upon by the Authority's Engineer that there is no suitable uncultivable land in the vicinity for borrowing, or there are private landowners willing to allow borrowing on their fields. The contractor has to ensure that, there is no loss of productive soil and the requisite environmental considerations are met with.
- Location of source of supply of material for embankment, or sub-grade and the procedure for excavation or transport of material shall be in compliance with the environmental requirements of the MoEFCC, and as specified in IRC: 10-1961.

248. Redevelopment of the identified borrows areas worked out, as part of the project preparation will be implemented to mitigate the impacts.

249. **Construction Stage.** To avoid any embankment slippages, the borrow areas will not be dug continuously. In case borrow areas other than specified are selected, the size and shape of borrow pits will be decided by the Authority's Engineer. Borrowing of earth shall be carried out at locations recommended as per IRC: 10-1961 The mitigation measures to be adopted for borrow areas at different land uses are given below:

- **Non-Cultivable lands**: Borrowing of earth will be carried out up to a depth of 1.0 m from the existing ground level. Borrowing of earth shall not be done continuously. Ridges of not less than 8m width shall be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges, if necessary, to facilitate drainage. Borrow pits shall have slopes not steeper than 1 vertical to 4 horizontal.
- **Public or private agricultural lands**: Borrowing of earth shall not be carried out on productive lands. However, in the event of borrowing from productive lands, topsoil shall be preserved in stockpiles. A 150mm layer of the topsoil shall be stripped off from the area designated for borrowing and it shall be stored in stockpiles in a designated area of height not exceeding 2m while side slopes shall not steeper than 1:2. At such locations, the depth of borrow pits shall not exceed 45 cm and it may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside.
- **Borrow pits on the riverside**: Precautionary measures like the covering of vehicles will be taken to avoid spillage during transport of borrow materials. To ensure that the spills likely to result from the transport of borrow and quarry materials do not impact the settlements, it will be ensured that the excavation and carrying of earth will be done during the day time only. The unpaved surfaces used for the haulage of borrow materials will be maintained properly.

250. The contractor shall evolve site-specific redevelopment plans for each borrows area location. These site specific borrow areas redevelopment plans will be approved by the Authority's Engineer.

251. **Operation Stage.** In case of requirement of significant quantities of earthworks, all precautions mentioned above will be followed.

11. Quarries

a. Impacts

252. The excavation of quarries and borrow pits used for obtaining rocks, soil and aggregate materials for construction can cause direct and indirect long-term adverse impacts on the environment. The impacts of quarrying operations could be significant at various stages of road construction. Quarrying and crushing could have a critical impact, especially on the air quality of the area and especially the area in the downwind direction of the quarry. The stage wise impacts are as described below:

253. **Pre Construction Stage.** Existing quarries that are already in operation have been identified and have been recommended for this project. No new quarries have been proposed. The bulk of the materials needed for the construction of the embankments will be procured from the existing quarries. These quarries have been identified close to the bridge site. The lead distance from the bridge site is 6-15 km. As these quarries are already in operation with the requisite environmental clearances and redevelopment plans, no major impacts, which arise in making new quarries operational, are likely. Necessary environmental mitigative measures recommended by the West Bengal Pollution Control Board are being followed at these quarries. Due to limited requirement of subgrade and aggregates, the chances of installation of new crushers are not there.

254. **Construction Stage.** A major source of dust during the construction stage is from stone crushing operations from the crusher and the vibrating screen. The dust, in addition to being an eyesore, reduces visibility thereby increasing safety concerns. Dust is generated due to procurement and transport of raw materials from quarries and borrows sites to the road construction area. These impacts will persist till the activity ceases. The regions, especially downwind to the quarries/borrow areas are more vulnerable to air pollution.

255. As no new quarry needs to be opened for this project, therefore, no new impacts are likely to arise due to quarrying operations. The material from these quarries and crushers will be transported through the existing roads only.

b. Mitigation Measures

256. **Design Stage.** As part of the project preparation process, an evaluation of all existing quarries in the surroundings of bridge site has been carried out and the status in terms of the suitability of the quarry material and their legal status has been assessed. The crushers operating at quarries at have already been identified by the design team.

257. **Construction Stage.** It will be ensured that quarries from where the material is taken have all valid permits & licenses and the haul road network is properly maintained.

258. **Operation Stage.** No mitigation measures from project end are warranted.

12. Land Use

a. Impacts

259. **Pre - Construction and Construction Stage.** The change in land use will take place at locations of land acquisition. There is a requirement for land acquisition in the proposed RoW. The land acquisition details have been given below:

- Nepal side - 0.7849 Ha
- India Side - 3.0773 Ha

260. In Nepal side most of the land is owned by Nepal Government, and this land is under residential and Government offices. On the India side most portion of land belongs to Tea Estate land. Hence there will be a change in land use from Tea Estate land/ residential land to road use.

261. **Operation Stage.** In operation stage no impact on land use changes in RoW of the proposed project is anticipated.

b. Mitigation Measures

262. **Pre Construction and Construction Stage.** The compensation for land acquisition will be made as per the resettlement framework of the project. The Tea estates are on the Government owned leased land. The compensation for any private land acquisition will be paid prior to taking possession of the land. The project affected persons due to land acquisition have been identified in the Resettlement Action Plan report under separate cover.

263. **Operation Stage.** No mitigation measures are warranted as project surroundings are international borders so land use change outside RoW is ruled out.

13. Meteorological Parameters

a. Impacts

264. **Construction Phase.** The alignment of the Mechi Bridge and approaches is located in a region that experiences typical tropical climate with marked monsoon effects. Though no change in the macro-climatic setting (precipitation, temperature and wind) is envisaged due to the project, the microclimate is likely to be temporarily modified by vegetation removal and the creation of paved surface due to construction of facilities. This microclimatic change may result in reduced precipitation and slight increase in temperature. The increase in temperature may be felt localised.

265. The numbers of trees to be cut are not significant due to length being 1.5 km. Total trees to be cut are 116.

266. **Operation Stage.** In the operation phase no impact on meteorological parameters is anticipated.

b. Mitigation Measures

267. **Design and Construction Stage.** Avoidance measures, as the minimising of the number of trees to be cut, have been worked out as part of the design finalisation. No change in the macro-climatic setting (precipitation, temperature and wind) is envisaged due to construction of

the Mechi Bridge and approaches. The microclimate is likely to be temporarily modified by vegetation removal, and due to construction of paved pavement surface.

268. In order to compensate negative impacts on flora due to cutting of trees the project plans compensatory plantation in the ratio of 1:10 (India side) and 1:25 (Nepal side) i.e. for every tree to be cut ten trees (on India side) and twenty five trees (on Nepal side) will be planted. Hence total numbers of trees to be planted are 2300.

269. **Operation Stage.** Since no impacts have been identified, therefore, no mitigation measures are warranted.

14. Ambient Air Quality

270. The ambient air quality of project influence area will be affected during pre construction, construction and operation phases. Pre construction and construction phase impacts will be intermittent in nature and will change from location to location as work progresses and continues. These types of emission sources cannot be categorised point, area or line sources. The quantification of emission is difficult for pre construction and construction phases. During the operation phase, there will be an increase in vehicular emissions on account of increased traffic.

a. Impacts

271. Air quality along the bridge and approaches will be adversely impacted both during the pre construction and construction phases. Construction stage impacts will be of short term and have adverse impacts on the construction workers as well as the settlements adjacent to the road, especially those in the downwind direction. Construction stage impacts will be confined generally to a band of width ranging from 50 to 100m from the edge of the Proposed Right of Way. However, they will continue for the entire construction duration. The following sections present the impacts of the project activities on this component.

15. Generation of Dust

272. **Pre Construction & Construction Stages.** Generation of dust is the most likely impact during these stages due to:

- Site clearance and use of heavy vehicles, machinery, etc.;
- Procurement and transport of raw materials and quarries to construction sites; the impacts will mostly be concentrated in the RoW. It is likely that impacts due to dust generation are felt downwind of the site rather than on the site itself.

273. As the entire project corridor has a soil type with significant sand and silt content and the construction activities to be carried out during the dry season when the moisture content would be less, dust generation, particularly due to earthworks will be significant. Dust is also likely to be generated due to the various construction activities including:

- Stone crushing operations in the crushers;
- Handling and storage of aggregates at construction camp sites ;
- Concrete batching plants; and
- Asphalt mix plants due to mixing of aggregates with bitumen.

274. Generation of dust is a critical issue and is likely to have an adverse impact on the health of workers in quarries, borrow areas and stone crushing units. This is a direct adverse impact, which will last almost throughout the construction period.

16. Generation of Exhaust Emissions

275. **Pre Construction & Construction Stages**. Generation of exhaust gases is likely during the pre-construction stage due to the movement of heavy machinery for clearance of the RoW for construction. This impact is envisaged to be insignificant during the pre-construction stage.

276. High levels of SO_2, HC and NOx are likely from hot mix plant operations. Toxic gases are released through the heating process during bitumen production. Although the impact is much localised, it can spread downwind depending on the wind speeds. The Environmental Management Plan needs to ensure that adequate measures are taken especially for health and safety of workers such as providing them with pollution masks during working hours. Also, the contractor should ensure that hot mix plants, stockyards, crushers, etc. are away from residential areas and residential quarters of all workers. If adequate measures are taken, impacts from generated gases can be considered negligible. Both Indian and Nepalese air quality monitoring standards will be followed.

277. **Operation Stage.** During the operation stage there will be an increase in the vehicular emissions. These vehicular emissions have been quantified with the projected traffic and operation phase, ambient air quality has been predicted through mathematical modelling.

17. Air Quality Prediction through Mathematical Model

278. To assess the likely impacts on the ambient air quality due to the proposed bridge project, the prediction of the carbon monoxide (CO) and particulate matter (PM) concentrations have been carried out using line source dispersion modelling approach, based on Gaussian equation. The modeling for this project has been carried out using CALINE-4, line source model developed by the California Transport Department. It has been setup and run by using emission factors prevalent for Indian vehicles (ARAI, 2007) and hourly traffic volumes as predicted for the project. The study is conducted to predict hourly increment in CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx concentrations for the base year (i.e. 2015) and future traffic, i.e. Year 2020, Year 2025, Year 2030 and Year 2034. The study only focused on the CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx dispersion, generated from the traffic on the proposed bridge. Details of the air quality impacts assessment for the proposed Mechi River Bridge are detailed in **Appendix 3**.

279. The emission factor for CO, $PM_{2.5}$ and NOx used in the present study for different vehicles type are given in **Table 24**. The calculated WEF for CO, $PM_{2.5}$ and PM_{10} for peak traffic hours is given in **Table 25**. The calculation of SO_2 emission factor for different categorized of vehicles are described in **Table 26**.

Table 24: Emission factors for different types of Vehicle (ARAI, 2007)

Vehicle type	CO Emission factor (gm/km)	$PM_{2.5}$ Emission factor (gm/km)	NOx Emission factor (gm/km)
Two wheeler	3.08	0.20	0.412
Three Wheeler	2.50	0.24	0.532
Cars/Jeep	1.53	0.06	0.424
LCV	2.02	0.49	1.723
BUS	8.40	1.08	6.53

Vehicle type	CO Emission factor (gm/km)	$PM_{2.5}$ Emission factor (gm/km)	NOx Emission factor (gm/km)
HCV	12.65	1.60	6.53

Table 25: Weighted Emission Factor for proposed traffic

Year	Weighted Emission factor for CO (g/mile)	Weighted Emission factor for $PM_{2.5}$ (g/mile)	Weighted Emission factor for PM_{10} (g/mile)
2015	4.79	0.40	0.73
2020	4.79	0.40	0.73
2025	4.79	0.40	0.73
2030	4.79	0.40	0.73
2034	4.79	0.40	0.73

Table 26: Emission Factor of SO_2 for proposed traffic

Vehicle Category	Vehicle mileage(km l^{-1})	Fuel consumed per km (ltrs)	Sulphur content (%)	Density (kg/m^3)	SO_2 (g/km)
2Ws	45.1	0.022	0.015	750	0.004989
LMVs-passenger	20.5	0.049	0.015	750	0.010976
4Ws-Petrol	12.6	0.079	0.015	750	0.017857
4Ws-Diesel	13.8	0.072	0.035	876	0.044435
LMV-goods	10	0.100	0.035	876	0.06132
HDVs-truck	4.6	0.217	0.035	876	0.133304
Buses	4.6	0.217	0.035	876	0.133304

280. The model has been setup and run to predict hourly average CO, $PM_{2.5}$ and PM_{10} concentrations for 1st year (2015), 5th year (2020), 10th year (2025), 15th year (2030) and 19th year (2034) using forecasted traffic data on proposed highway. The predicted hourly average concentration of CO, $PM_{2.5}$ and PM_{10} during peak traffic are shown in Figures 16 to 19 for proposed bridge project at selected receptor locations.

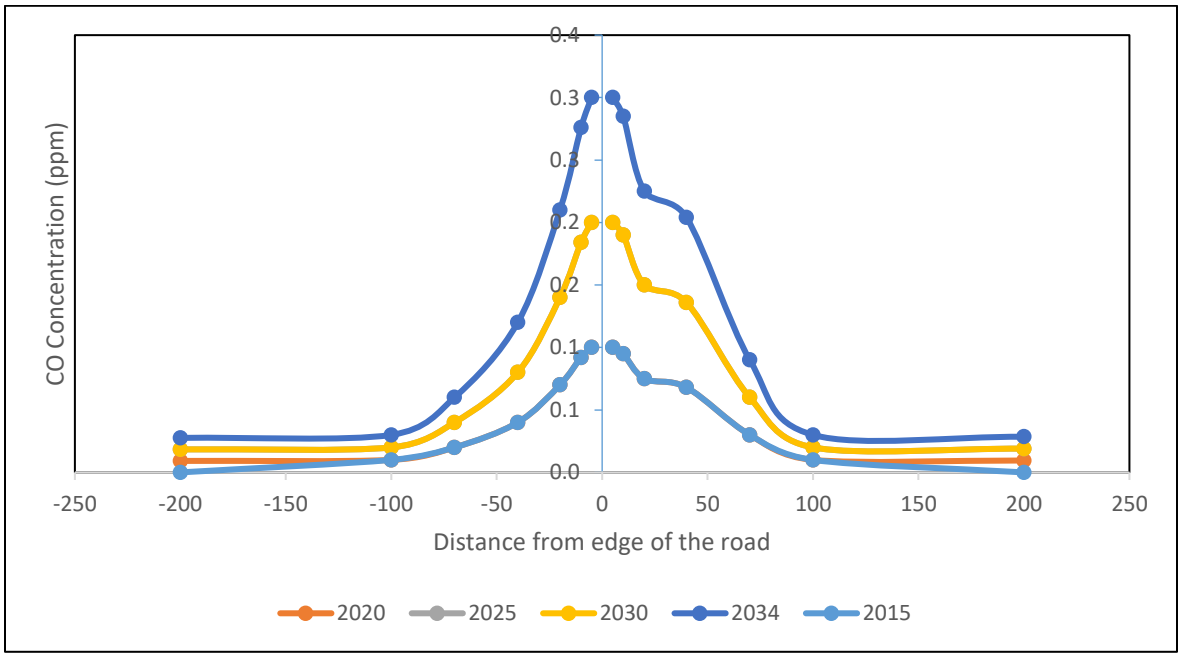


Figure 16:: CO predicted concentrations (ppm) along the proposed bridge

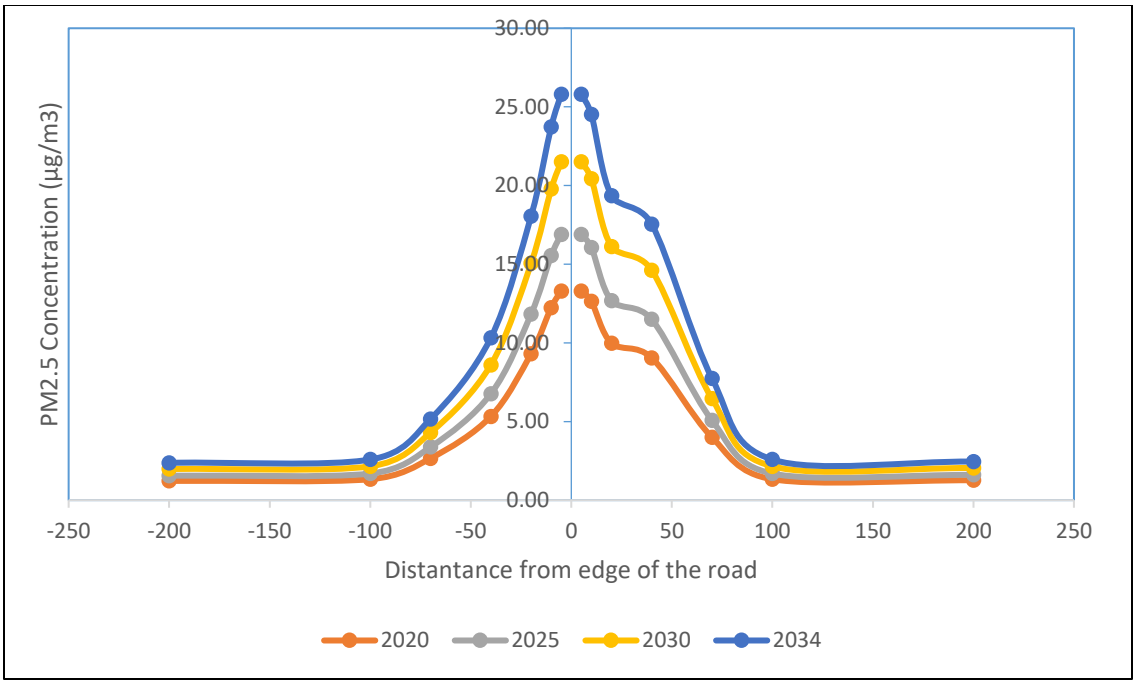


Figure 17: $PM_{2.5}$ predicted concentrations (µg/m^3) along the proposed bridge

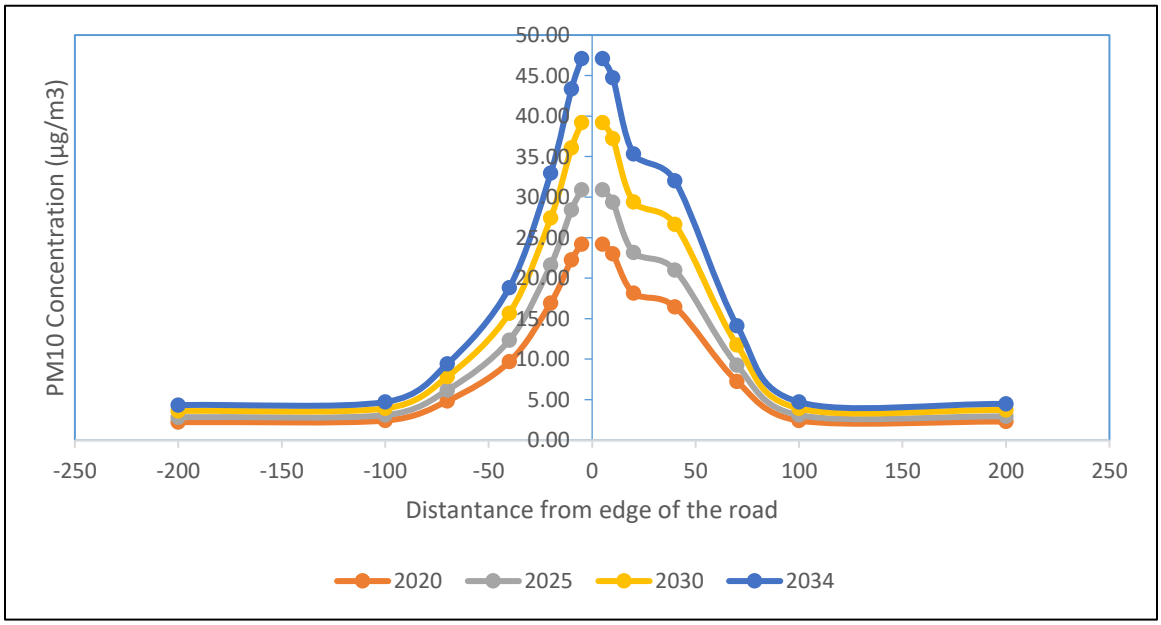


Figure 18: PM_{10} predicted concentrations (µg/m^3) along the proposed bridge

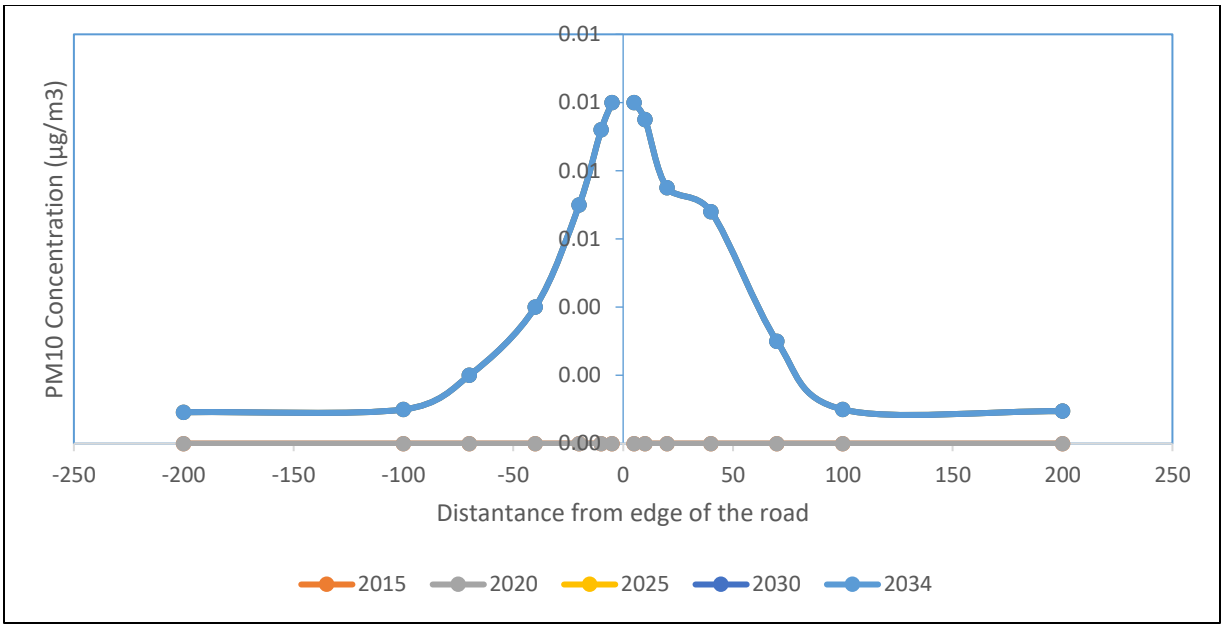


Figure 19: NOx predicted concentrations (ppm) along the proposed bridge

281. The predicted values at locations of ambient air quality (Panitanki and Naxalbari) are given in **Tables 27** and **28**.

Table 27: Incremental pollutant concentration at Panitanki (at 100 m distance from Bridge)

Description	Pollutant				
	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	SO_2 ($\mu g/m^3$)	NOx ($\mu g/m^3$)
Baseline Concentration	34.5	67.5	446.5	12.1	28.35
Increment in Concentration due to project	1.04	1.9	0	0	0
Concentration during operation of Bridge	35.54	69.4	446.5	12.1	28.35
Increment in Concentration due to project	3%	3%	0%	0%	0%
NAAQS (India)	40	100	2000[13]	40	100
NAAQS (Nepal)		120	10,000[14]	70	120
WHO Guidelines	25[15]	50[16]		20[17]	40[18]

Table 28: Incremental pollutant concentration at Naxalbari (at 6 km distance from Bridge)

Description	Pollutant				
	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	SO2 ($\mu g/m^3$)	NOx ($\mu g/m^3$)
Baseline Concentration	31	50.5	375.5	7	24
Increment in Concentration due to project	0	1.04	1.90	0	0
Concentration during operation of Bridge	31	50.5	375.5	7	24

[13] 8-hourly concentration in ambient air standard for industrial, residential, rural and other areas.
[14] Ibid
[15] 24-hour mean
[16] 24-hour mean
[17] 24-hour mean
[18] annual mean for NO_2

Description	Pollutant				
	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	SO2 ($\mu g/m^3$)	NOx ($\mu g/m^3$)
Increment in Concentration due to project	0%	0%	0%	0%	0%
NAAQS (India)	40	100	2000	40	100
NAAQS (Nepal)		120	10,000	70	120
WHO Guidelines	25	50		20	40

282. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10} concentrations have been plotted in Figures 6-10 of Appendix 3, respectively for peak traffic hour which shows that pollutant concentrations is decreasing away from the bridge. From the CALINE-4 modelling results, it is observed that maximum dispersion of pollutants concentration emitted from traffic volume at proposed bridge is up to 70m in year 2015 and up to 200m in year 2034. Therefore, the impacts of traffic movement at proposed bridge over Mechi River will not impact the surrounding atmosphere.

a. Mitigation Measures

283. The mitigation measures for the construction and operation phases are summarized below:

284. **Construction Stage.** The asphalt plants, crushers, hot mix plants and the batching plants will be sited at least 1 km in the downwind direction. These will be located in open areas. These will not be located in near habitations of Panitanki and Kakarbhitta.

285. All precautions to reduce the level of dust emissions from the construction activities, crushers and batching plants and other transportation of materials will be taken up which include vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce spills on existing roads. Water will be sprayed on earthworks, temporary haulage and detour roads on a regular basis. The hot mix plant will be fitted with dust extraction units. It shall be ensured that the dust emissions from the crusher and vibrating screen at the stone quarries do not exceed the emission standards set by the Central Pollution Control Board.

286. To ensure the control of exhaust gas emissions from the various construction activities, the contractor shall take up the following mitigation measures:

- An adequate cyclone/scrubber to control emissions from the stack of hot mix plants will be provided in the event of the emissions exceeding the West Bengal Pollution Control Board and the National Ambient Air Quality Standards of Nepal.
- To ensure the efficacy of the mitigation measures suggested, air quality monitoring shall be carried out at least once a season during the period of construction.
- All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the West Bengal Pollution Control Board and Government of Nepal norms. A vehicle maintenance schedule prepared by the contractor and approved by the Authority's Engineer shall be adhered to.
- The Contractor will take necessary consent from West Bengal Pollution Control Board and Ministry of Population and Environment (Nepal) for location of concrete batching plant, Hot Mix Plant and other facilities in the construction camp.

287. **Operation Stage.** The project plans a compensatory plantation in available space in RoW. This plantation and shrubs on side slopes will arrest the spread of pollutants. The compensatory plantation will be maintained. Any shortfall in survival less than 90 % will be made during the start phase of monsoon seasons. Necessary budget for plantation and maintenance has been budgeted in the EMP. Further environmental monitoring will be taken up during the operation phase to check the air quality values in the project area and surroundings.

18. Water Resources

a. Impacts

288. The project implementation will impact one hand pump falling in the approaches of bridge. The hand pump is located at km 0+580 at 17m at the left hand side. There is probable impact on the groundwater due to leakage from oil, grease and fuel from equipment, or from construction materials accidentally spilled that may contaminate the groundwater.

289. Contamination to the Mechi River water may occur due to spilling of construction materials, oil, grease, fuel and paint in the equipment yards and asphalt plants.

290. The other impact identified on water resources is usage of water for construction. The ground water table along the project corridor is 3-5 m, being in high intense rainfall area.

b. Mitigation Measures

291. **Design Stage.** The water for construction will be obtained from the Mechi River and a rivulet flowing at Panitanki. The rivulet is perennial. Necessary permission for water withdrawal will be obtained from the River authorities (State Irrigation Department).

292. **Construction stage.** The community hand pump falling in the proposed right of way will be replaced. In consultation with the community, no other water resource is being impacted due to bridge construction. The project itself is over a water body. The water way in the bridge design has been decided based on 100 year return flood period. Labour camps shall be sited at least 500 m away from the Mechi River. No refueling or repair of machines and vehicles will be allowed within 500m of the river.

293. **Operation Stage.** In operation stage to avoid any impact, storm water from the bridge has been properly channeled through the design of drainage system.

19. Drainage

a. Impacts

294. The project site is at Mechi River and its bridge approaches are on steep slopes so the project site has quick natural drainage. There will be a generation of storm water during monsoon and this water needs to be diverted.

295. **Pre Construction Stage.** No drainage modification of surface flow of rivers, streams and local drains is envisaged during pre-construction period, hence no impacts on surrounding area is anticipated. Proper drainage system has been designed as part of the drainage system.

296. **Construction Stage.** During the construction stage no drainage issue is anticipated as project site is on the Mechi River.

297. **Operation Stage.** One of the unavoidable aftermaths of infrastructure project like roads is the increased surface runoff. The addition of hard paved road surface, which essentially increase paved impervious surface, will cause increased surface runoff in the project influence area. The increased runoff from the project has been worked out as follows:

*Increase in runoff (cu.m) = increase in runoff co-efficient due to construction * annual rainfall in the area (m) * area of the newly constructed surface.*

298. The entire corridor traverses over alluvium with runoff coefficient of 0.35 and the black top has a run-off coefficient 0.90. The increase in the runoff co-efficient has been worked out as 0.55, i.e., the difference between the runoff co-efficient of black top surface and alluvial soil has been adopted as increased run-off co-efficient due to the project. The run off of has been calculated and this has been given in **Table 29** below.

Table 29: Increased Run-off along Bridge and Approaches

Package No	Description	Total Length (km)	Increased Paved Impervious width (m)	Rainfall (m) (Average)	Increased Co-efficient of run-off	Increased run-off (m^3)
1	Mechi Bridge and Approaches	1.50	22	2.495	0.55	45284

299. Impacts due to surface runoff include increased soil erosion and local flooding or water logging.

b. Mitigation Measures

300. **Design Stage.** The project design has following design features to take care of storm water drainage:

- Nepal side bridge approach - Footpath cum drain (in 545 m length) having a width of 1.5 m and depth of 1.0 m;
- Drainage spouts on every 5 m on bridge deck on LHS and RHS; and
- India side bridge approach has 2:1 slope and all storm water will flow through earthen drains on either side of the divided carriageway.

301. **Construction Stage.** The contractor will remove obstructions that may cause any temporary flooding of local drainage channels during construction. No spoil or construction material will be stored outside the proposed RoW or at places obstructing the natural drainage system.

302. **Operation Stage.** To maintain an efficient storm water flow, all drains will be regularly cleaned as part of the bridge and road maintenance. This cleaning will be taken up during monsoon months.

20. Loss of Water Bodies / Groundwater sources

a. Impacts

303. Water table around the project area is 3-4 m. The alignments of bridge and approaches have fluvial deposits and have good ground water potential. The project impacts on one hand pump, details of this have already been given.

b. Mitigation Measures

304. **Design Stage.** The bridge and approaches are not having any significant impact on ground water resources such as tube wells, wells, irrigation tanks, etc. so no specific measures in the design phase are required.

