Initial Environmental Examination

June 2023

Bangladesh: South Asia Subregional Economic Cooperation Dhaka-Northwest Corridor Road Project, Phase 2 - Tranche 3

Elenga – Hatikamrul Road

Volume 1 of 5, Main Document

Prepared by Roads and Highways Department, Government of Bangladesh for the Asian Development Bank.

CURRENCY EQUIVALENTS

(As of 02 June 2023)
Currency unit – Bangladeshi Taka (Tk)
Tk 1.00 = $ 0.0093
$ 1.00 = Tk 107.50

ABBREVIATIONS

AADT	Annual Average Daily Traffic
AAQ	Ambient air quality
AAQM	Ambient air quality monitoring
ADB	Asian Development Bank
AH	Asian Highway
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BOD	Biochemical oxygen demand
BOQ	Bill of quantity
BUET	Bangladesh University of Engineering and Technology
CITES	Convention on International Trade of Endangered Species
COD	Chemical oxygen demand
CSC	Construction Supervision Consultant
DO	Dissolved oxygen
DPR	Detailed project report
EA	Executing Agency
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EHS	Environment Health and Safety
EMOP	Environment Monitoring Plan
EMP	Environment management plan
IEE	Initial Environment Examination
EHS	Environment Health and Safety
GHG	Greenhouse gas
GIS	Geographical information system
GOB	Government of Bangladesh
GRC	Grievance redress committee
GRM	Grievance redress mechanism
HFL	Highest flood level
IA	Implementing Agency
NOx	Oxides of nitrogen
PAP	Project Affected Persons
PCU	Passenger Car Units
PD	Project Director
PIU	Project Implementation Unit
PM	Particulate Matter
PPE	Personal protective equipment
PPTA RHD	Project Preparedness Technical Assistance Roads and Highways Department

RRTC	Road Research and Training Centre
SASEC	South Asia Subregional Corridor
SO2	Sulphur Dioxide
SPM	Suspended Particulate Matter
SPS	ADB Safeguard Policy Statement, 2009
TA	Technical assistance
TDS	Total dissolved solids
TSS	Total Suspended Solids

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
ha	–	hectare
km	–	kilometre
km^2	–	square kilometre
KWA	–	kilowatt ampere
Leq	–	equivalent continuous noise level
µg	–	microgram
m	–	meter
MW (megawatt)	–	megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10-micron size

NOTE

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

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EXECUTIVE SUMMARY

A. Introduction

1. **Background:** The Government of Bangladesh is emphasizing on improved connectivity in the country. In line with this objective, the Government of Bangladesh (GOB) announced its National Land Transport Policy in 2004 defining long term (20 years) Road Master Plan (RMP). The RMP has identified many feasible and priority projects. One of priority roads identified is the Elenga – Hatikamrul road. This road is a vital link in the national highway network and forms a part of the Asian Highway Network complementing the government plans to increase trade with India.

2. The upgrading of the road exerts its associated environmental impacts that require due consideration in project design for its mitigation and management based on detailed environmental assessment. This report presents the Initial Environmental Examination (IEE) carried out to determine the likely significant environmental changes due to the project and crafts mitigation measures to avoid, minimize, or compensate these impacts.

3. The previous road has inadequate capacities to accommodate increasing volume of traffic of the route and experienced lack of safety. The road was two lanes with no shoulders and no provision for slow moving vehicular traffic (SMVT) or non- motorized traffic (NMT). There were capacity constraints caused by congested junctions, markets, and community areas. The project has been upgrading the road to a four-lane road with safety features, dedicated SMVT lane, flyovers at business junctions, and overpasses at intersections.

4. **Purpose of the Report:** This updated Initial Environmental Examination (IEE) is part of the process of compliance with the Government of Bangladesh and ADB guidelines in relation to Road Improvement Project under Subregional Road Transport Project Preparatory and Facility (Road Component: Package-1) and as part of the Second Phase of SASEC Dhaka – Northwest Corridor Road Project. In this project, variation of orders include widening of one bridge and one railway overpass from 3-lane to 4-lane, construction of one flyover for Sirajganj Economic Zone, increased width of 2.113km main carriageway, and overall widening of SMVT lanes.

5. The IEE provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The updated IEE also provides a detailed description of the direct and indirect environmental effects associated with the variation of orders proposed to be conducted under the phase 2 Tranche 3 of the project.

6. **Extent of the Study:** This updated IEE is carried out based on most up-to-date project details and detailed designs including proposed design variations provided by the design team during the preparation of this report. The corridor of impact has been defined as 500m on either side from the edge of the road alignment. However, the study area has been extended to 5km wide area on both side of the alignment to analyze the land use, identify potential borrow areas and environmental sensitive areas. GeographicalInformation System (GIS) techniques have also been used based on recent satellite imageries of the project areas for above purposes. The impacts on ecologically sensitive areas (e.g. national parks, wildlife sanctuaries, biosphere reserve, and protected places) within 5km radius of the project areas have also been assessed.

7. **Approach and Methodology:** The updated IEE study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GOB) IEE Guidelines (1997) and ADB Safeguard Policy Statement (2009). The study is based on both primary and secondary data and information. The primary data includes data collected from field observationsand

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secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including government officials, community representatives and a wide range of road users and roadside dwellers. The main purpose of this approach was to obtain a fair impression on the people's perceptions of theproject and its environmental impacts.

B. Environmental Policy, Legal and Administrative Framework

8. **Regulatory Requirements for the Project:** The government has many regulatory requirements toward protection and conservation of both natural and social environment from adverse impact of projects and activities. Some of the pertinent requirements and guidelines arethe following:

- GoB Environmental Policy, Regulations, and Guidelines
- National Environmental Policy, 1992
- National Environmental Policy (amendment 2018)
- National Environmental Management Action Plan, 1995
- Environmental Conservation Act (ECA), 1995
  - Environmental Conservation Act (Amendment 2000)
  - Environmental Conservation Act (Amendment 2002)
  - Environmental Conservation Act (Amendment 2010)
- Environmental Conservation Rules (ECR), 1997 and Amendments
- Bangladesh Climate Change Strategy and Action Plan
- Relevant other regulatory requirements for the project
- Solid Waste Management Rules 2021
- National 3R(Reduce, Reuse & Recycle) Strategy 2010
- National Labour Act 2006
- National Labour Rules 2015

9. **Asian Development Bank Safeguard Policies, 2009:** Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects.Since the ADB Safeguard Policy Statement had been approved, it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para. 73, and paras. 77–85, and 92 of the Public Communications Policy (2005).

10. **Project Category:** The ADB SPS addresses environmental concerns, if any, of a proposed activity in the initial stages of project preparation. For this, the ADB SPS categorizes the proposed components into A, B, or C to determine the level of environmental assessment required to address the potential impacts. The project has been categorized as B based on SPS.Stakeholder consultation was an integral part of the IEE, and an environmental management plan(EMP) specifying mitigation measures to be adhered to implementation of the project has been prepared.

11. According to ECR Schedule 1, the project is red category because it involves construction, reconstruction, and extension of roads and bridges. This IEE report has been prepared and updated duly in the prescribed format and submitted to the Department of Environment (DOE) for approval. The project obtained environment clearance certificate (ECC) and renewal every year.

C. Description of the Project

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12. **Project Location:** The Elenga - Hatikamrul Road, located north of Tangail City, starts at Elenga Junction (24°20'22" N and 89°55'28" E) near the intersection of N4 and N405. The project road terminates at chainage 83+081 because of the Bangabandhu Bridge and starts again at chainage 90+700 at the West side of this bridge. The road ends at Hatikamrul (24°25'8.97"N and 89°33'6.97"E) of Sirajganj district. The total length is 41 km.

13. The road is a standard two-lane highway (two 3.65 m lanes, paved shoulders each 1.5 mand verges each 1.0 m). The road condition varies in different sections. Pavement crack is one the main problems for this road. There are several sub-standard horizontal curves. Road passes through some commercial areas at Elenga, Kodda Moor and Hatikamrul.

14. Project Components: Road component of the project comprises six road improvement packages. The scope of works includes detailed design, earthworks, pavement construction, construction of SMVT lanes, new Bridges and rehabilitation of old Bridges, drainage, structures, link/roadside improvements, and installation of road furniture such as signs and safety barriers. A total of 15 Bridges and 27 culverts will be rehabilitated and/or reconstructed. In addition, construction of two flyovers, 6 SMVT underpasses, bus bays, pedestrian overpass etc. are being constructed under two work packages. The project components and design standards are defined in the following table.

Table 1: Road Components and Design Standards for Elenga-Hatikamrul Road

	Road Components
Length	41 Km (including 7.6 Km Bangabandhu Bridge on JamunaRiver and approach roads)
Alignment	Mainly the existing road alignment have been followed forroad widening and improvement. No new bypass is proposed.
Flyovers	2 flyovers (Elenga Intersection and Koddar Moor Intersection)
Major Bridges	42 structures of which 15 bridges (1 Major Bridge >100m in length over Fuljor River) and 27 culverts
Underpass	06 SMVT Underpass at side road location (Total length 222m)
Embankment Design	Embankment height established for 1m free board on 20-year frequency HFL Dredged river sand based, side slope 3 hor: 1 ver, 600mm compacted cladding layer and turf for slope stabilization.
Design Standard	
Speed	Design : 80 kphPosted : 70 kph
Horizontal Controls	Controlling Curve: Maximum Super Elevation: 0.06 m/mMinimum Curve Radius: 252 m Design Speed: 50 km/h
Cross-Section Elements	Travelled each lane: 3.65 mCross Fall : 3 %
Structural design standards	Roads and Highways Department (RHD) Bridge DesignStandard 2004 American Association of State Highway and TransportationOfficials (AASHTO) Standards Specification

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15. To support RHD's road sector development strategy and operation, a 10-storey Road Research and Training Centre (RRTC) building will be established within RHD Headquarter in Mirpur, Dhaka. The building will host RHD Training Centre and ICT; and Road Research and Laboratory. The Training Centre and ICT will comprise training / classrooms, conference room, network and computer training room, office, and living accommodation. The Road Research and Laboratory will include research center, laboratory, equipment hall, office, computer laboratory, auditorium, and internal mosque.

16. The Road Operations Unit (ROU) will also be established and implemented initially alongthe Dhaka-Elenga-Hatikamrul-Rangpur (Dhaka-Northwest international trade corridor). The unit will focus on pilot good practices on overloading control, road asset management and road safety.The ROU will establish axle load control stations, required facilities and equipment, business models (operation plan and staffing plan), enforcement mechanism engaging other agencies, and safety provisions to reduce the safety vulnerability.

D. Description of the Environment

17. The existing baseline condition of environmental features in the locality of project site serves as the basis for identification, prediction, and evaluation of impacts. The following section describes the baseline environment into three broad categories:

1. Physical Environment

18. **Climate:** Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

19. **Temperature**. The highest temperature recorded at Tangail station was 37.5 °C in April and the lowest temperature was found in the month of January which was 7.7 °C. The average monthly temperature graphs show that the area face high temperature from March to May and lowest temperature during winter remains from December to February in the year.

20. **Rainfall.** Maximum rainfall occurs during May to September and the lowest rainfall occursin November to February during winter season. Statistical data of 1991 to 2012 shows that the station experiences more than 300 mm rainfall in June and July months during monsoon. In the month of December and January of winter season around 10 mm rainfall occurred in the region of Tangail stations.

21. **Humidity** Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2012 indicates that humidity in the area maximized in Julyto September in the year which is ranges from 80% to 85%. On the other hand, humidity falls 60%to 75% in February, March and April during the winter season in the considered area.

22. **Wind Speed**. Wind speed remained maximum with 3.3 knots in May and the minimumwas 1.9 knots in the month of December for Tangail station.

23. **Physiographic Features**. The Elenga - Hatikamrul road alignment area lies mostly in the

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central part of the country and depends on the Jamuna River for freshwater supply. The Elenga - Hatikamrul road area is characterized by the floodplains of Jamuna in Tangail District and Teesta floodplain in the Sirajganj District. The entire road alignment runs through the following two physiographic units 2: Teesta floodplain and 4: Old Brahmaputra floodplain.

24. **Topography**. The general topography of the project area comprises floodplains in the majority of the road and terraces. The general topography of the project area slopes from north to south with elevation ranges from 16 m a.m.s.l to 15 m a.m.s.l.

25. **Soil**. The project road passes through three different soil formation zones. The general soil types of the project road area predominantly include the following: Non-calcareous Alluvium (1) and Grey floodplain soil (5). The nature and soil characteristics of these zones influence the crops and cropping patterns within the region. Human interventions and modifications in the drainage patterns have already affected the cropping calendar, crop diversity and introduction ofnew varieties and agricultural products.

26. **Seismicity**. As per the seismic zone map, project road falls under Zone II, which means medium seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

27. **Surface Water.** Two major surface water bodies traverses the project area - Jamuna River and Fuljor River. The project road alignment crosses all the water bodies at several locations. The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically water quality improves during the monsoon due to the influx of freshrainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases. The concentration levels of all the measured parameters for surface water were found within the acceptable limit set by the DoE, GoB for fishing water in both Jamunaand Fuljor River. River bed material (sand) of the Jamuna and Fuljor Rivers contains acceptableamount of Arsenic (As), Lead (Pb), Zinc (Zn) and Mercury (Hg) comparing with the standard of EU Directive 86/278/EEC for land application. That is why; sand from the two rivers can be usedfor developing project Road Embankment.

28. **Ground Water.** The groundwater resources in the project area are found in three separate aquifers. An upper aquifer: a surface layer consisting mainly of clay and silt, characterized by high porosity but low permeability; composite aquifer: an intermediate layer of mainly fine sand and clay characterized by high porosity and moderate permeability (possibility of providing water withhand pumps); and main aquifer: a deeper layer, containing mainly fine to coarse sand. The concentration levels of Mn, Fe, Cl^-, Total Hardness, for the tube well of Gorilabari Village and Fuljor College Moor were found above or less within the acceptable limit set by the DoE, GoB fordrinking water. However, TC and FC in the groundwater were not present and it was within the given standards. In case of Arsenic, both the samples contain higher amount than the standard drinking water quality which is hazardous for health.

29. **Air Quality.** The SPM and PM_{10} concentrations exceeded the DoE allowable limit in the measured locations. There are two different sources of particulates matters; natural and human induced. The naturally generated particulates originates from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of particulates. In the project area human activities are mainly responsible for the high concentration of SPM and PM_{10}.

30. **Noise Level.** Analysis of the day time noise data shows that the baseline noise around the

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project area varies from location to location. The highest day time equivalent noise levels recorded at Hatikamrul intersection, Ullapara, Sirajganj was 79.6 dBA. The highest night time equivalent noise levels also recorded at the same place for day time Hatikamrul intersection, Ullapara, Sirajganj was 79.1 dBA. The noise level at the four locations is above the standard setin Bangladesh Noise Pollution (Control) Rules, 2006 in both day and night time.

2. Biological Environment

31. **Bio-ecological Zones.** The project road alignment crosses the three bio-ecological zones: Teesta floodplain (4a), The Brahmaputra-Jamuna floodplain (4c) and Major Rivers (11).

32. **Terrestrial Flora**. The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated in the surrounding area mainly include rice, wheat, rabi crops and variety of homestead vegetables. According to the census and IOL survey completed in February-March 2014, a total of 31,450 trees of different sizes (large=3,432, medium= 7,318, small= 17,383 and saplings= 3,317) are standing within ROW of the road's alignment. A sizeablenumber of fruit trees with economic value have been observed in the PIA. The fruit trees includejackfruit, mangoes, litchi, banana, coconut, blackberry, and timber trees that that include mehegoni, neem, epil-epil, koroi etc. A considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. The composition of plant community includes low growing grasses, trees, herbs, and shrubs. The data collected from the field survey suggests thatthe predominant species are those of cultivated vegetables and trees.

33. **Terrestrial Fauna**. The diversified habitat and ecosystem in the project area support various types of animals. Primary and secondary mode was adopted for identification of fauna. Most of the birds are identified through direct observation rather than from people. Most of the amphibians, reptiles and mammals were identified by using books and descriptions of the local people during the field survey.

34. **Aquatic Flora.** Different types of aquatic flora species were recorded in the project areas.The most abundant hydrophytes in the project area are Kochuripana (*Eichhornia crassipes*), Topapana (*Pistia stratiotes*), Khudipana (*Lemna minor*) Pata Jhajii (Vallisneria *spiralis*), Shapla (*Nymphaea sp.*), Kolmi (*Ipomoea aquatica*), Helenchaa (*Enhydra fluctuant*), and Duckweed (*Spiredella sp.*). Numerous algae (e.g., *Spirogyra and Scytonema*) and amphibian plant, Dhol kolmi (*Ipomoea fistulosa*) are also found in the roadside water bodies.

35. **Aquatic Fauna.** Fish is the most important aquatic fauna of the project areas, along with other groups. The aquatic fauna includes Prawns (*Macrobrachium spp*.), crabs, snails (Pila, Vivipara, Lymna etc.), freshwater mussels (*Lamellidens sp.)* etc. invertebrates and about 70 species of fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydris enhydris*) are common. The aquatic birds are Pancowri (*Phalacro coraxcarto*), Kanibok (*Ardeo lagrayii*), Sadabok (*Egretta garzetta*), Borobok (*Egretta alba*), Machranga (*Halcyon pileata*), Dahuk (*Gallicrex cinerea*), and winter migratory birds Balihash (*Dendrocygna javanica*) and Chakha (*Tadorna ferruginea*).

36. **Wildlife Sanctuary.** In and around the project area some wildlife species were identified as locally vulnerable. The name of these vulnerable species is Bengal monitor and Bengal fox. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. The Chalan Beel is one of the biggest wildlife sanctuaries are quite far from the project location and not within the 5 km buffer zone.

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3. Socio-Economic Environment

37. **Housing and Settlement.** The entire alignment runs through an open place. Agricultural lands are found in both sides of the road, although there are few houses and bazars along the road. There are some large and small restaurants/refreshment centres situated in both sides of the RoW. Housing condition of the five upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganjand Ullapara) of the project is predominantly kutcha, semi pucca and pucca houses found in thesemi-urban area. The average data about the main house of the dwelling households by type of structure shows that pucca and semi-pucca household structures remain higher in urban area comparing to the rural area and upazila. According to the resettlement survey, a total of 181,083square feet primary structures of different types will be affected. A total of 8.87 ha of land will be acquired.

38. **Land Use.** Land use analysis was carried out along five-kilometre buffer zone from centreline of the Elenga-Hatikamrul road using optical satellite imageries. Agriculture area is in the dominant position along the project road which is 63.72%. A significant portion covers the river area which is 12.59%. The settlement area covers 20.66% and water bodies covers 3.03%respectively.

39. **Water Supply and Sanitation.** Tube wells are the most common source of drinking waterin both the urban and rural areas. Tap water is accessible only in urban areas. Most householdsdo not treat water prior to drinking. Sewage facilities are available in most of the urban areas. The sanitary facilities are better in the semi-urban areas than the rural areas. Particularly, in the Sirajganj Sadar and Kamarkhand area have better sanitary facilities than the other upazilas alongthe road alignment.

40. **Transport and Communication**. The project road is connected with national highways, village roads, and railways in certain locations. The common types of transports are bus, truck, microbus, car, CNG, motorcycle, van and rickshaw. Mobile and wire telephone services are available in most of the areas. During the field survey, it is found that there are many roads crossing present in the Elenga-Hatikamrul road alignment which connect the adjacent villages tothe highway.

41. **Environmental Hotspots.** The socio-cultural aspects include the educational institutions, hospitals/health centers, religious structures, cultural structures, burial grounds, cremation yards, market places, industrial structure, water bodies, etc., few of which would be affected directly and indirectly through implementation of the both routes. Such sites could be termed as Environmental Hotspots in relation to project activities and, hence, need to be dealt carefully during the construction phase. There are no archaeological and historic sites in the RoW of the Elenga- Hatikamrul road project. Among the cultural sites, four mosques, one school, three filling stationsand one mazar (shrine) fall within the RoW of the road alignment.

E. Anticipated Environmental Impacts and Mitigation Measures

42. The current environmental assessment is based on the potential sensitive issues and impacts identified during site visits, consultation with local administrations, and the public. This section identifies the overall impacts on the physical, biological and socio-economic environmentof the project area. An environmental impact is defined as any change to an existing condition ofthe environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities.

43. Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. Impacts are

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described in the sections below.

44. Some of the important impacts associated with the road project are associated with land use (land acquisition), land stability (soil erosion), soil compaction and contamination, water availability, water quality of river/stream/canal, ground water contamination, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, tree cutting (includingsocial forestry tree), fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change,socio economic, places of social/cultural importance (religious structures, community structure), construction material sourcing and occupational health and safety. Adequate mitigation measuresare devised to mitigate/minimize all likely environmental impacts and the same have been presented along with the impacts.

45. To assess the likely impacts on the ambient air quality due to the proposed road project, CALINE-4, a line source model developed by the California Transport Department, was used to predict carbon monoxide (CO) and particulate matter (PM) concentrations on the road. The modelwas run to predict hourly average CO, $PM_{2.5}$ and PM_{10} concentrations generated from traffic movement on proposed highway.

46. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of $PM_{2.5}$, PM_{10} and CO concentrations, the predicted concentration of each pollutant is lower.

47. In addition, the spatial distribution of hourly average predicted CO, $PM_{2.5}$ and PM_{10}, concentrations have been plotted for peak traffic hour which shows that pollutant concentrationsis decreasing farther away from the highway corridor. Therefore, the impacts of traffic movement at proposed highway project will not impact the surrounding atmosphere.

48. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emission from vehicles along the proposed Elenga–Hatikamrul Road is modelled as steady state line source. Sensitive noise receptors along the corridor were identified such as educational institutions, health complexes and religious centers. Based on the model prediction, the predicted noise for the following sensitive receptors will be exceeded by 2040, compared to the current scenario: Bytunnur Jame Mosque, An-Noor Mosque, unnamed mosque, Sayadabad Mosque, Bangabandhu Setu Purbo Station, Bangabandhu Setu Poschim Station, Analiabari High School, Talimul Islam Madrasha, Jamuna Polytechnic Institute, Shohidul Bulbul Karigori College, and Simanto Bazar. Predicted noise levels ranged from 65.6-74.8 Leq.

49. Consultations were also held with people in the locality including those presently living inthe project areas and Government authorities. The outcome of these consultations was used in impact assessment and devising mitigation measures.

F. Greenhouse Gases Emission and Climate Change Assessment

50. GHG emissions likely to be generated from the project roads have been computed usingthe Transport Emissions Evaluation Model for Projects (TEEMP)[1] developed by Clean Air Asia[2] was

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

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

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utilized to assess the CO_2 gross emissions with and without the project improvements. In terms of intensity, total CO_2 emissions at business-as-usual, with-project (without induced traffic)and with project (with induced traffic) scenarios were estimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. These values are significantly above the 100,000tons CO_2e/year threshold[3] set in ADB SPS 2009. ADB requires the borrower (the Government ofBangladesh through the Roads and Highways Department) to evaluate feasible and cost- effective options to reduce or offset project related greenhouse gas emissions.

51. Climate change in Bangladesh indicate risks and vulnerabilities due to changes of temperature, rainfall, temperature and rainfall related extreme events, cyclones, floods, and sea level rise that will likely result to (1) higher annual precipitation and daily temperature; (2) greater temperature and rainfall extremes; (3) increased flooding, both in terms of extent and frequency; (4) increased cyclone and storm surges both in terms of extent and frequency; (5) low river flow during dry periods; and (6) sea level rise and increased salinity intrusion. Climate change adaptation measures include (1) Adaptation allowance of 0.37 m above flood level; (2) Additional 102.4 cm for road embankment; (3) Additional 37 cm in bridge above HFL; (4) Incorporation of longitudinal drains along total highway length and increasing the number of cross drainage per unit distance; (5) Construction materials policy adaptation through the use of river sand rather than clayey agricultural soil for roadway embankment; (6) and using high quality asphalt pavement to adapt to increase in temperature.

G. Environmental Management Plan

52. **Environmental Management Plan (EMP):** On the basis of identification of the environmental impacts and recommended mitigation measures linked with the Elenga-Hatikamrul project activities, an EMP has been prepared which will be followed at the construction and operation stages. While preparing the EMP, medium and significant impacts aretaken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by ADB SPS, 2009 and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied.

53. **EMP Implementation Schedule:** An implementation schedule has been sketched basedon the environmental components that may be affected during the construction and operation ofthe project. Since project is likely to have impact on various components of environment, a comprehensive EMP implementation schedule covering terrestrial and aquatic ecology, soil erosion, drainage congestion, tree plantation, air quality, noise, and vibration are provided. Monitoring Plan has been separately suggested for construction and operationphase.

54. **Environmental Monitoring Plan:** Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. The purpose of the monitoring program is to ensure that the envisaged purposes of the project are achieved and result in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program be designed and carried out. Compliance monitoring will be conducted in accordance with the environmental mitigation measures and monitoring plan provided with this report.

[3] Page 38, Appendix I, footnote 10 of SPS 2009.

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55. **Environmental Budget:** The overall costs of the EMP comprises:

- Environmental monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental damage;
- Designing and implementing all mitigating and enhancement measures;
- Supervision staff from RHD and consultants including direct costs and travel subsistence.

56. The total budget is estimated to be US$ 0.3986 million.

H. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism

57. **Institutional Arrangement:** The Environmental Management Plan (EMP) implementation requires an organization support structure in the form of organizational requirements, training needs and plan, and information management system.

58. The Roads and Highways Department (RHD) is the Executing Agency (EA) and will be responsible for ensuring compliance of all the provisions of the EMP. The RHD has the responsibility to ensure that the investment follows the legal requirements for environmental assessment. The Environmental and Social Circle (ESC) headed by the Superintending Engineer,will be responsible for managing environment and social safeguards including safeguards relatedcapacity building for all RHD projects, although they will not be involved in the day-to-day implementation of safeguards for specific projects.

59. The Project Implementation Unit (PIU) is responsible for ensuring proper implementation of environment safeguards in their respective projects including implementation of the EMP and Environmental Monitoring Plan (EMoP), timely reporting and timely resolution ofcomplaints and grievances.

60. The Additional Project Director under the PIU serves as the Environmental Focal Person at the Project Headquarter level. At the site level an Assistant Engineer supporting the Project Manager serves as the environmental focal person.

61. The Project Implementation Consultant (PIC) provides support to the PIU for day-to-day monitoring and reporting on environmental safeguards. The PIC is responsible for supervising the civil works contractor and to ensure the conformity of contractors with the relevant clauses in construction contracts and national regulations. The Contractor implements the EMP and EMoP and obtains all environment related permits and clearances required for construction.

62. **Capacity Building:** In Bangladesh, the environmental assessment process is established, but environmental awareness and capability for implementation of EMP in infrastructure projects are still developing. The project implementation unit (PIU) of RHD had some officers in the Environmental and Social Circle department (ESC) that delegated environmental duties. The delegated officers have responsibility to bring environmental issues tothe notice of senior management. Typically, the delegated officers have been moved to differentdepartments due to promotions and operational needs after about every 3 years, and they moveon to other engineering departments in RHD. The status quo is that ESC engineering officers aredelegated to check environmental assessments prepared by consultants. The IEEs and EMP arereferred to the DOE in the Ministry of Environment and Forests (MOEF) for approval. The ESC in RHD is not directly involved with project implementation but has more administrative responsibility to ensure environmental compliance and

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a general role to increase environmental awareness for RHD. It is therefore not clear if RHD/ESC has the capacity to check the adequacyof the developed EMP for this project.

63. **Grievance Redress Mechanism:** To facilitate the resolution of affected people's concerns, complaints, and grievances about the social and environmental performance of the project, a Grievance Redress Mechanism (GRM) is established which aims to provide a time bound and transparent mechanism to voice and resolve social and environmental concerns.

64. The Environment and Social Circle (ESC) of RHD makes the public aware of the GRMthrough public awareness campaigns. The contact phone number of the respective ESC serves as a hotline for complaints, and is publicized through sign boards, posters and placed on notice boards outside their offices and at construction sites. The project information brochure includes information on the GRM for wider dissemination throughout the project area by the Environmental Specialist/Engineer in the ESC, with support from the NGOs and communications firm. Grievances can be filed in writing or by phone with any member of the SEC.

I. Information Disclosure, Consultation and Participation

65. Information disclosure, and public consultation with affected people and other concerned stakeholders, including civil society to facilitate their informed participation IEE preparation are requirement of ADB SPS 2009 both during conducting a new IEE study and updating of the IEE report. Updating of Elenga-Hatikamrul IEE report requires public consultation and stakeholders' feedback to understand whether the project being implemented has been managed with proper environmental and health-safety guidelines as mentioned in the EMP.

66. Series of Public Consultations, Focus Group Discussions (FGDs), Government Officials, Individual Local People were conducted during preparation of the IEE report from February to May 2013 in conformity with the ADB and DoE guidelines. Project staffs have carried out a series of stakeholder consultations at different locations of the project during information and data collection, disclosure of information and draft IEE report to obtain feedback from the community, government agencies, civil society and project affected people before finalization of the IEE report.

67. To update the IEE of Elenga to Hatikamrul, no public consultation or Focus Group Discussions (FGDs) has been conducted. The variation of orders proposed for Phase 2 and Tranche 3 project are to be implemented within the existing RoW and are unlikely to cause any new environmental impacts with significant intensity and different dimensions. All anticipated impacts are known, reversible and as usual short term through implementation of EMP properly. Hence, there is no requirement of public consultations engaging local community, government officials, or particular stakeholders of the road project. Rather, from the stakeholder discussions during conducting IEE study and construction period, it has been noted that the project will indeed be helpful for socio-economic development for central region of the country by timely transporting of essential goods and products required for agricultural and industrial development which will bring direct benefit to the wellbeing of the people of northern Bangladesh.

68. The project periodically has conducted meetings with participation of representatives from PMU, PIC, and contractors where environment safeguard impacts and safety issues, and status of environmental compliance with respect to implementation of EMP are discussed for adhering to environmental safeguard activities. Environmental monitoring reports are being submitted to ADB in line with the requirements ADB SPS 2009 and contractual obligation of the project. Necessary corrective action plans are produced and implemented, rigorous monitoring and surveillance efforts from the safeguard staff of contractors and project engineers have been

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provided throughout the construction period. Several minutes and attendance list of project meetings are included in Appendix K.

J. Conclusions and Recommendations

69. **Conclusions:** Updating IEE report concludes that the environmental impacts are manageable if the mitigation measures are implemented thoroughly. The EMP is based on the type, extent, and duration of the identified environmental impacts. The EMP has been prepared with close reference to best practices and in line with the ADB's Safeguards Policy Statement (SPS) and DoE environmental guidelines. The impacts to be generated due to implementation of variations of orders will be manageable through implementation of the EMP. Although widening of SMVT lanes, bridge, culverts, etc will increase volume of works, and it is likely that more areas will be disturbed throughout the road project, operation of road will be safer and eventually reduce environmental footprint and health-safety issues.

70. The project is classified 'B' in accordance with ADB's Safeguard Policy Statement 2009 requiring preparation of an Initial Environmental Examination Report. As per the Environmental Conservation Act, 1995 of Bangladesh, the project falls under Red category and requiring preparation of an IEE. This report is prepared keeping the ADB and GOB environmental requirements in consideration.

71. **Recommendations:** The EMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor is responsible for the implementation of the requirements of the EMP through his own Site-Specific Environmental Management Plan which adopts all of the conditions of the EMP and add site specific elements that are not currently known, such as the Contractors borrow pit locations. This ensures that all potential bidders are aware of theenvironmental requirements of the project and its associated environmental costs.

72. The EMP and all its requirements are then added to the contractor's contract, therebymaking implementation of the EMP a legal requirement according to the contract. He then prepared his CEMP which has been approved and monitored by the Engineer/Environmental Specialist. To ensure compliance with the CEMP the contractor should employ an environmental monitoring officer (EMO) to monitor and report project activities throughout the project constructionphase.

73. RHD has an Environmental and Social Circle but they need capacity building and practical exposure. Adequate training has been organized and is continued as proposed under environmental management plan to enhance the capability of concerned EA officials. It is recommended to update environmental guidelines focused on effective implementation of mitigation measures.Performance indicators may also be developed as part of these guidelines to monitor and assessthe effectiveness of the mitigation measures.

74. The Initial Environmental Examinations and Environmental Management Plans for the establishment of Research and Training Centre (RRTC) has been prepared and being implemented by the contractors under supervision of Project Implementation Consultant (Supervision Consultant).

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I. INTRODUCTION

A. Project Background and Rationale

A. Background

1. The Government of Bangladesh (GoB) is emphasizing on improved connectivity betweeneach part of the country. In support with this objective the GoB announced its National Land Transport Policy in 2004 defining long term (20 years) Road Master Plan (RMP). The RMP has identified many feasible and priority projects. One of priority roads identified is the Elenga - Hatikamrul road. This road is a vital link in the national highway network and forms a part of the Asian Highway Network complementing the government plans to increase trade with India.

2. The previous road has inadequate capacities to accommodate increasing volume of traffic of the route and experienced lack of safety. The road was two lanes with no shoulders and no provision for slow moving vehicular traffic (SMVT) or non- motorized traffic (NMT). There was capacity constraints caused by congested junctions, markets, and community areas. The project is upgrade the road to a four-lane road with safety features, dedicated SMVT lane, flyovers at business junctions, and overpasses at intersections.

3. The upgrading of the road will have its associated environmental impacts that require due consideration in project design for its mitigation and management based on detailed environmental assessment. This report presents the updated Initial Environmental Examination (IEE) carried out to determine the likely significant environmental changes due to the project and techniques mitigation measures to avoid, minimize, or compensate these impacts.

4. This IEE is prepared under the Technical Assistance for Subregional Road Transport Project Preparatory Facility (ADB Loan 2688-BAN) which is currently updated under second phase of SASEC Dhaka- Northwest corridor Road Project, with the guidance of the Roads and Highways Department (RHD) which is the project's executing agency (EA). Considering ADB's Screening Checklist for Environmental Classification the proposed road has been categorized under Category B of ADB's environmental classification system. The required level of environmental assessment for Elenga-Hatikamrul with respect to Government of Bangladesh (GoB) requirements established prior to commencing the assessments. Accordingly, as the road proposed for developments is in the Red List of GoB Environment Conservation Rules, 1997, there is requirement for preparation of updated IEE.

B. Purpose of the Report

5. This updated IEE is a part of the process of compliance with the Government of Bangladesh and ADB guidelines in relation to Road Improvement Project under Sub-regional Transport Project Preparatory and Facility (SASEC-2) and as part of the Second Phase of SASEC Dhaka – Northwest Corridor Road Project.

6. Several activities that are likely to take place during the project implementation and the associated potential impacts have been analyzed in this present updated IEE. The IEE provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The IEE also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work. The Elenga - Hatikamrul road mainly passes through agricultural land and a small portion through residential area. There are some small commercial places where business closely related to

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passengers of the vehicle running on this road. This road crosses various water bodies, whichare important from aquatic ecology perspective. Assessment has been carried out to identify theimpacts of the proposed road improvement works on terrestrial and aquatic ecology, land use, air, and water and noise quality. An Environmental Management Plan (EMP) has been developed with suggestions to mitigate the potential impacts. Extensive consultations with the local people and people from government officials undertaken as part of the update IEE work have been considered for identifying the mitigation measures. See Appendix K & L for references.

1. Extent of the Study

7. The most up-to-date information on project details and detailed designs provided by the design team has been considered in the preparation of this report. The impact area for the project activities has been categorized according to its extent on the surrounding environment. The corridor of impact has been defined as 500m on either side from the edge of the road alignment.However, the study area has been extended to a 5km wide area on both side of the alignment to analyze the land use, identify potential borrow areas and environmental sensitive areas. Geographical Information System (GIS) techniques have also been used based on recent satelliteimageries of the project areas for the above purposes. The impacts on ecologically sensitive areas (e.g., national parks, wildlife sanctuaries, biosphere reserve, and protected places) within 5km radius of the project areas have also been assessed.

8. Along with the original scope of the IEE study, necessary additional scope has been added to update the IEE report encompassing construction activities irrespective of original design and variation of orders proposed for Tranche 3 of Phase 2 project. Impact assessment for construction activities as variation of orders has been conducted to devise corresponding mitigation measures to offset environmental degradation. Here, the TOR of the IEE is provided in Appendix A and DoE approval of the TOR is provided in the Appendix B.

2. IEE Content

9. This updated IEE report comprises nine chapters, in consistent with the Government of Bangladesh guidelines and ADB's Safeguard Policy Statement, 2009. These chapters are:

1. Introduction
2. Policy, Legal and Administrative Framework
3. Description of the Project
4. Description of Existing Environment
5. Anticipated Environmental Impacts and Mitigation Measures
6. Environmental Management Plan
7. Institutional Arrangement, Capacity Building and Grievance Redress Mechanism
8. Information Discloser, Consultation and Participation and
9. Conclusion and Recommendations.
10. Appendix

C. Approach and Methodology

1. Approach

10. The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GoB) EIA Guidelines 1997, and ADB Safeguard Policy Statement (2009). The study is based on both primary and secondary data and information. The primary data

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includes data collected from field observations and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including government officials, community representatives and a wide range of road users and roadside dwellers. The main purpose of this approach was to obtain a fair impression of the people's perceptions of the project and its environmental impacts.

11. **Methodology.** The following methodology is adopted for carrying out the updated IEE study of the project.

12. **Orientation.** Meetings and discussions were held among the members of the IEEConsulting Team. This activity was aimed at achieving a common ground of understanding of various issues of the study.

13. **Data Collections Planning.** Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan has been developed for the internal use of the IEE Consulting Team. The plan included identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection; and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

14. **Data Collection.** In this step, primary and secondary data is collected through field observations, environmental monitoring in the field, concerned departments and publishedmaterials to establish baseline profile for physical, biological, and socioeconomic environmental conditions. Following activities is perform for data collection:

- Site Reconnaissance
- Analysis of Maps and Plans
- Literature Review
- Desk Research
- Public Consultations
- Field Observations, Data Collection & Studies
- Laboratory Analysis

1. **Physical Environment**

15. Information is collected on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, water quality, air quality and noise, etc.

16. **Geology, Topography, Soils.** Data related to geology, topography and soil is collected to establish the baseline of the project area and further to find out the impacts of the project during the construction and operational phases.

17. **Hydrology and Drainage.** Data related to hydrology and drainage was collected to identify the elements of the hydrological cycle that are likely to have impacts on the project and the possible impacts that the project could have on the hydrological regime. Field assessments included a determination and verification of all the existing inflows into the drain, assessment of drainage issues, interviews with local community members, and roundtable discussions with stakeholders.

18. **Air Quality.** Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed construction on air quality conditions.

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Ambient air quality was continuously monitored for Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Particulate Matter (PM_{10} & $PM_{2.5}$), and other regular weather conditions for 24 hours. To monitor air quality at the different locations, a field investigation was undertaken on 20-25 December 2022. The high-volume sampler, Ecotech Model AAS 271 MINI has been used to collect particulate matter and Ecotech Model AAS 118 Gaseous Pollutions Sampler for gaseous measurement.

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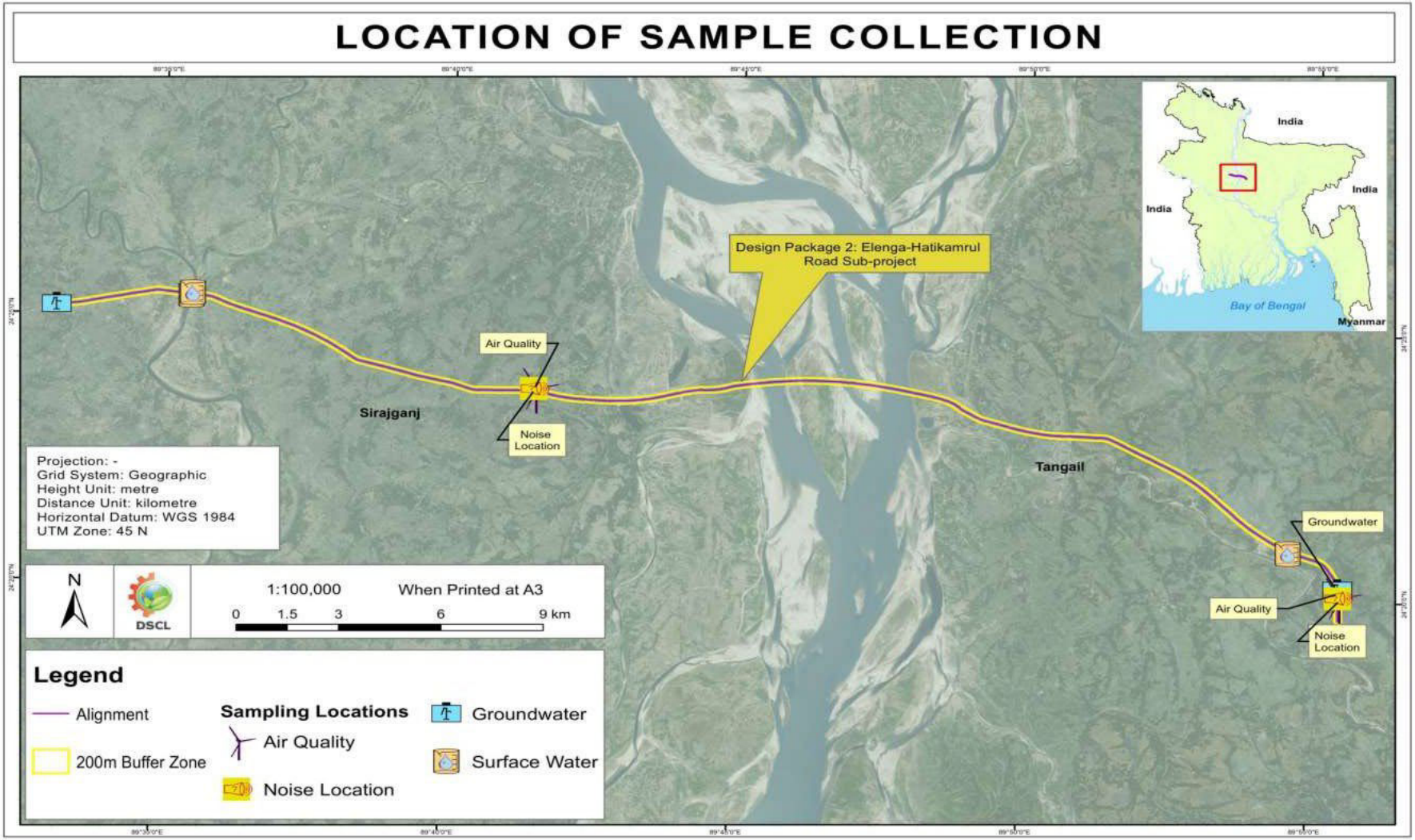
Figure 1: Location of Sample Collection along the Project Road



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19. **Noise.** The noise monitoring was performed by a trained specialist, using a calibrated Digital Sound Level Meter (Model No SL-4033SD) set to A-weighting, fast response, and statisticalanalysis settings. The Sound Level Meter (SLM) mounted on a tripod at a height of approximately 1.5m, facing in the direction of the apparent predominant noise source. The SLM is a program to record statistical noise levels for 24 hours at each location and calibrate before and after the survey to detect significant drift, if any.

20. **Ground/Drinking Water Quality**. Sampling and analysis of ground/drinking water have been carried out for the following parameters: pH, Manganese (Mn), Arsenic (As), Iron (Fe), Chloride(Cl), Total Hardness, Total Coliform (TC) and Faecal Coliform (FC).

21. **Surface Water Quality**. Sampling and analysis of surface water quality have been carried out for the following parameters: pH, Total Organic Carbon (TOC), Total Phosphate (PO_4), Total Suspended Solids (TSS), Oil and Grease, and Dissolved Oxygen (DO).

22. **Soil Quality**. Soil quality has been carried out to identify presence of heavy metals for the parameters: Mercury (Hg), Zinc (Zn); Arsenic (As), Cadmium, Copper and Lead (Pb).

2. **Biological Environment**

23. The status of the flora and fauna of the project area have been determined by an ecological survey, review of literature relevant to the area, and an assessment of terrestrial environment.

24. **Flora.** Vegetative communities have been identified and classified into community types. Identification includes dominant tree species, assessment of stage of growth (mature orsapling) and assessment of canopy cover.

25. **Fauna.** Information on fauna has been gathered from existing literature on reported species as well as observations in the field.

3. **Socio-Cultural Environment**

26. In order to assess the socio-cultural environment, the Consultants utilized a combination of desk research, field investigations, census data, structured interviews, maps, reports to generate the data required for description of the existing social environment and assessment of the potential impacts due to the construction of the project. The important data collected and analyses to assess the parameter are given below:

- Land use
- Traffic, transportation, and access Roads
- Demographics
- Livelihoods
- Poverty
- Education
- Health
- Social setup
- Community facilities
- Recreational activities
- Archaeological and cultural heritage, etc.

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27. **Public Consultation.** Public consultation is one of the important components of the IEE preparation activities. Local knowledge about the ecosystem and problems associated with the existing roads are carefully recorded and use in impact assessment and developing mitigationplan. Formal institutional level public consultation, in tandem with opportunistic informal ones involving local dwellers, road users and people whose livelihood depends on these roads, has been executed. Detailed description of public consultation is present at Chapter 8.

D. The Initial Environmental Examination (IEE) Team

28. This update IEE is prepared by the project supervision consultants both PIU, PIC, and deliver the update IEE for the project. The PIC team members have many years of professional experience working in Initial Environmental Examination both within Bangladesh and internationally. The composition of the update IEE team is below in Table 2.