305. **Pre- Construction Stage.** The relocation of private and community water supply sources shall be completed prior to the commencement of the construction by the contractor, in accordance to the utility and community assets relocation plan prepared for the project. To prevent any stress on the local water sources due to the relocation, the process of dismantling shall commence only after the provision of the water supply source at the relocation site is agreed upon by the community. The contractor will identify water sources for construction, which in all probability will be local river/streams. Necessary permission for water usage will be obtained from the competent authority.

306. **Operation Stage.** During the operation phase no ground water sources will be lost as after completion of the project no land acquisition is planned.

21. Increased Sediment and Degradation of Surface Water Quality

a. Impacts

307. **Pre-construction and Construction Stage.** The degradation of water quality can occur during construction stage from the increased sediment load into watercourses near the construction site. This may be aggravated by removal of trees and consequent increase in soil erosion.

308. Degradation of water quality is also possible due to accidental discharges into the Mechi River from drainage of workers' camps and from the spillage in vehicle parking and/or fuel and lubricant storage areas and construction material stored near banks may also find their way due to storm water runoff.

309. **Operation Phase.** During operation phase degradation of water quality will occur due to damage of embankment due to soil erosion or accidental overturning of vehicles at the bridge site.

b. Mitigation Measures

310. **Construction Stage.** To avoid contamination of the Mechi River and drainage channels near the construction site, construction work close to the river will be avoided, especially during the monsoon period. The excavated earth will not be stored near the banks of Mechi River. No construction material will be stored near the banks of the Mechi River and its floodplains. All necessary precautions will be taken to construct temporary or permanent devices to prevent water pollution due to increased siltation and turbidity. All wastes arising from the project will be disposed off, as per West Bengal Pollution Control Board and Ministry of Population and Environment (Nepal) norms, so as not to block the flow of water in the river. The wastes will be collected, stored and taken to the approved disposal sites.

311. The vehicles and equipment will be maintained and refueled in locations atleast 500m from the river, so as to avoid contamination of the river water from fuel and lubricants. The slopes of embankment leading to water bodies will be modified and re-channeled so that contaminants do not enter the water body. Oil and grease traps will be provided at fueling locations, to prevent contamination of water. The sewage system for construction camps will be properly designed and built so that no water pollution takes place in Mechi River and other surface water sources close to the construction camp.

312. **Operation Stage.** The storm water will be diverted through the properly constructed drains and these drains will be maintained.

22. Flood Hazards

a. Impacts

313. **Preconstruction and Construction Stage**. The flood hazards in the project area are not there as project site and surroundings have swift flow.

314. **Operation Stage.** During the operation phase no flood hazards are anticipated as all storm water from the bridge and approaches will be diverted through the properly constructed drains.

b. Mitigation Measures

315. **Preconstruction Stage and Construction Stage.** During construction local drainage at the construction site will be maintained to avoid flooding.

316. **Operation Stage.** During the operation phase all drainage networks constructed will be maintained. It will be ensured that these drains are cluttering free before the onset of monsoon.

23. Surface Water Hydrology

a. Impacts

317. **Pre - Construction and Construction Stage**. The impacts on surface water hydrology will be due to construction of bridge and approaches. The main impact on hydrology is the obstruction to the free flow of water.

318. **Operation Stage.** During operation stage also no impact on surface water hydrology are anticipated as adequate waterway has been planned for the Mechi River Bridge.

b. Mitigation Measures

319. Preconstruction and Construction stage. No obstruction to the water flow will be ensured during the construction phase. The piers for the bridge are parallel to existing piers. The bridge designs have been taken up after thorough hydrological investigations. No construction material will be stored in the river bed.

320. **Operation Stage.** During the operation phase all storm water flow will be diverted through the drainage system constructed and this drainage system will be properly maintained. The water way of bridges will be maintained obstruction free. The clearance from River bottom level to bridge

deck has been kept 9.5 m for free flow of water, whereas HFL is 2 m above the bottom of the river.

24. Ground Water Hydrology

a. Impacts

321. **Pre Construction and Construction Stage.** There will be minor impacts on ground water hydrology due to the creation of embankment compacted base at the locations of the bridge approaches. This paved surface will reduce ground water recharge potential. The impacts on ground water hydrology will also be felt, if there is an uncontrolled withdrawal of ground water for the construction.

322. **Operation Stage.** No impact on ground water hydrology is anticipated in the operation phase.

b. Mitigation

323. **Pre Construction and Construction Stage.** The impact on ground water hydrology will be minimised through provisions of adequate side drains as earthen drains. There will be some recharge through these earthen drains. The project region received rainfall well above 2400 mm spread over a long period (March to September). This rainfall will ensure adequate recharge. The contractor will be instructed not to withdraw water from ground without permission from the Central Ground Water Board.

324. **Operation Stage.** The cross drainage structures and earthen drains will be maintained properly.

25. Noise

a. Impacts

325. Though the level of discomfort caused by noise is subjective, there is a definite increase in discomfort with an increase in noise levels. In the present case noise generation is an important environmental attribute both during construction and operation.

326. The baseline noise levels have been found within the acceptable levels at all locations of monitoring.

327. The impacts on noise due to the project will be of significance in both the construction as well as the operation stages.

328. **Pre-Construction stage.** Noise levels during the pre construction stage are mostly expected to be indicative of prevalent baseline levels apart from localised noise levels at locations where pre construction stage activities are taking place such as establishment of workers' camps, stockyards, establishment of construction camps, etc. These increased noise levels will prevail only for a short duration during the pre construction stage. Moreover, as these activities are not likely to be placed near settlement locations the increased noise impact is bound to be negligible.

329. **Construction Stage.** Due to the various construction activities, there will be temporary noise impacts in the immediate vicinity of the bridge project corridor. The construction activities

will include the excavation for the foundations of piers and grading of approaches on both sides of the bridge, construction of piers, and other associated facilities. Crushing plants, asphalt production plants, movement of heavy vehicles, loading, transportation and unloading of construction materials produce significant noise during the construction stage. The typical noise levels associated with the various construction activities and the various construction equipments are presented below in **Table 30**.

Table 30: Typical Noise Levels of Principal Construction Equipment

Clearing		**Structure Construction**	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Exavation and Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading and Compacting		**Landscaping and Clean-up**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
PAVING		Front end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94

Source: U.S. Environmental Protection Agency. Noise from Construction Equipment and Operations, Building Equipment and Home Appliances. NJID. 300.1. December 31. 1971

330. Though the noise levels presented for the various construction activities far exceed the permissible standards, it is important to note that the construction noise is generally intermittent and depends on the type of operation, location and function of the equipment. Proper mitigation measures as to regulate the timings of construction, employing noise protection measures ,etc. need to be worked out.

331. **Operation Stage.** There will be significant noise generation due to vehicular movement during the operation stage.

332. To assess the noise levels at the various sensitive receptor locations along the corridor, the prediction of noise levels[19] has been made for the years 2015, 2030 and 2040 using the FHWA Transport Noise Model.

[19] Operational noise for the highway are predicted through the model developed by Federal Highway Administration, Department of Transportation of the U.S. Likely noise levels at various receptor locations predicted through FHWA noise model in present study. The various assumptions predicting the noise levels along the corridor through the FHWA model were:

- No significant change in the vehicle characteristics is anticipated during the projected period;

333. The FHWA Noise Model presented below is based upon calculating the hourly Leq for all category-wise vehicles separately and then adding these logarithmically to obtain the overall hourly Leq as follows:

$$L_{eq}\,(hi) = Loei + {}^{10}\log \frac{Ni}{SiT} + {}^{10}\log 15^{1+\alpha} - 13 + \delta s$$
$$D$$

Where,

L_{eq} (hi)	Equivalent noise level at the hour (hi) for vehicle type (i)
L_{oei}	Reference mean energy level for (ith) vehicle type
Ni	Number of vehicles of (ith) class passing in time (T) one Hour (1 hour)
Si	Average Speed of vehicles of (ith) class (kmph)
T	Time duration corresponding to Ni, one hour
D	Perpendicular distance in (m) from centreline of the traffic lane to observer
α	Factor relating to absorption characteristics of the ground cover between roadway and observer (to be conservative, this is taken as O in actual modelling, but considered qualitatively in the final analysis)
δ_s:	Shielding factor for barrier (to be conservative, this is taken as O in actual modelling, but considered qualitatively in the final analysis)

334. The combined effect of all the vehicle categories can be determined at the receptor by adding the individual values using the following equation.

$$L_{eq\,(h,total)} = \log_{10} \sum_{h=i} 10^{Leq(hi/10)}$$

335. **Reference Noise Levels.** The vehicular noise emission levels significantly vary with vehicle speed. It is therefore necessary that speed dependency of noise emissions for various categories of vehicles is taken into account while using the model for noise prediction due to the roadway. In this work the speed-noise relations presented by National Environmental Engineering Research Institute (NEERI) in their report on Environmental and Social Assessment Delhi - NOIDA Bridge Project have been adopted (**Table 31**).

Table 31: Speed-Noise Relationships for Various Motor Vehicles

Speed (kmph)	Cars (dB (A)	Trucks & Buses (dB (A))	2/3 Wheelers (dB (A))
30	56.0	73.0	58.0
40	59.0	76.0	61.0
50	63.0	80.0	66.0
60	68.0	81.0	68.0
70	68.0	81.5	70.0
80	70.0	82.0	72.0

- There are no major grade differences in the project area as it is generally a plain terrain and gentle slopes of 1% to 3%., and no significant effect of grade on the noise levels is anticipated;
- The traffic along the proposed section is assumed to flow simultaneously in both the lanes and in both directions;
- Noise from other sources apart from the highway is not being accounted for in the modelling; and
- The receptor is considered to be independent of the noise emitted from the adjacent stretches.

Speed (kmph)	Cars (dB (A)	Trucks & Buses (dB (A))	2/3 Wheelers (dB (A))
90	72.0	83.0	74.0
100	74.0	83.5	76.0

336. **Traffic Volumes and Speed.** To arrive at the hourly distribution of the category-wise traffic over a day for the horizon years the ratio of category-wise hourly traffic to the daily traffic based on the 2015/2016 surveyed data of the existing Mechi Bridge. The predicted noise levels based on the design speed of 80km/hour at locations of baseline monitoring have been given in **Table 32** below:

Table 32: Predicted Noise Levels (dB (A)) During Operation Phase On Mechi Bridge and Approaches

S.No.	Location	Predicted Noise Levels 2030		Predicted Noise Levels 2040	
		Day	Night	Day	Night
1	Mechi Bridge and Approaches	70	66	73	67
2	Naxalbari	70	66	73	67
Ambient noise standards GOI		65	55	65	55
Ambient noise standards, GON (24 hour average)		74.36		74.36	
WB-EHS standards		70	70	70	70

Note: The relevant noise zone under the GON is High Traffic Area and Commercial zone for both WB-EHS and GOI

337. The ADB SPS requires the most stringent requirements to be followed when there are differences between the national standards and the World Bank Environment Health and Safety (WB-EHS) standards. Accordingly in comparing the predicted noise levels with the standard of GOI, which is the most stringent, is clear from above table that 'Day Time' and 'Night Time' noise levels are exceeding the limits. However there are only a group of 3 – 4 houses (noise sensitive receptors) close (10 – 15m) to the RoW of the approach road on the Nepal side as shown in Figure 20. One temple currently existing on the left hand side at a distance of 9m from centerline of the approach road in Nepal will be relocated and hence will not be subjected any more to noise and disturbance from future traffic. There are no sensitive receptors that will be impacted on the India side as as shown in the following Figure 21. The noise level variation for various horizon years has been given in **Figures 20-21.**

Figure 20: Noise Levels, Leq (Day) and Leq (Night) Variation at Mechi Bridge and Approaches, Year 2030

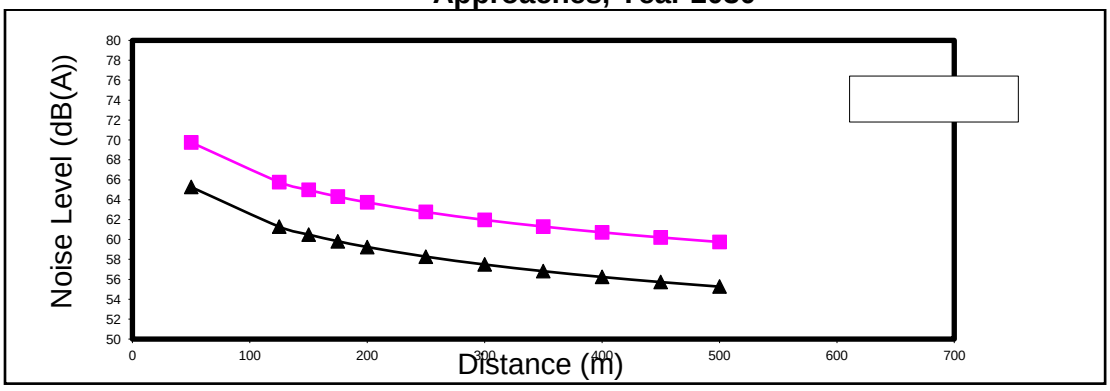
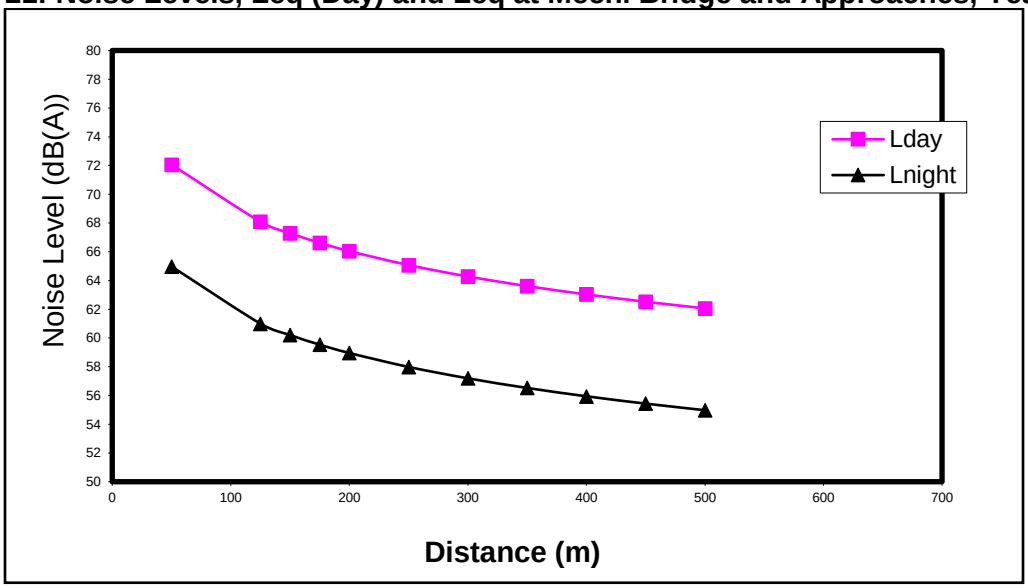


Figure 21: Noise Levels, Leq (Day) and Leq at Mechi Bridge and Approaches, Year 2040



b. Mitigation Measures

338. **Design Stage.** At Kakarbhitta the bridge approach is already in a commercial area and along the existing road. The noise impacts will reduce as congestion will reduce. Further plantation on side slopes will be taken up after the construction works.

339. **Construction Stage.** The plants and equipment used for construction will strictly conform to CPCB and Government of Nepal noise standards. Vehicles and equipment used shall be fitted with exhaust silencers. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective, it shall be replaced. The noise level from any item of plants (measured at one metre from the edge of the equipment in the free field) such as compactors, rollers, front end loaders, concrete mixers, cranes, vibrators and saws shall not exceed 75 dB (A), as specified in the Environmental Protection Rules, 1986.

340. To protect construction workers from severe noise impacts, noise standards of industrial enterprises will be strictly enforced at construction site and construction camps and workers shall be provided with Personal Protective Equipment (PPE) such as earplugs and muffs.

341. **Operation Stage.** In order to minimise impacts related to noise side slopes plantation will be maintained. There will be proper regulation of traffic. Noise barriers will be constructed near the group of houses along the Nepal approach road in consultation with the residents of the houses.

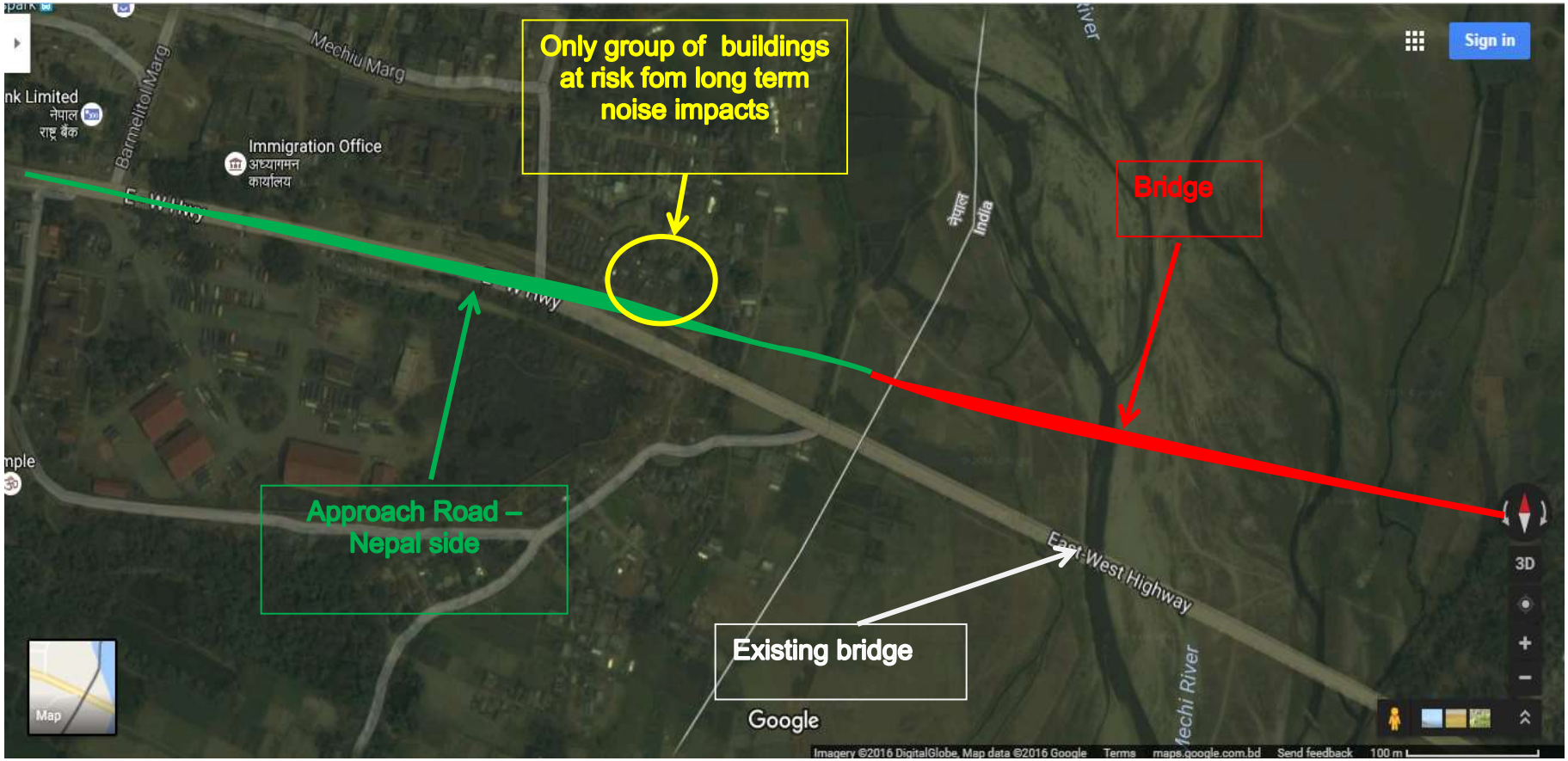


Figure 22:: Sensitive receptors (residential areas) on the Nepal side

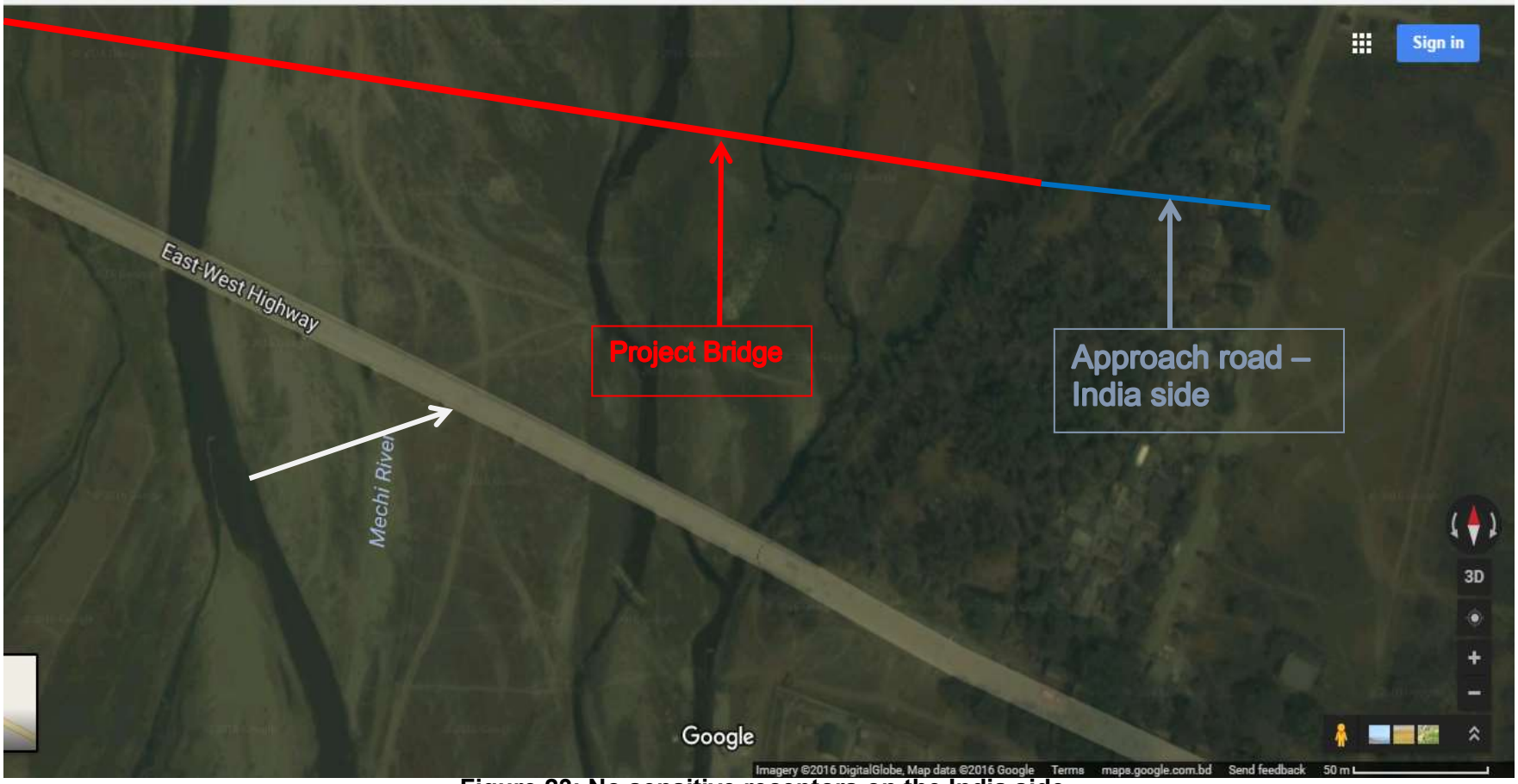


Figure 23: No sensitive receptors on the India side

C. Biological Environment

1. Terrestrial Flora

a. Impacts

342. **RoW Plantations, Protected and Reserved Forest Areas.** The alignment of the Mechi Bridge and approaches is not passing through reserved or protected forest. There is no Wild Life Sanctuary or National Park within the aerial distance of 10 km. The RoW of project is in most portions through Government land. The principal impact on flora involves the removal of trees from the RoW for the construction. Tree cutting in the corridor is 116 (40 numbers in India side portion and 76 numbers in Nepal side portion). These trees to be cut are common road side trees.

343. The stage wise impacts on biological environment have been described in the following sections.

344. **Pre Construction Stage.** The project has direct and long-term impact on the trees within the RoW. The cutting of trees shall have manifold impact. Most visible impact is the loss of shade. Also, there is a possibility of the local people being deprived of tree products, such as wood, fruits, leaves etc.

345. The micro-ecosystems supported by the trees are also a point of environmental concern. The removal of trees will not only lead to erosion, and depletion of the ground water table, but also to the loss of the micro-ecosystems developed in the project area.

346. **Construction Stage.** During the construction stage no cutting of trees will be involved within the RoW, but there may be accidental cutting of trees by the construction workers for cooking of food near the construction camps. The compensatory plantation available space in RoW will also take place at the end of the construction period.

347. **Operation Stage.** During operation stage there will be positive impact on flora as compensatory plantation in RoW will grow and shrubs plantation on side slopes will also mature.

b. Mitigation Measures

348. **Design Stage.** In order to compensate negative impacts on flora due to cutting of trees the project plans compensatory plantation in the ratio of 1:10 (India side) and 1:25 (Nepal side) i.e. for every tree to be cut ten trees (on India side) and twenty five trees (on Nepal side) will be planted. There is planning to plant 2300 trees as compensatory plantation. In addition to this compensatory plantation there will be plantation of shrubs at side slopes and in median of approaches and bridge. Tree cutting permission will be obtained from the district administration and respective Divisional Forest Offices (DFO Office Karseong in Darjeeling district for India portion and DFO office Jhapa district for Nepal portion).

349. **Construction Stage.** The trees to be filled will be marked inside the RoW. Construction vehicles, machinery and equipment will move or be stationed in the designated area only to prevent compaction of vegetation. While operating on temporarily acquired land for traffic detours, storage, material handling or any other construction related or incidental activities, it will be ensured that the trampling of soil and damage to naturally occurring (RoW or Construction Camp) herbs and grasses will be avoided. The workers will be prohibited from using trees or branches

of trees for cooking fuel. The contractor will arrange LPG or kerosene for cooking of food at construction camp.

350. **Operation Stage.** During the operation stage, the compensatory plantation and shrubs will be maintained. A minimum survival of 90 % will be ensured for initial three years. Any deficit will be made up before the onset of monsoon.

2. Aquatic Flora

a. Impacts

351. **Construction Stage.** There will be an impact on riparian vegetation on either side of Mechi River banks due to bridge construction. The aquatic flora of the river will be disturbed only if construction waste/construction material is disposed off or there is discharge of waste water from the construction camp to the river.

352. **Operation Phase.** In the operation phase no impact on aquatic flora is anticipated.

b. Mitigation Measures

353. **Construction Stage.** The Authority's Engineer will ensure that contractor does not dispose of construction waste or material in the streams where construction works are to be undertaken. The construction camps will be located sufficiently away (at least 100 m distance) from the river. Septic tanks will be provided to prevent the direct discharge of effluent into the river.

354. **Operation Phase.** No mitigation measures warranted as no impacts have been identified.

3. Terrestrial Fauna

a. Impacts

355. The Mechi Bridge and its approaches are beyond 10 km distance from Mahanada Wild Life sanctuary and the Jorpokhari Wild Life sanctuary. The fauna around near the project site is domesticated. Hence, no impact is anticipated on the two wildlife sanctuaries and the wildlife species in them.

b. Mitigation Measures

356. **Construction Stage.** All construction activities will be carried out in such a manner that damage and disruption to fauna will be minimal. There will be no construction works during night time in the habitations. The construction workers will be given instructions to conserve/protect natural resources and fauna, including wild animals and aquatic lives. In order to minimise dust generation during construction, water spray will be taken up frequently.

357. **Operation Stage.** No direct impacts on fauna are anticipated during operation stage due to the project. Indirect impacts on aquatic fauna such as water pollution from fuel spills etc. will be managed under the emergency response system. In the operation phase a positive impact on the fauna is anticipated due to enhanced tree cover in the RoW. The enhanced tree cover will provide a good nesting ground for the avi-fauna.

4. Aquatic Fauna

a. Impacts

358. Table 19 lists the fishes and amphibians that can be found in the vicinity of Mechi River. There is a potential for negative impacts on the existing species through overfishing by workers, killing of amphibian species during construction works, siltation as a result of construction activities, and indirect impacts through pollution of the river water through solid waste dumpring and indiscriminate spillage of liquid wastes. Incremental siltation impacts from the project construction activities are expected to be minimal as the river naturally has a heavy silt load which is washed down from the upper reaches of the Mahabarat range. However, these are expected to be short term and limited only to the construction stage.

359. Impacts during the operation stage will mainly be limited to pollution through fuel spills into the river particularly during vehicle accidents. Road run off impacts are expected to be neglible as run off content from the bridge will mainly be soil/silt with no or negligible amounts of pollutants.

b. Mitigation Measures

360. **Construction Stage.** Construction of the bridge will be carried out during the dry season when the flow of the river is minimum inorder to have minimal disturbance to fishes and amphibians. Construction camps will be located at least 500m away from the river. Disposal of liquid waste such as used oils, chemicals, lubricants into the river or river bed will be prohibited. Construction camps will be equipped with proper septic tanks and waste water disposal systems to ensure that neither ends up in the river. Fishing, poaching or hunting by the workers will be strictly prohibited.

361. **Operation Stage.** Proper safety features such as signage, speed limits etc. will be provided on the bridge and approach roads to avoid accidents. An emergency response system including spill management will be established by the PIU under NHIDCL.

D. Human Use Values

1. Land Acquisition

362. The land acquisition for the bridge project is very marginal. The requirement is for the approaches of the bridge. The total land acquisition will not exceed 3.8622 Ha.

2. Loss of Private Properties

363. There shall be some loss of private properties due to implementation of the project. The compensation for losses will be paid as per the policies of GoI and GoN and resettlement framework for the project. The extent of losses of private properties has been elaborated in the Resettlement Action Plan report. It has been estimated that about 79 (about 73 in Nepal side and 6 on India side) structures will need to be removed.

3. Common Properties Resources

364. In the RoW there will be some loss of permanent structures and human use values such as tube wells, hand pumps, and religious structures. The compensation will be paid to the owners as per the provisions in the Resettlement Framework. The religious structures will be relocated

before start of construction with rituals and in consultation with locals. The resettlement action plan of the project being separately taken up will have more elaborations on these aspects. The common property resources being impacted due to the proposed Mechi Bridge and its approaches are as given below:

Type of Community Asset	Number of Structures	Percentage
Place of worship	1	11.2
Compound wall of Govt Buildings	3	33.3
Check post / booth (security / customs)	2	22.2
Other government buildings	3	33.3
Total	**9**	**100.0**

Source: Census and Social Survey, December 2015

4. Change in land use

365. Impacts related to changes in land use around the bridge and approaches are not likely as Bridge is on the River and approaches are already in built up portion and the International Border.

5. Cropping Pattern and Crop Productivity

366. The chances of change in the cropping pattern are not there as a major portion of the project is in the built up section and there is existence of Tea estates at the end of the Indian side bridge approach.