Table 2: The IEE Team

Name	Position
Md. Mahbubur Rahman	Environmental Focal Person from RHD (EE)
Md. Gias Uddin	Coordinator of Environmental Safeguard (PIC)
Syed Nazmul Husain	Environmental Specialist (PIC)
G. M. Hasan	Environmental Specialist (PIC)
Sanoni Ara Syed Dimity	Jr. Environmental Specialist (PIC)
Respective EMO of the Contractor	

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II. DESCRIPTION OF THE PROJECT

A. Background

29. Geographically, Bangladesh is an important location which can serve as vital link between neighboring countries Nepal, Bhutan, Myanmar, and India. The Transport Working Group (TWG)of the South Asia Sub-Regional Economic Cooperation (SASEC) has also identified four of the sixcorridors passing through Bangladesh. With the opening of Bangabandhu Bridge and the proposed development of Padma Bridge, the Dhaka –Chittagong transport corridor and other transport corridors can serve to facilitate trade between Bangladesh and the north-eastern statesof India, the Indian state of West Bengal, and neighboring country Bhutan and Nepal. This central location of Bangladesh generates immense potential to benefit from better trade facilitation efforts.However, this potential has not been fully realized because of deficiencies in key infrastructure and the trade-related constraints.

30. The Elenga-Hatikamrul road is vital links in the national highway network. The Elenga-Hatikamrul road is part of Asian Highway Network route AH2.

31. The Road Master Plan 2008 of Bangladesh already considered the improvement of this road. The existing road is a two lanes road with shoulders. There is no separate provision for slow moving vehicular traffic (SMVT) or non-motorized traffic (NMT). Moreover, this road does not have the capacity to carry the required number of vehicles in some places like congested junctions.

32. The execution of the proposed upgrading will substantially improve transport efficiency onthe road linking North and North-west of Bangladesh to Dhaka (the capital) and the Southeast Road Corridor (to Chittagong). This will also contribute in integrating the southwest region into the national economy, a key issue identified in the Asian Development Bank country strategy andprogramme for Bangladesh (2006-2010) as a requirement to support the country's National Poverty Reduction Strategy.

B. Project Location

33. The Elenga-Hatikamrul road located north of Tangail city starts at Elenga Junction (N 24°20'22" and E 89°55'28") (chainage 69+300) near the intersection of N4 and N405. At the beginning of this road touches the N4 and then follows the N405. The project road halts at chainage 82+900 because of the Bangabandhu Bridge and starts again at chainage 90+700 at the West side of this bridge. The road ends at Hatikamrul (24°25'8.97"N and 89°33'6.97"E)(chainage 110+700) of Sirajganj district. Excluding the Bangabandhu bridge the total length is 33.4 km. Figure 3 shows the project location.

34. The road is a standard two-lanes highway (two 3.65m lanes, paved shoulders each 1.5mand verges each 1.0m). The road conditions vary in different section. Pavement cracks are one of themain problem for this road. There are several sub-standard horizontal curves. The road passes through some commercial areas at Elenga, Koddar Moor and Hatikamrul but there is no heavily congested area.

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Table 3: List of Structures (Updated December 2022)

SL No	Work Package (WP)	Length (km)	SMVT Length	Bridge	Culverts	Flyover	Underpass (SMVT)	U-Turn	Bus-Bay
1.	WP 05	13.6Km	13.6Km	8	10	1	2	3	11
2.	WP 06	19.8km	5.5	7	15	2	4	0	2

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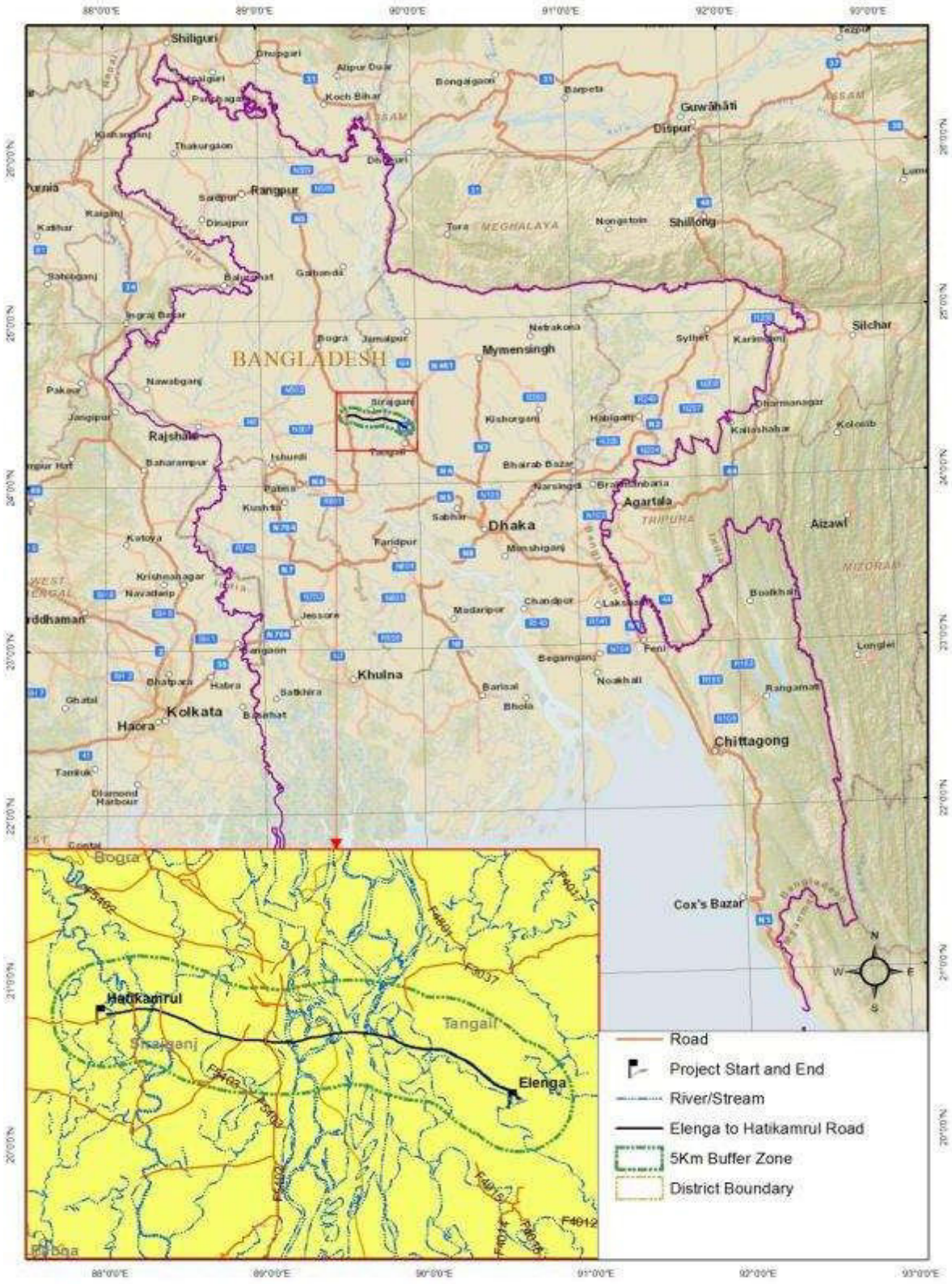

Figure 2: Locality Plan

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C. Project Components

35. The project components and design standards are defined in the following sections:

Table 4: Road Components and Design Standards for Elenga-Hatikamrul Road (U)

Road Components	
Length	41 km (including 7.6 km Bangabandhu Bridge on Jamuna River and approach roads)
Alignment	Follow existing road alignment for road widening and improvement. No new road construction or bypass is proposed.
Flyovers	2 flyovers (at Elenga and Koddar Moor Intersection)
Major Bridges	42 bridges /culverts of which 15 bridges (1 Major Bridge (>100m in length over Fuljor River) and 27 culverts
Underpass	06 SMVT Underpass at side road location (Total length 222m)
Embankment Design	Embankment height established for 1m free board on 20 years frequency HFL Dredged river sand based, side slope 3 hor: 1 ver, 600mm compacted cladding layer and turf for slope stabilization.
Design Standard	
Speed	Design: 80 km/h Posted : 70 km/h
Horizontal Controls	Controlling Curve: Maximum Super Elevation: 0.06 m/m Minimum Curve Radius: 252 mDesign Speed: 50 km/h
Cross-Section Elements	Travelled each lane: 3.65 mCross Fall : 3 %
Structural design standards	Roads and Highways Department (RHD) Bridge Design Standard 2004 American Association of State Highway and Transportation Officials (AASHTO) Standards Specification

1. Alignment and ROW

36. The project road is two lanes at most of the places, and upgraded to a four-lane highway. The carriage way at each side typically will be 7.3 m width with median of 1.2 m and either side shoulder of 1.0 m wide. The side slope of road embankment will be of 1:2. Widening will be either right aligned or left aligned, but mostly left aligned. The RoW required is 50m on the average, and is available throughout the road. The ROW may not be available in areas where new parallel bridges and its approach roads are to be constructed. Theroad is also passing through rural, semi-urban, and sparsely populated areas. In many areas, ROW is encroached by the people. At some places, either ROW may not be available for the desired embankment height or cannot be utilized due to encroachment. At such places, RC retaining wall option exercised to reduce the ROW requirement.

37. Typical cross sections of road alignment for normal road, constricted road and highly constricted road are given in Figure 4. The pavement works comprise construction of sub-grade,sub-base, base binder course and wearing course. All roads have been designed following roadsafety requirements as per RHD published guidelines and standards. This includes separation ofmotorized and non-motorized traffic, planning of cross section, bus stop, and service road to ensure accident

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flow of traffic. The cross-section bus stand layout and embankment drain on curve is shown.

38. No new bypass is proposed. The river protection works decided based on the depthand flow pattern of the river, the scouring regime and the type of structure. Geotextiles, brick blocks, concrete blocks, sand cement blocks and sand geo- bags use for construction of protective works.

D. Rational of updating the IEE

39. The last IEE report prepared on May 2017. Now the updated IEE prepared to check the status of existing environmental data and the baseline data. To assess the environmental impact of the ongoing project during construction according to the baseline data are varies. Infect the existing contract and scope of work also varies from on work package to another.

40. Feasibility study and detailed design for this project were completed in 2015 with the Technical Assistance of ADB under Sub-Regional Road Transport Project Preparatory Facility (SRTPPF). The project document was prepared based on the study in 2015 and all items are included in the Bid documents accordingly. All the items and quantities were considered in the bid documents in a similar fashion with the SASEC-1 project. SASEC-2 project is a continuation of SASEC-1 project, which is in the culmination of completion and has undergone several changes viz. incorporation of concrete pavement, increase in SMVT length and width, change in pavement design etc. at various stages. From the lessons learnt and to alleviate the shortfalls in the specification and BOQ items, it was felt necessary to go for the inclusion of certain additional items, increase quantities of certain specific items, change of scope of work of some items including specification changes, as found necessary for proper implementation of the project, at the initial stages of the work. Hence, variation events can be attributed to four triggers:

a) Events which were brought on from the gap found between the design phase or feasibility findings and the original requirements in the field. Example- existing four bridges were found severely damaged and deplorable; one became inactive during construction period.

b) Events which are jointly agreed by the client and the contractor on some improvement issues fetched from the lessons learnt from SASEC-1 project which has similarity in design, features and orientation with SASEC-2. Example- Concrete Pavement, Widening of SMVT etc.

c) Events which are identified and measured by the tri-party (RHD, Consultant and Contractor) during the pre-construction and construction period with a view to implement the features of the contract. These events mostly affected the quantities. As per contract stipulations, the quantities given in Original Bill of Quantities (BoQ) are estimated as provisional and are given to provide a common basis for bidding. The works during construction phase shall be measured at the site on tri-party basis, and the determined quantity shall have to be the actual quantities of work which can be referred as ‘Permanent Works’. Example- Earthwork or Sand Backfill to Swamp.

d) Events which can be referred to new changes proposed in SASEC2 or contract specific changes for the improvement of the alignment/construction works or modify specifications or change of pavement design or changes which are inevitable as per site. Example- Reducing Aggregate Base Type-2 thickness and increasing Type-1.

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Table 5: Major Scope Changes as per Variation Events, WP-06

SL.	Original Scope	Revised Scope
1	Contract Length- 19.8 kilometer	Contract Length- 19.014 kilometer
2	Number of Bridges (3Lane)- 4 Nos , Railway over pass(3lane)-1, Nos Number of SMVT Bridges- Zero Number of Culvert-17Nos. Nalka Bridge-3 lane No SMVT Bridrge at R/S	Number of Bridges (3Lane)- 4, Number of SMVT Bridges- 4 Number of Culvert- 15 Nos. Railway bridge 4 lane-1 nos Nalka Bridge-4 lane.
3	SMVT Road Width- 3.6 meter SMVT Road Area- 136900 sq. meter	SMVT Road Width- 4.2~7.3 meter SMVT Road Area- 185440 sq. meter
4	single vent Culvert type SMVT Underpass- 4	Bridge Type SMVT Underpass- 4
5	Flyover-1	Flyover-2
6	Flexible Pavement Area • Main Carriageway- 360360 sqm • SMVT- 136900	Flexible Pavement Area • Main Carriageway- 346054.8 sqm • SMVT- 185440 sqm
7	Rigid Pavement Area • Main Carriageway- Zero • SMVT- Zero	Rigid Pavement Area • Main Carriageway- 0. • SMVT- 80300 sq. m.
8	Aggregate Base-1- 101695 Cum Aggregate Base-2- 52055 cum	Aggregate Base-1- 127293 Cum Aggregate Base-2- 0 cum
9	Sub Base- 99361 cum	Sub Base- 113654.84 cum
10	Earthwork - 469127047.00 cum	Earthwork- 581152737.90 cum
11	Sand Backfill to Swamp - 30000 cum	Sand Backfill to Swamp- 30000 cum
12	Sand Backfill for Structures- 13847 cum	Sand Backfill for Structures- 13847 cum
13	Unsuitable Soil- 21785 cum	Unsuitable Soil-21785 cum
14	Cladding Soil- 22392 cum	Cladding Soil-127130cum
15	Standard Compaction in Earthwork and ISG	Modified Compaction in Earthwork and ISG
16	RE Wall - 4486 Reinforced Earth- 33240	RE Wall-5495 Sqm Reinforced Earth-49553 Cum
17	No Scope of New Jersey Barrier (NJB)	No Scope of New Jersey Barrier (NJB)
18	Semi-Continuous or Finger Type Expansion Joint	Modular Sinus Type Expansion Joint
19	Elastomeric Bearing	Elastomeric Bearing

41. The updated IEE prepared due to change of scopes of work mainly comprising of Concrete pavement, RE wall, modified SMVT Underpasses, additional strengthening layer for the flexible part, inclusion of Pedestrian Underpasses, additional one Flyover, change in width of SMVT Lanes, change in compaction standard and quantity for earthwork, changes in BOQ quantity of different items in original contract, etc. The river protection works decided based on the depth and flow pattern of the river, the scouring regime and the type of structure. Geotextiles, Brick Block, Concrete Blocks, Sand Cement Blocks and sand geo-bags may be used for construction of protective works. The design of river protection works attached in the Annex M.

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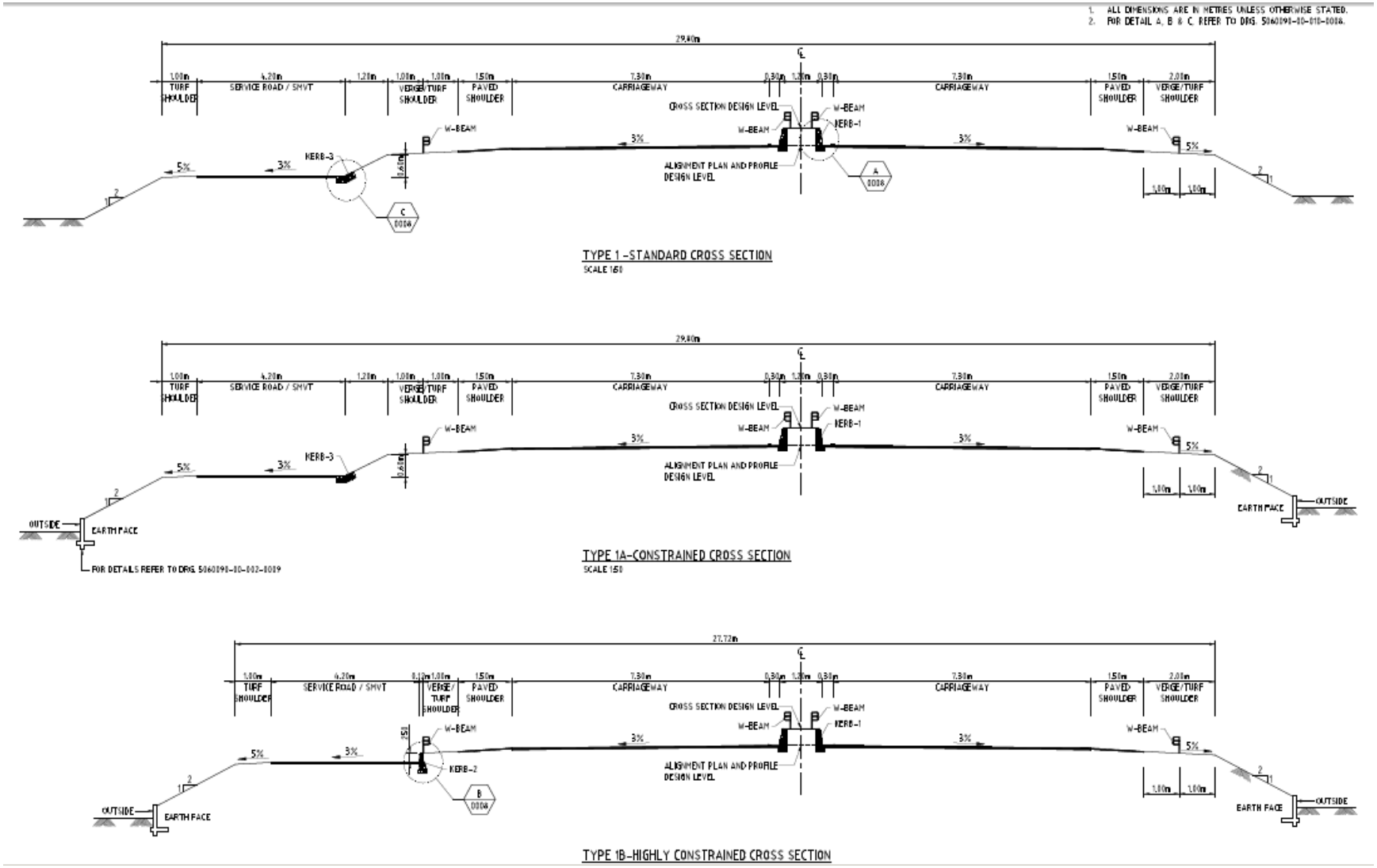

Figure 3: Typical Cross Section

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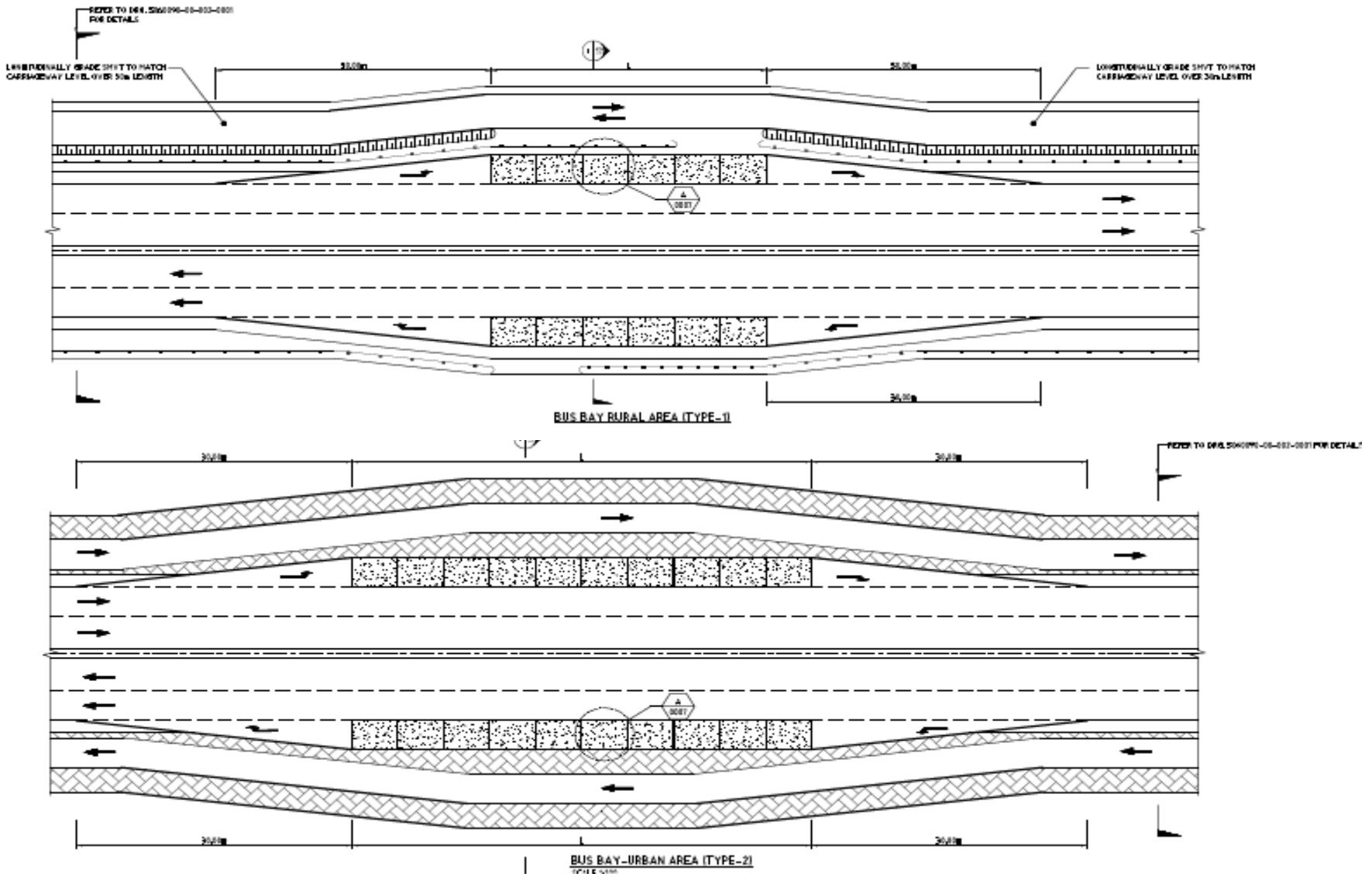

Figure 4: Layout Plan of Bus Bay at Rural and Urban Area

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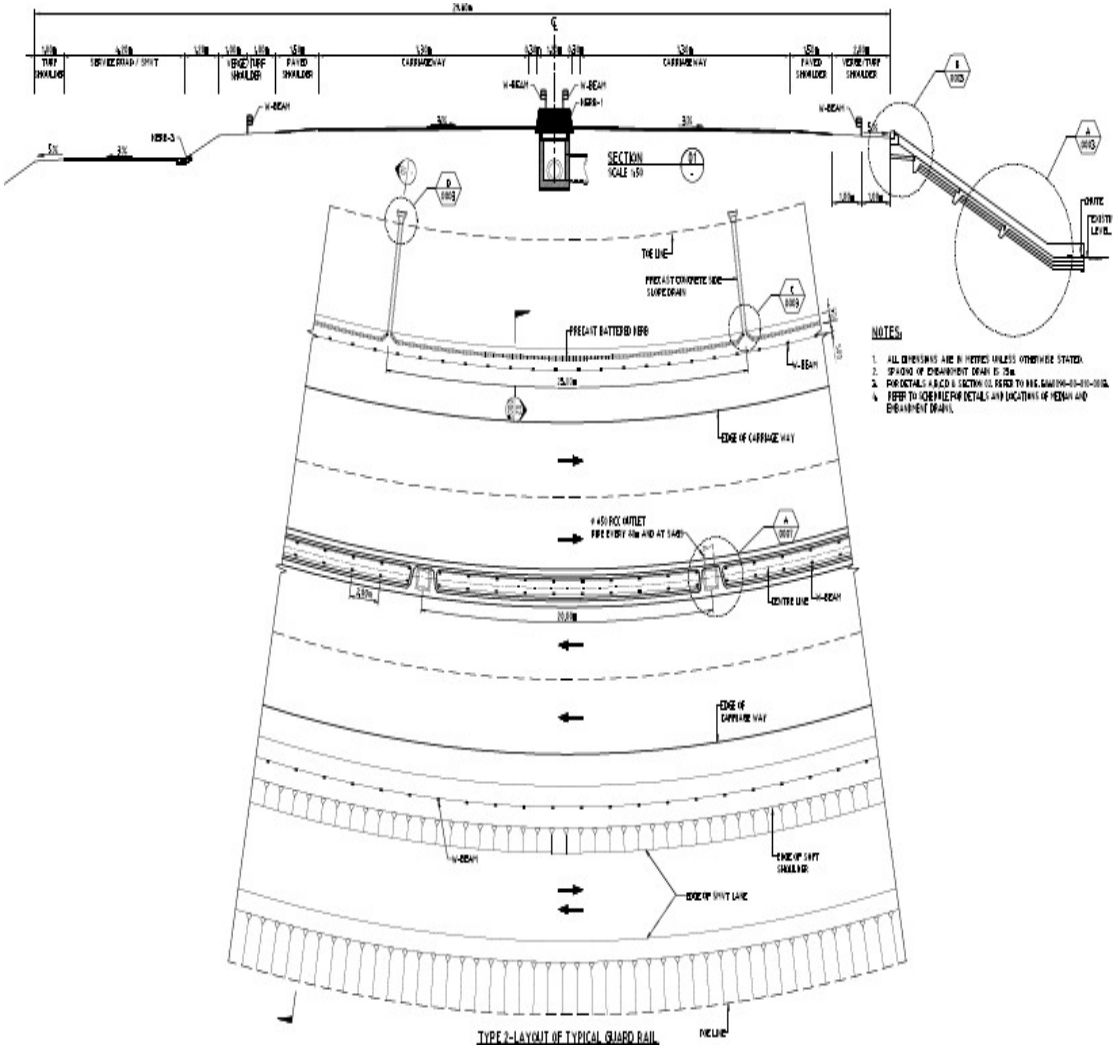

Figure 5: Embankment Drain on Curve

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2. Existing and Proposed Cross Drainage Structures

42. One major bridge of more than 100m length is proposed to be constructed over Fuljor River. The location of this bridge at chainage 106+310km as starting Vogra Bazar Junction and its length is 236.4m. As predicted during the design phase of the project, there has been no need for any river training work as this river is not morphologically active.

43. The Elenga-Hatikamrul project IEE TOR that will cover the possible impact and mitigation measures for the entire project has been approved by the concerned authorities. This major bridge is within the Elenga-Hatikamrul project and work activities arewithin the same project. Therefore, this IEE has been fulfilled details environmental impacts and mitigation measure for this bridge also. In addition to the major bridge, there are many other lesser bridges and culverts on the project roads. These structures mostly cross-undefined channels and carry only seasonal flow. Some of these bridges are located over depressions and low-lying ditches. Culverts are located in depressions and at low lying agricultural land and are used merely as balancing structures and equalizing waterlevels either side of the road embankment. The list of all the structures with length and structural condition is given in Table 6

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Table 6: List of All Drainage Structures on the Elenga-Hatikamrul Road (Updated)

Sl. No.	Chainage (km)	GPS Reading (Decimal Degrees) Latitude/ Longitude	Name of the Structure	Type of Structure	Size of Bridge (Span arrangement) / Size of culvert (vent no x opening x height) (m)	Length (Along the Road) (m)	Width (Across the Road) (m)	Recommendations
1	70+094	24.34068/89.92354	Elenga Box Culvert	Box Culvert	1 Vent x 5.0m x 4.0m		30.04	Extend to 4-lane
2	70+836	24.3459/89.91914	Elenga Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		32.84	
3	71+462	24.34754/89.91468	Babla Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
4	72+293	24.3475/89.91477	Char Babza Bridge-1	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
5	72+632	24.3507/89.90725	Char Babza Bridge-2	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
6	73+129	24.35228/89.90465	Dhalatankor Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		31.42	
7	73+472	24.35481/89.90049	Doladongor Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
8	73+842	24.35902/89.89504	Hangula-1 Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		30.61	
9	74+424	24.35908/89.89510	Hangula-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 5.0m		30.43	
10	74+979	24.36274/89.8911	Hananla Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		30.52	
11	75+361	24.36624/89.88725	Hananla Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
12	76+053	24.36861/89.88444	Challa Bridge-1	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
13	76+657	24.37234/89.87903	Hananla-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 3.5m		30.69	
14	77+245	24.37514/89.87388	Shalla-1 Box Culvert	Box Culvert	2 Vents x 5.0m x 4.5m		30.49	
15	77+900	24.37774/89.86878	Challa Bridge-2	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
16	78+369	24.38268/89.85913	Jogarchar-1	Box Culvert	2 Vents x 5.0m x 3.5m		31.06	
17	78+682	24.38263/89.85913	Jogarchor-2 Box Culvert	Box Culvert	2 Vents x 5.0m x 4.0m		30.12	
18	79+851	24.38353/89.8563	Jogarchar Bridge	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
19	94+473	24.39485/89.69331		Box Culvert	2 Vents x 5.0m x 4.0m		29.89	Extend to 4-lane
20	95+392	24.3952/89.6868		PC Girder Bridge		70.48	9.91	New Bridge(2Lane)
21	96+067	24.39514/89.6868		Deck Culvert	1 Vent x 5.0 m x 4.0 m		35.91	Extend to 4-lane
22	96+365	24.39509/89.68069		Box Culvert	1 Vent x 5.0 m x 4.0 m		31.10	Extend to 4-lane
23	96+685	24.39512/89.68064		Box Culvert	1 Vent x 5.0 m x 4.0 m		30.90	Extend to 4-lane

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24	97+632	24.39754/89.6655	Rail Deck Slab	PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
25	97+701			Box Culvert	1 Vent x 5.0 m x 5.0 m		35.53	Extend to 4-lane
26	97+747			Box Culvert	2 Vent x 5.0 m x 4.0 m		43.67	Extend to 4-lane
27	98+268	24.40012/89.65423		Box Culvert	2 Vents x 5.0 m x 3.5 m		30.67	Extend to 4-lane
28	99+448	24.40272/89.64432		PC Girder Bridge		67.43	14.71	New Bridge (2Lane + SMVT)
29	100+490	24.40856/89.63262		Box Culvert	1 Vent x 5.0 m x 4 m		29.80	Extend to 4-lane
30	101+864	24.41323/89.6235		Box Culvert	2 Vents x 5.0 m x 3.5 m		29.85	Extend to 4-lane
31	102+929	24.41654/89.61475		PC Girder Bridge		34.71	14.71	New Bridge (2Lane + SMVT)
32	103+883	24.41655/89.61473		Box Culvert	1 Vent x 5.0 m x 4.5 m		30.77	Extend to 4-lane
33	104+283	24.41768/89.61118		RCC Girder Bridge		49.13	14.71	New Bridge (2Lane + SMVT)
34	104+538	24.41858/89.60895		Box Culvert	2 Vents x 5.0 m x 4.5 m		29.80	Extend to 4-lane
35	105+108	24.42275/89.5972		Box Culvert	1 Vent x 5 m x 4 m	34.71	14.71	New Bridge (2Lane + SMVT)
36	105+792	24.42324/89.59242		Box Culvert	1 Vent x 5.0 m x 4.0 m		30.93	Extend to 4-lane
37	106+381	24.42325/89.59239	Nalka Bridge	PC Girder Bridge		296.44	14.71	New Bridge (2Lane + SMVT)
38	106+928	24.42431/89.58059		Box Culvert	2 Vents x 3.0 m x 2.5 m		33.41	Extend to 4-lane
39	107+481	24.42454/89.58044		Box Culvert	4 Vents x 3.0 m x 2.5 m		33.16	Replace with New 4-vent BC
40	107+822	24.42359/89.57746		Box Culvert	3 Vents x 3.0 m x 2.5 m		32.61	Extend to 4-lane
41	108+024	24.42169/89.56705		Box Culvert	3 Vents x 3.0 m x 2.5 m		33.82	Extend to 4-lane
42	108+885	24.41964/89.55634		Box Culvert	3 Vents x 3.0 m x 2.5 m		32.51	Replace with New 3-vent BC

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2. Major Bridge with Design Features in Elenga-Hatikamrul Road

44. The Nalka Bridge over Fuljor River at Km 106+381 is replaced with a new four-lane bridge which is 296.44 m long. The river carries seasonal flow and appears to be gradually drying up due to encroachment and the lack of adequate rainwater discharge from the upstream area. This new bridge is to be built at this location will provide two traffic lanes plus a SMVT lane through upgrading to four-lane standard.

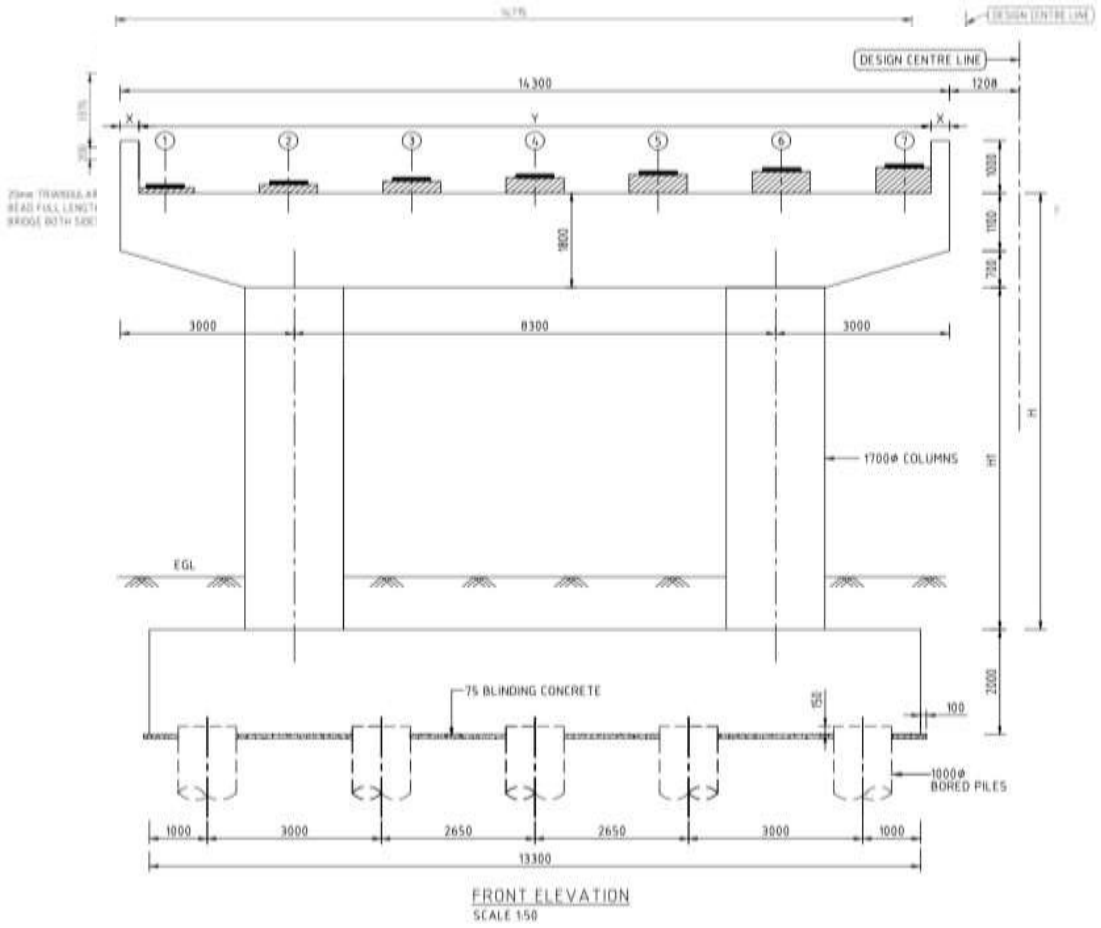

Figure 6: Cross Section of the Proposed Bridge

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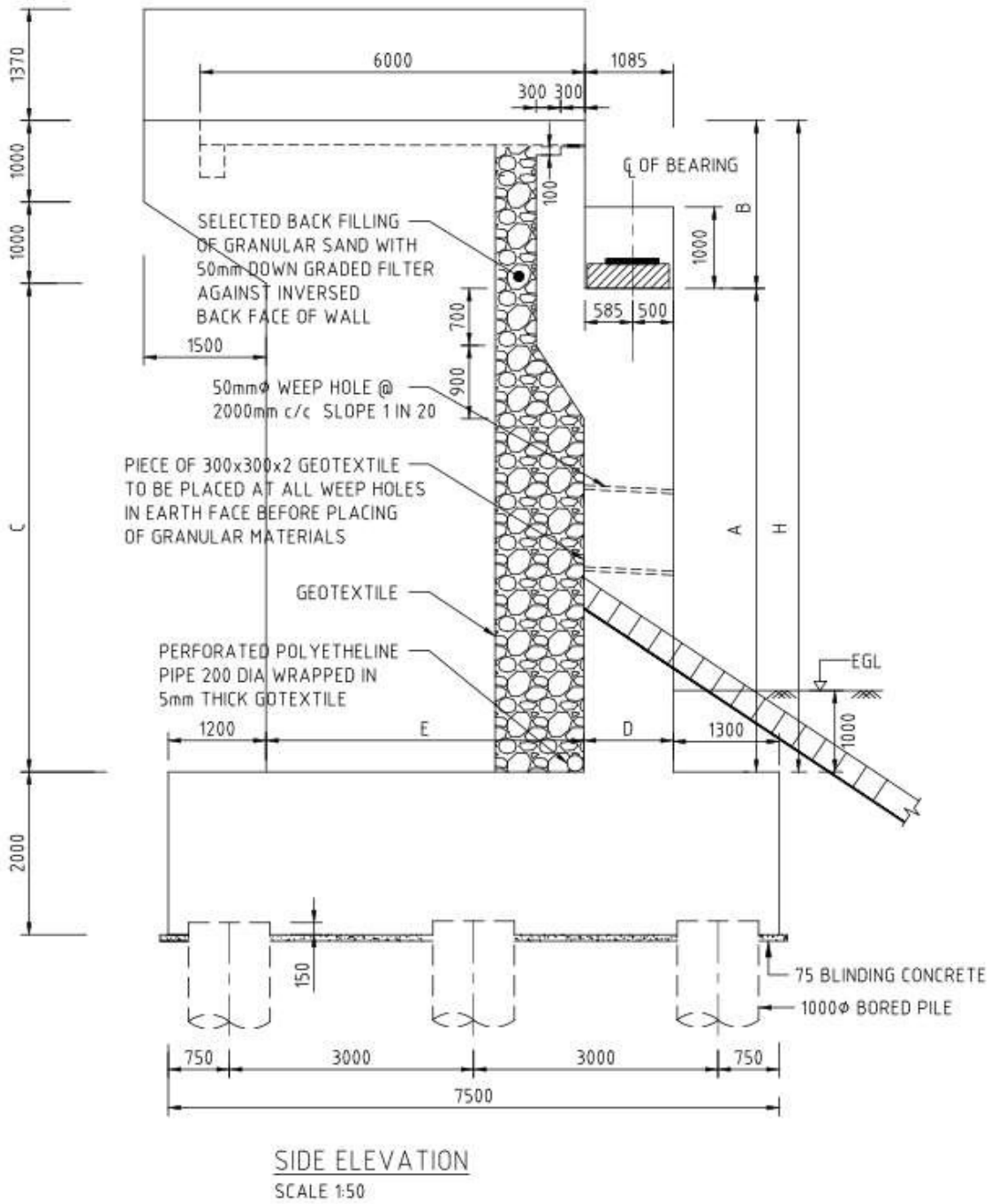

Figure 7: Abutment Design of the Nalka Bridge Flyovers and Overpasses

45. To improve road efficiency and safety two flyovers and foot overpasses are proposed in Elenga-Hatikamrul road. The navigational clearances for the bridges and railway overpasses are obtained from relevant authorities. Navigation Case-II, 30.48 m x7.67 m for Bridge and for Railway Overpass is 8.5m from the existing Track (Appendix N). Design also approved by the relevant authorities Navigation Case-II. The list of these structures is given at Table 7.

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Table 7: Details of Proposed Flyovers and Overpasses in Elenga-Hatikamrul Road

Sl. No.	Location	Chainage	Length (Along the Road) (m)	Width (Across the Road) (m)	Type
1	Elenga	70+056	1538.61	19.120	New Flyover (4 lane)
2	Koddar Moor	95+553	395.64	19.120	New Flyover (4 lane)
3	Elenga	69+373	35.2	3.0	PedestrianOverpass
4	Panchlia Bazar	108+278	35.2	3.0	PedestrianOverpass

a. Construction Material and Sources

46. **Embankment Fills.** The GoB has adopted a policy to encourage construction of roadway embankments with river sand rather than clayey agricultural soil. Accordingly, the embankments for new carriageways on this project have been designed based on the use of river sand with a CBR value estimated as 10% or greater. River sand is a good fill material with higher CBR value. It is quite abundant in the various riverbeds in the project area. Sand is easily compactable to a high degree of compaction but will require protection against erosion by cladding with a layer of cohesive soil. For construction of the project embankment, the sands for filling up of the embankment have been purchased using third party contractors, hence no dredging related issue raised at site.

47. **Concrete Aggregate**. Stone aggregates from Sylhet quarries are commonly used for manufacturing of normal and high strength concrete. As per contract, there is a provision of using brick chips in Base II throughout the length of road. However, according to variation, the provision of using brick chips in Base II was eliminated by using stone aggregate in both Base II and I. Using stone chips instead of brick chips will improve indirectly the environment by reducing carbon emission and reducing the use of fertile top soil from surrounding areas.

48. **Cement and Steel Reinforcement.** Bangladesh produces different classes of EN and ASTM standard cement and high strength deformed bar of 40, 60 and 75 grades. These materialsare readily available in the project area.

49. **Bitumen.** Bitumen is being be imported, while a portion is being sourced from the government owned refinery. Commonly used bitumen in the road construction industry in Bangladesh is 60-70 and 80-100 penetration grade bitumen. For Bangladesh temperatures 60-70 grade is better suited but the supply of this grade is limited.

50. **Recycled Pavement Materials**. The preliminary design envisages recycling pavement materials by milling the existing asphalt concrete and re-using the product. This recycled asphalt concrete mixed with unbound base and sub-base materials shall be used in the sub-base or lower base of the new carriageways.

Establishment of Road Research and Training Centre (RRTC)

51. The Technical Assistance for Sub regional Road Transport Project Preparatory Facility recommended to combine Bangladesh Road Research Laboratory (BRRL) and Roads and Highways Department Training Centre (RHDTC) and establish a new Centre of Excellence for quality Control, research and training for human resource development. This new institution, to be named

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Road Research and Training Centre (RRTC) will support RHD's road sector development strategy and road operation, and aims to an enhanced holistic approach to quality management, applied sector-specific research and development of skills needed to manage and achieve improvements in road network service quality levels.

52. The Road Research and Training Centre will establish a) RHD Training Centre and ICT; and b) Road Research and Laboratory. The Training Centre and ICT will comprise training / class rooms, conference room, network and computer training room, office, and living accommodation. The Road Research and Laboratory will include research center, laboratory, equipment hall, office, computer laboratory, auditorium, and internal mosque.

53. The proposed 10-storey RRTC building will cover gross area of about 185,000 sq. ft. and will include parking facility with 100 slots. The building will be established inside the RHD Headquarter in Mirpur, Dhaka. The green building concept with low energy, low water footprint, environment friendly material use, rainwater harvesting, cool roof, climate and environment friendly building orientation etc. are proposed in the meeting (September 01, 2022) chaird by Project Manager (RHD) and in the meeting it is decided to consider the issues in RRTC, (Meeting minutes Appendix P).

b. Establishment of Road Operations Unit (ROU)

54. The Road Operations Unit (ROU) will be established and implemented initially along the Dhaka-Elenga-Hatikamrul-Rangpur (Dhaka-Northwest international trade corridor). The ROU will focus on pilot good practices on overloading control, road asset management and road safety. The ROU will establish axle load control stations, required facilities and equipment, business models (operation plan and staffing plan), enforcement mechanism engaging other agencies, and safety provisions to reduce the safety vulnerability.

55. There will be 3 ROU located 01 at Chandra (Chainage 17+000 km from Joydevpur on SASEC-I Project area), 01 at Hatikamrul (Chainage 107+00 km from Joydevpur on SASEC-II Project area and 01 at Polashbari (Chainage 207+00 km from Joydevpur on SASEC-II Project area.

c. Existing Traffic and Forecast

56. The type of traffic considered for traffic assessment and forecast includes (i) normal traffic which is using the existing corridor, and (ii) generated traffic likely to arise from reduced transport costs. The existing weighted average Annual Average Daily Traffic (AADT) as per the traffic studies carried out for 2013 including two- and three-wheelers and forecast traffic are given at Table 8.

Table 8: Existing and Traffic Forecast for Elenga-Hatikamrul Road

Traffic Assessment Year	Traffic in AADT (Maximum of any section of the road)
2013	15,035
2015	17,366
2016	18,848
2020	28,231
2025	38,419
2030	51,352
2035	68,650
2040	91,786

Source: Traffic Survey by Project Personnel, 2013

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57. The nature of traffic is mixed in nature except in case of Elenga-Hatikamrul road where a high proportion goods vehicles and Heavy Goods Vehicle (HGVs) is high. It is probably the common route for traffic between Dhaka and the districts in North and North-western Bangladesh.

d. Project Schedule

58. Project construction duration was 36 months, with additional 12 months as defect liability period, and operation period is assumed as 20 years after construction. However, due to COVID 19 pandemic and delay in land acquisition and resettlement process the project duration rescheduled and present completion target is December of 2023 for the road sections. The new EOT attached in the Annex N.

e. ADB's Environmental categorization

59. Based on REA Checklist (Appendix C) and the field assessment, the project is categorized as Category B as per ADB Safeguard Policy Statement 2009. The project is unlikely to cause any significant adverse environmental impact. It does not pass through any protected areas or ecologically sensitive areas. Most of the habitat areas are provided with flyover or pedestrian overpasses.

Approved EOT of WP-6 ~up to 30/09/2023

WP-6

EOT-(01),	131 days -> 1stly Revised Completion Date: 09/08/2022
EOT-(01),	129 days -> 2ndly Revised Completion Date: 18/12/2022[260 days (131 + 129 days)] due to recalculation of delayed date by 2nd & 3rd wave Pandemic
EOT-(01),	288 days ->3rdly Revised Completion Date under consideration: 30/09/2023 (total, 548 days = 131 + 129 +288) due to increased Works Scope

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III. ENVIRONMENTAL POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Regulatory Requirements for the Project

60. Regulatory requirements toward protection and conservation of environment and various environmental resources and also toward protection of social environment from adverse impact of projects and activities associated with them have been enunciated by the GOB as well as the ADB pertinent among these requirements are summarized below.

B. GOB Environmental Policy, Regulations, and Guidelines

1. National Environmental Policy, 1992

61. Bangladesh has adopted a National Environmental Policy (NEP) in 1992 aimed at sustainable development. The NEP sets out the basic framework for environmental action together with a set of broad sectoral guidelines for action. Major elements of the policy are as follows:

- Maintaining the ecological balance and ensuring sustainable development throughprotection and conservation of the environment;
- Protection of the country against natural disasters;
- Identification and control of activities that pollute and destroy the environment;
- Ensuring environment-friendly development in all sectors;
- Promoting sustainable and sound management of natural resources; and
- Active collaboration with international initiatives related to the environment.

62. The environmental policy in the transport sector aims at prevention of pollution and degradation of resources caused by roads and inland waterways transport. The policy mentions that Initial Environmental Examination (IEE) should be conducted before projects are undertaken.

2. National Environmental Management Action Plan, 1995

63. The National Environmental Management Action Plan (NEMAP) builds on the National Environment Policy (NEP) and was developed to address specific issues and management requirements during the period 1995-2005. The plan includes a framework within which the recommendations of a National Conservation Strategy (NCS) are to be implemented. The NEMAP was developed with the following objectives:

- Identify key environmental issues affecting Bangladesh;
- Identify actions to halt or reduce the rate of environmental degradation;
- Improve management of the natural environment;
- Conserve and protect habitats and bio-diversity;
- Promote sustainable development; and
- Improve the quality of life of the people.

3. Environmental Conservation Act (ECA), 1995

64. The ECA is currently the main legislation relating to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement.

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65. The main objectives of ECA are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

66. The focus of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried out/ initiated in the ecologically critical areas (ECA);
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areasfor different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

67. Before any new project can go ahead, as stipulated under the ECA, the project proponent must obtain Environmental Clearance from the Director General (DG), DOE. An appeal procedure does exist for these proponents who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 5 years imprisonment or a maximum fine of Tk.100, 000 or both. The DOE executes the Act under the leadership of the DG.

4. Environmental Conservation Act (Amendment 2000)

68. The Bangladesh Environment Conservation Act Amendment 2000 focuses on ascertaining responsibility for compensation in cases of damage to ecosystems, increased provision of punitive measures both for fines and imprisonment and the authority to take cognizance of offences.

5. Environmental Conservation Act (Amendment 2002)

69. The 2002 Amendment of the ECA elaborates on the following parts of the Act:

- Restrictions on polluting automobiles;
- Restrictions on the sale, production of environmentally harmful items like polythenebags;
- Assistance from law enforcement agencies for environmental actions;
- Break up of punitive measures; and
- Authority to try environmental cases.

6. Environmental Conservation Act (Amendment 2010)

70. This amendment of the act introduces new rules & restriction on:

- No individual or institution (Gov. or Semi Gov, / Non Gov. / Self-Governing) cannot cut any Hill and Hillock. In case of national interest; it can be done after getting clearance from respective department

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- No remarked water body cannot be filled up/changed; in case of national interest;it can be done after getting clearance from the respective department; and
- Emitter of any activities/incident will be bound to control emission of environmentalpollutants that exceeds the existing emission standards.

7. Environmental Conservation Rules (ECR), 1997 and Amendments

71. These are set of rules, promulgated under the ECA, 1995 and its amendments. The Environment Conservation Rules provide categorization of industries and projects and identify types of environmental assessment required against respective categories of industries or projects. The Rules set:

- The National Environmental Quality Standards (NEQS) for ambient air, varioustypes of water, industrial effluent, emission, noise, vehicular exhaust etc.;
- The requirement for and procedures to obtain environmental clearance; and
- The requirement for IEE and IEE based on categories of industrial and otherdevelopment interventions.

72. The Environment Conservation Rules, 1997 were issued by the GOB in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas;
- Classification of industries and projects into 4 categories;
- Procedures for issuing the Environmental Clearance Certificate (ECC); and
- Determination of environmental standards.

73. Rule 3 defines the factors to be considered in declaring an 'ecologically critical area' as per Section 5 of the ECA (1995). It empowers the Government to declare the area as Ecologically Critical Areas (ECA), if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which operations or processes may be carried out or may not be initiated in the ECA. Under this mandate, the Ministry of Environment and Forest (MOEF) has declared Sundarbans, Cox's Bazar-Tekhnaf Sea Shore, Saint Martin Island, Sonadia Island, Hakaluki Haor, Tanguar Haor, Marzat Baor and Gulshan-Baridhara Lake as ecologically critical areas and prohibited certain activities in those areas.

74. Rule 7 of the 2023 ECR provides a classification of industrial units and projects into four categories, depending on environmental impact and location. These categories are:

- Green;
- Orange A;
- Orange B; and
- Red.

75. The categorization of a project determines the procedure for issuance of an Environmental Clearance Certificate (ECC). All proposed industrial units and projects that are low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial

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units and projects falling in the Orange-A, Orange-B and Red Categories, a site clearance certificate and thereafter an environmental clearance certificate will be required.

76. A detailed description of these four categories of industry/project is in Schedule-1 of ECR (1997). The Rules were essentially developed for industrial development, but under Schedule 1 of the Guidelines (Clauses 63 and 64) the following falls into the Orange B Category.

- Clause 63 - Construction, reconstruction and extension of road (feeder road, localroad);
- Clause 64 - Construction, reconstruction and extension of bridge (length below 100meters).

77. According to Schedule 1, the Red Category includes the following projects:

- Clause 67 – Construction / reconstruction / expansion of road (regional, national,and international)
- Clause 68 – Construction / reconstruction / expansion of bridge (length 100 metersand above).

78. Thus, for the Elenga – Hatikamrul Road, an IEE update required to secure ECC from DoE. Apart from general requirements, for every Red Category proposed industrial unit or project, the application for ECC must be accompanied with update Initial Environmental Examination/Environmental Impact Assessment with Environmental Management Plan (EMP), which are based on the ToR approved by DoE.

79. The GoB also prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2008 and revised in 2009. This is a comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on and expanded the NAPA. It is built around the following six themes:

Bangladesh Climate Change Strategy and Action Plan

- **Food security, social protection and health** to ensure that the poorest and mostvulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.
- **Comprehensive disaster management** to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.
- **Infrastructure** to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructure (cyclone shelters and urban drainage) is put in place to deal with thelikely impacts of climate change.
- **Research and Knowledge management** to predict that the likely scale and timingof climate change impacts on different sectors of economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.
- **Mitigation and low carbon development** to evolve low carbon development options and implement these as the country's economy grows over the coming decades.
- **Capacity building and Institutional strengthening** to enhance the capacity of government ministries, civil society and private sector to meet the challenge of climate change.

80. There are 44 specific programs proposed in the BCCSAP under the above six themes.

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8. **Relevant other regulatory requirements for the project**

81. The Government of Bangladesh has framed various laws and regulations for protection and conservation of natural environment. These legislations with applicability to this project are summarized below in Table 9.

Table 9: Applicability of Key Environmental Legislation

No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
1	Water Pollution Control Ordinance 1970	Ministry of Water Resources	The Ordinance adopt measures for the prevention, control and abatement of existing or potential pollution of any waters, including construction, modification, extension or alteration of disposal systems; provide informationto the Board regarding wastes, sewerage or treatment works; and permit any officer to inspect and search land and buildings.
2	Bangladesh Labour Law, 2006, and Bangladesh Labour Rules 2015	Ministry of Labor	This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable working environment and reasonable working conditions. The Law provides necessary practicing guidelines, including set standards through the labour rules.
3	National Land use Policy, 2001	Ministry of Land	The plan deals with land uses for several purposes including agriculture (crop production, fishery and livestock), housing, forestry, industrialization, railways and roads, tea and rubber. The plan basically identifies land use constraints in all these sectors.
4	National Forest Policy and Forest Sector Review (1994, 2005)	Forest Department, MOEF	▪ Afforestation of 20% land. ▪ Bio-diversity of the existing degraded forests ▪ Strengthening of agricultural sector ▪ Control of global warming, desertification, control of trade in wild birds and animals ▪ Prevention illegal occupation of the forestlands, tree felling and hunting of wild animals.
5	National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment and Forest	▪ Conserve, and restore the biodiversity of the country; ▪ Maintain and improve environmental stability of ecosystems; ▪ Ensure preservation of the unique biological heritage of the nation for the

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No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
			benefit of the present and future generations; ▪ Guarantee safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country; ▪ Stop introduction of invasive alien species, genetically modified organisms and living modified organisms.
6	Bangladesh Climate Change Strategy and Action Plan (2008)	Ministry of Environment and Forest	Establishment of six strategic pillars for action, including: 1. food security, social protection and health 2. disaster management 3. protective infrastructure 4. research and knowledge management, 5. decreased carbon development, and 6. capacity building and institutional strengthening.
7	National Fisheries Policy, 1998	Ministry of Fisheries and Livestock (MOFL)	Preservation & management of inland open water fisheries.
8	The Protection and Conservation of Fish Act, 1950 and The Protection and Conservation of Fish Rules, 1985	Ministry of Fisheries and Livestock	Prohibits and regulates the construction of temporary or permanent of weirs, dams, bunds, embankment and other structures
9	Wetland Protection Act 2000	Ministry of Water Resources (MOWR)	Advocates protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes. Prevents the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment. Prevents unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.
10	Embankment & Drainage Act, 1952	Ministry of Water Resources	An Act to consolidate the law relating to embankment & drainage.

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No.	Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
11	The ground Water Management Ordinance 1985	Ministry of Water Resources	Focuses on management of Ground Water Resources. Disallows digging of tube wells without permission from the Upazilla Parishad
12	Vehicle Act 1927 & Motor vehicle ordinance 1983	Bangladesh Road Transport Authority (BRTA)	Road/traffic safety Vehicular air & noise pollutions Fitness of vehicles & registration
13	National Land Use Policy, 2001	Ministry of Land	The National Land Use Policy was adopted by Bangladesh government in 2001, setting out guidelines for improved land-use and zoning regulations. The main objectives of this policy is to ensure criteria based uses of land and to provide guidelines for usage of land for the purpose of agriculture, housing, afforestation, commercial and industrial establishments, rail and highway and for tea and rubber gardens. Overall, this policy promotes a sustainable and planned utilization of land.
14	The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry))	Forest Department, Ministry of Environment Forest and Climate Change (MOEFCC)	Declare any forests land or wasteland as protected forests. May stop public or private way or watercourse in the interest of preservation of the forest. Declare an area as Social forests or launch a social forestry programme in Govt. land or private land with permission.
15	National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment Forest and Climate Change (MOEFCC)	▪ Conserve, and restore the biodiversity of the country; ▪ Maintain and improve environmental stability of ecosystems; ▪ Ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations; ▪ Guarantee safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country; ▪ Stop introduction of invasive alien species, genetically modified organisms and living modified organisms.

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16	Bangladesh Climate Change Strategy and Action Plan (2008)	Ministry of Environment Forest and Climate Change (MOEFCC)	Establishment of six strategic pillars for action, including: food security, social protection and health disaster management protective infrastructure research and knowledge management, decreased carbon development, and capacity building and institutional strengthening.
17	National Fisheries Policy, 1998	Ministry of Fisheries and Livestock (MOFL)	Preservation and management of inland open water fisheries.
18	National Environmental Policy 2018	Ministry of Environment Forest and Climate Change (MOEFCC)	National Environmental Policy has been updated in 2018 reemphasizing environmental pollution control by the anthropogenic activities and climate change mitigation importance.
19	Solid Waste Management Rules 2021	Ministry of Local Government, Rural Development and Cooperative	The government has formulated Solid Waste Management Rules 2021. Specific sub clauses have been added to the Solid Waste Management Rules 2021 for the proper management of solid waste. Extended Producers Responsibility (EPR) has been included in the rules for the first time in Bangladesh.
20	National 3R (Reduce, Reuse & Recycle) Strategy 2010	Ministry of Environment Forest and Climate Change (MOEFCC)	Formulated strategy to reduce waste generation at source through promoting and imposing practices through reuse and recycling of waste.
21	Wetland Protection Act 2000	MOWR	Advocates protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes. Prevents the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment. Prevents unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.

C. Transport Related Policies and Regulations

a. National Land Transport Policy

82. The Land Transport Policy has been formulated in light of the Government pledge to establish

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a transport system that is safe, cheap, modern, technologically dependable, and environmentally friendly. The objectives are:

- To introduce long-term network planning
- To maintain the road network at a level which protects the value of the investment
- To secure a sustainable means of funding road maintenance
- To improve the management of traffic
- Management of road-side activities
- To develop an integrated planning approach in road construction
- To involve the private sector more in infrastructure, services and maintenance
- To well protect the environment from road construction program.

83. According to the policy, all new roads and major improvements, tolled or otherwise, are subjected to an Initial Environmental Examination (IEE).

b. Geometric Design Standards for Roads & Highways Department

84. This manual aims to promote good, consistent practice in the geometric design of the Roads and Highways Department's roads. All RHD road projects should be designed in accordance with the design approach, standards, assumptions, etc., which are set out in this manual.

85. The Roads and Highways Department (RHD) is committed to following good practice with regard to the safety and environmental impact of its roads. RHD ensures that all the Government's environmental regulations are complied with, and for major projects this will usually involve the preparation of environmental impact assessments and environmental management plans.

D. Applicable Road Safety Policies in Bangladesh

86. Bangladesh lags in ensuring that its road safety laws meet international standards and best practices. The existing 'The Motor Vehicle Ordinance 1983' has not been able to meet the standards and good practices as well as current demands to ensure road safety. Against this backdrop, the Government has initiated two new laws: The drafting of the Bangladesh Road Transport Authority (BRTA) Act 2015 has already been completed, including the incorporation of feedback from stakeholders; another law – the Bangladesh Road Transport Act (RTA) 2015 is currently in the drafting phase under the leadership of BRTA.

E. International Treaties

87. Bangladesh has signed several international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation and the Kyoto Protocol on climate change. An overview of the relevant international treaties and conventions signed by GOB is shown in Table 10.

Table 10: Relevant International Treaties, Conventions and Protocols signed by Bangladesh

Treaty or Convention	Year	Brief description	Responsible Agency
"International Convention for the Protection of Birds (Paris 1950)	1950	Protection of birds in wild state	DOE/DOF
Convention concerning the Protection of Workers against Occupational Hazards in the	1977	Protect workers against occupational hazards in the working environment	MOHFW

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Working Environment Due to Air Pollution, Noise and Vibration (Geneva 1977)			
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MOHFW
Occupational health services (Geneva)	1985	To promote a safe and healthy working environment	MOHFW
International Convention on Climate Changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases	DOE/MOEF

F. GoB Environmental Clearance and Public Consultation Procedure

88. Steps to be followed for obtaining the Environmental Clearance Certificate for this road construction project are shown in Figure 9. For any Orange B or Red category project, an update IEE must be submitted to DoE in order to obtain clearance to proceed to construction or to undertake the full IEE if Orange B is bumped up to Red by DoE. Once the Orange B IEE is approved by DoE, the environmental requirements have been met. All Red Category projects require a DoE approved IEE before proceeding to IEE preparation.

89. For all SRTP-road subprojects DoE agreed to allow RHD to conduct full IEE without preparing the IEE, and to no require separate IEEs for large bridges so long as IEEs provided additional details for each large bridge over natural waters (as opposed to canals).

90. Public participation/consultation during the IEE process is not a condition in the Act, the ECR 1997, or IEE Guidelines; however, is mandatory under the ADB's SPS 2007. Therefore, a full public consultation program was included in this IEE.

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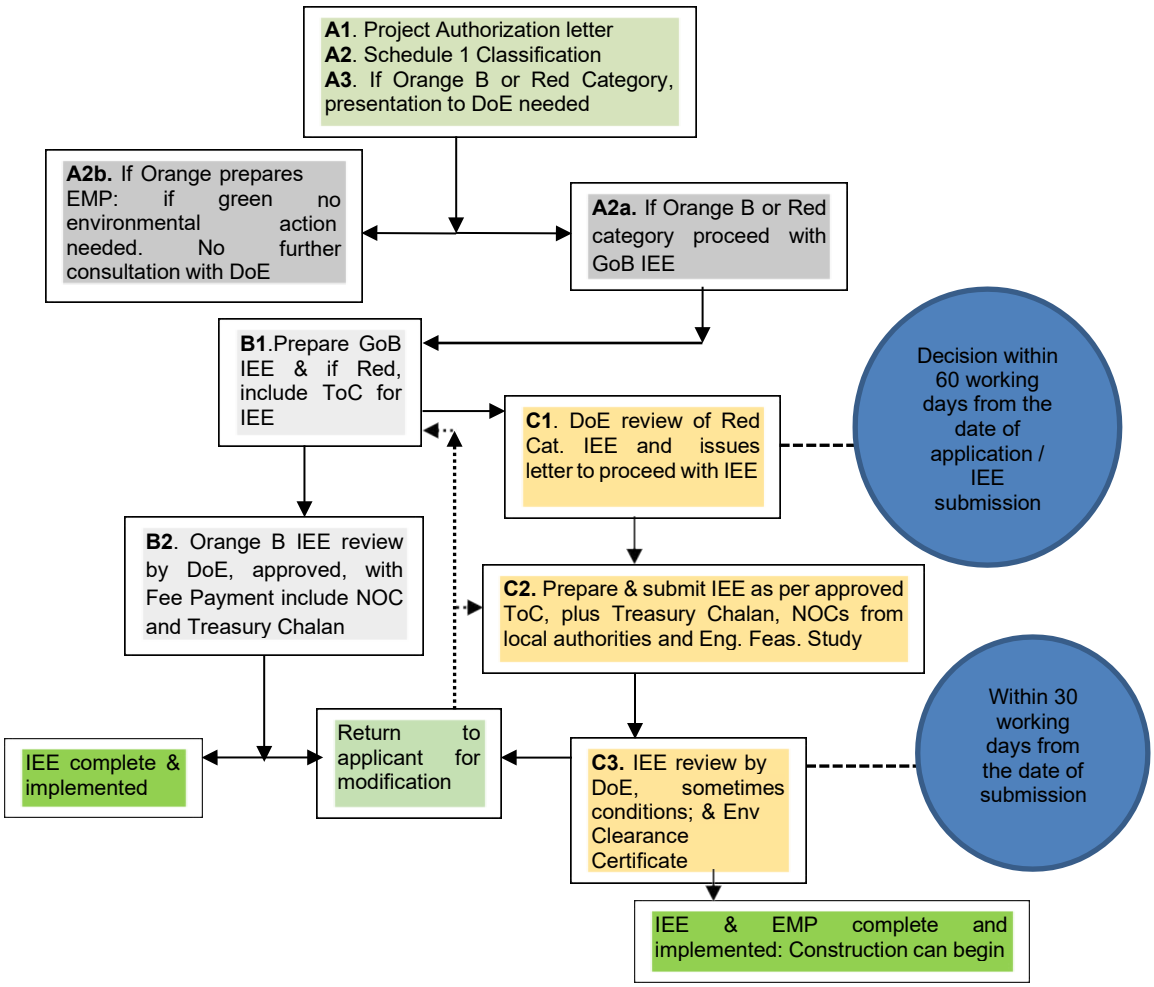

Figure 8: Government of Bangladesh Environmental Assessment Process

G. Asian Development Bank Safeguard Policies, 2009

91. Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups because of development projects[4].The current generation of safeguard policies was designed when direct project lending was the dominant modality for development assistance. New lending modalities and financing instruments, such as the multi tranche financing facility (MFF), have increased the complexity of applying safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB 's safeguards, which has been reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard PolicyStatement 2009.

92. According to the newly revised and published Safeguard Policies in 2009 (SPS 2009) of ADB, ADB 's overarching statement on its commitment and policy principles are.

93. ADB affirms that environmental and social sustainability is a cornerstone of economic growth

[4] ADB.2009. Safeguard Policy Statement, Manila

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and poverty reduction in Asia and the Pacific. ADB's Strategy 2020 therefore emphasizes assisting Developing Member Countries (DMCs) to pursue environmentally sustainable and inclusive economic growth. In addition, ADB is committed to ensuring the social and environmental sustainability of the projects it supports. In this context, the goal of the SPS is to promote the sustainability of project outcomes by protecting the environment and people from projects' potential adverse impacts.

94. The objectives of ADB's safeguards are to:

- avoid adverse impacts of projects on the environment and affected people, where possible.
- minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

95. Since the ADB Safeguard Policy Statement had been approved it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para. 73, and paras. 77–85, and 92 of the Public Communications Policy (2005).

a. Safeguard Requirements

1: Environment

96. The objectives are to ensure the environmental soundness and sustainability of projects, and to support the integration of environmental considerations into the project decision-making process.

97. The requirements apply to all ADB-financed and/or ADB-administered sovereign and non-sovereign projects, and their components regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. Mechanisms such as Public Consultation, Identification of potential impacts, elaboration of adequate mitigation measures and impact monitoring as well as implementation of an appropriate environmental management plan remained mainly unchanged referring to the former Environmental Safeguard Policy.

98. Special attention has been put on the Grievance Redress Mechanism, securing that the borrower/client will establish a mechanism to receive and facilitate resolution of affected peoples 'concerns, complaints, and grievances about the project's environmental performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people at no costs and without retribution. The mechanism should not impede access to the country 's judicial or administrative remedies. The affected people will be appropriately informed about the mechanism.

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99. Guidelines provide a rational approach for determining environmental category of the Project, the need for public consultation and disclosure, environmental management planning, and resolving involuntary resettlement, indigenous people, and gender issues.

b. Safeguard Requirements

2: Involuntary Resettlement

100. The objectives are to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups. The safeguard requirements underscore the requirements for undertaking the social impact assessment and resettlement planning process, preparing social impact assessment reports and resettlement planning documents, exploring negotiated land acquisition, disclosing information, and engaging in consultations, establishing a grievance mechanism, and resettlement monitoring and reporting.

101. The involuntary resettlement requirements apply to full or partial, permanent, or temporary physical displacement (relocation, loss of residential land, or loss of shelter) and economic displacement (loss of land, assets, access to assets, income sources, or means of livelihoods) resulting from (i) involuntary acquisition of land, or (ii) involuntary restrictions on land use or on access to legally designated parks and protected areas. Resettlement is considered involuntary when displaced individuals or communities do not have the right to refuse land acquisition that results in displacement.

c. Safeguard Requirements

3: Indigenous Peoples

102. The objective is to design and implement projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the Indigenous Peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

103. For operational purposes, the term Indigenous Peoples is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:

i. self-identification as members of a distinct indigenous cultural group andrecognition of this identity by others;
ii. collective attachment to geographically distinct habitats or ancestral territories inthe project area and to the natural resources in these habitats and territories;
iii. customary cultural, economic, social, or political institutions that are separate fromthose of the dominant society and culture; and
iv. a distinct language, often different from the official language of the country orregion.

104. In considering these characteristics, national legislation, customary law, and any international conventions to which the country is a party will be taken into account.

105. Guidelines provide a rational approach for determining environmental category of the Project,

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the need for public consultation and disclosure, environmental management planning, and resolving involuntary resettlement, indigenous people and gender issues.

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106. Activities carried out under the project needs to conform to current laws in Bangladesh and sound social and environmental principles. In general, the project activities will not trigger serious impacts on the physical and human environment.

H. Project Category

107. The ADB SPS addresses environmental concerns, if any, of a proposed activity in the initial stages of project preparation. For this, the ADB SPS categorizes the proposed components into A, B, or C to determine the level of environmental assessment required to address the potential impacts. The project has been categorized as B based on SPS 2009. Stakeholder consultation was an integral part of the IEE, and an environmental management plan (EMP) specifying mitigation measures to be adhered to during implementation of the project has been prepared.

108. According to ECR Schedule 1, the project is red category because it involves construction, reconstruction, and extension of roads and bridges[5]. In due course an environmental assessment must be prepared in the prescribed format and be submitted to the Department of Environment (DOE) for approval. Table 11 shows the summary of environmental regulatory compliance required for the project.

Table 11: Environmental Regulatory Compliance

Component Description	Government of Bangladesh		ADB	
	Category in Accordance withECR	Environmental Assessment	Category in Accordance with SPS	Environmental Assessment
Elenga- Hatikamrul RoadProject	Red Category: Construction / reconstruction / expansion of roads and bridge (regional, national & international)	IEE, IEE, and EMP	Category B	IEE

a) Occupational Health and Safety

109. During construction, the project will conform to the labor laws and occupational and health related rules as outlined in Table 12.

Table 12: Relevant Occupational Health and Safety Laws and Rules

Title	Overview
Bangladesh Labor Act, 2006	Provides for safety of work force during construction period. The act provides guidance of employer's extent of responsibility and the workman's right to compensation in case of injury caused by accident while working.
Labor Relations under Labor Laws, 1996	General concerns during the project implementation statethat the project manager must recognize labor unions.
Public Health (Emergency Provisions) Ordinance, 1994	Calls for special provisions about public health. In case of emergency, it is necessary to make special provisions for

[5] Consultation with the DoE during the course of this environmental assessment confirmed that the project is category red and requires IEE under the ECA and ECR.

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Title	Overview
	preventing the spread of disease, safeguarding the public health, and providing adequate medical service, and other services essential to the health of respective communities and workers during construction-related work.
The Employees StateInsurance Act, 1948	Health, injury and sickness benefit should be paid.
The Employer's Liability Act,1938	Covers accidents, risks, and damages with respect to employment injuries
Maternity Benefit Act, 1950	Framed rules for female employees, who are entitled to various benefits for maternity
Bangladesh Factory Act, 1979	Workplaces provisions: these Act and Labor Laws require medical facilities, first aid, accident and emergency arrangements, and childcare services to be provided to the workers at workplace.

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IV. DESCRIPTION OF THE ENVIRONMENT

A. General

110. The environmental baseline reflects the environmental conditions of the project area. The baseline condition of environmental quality in the locality of project site serves as the basis for identification, prediction, and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, land and socio-economic, etc.

111. To take significant actions against environmental impacts or consequences in environmental assessment process information of baseline environmental status of the project area is mandatory. Based on the existing environmental scenario potential impacts of road expansion will be identified and accordingly management plan will be proposed in forthcoming sections. The baseline environmental conditions will help in comparing and to monitor the predicted negative and positive impacts resulting from the project during pre-construction, construction, and operation phases. Significant action depicts direct adverse changes caused by the action and its effect on the health of the biota including flora, fauna and human being, socio- economic conditions, current use of land and resources, climate change aspects, physical and cultural heritage properties, and biophysical surroundings. Baseline data generation of the following environmental attributes is essential in IEE studies.

112. The data of several macro-environmental settings like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. was collected from secondary sources. Firsthand information have been collected to record the micro-environmental features within and adjacent to the project corridor. The collection of primary information includes extrapolating environmental features on proposed road design, tree inventories, location and measurement of socio-cultural features adjoining proposed road. Ambient air, noise, soil and water quality samples were collected at important locations in terms of environment quality to prepare a baseline database. Consultation was another source of information to explain local environmental conditions, impacts, and suggestions, etc.

113. The following section describes the baseline environment into three broad categories:

- Physical Environment- factors such geology, climate and hydrology;
- Biological Environment- factors related to life such as flora, fauna and ecosystem;and
- Socio-economic Environment- anthropological factors like demography, income,land use and infrastructure.

B. Physical Environment

114. Physical environment denotes the physical features that occur naturally (air, water, soil, atmosphere etc.). In order to depict the existing physical environment in the project area, a few of the major parameters are considered like geology & soil, ambient air, noise, surface & ground water, etc.

1. Climate

115. Although less than half of Bangladesh lies within the tropics, the presence of the Himalayan Mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the classification,

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the project area is located in three different climatic regions (Figure 10). These areas are the South-central region, South-western region and North-western climatic zone.

i. ***South-central Zone:*** In this zone, rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, butsomewhat more than in South-eastern zone. This is a transitory zone between theSouth-eastern, North-western and South-western zones and most of the severe hail storms, northwesters and tornadoes are recorded in this area.
ii. **South-western Zone:** Here the extremes of the zones to the north are somewhat tempered. Rainfall is between 1,500 mm and 1,800 mm. Mean summer maximum temperature is below 35°C. Dew-fall is heavier than in Western zone.
iii. **North-western Zone:** Except that the extremes are less and the rainfall is lower, this zone is similar to northern part of the northern region. The lower rainfall makesthis area both atmospherically and pedagogically drier (Banglapedia, 2010).

116. Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

117. The pre-monsoon hot season is characterized by high temperatures and thunderstorms. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, can account for 10 to 25 percent of the annual total.

118. The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September.

119. The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meagre rainfall. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.

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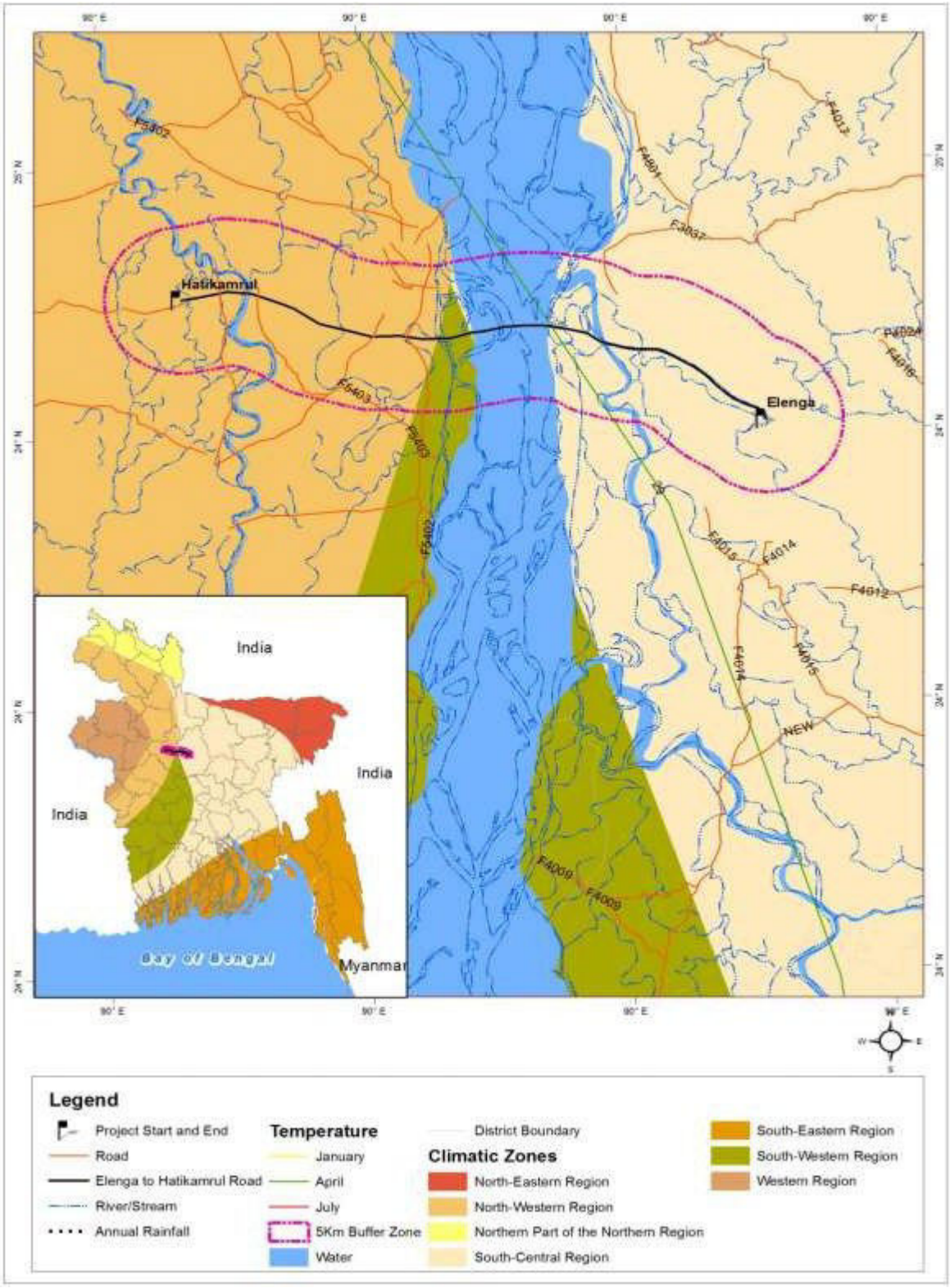

(Source: Rashid, 1991)

Figure 9: Climatic Zones

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120. **Temperature**. Long-term average monthly temperature data (1991-2012) were collected at Tangail weather station from Bangladesh Meteorological Department (BMD). The highest temperature recorded in this station was 37.5 °C in April and the lowest temperature was found in the month of January which was 7.7 °C. The average monthly temperature graphs (Figure 11) show that the area faces high temperatures from March to May and lowest temperature during winter remains from December to February in the year.

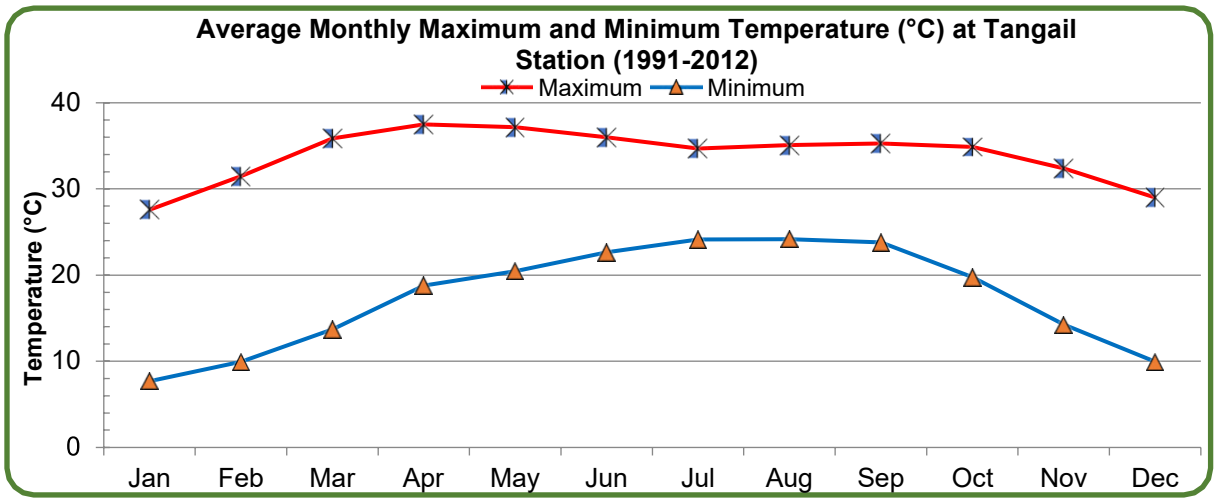

Figure 10: Average Monthly Max and Min Temperature at Tangail Station (1991-2012)

121. **Rainfall.** The rainfall data collected for the same station represents that maximum rainfall occurs during May to September and the lowest rainfall occurs in November to February during winter season (Figure 12). Statistical data of 1991 to 2012 shows that the station experiences more than 300 mm rainfall in June and July months during monsoon. In the months of Decemberand January of winter season around 10 mm rainfall occurred in the region of Tangail stations.

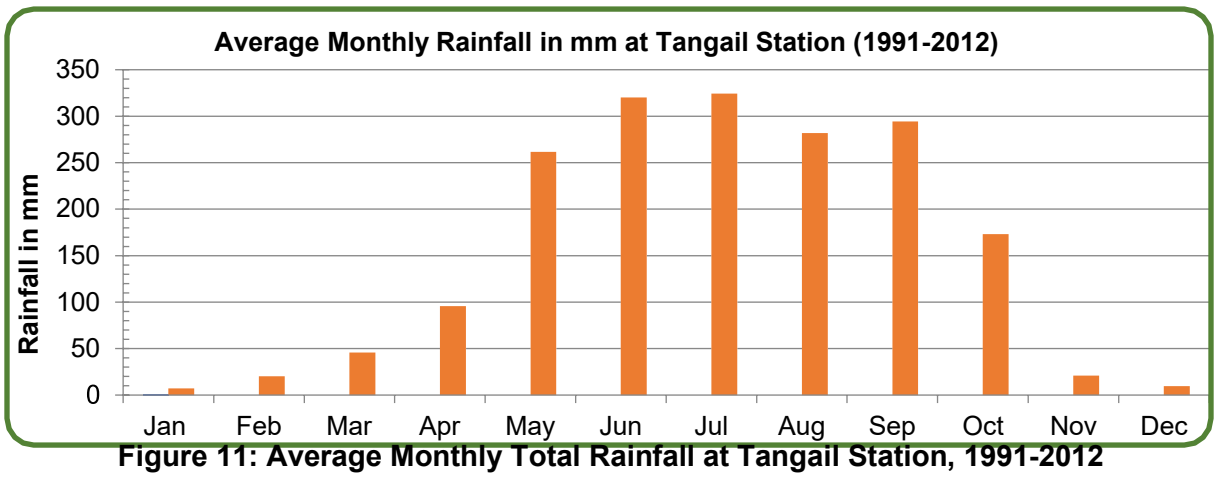

Figure 11: Average Monthly Total Rainfall at Tangail Station, 1991-2012

122. **Humidity**: Humidity is the amount of water vapor in the air. There are three main measurements of humidity: absolute, relative and specific. Relative humidity is an important metric used in weather forecasts and reports, as it is an indicator of the likelihood of precipitation, dew, or fog. While humidity itself is a climate variable, it also interacts strongly with other climate variables.

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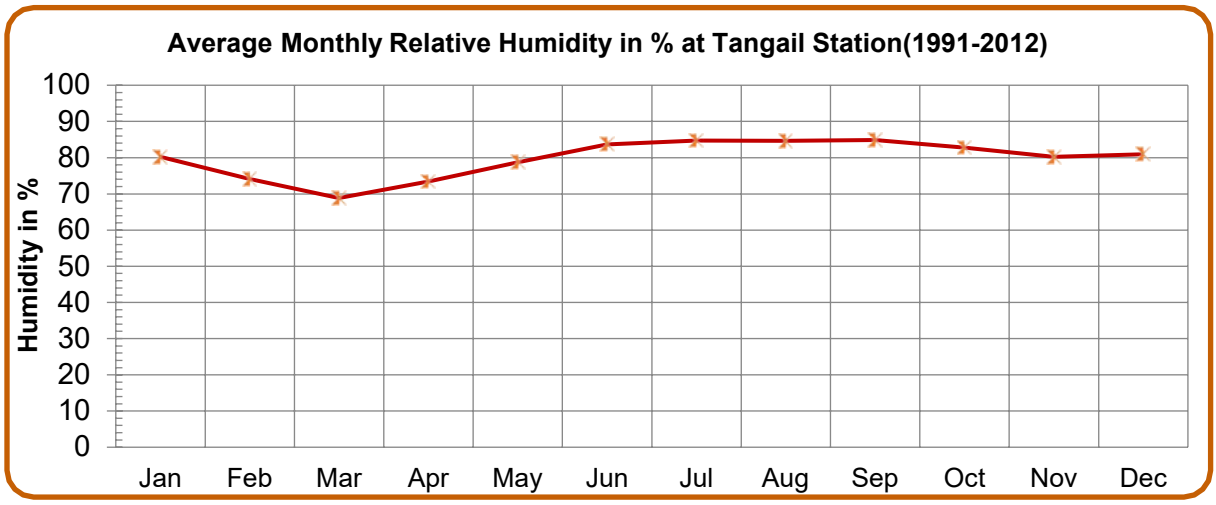

Figure 12: Average Monthly Humidity at Tangail Station, 1991-2012

123. Humidity remains high in summer and comparatively low in winter season. The statisticaldata of humidity from 1991 to 2012 indicates that humidity in the area maximized in July to September in the year which is ranges from 80% to 85%. On the other hand, humidity falls 60% to 75% in February, March, and April during the winter season in the considered area (Figure 13).

124. **Wind Speed.** Prior to the onset of the monsoon in March and April, hot conditions and thunderstorms prevail while winds gradually start blowing from the south or southwest - a patternthat continues throughout the monsoon period. Winds are generally stronger in the summer thanthey are in winter. The direction of prevailing winds is generally consistent during the winter and monsoon seasons and more variable during the transition periods. The Himalayan mountains infleunce wind patterns. Recirculation of winds during the monsoon season under the influence of the Himalayas can result in winds circling to the east–southeast in the northern parts of the country.

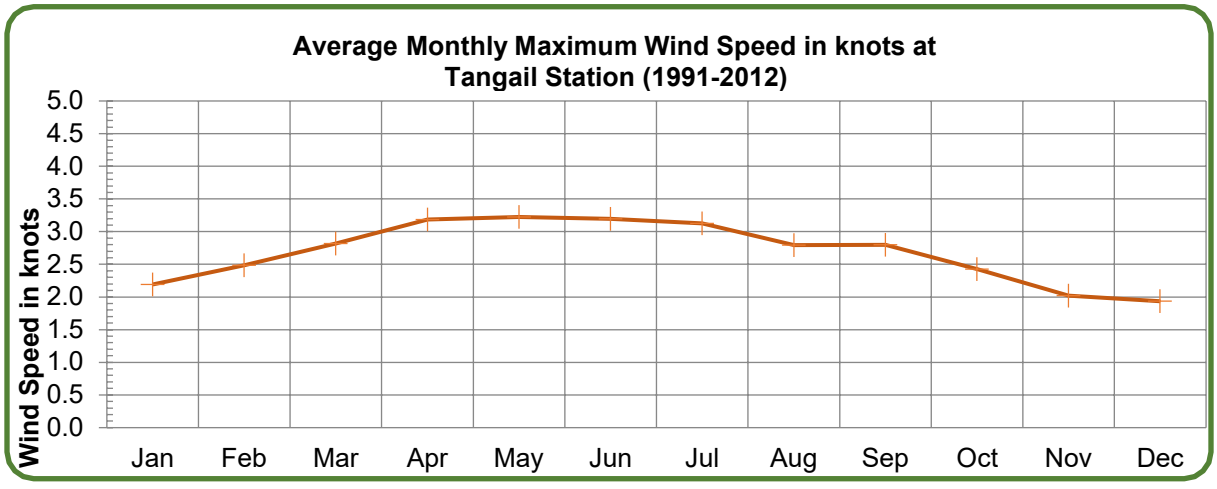

Figure 13: Average Monthly Maximum Wind Speed at Tangail Station, 1991-2012

125. The statistical wind speed data (Figure 14) shows that wind speed remained maximum with 3.3 knots in May and the minimum was 1.9 knots in the month of December for Tangail station.

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1. Physiographic Features

126. Physiography is the subfield of geography that studies physical patterns and processes ofthe Earth. It aims to understand the forces that produce and change rocks, oceans, weather, andglobal flora and fauna patterns. Physiographic region/unit refers to a region of which all parts aresimilar in terms of physical characteristics, and which have consequently had a uniform geomorphic history, and whose pattern of topographical features or landforms differs significantlyfrom that of adjacent regions.

127. In the context of physiography, Bangladesh can be divided into three broad categories based on topography, physical features, and geological history (Brammer, 1996):

- Floodplains
- Terraces
- Hills

128. The Elenga-Hatikamrul road alignment area lies mostly in the central part of the country and depends on the Jamuna River for freshwater supply. The Elenga-Hatikamrul road area is characterized by the floodplains of Jamuna in Tangail District and Tista floodplain in the Sirajganj District. The entire road alignment runs through the following two physiographic units 2 and 4 (Figure 15).