6. Consumption of Natural Resources

367. The proposed widening of Mechi Bridge envisages the use of significant quantities of the earth, stone and grit and sand. The quantities required for both the corridors are as given below:

- Earthwork 6996 m^3
- Coarse aggregates 1720.50 m^3
- Sand (Cum): 20,000 m^3
- Cement (MT) : 2000 MT

7. Safety

a. Impacts

368. The concern for safety stems from the proposals for faster movement of vehicles on the bridge. Though speedy travel is one of the objectives of the project, it also increases the intensity of loss of life in case of an accident.

b. Mitigation Measures

369. **Design Stage.** Safety of road users as well as of the project related infrastructure is given highest importance and adequate measures have been incorporated in the design.

370. For smooth movement of through traffic from Nepal to Panitanki bypass & Siliguri, service roads are proposed on either side of main carriageway so that the conflict between slow moving and fast moving vehicles can be avoided.

371. The main carriageway is raising from starting point Km. 0+000 (At Kakarbhitta) with a barrier between service road and main carriageway. The entry and exit to LCS on Nepal side to the main carriageway and service road is defined. Hence the pedestrian movement from one side to other side will be at Kakarbhitta junction / through the VUP which is proposed below the approaches on Nepal side. Hence the specific “Directional Sign Boards” are proposed at the starting point for the respective fast / slow moving vehicles to take their path on to main carriageway / service roads.

372. “RE wall with Crash barrier” is proposed on either side of the main carriageway to the approaches of bridge on Nepal side as safety measure as there is level difference between the main carriageway and service at the bridge start point.

373. A Vehicular underpass has been proposed below the main carriageway so that the slow moving vehicles coming from Nepal can pass smoothly through the VUP and join the service road on RHS side and use the existing bridge to reach the Panitanki village.

374. The project highway has been designed for 40kmph. Hence “Speed Limit” sign boards are proposed.

375. The “RCC Crash Barriers” are proposed on either side of carriageway at ends for the safety of the fast moving vehicles on the bridge portion.

376. Immediately after the bridge, there is an At-grade junction proposed to connect the Panitanki village to Seema Suraksha Bal. Hence “At-Grade Junction” sign board will be placed on the bridge portion for speed restriction.

377. “Metal Beam Crash barriers” are proposed on either side of the approach after the bridge portion on Indian side as safety measure as the approach is embankment of about 3m.

378. Temporary Truck-Lay byes (Pota Cabins) are proposed on either side of approach of bypass to park vehicles having space for 3 rows of lanes. As the distance between the end of bridge portion to raising gradient of bypass approach is very close, the truck lay byes are proposed on sloping ground. Hence “Cautionary Sign Boards” are proposed for the parking of the vehicles in the designated lanes.

379. **Construction Stage.** Construction activities cause hindrance to traffic movement and are also hazardous for the traffic. Traffic management plans shall be prepared. For the Nepal side bridge approach construction, there may be a requirement for traffic diversion. Signboards indicating construction sites and flags shall be erected. All the signboards giving caution, barricades for diverting the traffic shall be as per specifications.

380. **Operation Stage.** All safety measures erected at the time of construction will be maintained properly. There will be special attention to the signages.

8. Historical, Archaeological and Cultural Sites / Places

a. Impacts

381. **Construction Phase.** There are no notified archaeological, historical and cultural sites along the proposed bridge and its approaches. These also do not exist within 10 km distance from the proposed RoW.

382. **Operation Phase.** No adverse impact on archaeological, historical and cultural sites is anticipated during the operation phase.

b. Mitigation Measures

383. **Construction Phase.** Since no impacts are identified, therefore, no mitigation measures are warranted. Chance find procedures will be based on Indian and Nepal governments' guidelines. If in case, there is a chance find during project implementation, the contractor will inform the Authority's Engineer. Pending the decision the work will be stopped.

384. **Operation Phase.** No mitigation measures are needed in the light of the explanation given under impacts subsection.

9. Accidents Involving Hazardous Materials

a. Impacts

385. **Construction Phase.** The storage of the inflammable and toxic materials may result in accidents during the construction phase. There will be storage of fuel oil and lubricants at construction camp sites. These are hazardous in nature. There will be storage of explosives at the crusher site for rock blasting and cutting. Accident may result due to improper handling of explosive (s) at crusher site (s).

386. **Operation Phase.** During operation phase impact will be due to accidental spillage due to the vehicle overturning of vehicles transporting the hazardous material specially fuel oil.

b. Mitigation Measures

387. **Construction Phase.** During pre construction and construction stage the storage of hazardous materials will be stored after obtaining permit/ license from the Chief Controller of Explosive, Nagpur. Necessary precautions as stipulated in conditions of license will be enforced. The contractor will prepare an on-site emergency plan for the construction site, construction camp and crusher site. This plan will be reviewed and approved by PMC/Authority's Engineer

388. **Operation Phase.** Accidents involving hazardous material spillage will generally be catastrophic to the environment, though the probability of occurrence is low. Prevention of an accident involving hazardous material is a better way of minimising the impacts. The provisions mandated by 'The Hazardous Wastes (Management and Handling) rules, 1989' and "Manufacture ,Storage and Import of Hazardous Chemicals Rules" 1989 under the Environmental (Protection) Act, 1986 will be complied with.

10. Cultural Properties

a. Impacts

389. Other cultural properties include religious structures, Mazars and Samadhis. In all one temple on Nepal side bridge approach are being impacted. Those to be impacted will be appropriately relocated / reconstructed in consultation with the local community.

11. Loss/ Disruption of Access/ Cultural Properties

390. **Pre Construction.** One of the impacts of the bridge and approach construction is interrupted access to the cultural properties on existing on either side of proposed RoW. There are chances that users of the cultural property may face difficulty in accessing the property during the period of pre-construction.

391. **Construction Stage.** Loss of access is likely to be severe during the construction period, due to movement of construction machinery, construction equipment, setting up of borrow areas, setting up of construction camps etc.

392. **Operation Stage.** During the operation phase no difficulty in access to cultural property will be faced by the public.

a. Mitigation Measures

393. **Pre Construction Stage**. The access to the religious structures will be provided during the pre construction through proper signages and marked access.

394. **Construction Stage.** All necessary and adequate care will be taken to minimize impacts on cultural properties that will be affected by the project. These include cultural sites and remains, places of worship including religious structures, mazars and samadhis as identified during design. The contractor shall ensure that no construction activities will spill over to these property's premises and precincts.

395. Access to cultural properties on either side of RoW such properties from the road shall be maintained clear and clean.

E. Socio-economic Environment

1. Project Affected Displaced Population

396. There will be acquisition of land to the extent of 3.8622 Hectares (0.7849 Ha on Nepal side and 3.0773 Ha towards the India side). Major portion of this land is Government Land in Nepal and Tea Estate land in India. There will be demolition of some properties also. This land acquisition will have an impact on the socioeconomic conditions of project affected persons. The project affected persons have been identified during land acquisition. Resettlement & Rehabilitation Plan is being prepared for the project affected and displaced families under separate cover.

2. Positive Impacts on Socio-economic Environment

397. The positive social impact due to the project will be faster connectivity bordering nations (Bhutan, Nepal and Bangladesh), generation of huge employment during construction, and fast economic development in the post construction phase due increased international trade and business. There will be availability of improved infrastructure facilities.

3. Mitigation Measures

398. The compensation to project affected persons will be paid as per the provisions in the National Rehabilitation and Resettlement Policy 2006 (NPRR) of the Government of India or Government of West Bengal. On the Nepal side also compensation will be paid as per GoN Policy. The entitlement framework for the project has been prepared and approved. The compensation will be paid as per this framework. The entitlement framework takes care of regulatory requirements of GoN and GoI. Details on these are available in the Resettlement Action Plan.

4. Positive Impact on Quality of Life (QOL)

399. The project will improve quality of life of people living Kakarbhitta and Panitanki due to availability of huge employment and business potential (growth of international trade and movement for tourism) and improved and fast connectivity.

5. Health

400. The adverse impact on the health of the public living near RoW of the project is not anticipated during the phase as construction activities will be within RoW. The construction works during the night time will not be carried at the Nepal side approach as there is a residential area close to RoW. The mitigation measures stipulated in the previous sections will be implemented as part of EMP to avoid any adverse impact due to movements of construction machinery and vehicles. In operation , there will be a positive impact on health of public as the project will relieve traffic congestion in Panitanki and Kakarbhitta.

F. Transboundary Impacts

1. Air pollution impacts

401. It is expected that there will be transboundary flows of air pollution between Kakarbhitta district in Nepal and Panitanki district in West Bengal, India. Particulate matters (PM2.5, PM10), as well as combustion byproducts (Carbon Monoxide (CO), Oxides of Nitrogen (NOx), and Sulphur Dioxide (SO2)) will be generated from various construction activities and may impact both areas, magnitude and range of which depends on prevailing wind direction. Construction activities that may generate air pollution include the transportation of gravel, sand, and stone dust from quarry areas, operation of hot mix plant, concrete batching plant and construction yard, and the movement and operation of construction vehicles and machinery. The most exposed are the construction workers themselves who may contract lung related diseases. Also at risk in Kakarbhitta are the residential and commercial areas as well as the land custom station (LCS). On the India side, at risk from air pollution are residents of Panitanki town and some residential houses of Tea Estate workers. Equally vulnerable are those passing through East-West Highway. Particulate matter can also travel long range that may also impact beyond the two districts in the two countries, but its impacts are expected to be minimal.

402. Mitigating measures to address transboundary impacts of air pollution include dust management such as water sprinkling and covering of trucks and vehicles used for transporting construction materials. The contractor will also ensure that vehicles and machineries used for construction activity passed the national emission standards of Nepal and India.

2. Noise pollution impacts

403. Noise pollution that will likely have transboundary impacts will come from the operation of plants and equipment for construction, and vehicles used for transporting aggregates and construction workers. The contractor will ensure that these plants and equipment conforms to CPCB noise standards. Construction workers especially those operating concrete mixer and jack hammer are the most affected receptors in terms of noise impact, and should be fitted with appropriate earplugs for protection.

3. Water pollution impacts

404. The bridge construction has the potential to contaminate Mechi River through sedimentation of soil and hazardous wastes from construction activities. The transboundary river both flows through Nepal and India until it joins Mahananda River. Possible sedimentation may come from excavated soil near the banks of Mechi River, which will be greatly eroded during monsoon period. The contractor has the responsibility to prevent storage of construction materials near the riverbank. Construction during monsoon period should be avoided.

405. As Mechi River affects both Nepal and India, there is also a likelihood of transboundary pollution from non-hazardous, hazardous and toxic wastes from construction activities. Typically, construction activities generate more non-hazardous wastes, composed of solid wastes, than hazardous and toxic wastes. Non-hazardous wastes include scrap wood, bricks, concrete, asphalt, metal scraps and excess aggregates. The contractor shall submit a solid waste management plan that will govern the storage and disposal of wastes, based on West Bengal Pollution Control Board guidelines. Toxic and hazardous wastes, on the other hand consist of used engine oil, hydraulic fluid, contaminated soil, batteries, waste paints and solvents, contaminated clean-up materials (rag), and containers containing hazardous and toxic materials. The contractor shall be responsible for the handling, treatment and disposal of hazardous and toxic materials. Vehicles will also be properly maintained to avoid contamination arising from oil leaks.

406. To address sanitation issues that might compromise the water quality of Mechi, the contractor shall build sewage system for construction camps that will treat wastewater coming from construction workers.

4. Impacts on endangered species and habitats

407. The nearest ecologically sensitive area, Jorphokri Wildlife Sanctuary in West Bengal is about 16 km from the proposed Mechi Bridge. There are no expected impacts on sensitive habitats and endangered species of flora and fauna in the sanctuary. The improved access and easier transport of goods and people may facilitate negative activities such as transport of wildlife products and poaching. However, given that there is already considerable cross border traffic on this existing bridge, the incremental impacts from the new bridge is expected to be limited. On the other hand regional efforts on addressing cross border wildlife trade and poaching is being addressed through the South Asia Wildlife Enforcement Network (SAWEN). SAWEN is a inter-governmental law enforcement body between Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka.

5. Social impacts

408. The construction of Mechi River bridge will offer opportunities for employment for people of Nepal and West Bengal. It is also expected that faster travel time will result after bridge construction. During construction, it is also expected that negative social impacts will arise. These

include conflicts with the local community arising from migration of workers from other areas and potential spread for diseases such as HIV / AIDS. Aside from the consultation with the stakeholders, negative transboundary social impacts can be addressed through constant consultation with the community and capacity building with workers on the appropriate norms during duration of their contract, conduction of awareness programs on HIV/AID and human trafficking.

G. Cumulative and Induced Impacts

409. The project bridge will be constructed a few meters upstream of the existing bridge. The project bridge will also be a bank to bank bridge, similar to the existing bridge. Cumulative impacts will be the creation of another source of road runoff and pollution for the river once the bridge starts operating. However this impact is expected to be minimal as the main content of the road runoff is expected to be sediments. The bridge will have a proper drainage system to capture road runoff. Appropriate safety features such as sign boards and speed bumps will be provided to avoid and/or minimize vehicle accidents that may cause fuel spills.

410. Similary, the new bridge and approach roads will become another source of vehicle exhaust emissions and noise due to movement of vehicles. Emissions and noise will be controlled and maintained within standard requirements through annual vehicle registration and renewal system. Residential houses particularly the ones along the approach road on the Nepal side will be provided with noise barriers.

411. The project bridge connects with AH-02 the national highway on the Indian side which is currently under construction (improvement and widening of the existing highway). By the time construction of the bridge begins the construction works of AH-02 will be completed. Residents/business in the Panitanki area will be subjected to yet another source of noise and disturbance from the bridge construction works and movement of trucks transporting construction material. However, the incremental impacts of this is expected to be minimal as the road in that area is anyway very busy with the movement of many large commercial trucks transporting goods in and out of Nepal.

412. Induced impacts that will be generated by the project will be increased traffic due to the improved access to and from Nepal. The increased traffic and creation of new shops and business nearby will result in new problems of noise, dust, solid and liquid waste. These issues will need to be managed under the local area development plans. The approach road and connecting AH-02 road will be maintained regularly by the local Public Works Department (PWD) to minimize problems of pot holes, dust, flooding, accidents etc. The positive induced impacts are discussed in the section below on Project Benefits.

413. The improved access and easier transport of goods and people may facilitate negative activities such as transport of illegal goods (such as wildlife products, disallowed agricultural products etc.) and human trafficking. However, given that there is already considerable cross border traffic on this existing bridge, the incremental impacts from the new bridge is expected to be limited. On the other hand regional efforts on addressing cross border wildlife trade and poaching is being addressed through the South Asia Wildlife Enforcement Network (SAWEN). SAWEN is a inter-governmental law enforcement body between Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka. In addition the SASEC Trade Facilitation Strategic Framework (2014 – 2018) aims to facilitate cross-border trade between the SASEC countries including improved systems and capacity for trade of goods as well inspection and identification of illegal goods and activities.

H. Project Benefits

414. Good transport facilities have varied embedded connotations, like the backbone of modern economy, the philosophy of life signifying the voyage unremitting from birth till death, the history of mankind and its endeavour, the passion for speed and dart non-episodically, etc. The road projects promote access to markets, materials and opportunities by facilitating movement of people and goods and improve earning and thereby enhancing the quality of life. The economic development enhances the demand for transport. This two-way interaction works through a host of inter-sectoral forward and backward linkages effects and dynamic externalities, tend to relocate industries, services and labour and thus helps to shape the economic geography of the region.

415. The ultimate aim of the construction of Mechi Bridge is to promote societal welfare of the region and increase of trade and tourism with the neighbouring countries in the project region namely Nepal, Bangladesh and Bhutan. The ultimate aim of the project is poverty reduction in the project influence area. The development of such a project plays a significant role in changing the socio-economic condition of the living of people of a region through dynamic externalities that such development often generates. Thus, the benefits of the project may be direct or indirect in nature.

416. All these shall have a bearing on the level of well being of the households and commuter who are frequent user of the existing Mechi bridge bridge. These would in turn lead to changes in the level of well being and human development, through their benefit on consumption level, educational attainment, health status, etc.

417. Various positive impacts have listed under the following headings:

- Enhancement of economy,
- Poverty reduction
- Lessening of congestion
- Tourism development
- Mobility
- Traffic Congestion Reduction on existing Mechi Bridge, Panitanki (India) and Kakarbhitta (Nepal) towns.
- Employment opportunity
- Tourism impacts

1. Enhancement of Economy

418. The project will provide better and smooth connectivity between India and Nepal via Mechi Bridge to the population of local community. In addition to this people travelling from Bangladesh to Nepal, India to Nepal and vice versa will get benefitted. The total population likely to be benefitted is around 2 million.

419. The project will give boost to local economy in India as well as neighbouring countries. The project will induce more commercial development and trading hubs in rural area and hinterland of the project. This will help in raising the income level and quality of life.

2. Poverty Reduction

420. Both Nepal and India will benefit substantially from social impacts arising from Mechi Bridge construction. Both citizens wil have access to state services such as health, education,

and other government services. The bridge will allow better access between two countries. This accessibility will greatly benefit especially the poor people in accessing different services offered by each country.

3. Tourism Development

421. The construction of Mechi Bridge will boost to tourism in the project area as accessibility to tourist places will improve. This is in fact one of the objectives of the project.

4. Mobility

422. The project will increase mobility of the public residing. It is estimated that project road (Asian Highway) and construction of new bridge on Mechi River will benefit about 2 million people. The journey time will be reduced considerably.

5. Traffic Congestion Reduction

423. The existing bridge was constructed in late 60's and is about 48 years old. The carriageway width of existing bridge is to cater for 2 lane loading only where as at present there are many slow moving vehicles along with pedestrian traffic plying on the bridge in addition to fast moving/ commercial traffic. The capacity of the bridge is insufficient to take care of the present traffic. The project will reduce traffic congestion on the existing bridge and will provide smooth flow between India and Nepal.

424. In order to make the project bridge accident free road signage and safety features have been planned at the design stage. There will be lighting arrangement on the proposed bridge which is absent on the existing bridge.

6. Employment Opportunity

425. The project is likely to be completed in a period of about 3 years. During this period manpower will be needed to take part in various activities. About 400 persons are likely to work during peak period of activity. Thus the project would provide substantial direct employment; besides, more people would be indirectly employed in allied activities and trades.

7. Tourism Impacts

426. With improved accessibility between two countries, sites with tourism potentials can now be easily reached. This will greatly benefit the tourism industry in both countries.

I. Climate Change Screening and Mitigation

427. Greenhouse gas emissions attributed to increase in projected traffic by the year 2034 was estimated based on fuel consumption provided in the DPR on the assumption of 30:70 split on gasoline and diesel consumption. Emission factors for CO_2, CH_4, and N_2O of 2,289, 0.4, and 0.5 g/litre for gasoline or petrol fed vehicles and 2,663, 0.08, and 0.22 g/litre for diesel-fed vehicles were adopted using the GHG Emission Quantification Guideline of Environment Canada. The estimated GHG emissions are given in **Table 33**. The total CO_2 equivalent emission from the project bridge for the year 2034 is **2,031.00** MT/Annum.

Table 33: GHG Emission Estimate for Mechi Bridge (Year 2034)

Description	GHGs	Unit	Quantity
Annual Fuel Consumption		Litres	767,632.50
Petrol	CO_2	MT/annum	527.13[20]
	CH_4	MT/annum	2.31[21]
	N_2O	MT/annum	34.31[22]
Diesel	CO_2	MT/annum	1,430.94
	CH_4	MT/annum	1.08
	N_2O	MT/annum	35.23
Total	CO_2	MT/annum	1,958.08
	CH_4	MT/annum	3.38
	N_2O	MT/annum	69.54
Total CO2e Emission		**MT/annum**	**2,031.00**

1. Introduction

428. Projected change to the global climate will almost certainly have a significant impact on the appraisal, planning, design, construction, operation and maintenance of road infrastructure[23]. Road infrastructure is typically designed to withstand local weather and climate and as such, designers and engineers typically rely on historical records of climate when designing road infrastructure. However, due to climate change, using historical climate data alone is no longer a reliable predictor of future impacts. There is already evidence of climate change having an impact on road infrastructure such as through increased frequency and severity of flooding events, increased landslide frequency, damage to road pavements from excessive heat, and reduced snow and ice coverage in some regions.

429. Climate-induced disasters such as floods, landslides and droughts have killed more than 4,000 people in Nepal over the last 10 years. The economic losses caused by disasters add up to about USD 5.34 billion. Nepal has prepared its National Adaptation Programme of Action (NAPA) for adapting to extreme climate events and variability through an extensive country-driven consultative process. The document was shared with Parties to the UNFCCC in November 2010. Nepal has also prepared a National Framework for Local Adaptation Plan for Action (LAPA) with the twin objectives of implementing adaptation actions, and integrating climate change into local development planning and implementation[24].

2. Literature Review on Climate Change, Nepal[25]

430. **Climate of Nepal and Future Climate Change Projections**. The climate of Nepal varies greatly from South to North due to the vast altitudinal variation. The altitudinal variation within a

[20] Sample computation: Annual fuel consumption (767,632.50 L) x EF_{CO2} (2,289 g/L) x Consumption ratio (0.3) x 1 kg/1000 g x 1 MT/1000 kg = 527.13 MT/annum

[21] To convert to CO_2 equivalent, emission factor of CH_4 is multiplied to 25, its equivalent global warming potential (GWP) - https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf.

[22] N_2O's global warming potential compared to CO_2 is 298 - https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

[23] Defra (2010): Adapting Energy, Transport and Water Infrastructure to Long-term Impacts of Climate Change. Available at: https://www.gov.uk/government/publications/adapting-energy-transport-and-water infrastructure to-the-long-term-impacts of-climate-chang

[24] Adaptation to Climate Change, NAPA to LAPA, Ministry of Environment, Government of Nepal, 2010

[25] Nepal National Adaptation Programme of Action (NAPA) 2010; Ministry of Science, Technology and Environment, Government of Nepal, Kathmandu, Nepal.

short span of about 193 km, ranging from 60 meters to 8848 meters above mean sea level, makes the country with diverse agro-climatic zones. The regional climate variations are largely a function of elevation. The variable geo-climatic conditions, unplanned settlements, degradation of natural resources and increasing population makes the country vulnerable to a variety of climate related extreme events.

431. **Extreme climate events**: Nepal is prone to a variety of recurring natural disasters such as floods, landslides, snow avalanches, Glacial Lake Outburst Floods (GLOF), hailstorms, thunderstorms, cold waves, hot waves, drought, epidemics and earthquake. Out of the 75 districts in the country, 49 are prone to floods and/or landslides, 23 to wildfires, and one to windstorms. A total of 64 out of 75 districts are prone to disasters of some type (MOHA, 2009). High intensity rainfall events during the monsoon season leave the country highly susceptible to water induced natural disasters such as floods, landslides, flash floods, debris flows and slope failures. Flooding is frequent in the monsoon season during summer, while droughts are not uncommon in certain regions at other times of the year. Prolonged breaks in the summer monsoon cause severe drought.

432. **Trends in climate**: Temperature observations in Nepal show a consistent and continuous warming trend. According to available data, average annual mean temperatures have been increasing in Nepal by 0.04 - 0.06°C and these increases are more pronounced at higher altitudes and in winter. There is a general increase in temperature extremes with hotter days becoming more frequent and cooler nights less frequent. The temperature differences are most pronounced during the dry winter season, and least during the monsoon. There is also significantly greater warming at higher elevations than at lower elevations in the Terai region. Glacier melt as well as expansion of glacial lakes have been recorded in recent decades, with a high likelihood that such impacts are linked to rising temperatures.

433. **Precipitation**: The precipitation data for Nepal does not reveal any significant trends. However, the analysis based on data from 166 stations across Nepal from 1976 to 2005 reveal a positive annual rainfall trend in Eastern, Central, Western and Far-western Nepal. The monsoon precipitation shows general declining trends in the mid-western and southern parts of western Nepal, with few pockets of declining rainfall in the central and eastern Nepal. In the rest of the country, the monsoon precipitation displays an increasing trend.

434. **Future climate change projections**: The climate model projections show that there will be a rise in the average annual temperature over Nepal and that it will vary both spatially and temporally. In the OECD study, General Circulation Models (GCM) run with the SRES B2 scenario show an annual mean temperature increase by an average of 1.2°C by 2030, 1.7° C by 2050 and 3° C by 2100 compared to pre- 2000 baseline. In general, several studies show higher temperature increment projections for winter as compared to the monsoon season. In terms of spatial distribution, a higher temperature increment over western and central Nepal is projected as compared to eastern Nepal.

435. For precipitation, the trends are less certain, but there is evidence of increasing occurrence of intense rainfall events, and an increase in flood days and generally more variable river flows. Importantly, the above changes, which are consistent with a range of climate change models, are predicted to continue into the 21st Century. The summer monsoon is likely to become more intense with increasing occurrence of heavy rainfall events. In terms of winter precipitation, the models project almost no change in western Nepal and up to 5 – 10% increase in precipitation in eastern Nepal. During the summer months, the projections show an increase in precipitation for the whole country in the range of 15 to 20%. In terms of spatial distribution, studies show an

increase in monsoon rainfall in Eastern and Central Nepal as compared to Western Nepal. In terms of increasing number of extreme rainfall events, events that now occur every 5 years are projected to occur every 2 years.

436. **Trends in Daily Climatic Extremes of Temperature and Precipitation in Nepal**[26]. The daily temperature data for 36 years from 1971 to 2006 and the precipitation data for 46 years from 1961-2006 of Nepal were analyzed. The network of stations was so chosen that it encompasses all the climatic zones of the country as far as possible. Trends in precipitation and temperature extremes have been investigated using the precipitation and temperature indices of climate extremes for this study using specially designed software, RClimDex.

437. General increasing trend has been observed in the temperature extremes. Most of the temperature extreme indices show a consistent different pattern in the mountainous and the Terai belt. The trend is of relatively higher magnitude in mountainous region. The precipitation extremes show increasing trend in total and heavy precipitation events at most of the stations. However, the systematic difference is not observed in extreme precipitation trend between hills and low land southern plains of Terai. The evidence suggests complex processes in precipitation extremes, but at the same time there is indication that more weather related extreme events like floods, landslides can be expected in future.

438. The daily data of temperature and precipitation were analyzed using RClimDex software and salient observations are briefly reproduced as follows. The study observed that there is decrease in the annual occurrence of cool nights and increase in warm nights. Similar features were also observed in the trend of the maximum temperature extremes i.e. warm days are increasing and cool days are decreasing. The majority of the stations showed increase in the maximum temperature.

439. In terms of precipitation, 73% of the stations exhibited increase in the annual count of days when precipitation was greater or equal to 50 mm. Trend analysis of the monthly maximum 1-day precipitation showed that 65% of stations exhibited increasing trend, whereas the rest of the stations showed decreasing trend. In the trend analysis of precipitation index the annual precipitation in wet days showed that 81% of stations indicated increasing trend and rest of the stations showed decreasing trend. The precipitation extremes show increasing trend in total and heavy precipitation events at most of the stations. In view of the extreme events, the results are significant in the sense that there is strong evidence that it is likely to have more intense precipitation in future.

440. **Risks of Flooding and Inundation in Nepal Terai**. A 2011 publication by the Water and Energy Commission[27] states that Nepal is highly vulnerable to recurrent floods and landslides. In Nepal, devastating floods are triggered by different mechanisms such as: (i) continuous rainfall and cloudburst (CLOFs), (ii) glacial lake outburst floods (GLOFs), (iii) landslide dam outburst floods (LDOFs), (iv) floods triggered by the failure of infrastructure, and (v) sheet flooding or inundation in lowland areas due to an obstruction imposed against the flow.

441. The report highlights that sheet flooding or inundations are common during the monsoon in lowland areas of the Terai. The risk of such hazards has been increasing in recent years as a

[26] Trends in Daily Climatic Extremes of Temperature and Precipitation in Nepal; S.K. Baidya et.el. Journal of Hydrology and meteorology, Vol. 5, No. 1, March 2008

[27] Water Resources of Nepal in the Context of Climate Change, Water and Energy Commission Secretariat (WECS) , Government of Nepal 2011.

result of the increasing development of infrastructures such as roads, culverts, check dams etc. and the consequent obstruction in the natural flow of the surface runoff. Moreover, the unilateral construction of roads perpendicular to the natural flow of rivers near the border area between India and Nepal without sufficient drainage and construction of barrages, dams, afflux bunds and dykes have also exacerbated flooding in Nepal.

442. A study on “Flooding and Inundation in Nepal Terai28” states that according to the origin, size and nature of the flow, Nepal's rivers are grouped into three categories: (i) Large rivers originating from the Higher Himalayas, (ii) Medium rivers originating from the Mahabharat Hills, and (iii) Small rivers originating from the Siwalik and Churia Hills. All rivers are incised in the hills and mountains and are comparatively less vulnerable until they debouch into the Terai plain and it is during the monsoon months (from June to September) that rivers in Nepal come to spate with bank-full discharges and cause flooding and inundation in several parts of the Terai. The rivers flowing through the Terai are featured with morphological characteristics such as: severe erosion of hill slopes, excessive sediment load, high peak floods and wide and braided channels.

443. The report laments that infrastructures constructed just downstream of the border have congested the drainage passage of the natural water bodies and have caused inundation in upstream areas adjacent to the border. India has constructed dozens of the embankments, dams, water control structures just at the boarder inundating Nepalese territory/farmland. Nepal's requests to alleviate the problems have not been considered by India. In addition, embankments constructed in India near the Nepal-India border block the sheet flow as well as natural drainage passage causing flooding and inundation in Nepalese territory. The embankment in the Mechi river near Kakarbitta in Jhapa District of Nepal has been cited amongst several examples in the Terai region of Nepal.

444. **Climate Change Policy of Nepal**[29]. The policy paper states that there are very few studies about the effects and likely impacts of climate change in Nepal. Scientific evaluations are yet to be carried out to understand the types and degrees of impacts on specific geographical region and development sector. Activities related to climate modeling and assessing the ongoing effects and likely impact of climate change in natural resources, including water resources and other economic sectors from the mountain and hill regions to the Terai plains in the south, have not been carried out due to inadequate human and financial resources and lack of appropriate equipment. Detailed studies, surveys and monitoring of snow and glacier melting and glacier lake outburst floods (GLOFs) have yet to be conducted. The detailed impacts from climate change on agriculture, water resources, forests and biodiversity, public health, disaster incidence, tourism and other related sectors have yet to be assessed. Similarly, programmes for avoiding, minimizing or adapting to the changing climate by developing appropriate technologies for risk reduction and disaster preparedness are also have to be implemented. The major challenge is the lack of an effective framework for addressing the adverse impacts of climate change; such a framework should consider the UNFCCC provisions and decisions of the Conference of the Parties, including adaptation, mitigation, finance, technology development and transfer, capacity building, and climate resilience. Although climate change has become an issue of global importance, there is a lack of institution which can examine climate change from the perspectives of science and technology.

[28] Flooding and Inundation in Nepal Terai: Issues and Concerns; Bashista Adhikari, Hydro Nepal, Issue 12, 2013

[29] Climate Change Policy, (Approved by Government of Nepal, 2011), unofficial translation

445. **Impacts of Climate Change on Hydrological Regime and Water Resources Management of the Koshi River Basin**[30]. This recent study has made an assessment of the hydrological regime of the Koshi river basin in Nepal under climate change. Results from two Regional Climate Models (PRECIS-HADCM3Q0 and PRECISECHAM05), based on IPCC-SRES A1B scenario, have been bias corrected against historical gauged data. Hydrological impact simulations were conducted using SWAT model. Design flood estimation was done done after extreme value analysis based on annual flow maxima.