- ***Tista floodplain (2):*** A big sub-region stretches between the Old Himalayan Piedmont Plain in the west and the right bank of the N-S flowing Brahmaputra in the east. An elongated outlier representing the floodplain of the ancient Tista extends up to Sherpur (Bogra district) in the south. Most of the land is shallowly flooded during monsoons. There is a shallow depression along the Ghaghat river,where flooding is of medium depth. The big river courses of Tista, Dharla and Dudhkumar cut through the plain. The active floodplain of these rivers, with their sandbanks and diyaras, is usually less than six kilometers wide.

- ***Old Brahmaputra floodplain (4):*** In 1787, a remarkable change in the course of the Brahmaputra took place. In that year, the river shifted from a course around the eastern edge to the western side of the Madhupur Tract. The Old Brahmaputrafloodplain stretching from the south-western corner of the Garo Hills along the eastern rim of the Madhupur Tract down to the Meghna exhibits a gentle morphology composed of broad ridges and depressions.

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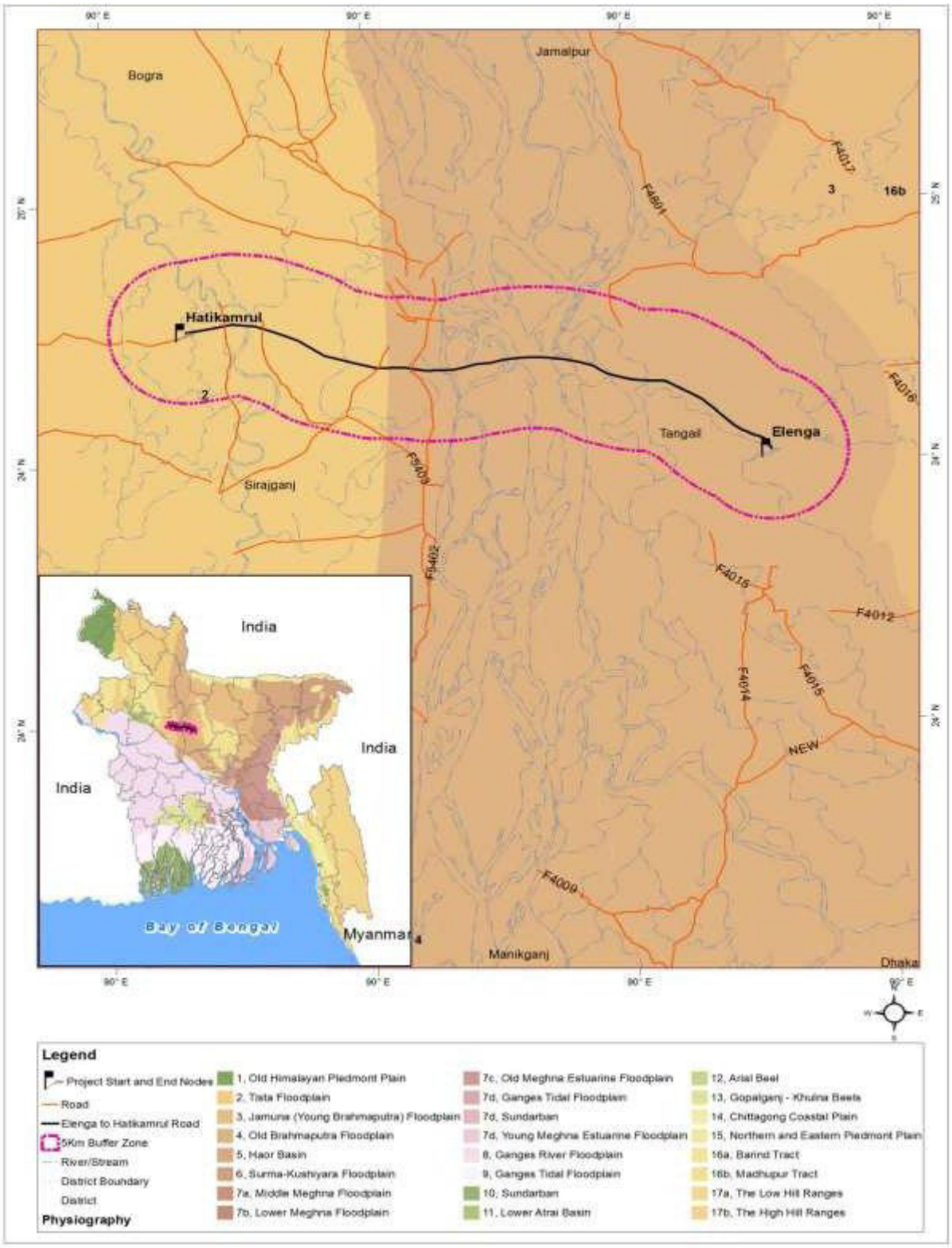

Figure 14: Physiographic Sub-regions of Bangladesh

(Source: SRDI, 1997)

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Photograph 1: Physiography of the Project Area.

2. Topography

129. Topography is the configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers.

130. The general topography of the project area comprises floodplains in most of the road and terraces. The general topography of the project area slopes from north to south with elevation ranged from 16m a.m.s.l to 15m a.m.s.l (Figure 16).

131. The project is located on the flood plain of the Jamuna and Fuljor River. The ground elevation of the project area is about 13mPWD. Topographically the cluster of the project locationis almost flat, with many depressions, natural khals, bounded by the rivers. There are many vacant lowlands on the bank of the Rivers, where mainly agricultural practices are dominant.

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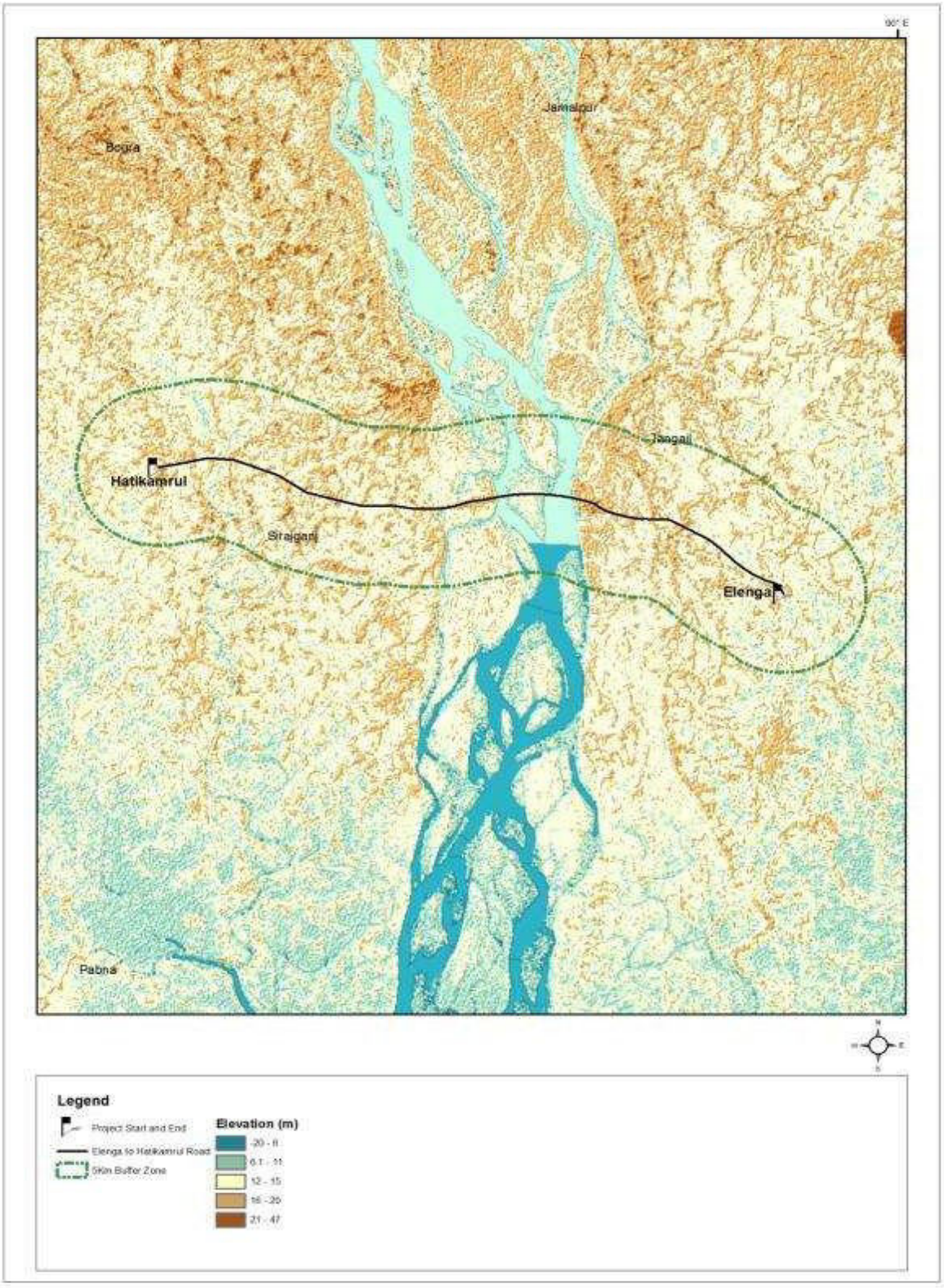

Figure 15: Topographical Map of Elenga – Hatikamrul Road

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3. Geology

132. Bangladesh is situated to the east of the Indian sub-continental plate. Nearly 85% of Bangladesh is underlain by deltaic and alluvial deposits of the Ganges, Brahmaputra, and Meghna river systems. The project area consists of Holocene alluvial deposits flood plain and predominantly consisting of fine sand, silts and clay. The site is on deep Cenozoic deposits that overlie Precambrian basement rock. The Precambrian rocks form the basement of all geologicalformations of Bengal Basin and shield areas. The materials deposited are a mixture of sedimentstransported by the old Brahmaputra and by the Jamuna (Brahmaputra) River. The generalized geological features of the project area are shown in the geological map of Bangladesh (Figure 17).

- ***Faridpur Trough:*** Situated adjacent to Hinge Zone is characterised by a generalgravity low with development of Neogene sequence. Sylhet Limestone is 6500 m deep in area south of the confluence of the Padma and the Jamuna. Chalna and Bagerhat are the notable structural highs of very low amplitude (Banglapedia, 2006).

- ***Bogra Shelf:*** Represents the southern slope of Rangpur Saddle which is a regional monocline plunging towards southeast gently to Hinge Zone. This zone marks the transition between the Rangpur Saddle and the Bengal Foredeep fromdepositional as well as structural point of view. The width of Bogra Shelf varies from 60-125 km up to the Hinge Zone and the thickness of the sedimentary sequence increases towards the southeast. Stanvac Oil Company (SVOC) carriedout aeromagnetic and seismic surveys in the mid-fifties followed by two wells at Kuchma and Bogra. Seismic contours on top of Eocene Limestone (Bogra limestone) show regional dip of 2-3° besides revealing a number of NE-SW trending faults of which Bogra fault is the most prominent. The attitude of Sylhet Limestone most possibly reflects the surface of the Archean Basement. There is no closed anticlinal fold in this tectonic zone. The Bogra fault did not provide the seal to the structural trends at Kuchma and Bogra for accumulation of commercial hydrocarbons (Banglapedia, 2006).

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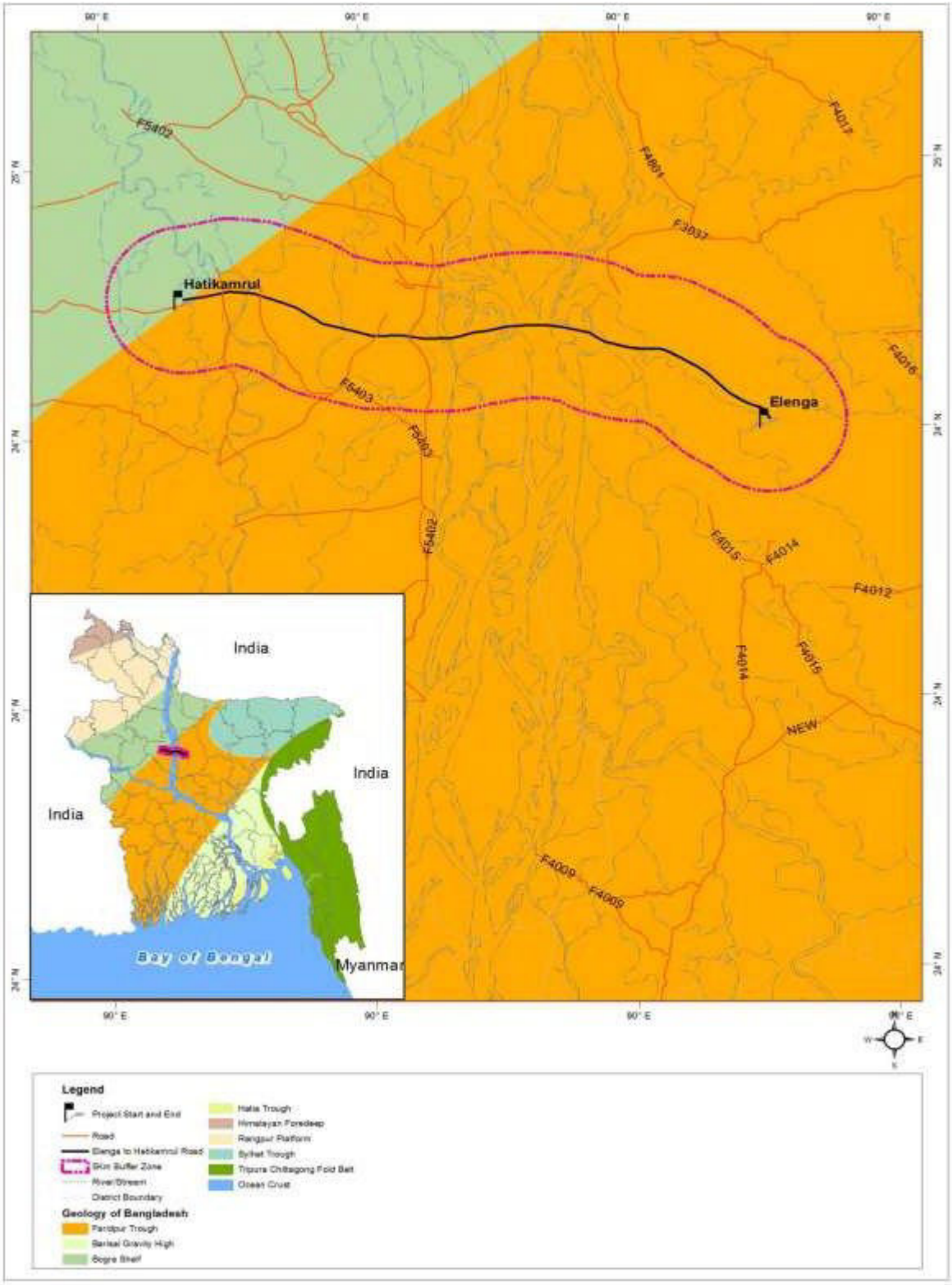

Figure 16: Geology of the Project Area

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4. Seismicity

133. Seismic Zone expression of the proneness of a region to earthquake occurrence in the historical past including the expectations in future. A region experiencing more frequent and large earthquakes has a higher seismicity compared to one with less frequent and small earthquakes.Both the temporal and spatial distributions of all earthquakes, small and big, have to besystematically accounted for by determining their past behaviour to determine the future trend.

134. Bangladesh is situated in one of the most tectonically active regions in the world. The project area is located over the Indian Plate, which is moving north. However due to the locationof relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (Table 13), based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes arelikely to occur*). Zone 3 is in the most seismically active area with a seismic coefficient on 0.25, and Zone 1 is the least active with a significantly lower seismic coefficient of 0.075 (Zahiruddin, 1993). As per the seismic zone map (Figure 18), project road falls in Zone II, which means mediumseismic intensity. There is no evidence of major earthquakes in the project areas in the past.

Table 13: Seismic Zones of Bangladesh

Zoning	Area Mercalli Scale	Bask Seismic Coefficient
I	North and eastern regions of Bangladesh (Seismically most active)	0.08
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt	0.05
III	Khulna division S-E Bangladesh (Seismically relatively quiet)	0.04

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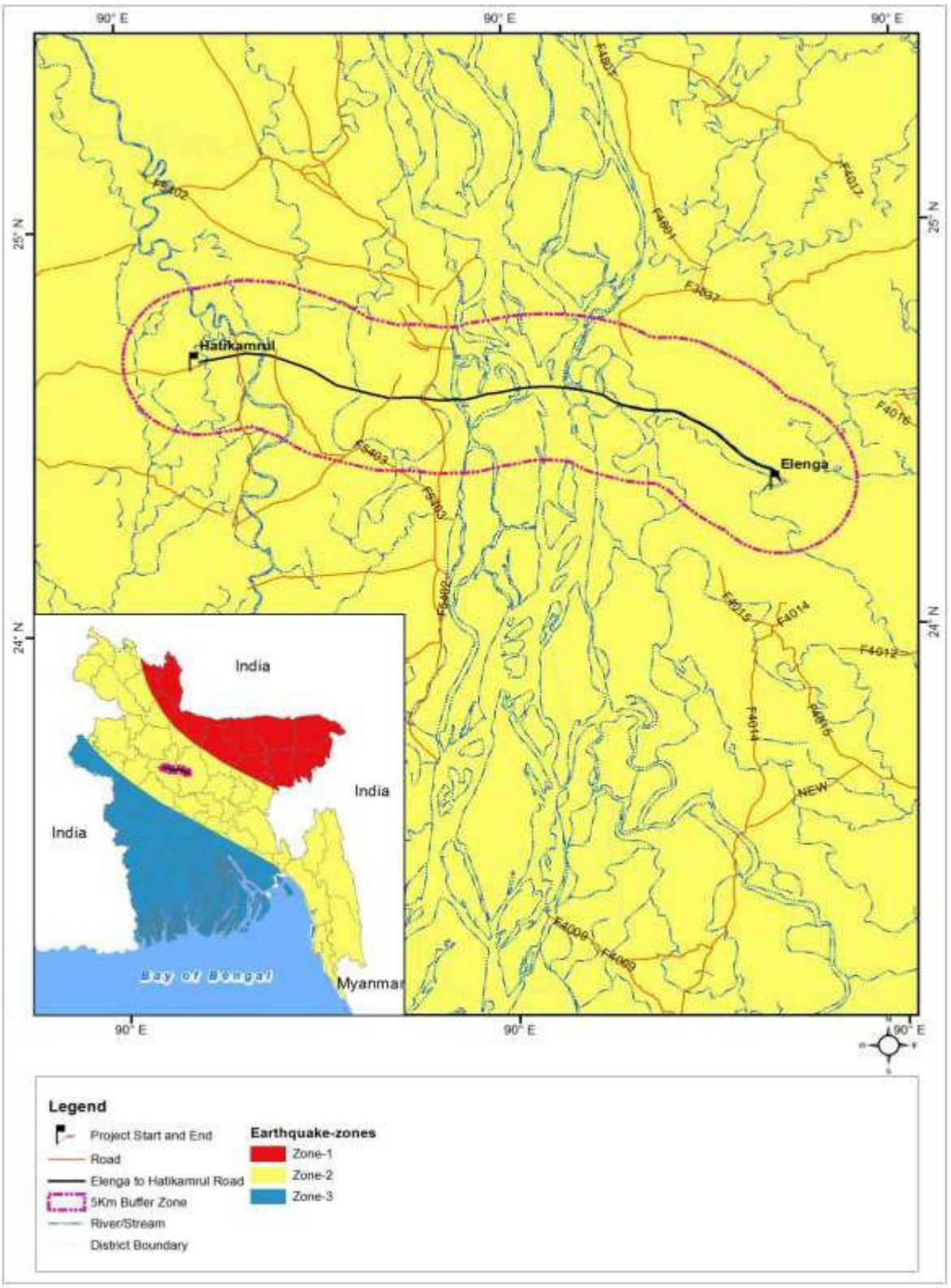

Figure 17: Seismic Zones within Bangladesh
(Source: Hossain, 1988 & Zahiruddin, 1993)

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5. Soil

135. The major part of Bangladesh is on the delta formed by the three major rivers Brahmaputra, Ganges and Meghna. These rivers and many of the country's other minor rivers originate outside the national boundary of the country and make up the Ganges-Brahmaputra- Meghna river system.

136. The project road passes through two different soil formation zones (Figure 20). The general soil types of the project road area predominantly include the following:

- ***Non-calcareous Alluvium (1):*** Similar to calcareous alluvium, except they are non-calcareous in soil profiles. These soils occupy extensive areas on the active Tista and Brahmaputra-Jamuna floodplains. They are sandy or silty, grey or olive,neutral to slightly alkaline. Most of these soils have been included as Eutric Fluvisols.
- ***Grey floodplain soil (5):*** Generally comprise grey topsoil and a cambic B-horizonin the subsoil with a grey matrix or grey gleans. They extensively occupy Tista, Karatoya-Bangali, Jamuna, middle Meghna and eastern Surma-Kushiyara floodplains. However, there are considerable regional differences in theproportions occupied by individual soil textures. Silt loam texture is dominant in theTista meander floodplain whereas silty clays are predominant in the Ganges tidal floodplain and in the Surma-Kushiyara floodplain. But the Jamuna floodplain has a more even distribution of silt loam, silty clay loam and silty clays. Most of these soils have been included in Eutric Gleysols (Banglapedia, 2006).

6. Agroecological Zones within the Project Area

137. Agroecological Zone is the land areas recognised on the basis of hydrology, physiography,soil types, tidal activity, cropping patterns, and seasons. In fact, an agroecological zone indicatesan area characterised by homogeneous agricultural and ecological characteristics. This homogeneity is more prominent in the sub region and unit levels.

138. The purpose of assessing the AEZs within the project area is to establish a broad overviewof expected soil conditions which can be compared against more detailed, Upazila-level data sources.

139. The agroecological zones of Bangladesh have been identified on the basis of four elements such as physiography, soils, land levels in relation to flooding and agroclimatology. Themost recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998)which classified Bangladesh into 30 AEZs. These 30 zones have been subdivided into 88 agroecological sub-regions, which have been further subdivided into 535 agroecological units. The project area contains 3 AEZs (refer Figure 19), namely:

i. ***Karatoya - Bangali Floodplain (4):*** This region is very similar to the Tista Meander Floodplain in physiography and soil and comprises a mixture of Tista and Brahmaputra sediments. Most areas have smooth, broad, floodplain ridges and almost level basins. The soils are grey silt loams and silty clay loams on ridgesand grey or dark grey clays in basins. Five general soil types occur in the region, of which non-calcareous grey floodplain and non-calcareous dark grey floodplain soils predominate. The soil is moderately acidic throughout. Organic matter contents are generally low in the cultivated layer of ridge soils and moderate in basins. General fertility is medium. The eastern half of Bogra and most of Sirajganjdistricts are included in this zone (Banglapedia, 2006).

ii. ***Active Brahmaputra - Jamuna Floodplain (7):*** This region comprises the belt of

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unstable alluvial land along the Brahmaputra-Jamuna Rivers where land is constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandyand silty alluvium, rich in weatherable K minerals that are slightly alkaline in reaction. Six general soil types occupy the area. Organic matter status is low andfertility status is low to medium (Banglapedia, 2006).

iii. ***Young Brahmaputra - Jamuna Floodplain (8):*** The zone comprises the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially filled cut-off channels and basin. This area is occupied by permeable silt loam to silty clay loam soils on the ridges andimpermeable clays in the basins, neutral to slightly acid in reaction. General soil types include predominantly grey floodplain soils. Organic matter content is low inridges and moderate in basins. Soils are deficient in N, P, and S but the status of K and Zn are reasonable (Banglapedia, 2006).

140. The nature and soil characteristics of these zones influence the crops and cropping patterns within the region. Human interventions and modifications in the drainage patterns have already affected the cropping calendar, crop diversity and introduction of new varieties and agricultural products.

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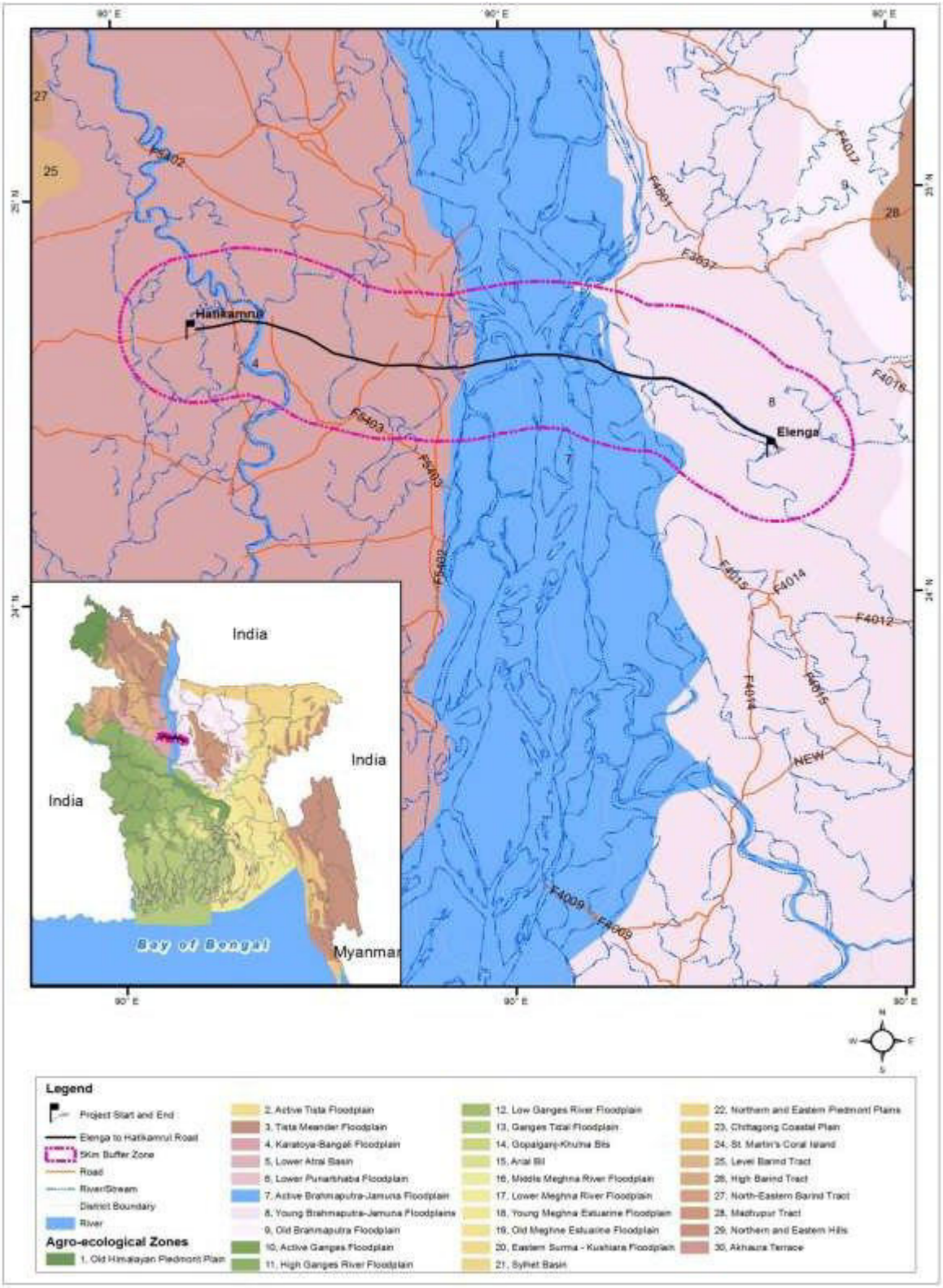

Figure 18:Agroecological Zone

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7. Soil Quality

141. According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service, soil quality is the capacity of a specific kind of soil to function, within naturalor managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhancewater and air quality, and support human health and habitation. Soil in the project area is highly productive and suitable to support different ecosystems in balance. The land in this area is mostlyused for agricultural cultivation. During the construction phase of the project, road embankment will be built by carried earth. Hence, there is the chance of the native soil to be disturbed by the external carried earth. There has the priority of using the dredged earth from the rivers along theroad alignment instead of using the local soil from the land.

142. Soil sample in 1 m depth from the bed of the Jamuna River and Fuljor River was analysedin the environmental laboratory of BUET to assess the current soil quality as the dredged material.Table 14 reflects the test results of the collected soil sample. Test report of soil analysis proves that riverbed material (sand) of the Jamuna and Fuljor Rivers contains acceptable amount of Arsenic (As), Lead (Pb), Zinc (Zn) and Mercury (Hg) comparing with the standard of EU Directive86/278/EEC for land application. Thus, sand from the rivers can be used for developing project Road Embankment.

Photograph 2: Riverbed Materials Collection at Jamuna River, Tangail and Fuljor River, Sirajganj

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Table 14: Test Results of Soil Quality

Parameter	Unit	Concentration Present		EU Directive 86/278/EEC for Land Application	Method of Analysis
		Jamuna River Location: 24° 18' 57.716" N 89° 55' 15.340" E	Fuljor River Location: 24° 25' 20.088" N 89° 35' 26.547" E		
Arsenic (As)	mg/kg	1.761	1.911	-	USEPA 206.2; SM 3113 B
Lead (Pb)	mg/kg	23.2	25.2	1200	USEPA 200.9 Rev 2.2; SM 3111 B
Zinc (Zn)	mg/kg	49	64	4000	USEPA 200.9; SM 3111 B
Mercury (Hg)	mg/kg	0.109	0.095	25	----------
Parameter	**Unit**	**Concentration Present**		**EU Directive 86/278/EEC for Land Application**	**Method of Analysis**
		Jamuna River Location: 24° 18' 57.716" N 89° 55' 15.340" E	**Fuljor River Location: 24° 25' 20.088" N 89° 35' 26.547" E**		
Copper (Cu)	mg/kg	29	41	-	----------

Source: Lab Analysis, November 2012, BUET

8. Water Resources and Hydrology

143. Bangladesh is located over a subsiding basin of tectonic origin overlain with a great thickness of sedimentary strata. This sedimentary stratum is an unconsolidated alluvial deposit ofrecent age overlaying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface Quaternaryalluvium contains good aquifer characteristics (transmission and storage coefficients). Thegroundwater (GW) storage reservoir has three divisions: upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand.Drinking water is generally taken from deep tube wells with strainers set between depths of 200 meters to around 400 meters (DPHE, 2011). The Ground water level is at or very close to the surface during the monsoon; whereas, it is at maximum depth during the months of April and May(Banglapedia, 2010).

144. **Surface Water.** Two major surface water bodies surrounding the project area which are Jamuna River and Fuljor River. The project road alignment crosses all the water bodies are presented in Figure 20. There are also significant numbers of beel and khal in and around the project locations. Besides, there are remarkable numbers of ponds and ditches available in the project area. Most of the water bodies become waterless or contain minimum amount of water during the dry season and gets water in rainy season. People use the water from the river, khal, canal and ponds for washing, bathing and irrigation purposes. In the wet season, substantial amount of the land in the area is inundated due to flood. In the dry season local canals and channels provide water for irrigation for boro cultivation and for growing winter crops. Table 15 represents the affected water bodies & fish resources in the RoW of the project road alignment.

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Photograph 3: Water Bodies along the Elenga-Hatikamrul Road.

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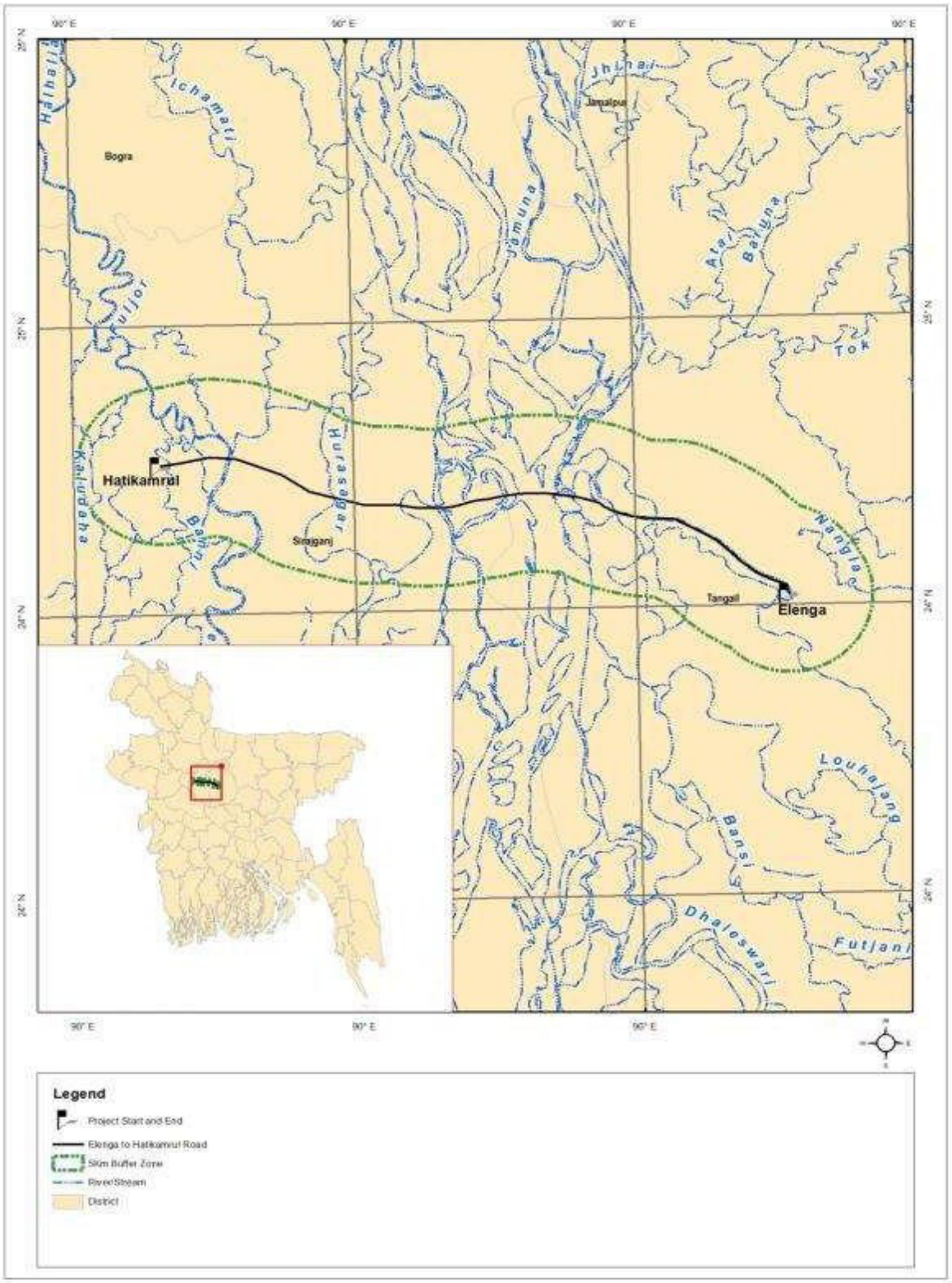

Figure 19: River Network

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Table 15: Affected Water Bodies & Fish Resources within 25m of the Rows of the Alignment

Type of Water Bodies	Chainage (Km)		Total No. of Water Bodies	Area (ha)		Affected Total Fish Production	
	Right	Left		Total Area	Affected Area	MT/ha/Year[6]	Total Production (MT)
River	95+425, 106+320		2	-	-	-	-
Canal	72+100, 77+700, 79+070, 99+500,		4	-	-	-	-
Pond	69+500, 70+560,		2	0.133	0.032	1.92	0.061
Beel		92+800,	1	-	-	-	-
Khal		98+300, 105+850-106+000,	2	-	-	-	-
Ditch	69+550, 69+700,		2	0.101	0.036	0.82	0.029

9. Surface Water Quality

- Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of oneor more biotic species and or to any human need or purpose. It is most frequentlyused by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. To assess thecurrent quality of ground and surface water, water samples were collected from two locations along the whole alignment.
- The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically water quality improves during the monsoon due to the influx of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases. The surface water quality at various locations was measured in the project area during the Environmental Impact Assessment. In March 2017, surface water samples were collected by environmental team from two surface water bodies (at major bridge site two samples were collected from 50 m upstream and 50 m downstream of bridge location) along the project corridor. The Bangladesh Council of Scientific and Industrial Research (BCSIR) analyzed the samples. The result of the surface water samples and are shown in Table 16. In December 2022, surface water samples are collected by environmental team from same water bodies along the project corridor. The contractor has contracted the 3rd party to analyse the samples. Table 16-A shows that surface water quality varies with sampling locations. Total Phosphate in two locations were reported higher than the national standards as given in (ECR 2023). Dissolved Oxygen (DO) is also found lower than standard. In no cases, these results are influenced by the project activities. Testing reports of surface water samples are provided in Appendix-D.

[6] Production in MT/ha/Y has been given based on the information collected from the owners of the water bodies

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Photograph 4: Surface Water Sample Collection from River along the Project Road

Table 16: Results for Surface Water Field Samples

SL No.	Sample ID	Sampling Location	Results					
			pH	**Total Organic Carbon (TOC)**	**Total phosphate (PO_4)**	**Total Suspended Solids (TSS)**	**Dissolved Oxygen (DO)**	**Oil and Grease**
Method of Analysis			**pH Meter**	**Wet Oxidation Method Followed by Potentiometric Titration**	**Vanadomolybdophosphoric Yellow Color Method**	**Gravimetric Method**	**DO Meter**	**APHA 5520.B**
Unit			**-**	**ppm**	**ppm**	**mg/L**	**mg/L**	**mg/L**
1	SW 14.1 (50m US)	Hatikamrul (Fuljor River)	6.88	4.01	0.26	<5	3.66	8.80
2	SW 14.2 (50m DS)	Hatikumrul (Fuljor River)	7.27	3.65	0.71	< 5	4.04	<5
3	SW 16	Elenga	7.49	12.69	6.12	192.70	4.63	2.40
Standards for Inland Surface Water (water usable for recreational activity)			6.5-8.5	No standard	No standard	No standard	5 or more	No standard

Source: Lab Analysis, April, 2017, BCSIR

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Table 17-A: Results for Surface Field Samples

Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Monitoring Result	National Standard	Remarks
Work Package 06: Surface water 1						
Temperature	106+800	Nalka Bridge	24.42°59N89.58°E	23.7	25 -30	Water Quality parameter are within the National Standard level
Biochemical Oxygen Demand (BOD)	106+800	Nalka Bridge	24.42°59N89.58°E	4.2	6 or less	Water Quality parameter are within the National Standard level
Dissolved Oxygen (DO)	106+800	Nalka Bridge	24.42°59N89.58°E	9.0	6	Water Quality parameter are within the National Standard level
Electrical Conductivity (EC)	106+800	Nalka Bridge	24.42°59N89.58°E	575	2000	Water Quality parameter are within the National Standard level
pH	106+800	Nalka Bridge	24.42°59N89.58°E	7.6	6.5-8.5	Water Quality parameter are within the National Standard level
Nitrate	106+800	Nalka Bridge	24.42°59N89.58°E	1.6	10	Water Quality parameter are within the National Standard level
Phosphate	106+800	Nalka Bridge	24.42°59N89.58°E	1.1	0	Water Quality parameter are exceed from National Standard level

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Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Monitoring Result	National Standard	Remarks
Work Package 06: Surface water 2						
Temperature	95+553	Kodda Intersection	24.59˚N 89.83˚E	23.1	25 – 30	Water Quality parameter are within the National Standard level
Biochemical Oxygen Demand (BOD)	95+553	Kodda Intersection	24.59˚N 89.83˚E	4.2	6 or less	Water Quality parameter are within the National Standard level
Dissolved Oxygen (DO)	95+553	Kodda Intersection	24.59˚N 89.83˚E	7	6	Water Quality parameter are within the National Standard level
Electrical Conductivity (EC)	95+553	Kodda Intersection	24.59˚N 89.83˚E	446	2000	Water Quality parameter are within the National Standard level
pH	95+553	Kodda Intersection	24.59˚N 89.83˚E	7,3	6.5-8.5	Water Quality parameter are within the National Standard level
Nitrate	95+553	Kodda Intersection	24.59˚N 89.83˚E	1.4	10	Water Quality parameter are within the National Standard level
Phosphate	95+553	Kodda Intersection	24.59˚N 89.83˚E	1.4	0	Water Quality parameter are exceed from National Standard level

Source: Lab Analysis, December 2022

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145. In December 2022, surface water samples are collected by environmental team from baseline water bodies (samples were collected from 50 m upstream and 50 m downstream of two major bridge location) along the project corridor. The contractor contracted the 3rd party to analyze the samples (See Appendix D). It also compared to the Base line data and existing data, which has no remarkable changes at all.

10. Groundwater

146. The groundwater resources in the project area are found in three separate aquifers. An upper aquifer: a surface layer consisting mainly of clay and silt, characterized by high porosity but low permeability; composite aquifer: an intermediate layer of mainly fine sand and clay characterized by high porosity and moderate permeability (possibility of providing water with hand pumps); and main aquifer: a deeper layer, containing mainly fine to coarse sand. The main aquifer is characterized by high porosity and moderate to high permeability and is separated from the composite aquifer by a clay layer. Fresh groundwater is relatively carbonate-rich with low total dissolved solid contents of less than 500 milligrams/liter (mg/l). Arsenic is a problem in large part of Bangladesh ground water. The project area also has Arsenic levels in ground water varying from <1 microgram to 50 microgram per liter of water. The acceptable quantity of arsenic in potable water is 0.05 mg per liter under the Department of Environment standard and 0.01 mg per liter under the WHO standards (Figure 21).

147. Based on field observations and interviews with local residents it was found that groundwater in the area is used as a drinking water source in many instances, as well as for irrigation purposes. Water is generally extracted via hand pump (tube wells) from the shallow regions of the composite aquifer, and via machine-driven pumps (deep tube wells) which draw from the deeper main aquifers (Table 17). The ground water reservoir usually recharges from rainfall, floods, and rivers. In summer season, the water table slightly goes down and goes up in rainy season.

Table 18: Source of Drinking Water in the Project Area

District	Upazila (sub-district)	No. of Households	Source of Drinking Water (%)		
			Tap	Tube-well	Others
Tangail	Kalihati	97,988	0.4	97.8	1.8
Sirajganj	Sirajganj Sadar	124,852	4.0	93.9	2.1
	Kamarkhand	31,920	0.8	97.7	1.5
	Royganj	77,104	0.7	95.4	3.9
	Ullapara	123,630	0.9	94.7	4.4

Source: Population Census, 2011

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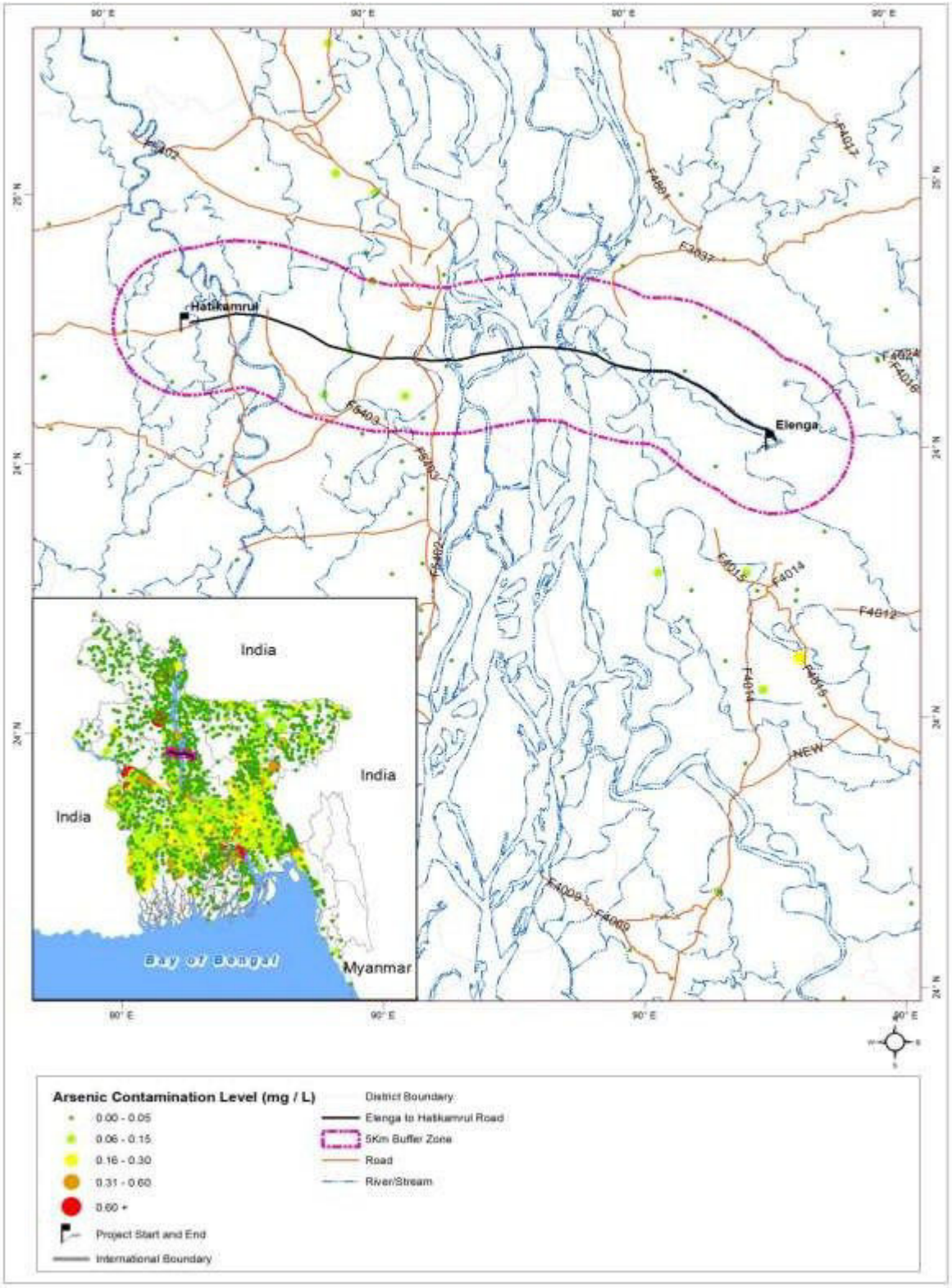

Figure 20: Arsenic Concentrations in Groundwater

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1. Groundwater Quality

148. In March 2017, groundwater samples were collected from two locations of shallow tube wells by environmental team along the project road. The Bangladesh Council of Scientific and Industrial Research (BCSIR) analysed the samples and coliforms were tested at International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) laboratory. The result of the groundwater samples and the GoB standards for potable water (ECR, 1997) are shown in Table 18.