446. The study has found under climate change temporal flow variations are expected to increase in the future. The magnitude of projected flow for given return periods, is reported as strongly dependent on the climate model run considered. The ECHAM05 results showed higher flow changes than those estimated from the HADCM3 outputs. A relation was derived to estimate projected flood flow as a function of return period and flow estimated from historical series. Amidst the uncertainties, these predictions provide reasonable insight for re-consideration of design standards or design values of hydraulic structures under climate change.

3. Design Discharge of the Mechi River

447. **The DPR Design Discharge**[31]**.** The general physiography and hydrology describes Mechi as a typical Himalayan river with a catchment area of 210 km2, originating from the Mahabharat hills of Nepal debouching into the Terai region in south eastern Nepal. The immediate upper reach of the Mechi proposed bridge is characterized by braided and interlaced system of independent channels or branches. These braided channels meander between the flood plain (khadir) of the Mechi River. The courses of the braided channels are unstable, i.e., during one season some of the channels remain almost dead but in the next season can get active and vice versa. The channels that meander unpredictably are separated by shallow sandy beaches, which are in fact bed of the Mechi itself. At the end of the flood plain, there are banks which on the upstream side of the existing bridge are stabilized by the high bund roads, both on India and Nepal side.

448. During high flood (which is never more than 2.0 m from the low bed as per the local information collected from senior and informed citizens), the river flow widens to almost bank to bank. The rest of the year the flow of Mechi remains divided and restricted within the shallow braided channels. Flash floods that occur during periods of heavy precipitation are characterized by high velocity and contribute to deep erosion on the concave side of the bank and silting on Nepal side.

449. In the absence of gauged flood discharge and topographic data of the Mechi river catchment, the hydrological and hydraulic design report of the Mechi River outlines methodologies for the estimation of design discharge following procedures as reproduced below. The highest of the estimations was intended to be used as design discharge.

Methods Used	Remarks
Synthetic Unit Hydrograph (SUH)	• Per IRC: 5-1998, and as recommended for catchments > 25 km2

[30] Impacts of climate change on hydrological regime and water resources management of the Koshi River Basin, Nepal, L.P Devkota et.el., Nepal Development Research Institute, Lalitpur; Journal of Hydrology, Regional Studies, 4 (2015); *http://start.org/files/2015/09/Journal-of-Hydrology_regional-studies-4-2015-502-515.pdf*

[31] Hydrological and Hydraulic Design Report of Major Bridge Across Mechi River at Km 0+885, Sheladia Associates Inc., (ADB TA Consultants), January 2016

Methods Used	Remarks
	• North Brahmaputra Sub-Zone 2(a) of IRC assumed for SUH derivations • 100-year peak discharge obtained as 1835 m3/s
Area-Velocity Method	• 3 cross-sections, one at proposed bridge location and two other upstream at 250 and 500 m interval, surveyed • HFL identified at existing bridge location through extensive local enquiry and their judgment; and assumed as 100-year HFL • Discharge calculated at each cross-section, adopting a rugosity coefficient 'n' of 0.03 and the highest value adopted for comparison with other methods • Flood discharge obtained as 1730 m3/s
Rational Method	• Generally not recommended for catchments > 50 km2, nonetheless tabulated to compare with outputs of other methods • Flood discharge obtained as 1456 m3/s
Empirical Methods	• None specific to Nepal and hence avoided; further, empirical methods prescribed in IRC handbook overlook many runoff factors as the prescribed empirical relations are solely reliant on catchment area

450. Comparing discharges obtained from various methods, the maximum discharge as obtained by SUH method was adopted. Further, in the absence of other reliable data such as gauged flood discharge data and topographic data of the Mechi catchment, the design team has opted to upgrade the SUH discharge by 33.33%, thereby yielding a design discharge of 2,500 m3/s. The reason for the increase in the design discharge has been attributed to the importance of the bridge crossing at the international border rather than any influence under a changing future climate.

451. **Contemplation on the Design Discharge under the Influence of Climate Change.** According to climate data and monitoring report by WMO[32], most existing systems for water management and other infrastructure are designed under the assumption that climate is stationary. As such current design practices for new infrastructure typically follow historical information on weather and climate extremes and on local informants' information. Thus and often, the maximum value of a particular variable in the historical record (narrated also as in the case of HFL for Mechi river) is considered to be the normative value for design but yet disregards climate change. Further infrastructure designers rely on the convenient use of prescribed guidelines and empirical methods that could be no longer be relevant in the light of climate change.

452. A review of applied methods in Europe for flood frequency analysis[33] in a changing environment, indicate a gap between the need for considering climate change impacts in design and actual published guidelines that incorporate climate change in extreme precipitation and flood frequency. In the absence of such methods, some countries have adopted guidelines; an example is a summary of existing European guidelines on climate change adjustment factors on design floods and design rainfall. Literature search could not identify the existence of such policy

[32] Guidelines on Analysis of extremes in a changing climate in support of informed decisions for adaptation, World Meteorological Organization, 2009, (WCDMP-No. 72)

[33] FLOODFREQ Cost Action ESO901; European Cooperation in Science and Technology, Center for Ecology and Hydrology, 2013; http://www.cost-floodfreq.eu

guidelines for Nepal; even in literature 2.4 cited earlier on climate change and policy for Nepal stands silent where infrastructure is concerned.

Table 34: Existing European Guidelines on Climate Change Adjustment Factors

Country	Region	Variable	Guideline	Reference
Belgium	Flanders	Design Floods	30% increase	Boukris and Willems (2008)
Belgium	National	Design rainfall	30% increase	Willems (2011)
Denmark	National	Design rainfall	20%, 30% and 40% increase for return periods 2, 10 and 100 years	Arnbjerg-Nielson (2008)
Germany	Bavaria	Design flood with 100-year return period	15% increase	Hennegriff et al. (2006)
Germany	Baden – Wurrtemberg	Design floods	Increase between 0% and 75% depending on location and return period	Hennegriff et al. (2006)
Norway	National	Design floods	0%, 20% and 40% increase based on region, prevailing flood season and catchment size	Lawrence and Hisdal (2011)
Sweden	National	Design rainfall	Increase between 5% and 30% depending on location	SWWA (2011)
United Kingdom	National	Design floods	20% increase for 2085	Defra (2006)
United Kingdom	National	Design rainfall	10%, 20% and 30% increase for 2055, 2085 and 2115	Defra (2006)

Note: As engineering infrastructure designs are usually addressed using the traditional risk-based approach of a "design return period", it must be cautioned that most climate change literature assert that it is likely under a changed future climate, where frequencies and intensities of extremes are likely to increase, that a 1 in a 50 year event could become a 1 in 20 or so or less year event in the future and in such a case the sizing of any structure is achieved by increasing the return periods to account for climate change rather than using a lower recurrence period.

453. **An Example from Koshi River, Nepal, on Design Discharge**[34]. This recent study has made an assessment of the hydrological regime of the Koshi river basin in Nepal under climate change. Results from two Regional Climate Models (PRECIS-HADCM3Q0 and PRECISECHAM05), based on IPCC-SRES A1B scenario, have been bias corrected against historical gauged data. Hydrological impact simulations were conducted using SWAT model. Design flood estimation was done done after extreme value analysis based on annual flow maxima.

454. The study has found under climate change temporal flow variations are expected to increase in the future. The magnitude of projected flow for given return periods, is reported as strongly dependent on the climate model run considered. The ECHAM05 results showed higher

[34] Impacts of climate change on hydrological regime and water resources management of the Koshi River Basin, Nepal, L.P Devkota et.el., Nepal Development Research Institute, Lalitpur; Journal of Hydrology, Regional Studies, 4 (2015); *http://start.org/files/2015/09/Journal-of-Hydrology_regional-studies-4-2015-502-515.pdf*

flow changes than those estimated from the HADCM3 outputs. A relation was derived to estimate projected flood flow as a function of return period and flow estimated from historical series. Amidst the uncertainties, these predictions provide reasonable insight for re-consideration of design standards or design values of hydraulic structures under climate change.

In the absence of much literature on extreme flood discharge under climate change and taking the assumption that major rivers originating from the North-South major rivers of Nepal bear homogeneity for entire Nepal, the following empirical developed for Koshi river is reproduced from this research as Eq. 3.1; Note this formula was developed by calibrating the ratio of future over historical peak flows versus the corresponding return periods.

$$Q_p = [1.592 + 0.188\, ln(T)]Q_h \qquad \textit{Eq. (3.1)}$$

where,
Qp = future Peak flow
Qh = historical peak flow (as derived from conventional stationarity analysis)
T = Return period in years

Note: The study strongly recommends that any design based on a 100-year design flood flow may need to be changed to a design flood flow for a return period of higher than 100, in order to account for the impact of climate change. The study admits that amidst the uncertainties, these projections provide reasonable insight in support of alterations or re-consideration of design standards or design values of hydraulic structures if impact of climate change is to be taken into consideration during hydraulic design of water resources works.

455. **Deliberation on Design Discharge.** Giving due respect to the literature cited in Sec. 3.3 above, the design discharge of 1,835 m3/s by the synthetic unit hydrograph method if substituted into Eq. 3.1 as the historical peak flow, produces a future 100-year peak flow of 4,510 m3/s.

456. The hydrological and hydraulic design report mentions that the present Mechi bridge has been built bank to and bank, and the new design proposal is to span the entire khadir, i.e. high bank to high bank. Upon checking the design it was found that the proposed (high bank to high bank) bridge design is indeed able to accommodate the conveyance of the estimated 4,510 m3/s peak flow.

VI. ANALYSIS OF ALTERNATIVES

A. Preamble

457. This chapter discusses the analysis of alternatives that have been considered for the finalisation of alignment for Mechi Bridge and Approaches. It also includes a discussion on the "**With**" and "**Without**" project scenario. The methodology that has been adopted for the evaluation of the alternate alignments for the bridge based on engineering, economic, environmental and social considerations have been highlighted. The minimisation of environmental impacts by considering design alternatives determines the extent of mainstreaming of the environmental component. An evaluation of the various alignment options has been done to arrive at the most promising alignment of the bridge from environmental, social and techno economic considerations. This chapter looks at the decisions made during the project when alternatives were available and describes the rationale behind each decision.

B. "With" and "Without" Project Scenario

458. As per the inquiry, the existing Mechi bridge was built in the year 1968 and is about 48 years old. The bridge is in fair condition as per condition survey with minor distress at some locations. The carriageway width of the bridge is to cater for 2 lane loading only, whereas at present there are many slow moving vehicles along with pedestrian traffic plying on the bridge in addition to fast moving / commercial traffic. The capacity of the existing bridge is insufficient to take care of the present traffic. Further, the AH-2 being implemented will increase international traffic. The proposed bridge will take care of increased traffic. The bridge will also reduce traffic congestion and air and noise pollution. The bridge will also help in realising the aims and objectives of the AH-2 project for the increased international trade and faster movements of goods and commodities to and from bordering countries. The '**With**' and '**without**' project scenarios are further analysed with this backdrop of requirement of reliable quality infrastructure for sustained growth of economy in north Bengal region of the West Bengal and Eastern part of Nepal and consequent well-being of its inhabitants.

459. The project will have multiple benefits. It will reduce the travel time substantially between Nepal and Bangladesh. In addition the project will provide other benefits like

- Fast and Safe connectivity resulting in fuel savings l, travel time and total transportation cost to society;
- Employment opportunity for people;
- Development of local industry, agriculture and handicrafts;
- Development of tourism and pilgrimage;
- Transporting processing and marketing of agricultural products;
- Reduction in accidents;
- Streamlining and fast custom clearances
- Increase in International Trade
- Poverty reduction
- Reduction in pollution;
- Opening up of opportunities for new occupations;
- Better approach to Medical & Educational services and
- Improved quality of life for people and so on.
- The details of the project have already been discussed in Chapter – 3.

460. **Therefore, "With" project scenario, with its minor adverse impacts is more acceptable than the "Without" project scenario** which would mean an aggravation of the existing problems. The potential benefits of the project are substantial and far-reaching both in terms of the geographical spread, international trade and time savings. Hence, it is clear that the implementation of the project will be a definite advantage to bordering countries in order to achieve all-round development respective economies of bordering countries and progress of their people.

C. Alternative Modes of Transport System

461. The other modes of transport system for the improved connectivity are Rail and Air and water ways. These transport systems are not feasible in the project region. Rail transport development for the connectivity is cost exorbitant and cross border, especially Nepal, difficult to develop due to terrain constraints. Hence connectivity improvement through road is cost efficient and can be realised in shorter time.

D. Alternatives of Bridge and Approaches Alignments

462. In order to finalise the alignment of the Mechi Bridge and its approaches an alignment option study was undertaken. Five options were explored for the bridge and approaches. The analysis of alternatives of these alternatives has been presented below:

1. Alternative I

463. This alignment alternative is proposed on the upstream side of the existing bridge running nearly parallel to it and merging with the already finalized alignment of Panitanki bypass. A rotary has been proposed for the continuous movements of vehicles in and out from LCS on Indian side.

Merits	Demerits
▪ This alignment can be easily connected to the already finalised alignment without much modification. ▪ Close proximity to the existing bridge, hence access to LCS would be easier. ▪ Minimum length of the bridge will be required.	▪ Keeping in view of the present bridge operational, the traffic in and out of LCS will create congestion.

2. Alternative II

464. This alternative is similar to Option I but with a slip road on the left side of the proposed approach alignment and then taking a U-turn underneath the VUP proposed across the existing cross road for the approaches to enter into the LCS, thus avoiding the direct conflict with the vehicles moving in and out from LCS.

Merits	Demerits
▪ This alignment reduces the conflicts to certain extent.	▪ This alignment requires additional slip roads and even additional bridges on both sides of main carriageway for turning and to reach the LCS. In addition it will have conflict with the cross-road vehicles.

Merits	Demerits
	▪ Even after providing the slip road for the movement of in & out vehicles from LCS, will have conflict with the traffic moving straight.

3. Alternative III

465. This alternative alignment is proposed on the downstream side of the existing bridge running parallel to it with direct connectivity to the LCS and the outgoing vehicles will follow the already finalised alignment from LCS towards Naxalbari through Panitanki. An intersection is proposed at the junction of the existing bridge approach and the Panitanki bypass alignment.

Merits	Demerits
▪ This alignment reduces the conflicts to a greater extent.	▪ Due to the meandering behaviour of the river and more prone to the scouring effect of the banks on India side, as observed at the site, this alignment is not suitable for siting of the bridge. ▪ All the vehicles are required to enter into LCS resulting in congestion for the movement of vehicles inside the LCS. ▪ Existing ground before the abutment A1 of proposed bridge on the Nepal side is at a higher elevation of about 8m w.r.t FRL of the proposed bridge and there are some establishments including the existing LCS of Nepal on this terrain. Hence it is very difficult to connect to LCS and Kakarbitta junction.

4. Alternative IV

466. This alternative alignment is proposed on the upstream side of the existing bridge with take-off from the Nepal side abutment, very close to A1 and abutment A2 is located at about 200m on the upstream side of Indian side and the alignment is more or less away from the sharp curvature of stream flow. The A2 location shall be on the bank of Indian side and at a sufficient distance from “Seema Suraksha Bal” camp to form a rotary to have the turning movements to LCS and Naxalbari.

Merits	Demerits
▪ This alignment reduces the traffic conflicts to a minimum as the rotary is now planned away from the existing bridge, near the proposed A-2 abutment located near the Seema Suraksha Bal campus. ▪ From the google imagery, it is observed that this alignment is more or less away from the sharp curvature of flow and is reasonably away from the erodible bend. However, this siting may need further confirmation from the concerned Irrigation Department.	▪ Length of the bridge will be increased by about 150m. ▪ The already finalised alignment of Panitanki bypass requires modification along with the change in location and orientation of minor bridge, VUP and ROB.

5. Alternative V

467. This alternative alignment is proposed on the upstream side of the existing bridge with take-off from the Nepal side abutment, very close to A1 and abutment A2 is located at about 100m on the upstream side of Indian side and the alignment is slightly towards the sharp curvature of stream flow. The A2 location shall be on the bank of Indian side and at a sufficient distance from "Seema Suraksha Bal" camp to form a rotary to have the turning movements to LCS and Naxalbari.

Merits	Demerits
▪ This alignment reduces the traffic conflicts to a minimum as the rotary is now planned away from the existing bridge, near the proposed A-2 abutment located near the Seema Suraksha Bal campus. ▪ The already finalised alignment of Panitanki bypass can be utilised with minimum modification. ▪ Length of the road will be decreased by about 50m w.r.t Alternative IV.	▪ Length of the road will be increased by about 50m w.r.t Alternative I. ▪ From the google imagery, it is observed that this alignment is slightly towards the sharp curvature of flow and is towards the erodible bend. However, this siting may need further confirmation from the concerned Irrigation Department.

468. The analysis of alternatives of all five options on environmental considerations has been taken up and presented in below in **Table 35**. The options have been shown in **Figure 23**.

Table 35: Analysis of Alternatives from Environmental Considerations

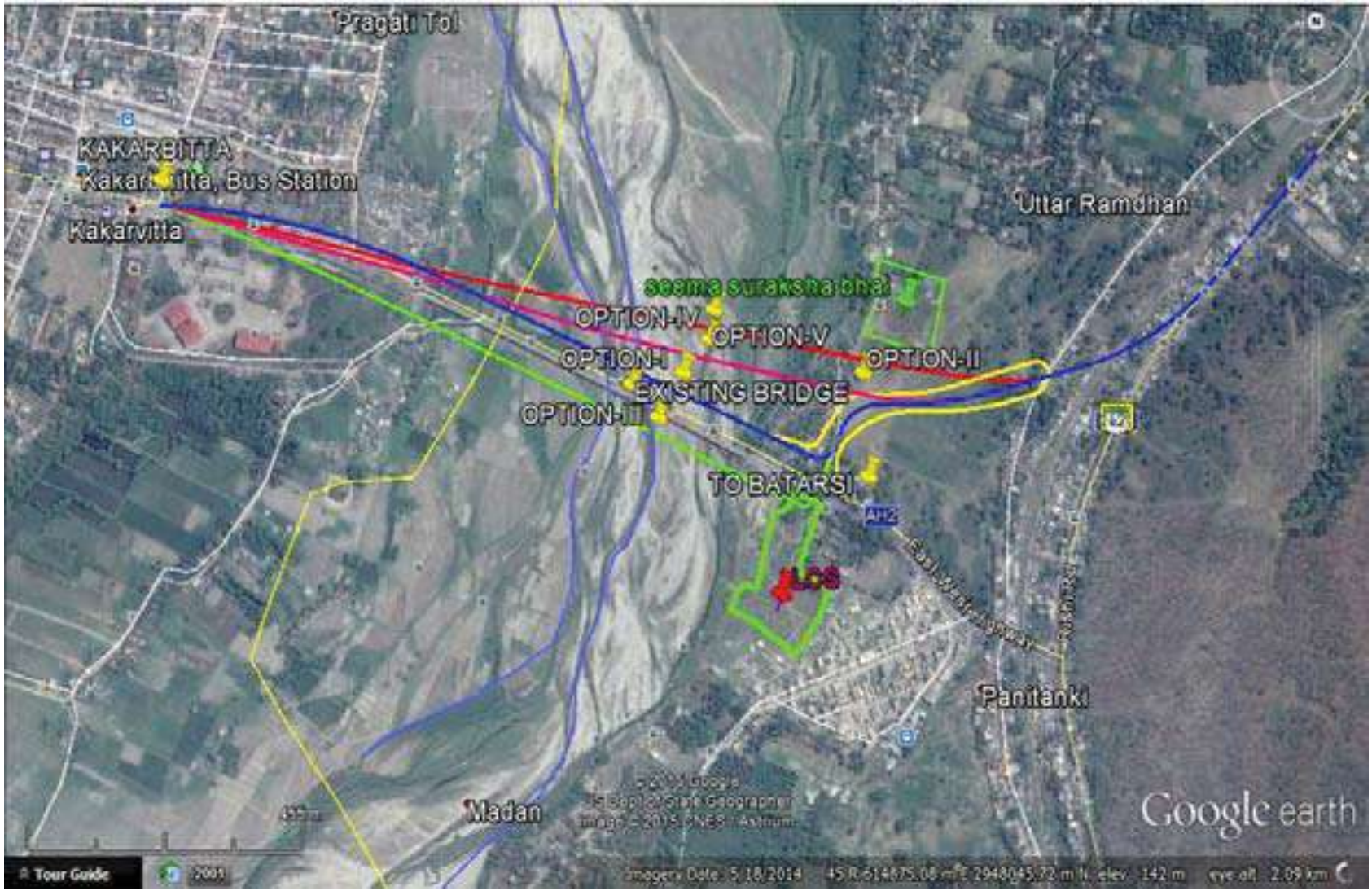
S. No.	Environmental Attribute	Option I	Option II	Option-III	Option-IV	Option V
1	Length	1.2 km	2.2 km (approx.)	1.3 km	1.8 km (approx.)	1.5 km
2	Number of Trees	This option has maximum number of trees and passing through habitation area in Nepal. The number of trees to be cut are about 170	This option also has approximate same length as option-1 but provides connectivity with proposed LCS in India. The number trees to be cut are about 180 due to connectivity to LCS	This option has minimum length among all options and number of trees to be cut are 29. But this option is not technically acceptable due to meandering nature of river.	This option alignment is close to Seema Suraksha Bal (SSB) Chowki and distance from proposed LCS is also more in comparison to other options. Trees to be cut are about 105	This option alignment is equidistance from proposed LCS and Seema Suraksha Bal Chowki. The trees to be cut are 116. This alignment is also preferred alignment from engineering considerations.
3	Wild Life /Fauna Movement	No movement of wild life as alignment is through habitation area both in India and Nepal and tea estate land.	No movement of wild life as alignment is through habitation area both in India and Nepal and tea estate land.	No movement of wild life as alignment is through habitation area both in India and Nepal and, tea estate land.	No movement of wild life as alignment is through habitation area both in India and Nepal and tea estate land.	No movement of wild life as alignment is through habitation area both in India and Nepal and tea estate land.
4	Noise Sensitive Receptors – Educational Institutes and Health Facilities close to project bridge and its approaches	There is no existence of educational institute or health facility close to RoW	There is no existence of educational institute or health facility close to RoW	There is no existence of educational institute or health facility close to RoW	There is no educational institute or health facility close to RoW	There is no educational institute or health facility close to RoW
5	Common property Resources- Hand Pumps, Wells,	Entrance gate at Nepal-1 Temples -03	Entrance gate at Nepal-1 Temples -4	Entrance gate at Nepal-1 Temples -02	Entrance gate at Nepal-1 Temples -02	Entrance gate at Nepal-1 Temples -01

S. No.	Environmental Attribute	Option I	Option II	Option-III	Option-IV	Option V
	Religious structures	Check Posts Nepal side-2 Check Post India side -0 Hand Pump -02 Wells-0	Check Posts Nepal side-2 Check Post India side -1 Hand Pump -01 Wells-0	Check Posts Nepal side-2 Check Post India side -0 Hand Pump -03 Wells-1	Check Posts Nepal side-2 Check Post India side -0 Hand Pump -01 Wells-0	Check Posts Nepal side-2 Check Post India side -0 Hand Pump -01 Wells-0
6	Water Bodies	The alignment crosses Mechi River	The alignment crosses Mechi River	The alignment crosses Mechi River	The alignment crosses Mechi River	The alignment crosses Mechi River
7	Project Implementation Environmental statutory Risks	No risks, as Bridge and Approaches in India do not need environmental clearance. But IEE report in Nepal needs approval from the Ministry of Physical Infrastructure and Transport	No risks, as Bridge and Approaches in India do not need environmental clearance. But the IEE report in Nepal needs approval from the Ministry of Physical Infrastructure and Transport	No risks, as Bridge and Approaches in India do not need environmental clearance. But the IEE report in Nepal needs approval from the Ministry of Physical Infrastructure and Transport	No risks, as Bridge and Approaches in India do not need environmental clearance. But IEE report in Nepal needs approval from the Ministry of Physical Infrastructure and Transport	No risks, as Bridge and Approaches in India do not need environmental clearance. But IEE report in Nepal needs approval from the Ministry of Physical Infrastructure and Transport
8	Air and Noise Pollution	The vehicular air pollution may have impacts on tea estates plantation and partly on residential dwellings on both ends. There will be reduction in congestion, air and noise pollution in existing	The vehicular air pollution may have impacts on tea estates plantation and partly on residential dwellings on both ends. There will be reduction in congestion, air and noise	The vehicular air pollution may have impacts on tea estates plantation and partly on residential dwellings on both ends. There will be reduction in congestion, air and noise	The habitants of Panitanki and Kakarbhitta will be subjected to increased air and noise pollution due to increased traffic	The impact of air and noise pollution on account of vehicular traffic will be minimum on Panitanki town as bridge approach is 100 m away from town. There will be impact on residential area and land custom station in Nepal (Kakarbhitta) due to

S. No.	Environmental Attribute	Option I	Option II	Option-III	Option-IV	Option V
		Panitanki and Kakarbhitta habitations.	pollution in existing Panitanki and Kakarbhitta habitations.	pollution in existing Panitanki and Kakarbhitta habitations.		air and noise pollution as alignment passes close to these features.
9	Reserved Forest	No Reserved or Protected forest land acquisition required	No Reserved or Protected forest land acquisition required	No Reserved or Protected forest land acquisition required	No Reserved or Protected forest land acquisition required	No Reserved or Protected forest land acquisition required

469. From the above table it is concluded that Option III is rejected on technical considerations. Option-I has maximum R&R issues so it has also been rejected. Option II has maximum length and tree cutting so this option has also been discarded on environmental and cost considerations. Option -IV being close to SSB complex has also been rejected on Defence ground. Based on the above analysis option-V has been taken up considering all factors.

Figure 24: Mechi Bridge and Approaches Alignment Options



E. Conclusion

470. The analysis of alternative modes of transport indicates that the road connectivity to the neighbouring nations in North Bengal is the most environmental friendly and preferred mode of transport for meeting the objective of increase in trade and tourism and poverty reduction. The bridge project will help in connecting Nepal and Bangladesh through AH-2 under implementation. The analysis of the alignment alternatives of bridge and approaches indicates that the environmental considerations have been given due weightage in the finalisation of the alignment. The minor adverse impacts would be manageable to an acceptable level by implementing Environmental Management Plan. The IEE with EMP has been considered an acceptable and justified option.

VII. STAKEHOLDER CONSULTATIONS

A. Introduction

471. The project will affect the communities residing near the proposed Mechi Bridge and its approaches. There are structures and other private assets falling within the proposed RoW of Mechi Bridge and approaches. Moreover, successful implementation of the project requires co-ordinated efforts of various stakeholders at different levels. The consultations are continuous activities during all stages of any major infrastructure developmental activity as all the stakeholders (both direct and indirect) have key roles to play in achieving the goals of the project. Not only are the outcomes dependent on the consultations, but the very fact that though some community members are adversely affected, the community as a whole reaps the benefits of the project. The more the community participation better is the project planning, implementation and operation. Hence, consultations at different levels are being used as a tool to inform and educate stakeholders about the proposed action both before and after the development decisions are made. Public consultation is useful for gathering environmental data, understanding likely impacts and the community's needs and preferences.

472. The various alternatives could be evolved and sustainable mitigation measures could be formulated through consultations. It assists in identification of the problems associated with the project as well as the needs of the population likely to be impacted. This participatory process helps in reducing the public resistance to change and enabled the participation of the local people in the decision making process. The involvement of the various stakeholders ensured that the affected population and other stakeholders are informed, consulted and allowed to participate at various stages of project preparation.

B. Objectives

473. The objectives of the consultation process are the following:

- To promote public awareness about the Mechi Bridge project, especially amongst the potentially impacted communities/individuals;
- To educate the potentially impacted communities/individuals about the proposed course of action and the project alternatives;
- To solicit the views of affected communities/individuals on environmental and social problems;
- To gather inputs from the affected communities/individuals in crucial decisions regarding mitigation of the identified environmental and social issues;
- To stimulate community self evaluation and analysis;
- To inform Project Affected Persons (PAPs) about the compensation and resettlement in the project; and
- To ensure lessening of public resistance to change by providing them a platform in the decision making process.

C. Methodology Adopted for Stakeholder Consultations

1. Stages and Levels of Consultations

474. Stakeholder Consultations are an ongoing process till project is completely constructed. The consultations have been taken up at the time of alignment option study report for the bridge and approaches. After finalisation of alignment for bridge and approaches consultations with

various stakeholders were carried out in December 2015. In the initial phase consultations were carried out to finalise the alignment of bridge and its approaches. The state level consultations have been done with West Bengal Pollution Control Board and State Forest department and revenue department. Consultations have also been done with the Silliguri Jalpaiguri Development Authority (SJDA). Consultations with various agencies and public members have also been carried out in Nepal

2. Consultation at Local Level

475. Small focus group discussions have been done at local level. These consultations were done at Kakarbhitta in Nepal and Panitanki in India. These consultations were taken up in the month of December 2015.

3. Consultation at the District and Institutional Level

476. The consultations at district level have been done with PWD officials at Silliguri in India, revevue authorities at Silliguri and Khoribari.

477. Consultative discussions were held with DFO Kurseong in Darjeeling district to discuss the issue to tree cutting in the project and to confirm that alignment in India portion is not passing through Reserved Forest. This discussion was held on April 11, 2013.

478. The consultations in Nepal side have been held with Department of Road office at Damak, Divisional Forest Officer at Bhadrapur (Jhapa district) and Mechi Nagar Municipal Corporation.

Stakeholder Consultation at Nepal Side

Stakeholder Consultation at India Side

D. Consultations and Focus Group Discussions

479. The summary of consultations, views, comments and suggestions and incorporation in project design have been summarised below:

Table 36: Consultations with Institutional Stakeholders, Issues and Addressal in Project Design

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
1	DFO Kurseong Office	11-04-2013	• The DFO suggested that tree in RoW should be enumerated and marked at site. The list along with prescribed format of application should be submitted for tree cutting permission. • The consultant showed the alignment map of bridge, approaches and AH-2 road and enquired for any reserve or protected forest. • DFO Karseong enquired about environmental clearance requirement for the project. • Consultants enquired about time required for tree cutting permission from DFO office.	• The consultants replied that the list will be submitted in prescribed format. • The DFO confirmed that there is no reserved or protected forest in the bridge approaches and along the alignment of AH-2. • The consultants replied that bridge and approaches are not covered under the EIA notification 2006, hence no environmental clearance is required for Mechi Bridge. • The DFO replied that permission will be granted after site verification and approximate time is about one month.
2	DFO Office Bhadrapur (Jhapa District, Nepal)	27-12-2015	The Environmental expert from the consultants' team enquired tree cutting permission for trees to be cut. The DFO replied that tree list with details such as Height, name, girth size, etc. should be submitted by the user agency with a request letter. In this case Department of	• The consultants told the DFO that they will submit the list to the department of Roads Damak Office. The DoR will forward the list to DFO office.

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
			Roads Damak Office handling the project.	
3	Mechi Nagar Municipal Corporation (Nepal)	27-12-2015	The consultants enquired from the Mechi Nagar Municipal Corporation officials about the permissions and clearances required from them for the project. The consultants also requested for land map for the bridge site and surroundings for identification of plots being affected for bridge approach construction.	• The officials informed that draft IEE document should be submitted for the concurrence. • For land map officials suggested that a request letter from Department of Roads Damak office should be submitted. On receiving they will provide the land map.
4	Department of Roads Damak (Nepal)	27-12-2015 and 29-12-2015	The consultant's team discussed about the project and requested for suggestions on environmental protection. The Assistant Engineer told that bridge and approach alignment has been accepted and all necessary help to complete the work shall be provided by the Department. He suggested that there should be minimum tree cutting and R& R issues.	• The consultants replied that alignment having minimum R&R and environmental issues has been recommended. The details of impacted properties, trees, temples etc. are being collected. The IEE report will be submitted.

Table 37: Focus Group Discussions, Issues and Addressal in Project Design

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
1	Kakarbhitta	28-12-2015	• Some people whose property (house) falls in proposed RoW demanded that they have the house only as property. The project should provide the replacement plot.	• The Consultants replied that compensation will be paid as per the approved entitlement frame work of the project.

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
			• The participants demanded compensation for both plot and house . • Consultants asked the suggestions of participants to reduce the pollution during the project implementation stage. • The participants demanded that all the three temples being impacted should be located at project cost. The relocation site should be finalized in consultation with the community. • The participants demanded that an access road to their residential area should be provided from project cost as a compensation to pollution exposure to them during the construction. • The participants demanded that a retaining wall should be providing to prevent damages from floods from the River. • Participants demanded that 10-11 people from their area should be employed in the construction works as their residential area is	• The consultants replied that legal titleholders will get compensation for plot in addition to structures. • Measures to avoid and minimize air and water pollution and waste management will be implemented as part of the EMP during project implementation • The participants suggested that plantation should be taken up at the RoW boundary to screen vehicular emissions to residential area close to RoW. The consultants replied that compensatory plantation has been planned in the project. • The Consultants replied that temples will be relocated at project cost and at a location acceptable to the community. • The consultants replied that suggestion has been noted and will be conveyed to the project authorities. • The consultants replied that bridge design takes care of the retaining wall and protection from flood at the bridge site and surroundings. • The consultants replied that once contractor is mobilized then he will decide the employment of locals in the construction

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
			being impacted due to land acquisition. • The female participants welcomed the project and suggested during construction necessary safety measures should be taken to avoid any accidents during construction and operation especially for senior citizens and children. • Participants demanded road side drain and suggested that a drain from there residential area should connect to road side drain to take care of waste water from their colony.	works. However, suggestion has been noted and will be conveyed to the project authorities. • The consultants replied that necessary safety precautions will be taken during construction and operation phases to avoid any accidents. • The consultants replied that project design has provisions for covered drain cum foot path in the approaches of bridge on Nepal side. The provision for connecting drain from the residential area to road side drain has been noted and will be conveyed to project authorities
2	Panitanki	28-12-2015	• The participants welcomed the project and enquired about location of new bridge site. • The participants suggested that most of affected families on India side are Tea workers. The project should properly rehabilitate them. • The participants demanded that compensation should be paid in advance before dismantling of their structures and adequate advance notice should be given. • In the proposed RoW of bridge approach there are some houses of Tea workers and the apprehension of these	• The consultants replied that new bridge location is about 150 m upstream of the existing bridge. • The Consultants' replied that R&R compensation will be provided as per approved entitlement framework of the project. • The consultants replied that compensation shall be paid in advance and sufficient time for shifting will be provided as per law. • The consultants replied that project will pay cash compensation as per approved entitlement framework for the project.

Sl. No.	Location	Date and participants	Issues Raised	Addressal in Project Design
			workers is that they will not get plot to construct the house as they are on Tea estate land. • Participants suggested that tree cutting in the project should be compensated. • Participants demanded that water and sanitation facilities be provided by the project as they are using water from the river for washing and there are no sanitation facilities. • The participants told the consultants that they are facing air and noise pollution problem at present and this will increase in future during construction. This should be taken care.	• The consultants replied that project has planning to provide compensatory plantation in the 1: 10 ratio i.e. 10 trees for every tree to be cut on the India side. • Water for bathing will be provided to the people if their access to the river water is disrupted by the project. Sanitation facilities will be provided only if the project disrupts or relocates existing sanitation facilities • The consultants replied that for air and noise pollution during the construction phase mitigation measures such as water spray and no construction during night hours near habitations have been planned. These will be elaborated in Environmental Management Plan (EMP) being prepared. This EMP will be implemented by Authority Engineer.

480. The signatures and name of participants and photographs of consultations have been provided in **Appendix 4.**

E. Conclusion

481. It is clear from the above discussion that due to consideration has been given to the suggestions of all stakeholders in the project design and most of their suggestions have been incorporated into the project design. The EMP implementation during construction and operation phases will ensure compliances with all mitigations measures.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

482. Environmental Management Plan (EMP) is the key to ensure that the environmental quality of the zone under impact does not deteriorate beyond the expected level due to the construction and operation of the Mechi Bridge and its approaches. The EMP comprises a set of measures to be taken in different stages like the design, construction and operation to eliminate, offset or reduce adverse environmental impacts to acceptable levels. Elimination/prevention is possible through elimination of impacts or by avoiding the action. This can also be achieved by reducing the scale of action. Remediation is repairing or restoring particular features of the environment adversely affected by the activity. Offsetting actions means compensating for impacts by providing additions to or substitutes for the affected environment. Mitigation plans generally evolve around remediation and offsetting.

B. Environment Management Plan Matrix

483. The Environmental Management Plan is meant for mitigation/management /avoidance of the negative impacts and the enhancement of the various environmental components along the project bridge. For each mitigation measure to be taken its location, timeframe, implementation and overseeing/supervising responsibilities are listed in the EMP matrix. The measure adopted and /or to be adopted during the different stages of the project have been detailed in **Table 28** for pre construction, construction and operation phases respectively.

1. Implementation Arrangements

484. The project will be implemented by the Project Implementation Unit National Highways and Infrastructure Development Corporation Limited (NHIDCL) of India at Sikkim. This is headed by the Project Director (PD). The Project Director is a Superintendent Engineer Level official. The PD will have one General Manager (Technical) rank official to look into day to day activities of project implementation. This General Manager will be supported by Manager Technical.

485. For Nepal portion also one Project Director has been appointed and PIU has been formed at Department of Roads Office at Damak in Jhapa district. The Project Director will be supported by the Assistant Engineer.

486. The PIU INDIA/PIU NEPAL will have one Environmental Expert. The responsibility of implementing the mitigation measures lies with the PIU INDIA/PIU NEPAL. The PIU will be supported by the Implementation Support Consultant (ISC) to monitor implementation of environment safeguards by the contractor and Authority Engineer. The ISC will have an Environmental Specialist. All construction activities being taken up by the contractors under the supervision of the Authority Engineer. The Authority Engineer will have a qualified environmental expert in their team to supervise EMP implementation along with construction works. The contractor will have one designate Environmental Expert in their team.

2. Environmental Monitoring

487. **Introduction.** The environmental monitoring programme provides such information on which management decision may be taken during construction and operational phases. It provides basis for evaluating the efficiency and adequacy of mitigation and enhancement measures and suggest further actions that need to be taken to achieve the desired effect.

488. The monitoring includes:

- Visual observations;
- Selection of environmental parameters at specific locations;
- Sampling and regular testing of these parameters.

489. **Objectives.** The objectives of the environmental monitoring programme are:

- Evaluation of the efficiency of mitigation and enhancement measures;
- Updating of the actions and impacts of baseline data;
- Adoption of additional mitigation measures if the present measures are insufficient;
- Updating mitigation measures if warranted by changes in project design or if any unanticipated impacts are experienced
- Generating the data, which may be incorporated in environmental management plan in future projects.

490. **Methodology.** Monitoring methodology covers the following key aspects:

- Components to be monitored;
- Parameters for monitoring of the above components;
- Monitoring frequency;
- Monitoring standards;
- Responsibilities for monitoring;
- Direct responsibility,
- Overall responsibility;
- Monitoring costs.

491. The environmental monitoring plan along with budget has been described in this chapter.

C. Environmental Budget

492. The environmental budget for the various environmental management measures proposed in the EMP is detailed in **Table 38**. The cost of Compensatory Afforestation and monitoring is also included in this budget. There are several other environmental issues that have been addressed as part of good engineering practices, the costs for which have been accounted for in the Engineering Costs.

493. The budget reflects this and while retaining the types of enhancement suggested, allows the selection of the locations at the discretion of the Authority's Engineer.

Table 38: Environmental Management Plan Matrix for Mechi Bridge and Approaches

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
PRE-CONSTRUCTION PHASE					
Inadequate compensation and other grievances	Refer Resettlement Plan for Details	Check land acquisition records; design drawings vs land plans Interview with affected persons Check status of employment given to local people during construction	MI: Payment of compensation and assistance to DPs as per RP Number of complaints/grievances related to compensation and resettlement PT: Minimal number of complaints/grievances. All cases of resettlement and rehabilitation if any are resolved at GRC level. No case referred to arbitrator or court.	National Highways and Infrastrucure Development Corporation Limited (NHIDCL) and PIU of Department of Roads, Nepal	Ministry of Road Transport and Highways (India) and Department of Roads (Nepal)
Tree clearance (116)	Compensatory plantation & additional plantation in available clear space Only marked trees to be felled. Compensatory plantation of 2300 trees. Removal of trees only within the corridor of impact (CoI) after joint verification with forest department.	Check budget provision for compensatory afforestation and additional plantation.	MI: Budget amount allocated for compensatory afforestation and additional plantation PT: Budget allocation is adequate	Contractor	Forest Department (India) for India portion and Forest Department (Nepal) for Nepal portion
Grubbing & levelling at Bridge and approach construction site	Removal of remains of trees to facilitate construction and carting away of remains Contractor will carry out the clearing of stumps and levelling Carting away will be done by the NHIDCL in India portion and DoR for Nepal portion after the stumps are removed from the ground.	Site inspection	MI: Presence/absence of cut tree stumps in the construction site PT: Tree stumps must be removed soon after tree cutting	Authority's Engineer and Contractor NHIDCL and PIU of Department of Roads, Nepal	PIU India/PIU Nepal

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
Siting of construction Camp	Site will be located at least at 500 m downwind from Panitanki, Kakarbhitta, and Mechi River and at least 1 km away from Khoribari Reserved forest at Panitanki Authority's Engineer and PIU INDIA/PIU NEPAL will approve the site chosen by the contractors Conditions will be put in contract document for location of site at above specified distances. Machinery and equipment area will be protected. Vehicle refuelling sites will be avoided in the flood plains of Mechi River	Site inspection	MI: Location of camp site and nearby landuse PT: Campsite is at least 100m away from Mechi river	Contractor	Authority's Engineer and PIU INDIA / PIU NEPAL
CONSTRUCTION PHASE (Earthworks; Construction works related bridge and approaches; camp site operation; procurement of material from quarries, crushers and borrow areas; traffic management during construction)					
Borrow pit exploitation causing loss of productive land (Borrow area development	Indemnity by contractors to NHIDCL PIU India/PIU Nepal against third party claims. Contractor will verify that enough quantity of borrow materials is available at identified 2 borrow pits	Site inspection. Check estimates for borrow material requirements	MI: Capacity and Location of borrow pits Top soil storage area PT: Zero complaints or disputes registered against contractor by land owner	Contractor	Authority's Engineer / NHIDCL PIU India/PIU Nepal
	Equitable agreement for borrow pit development will be reached between land owners and contractors including measures for post-restoration.			Contractor	Authority's Engineer / NHIDCL PIU India/PIU Nepal

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	Authority's Engineer will check restoration and post-restoration use. Contractors will submit plans to Authority's Engineer and PIU India/PIU Nepal for borrow pit exploitation and post-use restoration before commencement of work and implementation of approved plans. Inclusion of appropriate clauses in construction contracts, monitoring of compliance during construction and proper administration of contracts will be ensured.				
Erosion/damage to embankments at approaches in Nepal and India	Inclusion of appropriate items in specification for retaining wall or slope stabilisation measures, monitoring of compliance during construction of retaining wall and appropriate administration of contracts will be ensured.	Site inspection. Review engineering drawing for road and retaining walls	MI: Design of road embankment and protection wall PT: No erosion of embankment during monsoon	Contractor	Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
Sanitation and disposal facilities at construction workers' camp	Proper availability of drinking water and sanitation facilities at workers' camp Contractor will install temporary toilets with septic tank/soak pits. Septic tanks shall be pumped out by a waste management contractor as required. No impact on the surface or ground water is allowed. Contractor will provide suitable collection and disposal system for domestic refuse. For collection of domestic refuse dustbins will be provided. The collected waste may be disposed off at the nearest municipal land fill site. Hazardous waste will be stored, transported and disposed based on existing regulations.	Site inspection. Review of EHS practices and solid waste management system	MI: Sanitation and solid waste management plans PT: No water-borne diseases reported within the camp. No overflowing of septic tanks. No foul odor emanating from toilets. Wastes are segregated, recycled and properly disposed.	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
Cooking fuel at workers' camp	Workers' will be prohibited from using fuel wood for cooking. Contractor will ensure availability of kerosene oil/LPG. Inclusion of the above conditions in contract document will be ensured.	Site inspection.	MI: Indoor air quality PT: No fuel wood gathered and used for cooking No respiratory diseases reported arising from use of fuel wood.	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
Health facilities at workers' camp	Availability of first aid and health facilities The contractor will ensure first aid boxes in adequate numbers and make shift dispensary at camp. The above condition will be put in contract document.	Site inspection. EHS implementation plan.	MI: Log book of patients who availed of health facilities. Log book of available medicines. PT: Patients who availed of health facilities treated or referred to other hospitals.	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
HIV/ AIDs awareness campaign at workers' camp	Workers to be made aware of HIV/AIDs and protection measures. To organise awareness programme every month	Observation and checking attendance of workers who attended campaign / awareness programmes.	MI: No. of workers who attended HIV / AIDS seminars. PT: Zero HIV / AIDS incidence	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
Damage to services running parallel or across the alignment of Mechi Bridge and approaches during construction leading to interruption in supply	Relocation of any potentially affected services prior to commencement of any construction works, including water supply. Potentially affected services will be identified in design stage.	Site inspection and observation.	MI: No. of utilities that need to be relocated PT: Zero damage to utilities that will be affected	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Contractors will be responsible for identifying and safeguarding services adjacent to works and for compensating statutory undertakers for any accidental damage to such services. Service undertakers will be notified for relocation and necessary programming to avoid construction delays (incl. payments).	Site inspection and observation.	MI: No. of utilities that need to be relocated PT: Zero damage to utilities that will be affected	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	Relocation works to be completed by statutory undertakers before construction works start in accordance with an agreed programme.	Site inspection and observation.	MI: No. of utilities that need to be relocated PT: Zero damage to utilities that will be affected	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Inclusion of appropriate clauses in construction contracts; monitoring of compliance during construction and proper administration of contracts will be ensured.	Site inspection and observation.	MI: No. of utilities that need to be relocated PT: Zero damage to utilities that will be affected	Contractor	PIU INDIA/PIU NEPAL
Fire Prevention	Adopt safe work practice and have adequate fire-fighting facilities Provision of adequate fire-fighting equipment will be made.	Observation and site inspection.	MI: Emergency response plan. Working fire-fighting facilities. PT: Zero damage due to fire incidence.	Contractor	PIU INDIA/PIU NEPA
Presence of contractor's workforce increasing pressure on already strained local facilities including health & medical facilities	Contractor will provide own suitably equipped and staffed site emergency medical facilities. Inclusion of appropriate clauses in construction contracts; monitoring of compliance during construction and proper administration of contracts will be ensured.	Observation and site inspection.	MI: Medical facilities availability on site PT: Patients who availed of health facilities treated or referred to other hospitals.	Contractor	Authority's Engineer and PIU INDIA/PIU NEPAL
Incomplete post-use clearance and rein-statement of construction camps leading to loss of land productivity or	Contractor will prepare site restoration plans for approval of Authority's Engineer and PIU to implement these plans fully prior to demobilization. All temporary	Observation	MI: Site restoration plan PT: Zero complaint from affected land owners.	Contractor	Authority's Engineer and PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
additional costs for land owners to reinstate land	works sites to be notified by the contractor prior to use Inclusion of appropriate clauses in construction contracts; monitoring of compliance during construction and proper administration of contracts will be ensured. All sites will be photographed to record pre-use state. BOQ's will include nominated lump sum for reinstatement of temporary sites to peruse status.		Full use of reinstated construction camps.		
Pollution of land, ground water and surface water arising from sanitary and other wastes and spillages	During construction it will be ensured that contractor does not dispose off debris in Mechi River. Monitoring of compliance during construction and strict administration of contracts will be ensured.	Water quality sampling.	MI: Water quality parameter levels PT: Monitoring result within India and Nepal's water quality standards.	Contractor and Statutory Undertakers	Authority's Engineer, PIU INDIA/PIU NEPAL
	Vehicle maintenance and refuelling will be confined to areas under construction yard to trap discarded lubricant and fuel spills. Condition will be included in contract document	Site observation.	MI: Presence of spills and oil-based discards PT: No fuel spills nor discarded lubricants.	Contractor and Statutory Undertakers	Authority's Engineer, PIU INDIA/PIU NEPAL
	Sanitation waste from workers' camp will not be diverted to Mechi River. The	Water quality sampling. Site observation.	MI: Water quality parameter levels	Contractors and Statutory Undertakers	Authority's Engineer, PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	waste water will be diverted to septic tank. Separate septic tanks shall be used for disposal of sanitary waste.		PT: Monitoring result within India and Nepal's water quality standards.		
	Contractor to prepare, for PIU's approval detailed public health utilities plan for the workers camps and other works sites, which make adequate provision for safe disposal of all wastes and prevention of spillages, leakage of polluting materials, etc. Monitoring of compliance during construction and strict administration of contracts will be ensured.	Site observation.	MI: Public health utilities plan PT: No spillages nor leakage of polluting materials.	Contractor and Statutory Undertakers	Authority's Engineer, PIU INDIA/PIU NEPAL
	Contractor will be required to pay all costs associated with cleaning up any pollution caused by their activities and to pay full compensation to those affected Monitoring of compliance during construction and strict administration of contracts will be ensured.	Survey of people affected	MI: Payment mechanisms for affected persons caused by pollution PT: Zero complaint from affected persons caused by pollution done by contractor	Contractor and Statutory Undertakers	Authority's Engineer, PIU INDIA/PIU NEPAL
Contractor's water abstraction resulting in depletion of scarce water resources with local users and	Contractor will make suitable arrangements for own supply and protection of water bodies from pollution	Site inspection	MI: Water quality of Mechi River	Contractor	Authority's Engineer, PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
pollution of surface water bodies (Mechi River and other streams) from construction activities	Silt fencing will be provided all around the base of the stockpile of materials wherever material is stockpiled near water bodies. Monitoring of compliance during construction and strict administration of contracts will be ensured.		PT: Monitoring result within India and Nepal's water quality standards		
Construction traffic causing pavement and structure damage to roads due to overloading, increasing congestion and increased road safety hazards	Contractor will use appropriate vehicles and to comply with legal gross vehicle and axle load limits Monitoring of compliance during construction and strict administration of contracts will be ensured.	Observation	MI: Axle load limits of vehicles PT: Axle load limits of vehicles within set guidelines	Contractor	Authority's Engineer, PIU INDIA/PIU NEPAL
	Contractors will repair damage to any road at own expense The Authority's Engineer will ensure preparation and enforcement of traffic management plans.	Observation	MI: Presence of potholes attributed to contractor's work PT: Zero potholes or damages	Contractor	Authority's Engineer, PIU INDIA/PIU NEPAL
	Contractor will minimise road safety hazards and inconvenience to other road users by taking appropriate measures such as proper diversions, signages, etc. Monitoring of compliance during construction and strict administration of contracts will be ensured.	Observation	MI: Presence of signages relevant to contractor's work PT: Zero accidents or incidents	Contractor	Authority's Engineer, PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
Road safety hazards associated with temporary traffic diversions	Contractor will take all reasonable measures to minimise interference with traffic flow at Kakarbhitta and Panitanki and to provide safe transit at diversions. The contractor will maintain two way traffic at diversions and will inform the local traffic police about the traffic diversion Monitoring of compliance during construction and strict administration of contracts will be ensured.	Observation. Traffic management plan Observation: Monitoring of traffic accidents	MI: Presence of signages relevant to contractor's work Presence of traffic personnel to manage the traffic, Number of accidents PT: Zero accidents or incidents Smooth flow of traffic	Contractor	Authority's Engineer and PIU INDIA/PIU NEPAL
Air pollution from Hot Mix Plant, concrete batching plant, construction yard and due to movement and operation of construction vehicles and machinery	Construction camps will be located in open areas and away from residential complexes Monitoring of air pollution and timely action to decrease the pollutant concentration by appropriate measures will be taken up.	Observation Air quality sampling	MI: Air quality parameter levels PT: Air quality within national standards Zero complaint from affected residents	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Trucks carrying construction material will be covered with tarpaulin sheet to avoid spilling. The Authority's Engineer will enforce the mitigation measures suggested through efficient monitoring.	Observation Air quality sampling	MI: Air quality parameter levels PT: Air quality within national standards	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Water sprinkling will be carried out in mornings and	Observation Air quality sampling	MI: Water quality sprinkling done	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	evenings on haul roads and compact surface. The Authority's Engineer will enforce the mitigation measures suggested through efficient monitoring.		PT: Air quality within national standards		
	Vehicles and construction machinery will be maintained to conform emission standards specified by West Bengal Pollution Control Board The Authority's Engineer will enforce the mitigation measures suggested through efficient monitoring.	Observation Air quality sampling	MI: Air quality parameter levels PT: Air quality within national standards	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Stock piled sand and stone will be wetted before loading. Construction debris shall be disposed only at designated sites. The Authority's Engineer will enforce the mitigation measures suggested through efficient monitoring.	Observation Air quality sampling	MI: Presence of construction debris PT: Zero construction debris	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
Noise Levels	Construction camp will be located in open areas as far as possible from residential areas Condition will be included in contract document	Noise level sampling	MI: Noise level appropriate for the zone PT: Zero complaint from residents Noise level within standard	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	All equipment will be maintained in good working order, properly designed	Observation	MI: Noise level appropriate for the zone PT: Noise level within standard	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	engine enclosures and inbuilt silencers. Condition will be included in contract document				
	Construction work will be prohibited between 10.0 PM – 6.00 A.M. near residential areas. Condition will be included in contract document	Observation	MI: Report on construction work done during prohibited hours PT: Zero complaint from residents	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
	Noise barriers will be constructed near the cluster of houses located near the access road on the Nepal side in consultation with the local residents	Review of noise barrier design Visual observation	MI: design of noise barrier, noise barrier PT: Noise barriers constructed in consultation with the residents of houses located along the approach road	Contractor	PIU INDIA/PIU Nepal, AE
Relocation of common property resources	01 Hand Pumps, 1 temples, 2 check posts, and one entrance gate are falling in the proposed RoW. These need to be relocated/rebuild in case of Public assets or the owners need to be compensated in case of private asset Condition will be included in contract document	Site inspection. Resettlement Action Plan	MI: Affected stakeholders consultation; Coordination with appropriate agencies PT: Zero complaint from affected stakeholders. Resettlement plan followed.	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer
Accidents Hazards and Safety	The contractor will prepare a safety manual for all activities of construction as well as activities at construction camps. This manual will have safety measures to be adopted. The safety procedure for transportation of construction materials will also be detailed.	Safety Manual provisions Observation	MI: Safety protocols; Number of EHS related incidents and accidents PT: Zero incidents and accidents.	Contractor	PIU INDIA/PIU NEPAL, Authority's Engineer

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	Condition will be included in the contract document				
Negative Impact on Flora due to Cutting of Trees and removal of vegetation	To compensate for 116 (40 in India and 76 in Nepal) numbers of trees to be cut, 2300 (400 in India and 1900 in Nepal) numbers of trees will be planted. The project authorities will deposit necessary funds to the State forest department West Bengal and Forest Department, Government of Nepal as part of tree cutting permission for the compensatory afforestation.	Afforestation Plan	MI: Percent survival of replaced trees PT: At least 90% survival of trees.	Authority's Engineer, Contractor	PIU INDIA/PIU NEPAL, Forest Departments (India and Nepal)
Negative Impact on Fauna	The compensatory plantation will provide nesting ground to avifauna as this will be done in available space on either side of road. Construction workers shall be trained about safe handling of animals if found by chance. Cost of training built into training component cost. Construction workers will be trained not to go for fishing in water bodies Necessary training to workers not hunt the animals and birds	Observation	MI: Percent survival of replaced trees PT: At least 90% survival of trees.	PIU INDIA/PIU NEPAL , Authority's Engineer, Contractor	PIU INDIA/PIU NEPAL, Forest Departments (India and Nepal)
Occupational Safety and Health	Construction workers will be provided with personal protective equipment (PPE)	Observation OSH Plan	MI: PPE availability and utilized by workers	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	such as earplugs, helmets, safety shoes, gloves, etc. The contractor will ensure adequacy and availability of PPEs.		PT: Zero incidents and accidents		
Siltation into Mechi River	The siltation will be avoided by not storing the construction material, construction waste, excavated earth, etc. near the banks of Mechi River and in Flood Plains of Mechi River Conditions will be included in contract document.	Water quality sampling Observation	MI: Presence of stored materials near Mechi River Bank PT: TSS within standards	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL
Contamination of water from construction wastes	a) All measures will be taken to prevent the waste water produce in construction from entering directly into Mechi River as directed by Authority's Engineer b) Construction works near surface water sources shall be avoided during monsoon c) The discharge standards promulgated under the Environmental Protection Act, 1986 shall be strictly adhered to. Conditions will be included in contract document.	Water quality sampling Observation	MI: Water quality parameter levels PT: Water quality within standards	Authority's Engineer and Contractor	\PIU INDIA/PIU NEPAL
Environmental monitoring during Construction Phase	Ambient air quality to be measured once in a season (except monsoon) at location	Air quality sampling	MI: Air quality parameter levels PT: Air quality within standards	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
	specified in monitoring plan along project bridge. Records will be maintained for reporting and for future reference.				
	Water quality (ground and surface) to be monitored once in a season except monsoon at locations specified in monitoring plan. Records will be maintained for reporting and for future reference.	Water quality sampling Observation	MI: Water quality parameter levels PT: Water quality within standards	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL
	Noise levels to be monitored once in a season at locations specified in monitoring plan. Records will be maintained for reporting and for future reference.	Noise quality sampling Observation	MI: Noise level PT: Noise level within standards	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL
	Soil quality in agriculture field along RoW of Bridge and approaches to be monitored once in a season except monsoon. Records will be maintained for reporting and for future reference.	Observation	MI: Productivity level of soil used for agriculture PT: Zero debris or contamination in soil used for agriculture	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL
	Monitoring of construction sites for arrangements made for protection measures at storage areas, drainage arrangement, and sanitation at construction camp. Inspection of construction camps for sanitation Records will be maintained for reporting and for future reference.	Observation Construction site management plan	MI: Construction site management plan guidelines PT: Zero breach of guidelines in the implementation of construction site management plan	Authority's Engineer and Contractor	PIU INDIA/PIU NEPAL

Environmental Issues/Impacts	Enhancement/ Mitigation Measures	Monitoring Method	Monitoring Indicator/Performance Target	Responsibilities	
				Implementation	Monitoring
Operations Phase					
Increased Air Pollution	Ambient air quality monitoring at locations specified in monitoring plan Monitoring frequency is thrice a year for initial period of 2 years	Air quality sampling	MI: Air quality parameter levels PT: Air quality within national standards	NABL approved monitoring agency	PIU INDIA/PIU NEPAL
Noise Pollution	Noise pollution monitoring at locations specified in monitoring plan Monitoring frequency is thrice a year for a period of 2 years.	Noise level sampling	MI: Noise levels PT: Noise levels within national standards	NABL approved monitoring agency	PIU INDIA/PIU NEPAL
Water Pollution	Monitoring of surface and ground water quality at locations specified in monitoring plan Monitoring frequency is once in a season for a period of 2 years	Water quality sampling	MI: Water quality parameter levels PT: Water quality within national standards	NABL approved monitoring agency	PIU INDIA/PIU NEPAL
Soil Characteristics	Monitoring of soil quality of agricultural field close to RoW Monitoring frequency is once in season except monsoon for 2 years	Observation	MI: Presence of debris or contamination PT: No contamination of soil used for agriculture	NABL approved monitoring agency	PIU INDIA/PIU NEPAL

D. Environmental Monitoring Programme

494. Monitoring programme has the underlying objective to ensure that the intended environmental mitigations are realized and result in desired benefits to the target population causing minimal deterioration to the environmental parameters. Such a programme targets the 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; and
- To meet the requirements of the existing environmental regulatory framework and community obligations.

1. Performance Indicators

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

- Air Quality with respect to $PM_{2.5}$, PM_{10}, NOx, CO and SO_2 at selected locations.
- Water Quality as per IS 10500:2012 and Surface water Quality as Specified by Central Pollution Control Board.
- Noise levels near habitations, construction sites, and sensitive receptors close to project site. The noise sensitive receptors include schools, hospitals and community/ religious places.
- Survival rates of trees planted as a compensatory plantation to compensate for the lost trees.

a. Ambient Air Quality (AAQ) Monitoring Parameters

496. Ambient air quality parameters recommended for monitoring in road project are $PM_{2.5}$, PM_{10}, Carbon Monoxide (CO), Oxides of Nitrogen (NOx), and Sulphur Dioxide (SO_2). These are to be monitored, right from the commencement of construction activity at construction camp sites, crushers on sites, excavation works etc. Data should be generated once in a season excluding monsoon at the monitoring locations in accordance with the National Ambient Air Quality Standards formulated by MoEFCC in 1981.

b. Water Quality Monitoring

497. The physical and chemical parameters recommended for analysis of water quality, relevant to current project are pH, total solids, total dissolved solids, total suspended solids, oil and grease, coliform, BOD, COD, Chlorides, Lead, Zinc, Iron, Arsenic and Cadmium. The location, duration and the pollution parameters to be monitored and the responsible institutional arrangements are given in the Environmental Monitoring Programme. The location of water quality monitoring will be the same as have been done in baseline studies.

c. Noise Level Monitoring

498. The measurements for monitoring noise levels would be carried out at habitations and construction sites along the alignment of bridge and approaches. The Ambient Noise Standards formulated by the Central Pollution Control Board (CPCB) in 1989 or the standards by the West Bengal Pollution Control Board if such standards are stricter than those of the CPCB are to be complied with. Sound pressure levels would be monitored on twenty-four hour basis. Noise should be recorded at “A” weighted frequency using a “slow time response mode” of the measuring instrument. Locations of noise monitoring have been given in **Table 39**.

d. Success of Re-vegetation

499. The bridge site and surroundings are located in the alluvial area that receives good monsoon rainfall. The implementation of the project will involve cutting of vegetation and trees. Compensatory plantation is required to replace the lost vegetation and trees. As per the guidelines of The State Forest Department compensatory afforestation has to be carried out @ 1:10 (India side) and 1:25 (Nepal side) i.e. for every tree to be cut ten trees (on India side) and twenty five trees (on Nepal side) will be planted. The implementing agency with the help of the Forest Department will monitor these compensatory plantations. Such monitoring will be conducted through random samples. Such sampling should cover at least 50% of the total length. There will be monitoring every year before the onset of monsoon and a 90% survival will be maintained. Any deficiency noted will be planted in the monsoon season.

e. Soil Quality

500. Soil quality monitoring has been done to establish a baseline scenario in terms of soil fertility contamination with pollutants, texture, etc. In order to see changes in soil quality parameters, soil monitoring has been recommended during pre-construction, construction and operation phases. The parameters of soil quality monitoring are colour, texture and class, sand, silt and clay percentages, bulk density water holding capacity (%), Phosphorus, available Potassium, organic Carbon, Lead, Arsenic, Iron, Sulphate, Chloride, Calcium, Copper, Zinc, Manganese, moisture Infiltration Capacity, alkalinity, acidity, Sodium absorption ratio, Sodium Carbonate and Sodium Chloride. The locations of soil monitoring have been given in monitoring plan.