149. The groundwater quality test reports are provided in Appendix E. The concentration of Mn and Fe is higher than the standard value at Hatikamrul water source.

Photograph 5: Groundwater Sampling along the Project Road

Table 19: Results for Groundwater Field Samples

Parameters	Unit	Elenga	Hatikamrul	Drinking Water Quality Standard, DOE (ECR,97)	Method of Analysis
pH	-	7.32	7.20	6.5-8.5	pH meter
Manganese (Mn)	ppm	0.056	**0.67**	0.1	AAS
Arsenic (As)	ppm	0.0051	0.022	0.05	AAS with HVG Unit
Iron (Fe)	ppm	0.027	**12.7**	0.3-1.0	AAS
Chloride (Cl^-)	ppm	20.83	2.66	150-600	Ion Chromatography
Total Hardness	ppm	83.9	172	200-500	Potentiometric Titration
Total Coliform (TC)	CFU/100mL	0	0	0	Membrane Filtration
Faecal Coliform (FC)	CFU/100mL	0	0	0	Membrane Filtration

Source: Lab Analysis, April 2017, BCSIR & icddr,b

150. In December 2022 groundwater samples were collected by environmental team from shallow tube wells in the project area. The Contractor contracted the 3rd party to analyze the samples (See

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Appendix E). It also compared to the Base line data and existing data which has no remarkable changes at all. Table 18-A shows that groundwater quality not varies with sampling locations. In no cases, these results are influenced by the project activities.

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Table 20-A: Results for Groundwater Field Samples

Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Monitoring Result	National Standard	Remarks
Work Package 06: Ground water 1						
Arsenic (As)	106+800	Nalka Bridge	24.59°59N89 .83°E	0.003	0.05	Water Quality parameter are within the National Standard level
Chloride (Cl)	106+800	Nalka Bridge	24.59°59N89 .83°E	58	150-600	Water Quality parameter are within the National Standard level
Electrical Conductivity (EC)	106+800	Nalka Bridge	24.59°59N89 .83°E	575	2000	Water Quality parameter are within the National Standard level
pH	106+800	Nalka Bridge	24.59°59N89 .83°E	7.4	6.5-8.5	Water Quality parameter are within the National Standard level
Fecal Coli form (FC)	106+800	Nalka Bridge	24.59°59N89 .83°E	0	0	Water Quality parameter are within the National Standard level
Total Coli form (TC)	106+800	Nalka Bridge	24.59°59N89 .83°E	0	0	Water Quality parameter are within the National Standard level
Iron (Fe)	106+800	Nalka Bridge	24.59°59N89 .83°E	0.9	0.3-10	Water Quality parameter are within the National Standard level
Manganese	106+800	Nalka Bridge	24.59°59N89 .83°E	0.04	0.10	Water Quality parameter are within the National Standard level

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Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Monitoring Result	National Standard	Remarks
Work Package 06: Ground water 2						
Arsenic (As)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	0.002	0.05	Water Quality parameter are within the National Standard level
Chloride (Cl)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	43	150-600	Water Quality parameter are within the National Standard level
Electrical Conductivity (EC)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	240	-	Water Quality parameter are within the National Standard level
pH	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	7.7	6.5-8.5	Water Quality parameter are within the National Standard level
Fecal Coli form (FC)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	0	0	Water Quality parameter are within the National Standard level
Total Coli form (TC)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	0	0	Water Quality parameter are within the National Standard level
Iron (Fe)	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	0.45	0.3-10	Water Quality parameter are within the National Standard level
Manganese	95+553	Kodda Intersection	24.83˚ N 89.93˚ E	0.05	0.10	Water Quality parameter are within the National Standard level

Source: Lab Analysis, December 2022

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2. Ambient Air Quality

151. Ambient air quality refers to the background air quality levels in a region, characterized by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their concentration depends on the type of polluting sources, and other factors that influence their flow and dispersion. In most cases vehicular emissions are the predominant source of air pollution. Existing ambient air quality data on various sections of the project corridors was collected to establish a baseline database. The aim was to identify areas that already have high pollution levels or are expected to experience so, on account of the road project, and to design adequate mitigation measures, as applicable.

152. The activities which generate modify atmospheric air quality, are transportation (i.e., motor vehicle emissions, which are addressed in this report); domestic and construction. The principal sources of air pollution due to road projects are hot mix plants and machinery used during construction phase and the vehicles that ply over it during the operation phase. The majorpollutants of significance to roadside air quality, on account of vehicular emissions, are suspendedparticulate matter (SPM), sulphur dioxide (SO_2), nitrogen oxides (NOx), hydrocarbons (HC), carbon-monoxide (CO), total volatile organic carbon (TVOC), etc.

153. Dispersal of pollutants depends upon factors like prevailing wind direction and other weather conditions, height of the source, and characteristics of roadside plantation and presenceof other sinks along the project corridor.

154. The main sources of air pollution in the project area are from road dust, black smoke from diesel engines, construction dust, windblown dust from agricultural lands, domestic heating, and cooking, and transportation.

155. In order to monitor air quality, a field investigation was undertaken in March 2017. The concentrations of SPM and PM_{10} were obtained by collecting the sample over 24 hours in the location. Photograph 6 shows snapshots of air quality monitoring processes. The field investigation is undertaken during December 2022 again (See Appendix F) and compared to the Baseline data. and existing data which haves no remarkable changes at all. For few minimal changes are found with existing air quality data and baseline (Table 19-A), so that taking interventions to maintain good air quality during the construction.

Photograph 6: Air quality measurement along the Project Road

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Table 21: Ambient Air Quality in Different Locations

Air Quality Parameters	Unit	Concentration Present			Bangladesh Standard (ECR, 2005)
		Hatikamrul	Koddar Moor	Elenga	
GPS Location		24°27'12.21"N 89°42'9.94"E	24°23'45.73"N 89°41'29.92"E	24°20'19.78"N 89°55'28.53"E	
Temperature	°C	26.15	25	27.96	
Relative Humidity	%	79.84	79.97	83.91	
Wind Speed	Km/h	0.14	0.43	0.0	
Wind Direction	Degree	194.57^0 South-West	238.37^0 South-West	153.5^0 South - East	
O_3	ppm	3.09	3.71	5.35	157 (8-hr Average) 235 (1-hr Average)
NO_x	ppm	92.42	83.79	**102.33**	100 (annual)
SO_2	ppm	9.85	19.50	20.81	80 (Annual) 365 (24-hr Average)
CO	ppm	0.0	.04	0.0	10 (8-hr Average) 40 (1-hr Average)
VOC	ppb	0.0	0.0	0.0	NYS
PM_{10}	$\mu g/m^3$	65.78	148.80	98.95	50 (annual average) 150 (24-hr average)
$PM_{2.5}$	$\mu g/m^3$	27.77	**99.85**	**67.20**	15 (annual average) 65 (24-hr average)

Source: Baseline Survey, March 2017

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Table 22-A: Ambient Air Quality in Different Locations

Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Frequency of Monitoring	Monitoring Result (µg/m3)	National Standard	Remarks
Work Package 06: Air Quality 1							
$PM_{2.5}$	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	8	46.36	65	Ambient air quality is within the National Standard Level
PM_{10}	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	8	94.01	150	Ambient air quality is within the National Standard Level
SO_2	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	8	54.16	365	Ambient air quality is within the National Standard Level
NO_X	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	8	23.54	100	Ambient air quality is within the National Standard Level
CO	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	8	<0.56 ppm	9 ppm	Ambient air quality is within the National Standard Level
Work Package 06: Air Quality2							
PM2.5	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	24	33.37	65	Ambient air quality is within the National Standard Level
PM10	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	24	71.31	150	Ambient air quality is within the National Standard Level
SO_2	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	24	17.21	365	Ambient air quality is within the National Standard Level
NO_X	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	24	26.53	100	Ambient air quality is within the National Standard Level
CO	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	8	<0.66 ppm	9 ppm	Ambient air quality is within the National Standard Level

Source: Lab Analysis, December 2022

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156. The particulate matters, and oxides of nitrogen concentrations exceeded the DoE allowable limit at several measured locations along the project road. Human activities, such as the burning of fossil fuels in vehicles, construction activities and various industrial processes also generate significant amounts of particulates. In the project area human activities are mainly responsible for the high concentration of particulate matter.

157. To assess the likely impacts on the ambient air quality due to the proposed road project, CALINE-4, a line source model developed by the California Transport Department, was used to predict carbon monoxide (CO) and particulate matter (PM) concentrations on the road. The modelwas run to predict hourly average CO, $PM_{2.5}$ and PM_{10} concentrations generated from traffic movement on proposed highway.

158. Kerb side locations were selected to compare the model prediction with monitored locations. Compared with the actual measurements of $PM_{2.5}$, PM_{10} and CO concentrations in Koddar More, the predicted concentration of each pollutant is lower (99.85 vs. 70 µg/m for $PM_{2.5}$ vs 85 µg/m for PM_{10}; and 0.4 vs. 0.3 ppm for CO). This might be due to the contributions of other sources of pollutants such as natural dust and emission of fossil fuels. The contribution of vehicles movement is almost 60-70% of total concentration at receptor location. The high movement of heavy duty diesel trucks (45%) along the road generates high amount of CO and particulates in the downwind side of the road. Details of the air quality modelling is in Appendix F.

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3. Noise Level

159. Excessive noise is a potential issue for both human and biological receivers and can potentially cause a range of negative issues, from mild annoyance and moderately elevated levelsof aggression to significant disturbance of behavioural patterns and in severe cases temporary or permanent hearing loss. According to World Health Organization's Guidelines for Community Noise (1999), daily sound pressure levels of 50 decibels (dB) or above can create discomfort amongst humans, while ongoing exposure to sound pressure levels over 85 dB is usually considered the critical level for temporary hearing damage.

160. Two primary sources of noise have been identified in the project area:

- **Commercial Areas:** There are some commercial or refreshment areas where always significant number of people gather and makes chaos continuously. This isanother source of noise pollution along the road.
- **Road Traffic:** Road traffic is one of the major noise sources in the project area. The project road is a common route of transportation for several districts. This highway carries a relatively high volume of both motorized and non-motorized vehicles, resulting in road traffic noise impacts along the road corridors.

161. Monitoring of ambient noise levels was undertaken by the environment team at three locations for twenty-four hours in March 2017 within the project area. The outcomes of this monitoring are presented in Table 18. Photograph 7 shows some of the snapshots during the monitoring phases.

Table 23: Noise Level at Different Locations of the Project Alignment

Location	Noise Level Description, L_{Aeq} (dBA)
Sirajganj Road Chowrasta/Hatikamrul	64.93
Elenga Bazar, Elenga	71.45
Koddar Moor	65.17

Source: On Site Monitoring, SMEC Environmental Team

Table 24-A: Noise Level at Different Locations of the Project Alignment

Monitoring Parameter	Chainage (Km+m)	Location	GPS Coordinate	Frequency of Monitoring (Day/Night)	Monitoring Result (Noise in dB)	National Standard (Zone)	Remarks
Noise Level at Different Locations of Work Package 06							
Average Noise Level (Day Time)	95+553	Kodda Intersection, Sirajganj	24.83˚ N 89.93˚ E	12 hr	75.0	75	Noise Level is within the National Standard Level
Average Noise Level (Day Time)	106+800	Nalka Bridge East, Sirajganj	24.59˚N 89.83˚E	12 hr	80.6	75	Noise Level is exceed the National Standard Level

162. Analysis of the noise data shows that the baseline noise around the project area varies from location to location. However, the noise levels at measured locations are higher than the standard

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set by the Bangladesh Noise Pollution Control rules. Noise pollution propagation generated from traffic was predicted using Canarina CUSTIC 3.2 software, where noise emissionfrom vehicles along the proposed Elenga – Hatikamrul Road is modelled as steady state line source. Sensitive noise receptors along the corridor were identified such as educational institutions, health complexes and religious centres. Based on the model prediction, the predicted noise for the following sensitive receptors will be exceeded by 2040, compared to the current scenario: Bytunnur Jame Mosque, An-Noor Mosque, unnamed mosque, Sayadabad Mosque, Bangabandhu Setu Purbo Station, Bangabandhu Setu Poschim Station, Analiabari High School, Talimul Islam Madrasha, Jamuna Polytechnic Institute, Shohidul Bulbul Karigori College, and Simanto Bazar. Predicted noise levels ranged from 65.6-74.8 Leq. Based on the model prediction, the predicted noise for the sensitive receptors is indicated in Table 21.

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Table 25: Predicted noise for the year 2040 where there is exceedance vs. baseline data

Segment name	Name of sensitive receptor	Type of establishment	Latitude	Longitude	Baseline noise (Leq) under current traffic conditions	Predicted noise (Leq) for the year 2040	Comments (No change/ net increase in noise)
Tangail (Elenga)-Hatikamrul Road	Bytunnur Jame Mosque	Religious	24.34407	89.91985	62.0	67.4	**Increase**
	An-NoorMosque	Religious	24.38649	89.8258	62.0	68.5	**Increase**
	Mosque	Religious	24.39461	89.73837	48.9	65.6	**Increase**
	Sayadabad Mosque	Religious	24.39177	89.71413	61.0	69.9	**Increase**
	Dhopakanti Mosque	Religious	24.42	89.5575	72.3	74.8	**Increase**
	Fuljor Degree College Mosque	Religious	24.42454	89.58956	65.7	68.0	**Increase**
	Bangabandhu Setu Purbo Station	Others	24.38945	89.81992	66.3	72.4	**Increase**
	Bangabandhu Setu Poschim Station	Others	24.39579	89.73359	59.7	71.8	**Increase**
	Hatikomrul Highway Thana	Others	24.41885	89.55367	76.0	70.7	No change
	Gas Transmission Company Ltd	Industry	24.3384	89.92561	73.5	68.9	No change
	Poschimanchol Gas Company Limited	Industry	24.42158	89.59808	74.6	68.6	No change
	Shakhawat Memorial Hospital	Health	24.41961	89.55268	80.0	72.3	No change
	Analiabari High School	Educational	24.37013	89.88501	60.3	66.1	**Increase**
	Talimul Islam Madrasha	Educational	24.39169	89.7142	66.0	69.3	**Increase**
	Jamuna Polytechnic Institute	Educational	24.39612	89.69189	64.6	67.6	**Increase**
	Shohidul Bulbul Karigori College	Educational	24.39864	89.65486	63.4	66.9	**Increase**
	Simanto Bazar	Bazar	24.41015	89.63028	67.0	73.6	**Increase**
	Rahbol Girls High School	Educational	25.05966	89.36947	63.4	68.3	Increase
	TMSS Health Complex	Health	25.08785	89.3807	61.8	73.3	Increase

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163. The noise analysis result using noise modeling software is given in Appendix G.

Photograph 7: Monitoring of Ambient Noise Level at Project Area

164. Permitted noise level in different area according to Bangladesh Noise Pollution (Control) Rules, 2006 is listed below in Table 22. The corresponding World Bank EHS guidelines is shown in Table 23. Except for the industrial area where World Bank's EHS guideline standard is 70 dBA during day time, most of the national standards are more stringent compared to World Bank's EHS guidelines.

Table 26: Bangladesh Standard for Noise Level at Different Types of Areas

Area Type	Noise Level (dBA)	
	Day	Night
Silent Zone	50	40
Residential Area	55	45
Mixed Area	60	50
Commercial Area	70	60
Industrial Area	75	70

Table 27: Bangladesh Standard for Noise Level at Different Types of Areas

Area Type	Bangladesh Standard Noise Level (dBA)		World Bank EHS Guidelines 1-hour L_{eq} (dBA)	
	Day (06:00-21:00)	Night (21:00-6:00)	Day (07:00-22:00)	Night (22:00-7:00)
Silent Zone	50	40	55	45
Residential Area	55	45	55	45
Mixed Area	60	50		
Commercial Area	70	60	70	70
Industrial Area	75	70	70	70

165. The field investigation is undertaken during December, 2022 again (Annex G) and compared to the Base line data and existing data which has no remarkable changes at all (Table 20-A). For few minimal changes are found with existing noise data and baseline, so that taking interventions such as set up Noise barrier, change the time schedule of construction according to the density of the location etc; to maintain standard noise level during the construction.

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166. Under this project the existing 2-lane roadways will be upgraded to a four-lane road with safety features that include the addition of a separate SMVT lane, flyovers at the busiest junctions, overpasses, Bus stops, pedestrian bridges and additional lanes at intersections. This will generate additional traffic and consequently alter the noisy environment along the route of the roadway. Canarina CUSTIC 3.2 software has been used for noise pollution modeling for the assessment of the noise pollution propagation generated from traffic. The CUSTIC Software allows us to create robust and useful numeric simulations that fully make use of the graphical user interface. The methodology and governing equations for noise modelling under the graphic user interface of CUSTIC 3.2 is described in Appendix G.

167. The noise simulation under different scenarios for the Elenga-Hatikamrul Road (Box 8-10 in figure 2 of Appendix G) is shown in Figure 11(a). Figure 11(b) provides a spatial noise intensity map of the segment. The analysis provides the baseline and predicted noise (for the year 2040) at different sensitive receptors identified along the route. It can be seen that:

a) The baseline noise at most of these receptors exceeds standards for residential areas mainly due to high level of human activities during daytime.
b) There will be an increase in ambient noise at most of the receptors identified alongthe route. It may be suggested in the mitigation plan that regular noise monitoringshould be conducted in these locations in future and proper mitigation measures should be devised (green-belt development) if required.

C. Biological Environment

168. Bangladesh was once well forested, but most of the native forests have disappeared in recent decades due to mounting pressure from human populations. Only scattered patches of native trees, wetlands and associated fauna habitat remain in isolated locations within the terrestrial environment (IUCN, 2002). In many parts of the country, the abundance of plantationsand groves of trees around villages creates an aspect of discontinuous forest (Wahab, 2008).

169. The floodplains of Bangladesh have long been subject to cultivation, the most dominant land use within the project area, with only scattered patches of native trees, wetlands and associated fauna habitat remaining in isolated locations within the terrestrial environment (IUCN, 2002).

1. Bio-ecological Zones

170. Within a relatively small geographic boundary, Bangladesh enjoys a diverse array of ecosystems. Being a low-lying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios of Bangladesh. Temperature, rainfall, physiographic variations in soil and different hydrological conditions play vital roles in the country's diverse ecosystems. The ecosystems of Bangladesh could be categorized into two major groups, i.e. (i) land based and (ii) aquatic. The land-based ecosystems include forest and hill ecosystems,a grow-ecosystems and homestead ecosystems; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine ecosystems fall into the aquatic category.

171. Each of the ecosystems has many sub-units with distinct characteristics as well. IUCN Bangladesh in 2002 classified the country into twenty-five bio-ecological zones (Figure 22). The project road alignment falls below the three bio-ecological zones.

- ***Teesta floodplain (4a):*** Teesta floodplain spreads over several different landscapes in

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greater Rangpur and the adjoining regions. The diversity results from the fact that the Teesta River had occupied and later abandoned several different channels during the last few thousand years including the valleys now areoccupied by the Mahananda, Punarnava, Atrai, Choto Jamuna, Karatoya and Ghaghat rivers. There were large patches of forests in this zone, but they have in most cases been ruthlessly cut down. However, this zone is still fairly wooded withmany valuable indigenous timber species. Although most of the large mammals have disappeared from this area but most of common bird species are still found in this location.

- ***The Brahmaputra-Jamuna floodplain (4c):*** The Brahmaputra floodplain situatedin greater Mymensingh and Dhaka districts comprises the active channel of the Brahmaputra River and the adjoining areas of the young floodplain lands formed since about 1780, when the river shifted to its present course (i.e., the Jamuna River) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided and consists of several interconnecting channels. This floodplainpossesses a unique variety of plants, medicinal herbs, fruit yielding trees, many jungle shrubs, creepers and climbers, flowering trees etc., many of which yield valuable products. Bushes of reeds and canes are also found here. The faunal diversity in this zone is also rich. Leopards were frequently sighted in this zone. Themost common poisonous snake is the Banded krait in this area, which could easilybe identified by its broad black and yellow bands (IUCN, 2002f).

- ***Major Rivers (11):*** Bangladesh consists mainly of riverine and deltaic deposits ofthree large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges and Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass (*Saccharum spontaneum* for example). Dense growth of catkin grass can accelerate silt deposition on chars. Jamuna River provide highest amount of char lands. Many of the species' natural distribution, migration and storage are primarily functioned via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowls are directly or ecologically dependent on these rivers and their associated ecosystems.However, it is quite alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction.

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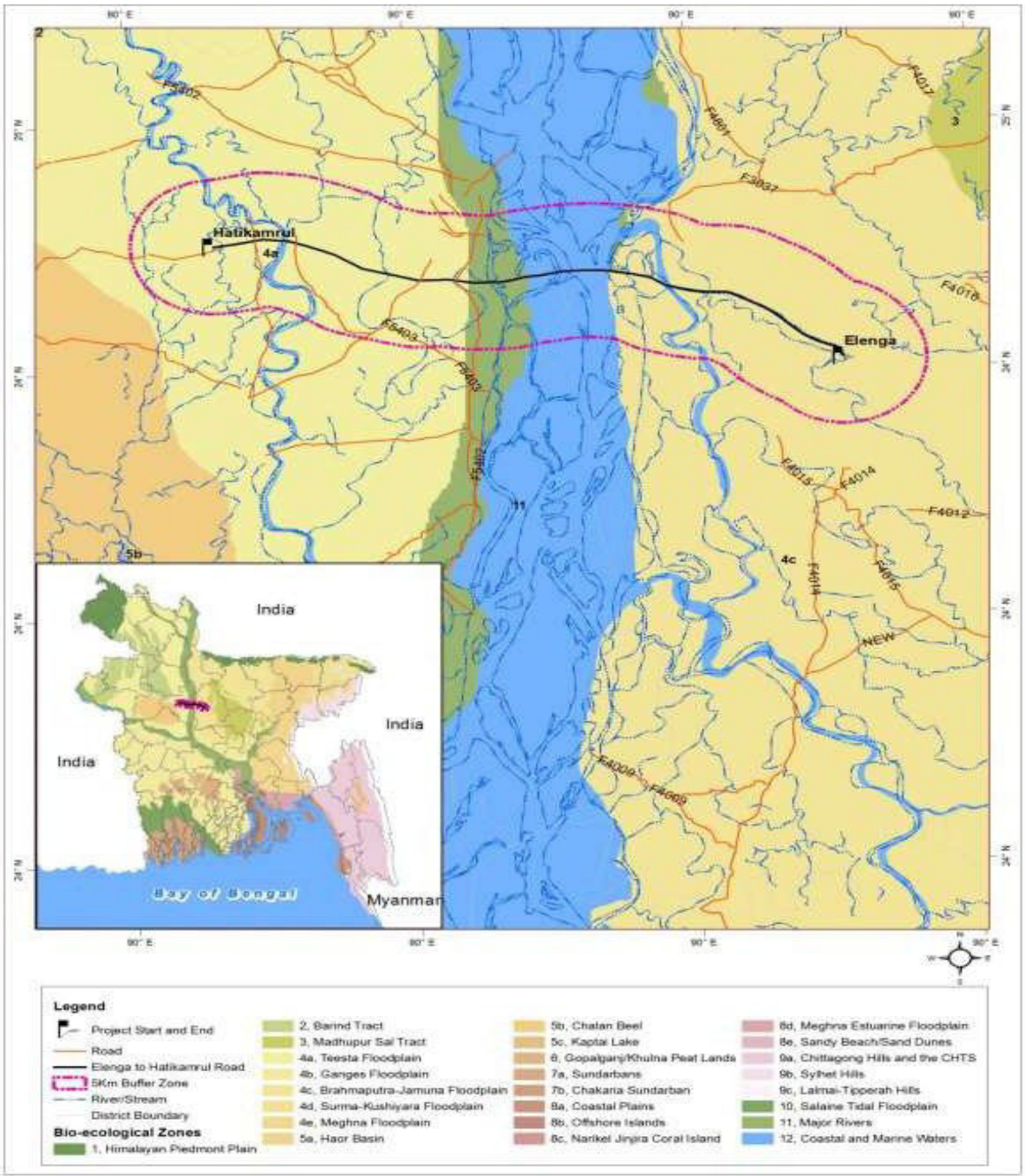
Figure 21: Bio-ecological Zones



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2. Diversity of Terrestrial Floral and Faunal Species

172. The prominence of terrestrial flora and faunas at the project area were assessed from visual observations, review of literature, and information documented by other agencies. The project area consists of several ecological subsystems e.g., open agricultural land, homesteads, and roadside vegetation. The open agriculture land ecosystem dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The vegetation covers of agricultural lands are different crop species, weeds, and otherherbaceous plants species. The faunal species in the agriculture land and roadside bushecosystems include birds, amphibians, fishes, snake's rodents and few mammals. The homesteadecosystem provides the main tree covered areas within the project site. The homesteads are covered by fruit, timber, fuel wood, medicinal plants, and various multipurpose tree species. The wildlife species in homestead ecosystem include the birds, amphibians, reptiles, rodents and mammals like mongoose, jackal, cats, monkey, etc. Many of the species including mammals arevulnerable or/and endangered in Bangladesh due to habitat loss, over exploitation, natural calamities and lacking management. The project area, including rivers where proposed bridgeswill be constructed, is not the specific habitat for any species of flora and fauna hence none such species will be specifically affected due to project implementation.

3. Terrestrial Flora

173. The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated in the surrounding mainly include rice, wheat, rabi crops and variety of homestead vegetables. A sizeable number of fruit trees with economic value have been observed in the PIA.The fruit trees include jackfruit, mangoes, litchi, banana, coconut, blackberry etc. and timber treesinclude mehegoni, neem, epil-epil, koroi etc. A considerable number of trees and bushes in the PIAsite provide habitat for birds and other animals. The composition of plant community includes lowgrowing grasses, trees, herbs, and shrubs. The data collected from the field survey suggests that the predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in Table 24.

174. According to the census and IOL survey done in February-March 2014, a total of 31,450 trees of different sizes[7] (large=3,432, medium= 7,318, small= 17,383 and saplings= 3,317) werefound standing within ROW (details in Appendix D) of the subproject's road alignment. Among the list of affected trees 876, 1288 and 29,286 trees were found on private land, Government land(other than RHD) and on the slopes of the road (RHD land) respectively. Among the affected trees, 25,647 trees are timber, 2,921 trees are fruit, 1,012 trees are medicinal, 658 trees are banana and 1,212

[7] **Large Tree:** A commonly found tree (except some particular species such as palm, dates, coconut, betel nut, guava,lemon, sharifa/sofeda, etc) with more than 4 feet of girth at the chest position has been classified as big tree. In case of fruit bearing trees (Mango, Jackfruit, Litchi, Black Berry, etc.) the girth size 3.5 feet and above are also considered as big category. In case of Palm, dates, coconut, betel nut, etc. 20 feet or above height is considered big. In case of guava, lemon, sharifa/sofeda, etc. the age of the trees and judgment of the surveyor and trees owners has been imposed to classify the size. More than 10 years of age of such species of trees has been categorized as large.
Medium Tree: Trees having 2-4 feet girth is classified as medium. In case of palm, dates, coconut, betel nut species, the height between 10-20 feet is medium and for guava, lemon, sharifa/sofeda, etc. the age of the trees between 5-10 years are classified as medium.
Small Tree: Three having less than 2 feet girth is classified as small, in case of palm, dates, coconut, betel nut species, the height between 5-10 feet is small and for guava, lemon, sharifa/sofeda, etc. the age of the trees between 2-5 years are classified as small
Sapling/plant: Tree planted for gardening or growing up is classified as sapling. The plant still in nursery or eligible for shifting is classified as seedling.

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trees are bamboo.

Photograph 8: View of Terrestrial Flora along the Elenga- Hatikamrul Road.

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Table 28: Common plants available in the subproject area

Common Name	Scientific Name	English Name	Family
Akashmoni	*Acacia auriculiformis*	Graps	Vaticeae
Akanda	*Calotropis procera*	Swallow wort	Asclepiadaceae
Ashok	*Saraca indica*	Ashoka	Caesalpinioideae
Am	*Mangifera indica*	Mango	Anacardiceae
Babla	*Acacia nilotica*	-	-
Bash	*Bambusa spp.*	Bamboo	Gramine
Kola	*Musa sapientum*	Banana	Musaceae
Boroi	*Zizyphus mauritiana*	Jujube	Rhamanaceae
Kamranga	*Averrhoa carambola*	Chinese Gooseberry	Averrhoaceae
Jambura	*Citrus grandis*	Shaddock	Citraceae
Olive	*Elaeocarpus robustus*	Olive plant	Elaeocarpaceae
Bot	*Ficus benghala nsis*	Banyan tree	Moraceae
Durba Ghas	Cynodon dactylon	Barmuda grass	Gramineae
Debdaru	*Polyalthia longifolia*	-	Annonaceae
Epil Epil	*Leucaena leucocephala*	Ipil ipil	Legominosae
Gheta Kumari	*Aloe indica*	Indian aloe	Liliaceae
Peyara	*Psidium guajava*	Guava	Myrtaceae
Helencha	*Alternanthera philoxeroides*	Jalabrahmi -	Amaranthaceae
Kathal	*Artocarpus heterophyllus*	Jackfruit	Moraceae
Koroi	*Samanea saman*	Rain tree	Leguminosae
Lajjabati	Mimosa pudica	Sensitive plant	Mimosoideae
Mehogoni	*Swietenia mahagoni*	Mahogany	Meliaceae
Papaya	Carica papaya	Papaw tree	Caricaceae
Tal	*Borasus flabellifer*	Palmyra palm	Palmae
Shimul	*Bombax ceiba*	Red Silk Cotton Tree	*Bombacaceae*
Kadom	*Anthocephalus chinensis*	Kadamba	*Rubiaceae*
Krishnochura	*Delonix regia*	Gulmohur	*Leguminosae*
Shishu	*Dalbergia sisoo*	-	-
Telakucha	*Coccinea cordifolia*	-	Cucurbitaceae
U-caliptas	*Eucalyptus citriodora*	River Red Gum Dehn	Myrtaceae
Ziga	*Lannea coromandelica*	Jiga	Anacardiaceae

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4. Terrestrial Fauna

175. The diversified habitat and ecosystem in the project area support various types of animalsas given in Table 23. Primary and secondary mode was adopted for identification of fauna. Mostof the birds are identified through direct observation rather than from people. Most of the Amphibians, Reptiles and Mammals were identified by using books and descriptions of the local people during the field survey. A total of 38 species were identified during field survey among them3 are Amphibian, 6 Reptilian, 24 Avian faunas and 5 Mammalian faunas. The list of these specieswith their vulnerability status is given in Table 25. Out of the species identified 2 are vulnerable. No endemic species are found in the project area.

Table 29: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name	Local Status	IUCN Status
Class: Amphibian				
Bufo melanostictus	Common Toad	Kuno bang	NO	Least concern
Rana temporalis	Bull Frog	Kola bang	NO	Near threatened
Rana pipiens	Grass Frog (Leopard frog)	Sona bang	NO	Least concern
Class: Reptilian				
Hemidactylus flaviviridis	Common House Lizard	Tiktiki	NO	Least concern
Calotes versicolor	Common Garden Lizard	Rokto-chosha	NO	Not yet classified
Varanus bengalensis	Bengal monitor	Gui shap	VU	Least concern
Xenochrophis piscator	Checkered keelback	Dhora shap	NO	Not yet classified
Enhydris enhydris	Common smooth water snake	Paina shap	NO	Least concern
Atretium schistosum	Olive keelback	Maitta shap	NO	Least concern
Class: Aves				
Phalacrocorax niger	Little cormorant	Paan-kowri	NO	Least concern
Ardeola grayii	Indian pond heron	Kani bok	NO	Least concern
Casmerodius albus	Great egret	Sada bok	NO	Least concern
Actitis hypoleucos	Common sandpiper	Kada Khocha	--	Least concern
Columba livia	Rock pigeon	Jalali Kobutar	NO	Least concern
Streptopelia chinensis	Spotted dove	Tila Ghughu	NO	Least concern
Psittacula krameri	Rose-ringed parakeet	Tia	NO	Least concern
Amaurornis phoenicurus	White-breasted waterhen	Dahuk	NO	Least concern
Eudynamys scolopacea	Asian cuckoo	Kokil	NO	Least concern
Tyto alba	Barn owl	Laxmi Pencha	NO	Least concern
Alcedo atthis	Common kingfisher	Choto Maachranga	NO	Least concern
Dinopium benghalense	Black-rumped flameback	Kaththokra	NO	Least concern
Oriolus xanthornus	Black-headed oriole	Holdey Pakhi	NO	Least concern
Corvus splendens	House crow	Pati Kak	NO	Least concern
Corvus marorhynchos	Jungle crow	Darn Kak	NO	Least concern

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Scientific Name	English Name	Local Name	Local Status	IUCN Status
Dicrurus macrocercus	Black drongo	Fingey	NO	Least concern
Copsychus saularis	Oriental magpie robin	Doel	NO	Least concern
Acridotheres ginginianus	Bank myna	Gang Shalik	NO	Least concern
Sturnus contra	Asian pied starling	Gobrey Shalik	NO	Least concern
Pycnonotus cafer	Red-vented bulbul	Bulbuli	NO	Least concern
Orthotomus sutorius	Common tailorbird	Tuntuni	NO	Least concern
Dicaeum. agile	Thick-billed Flowerpecker	Fuljuri	NO	Least concern
Passer domesticus	House sparrow	Charui	NO	Least concern
Ploceus philippinus	Baya weaver	Babui	NO	Least concern
Class: Mammalia				
Pteropus giganteus	Flying Fox	Badur	NO	Least concern
Herpestes auropunctatus	Small Indian Mongoose	Benji	NO	Least concern
Vulpes bengalensis	Bengal Fox	Khek shial	VU	Least concern
Rattus rattus	Common House Rat	Indur	NO	Least concern
Suncus murinus	House Shrew	Chicka	NO	Least concern

EN – Endangered, VU – Vulnerable, NO – Not Threatened

5. Diversity of Aquatic Flora and Fauna

176. **Aquatic Flora.** Different types of aquatic flora species are recorded in the project areas. The most abundant hydrophytes in the project area are Kochuripana (Eichhornia crassipes), Topapana (Pistia *stratiotes*), Khudipana (*Lemna minor*) Pata Jhajii (*Vallisneria spiralis*), Shapla (*Nymphaea sp*.), Kolmi (*Ipomoea aquatica*), Helenchaa (*Enhydra fluctuant*), and Duckweed (*Spiredella sp*.). Numerous algae (e.g., *Spirogyra and Scytonema*) and amphibian plant, Dhol kolmi (*Ipomoea fistulosa*) are also found in the roadside water bodies.

177. **Aquatic Fauna.** Fish is the most important aquatic fauna of the project areas, along with other groups. The aquatic fauna includes Prawns (*Macrobrachium spp*.), crabs, snails (*Pila, Vivipara, Lymna etc*.), freshwater mussels (*Lamellidens sp*.) etc. invertebrates and several species of fish. Kolabang (*Rana tigrina*); Guishap (*Varanus bengalensis*) and Matia sap (*Enhydrisenhydris*) are common. The aquatic birds are – Pancowri (*Phalacrocoraxcarto*), Kanibok(*Ardeolagrayii*), Sadabok (*Egrettagarzetta*), Borobok (*Egrettaalba*), Machranga (*Halcyon pileata*),Dahuk (*Gallicrexcinerea*), and winter migratory birds – Balihash (*Dendrocygna javanica*) and Chakha (*Tadorna ferruginea*).

178. **Fishes.** The fisheries in the project area comprise of ponds, canals, rivers, flood lands,Burrow pits, and Khals. The major fresh water fish species are the rui (*Labeo rohita*, LC[8]), katla (*Catla catla*, LC), mrigal (*Cirrhinus cirrhosis*), kalbashu (*Labeo calbasu*, LC); shoal (*Channa striata*), gajar (*Channa marulius,* EN[9]), taki (Channa *punctata*), pangash (*Pangasius pangasius*, EN), boal (*Wallago attu*, VU[10]), tengra (*Mystus tengara*, LC), aier (*Sperata aor*, VU), shing (*Heteropneustes fossilis,* LC), magur (*Clarias gariepinus*), baillya (*Awaous guamensis*, LC), chela (*Salmostoma acinaces*, LC), batashi (*Neotropius atherinoides*, LC), kahalisha (*Colisa fasciata*),

[8] LC= Least Concern
[9] EN= Endangered
[10] VU= Vulnerable

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puthi (*Puntius puntio*, DD[11]), kai (*Anabas testudineus*, LC), falli *(Notopterus notopterus,* VU), chital (*Chitala chitala*, EN), baim (*Mastacembelus armatus*), chanda (*Parambassis ranga*), etc.

179. Fresh water Crab is a common aquatic arthropod observed in most wetlands. Fresh water Crab is a common aquatic arthropod observed in most wetlands. No aquatic mammal like Dolphin was observed in the rivers (Jamuna and Fuljor) along the project road.

6. Biodiversity/Environmentally Sensitive Areas

180. Protected areas for biodiversity conservation in Bangladesh are based on three legislations: (i) Bangladesh Wildlife Preservation (amended) Act in 1973 (ii) Bangladesh Environment Conservation Act, 1995 (amended in 2002 and 2010) and (iii) Fish Act 1850 (amended in 1985).

181. Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened,and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings, this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatenedand are included in the appendices of Convention on International Trade in Endangered Species(CITES). Among the most endangered species are elephant, tiger, wild Cat, Leopard or wild goat,serao, dolphin; birds: white-winged duck, comb duck, stork, carne, pheasant, partridge, and crocodile, python, monitor, lizard, tiger terrapin, roofed turtle, soft turtle, and marine turtles.

182. In and around the project area some wildlife species were identified as locally vulnerable.The names of these vulnerable species is Bengal monitor and Bengal fox. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. The Chalan Beel is one of the biggest wildlife sanctuaries and are quite far from the project location and not within the 5 km buffer zone (Figure 24).

[11] DD= Data Deficient

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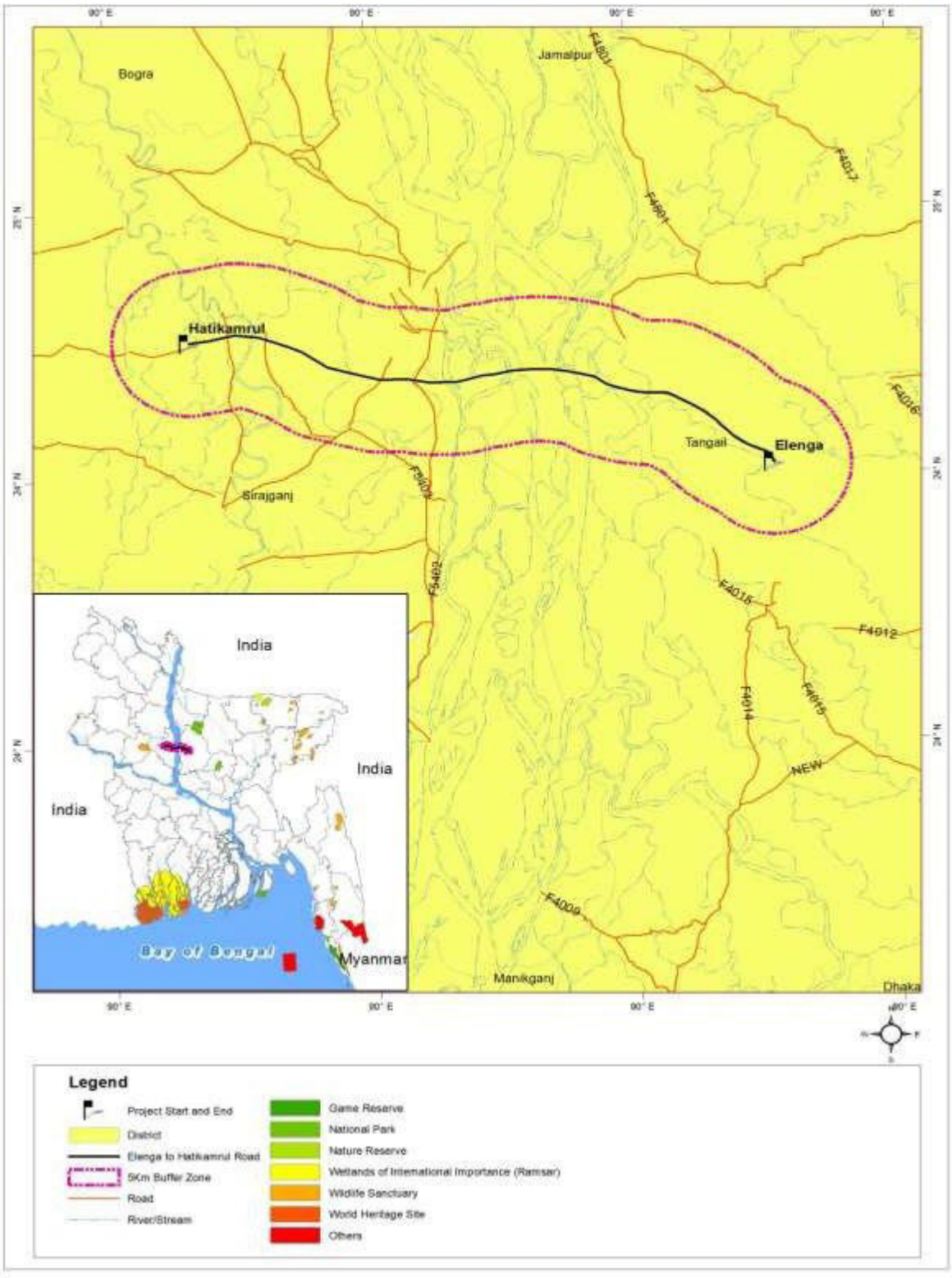

Figure 22: Environmental Protected Areas

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D. Socio-Economic Environment

183. Socioeconomics (also known as socioeconomics or social economics) is the social science that studies how economic activity affects social processes. In general, it analyzes how societies progress, stagnate, or regress because of their local or regional economy, or the globaleconomy. It is essential for every development project, whether small or large, to understand thesocial, human and economic aspects of the primary stakeholders, i.e., people living in and aroundthe project site. The following tools and techniques were used to collect the relevant data/information on the social and economic aspects of affected people:

- Literature review;
- Focus Group Discussion (FGD); and
- Informal meeting with various professionals.

184. In addition, data obtained from secondary sources were compared with the primary data/information gathered during the study.

185. Data on population, age/sex composition, household patterns, and sources of drinking water, sanitation facility, and ownership of agricultural land were enumerated from the latest community series census published by the Bangladesh Bureau of Statistics (BBS).

1. Demography

186. An overview of the socio-economic environment profile of Elenga-Hatikamrul area is presented below at the upazilas (sub divisional) basis in the region. The demographic informationis collated from Population Census, 2011. However, there are diverse religious group in this areawith several types of ethnic people, but the community is Muslim dominated. The demographic details are given in Table 26.

187. The road project alignment runs through two districts that cover five administrative Upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganj and Ullapara).

Table 30: Demographic Status in the Project Area

Upazilas Through	District	Total	Male	Female	Sex Ratio	Population density [sq. km]
Kalihati	Tangail	410,293	202,688	207,605	98	1,388
Sirajganj Sadar	Sirajganj	555,155	279,113	276,042	101	1,734
Kamarkhand	Sirajganj	138,645	68,411	70,234	97	1,527
Royganj	Sirajganj	317,666	158,604	159,062	100	1,223
Ullapara	Sirajganj	540,156	269,481	270,675	100	1,320

Source: Population Census, 2011

2. Settlement and Housing Pattern

188. The entire alignment runs through an open place. Agricultural lands are found on both sides of the road. However, there are some households and bazar take place. There are some large and small restaurants/refreshment centres situated in both sides of the RoW housing condition of the five upazilas (Kalihati, Sirajganj Sadar, Kamarkhand, Royganj and Ullapara) of the project is predominantly kutcha, semi pucca and pucca houses found in the semi-urban area.The average data about the main house of the dwelling households by type of structure shows that pucca and

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semi-pucca household structures remain higher in urban areas compared to the rural area and upazila. According to the resettlement, survey done in February-March 2014, a totalof 181,083 square feet primary structures[12] will be affected. Details of the housing structures by type in the project area have been given in Table 27.