2. Monitoring Plan

501. The monitoring plan covering various performance indicators, frequency and institutional arrangements of the project in the construction and operation stages, along with the estimated cost, is summarized in **Table 41** and **Table 42**.

Table 39: Environmental Monitoring Plan and Parameters

Environment component	Project Stage	REGULAR MONITORING PARAMETERS						Institutional Responsibilities	
		Parameters	Standards	Location	Frequency	Duration	Action plan in case criteria exceeds	Implementation	Supervision
Air	Construction stage	PM10, PM2.5, SO_2, NO_x, and CO	CPCB	At Construction camp	Once in a season excluding the monsoon for 3 years	Continuous 24 hours/ or for 1 full working day when Hot Mix Plant, concrete batching plant and other machinery is under operation	Check and modify control devices like bag filter/cyclones	Contractor through approved monitoring agency	Authority's Engineer
		PM10, PM2.5, SO_2, NO_x, and CO	CPCB	At Kakarbhitta (Nepal) and Panitanki (India)	Once in a season excluding the monsoon for 3 years	Continuous 24 hours/ or for 1 full working day	Check and modify control devices	Contractor through approved monitoring agency	Authority's Engineer
	Operation stage	PM10, PM2.5, SO_2, NO_x, and CO	CPCB	At locations of baseline monitoring At Kakarbhitta (Nepal) and Panitanki (India)	Thrice in a year (winter, summer and post monsoon seasons) for 2 years	Continuous 24 hours/ or for 1 full working day	-	PIU Environmental Cell through approved monitoring agency	PIU-India/ PIU-Nepal
Surface Water Quality	Construction stage	Drinking Water Parameter as defined in IS 10500:2012 and Surface water standards of Central Pollution Control Board.	Surface Water quality standards IS:10500-2012	Mechi River (upstream and downstream of bridge site, total 2 locations)	Once in a season excluding the monsoon for 3 years	Grab Sample	Check and oil interceptors, Silt fencing devices.	Contractor through approved monitoring agency	Authority's Engineer

Environment component	Project Stage	REGULAR MONITORING PARAMETERS						Institutional Responsibilities	
		Parameters	**Standards**	**Location**	**Frequency**	**Duration**	**Action plan in case criteria exceeds**	**Implementation**	**Supervision**
	Operation stage	Drinking Water Parameter as defined in IS 10500:2012 and Surface water standards of Central Pollution Control Board	Surface Water quality standards (IS:10500-2012)	At locations of baseline monitoring (Mechi River)	Once in a season excluding the monsoon for 2 years	Grab Sample	Check and modify oil interceptors, Silt fencing devices.	PIU environmental cell through approved monitoring agency	PIU-India/ PIU-Nepal
Ground Water Quality	**Construction stage**	Drinking Water Parameter as defined in IS 10500: 2012	Drinking water standards (IS: 10500-2012)	At identified locations (same as in baseline monitoring)- At Kakarbhitta (Nepal) and Panitanki (India)	Once in a season excluding the monsoon for 3 years	Grab Sample	Check and modify oil interceptors, Silt fencing devices.	Contractor through approved monitoring agency	Authority's Engineer
	Operation stage	Drinking Water Parameter as defined in IS 10500: 2012	Ground Water quality standards by CPCB	At identified 2 locations - At Kakarbhitta (Nepal) and Panitanki (India)	Once in a season excluding the monsoon for 2 years	Grab Sample	Check and modify oil interceptors, Silt fencing devices.	PIU environmental cell through approved monitoring agency	PIU-India/ PIU-Nepal
Noise levels	**Construction stage**	L_{eq} dB(A) (Day & Night), Average and Peak values	Noise standards by CPCB	One on construction camp and at maximum 2 locations at bridge approaches where work is in progress	Once in a season excluding the monsoon for 3 years	Readings to be taken at 60 seconds interval for every hour and then L_{eq} are to be obtained for Day time and Night time	Check and modify equipment and devices used to protect noise level.	Contractor through approved monitoring agency	Authority's Engineer

Environment component	Project Stage	REGULAR MONITORING PARAMETERS						Institutional Responsibilities	
		Parameters	**Standards**	**Location**	**Frequency**	**Duration**	**Action plan in case criteria exceeds**	**Implementation**	**Supervision**
	Operation stage	L_{eq} dB(A) (Day & Night), Average and Peak values	Noise standards by CPCB	At locations of baseline monitoring) - At Kakarbhitta (Nepal) and Panitanki (India)	Once in a season excluding the monsoon for 2 years	Readings to be taken at 60 seconds interval for every hour and then L_{eq} are to be obtained for Day time and Night time	-	PIU environmental cell through approved monitoring agency	PIU-India/ PIU-Nepal
Soil	**Construction stage**	Physical Parameters: Texture, Grain Size Distribution, Gravel, Sand, Silt, Clay; Chemical Parameters: pH (10%w/v slurry), Conductivity, Calcium, Magnesium, Sodium, Potassium, Sodium Absorption Ratio, Total Nitrogen, Phosphorous, Organic matter	Baseline	Near construction sites along the proposed bridge construction site (one location close to site)	Once in a season excluding the monsoon for 3 years	-	-	Contractor through an approved monitoring agency	Authority's Engineer

Environment component	Project Stage	REGULAR MONITORING PARAMETERS						Institutional Responsibilities	
		Parameters	**Standards**	**Location**	**Frequency**	**Duration**	**Action plan in case criteria exceeds**	**Implementation**	**Supervision**
	operation Stage	Physical Parameters: Texture, Grain Size Distribution, Gravel, Sand, Silt, Clay; Chemical Parameters: pH (10%w/v slurry), Conductivity, Calcium, Magnesium, Sodium, Potassium, Sodium Absorption Ratio, Total Nitrogen, Phosphorous, Organic matter	Baseline	At locations of baseline monitoring (Agriculture fields) near Panitanki (India))	Once in a season excluding the monsoon for 2 years	-	-	PIU through an approved monitoring agency	Authority's Engineer
Construction Sites and Construction Camps	**Construction Stage**	Monitoring of: 1. Storage Area 2. Drainage Arrangements 3. Sanitation in Construction Camps	As specified by the Construction Managers of the contractor	At Storage area and construction camps	Quarterly in the construction stage.	-	Check sanitation/ drainage and standards of camp sites and bring up to level of satisfaction of Authority's Engineer	Contractor	Authority's Engineer
Survival Plantation and Vegetation	**Construction Stage**	Monitor Plantation survival rate and maintain a minimum 90% survival	Minimum 90% Survival rate	In RoW of bridge and approaches.	Every Year prior to Monsoon	Every year till end of construction period.	Make up for any loss less than 90% in monsoon	Contractor	Authority's Engineer

Environment component	Project Stage	REGULAR MONITORING PARAMETERS						Institutional Responsibilities	
		Parameters	**Standards**	**Location**	**Frequency**	**Duration**	**Action plan in case criteria exceeds**	**Implementation**	**Supervision**
	Operation Stage	Monitor Plantation survival rate and maintain a minimum 90% survival	Minimum 90% Survival rate	At side slopes median and available space in RoW	Every Year prior to Monsoon for 3 years	For first 3 years.	Make up for any loss less than 90% in monsoon	State Forest Department, GoWB and Forest Department, GoN	NHIDCL-India/ DOR-Nepal

E. Environmental Reporting System

502. Monitoring and evaluation are critical activities in implementation of all projects. Monitoring involves periodic checking to ascertain whether activities are going according to the plans. It provides the necessary feedback for project management to keep the programme on schedule. In contrast, evaluation is essentially a summing up at the end of the project to assess whether those activities were actually achieved as was intended.

503. The reporting system will operate linearly with the contractors who are at the lowest rung of the implementation system reporting to the Implementing Agency (IA). There will be a single contractor for the entire project. The implementing agency in the current project is the National Highways and Infrastructure Development Corporation Limited of India - PIU Sikkim for India portion and PIU at DoR Damak for Nepal portion. All reporting by the contractor shall be on a quarterly basis. The respective PIUs shall be responsible for preparing targets for each of the identified EMP activities.

504. While on site inspections and monitoring will be carried out on a monthly basis the compliance monitoring on environmental components may be submitted to the PIUs quarterly during the implementation period and annually for disclosure on the ADB website.

505. Responsibilities for overseeing will rest with the Environmental Experts of both the PIUs. The Environmental Experts of PIUs will be ensuring that actions taken are in accordance with contract and specification clauses, and specified mitigation measures in the EMP.

506. During the implementation period, a compliance report may include a description of the items of EMP, which were not complied with by any of the responsible agencies. It would also report to the management about actions taken to enforce compliance.

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

508. The reporting system has been prepared for each stage of construction namely:

- Pre construction stage
- Construction Stage
- Operation Stage
- This reporting shall be done through:
- Reporting by the Contractor to both the PIUs

509. The stage-wise reporting system is detailed out in the following **Table 40**.

Table 40: Suggested Stage-Wise Reporting System

S. No	Item	Contractor	Supervision / Monitoring	
		Implementation and Reporting to PIUs		
Construction Stage				
1	Supervision of construction site and construction camp	Before start of work	-	Quarterly
2	Target sheet for Pollution Monitoring	-	As required	After Monitoring
3	Target sheet for compensatory plantation	-	Quarterly	Annually
Operation Stage				
1	Target sheet for Pollution Monitoring	-	Quarterly	Annually
2	Target sheet for survival reporting of compensatory plantation	-	Annually	Annually

F. Monitoring Plan Budget

510. An environmental monitoring budget has been allocated for the construction as well as operation phase. This amount has also been included in the Environmental Budget in **Chapter 8**. The details of environmental monitoring budget are given in **Table 41**.

Table 41: Environmental Monitoring Budget (Construction and Operation Phase)

Component	Stage	Item	Unit	Unit Cost (Rs.)	Quantity	Total Cost (INR)
Monitoring costs						
Air	Construction	Monitoring at construction camp	No. of Samples	10,000	At one location once in a season excluding monsoon for 3 years. (9 Samples)	90,000.00
		Monitoring at construction sites	No. Of Samples	10,000	At total 2 locations once in a season excluding monsoon for 3 years (18 samples)	180,000.00
	Operation	Ambient Air Quality Monitoring (at 2 Locations where baseline Monitoring Done)	No. Of Samples	10,000	At 2 locations for 2 years and once in each season excluding monsoon (total 12 samples)	120,000.00
Water Quality	Construction	Surface Water Quality	No. of Samples	10,000	Mechi River upstream and downstream of bridge construction site once in a season excluding monsoon for 3 years (18samples)	180,000.00

Component	Stage	Item	Unit	Unit Cost (Rs.)	Quantity	Total Cost (INR)
		Ground Water Quality (Along RoW)	No. of Samples	10,000	At 02 locations once in a season excluding monsoon for 3 years (18 Samples)	180,000.00
	Operations	Surface Water Quality (As per suggestion in monitoring plan)	No. of Samples	10,000	At 02 locations (one upstream and one downstream) once in each season excluding the monsoon season for 2 years (12sample)	120,000.00
		Ground Water Quality (As per recommendation in monitoring plan)	No. of Samples	10,000	At 02 locations once in each season excluding the monsoon season for 2 years (total 12 sample)	120,000.00
Noise	Construction	At equipment yards/ Concrete Batching plants / Construction Camp	No. of Samples	3,000	At construction camp once in each season excluding the monsoon season for 3years (9 Samples)	27,000.00
		At maximum 2 locations where work is in progress	No. of Samples	3,000	At 02 location once in each season excluding the monsoon season for 3 years (18Samples)	54,000.00
	Operation	At 02 locations where baseline monitoring done	No. of Samples	3,000	At 02 locations Thrice in a year for 2 years (12Samples)	36,000.00
Soil	Construction	At productive agricultural lands abutting traffic detours, construction camp , agriculture fields near camp sites, construction sites	No of Samples	6,000	At 01 location once in each season excluding monsoon for 3years (9 samples)	54,000.00
	Operation	At locations of baseline monitoring	No of Samples	6,000	At 01 Locations once in each season excluding monsoon for 2years (6 Samples)	36,000.00
Plantation	Operation	All along the project		Lumpsum	Once every year after monsoon for 3 years	600,000.00
Total Monitoring Costs Mechi Bridge and Approaches						**INR 1,797,000 say INR1.8 Millions**

Note: Sample Rates are based on Current Market Rates.

Table 42: Environmental Management Plan Budget for Mechi Bridge and Approaches

Environmental Budget for Mechi Bridge and Approach Roads

	Item	Unit	Unit Cost (INR)	Quantity	Total Cost (INR)	Cost Allocation
1.	Plantation including Compensatory plantation @ 10 saplings for each tree felled (40 x 10 = 400) including 3 years maintenance on India side	No.	2021* No.	400	1,999,003	Civil works cost (To be implemented by contractor)
2.	Plantation including Compensatory plantation @ 25 saplings for each tree felled (76 x 25 = 1900) including 3 years maintenance on Nepal side	No.	2021	1900	3,839,900	Civil works cost (To be implemented by contractor)
3	Provide the Noise barriers near residential areas. The noise barriers of hollow brick wall/reinforced concrete panels with height of 3.5m. The design of the noise barrier shall be approved by the engineer in charge**.**	Meter	200	7,500	1,500,000	Civil works cost (To be implemented by contractor)
4	Monitoring of air and water quality and noise levels as given in the Environmental Monitoring Plan				1,797,000.00	Civil works cost (To be implemented by contractor)
			TOTAL		**7,338,903.00**	
			Contingency @5%		**366,945.00**	
			GRAND TOTAL		**7,705,848.00**	

*Sapling cost + fencing material +labor cost = 821, watering, pesticide = Rs. 100 per tree per quarter for 12 quarter (900 +1200=2021)

G. Grievance Redress Mechanism

511. Grievances related to the implementation of the project, particularly regarding the environmental management will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken and their outcomes will be properly maintained and form part of the semi-annual environmental monitoring report to ADB.

512. Depending on the nature and significance of the grievances or complaints, the grievance redress mechanism (GRM) will comprise procedures to address grievances i) first at the PIU level and ii) second at the EA level and iv) third at the Grievance Redress Committee (GRC). Most serious complaints which cannot be addressed at the EA level will be forwarded to the GRC. The GRC will comprise members from the EA, IA, Authority's Engineer, contractor, local community, women groups and local forestry authority.

513. All the parties involved in project implementation i.e. contractor, engineer, and employer will maintain complaint registers at their following respective offices:

- Contactor's main site offices i.e. office of the Project Manager,
- Supervision Consultant's main site office i.e. office of the Engineer's Representative; and
- PIU office i.e. Employer's field office.

514. Environment complaints will be received through the Grievance Focal Point (GFP), these will be designated personnel from within the community and appointed by the community, who will be responsible for receiving the Environmental complaints. The Contractor will record the complaint in the onsite Environmental Complaints Register (ECR) in the presence of the GFP.

515. All public complaints regarding environmental issues received by GFP 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. The Executive Engineer and Engineer's Representative will immediately communicate the details of the complaint to the Contractor. The Environment and Safety Officer (ESO) of the contractor will promptly investigate and review the environmental complaint and implement appropriate corrective actions to mitigate the cause of the complaints. The Engineer's Representative will decide on the exact time frame within which the action will be taken on case-to-case basis depending on the nature and sensitivity of the same. However, in all the cases, it will be responsibility of the contractor to take action immediately upon receiving any complaint. The contractor will report to Engineer's Representative about the action taken on the complaint, within 48 hours of receiving the complaint, for his further intimating to PIU and the Executive Engineer. The person making a complaint would be intimated by the complaint receiving person or his representative, about the action taken, within 48 hours, along with his/her feedback. Figure 25 shows the proposed Grievance Redress Mechanism.

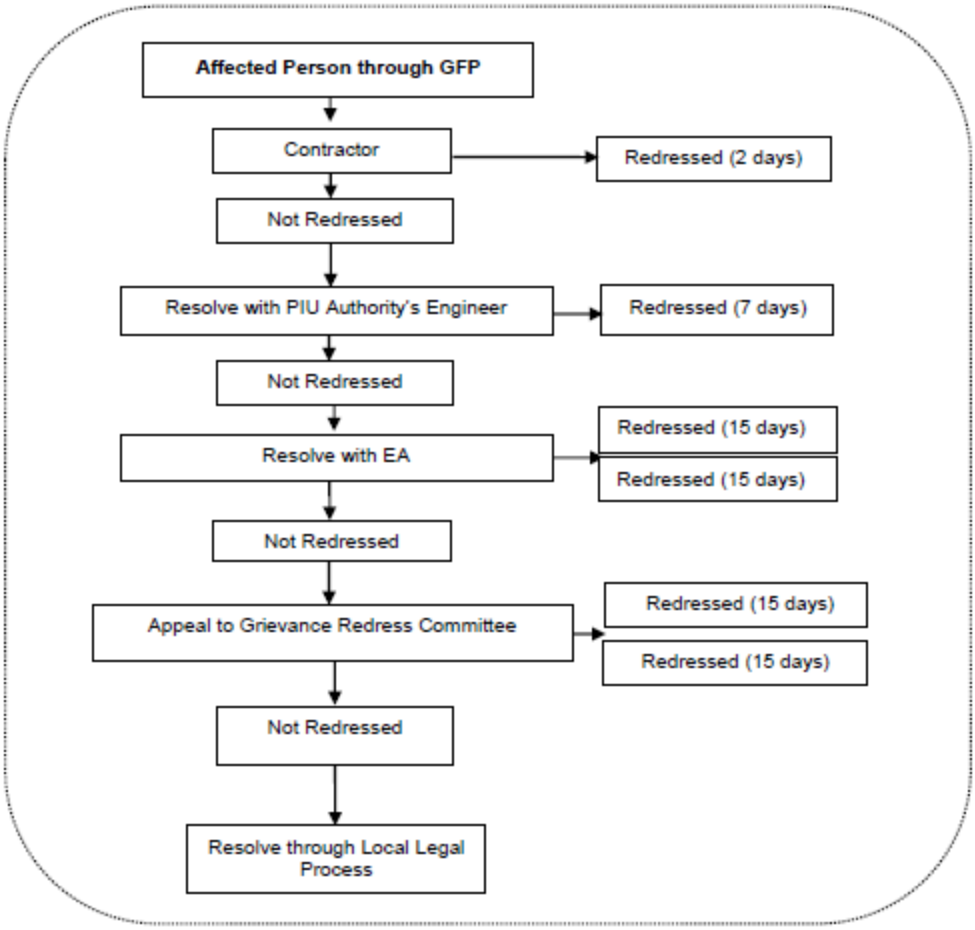


Figure 25: Grievance Redress Mechanism

IX. CONCLUSIONS AND RECOMMENDATIONS

A. Findings and Recommendations

516. The proposed Mechi Bridge and its approaches do not involve any interventions in and around the natural and cultural heritage destinations and have insignificant (direct/indirect) environmental impacts. It is expected that the bridge will enhance economic growth and livelihood opportunities for local communities through better connectivity between India and Nepal.

517. This IEE has identified minor likely impacts on air, water, soil and noise during construction and operation period and has defined mitigation measures. These mitigation measures will be implemented and monitored during the project construction and operation period.

518. The specific management measures laid down in the IEE will effectively address any adverse environmental impacts due to the proposed Bridge construction and functioning. The effective implementation of the measures proposed will be ensured through the building up of capacity towards environmental management within the PIUs with the technical expertise of a Safeguards Specialist as part of the Authority's Engineer Consultants. Further, the environmental monitoring plans provide adequate opportunities towards course correction to address any residual impacts during construction or operation stages.

519. On the basis of the IEE It is expected that the proposed project components have only minor, negative, localized, temporary and less significant environmental impacts. These impacts can be easily mitigated through adequate mitigation measures and regular monitoring during the design, construction and post construction phase of the project. It is recommended that PIUs (India and Nepal) should have monitoring responsibility in environmental issues of project to ensure the environmental sustenance.

520. It is recommended that proposed bridge construction and operation may be implemented with proper mitigation measures to protect the environment. For this EMP and monitoring plan given in this IEE should be followed. If there are any changes in project design and scope or experience of impacts that were not anticipated in this IEE, the need for updating the IEE or/and EMP will need to be reviewed by the EA and communicated to ADB.

B. Conclusions

521. The construction of proposed Mechi Bridge and approaches can be done without any major environmental impacts and is beneficial to the immediate vicinity of the project area and also for India and Nepal. As per the site visits, followed by discussion with stakeholders and public no major adverse impacts are anticipated. Further, there are hardly any significant environmental impacts that may arise during construction and operation period. The construction phase is of short duration i.e. three years.

522. Based on the findings of the IEE, the classification of the project as Category "B" is confirmed, and no further special study or detailed EIA needs to be undertaken to comply with ADB SPS (2009).

APPENDIX 1: RAPID ENVIRONMENTAL ASSESSMENT (REA) CHECKLIST

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES), for endorsement by Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title: India / South Asia Subregional Economic Cooperation Road Connectivity Investment Program Tranche 2 Mechi Bridge

Sector Division: SATC

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area adjacent to or within any of the following environmentally sensitive areas?			
▪ Cultural heritage site		√	
▪ Protected Area		√	There are no environmentally sensitive/ protected areas in or near the project area
▪ Wetland		√	
▪ Mangrove		√	
▪ Estuarine		√	
▪ Buffer zone of protected area		√	
▪ Special area for protecting biodiversity		√	
B. Potential Environmental Impacts Will the Project cause…			
▪ encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?		√	
▪ encroachment on precious ecology (e.g. sensitive or protected areas)?		√	
▪ alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?	√		The bridge is located in the high rainfall zone which is prone to flooding. Controlled construction activities will ensure minimization of sediment discharge into the river

Screening Questions	Yes	No	Remarks
▪ deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	√		During construction period suitable mitigation measures will be required to control the silt runoff. Adequate sanitary facilities and drainage in the workers camps will help to avoid this possibility. As the construction activity in this project will not contain any harmful ingredients, no impact on surface water quality is anticipated.
▪ increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?	√		With appropriate mitigation measures and use of most modern environment friendly equipment/machineries air pollution shall be reduced to permissible levels.
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?	√		Possible. With appropriate mitigation measures such risks would be minimized.
▪ noise and vibration due to blasting and other civil works?	√		No blasting will be required. However short term minor impact may occur during construction period, Suitable mitigation measures will be required to minimize the adverse effects
▪ dislocation or involuntary resettlement of people?	√		Yes. A Resettlement Plan is being prepared separately and compensation shall be paid as per approved entitlement matrix.
▪ dislocation and compulsory resettlement of people living in right-of-way?	√		Yes. A Resettlement Plan is being prepared separately and compensation shall be paid as per approved entitlement matrix.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		√	
▪ other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress?	√		Imposing of appropriate mitigation measures in contract agreement to keep the air pollution within permissible levels will keep a check on this problem.
▪ hazardous driving conditions where construction interferes with pre-existing roads?	√		To minimized the impact, suitable traffic management plan will be required
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?	√		Proper provisions for sanitation, health care and solid waste disposal facilities will be available in the contract documents to avoid such possibility. Workers will be made aware about communicable diseases

Screening Questions	Yes	No	Remarks
▪ creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?	√		Stagnant water bodies and unhygienic conditions harboring rodents and other pests will be avoided. Mosquito nets and insect repellents will be provided.
▪ accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials?	√		Adoption of suitable traffic control and signage system at sensitive places will reduce such possibility. Suitable emergency response system will be established for such incidents
▪ increased noise and air pollution resulting from traffic volume?	√		Mitigation measures along with a monitoring plan will be implemented incase air pollution and noise levels significantly exceed the baseline levels and/or WB-EHS standards
▪ increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?	√		Proper management construction materials and waste and control of construction activities will reduce this possibility.
▪ social conflicts if workers from other regions or countries are hired?		√	Impacts will be limited as it is likely majority of the workers will be from the locality.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		√	- Impacts will be minor as majority of workers will be from the locality. - The workers camp sites should be located outside residential and market areas. - Water and other social services and infrastructure will be sourced/used through ways that do not interfere with the local community
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?	√		- Possible. EMP shall be followed to minimize this risk.
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.	√		- Restriction of the local people to the construction areas, - Use of traffic and warning signs at and near the construction site - Educate the contractors and the local people on safety issues - Enforcement of speed limits, traffic rules and regulations; - Installation of warning signs, speed breakers and pedestrian crossings

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: South Asia Subregional Economic Cooperation Tranche 2 – Mechi Bridge
Sector : Transport
Subsector: Road transport (non-urban)
Division/Department: SATC / SARD

Screening Questions		Score	Remarks[35]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	1	Based on the AWARE screening, the proposed Mechi Bridge will be affected by floods and storms.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	0	The bridge project has a low risk for flooding because Mechi is a seasonal river and HFL is 2 m above the river bottom level. Due to the rolling terrain of flood plains, the river has a swift flow and hence the water can easily be discharged during flash flood events.
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	0	The increase in temperature, precipitation, and flooding will not likely affect the selection of construction materials.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s) ?	1	Increased precipitation in future may require more maintenance works particularly along the approach roads to ensure they are usable particularly during incidents of heavy rain and flash floods
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	1	The design life of the project, particularly the approach roads will be shortened if the required maintenance works are not undertaken.

[35] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

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

Result of Initial Screening (Low, Medium, High):MEDIUM

Other Comments:_____see attached AWARE screening output

climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

APPENDIX 2: AIR SAMPLING LOCATION AND MONITORING RESULTS

Location Code	Chainage	Location Name	Category As per AAQ Standards	Distance From Project Bridge (m)	Environmental Setting and Justification for Selection
AAQ-1	1+000	Panitanki	Semi Urban Residential	100	The monitoring instruments were put on one plate form at about 2 m height near existing custom office. The monitoring at this location will characterise baseline of semi urban area. The new land custom station is planned near the existing custom station, therefore baseline at this location is important as there will be increased activity after new custom station becomes operational.
AAQ - 2	Not Applicable	Naxalbari	Rural Area	6000	The monitoring station is located in a rural area. The location is justified as this will characterise AAQ in rural area close to rail line where RoB is planned as part of AH-2.

Note: - Sampling criteria Sampling @1 hourly for CO during early sunrise hours. Twice a week 24 hourly sample for three months of summer season for TSPM, SO2, NOx and RPM

Ambient Air Quality Monitoring Results for Summer Season (May 2013&June 2013)

Reading	PM 2.5(µg/m³)	PM10 (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (ug/m3)
	AAQ-1- Panitanki (km 1+000)				
Air Quality Standards	***60***	***100***	***80***	***80***	***4000***
01	41	76	13.40	29.4	-
02	39	68	12.1	28.2	-
03	43	81	11.9	31.0	-
04	36	61	10.9	26.0	414
05	40	71	14.6	33.1	526
06	37	56	11.4	24.2	-
07	39	65	10.4	29.0	523
08	36	54	9.6	23.6	467
Minimum	36	54	9.6	23.6	367
Maximum	43	81	14.60	33.1	426
Average	38.88	66.5	11.79	28.06	407
P_{50} Value	39	66.5	11.9	28.2	514
P_{98} Value	43	81	14.6	23.6	526
	AAQ - 2 Naxalbari (At 6.0 km distance from Bridge approach)				
01	35	61	6.3	21	
02	38	64	8.1	19.2	

Reading	PM 2.5(µg/m³)	PM10 (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (ug/m3)
03	28	51	9	18.9	
04	32	54	7	26.6	365
05	28	51	6.9	18	364
06	27	46	8.2	25.2	
07	24	38	6	18.2	314
08	33	53	6.7	18.4	286
Minimum	24	38	6	18	286
Maximum	38	61	9	26.6	465
Average	30.625	52.25	7.28	17.35	332
P_{50} Value	32	53	7	18	364
P_{98} Value	38	61	9	26.6	465

Photographs of Environmental Monitoring

A. Ambient Air Quality Monitoring at Panitanki

Air Sample-I

Air Sample-II

Air Sample-III

Air Sample-IV

Air Sample-V

Air Sample-VI

Air Sample-VII

Air Sample-VIII

B. Ambient Air Quality Monitoring at Naxalbari

Air Sample-I

Air Sample-II

Air Sample-III

Air Sample-IV

Air Sample-V

Air Sample-VI

Air Sample-VII

Air Sample-VIII

Noise Monitoring Photograph

Noise Monitoring at Panitanki

Noise Monitoring at Naxalbari

Soil Sampling Photographs

Soil Sampling at Panitanki

Soil Sampling at Naxalbari

Water Sampling Photographs

Ground Water Sampling at Panitanki

Surface Water Sampling at Mechhi River

APPENDIX 3: AIR QUALITY IMPACTS ASSESSMENT OF PROPOSED 6-LANE BRIDGE ON MECHI RIVER

A. Introduction

1. The major impact on the air quality during the operation stage will be due to plying of vehicles on the proposed bridge over Mechi River. 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 and results into low pollutant concentrations while stable atmospheric conditions buildup the pollution level. To assess the likely impacts on the ambient air quality due to the proposed bridge project, the prediction of the carbon monoxide (CO) and particulate matter (PM) concentrations have been carried out using line source dispersion modelling approach, based on Gaussian equation. CO is an indicator pollutant for vehicular pollution. So, prediction of CO concentration is representative of the impacts of air pollution due to traffic movement. The modeling for this project has been carried out using CALINE-4, line source model developed by the California Transport Department. It has been setup and run by using emission factors prevalent for Indian vehicles (ARAI, 2007) and hourly traffic volumes as predicted for the project. The study is conducted to predict hourly increment in CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx concentrations for the base year (i.e. 2015) and future traffic, i.e. Year 2020, Year 2025, Year 2030 and Year 2034. The impacts of other pollutant concentrations are also insignificant. Therefore, this study only focused on the CO, $PM_{2.5}$, PM_{10}, SO_2 and NOx dispersion, generated from the traffic on the proposed bridge.