Table 31: Type of Household Structure in the Project Area

Upazilas Through	District	Number of Households	Type of Structure (%)			
			Pucca	Semi-pucca	Kutcha	Jhupri
Kalihati	Tangail	97988	1.4	4.4	93.4	0.9
Sirajganj Sadar	Sirajganj	124852	4.1	14.0	80.9	1.0
Kamarkhand	Sirajganj	31920	1.2	11.3	86.4	1.1
Royganj	Sirajganj	77104	1.3	7.7	90.2	0.8
Ullapara	Sirajganj	123630	3.2	12.1	84.3	0.4

Source: Population Census, 2011

3. Land Use Patterns

189. Lands at the project area are used for agriculture, fisheries, agro-forestry, homestead, homestead forestry and vegetation, animal husbandry, etc. The areas through which the existing alignment passes are characterized by an agricultural ecosystem with very little of the natural ecosystem remaining. The most heavily vegetated areas along the alignment are the homestead areas where several species of trees of economic value are present.

190. The land use pattern along the alignment like other areas has traditionally been devised based on soil condition, relief, climate, hydrology and flood conditions, availability of resources, etc. The road alignment would impact the local land uses positively due to establishment of fast, safe, and convenient road linkages between the project command areas and small markets of rural areas.

191. Land use analysis is carried out along a five-kilometer buffer zone from centreline of the Elenga-Hatikamrul road using optical satellite imageries. Four land use classes i.e., agriculture; river, settlement and water body were found along Elenga-Hatikamrul section (Figure 4.16).

192. The below Table 28 shows the land use category and their area in 5km buffer zone from the centreline of Elenga-Hatikamrul road. The agricultural area is in the dominant position along the project road which is 63.72%. A significant portion covers the river area which is 12.59%. The settlement area covers 20.66% and water bodies covers 3.03% respectively.

Table 32: Land Use Category of Elenga-Hatikamrul Road Project Area

Category	Area (ha)	Area in %
Agricultural	248.570	29.590
Residential	131.102	15.606
Commercial	25.509	3.037
Industry	8.187	0.975
Brick Field	2.506	0.298

Structure used for residential (bed room, kitchen, store room, etc.) and commercial purposes or community interest those are measured in square feet/square meters.

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Playground	0.312	0.037
Road	61.195	7.285

Category	Area (ha)	Area in %
Road Island	0.401	0.048
Railway Line	9.180	1.093
Railway Station	0.438	0.052
River	73.173	8.711
Char	16.196	1.928
Vacant Land	68.848	8.196
Vegetation	101.499	12.082
Water body	92.939	11.063

4. Water Supply and Sanitation

193. Tube wells are the most common source of drinking water in both the semi-urban and rural areas. Tap water is not accessible in rural areas. Most households do not treat water prior to drinking. Sewage facilities are not available in most of the rural areas. The below Table 29 shows the sanitary facilities in the project area.

Table 33: Table 28: Sanitary Facilities in the Project Area

Upazilas Through	District	Number of Households	Toilet Facility (%)			
			Sanitary (water-sealed)	Sanitary (non- water-sealed)	Non-sanitary	None
Kalihati	Tangail	97988	19.5	49.2	26.0	5.3
Sirajganj Sadar	Sirajganj	124852	25.8	36.5	32.9	4.9
Kamarkhand	Sirajganj	31920	25.0	49.4	22.1	3.6
Royganj	Sirajganj	77104	15.3	46.5	28.8	9.3
Ullapara	Sirajganj	123630	17.1	50.7	29.2	3.0

Source: Population Census, 2011

194. According to the statistical data mentioned above it can be said that the sanitary facilitiesare better in the semi-urban areas than the rural areas. Particularly, in the Sirajganj Sadar and Kamarkhand area have better sanitary facilities than the other upazilas along the road alignment.

5. Transport and Communication

195. The existing highway is an important way of country's transport network which connects different parts of Bangladesh. The project road is connected with national highways, village roads,and railways in certain locations. The common types of transport are bus, truck, microbus, car, CNG, motorcycle, van and rickshaw. Mobile and wire telephone services are available in most ofthe areas. During the field survey, it is found that there are many roads crossing present in the Elenga-Hatikamrul road alignment which connects the adjacent villages to the highway. A list of the crossings is presented in the below Table 30 and Photograph.9 shows a dangerous road crossing.

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Photograph 9: Dangerous Road Crossing at Elenga-Hatikamrul Road

Table 34: List of Crossings along the Alignment

Sl. No.	Chainage (KM+M)	Name of Road	Type of Road
1	69+400	Bazar Khola to Bollat Pur	Pucca Road
2	71+270	Patakandi to Babla	Village Road
3	74+900	Anailla Bari to Anailla Bari	Earthen Road
4	77+675	Shalla Bazar to Narainda	Village Road
5	78+060	Golabari to Niklari Bari	Village Road
6	78+520	Nirhamjani Miya Para to Nirhamjani	Earthen Road
7	79+780	Potol to Nikrail Bazar	Village Road
8	94+070	Sirajganj to Belkuchi	Pucca Road
9	95+650	Sirajganj to Belkuchi	Pucca Road
10	97+300	Chala to Jawel	Village Road
11	100+190	Bondut Bazar to Pikosa Bazar	Pucca Road
12	102+200	Kamarkhanda to Dukuria	Pucca Road
13	103+700	Moddo Vodrogate to Shealkol	Village Road
14	105+800	Kamarkhanda to Nalka	Pucca Road
15	108+300	Borobar to Ratonkandi	Pucca Road

Source: Baseline Environmental Survey, May, 2013

E. Important Environmental and Social Features

196. The socio-cultural aspects include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, cremation yards, marketplaces, industrial structure, water bodies, etc., few of which would be affected directly and indirectly through implementation of both routes. Such sites could be termed as important environmental and social features (IESFs) in relation to project activities and, hence, need to be dealt with carefully duringthe construction phase. Locations of major IESFs along the road alignment are shown in Table 31.

197. There are no archaeological and historic sites in the RoW of the Elenga-Hatikamrul road project. Among the cultural sites, four mosques, one school, three filling stations and one mazar (shrine) fall within the RoW of the road alignment (Table 28). A list of the cultural and sensitive areas located within 500 m from the RoW boundary is presented in Table 31.

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Table 35: Locations of Important Environmental Components (IECs) along the Road Alignment

IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Mosque	97+700, 101+700, 106+600, 109+700	70+175, 77+390, 79+450, 97+800, 98+040, 98+650, 100+220, 103+720, 106+050, 109+950	100, 70, 40, 450, 450, 200, 100, 400, 420, 100	75+100, 77+350, 77+360, 79+490, 93+300, 93+500, 93+500, 97+800, 98+040, 102+200, 103+700, 103+950, 106+050, 106+980	150, 400, 400, 450, 150, 160, 150, 400, 400, 100, 400, 420, 200, 500
Cemeteries	-	100+850	450	92+110	200
School	108+200	74+800, 75+300, 79+450, 80+890, 99+500, 100+300, 106+060, 107+000, 107+950, 109+700	100, 35, 500, 70, 450, 450, 450, 200, 300, 350	69+800, 69+810, 77+340, 92+100, 92+200, 95+425, 97+320, 98+000, 106+980, 108+290, 108+320	400, 450, 500, 200, 300, 350, 120, 450, 500, 100, 150
College	-	79+450, 100+300, 106+060, 106+680	500, 250, 450, 150	70+750, 93+300, 94+200, 98+300, 98+300	220, 450, 150, 150, 150
Madrasa	-	77+370, 79+450, 100+850, 103+750, 104+550, 107+950	35, 500, 200, 400, 420, 300	70+450, 81+000, 94+100, 98+000, 102+200	450, 400, 300, 450, 500
Graveyard/Mazar (Muslim Shrine)	109+000 (Mazar)	72+130	30		
Eidgah	-	72+510	500		
Filling Station	106+800, 109+700, 109+400				
Gas Valve Station	-			81+900, 90+800, 106+100	45, 40, 80
Network Tower	-	69+430, 69+435, 69+780, 77+790, 79+510, 80+720, 95+640, 104+550	120, 50, 150, 150, 250, 50, 100, 60	69+780, 71+930, 72+100, 82+700, 107+940, 108+580, 110+145, 110+150	400, 300, 150, 200, 90, 50, 65, 70
Brickfield	-	100+400	500	101+350, 108+450, 108+900, 109+600	200, 400, 150, 150

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IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
Wooden Garden	70+290, 70+950, 98+600, 100+520, 102+960, 103+800	70+090, 70+100, 70+380, 78+580, 80+695, 94+300, 94+600, 94+750, 95+590, 100+380, 101+400, 105+500, 108+800	150, 100, 30, 40, 70, 80, 40, 50, 40, 150, 50, 100, 100	98+950, 100+350, 107+660	180, 30, 100
Hut/Bazar	69+300-70+000				
Hospital	-	95+490	50		
Road Crossing	69+400, 71+270, 74+900, 77+675, 78+060, 78+520, 79+780, 94+070, 95+650, 97+300, 97+670, 100+190, 102+200, 103+700, 105+800, 108+300				

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Pond		70+580, 96+050, 103+870, 107+500, 108+900	30, 40, 150, 20, 200	69+750, 70+940, 70+970 – 71+400, 71+800 – 72+080, 72+120 – 72+800, 72+820 – 73+500, 73+510 – 74+200, 74+210 – 74+900, 74+910 – 75+100, 75+300 – 75+600, 75+620 – 76+300, 76+310 – 77+000, 77+010 – 77+700, 77+710 – 78+300, 78+400 – 78+750, 79+110 – 79+500, 91+900 – 92+350, 94+200, 94+210 – 94+600, 95+430 – 95+700, 95+750 – 96+050, 96+100 – 96+920, 97+750 – 98+000,	30, 50, 60, 50, 60, 55, 60, 60, 50, 50, 55, 60, 60, 60, 50, 50, 150, 75, 75, 100, 70, 70, 50, 50, 50,

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IECs	Within RoW	From RoW boundary upto 500 m PIA on each side			
		Chainages (km) Right	Distance from Alignment (m)	Chainages (km) Left	Distance from Alignment (m)
				100+700–101+300, 102+985, 103+940-104+200, 104+330, 104+550 – 105+100, 105+200 – 105+650, 107+500, 108+310, 108+650	150, 50, 50, 40, 150, 80, 30
Beel	98+300, 105+850, 98+300, 105+850			92+800	120
Canal	72+100, 77+700, 99+500				
Khal	-	92+800	120		
River	106+305-106-540, 95+425				
Source: Baseline Environmental Survey, May 2013; and Census and IOL Survey February-March 2014					

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Photograph 10: Photographs of IECs along the Elenga-Hatikamrul Road.

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V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. General

198. The current environmental assessment is based on the potential sensitive issues and impacts identified during site visits, consultation with local administrations, and the public. This section identifies the overall impacts on the physical, biological, and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering the present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities of both the project are classified as:

(i) impacts during construction phase and
(ii) impacts during operation phase.

199. Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate, and major.

200. The important impacts related to the project have been discussed in the following sections according to the different phases of project implementation. Adequate mitigation measures are devised to mitigate/minimize all likely environmental impacts and the same have been presented along with the impacts.

1. Project Corridor

201. The Project corridor is delineated based on two criteria: right of way (RoW); which the RHD is legally entitled to, and Corridor of Impact (CoI), i.e., the width of the corridor that will be impacted, directly or indirectly, by the proposed project during the construction and operational phases.

2. Project Right of Way (RoW)

202. The proposed project corridor will have a well-defined RoW that will be 50 meters (164 ft) for the entire length of the highway. Major construction works will generally remain confined within the RoW. All the infrastructure and commercial activities within the existing or proposed RoW need to be relocated as they will have a direct impact of the project.

3. Corridor of Impact (CoI)

203. The Corridor of the proposed Impact (CoI) was delineated as the extent, which has director indirect impact of project. Direct impacts of the project are relocation of houses, utilities and air and noise pollution impact on workers during construction. All direct impacts are constrained within the RoW. Indirect impacts, caused by noise, dust emissions, camp sites and borrow sites could be beyond the RoW. The direct CoI of the surface water bodies will be confined within the RoW of the proposed project and will be temporary only for the construction period.

204. According to the Department of Environment (DoE) guidelines, the project impact area is divided into two sections. One, those related to the project which is 50m for the project. Another section is those related to the background environmental features of the project site. This should cover not only the project site in proper, but generally an area of 5km radius around the site. In this

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project 500m from the RoWs have been considered as core impact zone and 5km as buffer zone for better understanding.

4. Evaluation of Significant Impacts

205. As is the case for most development projects, potential negative impacts sometimes couldbe far more numerous than beneficial impacts. Whereas the anticipated negative impacts could be dealt with through carefully selected and undertaken efficient mitigation measures and good management practices, beneficial impacts could still be augmented through mobilizing and strengthening the realization about the positive outcomes of the project among all the stakeholders and project officials as well as contractors performing works related to various stages of implementation. It is generally expected that the long-term benefits of any developmentintervention will ultimately trickle down for the benefit of the local population and make contributions toward improvement of life quality.

i. **Intensity of the effect:** The intensity of the effect refers to the level of disruptionto the component. Three levels have been defined:
   1) Low: Little change in the characteristics of the component. Difficult to quantify;
   2) Average: Change in certain characteristics of the component. The change may be quantifiable;
   3) High: Change in all or in the main characteristics of the component. The change is quantifiable

ii. **Duration of the effect:** Duration means the time dimension of the effect. The terms permanent, temporary and short are used to describe the period of time:
   4) Short-lived: the effect disappears promptly;
   5) Temporary: the effect is felt during one project activity or, at most, throughout implementation of the project;
   6) Permanent: the effect has repercussions for the life of the infrastructure.

iii. **Scope of the effect:** The scope describes the spatial dimension of the effect caused by an action in the environment. It refers to the distance or area covered by the disruption. The terms regional, local and limited are used to describe the scope:
   7) Limited: the scope is limited when the action affects only one environmental element located near the project;
   8) Local: the scope is local when the action affects the study area;
   9) Regional: the scope is regional when the action affects areas beyond the study area

iv. **Assessment of the potential effect:** These three parameters are incorporated into a multi-criteria matrix, making it possible to place the potential effect into one of three categories:
   10) Major (MAJ): signifies an effect that is permanent and that affects the integrity, diversity and sustainability of the element. Such an effect substantially or irremediably alters the quality of the environment.
   11) Medium (MED): signifies a perceptible, temporary and/or low-return effect that has little impact on the environmental component and is not irreversible. Such an effect is short-lived and/or limited in scope.
   12) Minor (MIN): signifies that the effect is non-existent or virtually non-existent, that it does not affect the environmental component in any observable or Quantifiable way and that it is related to a randomly occurring natural effect. As a rule, this would be a short-lived effect, limited in scope.

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Intensity	Duration / Scope	Short-lived	Temporary	Permanent
Low	Limited	MIN	MIN	MED
	Local	MIN	MIN	MED
	Regional	MIN	MED	MAJ
Average	Limited	MIN	MED	MED
	Local	MED	MED	MAJ
	Regional	MED	MAJ	MAJ
High	Limited	MED	MAJ	MAJ
	Local	MED	MAJ	MAJ
	Regional	MAJ	MAJ	MAJ

206. The potential impacts due to implementation of the Elenga-Hatikamrul road project are identified by using the above Leopold Matrix for environmental assessment by project implementation stages. In this developed checklist, actions, which may affect the various Important Environmental Components (IECs) pertaining to the areas adjacent to the alignment during the various stages of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms Major, Medium and Minimum are used in the checklists to evaluate the magnitude of SEIs. In the checklist, each of the pre-construction, construction and operational phases of the Elenga-Hatikamrul road are considered separately inorder to distinguish the short term and long-term impacts as well as reversibility and irreversibilityof impacts in terms of their duration.

207. Identification and evaluation of potential/significant impacts due to project location, site preparation, construction and operation at the project has been done using the 'Impact Matrix' by identifying all stages of activities (pre-construction to operation and maintenance) and assessingthe potential impact of each operation upon individual environmental components.

208. As can be observed from the checklist in Table 32, major environmental components, which will be adversely affected by activities related to the project, are: air quality, noise hazard, loss of trees, accidental risk, hydrology/drainage and occupational health and safety and socio- economic environment. It should be noted that the environmental factors indicated in the table relate to the changeability or un-changeability of the existing situations due to interventions of theproject and significant level of impact without mitigation of negative impacts.

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Table 36: Evaluation of Significant Impact Using Leopold Matrix

Environment	Envisaged Impact Factors	Project Activities																			
		Pre-Construction				Construction								Post-Construction						Operation	
		Site Mobilization	Construction of Temporary	Maintenance of Traffic	Utility Shifting	Existing Pavement Stripping	Soil Stripping	Excavation/ Earthworks	Pavement Construction	Bridge Construction	Management of Wastes	Transportation	Equipment and Machineries	Deconstruction ofStructures	Demobilization ofWorksite	Demobilization ofBridge Site	Management of Wastes	Transportation	Equipment and Machineries	Presence of Road	Maintenance & Repair
Physical	Climate																				
	Physiography							MIN													
	Topography		MIN	MIN	MIN		MIN	MIN	MIN		MIN		MIN	MIN							
	Geology																				
	Seismicity																				
	Soil		MIN	MIN	MIN	MIN	MED	MIN	MIN		MIN			MIN			MIN			MIN	MIN
	Surface Water		MIN	MIN	MIN		MED	MIN	MIN	MED	MIN		MIN			MIN	MIN			MIN	MIN
	Groundwater										MIN										
	Air Quality		MIN	MIN		MED	MED	MAJ	MED	MIN	MIN	MED	MIN	MIN	MIN		MIN	MIN	MIN		MIN
	Noise		MIN	MIN		MED	MED	MED	MED	MED		MED	MIN	MIN	MIN		MIN	MIN	MIN		MIN
Biological	Bio-ecological Zones																				
	Terrestrial Flora		MIN		MIN		MIN	MED													
	Terrestrial Fauna		MIN		MIN		MIN	MED				MED									
	Aquatic Flora		MIN		MIN		MIN	MIN		MED						MIN					MIN
	Aquatic Fauna		MIN		MIN		MIN	MIN		MED						MIN					MIN
	Fishes		MIN		MIN		MIN	MIN		MED						MIN					
	Biodiversity/Environmentally Sensitive Area																				
Socio-economic	Demography	MIN																		MED	
	Settlement & Housing Pattern		MIN		MIN															MED	
	Land Use Patterns		MIN						MIN											MED	
	Water Supply and Sanitation				MED									MIN	MIN					MED	MIN
	Transport and Communication					MED		MED	MED	MED		MED	MED		MIN			MIN		MED	

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B. Climate Change

Impact Due to Changes in Climatic Condition

209. Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are vulnerable to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events.

210. Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. It is a normal part of the Earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. However, the term "Climate Change" is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "*A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*" (IPCC, 2007). The risks associated with these changes are real but highly uncertain.

211. Bangladesh is recognized worldwide as one of the most vulnerable countries to the impacts of climate change. This is due to its unique geographic location, dominance of floodplains,low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources, and services. The country has a history of extreme climaticevents claiming millions of lives and destroying past development gains. The people and social system have knowledge and experience of coping with the effects of such events–to some degreeand extent. Historically, Bangladesh is trying to adapt with the changing environment. The Intergovernment Panel on Climate Change (IPCC) has identified the country as one of the most vulnerable countries to climate change, which may severely affect lives and livelihoods of millionsof Bangladeshi people in coming decades. In this regard, Bangladesh has already prepared the National Adaptation Programme on Action (NAPA) and Climate Change Strategy and Action Plan(MoEF, 2005 and MoEF, 2009).

212. According to the fourth assessment report of IPCC, continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century, which would very likely be more severe than those observed during the 20th century would.

213. The climate change impacts are described for the following two aspects:

- Likely changes in the climatic conditions with respect to temperature, flooding, and drainage aspects.
- Greenhouse gas emission reduction.

Estimation of Changes in Climate Parameters

214. Global changes in climate also have impacts on regional basis. The climatic parameters of Bangladesh are also changing along with the global climate change. The increasing trend of temperature shows that it will increase 1.3°C by the 2050s while rainfall will increase by 8%. The maximum estimated change in temperature for Dhaka, Rajshahi and Barisal divisions are 2°C, 2.14°C and 1.72°C respectively in 2050s. These possible changes should be considered in road

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design as the Elenga-Hatikamrul road travels through Dhaka and Rajshahi division. The rainfall might increase by more than 30% in Dhaka division. Additional drainage capacity might be required for the proposed road in this regard (IEE, 2011).

Climate Change Impacts on Flooding

215. **Impact.** Future flood damages will depend heavily on settlement patterns, land-use decisions, the quality of flood forecasting, warning and response systems, and the value of structures and other property located in vulnerable areas as well as on climatic changes per se. The secondary impacts of climate change are not only in magnitude but also in frequency. For example, there are chances of not only increasing flood water levels but also reduction of floodreturn periods. This indicates that a 20-year return period flood might become a 15- year return period flood under climate change scenarios.

216. **Mitigation.** Additional road embankment height to incorporate climate change induced flooding is required in road design. As the roads are designed mainly based on 20-year return period, suggested additional heights should be applied over the design road heights for 20-year return period (not the existing road levels) including freeboard and other additional components.Due to climate change the river water level will rise and as a result the bridge clearances will be lower. So, the bridge height also needs to be increased. The bridges in the proposed roads are designed for a 1 in 50-year return period. Consequently, the additional height requirements for bridges and road embankment are presented in Table 33.

Table 37: Additional Height Requirement

Road Section	Additional Height Requirement (cm)	
	Road Embankment	Bridges
Hatikumrul-Tangail	36.80	35.70

Source: IEE, JCTE-, 2011

***These values do not include the additional safety factor (1.5). The designers should decide whether to consider that or not.*

1. Climate Change Impacts on Drainage

217. **Impact.** The future trans-boundary inflows of the three major rivers (Ganges, Brahmaputra,and Meghna) during the monsoon period indicate that inflows into Bangladesh are on average projected to increase over the monsoon period (driven primarily from increased basin precipitation). Because of increased discharges, the drainage structures throughout the roads have to drain much more water under climate change scenario.

218. **Mitigation.** There are 15 bridges and 27 culverts on the Elenga-Hatikamrul road. One ofthe bridges is over 100m in length and is located on the Fuljor River. The rest of the structures are mostly across undefined channels and carry only seasonal flow. Many bridges are located over depressions and low-lying ditches. Culverts are located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels on either side of the road embankment.

219. The Elenga-Hatikamrul road area might have to drain 20% additional discharge due to climate change induced higher rainfall during extreme events. Therefore, adequate numbers of drainage facilities along with larger openings should be considered in designing the structures forthe proposed roads (IEE, 2011).

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Greenhouse Gas (GHG) Emission

220. **Impact.** GHG emissions likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)[13] developed by Clean Air Asia[14]. TEEMP was utilized to assess the CO_2 gross emissions with and without the project improvements. Total CO_2 emissions at business-as-usual, with-project (excluding construction emissions) and with project (including construction emissions) scenarios wereestimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. This is above the significant threshold of 100,000 tons of CO_2 equivalent per year. ADB requires the borrower (the Government of Bangladesh through the Roads and Highways Department) to evaluate feasible and cost-effective options to reduce or offset project related greenhouse gas emissions.

221. **Mitigation.** As the SPS 2009 recommends the borrower to promote the reduction of project-related anthropogenic greenhouse gas emissions appropriate to the nature and scale of project operations and impacts, some of the recommended GHG reduction measures that can beundertaken under the project include: (i) implementation of manufacturer recommended engine maintenance programs; (ii) replacement of less fuel efficient vehicles; (iii) conversion of high-use vehicles to cleaner fuels, where feasible; (iv) installation and maintenance of emissions control devices (e.g., catalytic converter); (v) implementing regular vehicle maintenance and repair program (vi) driver training on driving practices that reduce accident risks and fuel consumption; (vii) enhance the tree planting program

C. Pre -construction Phase

1. Topography

222. Following is the brief description of impacts envisaged during the Pre-construction/ Design Phase:

223. **Impact.** With the construction of the project, the topography of project areas has not been affected significantly other than from excavations for borrow pits. Borrow pits have been selected carefully to avoid spoilage of agricultural land. The topography in the project area has been changed to some extent because of construction of the proposed project related structures such as embankments, bridges, flyovers, interchanges etc. Visual changes to the topography would be permanent and minor negative in nature.

224. **Mitigation.** As recommended, all requisites borrow pits are selected outside the RoW or in uncultivated areas or private land with concurrence and agreed borrow bit rehabilitation plan with landowners. Visual changes to the topography will be permanent but slightly adverse in nature and need no mitigation measures except that the project design should consider aesthetic concerns.

2. Removal of Trees

225. **Impact.** The project implementation activities, at different locations, involved trees and vegetation clearing for the up gradation, widening and geometric improvement of the project road. According to the census and IOL survey a total of 31,450 trees of different sizes (large=3,432,

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

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

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medium= 7,318, small= 17,383 and saplings= 3,317) (details in Appendix D)will be directly affected being located within ROW.

226. **Mitigation.** All efforts have been made to minimize the tree cutting by selecting road-widening option based on technical consideration. There have been consultations with the public and NGOs prior to cutting old trees.

227. RHD has been responsible for the compensatory tree planting program by forming an 'Environmental and Social Team' in coordination with the Forest Department (FD). The tree cutting programme started when RHD received required permission from Forest Department. RHD informed the Upazilla Forest Officer regarding tree cutting and the compensatory tree plantation programme. The respective Forest Officers encouraged the local community (especially women) to participate in this programme. RHD's compensatory planting will be in rows as per theprescription of FD e.g., two tree seedlings to be planted for each tree felled, after the project construction activities are completed. This ratio may be more in the case of social forestry trees as per any mutual understanding arrived with tree owners before cutting the social trees. These trees shall be planted primarily along the road within RoW. The social forestry can be planted on thearea allocated by local authorities. A minimum of 62,900 saplings shall be planted following tree plantation plan (**Appendix J**) on the slopes of the road, on the boundary of physical cultural sites and on the suitable locations in the subproject area. Permission from the Forest Department will also have to be sought to cut trees from the roadside or along the water courses within the RoW. Planting should be done as soon as the construction of the road is completed. Maintenance is the key to the establishment of the plantation. Regular monitoring of plantations should be carried out by the executing agency.

228. The suitable trees for planting, among others, on homestead platforms are am (*Mangifera indica*), jam (*Syzigium cumini*), kul (*ziziphus spp*.), litchi (*Litchi chinensis*), jambura (*Citrus grandis*) amra (*Spondias pinnata*), kathal, (*Artocarpus heterophyllus*), jalpai (*Elaeocarpus floribundus*), and guava (*Psidium guajava*), Many of these species are multipurpose tree species(MPTS) with timber fruit and fuel wood potentials.

229. The compact plantation shall be effective live screens against night glare, dust, noise and pollutant emissions. These vegetated strips shall develop into a complete ecosystem. Floweringand fruiting shrubs can be planted along the road to beautify the landscape. Planting should however be done keeping in view the principles of landscape design.

3. Land Acquisition

230. **Impact.** One of the major projects related impact is the land acquisition for Project RoW that will result in causing disturbance to the affected residents of the project area. The project activity involves widening of roads. The required RoW of 50m is available with RHD almost alongthe entire road length and proposed bridges and flyover locations. The total land acquired is 8.87 ha of which 5.47 ha (61.7%) is crop land, 1.17 ha (13.20%) is commercial land, 0.81 ha (9.12%) is fallow land, and 0.51 ha (5.79%) is homestead. Most of the land acquired is cropland, commercial, fallow and homestead land.

231. The construction activity for road widening and bridge/flyovers construction has temporarily changed the land use for use of construction site, access road, and construction camp. Due to these interventions, agricultural, seasonal wetland areas and social forestry tree around these areas may get affected adversely.

232. **Mitigation.** This impact related to land acquisition would be permanent and majornegative in nature. The mitigation measures include:

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- Careful alignment and route selection by the designer to minimize the impacts byavoiding the important environmental components, settlements etc.
- As far as possible the proposed alignment follows the existing alignment, withconcentric widening.
- The land acquisition is restricted to the bare minimum required.
- Provision of protection works like retaining/toe wall to confine the embankment within RoW /minimizing the width to be acquires.
- Developing proper judicious compensation package for affecters and giving compensation amount before the affecters shifting.

4. Loss of Structures (Dwellings, Commercial Buildings and IndustrialStructures)

233. **Impact.** To implement the Elenga-Hatikamrul roadway, 181,083 square feet primary structures (as described in section 4.4.2) has been affected and structures to be resettled from the project alignment. Few homesteads are acquired throughout the road alignment. There are some other rural and urban markets and shops along the alignment which are also relocated for the implementation of the project.

234. **Mitigation.** The mitigation measures include:

- Resettlement Specialists have calculated the amount needed to compensatefor the loss of land, house, trees, structures, crops, wage income, etc.
- To ensure similar or better living conditions for project affected persons (PAPs) forthe limited period of time their livelihood may be interrupted.

5. Educational Institution, Religious Structure, Culturally Sensitive Structures

235. **Impact.** According to the DOE guideline, the Project Influence Area (PIA) has to be 5 km radius of the development of the project activities. The PIA for the project alignment of road project was confined within a radius of 0.5 km from the alignment of the development since the nature of the project is such that most of the potential impacts are likely to occur within this area.However, there are some educational, religious, and cultural aspects that were investigated in the PIAthat directly and indirectly affected from the project activities (Refer to Table 4.20).

236. **Mitigation.** The project implementation should take into consideration construction of the alignment or making provision of allocating alternative land and financial resources (for rehabilitation of the Madrasah, Mosque and the educational institution falling within the alignment). As alignment is chosen, provision should be made of, at least, two rows of trees along the ROWs of the alignment and suitable noise barriers to absorb the noise and vibration to be caused by vehicle movement.

6. Public Utility

237. **Impact.** Due to the proposed project, public utilities have been affected creating disruption of public services and inconvenience to the local residents. This impact is temporary and may be considered as moderately negative in nature.

238. **Mitigation.** Mitigation measures include:

- Provision in the design and budget for the relocation of the existing utility infrastructures wherever required; and

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- All public utilities (e.g., gas pipes, power/ telephone lines likely to be affected by the proposed highway will be relocated well ahead of time before the actual commencement of the construction work.

7. Consents, Permits, NOCs, Clearances

239. **Impacts.** Without permission, the project cannot be implemented. Failure to obtain necessary consents, permits, and other appropriate regulatory clearances can result to design revisions and work stoppage.

240. **Mitigation.** All the necessary consents, permits, and clearances require to be obtained before the start of civil works and acknowledge in writing and provide report on compliance all obtained permits, clearance, NOCs, etc. Permissions and clearances might be required from the following government agencies and departments:

- Department of Environment;
- Forest Department;
- Respective DC Offices;
- Bangladesh Railway (BR);
- Bangladesh Inland Water Transport Authority (BIWTA) etc.

D. Construction Phase

241. Environmental effects of the construction phase are expected to be temporary. Construction impacts are minimal as all the construction works have been carried out within the site boundary of the acquired land and are being controlled via the mitigation measuresdefined in the EMP section. Following is the brief description of impacts envisaged during the construction phase:

1. Change in Hydrologic Regime

242. **Impact.** No major impacts are expected on hydrological aspects of the river due to bridge constructions. However, river hydrological, morphological, and ecological aspects have direct bearing on bridge location selection. All the new bridges shall be constructed at the same existing locations.

243. Mostly dredged material that has been involved have its impact in terms of localised sedimentation level increase and dispersion of pollutants present in the dredged material in the river water.

244. The proposed project area is in flood prone areas at some places but the project activities are to development of existing road alignment therefore, no major changes in hydrological regimewill occur. However, the road alignment crosses the Fuljor River, but the crossing willbe carried out by new bridge at the existing bridge location therefore no change in water flow pattern is likely to be caused. The major bridges (>100) will be constructed beside the existing bridges.Moreover, the water flow of these rivers is not vigorous but most of them are remain dry during dry season. Thus, the hydrologist does not suggest a separate morphological study for these rivers due to bridge construction. From the environmental perspective, it is also realized that the morphological study is not essential as there will be no changes in river hydrology due to bridge construction. For the crossing of canals and drains small bridges will be constructed. For the crossing of water courses, culverts and other possible arrangements are being done. Running off from storage of construction material near water bodies, or uncontrolled disposal may cause temporary drainage congestion, especially near the locations of small bridges, culverts, service areas, and construction sites.

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245. **Mitigation.** Possible impacts are temporary and minor negative, however followingmitigation measures have been incorporated:

- Proper design of bridges on the rivers and canals to accommodate design flows;
- Small bridges are constructed on canals and drains coming in the RoW;
- Provision of box culverts to control flood damages and provision of safety of embankments;
- Provision of sufficient sizes of drains to take design flows;
- Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed off in a controlled manner;
- The dredged material from the riverbank shall be tested for presence for heavy metals and other pollutants before its use.

2. Drainage Congestion & Flood

246. **Impact.** Run off from storage of construction material near water bodies, or uncontrolled disposal may cause temporary drainage congestion, especially near the locations of small bridges, culverts, service areas, and construction sites. Project design has made provisions of many lesser bridges and culverts. Hence, no significant impact is anticipated on these waterbodies during this phase. Stockpiling of fill materials dredged from the riverbeds for constructionof the embankment may result in erosion and subsequent deposition in the adjacent crop fields. Thehydrological impacts of the project are primarily limited due to faster post monsoon drainage caused due to faster fall of water level in the drainage channels following the monsoon season.

247. The project area is prone to flood. The average flood return period for the project area is 2.33 years. The road stretches are likely to be threatened due to flood, increase with increase in the return period. As per assessment and considering the existing road levels some parts of the road stretch is likely to be affected by flood respectively.

248. **Mitigation.** Construction is carefully planned to minimize drainage congestion.Waste should not be disposed near any water body. All waste depending on its characteristics,should be disposed of in a controlled manner. Adequate cross drainage structure is providedto easily drain off water to canals and other lowland areas. Drainage works can also be designedwith the provision of lower volume of water to drain in other low-lying areas, but the regulators areto be provided in such cases to permit controlled drainage rates and the consequent water levels.The road elevation level in the project area should be designed considering the flood threat levels. Provision of 1m free board is proposed.

3. Soil Erosion and Siltation

249. **Impact.** Soil erosion is observed at various locations of the road. Soil erosion levels depend on various factors like slope of an area, geological structure, soil type, and climatic variation. During the construction phase, some trees, shrubs, and grasses have been cleared and existing road pavement are removed. This may have created localized soil erosion problems during the rains.

250. The potential risk of river or water bodies' erosion increases after implementation of theproject road if the bridge crossings are provided with waterway width less than the regime width of the water bodies. The portion of the road that is in contact with river has been provided with slopeprotection measures. The bank erosion in certain sections of the project in contact with the riversis mild to minimal. The project is not expected to worsen the erosion risk particularly in areas where soil and

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topography are less vulnerable to erosion.

251. **Mitigation.** The following mitigation measures are proposed to alleviate or avoid potential impacts:

- Adopt good engineering & construction practices particularly at above identified locations.
- The road embankments and road cuttings shall be vegetated with a fast-growing crop and a native seed mix immediately after fill placement to prevent scour and to encourage stabilization. Use of stone pitching or riprap shall be made at appropriate places especially around overpasses, bridges, culverts.
- Based on morphological consideration provide adequate bank protection and structures.
- The erosion tendency increases at waterlogged areas as well. Adequate drain and slope protection measures shall be applied at such locations, specially as identified above.
- Spraying of water over the roadbed from time to time and use of geo-grids on a layer-by-layer basis for better bonding in the pavement structure must be carried out to resist erosion.
- Particular attention needs to be taken while designing the bridge, which will be provided for the regime waterway width without narrowing the natural channel width. The portion of the highway that is in contact with rivers, channel and canal will be provided with slope protection measures.

4. Soil compaction and contamination

252. **Impact.** Due to construction of the proposed project, soil contamination may take place around borrow pits, road cuttings, embankments, construction camps, workshop areas, equipment washing yards, asphalt plants, batching plants, fuel and chemical storage areas, etc. Soil contamination may affect the road stability in worst cases and may reduce the economic productivity of land and biodiversity in the project area.

253. During transportation of machines and materials, the cultivable lands beyond the proposed ROW may get compacted due to movement of vehicle and construction equipment, setting up construction camps, resulting in reduction in agriculture yield. Dumping of construction debris on fields adjoining the acquired areas may lead to impairment of soil for agriculture, especially when the nearby areas alignment is largely agricultural. Parking of vehicles by the side of roads also leads to soil compaction and may spoil the soil characteristics necessary for cultivation. Soilin the project area may also get contaminated particularly from the bituminous wastes, spillage ofoil and grease, mixing with construction materials, at the construction sites. The impacts of soil contamination would be temporary and moderate negative.

254. **Mitigation.** The movement of construction vehicles, machinery and equipment is restricted to the corridor or identified route. The unusable, non-saleable, non-hazardous construction waste has been disposed of in the properly delineated places. The compacted land is restored for agricultural use.

255. All efforts are made to prevent soil contamination. Following measures have been taken to prevent the same:

- The construction vehicles are fueled or repaired/serviced at the designated place

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with proper arrangement of waste collection and disposal. The arrangement includes cemented floor with dyke around for fuel storage and filling as well as repairing of construction equipment.

- Soil contamination by bitumen, fuel, and chemical storages are sittingzed by siting them on an impervious base within an embanked area and secured by fencing. The base and walls of the embankment are impermeable and of sufficient to contain of the total volume of stored fuels and chemicals.
- The disposal of waste asphalt is made in approved locations such as borrowpits or natural depressions and shall not be within the RoW. Unless located in areas with impervious soils, encapsulation with pre-laid impervious liners includingwalls and capping is required with the objective to prevent water percolating through the waste materials and leaching toxic chemicals into the surrounding soils. On completion of disposal at the site, the area should be capped with a compact thickness of impermeable soil covered and topsoil should be finally landscaped.

5. Topsoil

256. **Impact.** The potential impacts on topsoil are:

- Removal of topsoil for construction from outside the RoW.
- Compaction of topsoil.
- Loss of topsoil by wind and water erosion.
- Covering of topsoil by project works.

257. **Mitigation.** Mitigation measures include:

- The stockpiles are done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil.
- Locate topsoil stockpiles in areas outside drainage lines and protect from erosion.
- Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil.
- Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored topsoils are utilized for covering all disturbed area and along the proposed plantation sites.
- Prior to the re-spreading of topsoil, the ground surface should be ripped to assist the bonding of the soil layers, water penetration and revegetation.
- Limit equipment and vehicular movements to within the approved construction zone.
- Remove unwanted materials from topsoil like grass, roots of trees and similar others.

6. Air Quality

258. **Impact.** During construction phase, there are two main sources of air emissions i.e., mobile sources and fixed sources. Mobile sources are mostly vehicles involved in construction activities while emissions are from fixed sources that include diesel generator sets, construction equipment (e.g., compressors) and excavation/ grading activities. Certain amounts of dust and gaseous emissions will be generated during the construction phase from road construction machineries. Pollutants of primary concern include Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM). However, suspended dust particles are coarse and settle within a short distance of construction area. Therefore, impact in nearby inhabited area will be direct

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but temporary and restricted within the closed vicinity of the construction activities only.

259. Localized emissions are from hot mix plants and batching plants. These emissions would be in the form of coarse particulate matter and usually settle down in close vicinity of construction site. This type of emissions is short term. Hence, no significant impact is expected during the construction phase. Emissions may be carried over longer distances depending upon the wind speed, direction, temperature of surrounding air and atmospheric stability. Construction work involves breaking up, digging, crushing, transporting, and dumping large quantities of dry material. During construction, the continuous operation of machinery and movement of heavy trucks and vehicles generate gaseous emissions. Although insignificant, it contributes to an increase in suspended particulate matter (SPM) in and around the construction zones. Emissions from crushers and quarry sites can cause health impacts (e.g., coughing, flu, difficultyin breathing, irritation in eyes and reduction in visibility). This impact is temporary and major negative in nature.

260. **Mitigation.** Mitigation measures include:

- The stockpiles of construction material are sprinkled with water 3-4 times a day depending on weather condition and intensity dust. Water is sprayed at asphalt mixing sites and temporary service and access roads. After compacting, water should be sprayed on the earthwork regularly to prevent dust. Construction equipment is maintained to a good standard and idling of engines are discouraged. Machinery causing excessive pollution (e.g., visible clouds of smoke) is removed from construction sites and green tags are being used by the consultants to identify good and poor performing vehicles and equipment;
- The Contractor(s) must submit dust suppression program to RHD prior to construction. The plan provides detailed actions to be taken to minimize dust generation (e.g., spraying of roads with water), and identify equipment to be used.
- Road pavement design should be such that tyre friction due to vehicle movement will be reduced. Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce dust pollution on existing road.
- Dust control by equipping asphalt hot mix and batching plants with fabric filters or wet scrubbers to reduce the level of dust emissions;
- Hot mix plants are located at least 500 m away from the populated areas and be fitted with high stack (30m) to allow adequate dispersion of emissions. Further, the hot mix plants must be sited at least 1 km in the downwind direction from the nearest human settlement. Regular maintenance of machinery and equipment shall be carried out. Diesel Generating (DG) sets are fitted with stacks of adequate height. Dust masks are provided to the workers. Proper dust collection system is ensured at crushers and continuous sprinkling of water;
- Air pollution monitoring has been carried out as per monitoring plan and corrective action shall be taken in case of deviation.

7. Noise & Vibration

261. **Impact.** During construction, noise is likely to be generated from site clearing, excavation, concrete mixing, crushers, and piling during bridge construction. The general noise levels during construction phase due to heavy earth moving equipment and machineries installation may sometimes go up to 100 dB(A) or more at the work sites[15]. Under worst case scenario, it is

[15] The noise level from various construction equipment /machinery is (all levels are in dB(A)): Dozers (95-100), front Loaders (72-84), Backhoes (72-93), Tractors (76-96), Toppers/Truckes (82-94), Concrete mixers (75-83), Concrete

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assumed that all this equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is expected to increase from 100 dB (A) at 1 m to 52.1 dB (A) at a distance of 250 m from the sources. The vehicular increase during construction is likely to be limited and may not have any significant contributionsto increase in ambient noise level.

262. Vibrations caused by movements of heavy construction equipment, pile driving operations, operation of crushing, ballasting and aggregating plants may disturb the residents unless operation times are fixed by discussing with local representatives. The vibration caused by some of the construction activities such as the roller compaction of the embankment, movement of heavy material transport vehicles, driving of piles and erection of bridges may be detrimental to the neighboring structures.

263. **Mitigation.** Mitigation measures to minimize the impacts of noise and vibration include:

- Selection of the latest equipment and plant with reduced noise level ensured by suitable in-built damping techniques and appropriate muffling devices.
- All powered mechanical equipment and machinery shall be fitted with noise abating gear such as mufflers for effective sound reduction, in full compliance withthe DoE regulations.
- Vehicles and equipment should be fitted with silencer and maintained well. Mufflers should be used during pile driving hydraulic mechanism to ensure noise level is below 85 dB(A).
- The noisiest operations should be performed during daytime. Proper equipment maintenance and restricted operation between 0700 to 1800 hours will reduce noise.
- The construction equipment/machinery (stationary) should be placed away from inhabited areas. Provision of temporary noise barrier should be made near sensitive locations like schools, religious places and hospitals. If temporary noise barriers are not feasible then regulate construction activity and timing so as the impact intensity is minimized.
- The workers should be provided with personal protection devices as earplugs and earmuffs.
- In areas, where there are structures likely to be affected by vibrations because ofthe construction activities, precaution will be taken to minimize the vibration and the resulting impact.
- Noise and vibration monitoring shall be carried out as per the suggested monitoringplan.

8. Siting of Construction Camps

264. **Impact.** The precise locations for construction camps and other facilities such as workshops, equipment washing yards, borrow pits, quarries, crushing plants, asphalt plants, batching plants, construction material storage areas, haul routes and disposal sites for construction waste will be finally decided by RHD in consultation with Contractors. However, thesiting of these facilities may cause several issues such as loss of plantation and vegetation, permanent physical and visual impact on the area, siltation and pollution risks if constructionmaterials are extracted from the riverbed.

265. The construction process will take several years, with the result that the camps are built on a

pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material & plant machineries) (85-98), Dg Set (90-95), Pumps (69-71), Compressors (74-86), Pneumatic Wrenches (83-88), Jack Hammer and rock drills (81-98), Pile Drivers (peak) (95-105.

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semi-permanent appearance. The people and the changes they bring can have significant impacts on the local communities and social structures. Substantial numbers of workers are inhabit the area in temporary camps loading local infrastructure and causing ambient social influence. Most important aspects are: contamination risk of soil and surface water due to sanitation of the camps; waste and garbage from the camp.

266. **Mitigation.** Mitigation measures include:

- The construction camps and workshops are not be located in sensitive areas and, in most cases, are not be within 500-meter distance from the existing settlements or might be selected after consultation with local people.
- Conducting special briefing and/or on-site training for the contractors and workers on the environmental requirement of the project to understand the environmental requirements of the project and implementation of mitigation measures.
- Efforts are made to minimize vegetation loss while making site arrangements for construction camps and other facilities;
- The crushing plants, sites for borrow pits, asphalt hot mix and batching plants are not located in environmentally sensitive areas, productive land or existing settlements;
- The construction material storage areas are not located in sensitive areas and are placed within fence;
- Water and good sanitation facilities are provided for the camps.
- Solid waste and sewage are managed according to national regulations. Solidwaste must not be dumped, buried or burned at or near the project site, but are disposed of at the nearest sanitary landfill or site having and complying with thenecessary permits.
- The sites for camps and associated facilities are reinstated by the Contractor(s) after decommissioning of the project.

9. Quarry

267. **Impact.** The precise locations for quarries have been finally decided by RHD in consultation with contractors. Quarries (together with borrow sites) are important construction material sources. Impacts from quarry operation ranged from loss of vegetation, erosion, siltation, pollutionrisks, noise and air quality deterioration, as well as aesthetic impact in the area.

268. **Mitigation.** The contractor has to ensure that the construction materials to be used for road construction are sourced from quarry with government clearance. Transportation of materials from quarry areas should be done by using special vehicles to avoid spillage along theroad and they should be covered. During closure and reclamation of quarry sites, the contractor has to ensure that stripped materials will be levelled to facilitate water percolation and make natural grass planting possible. The contractor also has to ensure the restoration of the river's naturalflow to its previous state. Closure will be in accordance with the set guidelines in the EMP and inaccordance with the country's environmental regulations.

10. Surface Water

269. **Impact.** The project road crosses two important rivers. One major bridge is proposed on the Fuljor River. Dredging and piling activities may have localised impact in terms of increase in total suspended particulates (TSS) level in river water. Since this will be a temporary phenomenon, no significant adverse impact is anticipated during this phase.

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270. Surface water might get contaminated due to the disposal of construction waste generateddue to the project activity. Uncontrolled dumping of wastes, sewage, dredge materials, and accidental spillage of fuels and chemicals pollute these water bodies. Disposal of sewage and wastes from the construction camps to surface water bodies without treatment deteriorates thewater quality. The seasonal canals and ponds are unlikely to be affected by construction activities. This contamination not only endangers the aquatic life but also results in jeopardizing the health of people that use this water for meeting domestic requirements. The impact on these water bodies is occurred only during construction phase.

271. **Mitigation.** Proper care has been taken during construction of the project road above or near thewater channels so that no damage could be made during construction activities. To maintain the surface water flow/drainage, proper mitigation measures are taken along the road, like drainage structures in urban areas.

272. Proper construction management including training of operators and other workers are ensured to avoid pollution of water bodies by the operation of construction machinery and equipment. Temporary construction facilities including structures and material stockpiles arelocated at least 50 m away from water bodies. Avoid disposal of wash water, solid waste as discarded packing etc., waste from concrete agitator cleaning operations and excavated materialon water bodies adjacent to or within the vicinity of the project.

273. Construction of bridges and culverts is conducted during dry season as much as possible. Cast-in-place concrete piles are used in bridge and culvert construction. During the boring in the river cofferdams should installed to prevent silt from mixing with river water. Whenlarge amounts of boring slag are produced, this slag are hauled to spoiled disposal areas.

11. Groundwater

274. **Impact.** Increased demand for groundwater is anticipated during the construction phase for construction activities and domestic purposes. Since ground water is likely to be contaminatedwith arsenic at large places, consumption of arsenic contaminated groundwater may have adverse health effects on workers. Uncontrolled extraction of water may also affect availability of water to locals. In addition to that, construction waste, if left unattended results in forming leachate which will percolate through the soil strata and will reach underground water table and hence, will end up contaminating it.

275. **Mitigation.** Arrange safe drinking water is made prior to start of work. Good quality water is supplied for consumption and required testing analyses have been requisite treatment. Environmental awareness campaigns have been organized in all WPs including judicious use of freshwater resources.The contractors are advised to use water judiciously. The water reserves have been adequatelyprotected from any source of contamination such as construction and oily waste that degrade its potable quality.

12. Waste Pollution

276. **Impact.** Due to construction activities, waste is generated at construction and contractors camp site. The construction waste includes wastewater, oil spillage from machineryand solid waste etc. This results in unhygienic conditions, and health risks to the work force and general public at the camp site.

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Following are the types and sources of construction waste:

- Oil, grease etc. from construction machinery;
- Solid waste from waste construction material and food;
- Wastewater from washing and sprinkling; and
- Sanitary waste from staff toilets.

277. **Mitigation.** This impact is temporary and moderate negative in nature. Mitigation measures include (See Appendix - O for proposed Waste Management Plan):

- Wastewater effluent from contractor's workshop and equipment washing yards would be passed through gravel/ sand beds to remove oil/ grease contaminants before discharging it into natural streams;
- Wastes are disposed at designated sites and no waste are disposed in the productive agricultural field;
- The hazardous wastes are segregated and handed over to certified vendor for disposal following appropriate procedure as necessary;
- Solid wastes generated during construction are safely disposed in approved and demarcated waste disposal sites following the proper waste management plan;
- Sanitary wastes generating from staff and labour camps must be disposed of in environment friendly manner, i.e. provision of septic tank etc. for toilet wastes; and
- Aggregate waste material of existing riss are disposed of to desginated areas for reusing of local road improvement.

13. Dredging and Dredged Materials

278. **Impact.** Development of road embankment requires filling material to provide prescribed height of the embankment thinking the regional land elevation. Huge amounts of filling materials are collected from the government designated points nearby rivers bed. Dredging in the river has some physical and ecological impacts. The dredging activities have the chance of increasing riverbank erosionand higher flood risk downstream. During dredging the existing aquatic habitats are sometime dislocated.The surface water quality is affected and there is a chance of spilling/seepage of oil in the river.While collecting filling materials from the nearby ponds and lands, it may affect the surrounding agricultural land and local people will be temporarily disturbed due to noise and dust creation.

279. **Mitigation.** All reasonable steps must be taken to prevent the transport of sediments beyond the worked stretch. All reasonable steps must be taken to avoid increased erosion of thebanks and bed work must not be carried out when fish are likely to be spawning in the affected surface water, or in the period between spawning and the subsequent emergence of juvenile fish.While dredging, special care must be given to prevent any spillage/seepage of oil from the dredging machines and wastes from the workers on the river water. If some of the owners of theponds and lands nearby to the road alignment want to use their area for fisheries project, the contractor may collect filling materials from that area through proper contract and dredging guidelines.

14. Protection of Flora

280. **Impact.** There would be no major impact on flora except cutting of trees during project intervention in the project area. There is no protected forest, reserved forest or sanctuary etc. present in these areas. About 31,450 different tree species with different sizes in Elenga- Hatikamrul road section are located along the road alignment and are affected due to the project (refer to section 4.3.2 for details). In addition, many social forestry trees are likely to be cut down. Trees are of timber

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value, fruit bearing and medicinal in nature. Medicinal plants are common in the project area.

281. Establishment of contractor's camps and warehouses for storage of equipment, material etc. has involved clearing of vegetation from the area causing negative impact. During the entire construction period, dust laden polluted air forms a dust film on the leaves, thus blocking sunshine and stomata, thereby hindering photosynthesis process and cause quaintly causing detrimental effect on the plant health. Also, during construction activities, the contractor's workersmay damage the vegetation including trees (for use as firewood to fulfil the camp's requirements).This may affect the ecological habitat of the area. This impact is permanent and moderate negative in nature.

282. **Mitigation.** Mitigation measures include:

- All efforts have been made to minimize tree cutting by selecting road-widening option based on technical considerations. There will be consultations with the public and NGOs prior to cutting old trees. The option may also be explored at detailed design stage to widen the road on other side to prevent cutting of trees. Uncut trees may serve as road divider for the project;
- The Forest Department recommended that two trees be planted for every treecut. This value will be greater for social forestry. These trees shall be planted primarily along the road within ROW. The social forestry can be planted on the area allocated by local authorities;
- Based on a compensatory tree plantation plan flowering and fruiting shrubs will be planted along the RoWs to provide aestheticsin the surrounding landscape;
- An awareness campaign targeted on the neighborhood farmers may also be run to popularize the planting of trees;
- The contractor's staff and labour have been instructed not to damage any vegetation such as trees or bushes. Staff are instructed to utilize paths and tracks for movement and will not be allowed to trespass through farmlands.
- Construction vehicles, equipment and machinery remain confined within their designated areas.
- Contractor supply gas cylinders at the camps for cooking purposes and cuttingof trees/bushes for fuel will not be allowed.
- Camp sites and asphalt plants are established on waste/barren land rather thanon forested or agriculturally productive land. However, if such type of land is not available, it will be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to the trees, under growth and crops.
- Compensation for trees to be cut within the RoW of road must be paid to farmers/owners based on market rates.

15. Wildlife

283. **Impact.** There are no endemic wild animals within the project area. The project has posed minor negative impact on the fauna present in the project area. There is no game reserves nor wildlife along the project alignment, therefore no negative impact has been observed.

284. **Mitigation.** The following mitigation measures are taken:

- Illegal animal hunting is not allowed, and punishment enforced in case of violation;
- All efforts are made to prevent cutting of large trees. All efforts are made to ensure that these trees are cut only on one side of the road by making suitable adjustments

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in the road design.

- Only new and machineries and equipment in good condition are used in construction;
- Construction works have been carried out during daytime so that there are no disturbance to local birds and animals;
- Contractor ensures that the no hunting nor trapping of animal will be carried out during construction.

16. Fisheries

285. **Impact.** It is likely that there has been a loss of fish productivity in the pond fishery and borrow pit fishery due to filling of ponds along the road areas. Fish species such as Sheat Fish, Carp, Pale Carplet,Salmon, Prawn, Kakila, Aire, Tengra, Bele, Mrigal and Olive Barb migration takes place in Elenga-Hatikamrul road Section (in Jamuna and Fuljor). Migration is more prominent between June andAugust. Construction of bridges might have negative impact during the rainy season and without due consideration of maintaining the deep-water channel of migration of these fishes.

286. **Mitigation.** Adequate cross drainage structures have been provided in all waterlogged or pond extending both sides of the road areas. No construction has been undertaken during the high flood when the water depth is usually maximum 6m. During the dry period (from November to May) the river is almost dry up and no flow occurred in the river. Further, it is recommended that construction along the riverbanks must be avoided during the fish breeding season (July to September).

17. Land Use

287. **Impact.** Land use changes along the road corridors are anticipated. These may bring about a change in the characteristics of the adjacent lands. The construction activities for road widening and Bridge/flyovers construction may temporarily change the land use for use ofconstruction site, access road, and construction camp. Due to these interventions, agricultural, seasonal wet land areas and social forestry around these areas may get affected adversely.

288. A substantial earth is required for widening and elevating the road with existing levels. The RHD borrowed earth from the roadside during the previous construction activities. Earth has been borrowed mostly within RoW. The borrowed areas are seen left without rehabilitation or interconnectivity to maintain the natural drainage at various locations. These borrow pits are being used as fishponds. However, these are also causing water logging since no drainage is planned in these areas. Additionally, RHD has the practice of issuing contracts for sourcing borrow earth without specified controls for borrowing the earth or preserve topsoil or borrow areas rehabilitation. Similar practice for proposed road widening activity may cause direct impact on landuse, topsoil preservation and drainage pattern around the road.

289. **Mitigation.** GOB has adopted the practice of encouraging construction of roadway embankment with river sand rather than clayey agricultural soil. The same option is proposed forthe project road. Wherever earth to be borrowed for cladding with cohesive soil, following mitigation measures is recommended to minimize the impact on land use:

290. Preference is given to borrow earth from RoW itself wherever feasible. However, due care should be given for protecting the road embankment with slope protection measures. Each borrow pit may have a side opening for the flow of accumulated water. It should be put to community preferred

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used for fishing or other activity. Alternatively, it shall be rehabilitated and used for tree plantation using the preserved topsoil.

291. Wherever borrow earth is not available from the RoW, preference is given to land, which farmers want to convert either into a fishpond or lowering the agriculture field level to increase its water retention capacity. No land acquisition is made for borrow areas.

- While borrowing, the earth top soil should be preserved. The borrow pits should be rehabilitated after borrowing the earth;
- Borrow areas should not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth should not exceed 45 cm. The topsoil to a depth of 15cm should be stripped and set aside. Thereafter, soil may be dug out to a further depth not exceeding 30cm and used in forming the embankment.
- Borrow pit is selected from wasteland at least 500m away from the road;
- Priority should be given to the borrowing from humps (including from digging of wells) above the general ground level within the road land;
- Priority should be given to the borrowing by excavating/enlarging existing borrow areas;
- Borrowing should be from land acquired temporarily and located at least 500m away from the road;
- In case of settlements, borrow pits should not be selected within a distance 800m from towns or villages. If unavoidable, earth excavation should not exceed 30cm in depth;
- The haulage distance from site is not too far.
- Good engineering and construction practices should be followed.

18. Traffic Congestion

292. **Impact.** The project will be busier due to increased construction activities, and hence traffic management situation may be aggravated during the construction phase under tranche 3. This may result in traffic jams and cause inconvenience to the people passing through the road crossings at interchanges due to the movement of vehicles carrying construction materials.

293. **Mitigation.** This impact will be as usual temporary and minor negative in nature and can be mitigated by providing proper and effective traffic management plan (see Appendix - P), including signage, warnings for drivers, adequate diversions, etc. during construction of the road. Interchanges are constructed in a way that traffic flow is not disturbed; alternative routes are Clearly defined. Proper traffic management with marking should be done on the road crossings near interchanges.

19. Cultural Sites

294. **Impact.** There are no physical cultural resources as listed in UNESCO World Heritage listof archaeological sites exist along the entire alignment. There are some impacts like noise and dust pollution on the nearby socio-cultural structures from the road alignment such as the schools, mosques, and graveyards etc. (as stated according to the Table 4.20) due to construction activities.

295. **Mitigation.** This impact is temporary and minor negative in nature. Mitigation measures include:

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- Timely completion of the construction work and provision of alternative routes during the construction;
- Establishment of construction site camp and labor camp must maintain proper distance from the cultural sites.

20. Income and Employment

296. **Impact.** Normal living of the local people is affected for a certain period. Income loss on lower scale is happened due to the loss of agricultural lands and rehabilitation of the households. Some local roads are disturbed being located on the road alignment during developing the road embankment. Unplanned occupation of roadside land for habitation and commercial purposes may alter the land use of the project area beyond the project-acquired area.

297. During construction activities, local unemployed people get employment and increased income. The immediate benefits to the poorest residents in the project impact areas include employment in construction activities, and subsistence allowances and other benefits under resettlement, and increased income from petty business during construction. During the construction phase several other employment opportunities with contractor's office are made available for local people.

298. **Mitigation.** To minimize income loss, contractors as far as practicable recruit construction workers from the locality and maintain gender equity while employing the locals. Priority is always given to people from the PAPs and to those unemployed and belong to the lower income group. Additional benefits are derived by setting aside areas withincontractor camps/labor shed for local people to sell their products or to provide additional services to the workers.

299. Project authorities take necessary actions as per the recommendation ofResettlement Plan (RP) and Social Impact Assessment.

21. Occupational Health & Safety

a. Occupational Health and Safety of Workers

300. **Impact.** Health risks and workers' safety maybe compromised if working conditions are unsafe and/or unfavorable working environment due to storage, handling and transport of Hazardous construction material. Construction workers are at risk of accidents due to moving vehicle, and other construction related activities. Workers are also exposed to high levels of dust, exhaust from vehicles and noise levels. Workers are often required to work irregular working hours resulting in fatigue and increased risk of accidents. OHS plan showing in Appendix Q.

301. **Mitigation.** Mitigation measures include:

- Obligatory insurance for laborers/workers;
- Providing basic medical training to specified work staff and basic medical service and supplies to workers;
- Layout plan for camp site, indicating safety measures taken by the contractor, e.g.firefighting equipment, safe storage of hazardous material, first aid, security, fencing, and contingency measures in case of accidents;
- Protective devices (earmuffs) have been provided to the workers doing job in the vicinity of high noise generating machines;
- Provision of adequate sanitation, washing, cooking and dormitory;

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- Provision of protective clothing for laborers handling hazardous materials, e.g., helmet, adequate footwear for bituminous pavement works, protective goggles, gloves, etc.;
- Adequate signage, lighting devices, barriers, yellow tape and persons with flags during construction to manage traffic at construction sites, haulage and access roads

b. Occupational Health & Safety of Community

302. **Impact.** The construction activities and vehicular movement at construction sites and access service roads may result in roadside accidents particularly inflicting local communities who are not familiar with presence of heavy equipment. This is a temporary and minor negative impact. Quality of groundwater and surface water resources available in the nearby localcommunities may be affected due to construction activities, oil spillage and leakage, roadside accidents etc. Laborers with infectious diseases may infect local residents. The borrow pit areaslocated near the residential settlements may cause accident for the people moving near to thoseareas.

303. **Mitigation.** Mitigation measures include:

- There should be proper control on construction activities and oil spillage leakage of vehicles.
- Laborers with infectious diseases are restricted within the construction site and advised to seek medication.
- Efforts have been made to create awareness about road safety among drivers operating construction vehicles;
- Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity & social links;
- Provision of proper safety and diversion signages, particularly at urban areas and at sensitive/accident-prone spots.
- Reducing the impacts of vector borne diseases on long-term health effect of workers should be accomplished through implementation of diverse interventions aimed at eliminating the factors that lead to disease;
- During construction work, pedestrian and vehicular passages should be provided for crossing near settlement
- Use of water should not disturb public water availability. Source of water should be selected carefully.

c. Corona Virus Disease 2019 (COVID-19): Pandemic Control

304. The Corona Virus Disease 2019 (COVID-19) outbreak is one of the deadliest global health crisis in the history. COVID-19 had caused more than 6.3 million deaths in the world and more than 29 thousand in Bangladesh during the last 2 and half years. COVID-19 has big impacts on the health and safety issues of all walks of life, including the workforces and workplaces all around the world. The construction industry has been significantly affected by the COVID-19 pandemic and has been facing challenges to improve the safety and wellbeing of its workforce.

305. ADB as well as the office of the Director general of Health Services of the Government of Bangladesh provided Heath-Safety Guidelines to protect employees and workers of the country from corona virus. Starting from early 2020, Government of Bangladesh imposed several lockdowns across the country to control spread of COVID-19. Irrespective of low, medium, or high prevalence

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of COVID-19 breakdown, citizens of the country have been instructed to follow health-safety guidelines of COVID-19 pandemic condition. Below health-safety general instructions and guidance are important to follow at construction to control COVID-19 pandemic:

1. COVID-19 general guidance developed by ADB for construction projects should be followed in the project. Project proponent should conduct risk assessment and prepare site specific health safety plan.

2. Follow guidance for worksite entrance, as below:

    - Maintain physical distance of minimum 1 m (3ft) during worksite entry queue;
    - Everyone entering the worksite must wear a mask and gloves. Display hand washing protocol at entrance;
    - All personnel should wash their hands with soap for 20 seconds before, during and after work;
    - Spray bottom of shoes entering worksite/ campsite with disinfectant;
    - Disinfect all vehicles entering the site;
    - Check body temperature of all at the time of reporting to site. If temperature is above 37ºC send to the designated medical facility.

3. Worksite management

    - Physical distance min. 1m (3ft) all the time at work;
    - Rotated schedule for break to minimize gathering;
    - Frequently clean and disinfect highly used tools, machineries and surfaces (e.g. tables, toilets) by workers;
    - Mandatory morning briefing on COVID awareness at site maintaining physical distance;
    - Use alcohol-based wipe to clean tools, equipment, vehicle before and after use;
    - Discourage gathering at site. Discourage unnecessary entrance and exit at site.

4. Camp management

    - Ensure personal distance at least 1m (3ft) during lunch, dinner and prayer.
    - Encourage frequent hand washing. Provide soap, sanitizer, washing facility and safe water at the workers' dwelling.
    - Ensure separate covered bin for disposal of PPEs.
    - Protect against heat, cold, damp, noise, fire, and disease-carrying animals.
    - Maintain good housekeeping and social distancing in kitchens, meal rooms, canteens.
    - Ensure ample ventilation at the camp**.**

5. Work site awareness raising is important to take prompt action by the project management and environment health safety (EHS) personnel. Aware people as below through place awareness raising posters at common spaces of worksite and camp:

    - Inform ESH personnel immediately if any of the employee or workers having symptoms of COVID-19;
    - Practice respiratory etiquette – not to touch nose/eye/ mouth, not to spit;
    - Shorten gathering, even toolbox meetings;

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- Initiate remote meeting protocol to avoid physical contact;
- Cover nose while coughing or sneezing;
- Wash hands with soap for 20 sec;
- Use wastepaper basket more often;
- Disinfect bottom of shoes frequent interval;
- Disinfect tools frequently.

6. Measures to be taken before resumption of construction at the worksites after pandemic lockdown:

- Re-open the site at limited scale - engage essential labor force;
- Locate closest health facilities for emergency communication;
- Provide thermometer, soap, sanitizer, disinfectant, PPE at worksite/camp;
- Place adequate washbasins, disinfectant tub, dispenser, covered trash bin;
- Ensure all equipment and vehicles used are routinely disinfected;
- Ensure all to use the Personal Protective Equipment (PPE);
- Assign/engage health and safety supervisor;
- Establish electronic payment system to pay the daily wage;
- Prepare COVID-19 awareness posters throughout the worksites;
- Prepare a mechanism for monitoring and reporting at worksite.

7. Monitoring and Reporting

- Monitor level compliance of employees and workers with the ADB COVID-19 guidance through daily checking.
- Reporting - Share health and safety status with ADB (QPRs and Semi-Annual EMR)

306. **Details of component as per original design** Status of Implementation of COVID-19 Guidance of ADB: Contractors of the project upon instructions from PMU and PIC have implemented the General Health Safety Guidance of ADB across the work sites and camps. PIC shared the following COVID-19 safety measures guidelines with the Contractors (i) Safe Work Procedures (ii) Health and Safety Guideline, and (iii) Risk Assessment. It is vital, however, to conduct health and safety risk assessments, require employees to comply with scientific and policy requirements regardless of their work environment, and ensure that the workplace is safe. All the efforts extended by the PIC and Employers to promote the health and safety of employees during period of COVID-19 pandemic resulted to maintain partially compliance status against the provisions of the ADB's "COVID 19 Health and Safety Guidance for the Construction Workforce".

22. Impacts due to Bridge Construction

307. The Elenga-Hatikamrul road alignment necessitates construction of one major bridge longer than 100m at chainage 106+310 Km over the Fuljor River at Sirajganj. However, this bridge is within the same activities of Elenga-Hatikamrul road construction thus there is no separate environmental impact assessment for these bridges. But details impacts and mitigationmeasures for major bridges have been covered in this IEE and additionally this section discussessome major impacts and mitigation measures due to this bridge construction. Since constructionof such bridge involves earthwork, piling, concrete structures across rivers and over both the river-banks, restriction to plying of country boats, blockage of aquatic biodiversity movement, etc.,(for river bridges), environmental impacts due to such activities are different from those due to the construction of the project road and, hence, the environmental componentsand parameters addressed during the impact assessment and management processes are different.

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23. Navigation Channel Obstruction

308. A small quantity of construction materials and equipment are to be transported using water transport that might create disruption in movements of mechanized and non-mechanized water-transports unless dealt with carefully and properly. The piling, dredging and other construction related operations might also disrupt movement of navigational transports in the main river channels. These disruptions, however, are only localized and last during construction only.

24. Erosion and Drainage

309. With the project area, being low elevation flood plain, erosion is not the major concern, but drainage is. Nevertheless, at the location near the bridge crossings, the banks of the river are steep and might be prone to minor erosion. Proper river training measures have been adopted upstream and downstream of the bridge crossings for an appropriate reach length.

25. Soil and Water Quality Degradation

310. Spillage of fuel, solvents, lubricants and paint by leakage of tanks or careless handling of chemical waste can cause severe pollution of soil, groundwater and surface water. Soil pollutionand groundwater pollution by liquid wastes can have serious effects on the quality of drinking water in the project area for several years. Handling and storage of potential contaminants are organized under strict conditions and preventive measures to avoid contamination during construction of the bridge.

26. Vibration and Pile Driving Noise

311. The piles for the bridge foundations have been cast in place reinforced concrete piles. Therefore, the vibration is not significant and noise level is also remaining at low level. However, noise level has been elevated due to other construction activities, transportation, and loading, unloading of construction materials, dredging and electricity generation. Noise caused by these activities has been reported mostly within acceptable levels, excepting a few instances where other sources of noise are available as well.

27. Fisheries

312. The main project-related potential causes of adverse impacts on fisheries are:

- hydrocarbon spills and leaks from river transport
- disposal of construction and construction camp wastes into rivers and streams
- sediment-laden runoff from construction sites and camps
- Construction within waterways.

313. The amount of river transport involved in the project is low as only the Fuljor River is of navigation significance and most construction materials have been brought to site by road transport. This makes the potential for riverine spills to be less.

314. The construction contract specifications and EMP place high emphasis on proper environmental management. A full-time supervision consultant has been engaged to ensure compliance with these requirements for both disposal of wastes as well as the control of sediment laden runoff for the project site. There is rigorous control of hazardous materials, although for a road

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design project, these are not expected to be present in large quantities.

315. With the exception of Nalka Bridge over the Fuljor River, all the bridges and culverts are to be constructed across low-lying areas and non-perennial streams, thereby limiting the potentialfor disruption of waterways and fisheries. The bridge works will be of a conventional nature and the bored pile foundations which may generate some sediment, but the levels are not expected to be high compared with the natural sediment load in that river.

28. River Transport

316. The use of construction and dredging barges has the potential to cause some traffic disruption in Fuljor River. Construction barges may be employed for bridge construction and conventional management practices are able to mitigate any adverse effects on river navigation by identifying the navigation channel through use of aids such as buoys, beacons and lighting. Similar practices will minimize any effects on river traffic from sand dredging.

E. Operation Phase

317. Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. To achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, to reap the full environmental benefits of the activitiesand ensure environmental enhancement it would be necessary to implement the following whichare beyond the purview of this project and may require national level involvement.

1. Soil Erosion and Quality

318. **Impact.** No soil erosion is anticipated during the operation phase except where shoulders are not well maintained, and its damage triggers the erosion of road embankment. However, soil erosion may take place at different road structures (bridges, embankments, culverts etc.), which may increase the flood risk by rapid flash of storm-water runoff that will undermine these structures. Contamination of soil is not likely to happen other than due to accidental spillage fromvehicle movement. Soil contamination can take place on border areas by road runoff containing heavy metals (e.g., lead). If these areas are used for growing vegetables for human consumption,it can have adverse impacts on human health. The research has shown that the increase in heavymetals is generally limited to a narrow border along the edge of the road and concentrations rapidly fall away with distance from the hard shoulder.

319. **Mitigation.** The following mitigation measures are proposed to reduce the impacts on soil:

- In case soil erosion takes place, proper remedial measures will be undertaken to stop future impacts of loss of soils and the associated impacts caused by soil erosion;
- Slope protection measures by grass turfing and vegetation must be ensured.
- Proper measures must be ensured to prevent any oil spillage and leakage from vehicles.
- Depending on the nature and magnitude of spill, appropriate land remediation measures shall be employed by the concerned authorities.

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2. Noise and Vibration

320. **Impact.** During the operational phase, the noise levels are anticipated to increase due to traffic related noise pollution, vibrations from engines and tires and mainly use of pressure horns.The main source of noise during the operation phase is the traffic. It can be estimated that ambientnoise level will increase due to the increased traffic. However, the better road condition and lesscongestion on roads will reduce the net noise levels at market and other crowded places. The Noise levels are likely to reach the acceptable levels at a distance of 500 m from the road. Somesensitive locations within 500m of the road may be affected due to higher noise levels than the stipulated 45 dB(A). Overall, impact on noise environment is considered moderate during the operation phase.

321. **Mitigation.** This impact is permanent and moderate negative in nature. Mitigation measures will include:

- It is suggested that suitable engineering measures such as noise barriers, road pavement design, underpasses/foot over bridges at market areas as feasible should be adopted to minimize the noise generation.
- According to monitoring results, additional sound barriers in form of trees and hedges will be discussed with the affected people and planted if agreed;
- It is also suggested that surface roughness of the roads are maintained as per the design characteristics and honking should be discouraged through signboard displays.
- Signs for sensitive zones (health centres / educational institutions etc.) to disallow the use of pressure horns;
- Enforcement and penalties against traffic rules violators; and
- Noise monitoring shall be carried out as per the suggested monitoring plan.

3. Air Quality

322. **Impact.** The improved road conditions will change the air quality scenario, which will result in improved ambient air quality. However, in the longer run, increased traffic levels and congestion will lead to PM_{10} pollution levels above the national/international standards, which may result in causing public health risks, nuisance, and other impacts on bio-physical environment.

323. These conditions will result in the rise of vehicular emissions (CO, NOx, SOx, PM_{10}) associated with the adverse effects on the environment and humans. This impact is permanent and positive, in case of improvement of road conditions and minor negative, when traffic volumeis increased.

324. **Mitigation.** Mitigation measures will include:

- It is proposed to maintain the road conditions especially the shoulders and embankment turning.
- Setting up of a system to monitor air quality along project area in accordance with the applicable standards/limits;
- Roadside tree plantations as applicable and feasible under harsh climatic conditions; plants should be selected in accordance to their ability to absorb emissions;
- Densely populated trees shall be planted close to school, and religious places.
- Provision of slip road shall be made in urban and congested areas as feasible to separate slow moving and localised traffic.

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- Regular road maintenance to ensure good surface condition;
- Regular vehicles check to control/ensure compliance with air quality standards;
- Best traffic management practices shall also be adopted to regulate the traffic. Enforcement and penalties against traffic rules violators.

4. Water Quality

325. **Impact.** The surface water bodies may get flooded and polluted due to uncontrolled release of contaminated stormwater/road runoff from road surfaces. The pollutants associated with the road-runoff include hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from traffic. The worst contamination generally takes place during the first flush of runoff from roads after a spell of dry weather. The level of pollution is directly related to the traffic volume. The pollution risk from accidental spillagemay increase moderately. In the long run, the increased traffic volume and faster traffic speeds would increase the risk of accidental spillage, which could have medium adverse impact on surface water quality. The natural drainage of road runoff across embankments or discharge of runoff into water bodies from large area of carriageway may have medium adverse impacts on ponding and the flood risk to downstream locations.

326. Groundwater may get polluted due to contaminated road runoff on earthen shoulders and embankments planted with grasses. Additionally, the project may lead to faster urbanization nearthe project area, especially near the intersections. This will exert stress on the availability of groundwater in the project area.

327. **Mitigation.** The following mitigation measures are proposed to mitigate water quality related impacts:

- In order to discharge rapid removal of stormwater/road runoff, cross slopes and longitudinal drainage will be provided in the design. Well-designed cross drainage structures limit ponding across embankments;
- Proper drainage system with sedimentation ponds and oil separators will be provided to avoid contamination by run-off and oil spills, especially drainage will be provided for oil spills near water channels to prevent any contamination;
- Retention basins with reedbeds provided in the design will improve the quality of polluted storm-water/road runoff;
- Drainage and collection structures on the road project, particularly in areas near the river and irrigation canals, shall be designed such that spills of hazardous materials shall not result to contamination of these watercourses;
- Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared;
- The surface water quality monitoring will also be carried out at defined intervals and for environmental quality monitoring parameters suggested in the Environmental Monitoring Plan. If these parameters are above the prescribed limits, suitable control measures will be taken;
- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.

5. Land Use

328. **Impact.** The project road will induce land use changes in the form of development of commercial establishments (restaurants, petrol and gas filling stations), educational institutes etc.The

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existing settlements will be shifted due to resettlement and the agricultural land will be changed into road, with heavy traffic passing on it. The changes in land use may affect the land value, which will vary depending upon the location. The impacts on land use would be permanentand both moderate negatives especially for those whose land values have not increased and medium beneficial for businessmen and those having escalated land values (especially near interchanges). Unplanned occupation of roadside land for habitation and commercial purposes may alter the land use of the project area beyond the project-acquired area.

329. **Mitigation.** The mitigation measures include:

- All the facilities with the exception of restaurants and petrol/gas filling stations likelyto pop up in the future will be prohibited within the RoW.
- Permission will be sought from the concerned authority for the developmentof any establishment along the project corridor.
- Project authorities shall take necessary actions as per the recommendation ofResettlement Plan (RP) and Social Impact Assessment.

6. Wildlife

330. **Impact.** The project activities will bring some negative impacts on the fauna of the projectarea such as the uneasiness of movement and increased probability of accidents if the animals/livestock approach the road. This impact is permanent and minor negative in nature. Noise and air pollution caused due to heavy and fast traffic on highway, shall be a source of disturbance to the fauna of the area and especially to the avifauna of the area, which is another minor negative impact.

331. **Mitigation.** Rising of dense plantation of shady trees on both sides of the RoW shall provide resting, nestling, and roosting habitat to the fauna and especially to the avifauna which isa major positive impact. Provision of small nets on both side of the road shall be made where the animal movement is frequent.

7. Fisheries

332. **Impact.** Fisheries resources will be affected due to the damage of 2 ponds, 2 ditches and disturbance to fisheries species during construction of bridge & culvert over rivers and canals to build the Elenga-Hatikamrul road embankment. After completion of building the road embankment, proper steps must be taken to regain the fisheries resources in the project area. When the water level recedes in the post rainy season, the big fishes may get fragmented due toreduced water or unavailability of deep-water channel especially the places where sedimentationis high.

333. **Mitigation.** During the operation phase, RHD needs to take initiatives to enrich fisheries resources. In this case, RHD can provide logistic support to the PAPs of the water bodies to culture fish in other places in the PIA. Moreover, RHD can consult with the local fisheries department to enrich the fisheries resources in the PIA. Efforts shall be made as an enhancementmeasure to maintain deep-water stream up to certain distance on both ends of the bridge.

8. Cultural Sites

334. **Impact.** Loss of ancestral property, graveyards and mosques may cause some lasting stress on the affected people. Cultural and sensitive areas adjacent to 50 m away from the RoWboundary may be affected due to the noise originating from the moving traffic.

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335. **Mitigation.** Proper rehabilitation of the affected people and the religious and cultural monuments and structures will eventually ease out the stresses and this will not remain a significant issue over time. The noise barrier through plantation on the boundary of the affected cultural sites may reduce the magnitude of noise level.

9. Road Safety

336. **Impact.** The increased vehicular movement and speed may result in road safety issues like traffic accidents. The accidents may also be due to tiredness. This impact is permanent but moderately adverse in nature, since the frequency of accidents may be lowered, but their intensitymay be quite severe due to enhanced speeds at which vehicles will move.

337. **Mitigation.** Mitigation measures will include strict enforcement of speed limits, installation of speed guns and channelization of traffic with respect to categories (heavy vehicle traffic and light vehicle traffic) and enforcement of penalties for the violators. Traffic signs will be provided tofacilitate road users about rest areas, eating establishments etc. All the lanes, median, sharp bends will be reflectorized to facilitate travelers in the nighttime. Proper lighting arrangement onthe RoW will be done at required places.

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B. **Evaluation of Significant Impacts**

338. As is the case for most development projects, potential negative impacts sometimes couldbe far more numerous than beneficial impacts. Whereas the anticipated negative impacts could be dealt with through carefully selected and undertaken efficient mitigation measures and good management practices, beneficial impacts could still be augmented through mobilizing and strengthening the realization about the positive outcomes of the project among all the stakeholders and project officials as well as contractors performing works related to various stages of implementation. It is generally expected that the long-term benefits of any development intervention will ultimately trickle down for the benefit of the local population and makecontributions toward improvement of life quality.

339. The potential impacts due to implementation of the Elenga-Hatikamrul road project are identified by using DOE formatted matrix for environmental assessment by project implementation stages. In this developed checklist, actions, which may affect the various Important Environmental Components (IECs) pertaining to the areas adjacent to the alignment during the various stages of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms none, minor, moderate and major are used in the checklists to evaluate the magnitude of SEIs. In the checklist, each of the pre-construction, construction and operational phases of the Elenga-Hatikamrul road are considered separately in order to distinguish the short term and long term impacts as well as reversibility and irreversibility of impacts in terms of their duration.

340. Identification and evaluation of potential/significant impacts due to project location, site preparation, construction and operation at the project has been done using an 'Impact Matrix' by identifying all stages of activities (pre-construction to operation and maintenance) and assessingthe potential impact of each operation upon individual environmental components. Within the matrix, each potential interaction is represented by an impact category, as defined below:

- Type - beneficial or adverse
- Effect - direct or indirect
- Duration - short term or long term
- Change - reversible or irreversible
- Extent - local or wide
- Significance - low or high

341. The 'Matrix Rating' figures assume no mitigation measures were implemented.

342. As can be observed from the checklist in Table 32, major environmental components, which will be adversely affected by activities related to the project, are: air quality, noise hazard, loss of trees, accidental risk, hydrology/drainage and occupational health and safety and socio- economic environment. It should be noted that IECs indicated in the checklist relate to the changeability or unchangeability of the existing situations due to interventions of the project andsignificant level of impact without mitigation of negative impacts.

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Table 38: Checklist of Important Environmental Components (IECs)

Project Phases	Activity Important Environmental Components	Types of Impact	Significance of Impact	Duration of Impact
Pre-Construction Phase	Climate Change	Adverse, Direct	Low	Long term
	Loss of Trees	Adverse, Direct	Low	Medium term
	Land Acquisition	Adverse, Direct	Localized, Low	Short term
	Loss of Structure	Adverse, Direct	Low	Long term
	Educational, Cultural, Religious/Historical sites	Adverse, Direct	Localized, Low	Short term
	Public Utility	Adverse, Direct	Localized, Low	Short term
Construction Phase	Hydrology	Adverse, Direct	Minor, Reversible	Short term
	Drainage and Flood	Adverse, Direct	Minor, Reversible	Short term
	Soil Erosion and Siltation	Adverse, Direct	Localized, Reversible	Short term
	Soil Contamination	Adverse, Direct	Minor, Reversible	Short term
	Noise	Adverse, Direct	Localized, Reversible	Short term
	Air	Adverse, Direct	Localized, Reversible	Short term
	Groundwater	Minor	Low	Short term
	Surface Water	Adverse, Direct	Localized, Reversible	Medium term
	Waste Pollution	Adverse, Direct	Localized, Reversible	Short term
	Dredging	Adverse, Indirect	Localized, Low	Short term
	Flora	Adverse, Indirect	Moderate, Reversible	Medium term
	Wild Life	Adverse, Direct	Localized, Reversible	Short term
	Fisheries	Adverse, Direct	Localized, High	Short term
	Traffic Congestion	Adverse, Direct	Moderate, Reversible	Short term
	Income and Employment	Beneficial, Direct	Localized, Moderate	Short term
	Cultural and Religious Sites	Adverse, Direct	Localized, Reversible	Short term
	Educational Institutions, Health Facilities	Adverse, Direct	Localized, Reversible	Short term
	Occupational Health & Safety	Adverse, Direct	Minor, Reversible	Short term
Operation Phase	Soil Erosion and Quality	Adverse, Direct	Localized	Short term
	Flora	Positive, Direct	Localized	Long term
	Noise	Adverse, Direct	Localized	Persistent
	Air	Adverse, Direct	Localized	Persistent
	Water Quality	Adverse, Direct	Minor, Reversible	Persistent
	Land use	Positive, Direct	Moderate	Long term
	Wild Life	Positive, Direct	Moderate	Long term
	Fisheries	Adverse, Indirect	Moderate, Reversible	Medium term
	Cultural Sites	Adverse, Indirect	Localized	Persistent
	Road Safety	Adverse, Indirect	Localized, Reversible	Short term

343. The proposed variation of orders will increase work quantity with respect to volume of volume, construction, embankment, compaction, etc significantly. However, concrete based rigid pavement instead of flexible pavement, recycling of pavement, Aggregate B Type 1 will reduce environmental footprint in the project (Table 35).

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Table 35: Comparison of impacts in the previous IEE and as per variation orders

Particulars	Details of component as per original design	Details of proposed component as per variation order	Any change recommended (if yes detail of that component with approval)	Whether any new impacts due to changes/ impacts that were not assessed in the previous IEE
Pavement	Flexible Pavement	Concreate Pavement		Use of concreate pavement dust going to be reduced remarkably. So that, improve the air quality
Aggregate	Aggregate B Type 2	Aggregate B Type 1		Use of Aggregate B Type 1 is more environment friendly instead of Aggregate B Type 2
Recycling	There is no component of pavement recycling in the original design	Pavement Recycling	No change in the new component	Pavement Recycling is more environment friendly and also engineering aspect ,such as: Smooth Surface Less friction Emission less than anticipated Use in Layer / Granular pavement Asphalt pavement
Polymer	There is no component of Polymer Modified Bitumen in the original design	Polymer Modified Bitumen (Proposed)		Less carbon emission
SPC	There is no component of SPC in the original design	Steel post(SPC)		More safe in road operation

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VI. CLIMATE CHANGE ASSESSMENT

A. Greenhouse Gas Emission

344. Bangladesh generated 190 million metric tons of greenhouse gas (expressed in MtCO2e) in 2012, with the agriculture industry contributing about 40% to overall emissions.[16] This is followed by the energy sector, of which transportation is one of the subsectors, with 33% contribution. The Bangladesh Climate Change Strategy and Action Plan in 2009 identified improving transportation sector energy consumption as a priority since its share of emissions is growing faster than any other sector.

345. GHG emission likely to be generated from the project roads have been computed using the Transport Emissions Evaluation Model for Projects (TEEMP)[17] developed by Clean Air Asia[18],the Institute for Transportation and Development Policy and with funding from ADB. TEEMP is anexcel based tool to assess the equivalent CO_2 gross emissions without (business as usual or BAU) and with the project improvements (with project scenario or WPS). The main improvements from the project that was considered for the model are better surface roughness with le km and 2.5m/km, and widening of project road from 2 lanes to 4 lanes. These were translated into an increase in traffic speed and hence fuel consumption. The model has also been used for CO_2 emission assessment during construction stage. The model also allows for the inclusion of impacts related to traffic congestion with and without project through provisions for inserting dataon the traffic numbers, lane width, number of lanes and volume/capacity saturation limit. The model also computes for emission and emission intensity of PM and NOx.

346. Few assumptions made in this software are:

a. Fuel efficiency as reckoned in business as usual (BAU) and with project scenario(WPS) is given in Table 33. It is assumed that the fuel efficiency of the vehicles would increase due to improvement of the roads.

b. It is assumed that there would be no or minimum number of vehicles with vintageyear before 2000 using Euro–I fuel type after 20 years (Table 334). Pre Euro vehicles are assumed to be completely discarded for vehicle categories except for3 wheelers.

Table 33: Fuel efficiency in km/l

Scenario	2017			2036		
	Petrol	Diesel	LPG	Petrol	Diesel	LPG
2-Wheeler	50.00			50.00		
3-Wheeler	30.00	20.00	30.00	30.00	20.00	30.00
Car	15.00	18.00		11.00	18.00	
Multi-axle		8.00			8.00	
Bus		6.00			6.00	
2-axle		8.00			8.00	

[16] World Resources Institute. Climate Access Indicators Tool (WRI – CAIT) 2.0. 2015.

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

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

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Table 34: Emission Standards of Fleet (%)

Vehicle Type	Current Scenario				Post 20 Years		
	Pre-Euro	Euro I	Euro II	Euro III	Euro I	Euro II	Euro III
2 Wheeler		20%	80%		20	60%	20%
3 Wheeler	100%					50%	50%
Car			20%	80%		20%	80%
Multi-axle		10%	20%	70%	10%	20%	70%
Bus		10%	20%	70%	10%	20%	70%
2-axle		10%	20%	70%	10%	20%	70%

347. The model requires basic information and parameters from the project such as the type ofroad (expressway, rural or urban road), number of sections to be assessed, project's useful life, induced traffic elasticity, and maximum passenger car units (PCUs). TEEMP also requires physical details (lane width, lane length, number of lanes and roughness coefficient); traffic and trip details per section (average traffic volume per day, average trip distance, % share of local traffic, and trip distance for local trips); and fleet details (% breakdown of vehicles per fuel type, fuel efficiency at 50 kph, % breakdown of different vehicle fuel types by Euro standards, PCU equivalent of different vehicles, occupancy and loading factors).

348. Traffic forecasts were taken from a Detailed Project Report and is shown in Table 35. The corresponding growth rates for different vehicle types are indicated in Table 36.

Table 39: Annual Average Daily Traffic (AADT) for Elenga-Hatkamrul Road

Vehicle Type	2017	2020	2025	2030	2036
2-Wheelers	860	1,017	1,352	1,808	2,576
3-Wheelers	1,643	1,999	2,773	3,846	5,694
Car	769	935	1,297	1,799	2,664
Multi-axle	416	507	703	975	1,443
Bus	6,030	7,337	10,176	14,113	20,896
2-axle	9,540	11,609	16,100	22,329	33,061

Table 40: Normal Traffic Growth Rates for Different Category of Vehicles

Period	2-Wheelers	3-Wheelers	Car	Multi-Axle	Bus	2-Axle
2017~ 2019	4.70%	7.48%	7.48%	7.48%	7.48%	7.48%
2020 ~ 2024	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2025 ~ 2029	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2030 ~ 2034	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%
2035 ~ 2036	4.82%	7.74%	7.74%	7.74%	7.74%	7.74%

349. Input parameters as considered for all the project roads are as given in Table 37. The design period is 20 years and volume capacity saturation limit is considered based on the current traffic velocity and is considered as 2.0 for the entire project road.

Table 41: Input Parameters for TEEMP

No.	Particular	BAU	WPS
1	Lane width (m)	3.5	3.65
2	Lane length (km)	41.7	41.7
3	Number of lanes	2	4

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4	Roughness (m/km)	6	2.5
5	Induced Traffic		0.2
6	Start of Assessment Year	3	3
7	AADT	2017	2,036
	2-wheelers	860	2,576
	3-wheelers	1,643	5,694
	Car	769	2,664
	Multi-axle	416	1,443
	Bus	6,030	20,896
	2-axle	9,540	33,061

350. Maximum PCU for 2 and 4 lanes were considered as 36,000 and 80,000, respectively. Inthe absence of emission factors data for vehicles in Bangladesh, emission factors were mostly taken from the CPCB/ MoEF&CC, India (2007) Draft Report on Emission Factor Development forIndian Vehicles, The Automotive Research Association of India, and C. Reynolds et. al (2011) Climate and Health Relevant Emissions from in-use Indian three-wheelers rickshaw as presentedin Table 38.