B. Model descriptions

2. CALINE-4 is the fourth generation simple line source Gaussian plume dispersion model (Benson, 1984). It employs a mixing zone concept to characterize pollutant dispersion over the roadway. The main purpose of the model is to assess air quality impacts near transportation facilities. The input parameters are emission source strength, meteorology and road geometry. It can predict the pollutant concentrations at selected receptors locations for 1 hour and 8-hour average up to 500 meters of the roadway. For most applications, optional inputs can be bypassed and many other inputs can be assigned assuming worst-case values. More complex approaches to dispersion modeling are unnecessary for most of the applications because of the uncertainties in the estimation of emission factors and traffic volumes for the future years. CALINE- 4's accuracy is well balanced with the accuracy of state-of-art predictive models for vehicular pollution.

C. Source information

1. Traffic data

3. The fleet wise traffic volumes for the present study have been taken from the detailed project report of the project. The annual average daily traffic (AADT) data is available for the proposed bridge through traffic survey. CALINE 4 model needs hourly average traffic volume. However, model has been setup for peak traffic hours assuming 3 times of average hourly traffic volume. The total traffic hour volume is further categorized in to two wheeler, four wheeler, Light commercial vehicles (LCVs), Bus and high commercial vehicles (HCVs), based on the traffic survey at existing bridge (Figure 26).

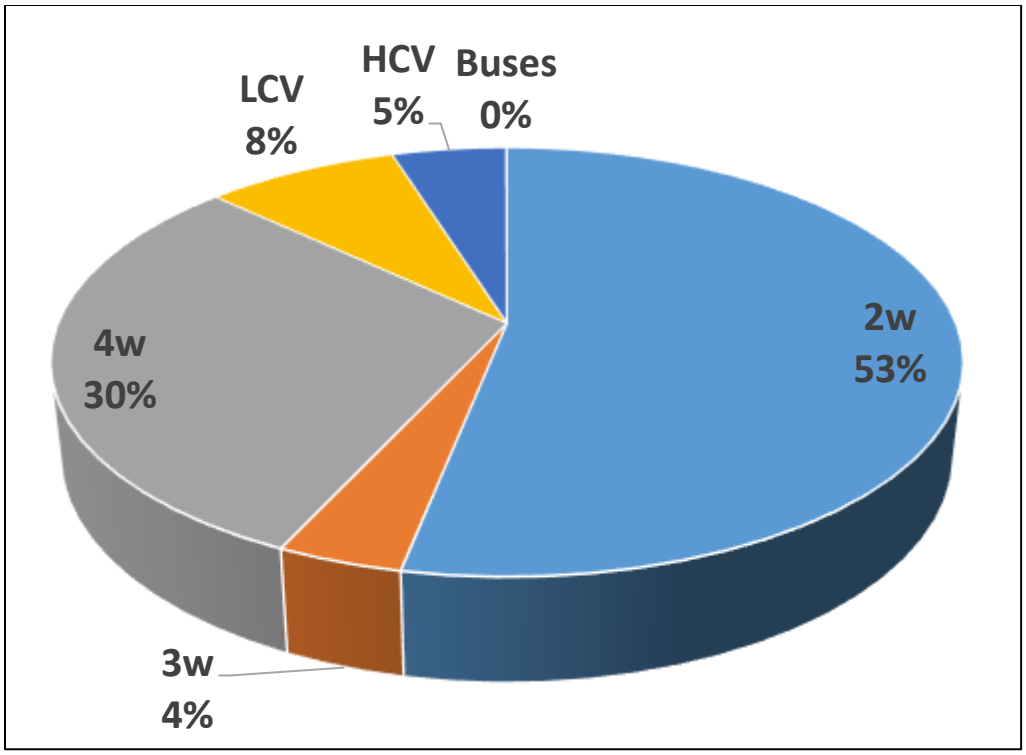


Figure 26: Traffic Fleet on the bridge

4. The annual average daily motorized traffic data are given in **Table 43** of proposed bridge along with future traffic growth.

Table 43: Annual average daily motorized traffic data

Year	2 W	3W	Car/Jeep/Taxi	LCV	HCV	Buses
2015	4547	325	2575	698	412	3
2020	5878	420	3329	902	533	4
2025	7599	543	4303	1167	689	5
2030	9824	702	5563	1508	890	6
2034	12064	862	6832	1852	1093	8

2. Road geometry

5. In the CALINE-4 model the entire length of the selected road section is divided into various road links. The division of sections into links has been done in such way, so that the link can be fairly considered as straight stretch of road having homogenous geometry with uniform road width, height and alignment. The coordinates of end points of links specify the location of the links in the model. The maximum numbers of link in each road section can be 20. The mixing zone width calculated for selected highway corridor is 21 m (1m+ 3 m + 3 m + 14 m) as per guideline provided in CALINE4 model.

3. Emission factors

6. Emission factor is one of the important input parameter in Caline-4 model. In the present study, the emission factors specified by the Automotive Research Association of India (ARAI, 2007) have been used for calculation of weighted emission factors. These emission factors have

been expressed in terms of type of vehicles and type of fuel used (for petrol and diesel driven passenger cars). Since, there is only one input requirement for total no. of vehicles in the CALINE 4 model, whereas, there are different categories of vehicles (viz., Two wheelers, Cars, Bus and trucks) with different year of manufacture and fuel used, it is essential that a single value representing the equivalent or weighted emission factors for all the vehicles is input into the model. The emission factor used to estimate WEF are given below in table 3. The traffic data are not available for fuel types, therefore average emission factor are used in this study. Thus, WEF expressed in g/mile (converted from gm/km) has been calculated for the present study using methodology given by Sharma et al., 2013. For PM_{10}, emission from re-suspension of road dust of paved road have been estimated using following empirical equation (USEPA 2011).

$E = k\,(sL)^{0.91} \times (W)^{1.02}$
Where:
E= particulate emission factor (g/VKT)
K =particle size multiplier (g/VKT), default value of "k" for $PM_{2.5}$ is 0.15 g/VKT
sL = road surface silt loading (g/m^2) = 0.531 g/m^2 (Sahu et al., 2011)
W = Average weight of vehicles (in tons) on road = 1.41 Ton (Sahu et al., 2011)

7. The emission factor for CO, $PM_{2.5}$ and NOx used in the present study for different vehicles type are given in **Table 44**. The calculated WEF for CO, $PM_{2.5}$ and PM_{10} for peak traffic hours is given in **Table 44**. The calculation of SO_2 emission factor for different categorized of vehicles are described in **Table 45**.

Table 44: Emission factors for different types of Vehicle (ARAI, 2007)

Vehicle type	CO Emission factor (gm/km)	$PM_{2.5}$ Emission factor (gm/km)	NOx Emission factor (gm/km)
Two wheeler	3.08	0.20	0.412
Three Wheeler	2.50	0.24	0.532
Cars/Jeep	1.53	0.06	0.424
LCV	2.02	0.49	1.723
BUS	8.40	1.08	6.53
HCV	12.65	1.60	6.53

Table 45: Weighted Emission Factor for proposed traffic

Year	Weighted Emission factor for CO (g/mile)	Weighted Emission factor for $PM_{2.5}$ (g/mile)	Weighted Emission factor for PM_{10} (g/mile)
Year 2015	4.79	0.40	0.73
Year 2020	4.79	0.40	0.73
Year 2025	4.79	0.40	0.73
Year 2030	4.79	0.40	0.73
Year 2034	4.79	0.40	0.73

Table 46: Emission Factor of SO_2 for proposed traffic

Vehicle Category	Vehicle mileage(km l^{-1})	Fuel consumed per km (ltrs)	Sulphur content (%)	Density (kg/m^3)	SO_2 (g/km)
2Ws	45.1	0.022	0.015	750	0.004989
LMVs-passenger	20.5	0.049	0.015	750	0.010976
4Ws-Petrol	12.6	0.079	0.015	750	0.017857

Vehicle Category	Vehicle mileage(km l^{-1})	Fuel consumed per km (ltrs)	Sulphur content (%)	Density (kg/m^3)	SO_2 (g/km)
4Ws-Diesel	13.8	0.072	0.035	876	0.044435
LMV-goods	10	0.100	0.035	876	0.06132
HDVs-truck	4.6	0.217	0.035	876	0.133304
Buses	4.6	0.217	0.035	876	0.133304

4. Meteorological data

8. The study was conducted to predict pollutant concentration for worst meteorological conditions. The meteorological parameters such as wind speed, wind direction standard deviation, temperature, mixing height and stability condition are used in model. The wind direction standard deviation was calculated to know the flexibility of wind direction and used as input parameters in worst case run condition. The model has been run with worst case, in which models predicted maximum pollutant concentration.

5. Receptors

9. A set of link receptors were taken at various receptor locations within each section at a distance of 5 m, 10 m, 20 m, 40 m, 70 m, 100m and 200 m both sides from edge of the carriageway to know the dispersion of pollutant from the road. The monitoring station are marked as receptor points to compare the monitoring and predicted pollutant concentrations.

D. Results

10. The model has been setup and run to predict hourly average CO, $PM_{2.5}$ and PM_{10} concentrations for 1st year (2015), 5th year (2020), 10th year (2025), 15th year (2030) and 19th year (2034) using forecasted traffic data on proposed highway. The predicted hourly average concentration of CO, $PM_{2.5}$ and PM_{10} during peak traffic are shown in Tables 47,48, 49, 50 and 51 for proposed bridge project, respectively at two selected receptor locations. The graphical representation of hourly average pollutant concentrations on both side of the road sections shown in figures 27–30 at different locations.

Table 47: CO predicted concentrations (ppm) along the proposed bridge for peak traffic hour

	CO Concentrations (ppm)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
Year	**-200**	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2015	0.0	0.0	0.0	0.0	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.0	0.0	0.0
2020	0.0	0.0	0.0	0.0	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.0	0.0	0.0
2025	0.0	0.0	0.0	0.1	0.1	0.2	0.2		0.2	0.2	0.2	0.1	0.1	0.0	0.0
2030	0.0	0.0	0.0	0.1	0.1	0.2	0.2		0.2	0.2	0.2	0.1	0.1	0.0	0.0
2034	0.0	0.0	0.1	0.1	0.2	0.3	0.3		0.3	0.3	0.2	0.2	0.1	0.0	0.0

Table 48: PM2.5 predicted concentrations (µg/m3) along the proposed bridge for peak traffic hour

	$PM_{2.5}$ Concentrations ($\mu g/m^3$)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
Year	**-200**	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2015	0.00	1.04	2.08	4.16	7.28	9.57	10.40		10.40	9.88	7.80	7.07	3.12	1.04	0.00
2020	1.22	1.33	2.66	5.32	9.31	12.24	13.30		13.30	12.64	9.98	9.04	3.99	1.33	1.26
2025	1.55	1.69	3.38	6.76	11.83	15.55	16.90		16.90	16.06	12.68	11.49	5.07	1.69	1.61
2030	1.98	2.15	4.30	8.60	15.05	19.78	21.50		21.50	20.43	16.13	14.62	6.45	2.15	2.04
2034	2.37	2.58	5.16	10.32	18.06	23.74	25.80		25.80	24.51	19.35	17.54	7.74	2.58	2.45

Table 49: PM10 predicted concentrations (µg/m3) along the proposed bridge for peak traffic hour

	PM_{10} Concentrations ($\mu g/m^3$)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
Year	**-200**	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2015	1.11	1.90	3.80	7.60	13.30	17.48	19.00		19.00	18.05	14.25	12.92	5.70	1.90	1.12
2020	2.23	2.42	4.84	9.68	16.94	22.26	24.20		24.20	22.99	18.15	16.46	7.26	2.42	2.30
2025	2.84	3.09	6.18	12.36	21.63	28.43	30.90		30.90	29.36	23.18	21.01	9.27	3.09	2.94
2030	3.61	3.92	7.84	15.68	27.44	36.06	39.20		39.20	37.24	29.40	26.66	11.76	3.92	3.72
2034	4.33	4.71	9.42	18.84	32.97	43.33	47.10		47.10	44.75	35.33	32.03	14.13	4.71	4.47

Table 50: SO_2 predicted concentrations (ppm) along the proposed bridge for peak traffic hour

	SO_2 Concentrations (ppm)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
Year	**-200**	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2015	0	0	0	0	0	0	0		0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0		0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0		0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0		0	0	0	0	0	0	0

Year	**SO_2 Concentrations** (ppm)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
	-200	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2034	0	0	0	0	0	0	0		0	0	0	0	0	0	0

Table 51: NOx predicted concentrations (ppm) along the proposed bridge for peak traffic hour

Year	**SO_2 Concentrations** (ppm)														
	Distance from the edge of the road, m. (Left side)								**Distance from the edge of the road, m. (Right side)**						
	-200	**-100**	**-70**	**-40**	**-20**	**-10**	**-5**		**5**	**10**	**20**	**40**	**70**	**100**	**200**
2015	2015	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
2020	2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
2025	2025	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.00	0.00
2030	2030	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.00	0.00
2034	2034	0.00	0.00	0.00	0.00	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.00	0.00

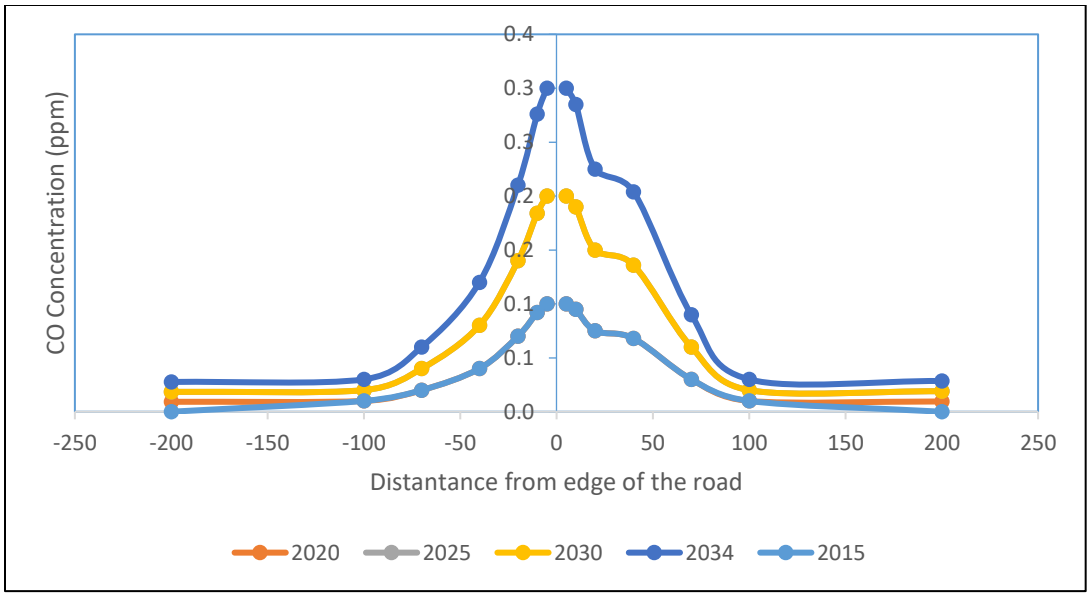


Figure 27: CO predicted concentrations (ppm) along the proposed bridge

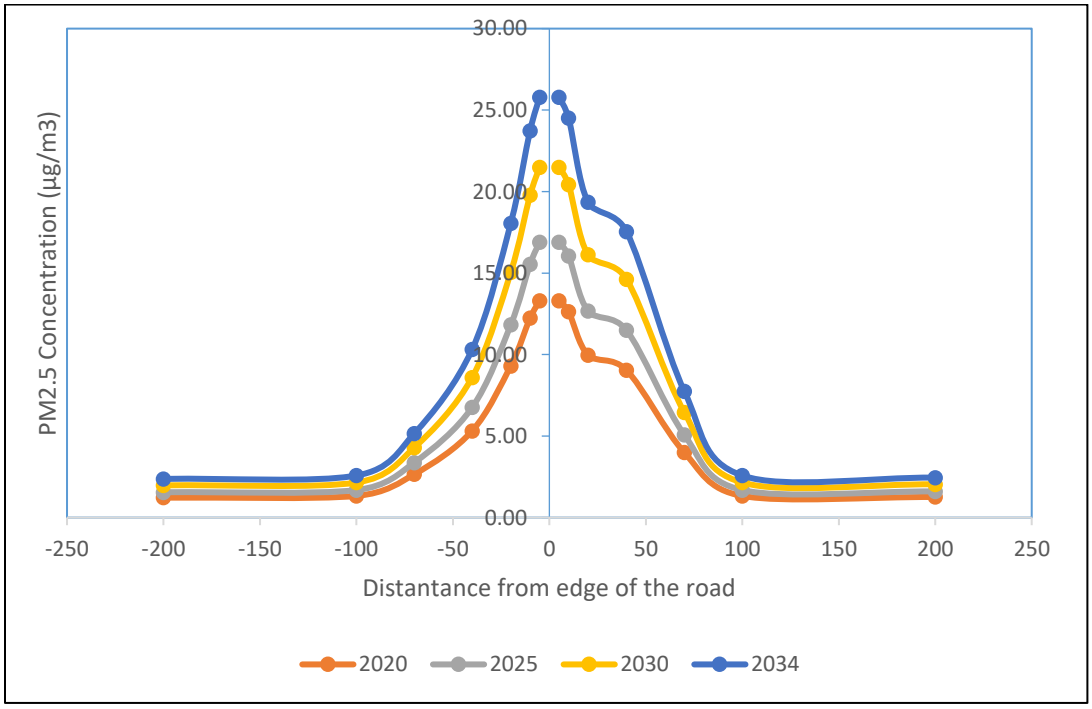


Figure 28: PM2.5 predicted concentrations (µg/m3) along the proposed bridge

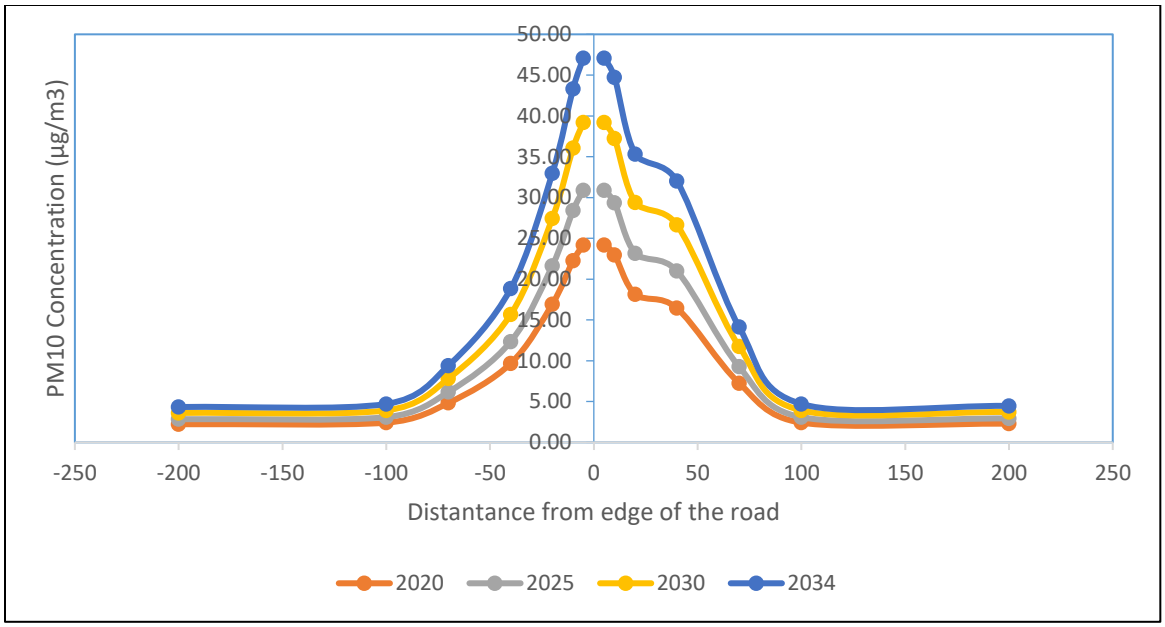


Figure 29: PM10 predicted concentrations (µg/m3) along the proposed bridge

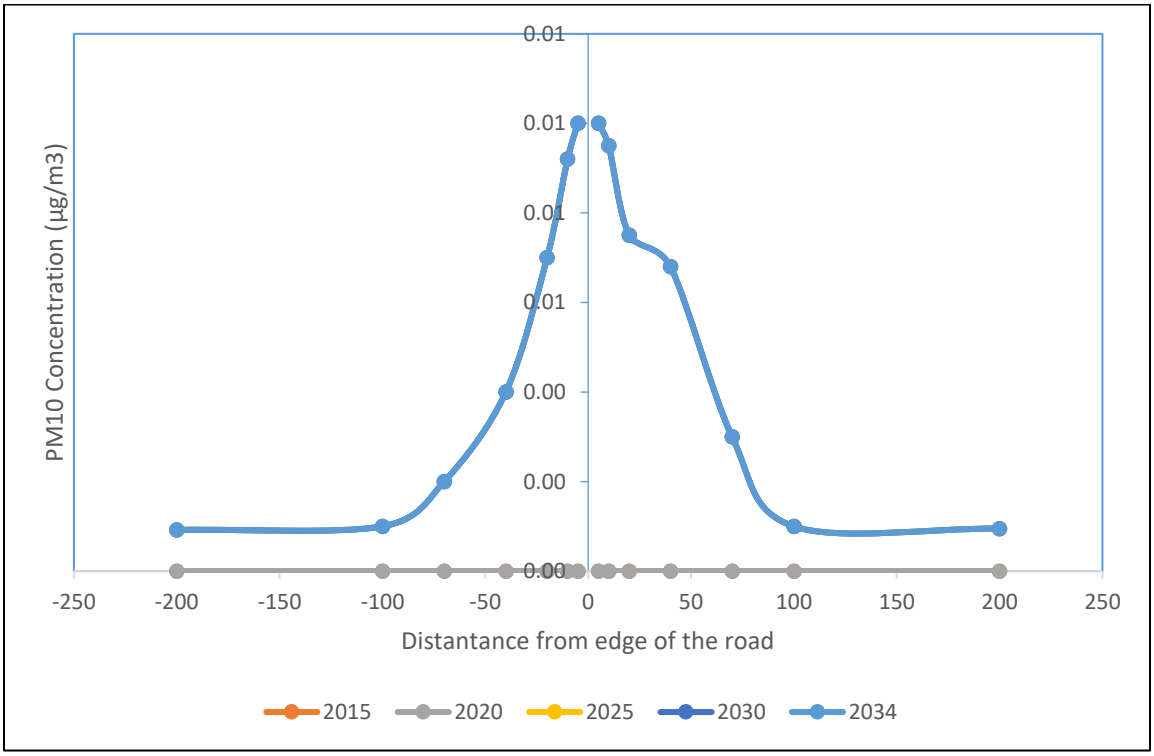


Figure 30: NOx predicted concentrations (ppm) along the proposed bridge

11. Tables 52 and 53 describes the average baseline and increment concentration of $PM_{2.5}$, $PM_{10,}$ CO, SO_2 and NOx monitored during the study period at around the proposed bridge.

Table 52: Baseline pollutant concentration at Panitanki (at 100 m distance from Bridge)

Description	Pollutant				
	$PM_{2.5}$ ($\mu g/m^3$)	**PM_{10} ($\mu g/m^3$)**	**CO (ppm)**	**SO2 ($\mu g/m^3$)**	**NOx ($\mu g/m^3$)**
Baseline Concentration	34.5	67.5	446.5	12.1	28.35
Increment in Concentration due to project	1.04	1.9	0	0	0
Concentration during operation of Bridge	35.54	69.4	446.5	12.1	28.35
Increment in Concentration due to project	3%	3%	0%	0%	0%

Table 53: Baseline pollutant concentration at Naxalbari (at 6 km distance from Bridge)

Description	Pollutant				
	$PM_{2.5}$ ($\mu g/m^3$)	**PM_{10} ($\mu g/m^3$)**	**CO (ppm)**	**SO2 ($\mu g/m^3$)**	**NOx ($\mu g/m^3$)**
Baseline Concentration	31	50.5	375.5	7	24
Increment in Concentration due to project	0	1.04	1.90	0	0
Concentration during operation of Bridge	31	50.5	375.5	7	24
Increment in Concentration due to project	0%	0%	0%	0%	0%

12. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10} concentrations have been plotted in figures 6-10 respectively for peak traffic hour which shows that pollutant concentrations is decreasing when goes away from the bridge. From the CALINE4 modelling results, it is observed that maximum dispersion of pollutants concentration emitted from traffic volume at proposed bridge is up to 70m in year 2015 and up to 200m in year 2034. Therefore, the impacts of traffic movement at proposed bridge over Mechi River will not impact the surrounding atmosphere.

Figure 31: Spatial distribution of CO concentrations

1st year

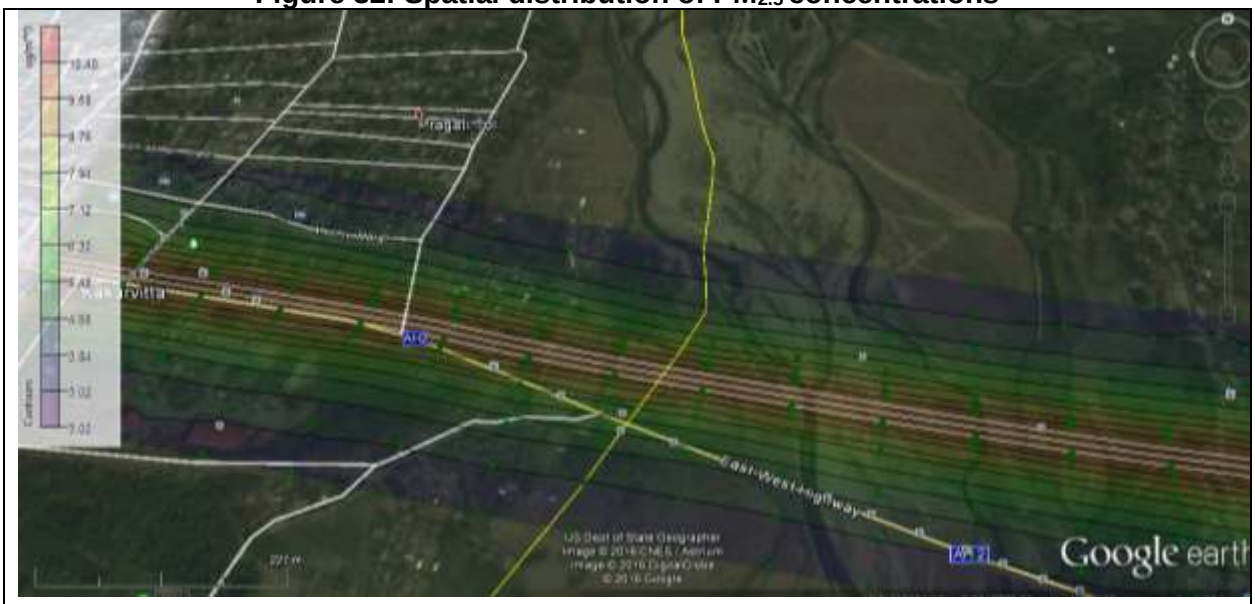
5th Year

10th Year

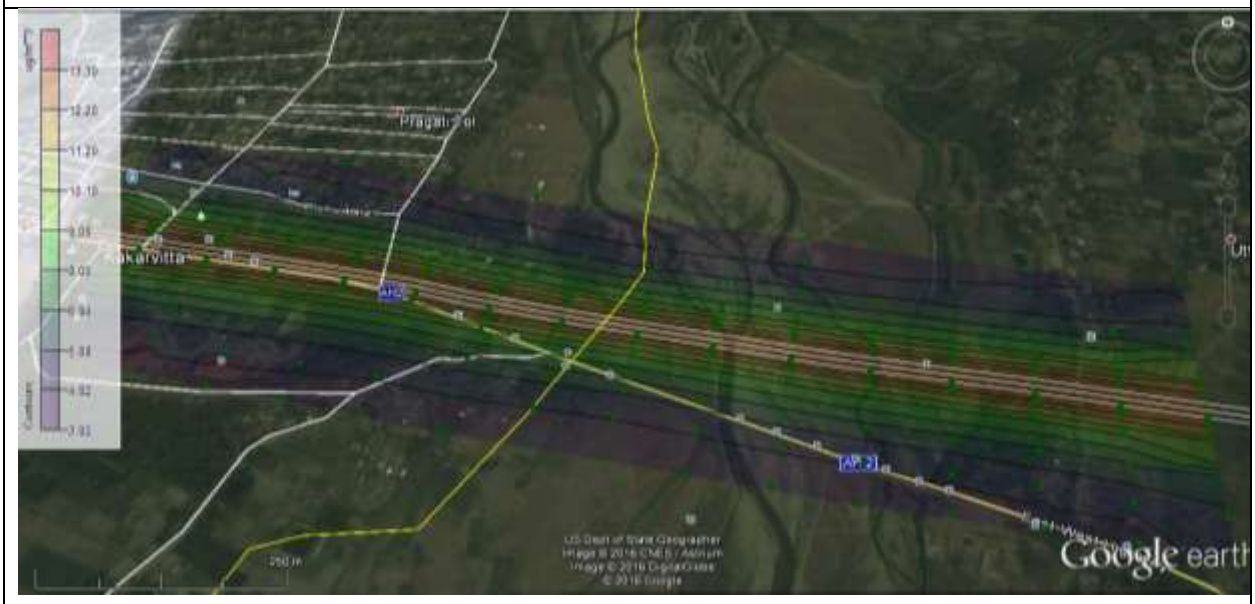
15th Year

19th Year

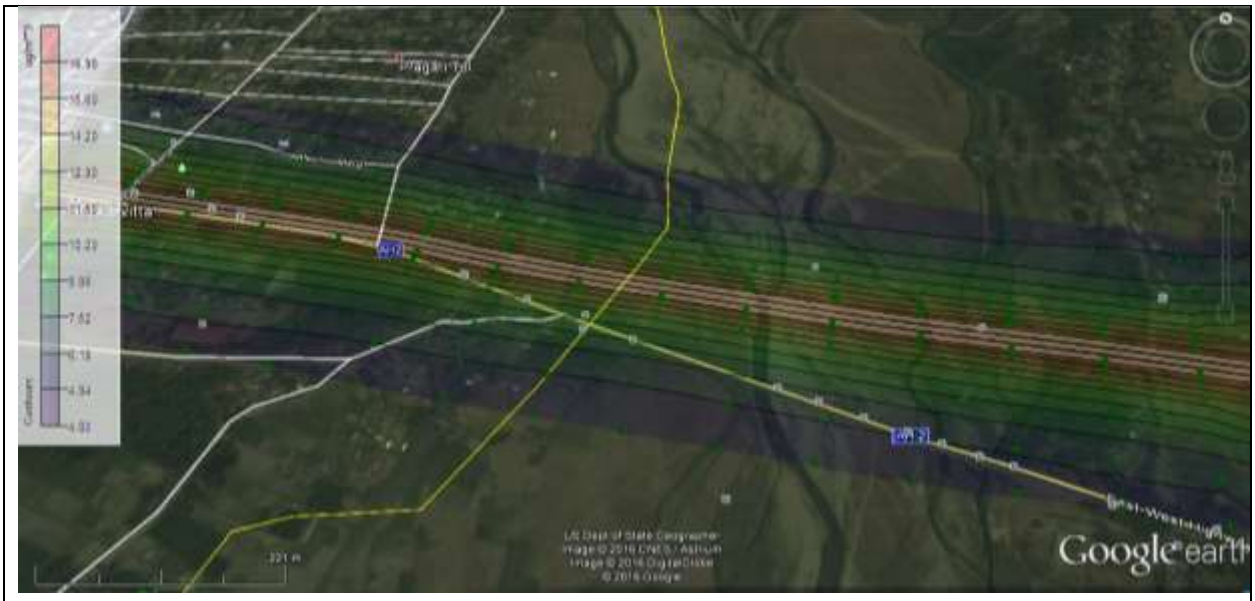
Figure 32: Spatial distribution of $PM_{2.5}$ concentrations



1st Year



5th Year

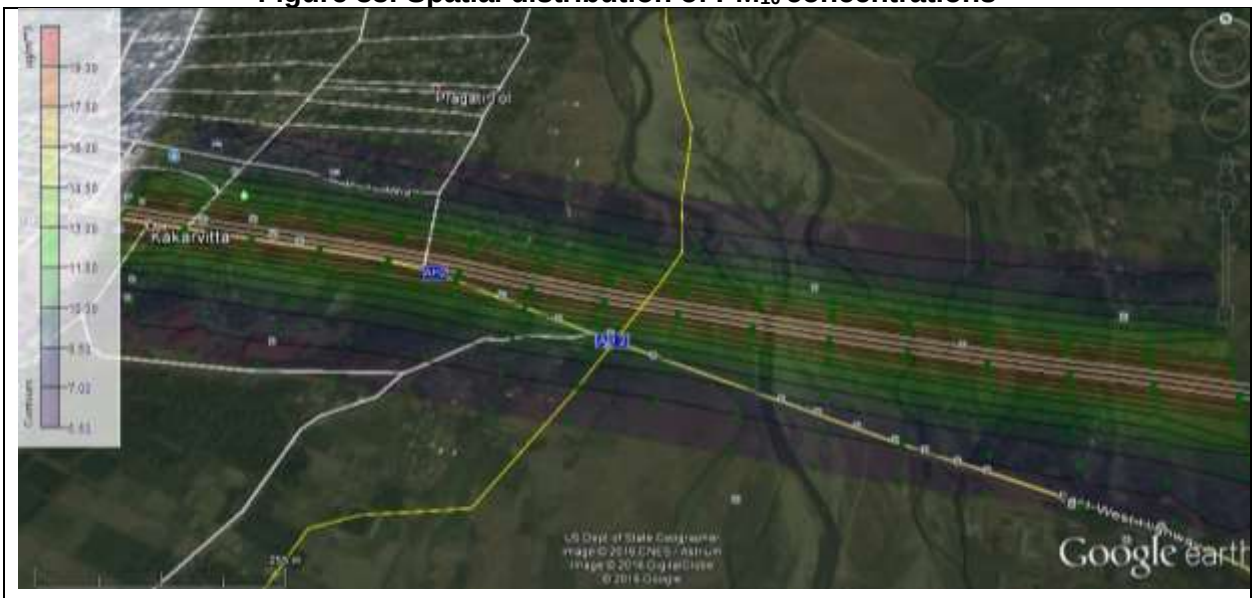


10th Year

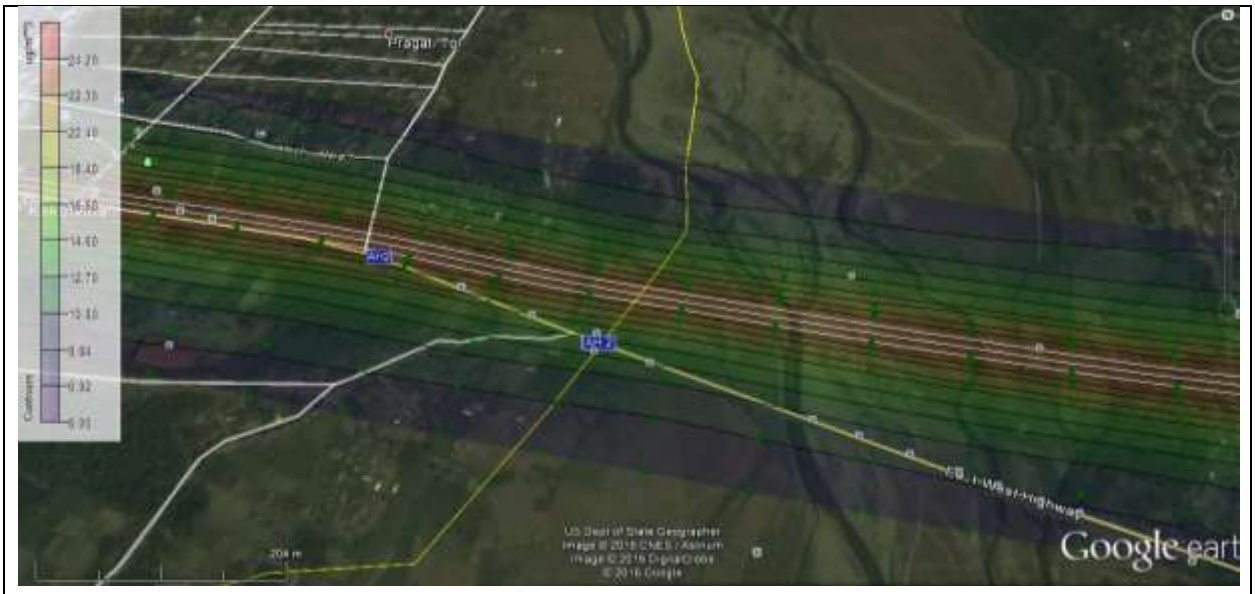
15th Year

19th Year

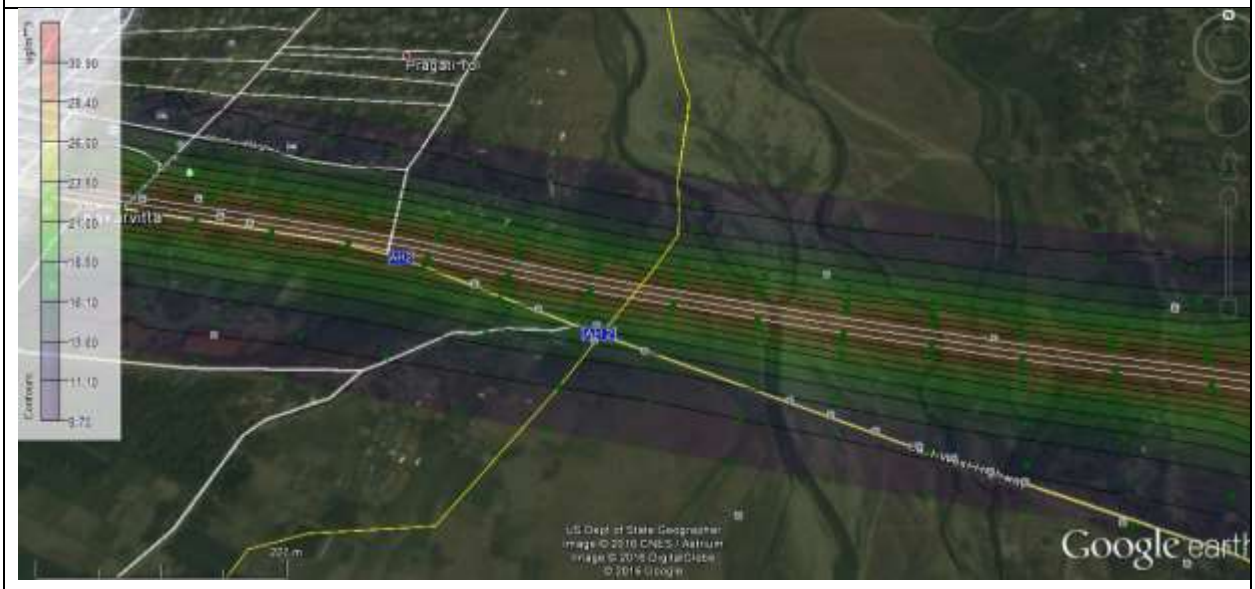
Figure 33: Spatial distribution of PM_{10} concentrations



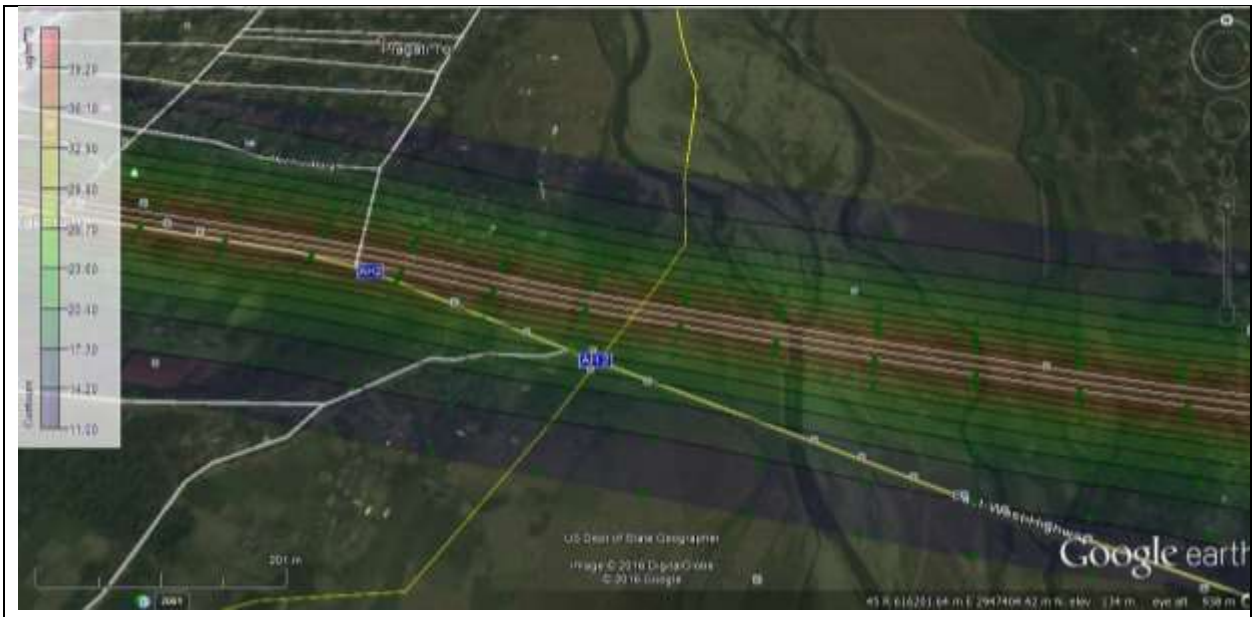
1st Year



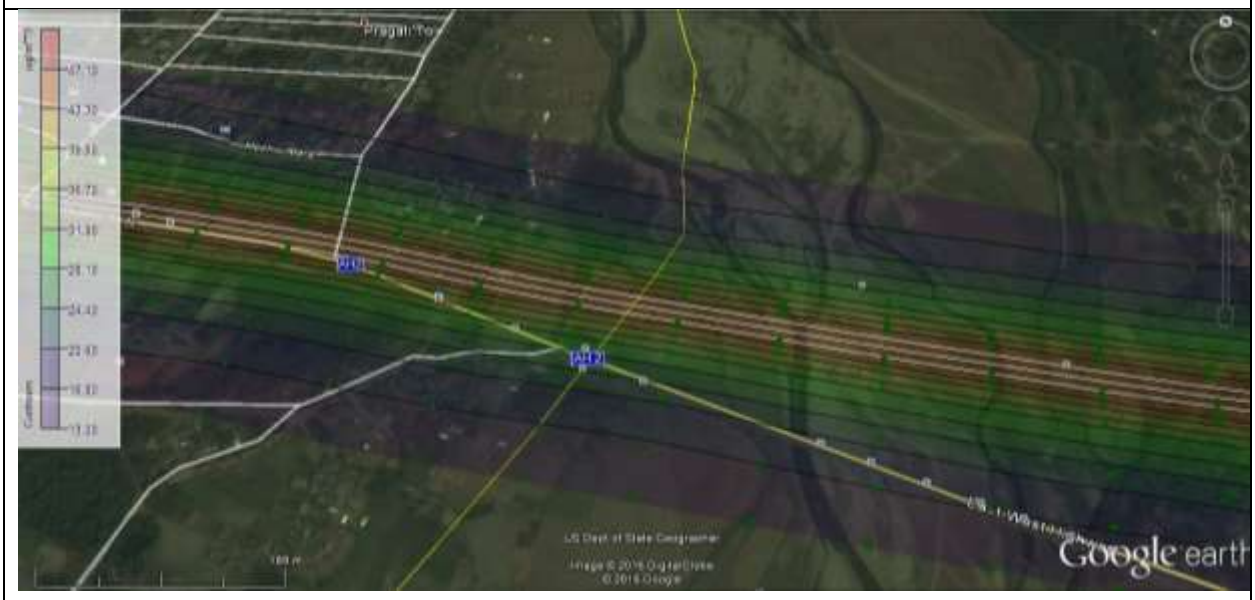
5th Year



10th Year

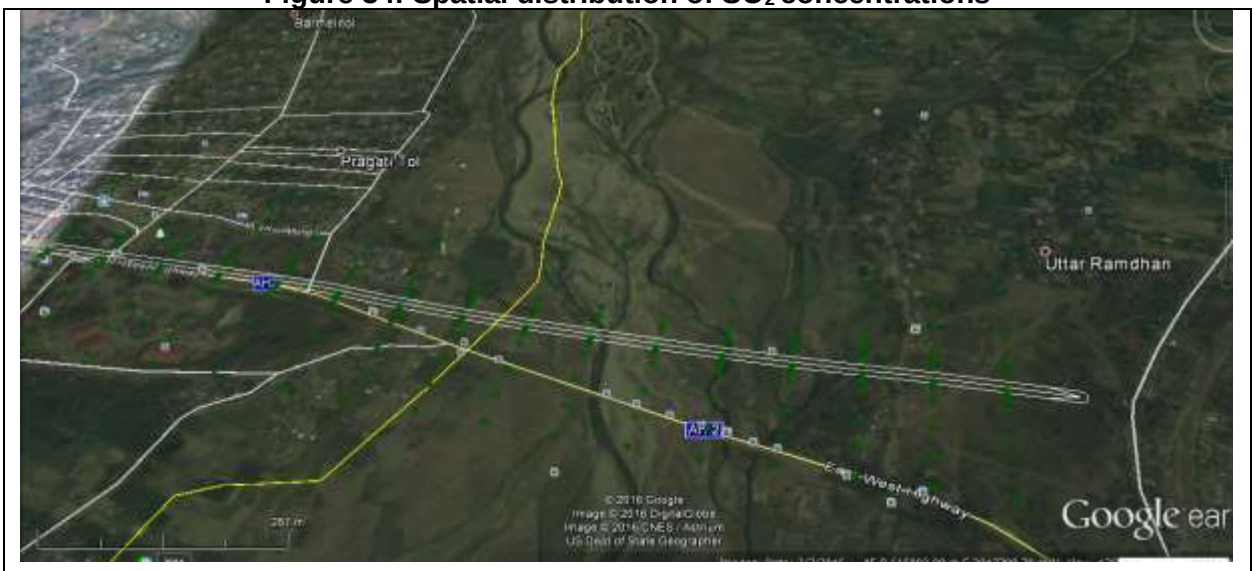


15th Year



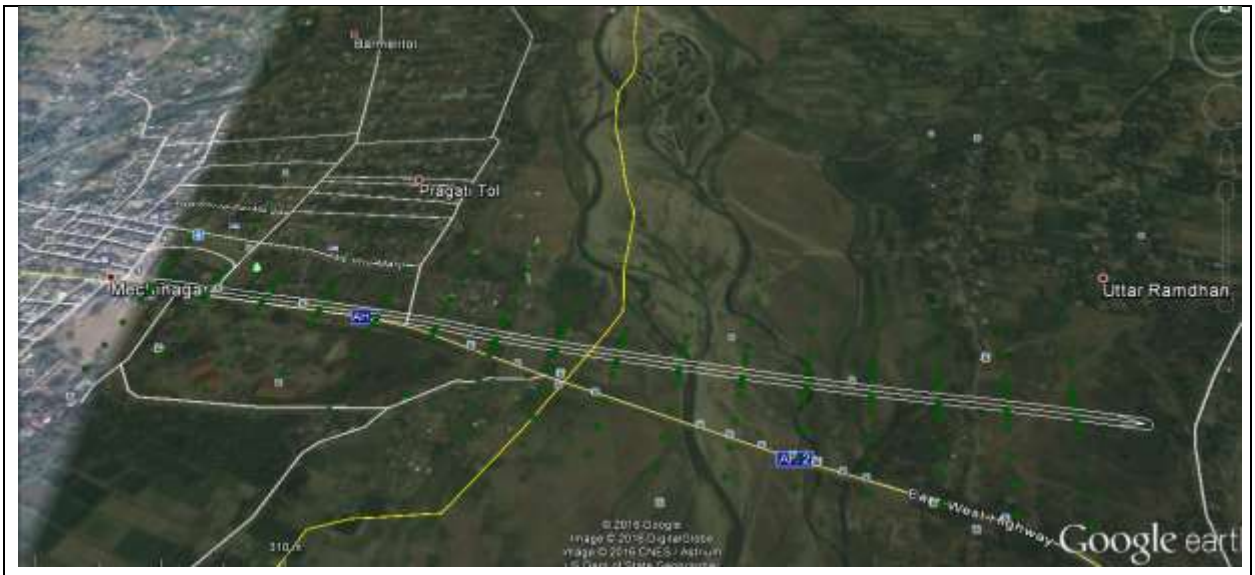
19th Year

Figure 34: Spatial distribution of SO_2 concentrations



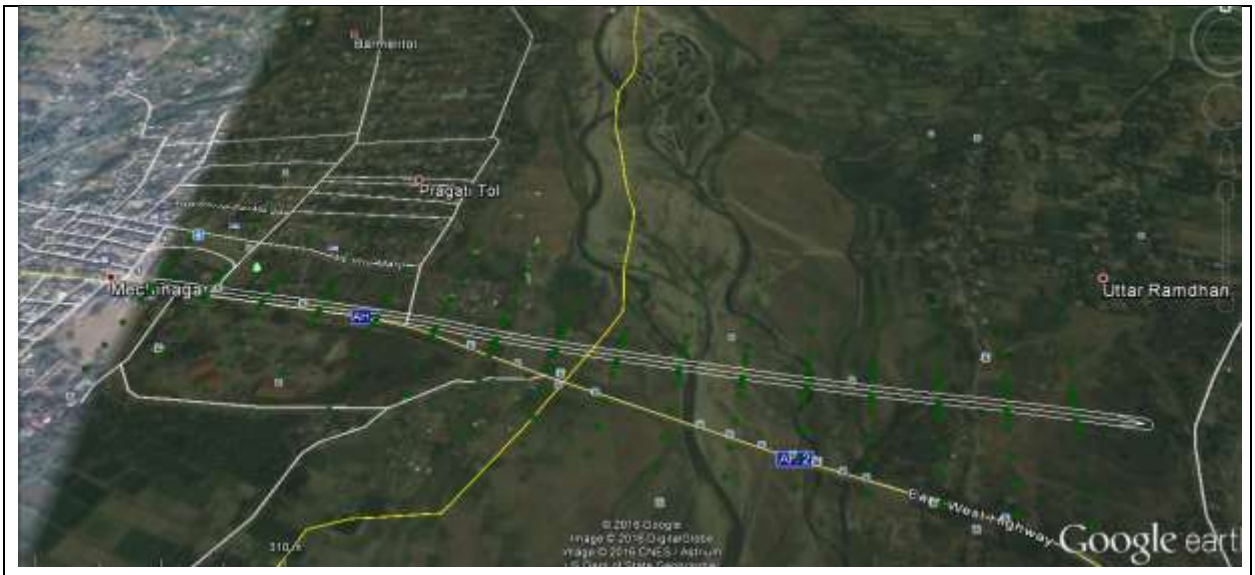
1st Year

5th Year



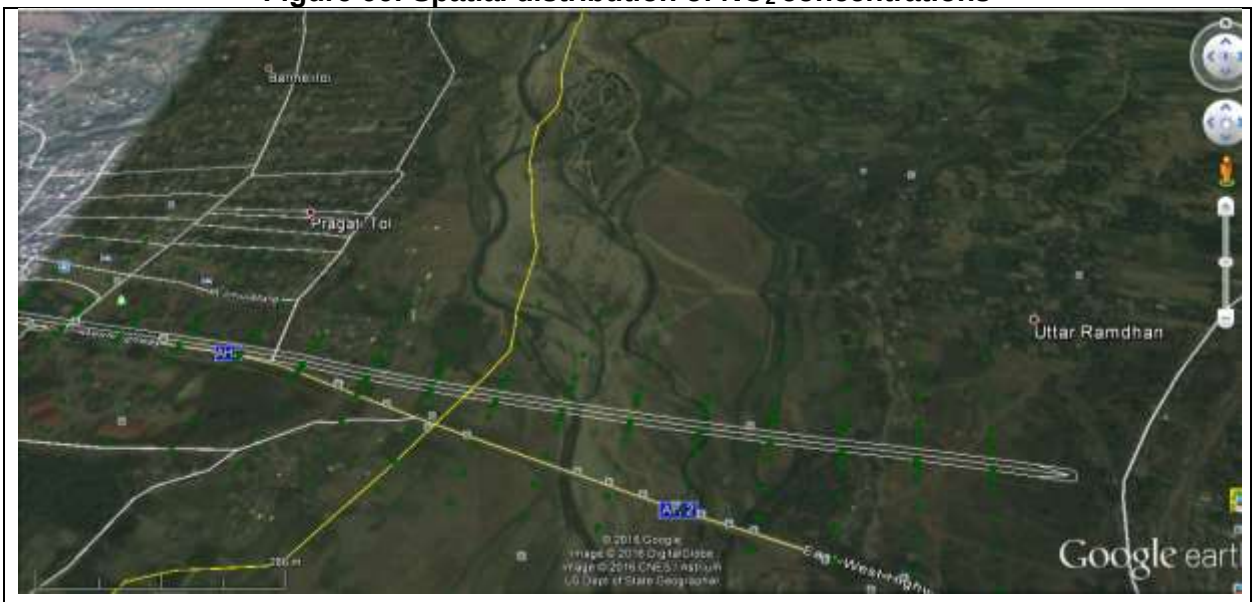
10th Year

15th Year



19th Year

Figure 35: Spatial distribution of NO_2 concentrations



1st Year

5th Year

10th Year

15th Year

19th Year

APPENDIX 4: PHOTO PLATE OF STAKEHOLDER CONSULTATION & ATTENDANCE

A. Consultations at Kakarbhitta in Nepal






B. Consultations at Panitanki in India

C. Attendance of Stakeholder Consultation at Kakarbhitta in Nepal

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Detailed Design of the Sub Regional Road Connectivity Project

Public Consultations

Attendance Sheet

Date : 29 - 12 - 2015 Nepal
Venue : Mechinagar Nagarpalika 10 meehi danda Kakarvitta Jhapa

S.No	Name	Address and Phone number	Signature
1	श्री तमर दाई	1097 9842048822	
2	श्री दुर्गा प्र~~सा~~द पाकोटी	00977 9842856600	
3	श्री किसनी ~~प्रसाद~~ सिग्रिं	00977 9852679111	
4	श्री हरि बंशा पौडेल	00977 9843652291	
5	श्री हरिलाल सिग्रोटी	9852674344	

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Date :
Venue :

S.No	Name	Address and Phone number	Signature
(6)	श्री रुद्र पुरु कोइराला	Kakarvitta 9842703624	
(7)	श्रीमती राधिका गुरुङ	Kakarritta 9842719984	
(8)	श्रीमती पम्फा लामा	9844661352 Kakarvitta	
(9)	श्री विष्णु बराल	9844196354 Kakarritta	
(10)	श्री भूपधोज दहाल पत्रकार	9807966686 Kakarvitta	

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Date :

Venue :

S.No	Name	Address and Phone number	Signature
(11)	श्री राजु कार्की		
(12)	श्री बाबु राम लामा		
(13)	श्री हरी प्रसाद पौडेल		
(14)	श्री नारायण कुडेल	9806082135 मे. न. पा. १०	Narayan
(15)	श्रीमती सावित्री तिवारी	9817924776 Kakarvitta	SABITRA

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Attendance Sheet

Date :
Venue :

S.No	Name	Address and Phone number	Signature
(16)	श्रीमती शुशिला कोहली	9861056671	
(17)	श्री राजु पोडेल		
(18)	श्री भुल्की प्र० पौडेल		
(19)	श्री वाल कृष्ण अधिकारी		
(20)	श्रीमती मैया बस्नेत		

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Date :
Venue :

S.No	Name	Address and Phone number	Signature
	[illegible]	9844696188	[illegible]
	[illegible]	9815930813	[illegible]
	[illegible]	9860362569	[illegible]
	Dr. Binod Tiwari [illegible]	9818165612	[illegible]

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Date :
Venue :

S.No	Name	Address and Phone number	Signature
	तेज प्रताप ढुंगाना	9806015 768	
	गोविन्द ढुंगाना	मे- नापा -10 9824098762	
	शिलाधार आचार्य	मे न पा 10 9804933869	
	शिव कुमार पंडित	9816081092	
	कोपीला रावत	कोपीला 9804940105	कोपीला

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Date :
Venue :

S.No	Name	Address and Phone number	Signature
	[illegible]	[illegible] 9647787472	
	[illegible]	[illegible] 9804763690	
	[illegible]		
	[illegible]		
	Sagar Adhikary	8110745721	

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Attendance Sheet

Date :
Venue :

S.No	Name	Address and Phone number	Signature
	Surendra Dahal	kvt Thapa 9K1869397C2 81162 22480	Surendra
	Bhim Prasad Tiwari	9816013571	भीम प्रसाद तिवारी
	Dili prasad Dahal	9816904170	Dahal
	Bishnu Prasad Tiwari	9816013571	Bishnu

Attendance of Stakeholder Consultation at Panitanki in India

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Attendar ce Sheet

Date : 28/12/2015
Venue :

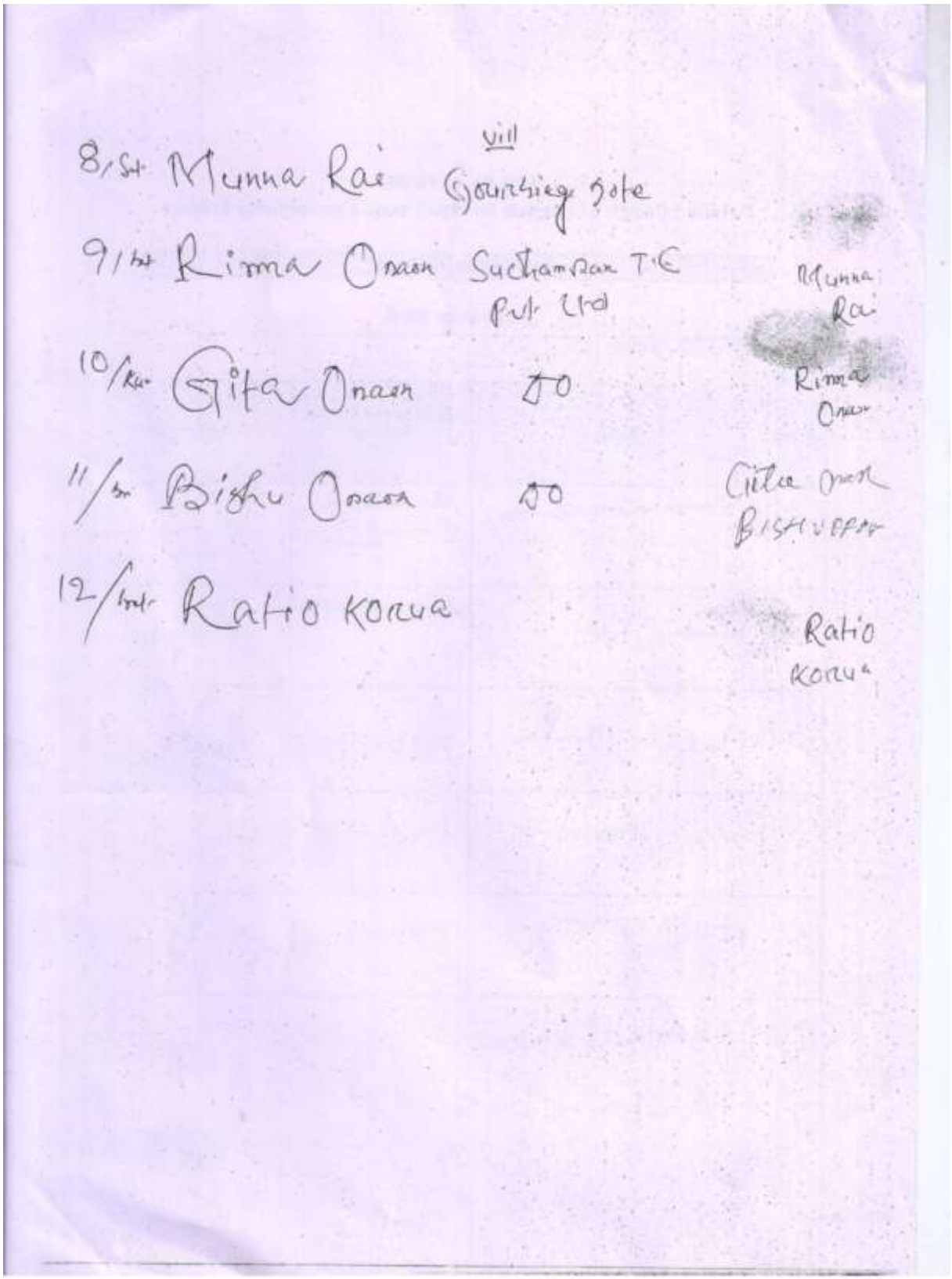
S.No	Name	Address and Phone number	Signature
1	Shree... Verma	Shaleda ...	[signature]
02	Handru Oraon	9933186885	[signature] 28/12/2015
3	Bablu Oraon	7933062781	[signature] 28/12/15
4	Sailu Oraon	3679297664	Sailu
5/	poudy ooraon	09932898349	[signature]

6/ Somari Korua

7, Anita Korua

Somari Korua

Anita Korua



viii

8/ Sri Munna Rai Gauriganj Gate

9/ Smt Rima Oraon Sucharan T.E Pvt Ltd

10/ Kum Gita Oraon 50

11/ Sri Bishu Oraon 50

12/ Smt Ratio Kerua

Munna Rai

Rima Oraon

Gita Oraon

Bishu Oraon

Ratio Kerua

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Date :
Venue :

S.No	Name	Address and Phone number	Signature
1	Phukli Oraon	Vill - Sucharpan Pvt Ltd	Phukli Oraon
2	Urvaila Oraon	00	Urvaila Oraon
3	Sunita Oraon	00	Sunil Ora
4	Mariyam Oraon	00	Mariy Ora
5	Rubanti Oraon	00	Rubant Ora
	Sunita Oraon	00	Sunita Oraon
	Dhukni Koraa	00	Dhukni Koraa