Table 42: CO2 Emission Factors for different vehicle types

Vehicle Type	CO_2 Emission Factor (kg/L)	
	Gasoline	Diesel
2-Wheel	1.37	
3-Wheel	2.12	2.63
Cars	2.24	2.59
Multi-axle		3.21
Bus		3.61
2-axle		3.50

351. It was assumed that the 2-wheelers and 3-wheelers have an average trip distance of about 5 km in each section, whereas all other vehicles do use the entire length as average trip distance. Furthermore, 2-wheelers and 3-wheelers constitute 90% each of the total local traffic, whereas car, multi-axles, bus, and 2-axles constitute 0% respectively of the total local traffic.

352. Emissions from road construction were estimated by using the emission factor for rural/urban roads, by using ADB - Carbon footprint 1 (http://www.adb.org/documents/reports/estimating-carbon-footprints-road-projects/default.asp), which is equivalent to 48,400 kg CO_2/km of road construction.

353. The proposed road widening and upgrading resulting to surface roughness and road capacity improvements have implications in CO_2 emissions. Improved roughness results in higher speed and lesser emissions while an increase in vehicles in the new road increases emissions. These factors are further affected by traffic congestion once the volume/capacity saturation limit is reached.

354. The project road section-wise CO_2 emission intensity is provided in Table 37. The designlife of the road is 20 years. Total CO_2 emission at business-as-usual, project without induced traffic, and project with induced traffic were estimated as 14,257,636 tons, 6,106,116 tons, and 8,084,304 tons, respectively. CO_2 emission from construction phase was estimated at 3,087 tons.

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355. Emissions from PM and NOx were likewise shown in Table 39. PM and NOx emissions are higher during with project scenario, as a result of more vehicles using the road compared to the BAU scenario.

Table 43: Table 39: Output and Output Intensity of CO2, PM and NOx

Parameters	GHG / Pollutants	Project Scenario		
		BAU	WPS (without induced traffic)	WPS (with induced traffic)
Output (tons)	CO_2	14,257,636	6,106,116	8,084,304
	PM	1,007	1,222	1,454
	NOx	35,886	43,567	51,829
Output Intensity (tons/year)	CO_2	712,882	305,460	404,370
	PM	50.33	61.11	72.70
	NOx	1,794.28	2,178.35	2,591.47

356. In terms of intensity, total CO_2 emissions at business-as-usual, with-project (without induced traffic) and with project (with induced traffic) scenarios were estimated at 712,882 tons/year, 305,460 tons/year and 404,370 tons/year, respectively. These values are significantly above the 100,000 tons CO_2e/year threshold[19] set in ADB SPS 2009. ADB requires the borrower (the Government of Bangladesh through the Roads and Highways Department) to evaluate feasible and cost-effective options to reduce or offset project related greenhouse gas emissions.

B. Climate Adaptation

1. Introduction

357. The Elenga - Hatikamrul road sub-project is mainly linked to transport engineering aspectsof augmentation, rehabilitation and in majority cases new infrastructures initiatives with the primary objective to supporting national poverty reduction. This climate risk and vulnerability Adaptation (CRVA) is a crucial component where under ADB's requirements and for the purposesof subsequent project approval, the study needs to demonstrate that climate considerations havebeen integrated into the detailed designs of the road project.

2. Synopsis of Climate Change Risks and Vulnerabilities by Literature Review

358. The Bangladesh Climate Change Strategy Action Plan[2020] (BCCSAP 2009) recognizes that climate change will exacerbate many of the current problems and natural hazards the country faces. It is apprehended that climate change will lead to: increasingly frequent and severe tropicalcyclones, with higher wind speeds and storm surges leading to more damage in the coastal region; heavier and more erratic rainfall during the monsoon season resulting in: higher river flows, causing over-topping and breaching of embankments and widespread flooding, severe river bank erosion and increased sedimentation.

3. Climate Change Impacts and Vulnerabilities

359. The most authoritative study on climate change impacts in Bangladesh is the "Bangladesh

[19] Page 38, Appendix I, footnote 10 of SPS 2009

[20] A publication by Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Sep. 2009; http://www.climatechangecell.org.bd/Documents/climate_change_strategy 2009.pdf

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Climate Change Impacts and Vulnerabilities[21], (BCCIV 2006). The specific objective of the studywas to prepare a synthesis for the general readership on climate change issues for Bangladesh.The modality of achieving this objective was to take note of all the important findings in publishedliterature and put it in a form so that the product helps the readership to clearly understand the dynamics of climate change and relate it within the contexts of various relevant sectoral development initiatives. The report expects to help create awareness among the stakeholders and in near future, lead to an 'informed decision making' while considering development decisions in vulnerable areas and/or sectors.

360. By BCCIV 2006 study, for Bangladesh, efforts were made to develop climate change scenarios using various generic methods as under: (a) In early stages of assessing climate change impacts, and in the absence of appropriate models and modeling facilities, researchers have used 'expert judgments' to come up with climate scenarios; (b) With the proliferation of computer assisted Atmosphere-Ocean Global Circulation Models (AOGCM), scientifically more rigorous and acceptable scenarios have been developed in the second stage; and (c) Further withdevelopment of regional models as well as strengthening of computational capabilities, scenarioshave been developed by using Regional Climate Models (RCM).

361. Under (a) above, Mahtab (1989) speculated that a general surface warming of 0.3 to 5°C would occur by the year 2050. It is also thought that rainfall would increase by 5 to 20%. For sea level rise, a range of 30 to 150 cm was assumed by the year 2050. However, Mahtab (1989) considered a median value by taking the mean of the two limits and adding 10cm for local subsidence, which provided for 100 cm 'net sea level rise' by the year 2050.

362. In another instance, the effects of 2°C and 4°C change in average temperature were speculated for defining 'moderate' and 'severe' climate change scenarios, respectively (BCAS- RA-Approtech, 1994). The two scenarios also speculated a rise in peak monsoon rainfall by 18 and 33%, respectively. It was anticipated that the increase in monsoon rainfall would cause an increase in river discharge during peak flow periods by 8 and 15%, respectively, for the two scenarios. The corresponding sea level rise was speculated to be 30 and 100 cm, with a corresponding rise in cyclonic intensity by 10 and 25%, respectively.

363. Further yet, Ali (1999) considered 2°C and 4°C changes in average temperature as lowerand upper bound thresholds for 2010, respectively, in order to analyze impacts of climate changeon cyclonic storm surge along the Bay of Bengal. The same study speculated rise in sea level by30 and 100 cm, for the two scenarios, respectively. The base case however considered no changein sea level.

364. Under (b), and starting early 1990s, several attempts have been made to generate climate change scenarios by the use of available General Circulation Models (GCM). The earliest BUP-CEARS-CRU (1994) study reported 0.5^0 C to 2.0^0 C rise in temperature by the year 2030 under 'business as usual' scenario of IPCC. The same modeling effort estimated 10 to 15% rise in average monsoon rainfall by the year 2030. The study could not draw an inference in relation to change in sea level, however it commented that both sedimentation and subsidence were likelyto complicate an expected net change in sea level along the Bangladesh coast.

365. A subsequent ADB (1994) study made use of four GCMs: CSIRO9, CCC, GFDLH, and UKMOH. A host of IPCC scenarios available at that point have been considered which provided a

[21] Bangladesh Climate Change Impacts and Vulnerabilities, A Synthesis, A .U. Ahmed, Climate Change Cell,Department of Environment, Comprehensive Disaster Management Programme, Government of the People's Republic of Bangladesh, July 2006.

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number of scenarios. In order to avoid complications, only the IPCC IS92a and its results (modeling outputs) were summarized in the study. It was reported that, for 2010 the temperaturewould rise by 0.3^0 C and for 2070, the corresponding rise would be 1.5^0 C. The four models usedfor developing scenarios all provided different results for monsoon rainfall. The high-estimating GFDL model (GFDLH) projected 59% higher rainfall in South Asian monsoon with a corresponding withdrawal of dry season rainfall by 16%. The CCC model, however, projected anincrease of monsoon rainfall by 20% and withdrawal of dry season rainfall by 6%. Both consideredа doubling of CO_2 concentration in the atmosphere (therefore, time independent). A time- dependent modeling provided a medium scenario for South Asian rainfall: the monsoon rainfall was projected to increase up to 5% by 2010 and between 5 to 30% by the year 2070, while the dry season rainfall was projected to vary between -10 to +10% by the year 2070.

366. The BCCIV 2006 states that it is important to note here that the two above modeling experiments haven't tried validation of the GCM outputs for Bangladesh. This is why the area-averaged results for the South Asian domain were used in a bid to develop climate change scenarios for Bangladesh. Recognizing the fact that, the extent of monsoon rainfall diminishes asthe front advances towards northwestern parts of the sub-continent, technically one may argue that South Asian domain might not have represented the country-specific rainfall conditions.

367. Under (c), major attempts to generate model-driven climate change scenarios were made under the 'Climate Change Country Studies Programme' (Ahmed et al., 1996; Asaduzzaman et al., 1997 and Huq et al., 1998). A number of GCMs have been used including Canadian ClimateCentre Model (CCCM), Geophysical Fluid Dynamics Laboratory equilibrium model (GFDL), and 1% transient model of GFDL (i.e., GF01). Observed climate data were supplied by the CLIM database, as provided by National Center for Atmospheric Research (NCAR), USA. The outputsof the three GCMs for the 1990 base year were validated against long-term 'climate normal', as provided in published report (FAO-UNDP5, 1988). The downscaling of climate data for Bangladesh down from GCM scale was possible by comparing different GCM outputs. The GFDL 1% transient model represented the long-term climate normal the best and was considered for the development of time-bound climate change scenarios (Ahmed et al., 1996). Three climate change scenarios by various authors which were largely used for a number of subsequent national assessments, as given in the BCCIV 2006 report, are tabulated below.

Table 44: Climate Change Scenarios as Presented in BCCIV, 2006

2.1(A): Source: Ahmed, A.U. and Alam, M., 1998												
Year	**Average Temp., ^{0}C**			**Temp. Increase, ^{0}C**			**Average Precipitation, mm/month**			**Precipitation Increase, mm/month**		
	W	**M**	**Av.**	**W**	**M**	**Av.**	**W**	**M**	**Av.**	**W**	**M**	**Av.**
1990	19.9	28.7	25.7	0.0	0.0	0.0	12	418	179	0	0	0
2030	21.4	29.4	27.0	1.3	1.3	1.3	18	465	189	+6	47	10
2075	22.0	30.4	28.3	2.1	1.7	2.6	00	530	207	-12	112	28
2.1(B): Source: Agrawala et al., 2003												
	Temperature Change, ^{0}C, Mean (standard deviation)						**Rainfall Change, %, Mean (standard deviation)**					

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	Annual	DJF	JJA	Annual	DJF	JJA
2030	1.0 (0.11)	1.1 (0.18)	0.8 (0.16)	2.3 (2.30)	-1.2 (12.56)	+4.7 (3.17)
2050	1.4 (0.16)	1.6 (0.26)	1.1 (0.23)	+5.6 (3.33)	-1.7 (18.15)	+6.8 (4.58)
2100	2.4 (0.28)	2.7 (0.46)	1.9 (0.40)	+9.7 (5.8)	-3.0 (31.6)	+11.8 (7.97)

2.1(C): Source: Adopted from the Bangladesh NAPA Document (GOB, 2005)

	Temperature Change, ^{0}C , mean			Rainfall Change, %, mean			Sea Level Rise, cm
	Annual	DJF	JJA	Annual	DJF	JJA	
2030	1.9	1.1	0.8	5	-2	6	14
2050	1.4	1.6	1.1	6	-5	8	32
2100	2.4	2.7	1.9	10	-10	12	88

4. Findings from Other Available Online Climate Change Literature onBangladesh

368. Review of findings from other published and online available literature on climate changein Bangladesh indicate risks and vulnerabilities due to changes of temperature, rainfall, temperature and rainfall related extreme events, cyclones, floods, and sea level rise. Climate change in Bangladesh is likely to result in: **(1) higher annual precipitation and daily temperature; (2) greater temperature and rainfall extremes; (3) increased flooding, both in terms of extent and frequency; (4) increased cyclone and storm surges both in terms of extent and frequency; (5) low river flow during dry periods; and (6) sea level rise and increased salinity intrusion**.[22] Similarly a working paper[23] by World Bank cites Bangladesh as one of more "potential impact hotspots" threatened by, "extreme floods, more intense tropical cyclones, rising sea levels and very high temperatures".

Table 45: Climate Change Scenarios in Bangladesh based on Available Online Literature

Climate Change Risks	Description
Rainfall	• Significant increase of average annual rainfall of Bangladesh at a rate of 5.52 mm/year over the period1958–2007 • number of wet months is increasing, and the number of dry months is decreasing both in monsoon and pre-monsoon in most parts of the country. • Heavy rainfall days (>200mm) in Bangladesh have increased significantly by an amount of 1.2 days/decade.
River Water Level and Flooding	• While the magnitude and duration of average flood events in Dhaka have decreased or remained the same over time, the frequency of the most extreme events has increased. • Flood severity has increased in Bangladesh in the recent years.
Change in Temperature	• An increase of mean temperature of Bangladesh by 0.097°C/decade has also been observed at 95% level of confidence in the last fifty years

[22] Vulnerability of the power sector of Bangladesh to climate change and extreme weather events; Regional Environmental Change, 12(3): 595-606, Shahid, S. (2012)
[23] http://climatechange.worldbank.org

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Climate Change Risks	Description
	• The trends in number of hot days (maximum temperature >30°C) and heat wave frequency (consecutive three days with maximum temperature greater than the 90th percentile)for the time period 1958-2007 increased by 1.16 days/year. at 99% level of confidence.
Tropical Cyclones	• The rate of land falling tropical storms has increased by 1.18per year since 1950 (Islam and Peterson, 2009). • Flooded area, flooding depth and surge intrusion length willbe substantially larger under intensified surge conditions.
Sea Level Rise	• It has been reported that the sea level in the coastal regionof Bangladesh will increase by about a meter by 2100 (World Bank 2000). • The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) projected that global mean sea levels would rise by 18 – 59cm above 1990 levels by the 2090s
Salinity in River Water	• Salinity in some parts of the coastal region of Bangladeshhas increased by 124% in the last 30 years. • Reduction in rainfall and low river flow during the dry seasonmay aggravate the salinity levels in the coastal rivers of Bangladesh.

5. Discussions on Climate Change Risks and Adaptation Measures for theElenga - Hatikamrul Road

369. The main climate change induced concerns on the road project will need to adequately address the following:

C. Flooding

370. With increases projected both in terms of magnitude and intensity of precipitation, the concern is that of flood discharge. Although there is the need for new design and maintenance criteria to be based on future climate projections, the projection of flood values based on global or regional climate change scenarios is a difficult task, and is shrouded with some degree of uncertainty. Further, there is the lack of long-term measurement series on precipitation and run- off in the project area and that makes statistical work and future projections challenging. Possible ways of temporarily compensating for the lack of measurement data and predicted runoff are theuse of more conservative return periods, or increasing the design capacity by an additional climatefactor.

371. Indeed, section 5.3.3 of the IEE [1] report of the Elenga – Hatikamrul road acknowledges concerns of climate change impacts particularly by flooding. The report states that there are chances of not only increasing of flood water levels but also reduction of flood return periods under an uncertain future climate. Weather is a complex system and so is climate change in whichthe prediction of absolute time and magnitude of future events cannot be envisaged with certainty.However, the IEE considers adaptation measures against flooding as described under:

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Additional road embankment height to combat climate change induced flooding:

372. Risk can be defined in terms of the recurrence interval, or the probability of a flood of stated magnitude, being equaled or exceeded in any given year. Drainage structures aredesigned to accommodate the flow of a given return period or probability of occurrence. The selection of the design flood recurrence interval involves an evaluation of the risk of disruption ordamage to the road, possible loss of life, property damage, interruption of traffic, and the economicconsequences.

373. The IEE [1] states that roads in Bangladesh are designed for 20-year recurrence period, which by the CRVA finds it to be low particularly when the IEE report admits to reduction of return periods under a changed future climate. However, as a safeguard, the IEE report suggests that additional height should be applied over the design road height of 20-year return period (i.e., existing height). Thus, the design of the road embankment considers an additional 102.4 cm fromthe existing road surface. The embankment design envisages a 37 cm rise in flood level under achanged future climate and together with allowances for freeboard and other additional components makes to 102.4 cm.

Additional Freeboard for Bridges to combat climate change induced flooding:

374. The IEE reports that there are 15 bridges and 27 culverts along the Elenga - Hatikamrul road alignment. One of the bridges is over 100m in length and is located on the Fuljor River. Therest of the structures are mostly across undefined channels and carry only seasonal flow. Most bridges are located over depressions and low-lying ditches. Culverts are also located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels on either side of the road embankment.

375. Bridge designs are commonly based on a criterion to withstand the n-year flood event. For example, a highway bridge might be designed to pass the 100-year flood. Failure may occur if the structure faces an event larger than this. Climate change may necessitate different design criteria because of changes to flood frequency behavior.

376. As an adaptation measure presented in the IEE report, the design of bridges in the projectarea advocates a 37 cm increase from existing levels in line with the envisaged increase in floodlevel under a changed future climate. The bridges in the proposed roads are designed for a 50-year return period. The climate change adaptation concept for bridges in the project area takes the bridge design to protect against a 1 in 50-year flood (i.e., 2% chance of occurrence of a 50- year flood magnitude in any given year), with an additional a 37 cm allowance for climate change.

1. Run-off and necessary drainage capacity

377. Higher precipitation intensity increases the risk of floods that exceed the capacity of the drainage infrastructure serving the road system. In Bangladesh where cyclonic storms are an annual occurrence and whose frequency has been observed to be on the rise, this will further aggravate the risk. This is an important safety issue that should be considered when discussing the capacity of drainage systems.

378. In line with the climate change literature summarized in Section 2 of this report, Section 5.3.4 of the IEE [1] report acknowledges that inflows from the three major rivers Ganges, Brahmaputra and Meghna into Bangladesh are on average projected to increase over the monsoon period (driven primarily by increased basin precipitation). As a result of these increaseddischarges, the drainage structures throughout the roads

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379. must drain much more water under climate change scenario.

380. The IEE report states that the present Elenga – Hatikamrul road has no longitudinal drainage system, and the existing cross-drainages are inadequate in terms of discharge capacity.The report estimates that the road area will need to drain about 20% additional discharge due toclimate change induced by higher rainfall during extreme events. As an adaptation measure, theproposed road will incorporate longitudinal drains along the total highway length, increase the number of cross drainages per unit distance and replace existing pipe culverts with box culverts that provide larger discharge openings.

2. Engineering Improvement in Road Design

381. Technological improvement is an option to address the emerging requirements linked to changes in climate. This is happening not only in the field of construction materials, aiming at providing a wider climate range of application, but also in the design of innovative structures for the operation of transport infrastructure.

382. Increased precipitation will lead to local elevation of groundwater levels. This, in addition to more infiltration into the road structure from above, will increase water content in the road sub-grade. This will lead to rutting of asphalt pavements (as is the case with higher temperature extremes) as a result of faster deterioration of materials in the road sub-base. The sub-base is meant to act as a drainage layer between the sub-grade and road base by preventing the sub- grade from wetting up to the road base. The design of the Elenga – Hatikamrul road envisage toimprove the sub-base as an effective drainage layer, by, in terms of quality of granular material required at that layer to barricade the upwards movement of moisture and lessening the deterioration of the road base.

3. Adaptation to High Temperature

383. It is well known that rutting is one of the main distresses in the asphalt pavements under the action of heavy traffic and high road surface temperatures, followed by cracking under the action of UV radiation. By literature cited in Section 2.2.3, climate models estimate a steady increase in temperature for Bangladesh and predict an average increase of temperature of 1.4°Cin 2050 and 2.4°C in 2100. The trends in number of hot days (maximum temperature > 30°C) andheat wave frequency (consecutive three days with maximum temperature greater than the 90th percentile) for the time period 1958-2007 increased by 1.16 days/year at 99% level of confidence.

384. Paragraph 108 (page 34) of the IEE report presents an average monthly maximum and minimum temperature from a representative station for data years 1991 - 2012. However, many practical problems require knowledge of the behavior of extreme values as the infrastructures we depend upon for food, water, energy, shelter and transportation are sensitive to changes in climate extremes rather than averages. By the IEE report the highest recorded temperature is stated to be 37.5^0C during the period 1991-2012.

385. The pavement binder bitumen is an essential component of any road pavement and is used widely throughout Bangladesh. General literature on bitumen suggests that road pavementmade from viscosity grade (VG) bitumen will have better performance, because the viscosity value measured at 60^0C correlates well with rutting behavior and viscosity value at 135^0C gives sufficient idea about the mixing and compaction temperature and as a result pavement life is improved. IS

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73:2013[24] classifies four grades of bitumen based on viscosity at 60^0C, and recommends applicability for maximum air temperature as given below:

Grade	Grade Suitable for 7-day Average Maximum Air Temperature, ^{0}C
VG10 (80/100)	< 30
VG20	30-38
VG30 (60/70)	38-45
VG40 (30/40)	>45
NOTE — This is the 7 day average maximum air temperature for a period not less than 5 years from the start of thedesign period.	

4. Climate Change Adaptation Costs for the Elenga - Hatikamrul Road

386. Since there are enough evidence that climate change will modify actual risk levels and therefore challenge design guidelines and procedures for the operation and maintenance of the road infrastructure, a budget of $9.79 million was allocated for engineering measures as climatechange adaptation costs. These covers increase in road embankment height by 37 cm for 33.4 kmlength of the Elenga-Hatikamrul road; increase in bridge height by 37 cm for 15 bridges with a total length 809 meters; addition of new box culverts and replacing pipe culverts with box culverts;installation of longitudinal drainage system to quickly drain out the water for heavy rainfall; and improvement of subgrade as drainage layer to lessen the deterioration of the road base.

[24] Bureau of Indian Standard (BIS, 2013); (Note: Literature on Bangladesh Standards for Bitumen could not be traced.)

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VII. ENVIRONMENTAL MANAGEMENT PLAN

A. General

387. This section contains a comprehensive Environmental Management Plan (EMP) for the Elenga - Hatikamrul Road project. As described in Environmental Safeguards policy principle, EMP 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.[25] The EMP for the Elenga - Hatikamrul Road describes the activities, the proposed mitigating measures,the monitoring indicators, performance targets, location, and the institutional responsibilities for implementation and supervision of proposed mitigating measures. This EMP is included as an integral part of the environmental safeguard requirements in the bid documents.

B. EMP Objective

388. The main objective of EMP formulation is to ensure environmental sustainability of project and to integrate environmental considerations in all aspects of road civil works. EMP recommendsa set of environmental safeguard measures to address adverse environmental and social impactsof the project. Moreover, performance indicators as well as performance targets are incorporatedto lessen ambiguity in monitoring. The EMP also has assigned implementation and supervision responsibilities to mitigate potential impacts. All mechanisms are put in place to ensure compliance with EMP requirements and environmental regulations of Bangladesh.

389. The EMP is necessary to manage the environment by offsetting the negative impacts with recommended mitigation measures and enhancing the positive impacts, within the allocated budget for the project. Thus, EMP for the implementation of Elenga - Hatikamrul Road project:

a. define the responsibilities of the project proponents during design pre-construction, construction and operation;
b. facilitates the implementation of the mitigation measures by providing the technical details of each project impact, and proposing an implementation schedule for the proposed mitigation measures;
c. define a monitoring mechanism and identify monitoring parameters to ensure that all proposed mitigation measures are completely and effectively implemented;
d. identify training requirements at various levels and provide a plan for the implementation of training sessions;
e. identify the resources required to implement the EMP and outline corresponding financing arrangements; and
f. provide a cost estimate for all proposed EMP actions.

[25] Safeguards Policy Statement 2009, page 16.

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Table 46: Environmental Management Plan

EMP Code[26]	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
IMPLEMENTATION PHASE: DESIGN/PRE-CONSTRUCTION (Pre-construction phase is completed, and hence not considered in updated IEE)								
$P01_{EMP}$	Lack of environmental awareness	Awareness on environmental protection aspects relevant to good construction practices to avoid or lessen potential environmental impacts of construction activities	• RHD to provide early training as part of the overall awareness and training program to be delivered before construction.	• Proof of completion. • Posting of proof of completion at worksites	Safeguard Compliance Orientation	Location to be confirmed	RHD	RHD

[26] P – Pre-construction; C – Construction; O - Operation

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P02EMP	Deforestation through removal of trees and vegetation	Cutting of 31,450 trees of different species.	• Minimize tree cutting by selecting road widening options based on technical and legal considerations. • Secure permit from Forestry Department prior to tree cutting / removal • Afforestation of tree saplings at ratio of 1:2 • For social forestry afforestation, ratio shall be as per the consultation with tree owner. • Raised median will be planted with grasses and shrubs which may not attain height of more than two meters.; • Compact plantation will be done on both sides; • In consultation with Forestry Department, only indigenous trees most suited to the tract will be planted; • Conduct information, education and communication (IEC) • campaign on importance ofplanting trees.	• No. of trees cut and planted • 75% survival of trees • No. of IEC campaigns conducted	Compliance with national guidelines	Throughout the project area	Design Consultants (DC)	RHD
P03EMP	Climate Change	• Changes in climate and long term impacts on the environment	• Consider potential impacts from extreme climate change scenario in designing bridge and culverts.	• Consideration of climate change in project design	Compliance with National guideline	Throughout the Project area	Design Consultant (DC)	RHD

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P04EMP	Topography	• Change in topography dueto construction-related structures suchas bridges, flyovers, and footbridges; and • Visual changesto topography.	• Implementation of tree planting program to reduce erosion due to change in topography	• Transport route and worksite cleared of any dust/mud	Compliance with National guideline for land use policy.	Through out the project areas andother suitable land identified by RHD	Design Consultant (DC)	RHD
P05EMP	Land Acquisition	Acquisition of 8.87 ha of land, 5.47 ha of which is agricultural land; Resettlement of Affected Persons (APs).	• Careful alignment and route selection to minimizeresettlement; • Develop compensation packagefor APs based on Land Acquisition and Resettlement Plan Entitlement Matrix	• Land substitution • Cash compensation of properties acquired.	Compliance with RP	Throughout the project areas	Design Consultant (DC)	RHD
P06EMP	Loss of residential, commercial and industrial structures	• A total of 181,083 square feet of primary structures will beaffected[27]	• Compensation for the loss of land, house, trees, structures, crops, wage/income to be included in the ResettlementPlan. • In case of relocation provision of similar or better living conditions for project affected persons (PAPs).	• Number of grievances related to resettlement • Number of complaints from sensitive receptors	Compliance with RP	Throughout the project area	Design Consultant (DC)	RHD
P07EMP	Civil work activities near educational, institutional, religious and other sensitive receptors	• Disturbance and other physical inconvenience on the people utilizing the structures	• Dialogue with the institutions on the schedule of construction works • Implement national guidelines on chance find procedures	• Number of meetings with institution heads on details of construction works • Records of chance finds • Provision of temporary access	Compliance with RP	Throughout the project area	Design Consultant (DC)	RHD

[27] Structures used for residential (bed room, kitchen, store room, etc.) and commercial purposes or community interest (IEE, page 67)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
P07EMP	Civil work activities near educational, institutional, religious and other sensitive receptors	• Disturbance and other physical inconvenience on the people utilizing the structures	• Dialogue with the institutions on the schedule of construction works • Implement national guidelines on chance find procedures	• Number of meetings with institution heads on details of construction works • Records of chance finds • Provision of temporary access	Compliance with RP	Throughout the project area	Design Consultant (DC)	RHD
P08EMP	Damage to Public Utilities	• Disruption of services	• Provision in the design andbudget for the relocation of the existing utility infrastructures, wherever required; • All public utilities (e.g. water/gas pipes, power/telephone lines, mobile tower likely to be affectedby the proposed project road expansion will be relocated before construction work. • Inform all hospitals, schools,places of worship, and affected communities well in advance; • Secure approval from agencies on removal of utilities; • Repair of damaged utilities at contractor's expense. • Reconnect utilities at shortest practicable time before construction commences. • It is necessary to separate the live parts and insulating material from underground water pipes/gas pipes.	• Number of complaints from sensitive receptors • Number of electric poles relocated; • Temporary power supply • Number of approval to relocate or remove utilities	Compliance with RP and emergency response plan	Throughout the project areas	Utility service providers	RHD

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
P09EMP	Legal permits and clearance	Taken from the GoB and local authorities	Obtain all necessary consents, permits, environmental clearances, etc. from concerned authorities like DOE, FD, BIWTA, DC office and other concerned stakeholders and authorities before the start of civil works.	Records of chance finds Temporary access provision; Permanent access restored	Compliance	Throughout the project areas	RHD/ DC	RHD
IMPLEMENTATION PHASE: CONSTRUCTION								
C01EMP	Changes to hydrologic regime due to construction of more bridge, and culverts	• Conditions of temporary blockage of drainage in small bridges, culverts, serviceareas, and construction sites may be increased • Increased floodrisk from rapid and higher levels of runoff	• More culverts will enhance cross drainage capacity ; • Non-disposal of wastes in body of water	• Designs of both Cross and side drains; • Number of culverts; • Number and size of pipes	Compliance with Design Report	Bridge and culvert sites	Contractor	RHD/Supervision Consultants (SC)
C02EMP	Drainage changes	• Drainage congestion due to waste / sediment disposal and construction of road embankment; • Erosion and subsequent deposition in the adjacent cropfields.	• Regular cleaning of channels to avoid choking. • Provision of adequate cross drainage structures to easily drain off water to canals and other lowland areas; • Ensure that storm water drains and highway drainage systems are periodically cleared to maintain storm water flowsduring construction.	• Designs of both cross and side drains; • Number of culverts; • Number and size of pipes	Compliance with Design Report	Drainage structure sites	Contractor	RHD / Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
C03EMP	Soil Erosion and Siltation	• Soil erosion due to construction activities, earthworks, cut and fill operations and from stockpiles	• Adopt good construction practices. • Replanting with native varieties of trees and shrubs • Construction schedule for bridges during dry season. • Turfing of embankments to protect slopes. • Earth stockpiles to be provided with gentle slopes • Vegetate road embankments and road cuttings with fast growing crop and a native seed mix immediately after fill placement to prevent scour and to encourage stabilization.	• Receipt of complaint regarding sediment loss or water turbidity. • Bridge locations; • Retaining walls • Number of any non-compliance reports	• Compliance with • National /International guideline limits for soil quality	Full length of the road alignment	Contractor	RHD / Supervision Consultants (SC)
C04EMP	Soil Compaction and Contamination	• Compaction of soil due to movement of vehicles and equipment's • Contamination of soil due to leakage/spillage of oil, bituminous and non-bituminous debris	• Construction vehicles, machinery, and equipment to be stationed in the designated ROWto avoid compaction. • Haul roads to be designated along the fallow and consolidated soil areas to reduce compaction of arable land. • Fuel storage and filling to be undertaken in areas withconcrete surfacing, bunds and interceptor traps • Oil interceptors to be provided at wash down and refuelling sites • Oil and grease spill and oil- soaked materials shall be sold off to authorized recyclers.	• Number of any non-compliance reports • Maintenance of temporary passages;	• Compliance with • National /International guideline limits forsoil quality	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
C05EMP	Topsoil removal	• Removal of top soil for construction from outside the RoW. • Compaction of topsoil. • Loss of top soil by wind and water erosion. • Covering of top soil by project works. •	• The stockpile top surface slope to be no steeper than 2 (H):1 (V) to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles outside drainage lines and protect stockpiles from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Use stripped topsoil only to cover all disturbed areas and along the proposed tree plantation sites. • Rip ground surface prior to the spreading of topsoil. • Limit equipment and vehicular movements to within the approved construction zone. • Remove unwanted materials from topsoil such as roots of trees, rubble and waste etc.	• Number of non-compliances • observed/ • reported	• Compliance with • National /International guideline limits for soil quality	Various construction sites throughout the road alignment	Contractor	RHD/ Supervision Consultants (SC)
C06EMP	Air Quality	• More dust generation due to ncreased construction activities and transport of construction materials.	• Vehicles transporting construction material to be covered; • Construction equipment to be maintained to a good standard and idling of engines discouraged.	• Location of stockpiles; • Number of complaints from sensitive receptors;	Compliance with DoE and National guideline limits for	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
		• Emissions from vehicles, equipment and machinery.	• Machinery emitting visible smoke to be banned from construction sites; • Contractor to prepare a dust suppression program detailing action to be taken to minimize dust generation (e.g. spraying of roads with water), and the equipment to be used. • Equipping asphalt hot mix and batching plants with fabric filters or wet scrubbers to reduce dust emissions; • Locate asphalt and crushing plants away from residential areas and social infrastructure such as mosques, schools and madrasas. Clearance should be at least 500 m and consider the prevailing wind direction • Dust masks to be provided to workers where dust hazards exist. • Proper dust collection and control systems to be installed at crushers • Air quality monitoring to be carried out as per the schedule in the environmental monitoring plan.	• Heavy equipment and machinery with air pollution control devices; • Levels of SOx, NOx, CO, PM_{10}, $PM_{2.5,}$	Air at sensitive receptors. • Certification that vehicles are compliant with air quality standards.			

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C07EMP	Noise and Vibration	• More noise from increased construction vehicles, equipment and machinery.	• Use of adequate modern plant and equipment with appropriate muffling devices. • All powered mechanical equipment and machinery to be fitted with noise abating gear	• Number of complaints from sensitive receptors;	• Equivalentdayand night time	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
		• Vibration caused by construction activities.	such as mufflers for effective noise control, in compliance with DoE regulations. • Construction operations to be restricted to 0700 to 1800 hours. • Locate rock crushing, concrete mixing and material shipment yards away from residential areas, schools, colleges and hospitals. • Install temporary noise barriers near sensitive locations such as schools, religious places and hospitals • Providing the construction workers with suitable hearing protection like ear cap, or earmuffs etc. • In areas, where structures may to be affected by vibrations from construction activities, take precautions to minimize the vibration and the resulting impact. • Noise quality monitoring to be carried out as per the schedule in the environmental monitoring plan.	• Noise measureme nt data • Use of silencers in noise-producing equipment and sound barriers;	noise levels • Complia nce with • DoE and National guidelin e limitsfor • Noise at sensitiv e receptors.			of Environment

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C08EMP	Changes to Topography and Landscape	• Land degradation dueto careless excavation from borrow area	• Borrow pits to be opened within the road right of way and not on agricultural land • Top soil to be preserved. Borrow pits to be rehabilitated. • Borrow pits opened on private land, to be either closed or converted to ponds at the	• Worksite clear of hazardous wastes such as oil/fuel • Worksite clear of any wastes,	• Compliance with • National guideline for land use policy.	Borrow areas	Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			completion of work as per the written direction of the landowner. • Construction wastes to be used in construction activities.	collected materials from drainages, unutilized materials and debris • Transport route and worksite cleared of any dust/mud	• Compliance with • Waste management plan			
C09$_{EMP}$	Siting of Construction Camps, Workshops and Processing Facilities	• Loss of plantation and vegetation. • Permanent physical and visual impact on the area. • Social disturbance for nearby community	• Construction camps and workshops to be located away from sensitive areas and not within 500 metres of existing settlements. • Briefing and/or on-site training for the contractor's workers on the environmental requirement of the project and the implementation of mitigation measures. • Minimise vegetation loss while making site arrangements for construction camps and other facilities; • Crushing plants, sites for borrow pits, asphalt hot mix and batching plants to be located clear of environmentally sensitive areas, productive land or existing settlements;	• Worksite clear of hazardous wastes such as oil/fuel • Worksite clear of any wastes, collected materials from drainages, unutilized materials and debris • Transport route and worksite cleared of any dust/mud	• Compliance with • Waste management plan	Construction camps, workshops and labour camps	Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			• Construct construction material storage areas away from sensitive areas; • Water and good sanitation facilities to be provided for the camps; • Solid waste must not be dumped, buried or burned at or near the project site, but shall be disposed of at the nearest sanitary landfill or site having and complying with the necessary permits. • The sites for camps and associated facilities shall be rehabilitated after completion of the project.					
C10EMP	Surface Water Bodies	• Loss of surface water bodies and impact on fish. • Disposal of construction wastes such as bentonite slurry and excess concrete during pile construction into water body.	• No bituminous or hazardous materials to be used for filling of water bodies. • Method statement on bridge/culvert construction works has to be prepared by the contractors for subsequent approval from the PMU-RHD.	No visible degradation to nearby drainages, khals or water bodies due to construction activities	• Effectiveness of water management measures	All water bodies likely to be affected along the project road	Contractor	RHD/ Supervision Consultants (SC)

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C11EMP	Surface Water Quality	• Contamination of surface water by disposal of construction waste. • Pollution of domestic water supplies	• No bituminous or hazardous materials to be used for filling of water bodies. • The workforce to be trained in proper means for storage and handling of materials and chemicals; • Work camps and work sites to be provided with toilets and septic tanks; • Proper drainage system with sedimentation ponds and oil separators to be provided to	No bituminous or hazardous materials to be used for filling of water bodies. Areas for stockpiles, storage of fuels and lubricants and waste materials; Number of silt traps installed along trenches leading to water bodies	Effectiveness of water management measures Compliance with National guideline limits for Surface water.	Construction sites along the full length of the project particularly beel / lowland / pond /	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
			cope with the rain water and oil spills. • Measures to be implemented to control oil spills near water channels • Washing of machinery and vehicles in surface waters to be prohibited. Sealed washingareas shall be provided and wastewater shall be collected in a sedimentation/retention pond for treatment prior to release. • Avoid or minimize damage to water channels; • Conduct regular water quality monitoring based on set schedule; • Prevent construction debris from entering drainage or irrigation canals; • Construction work close to ponds or other water bodies to be minimised especially during monsoon season; • Wastes to be collected, stored and taken to approve disposal sites.	Records of surface water quality inspection Levels of pH, TOC, PO_4, TSS, DO, oil and grease		ditch areas		

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$C12_{EMP}$	Groundwater Quality	• Contamination of underground water table from leachate of construction waste.	• Arrangements for safe drinking water to be made prior to start of work. Water for consumption to be supplied only after adequate analysis and requisite treatment. • Train workers on the need for judicious use of freshwater resources.	• No breaches of Material Safety Data Sheet (MSDS) for hazardous substances. • Levels of pH, $CaCO_3$, Cl^-,	• Compliance with • National guideline limits for • Ground water.	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			• Water reserves to be protected from contamination such as construction and oily waste.	Mn, As, Fe, total coliform, fecal coliform				
C13EMP	Waste Pollution	• Unhygienic conditions, health risks to work force and general public at the camp site. • Indiscriminate dumping of wastes from construction camp and construction sites cause negative impact on water, soil, and workers' health and safety.	• Solid and liquid wastes to be disposed at designated sites and no waste to be disposed in productive agricultural land; • Hazardous waste to be transported to nearby incineration facility; • Sanitary wastes generating from staff and labour camps to be disposed of in anenvironmentally friendly manner, i.e. provision of septic tank etc. for toilet wastes; • Pavement materials from the existing road to be incorporated in the upgrading works; • Develop a plan for waste management prior to commencing of construction and get approval from RHD.	• Number of non-compliances • observed/ • reported	• Compliance with • Waste management plan and national guidelines on management of wastes	Construction sites along the full length of the project, and vehicle maintenance and refueling areas.	Contractor	RHD/ Supervision Consultants (SC) / Department of Environment

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C14EMP	Dredging and Dredged Materials	• More area will be dredged for expansion of embankment construction that may enhance river bank erosion and higher flood risk and pollution due to spilling/ seepage of oil in the river. • More earth filling works will increase sedimentation and dispersion of pollutants in dredged material; • Contractors should submit a Dredged Material Management Plan to RHD for approval prior to commencing of construction works.	• Permits/NOC to be obtained, from relevant authority such as BIWTA prior to extraction • Work not to be carried out when fish are likely to be spawning or in the period between spawning and the subsequent emergence of juvenile fish (July to September). • While dredging, special care to be given to prevent any spillage/seepage of oil from the dredging machines; • If owners of the ponds and lands near the road alignment want to use their area for fisheries	• Results of dredged materials quality analysis	• Deploy additional compliance monitoring efforts to comply with National / International guideline limits for dredged materials.	Dredging sites and filling locations	Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			project, the contractor maycollect filling materials from that area through proper contract and dredging guidelines. • Dredged material from the river bank to be tested for presence of heavy metals and other pollutants before its use.					
C15EMP	Deforestation though clearing of vegetation from the RoW	• Loss of habitat due to tree cutting • A total of 31450 trees of different sizes and varieties were cut down due to site preparation and construction activities	• A total of 71500 plant saplings that suited to the tract to be planted; • Flowering and fruiting shrubs to be planted along the RoWs to enhance the landscape; • Contractor's personnel to be directed not to damage any vegetation such as trees or bushes. • Construction vehicles, equipment and machinery to be limited to their designated areas of movement. • Gas cylinders to be used for fuel at the camps for cooking purposes. Cutting of trees/bushes for fuel not to be allowed. • Camp sites and asphalt plants to be established on waste/barren land rather than on forested or agriculturally productive land.	• Number of complaints from sensitive receptors on disturbance of vegetation. • Illegal felling of trees • PMO and PIU to report in writing the number of trees cut and planted if tree-cutting will.be required	• Compliance with • Tree management plan	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC) / Forestry Department

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$C16_{EMP}$	Wildlife	• Hunting of wildlife and birds during construction.	• Wildlife Department to check and confirm that no hunting occurs; • New and good condition machinery with low noise generation characteristics to be used in construction;	• Number of complaints from sensitive receptors on disturbance of poaching.	• Compliance with National /International	Along the road alignment and bus depot	Contractor	RHD/ Supervision Consultants (SC) / Department

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			• Construction work not to be carried out at night. • Borrow pits to be fenced to protect animals.	• Illegal hunting	guideline for wildlife			of Environment
C17EMP	Fisheries	• Impact on fishing activity (production, spawning and breeding grounds) • Disturbance to aquatic life including migration of fish due to bridge construction.	• Construction not to be undertaken during high flood. • Construction along the riverbanks must be avoided during the fish breeding season (July to September). • Deep water channel to be maintained during bridge construction.	• Number of complaints from sensitive receptors on disturbance of fishing; • Any evidence of fish mortality.	Compliance with National/International guideline	Throughout the road corridor particularly in pond / ditch / river areas	Contractor	RHD/ Supervision Consultants (SC)

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C18$_{EMP}$	Land use	• Land disputes, soil erosion, loss of potential cropland and vegetation, landscape degradation, and damage to road embankments. • Land use change due to borrowing of earth. • Land use change and loss of productive top soil.	• Agricultural areas not to be used as borrow areas. • Land acquisition for borrow areas to be minimized. River sand to be used for embankment. Preference shall be given to borrow earth from right of way wherever feasible; • Necessary permits to be obtained for any borrow pits from the competent authorities and all environmental considerations to be ensured; • Topsoil from borrow areas to be preserved and borrow pits to be rehabilitated after completion of borrow operations ; • Borrow pits to be sited on waste land and at least 500 m away from the road;	• Number of complaints from sensitive receptors; • Records of sources of materials	Compliance with National/International guideline	Construction sites along the full length of	DC, Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
			• Priority to be given to borrowing from humps (including from digging of wells) above the general ground level; • Priority should be given to the borrowing by excavating/enlarging existing borrow areas;					

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$C19_{EMP}$	Vehicle traffic	• Increased traffic jams causing inconvenience to the people due to expansion of bridge and culverts during construction works	• Ensure implementation of traffic management plan to manage high traffic congestion and safe traffic plying • Provision to be made for passing traffic during construction • Traffic management shall be undertaken in coordination with the local traffic policedepartment. • Develop a site-specific Traffic Management Plan (TMP) by the contractor that should be approved by RHD before commencement of construction.	• Traffic route during construction works including number of permanent signage, barricades and flagmen on worksite as per Traffic Management Plan; • Number of complaints from sensitive receptors; • Number of signages placed at project location; • Number of walkways, signage, and metal sheets placed at project location	Compliance with Traffic managemen t plan	Constructi on sites along the full length of corridor	Contract or	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
$C20_{EMP}$	Cultural Sites	• Noise and dust pollution and movement of the people to the nearby schools, colleges, mosques, and graveyards etc.	• Timely completion of the construction work and provision for movement through or around the construction site; • Workshops and storage / processing facilities and labour camp to be sited to maintain proper clearances from the cultural sites.	• No complaints from sensitive receptors	• Compliance with • National guideline limits for • Noise and dust.	Along the project corridor	Contractor	RHD/ Supervision Consultants (SC)
$C21_{EMP}$	Income and Employment	• Income loss due to the loss of agricultural lands, private structures and common property resources and rehabilitation of the households.	• Contractor as far as practicable to recruit construction workers from amongst the locals and to maintain gender equity while employing the locals. • Priority shall always be given to people from amongst the project affected persons, the unemployed and lower income groups. • Set aside-areas within the contractor's camps/labour shed for local people to sell their products and to provide additional services to the workers.	• Employment records	• Compliance to Bangladesh Labor Law of 2006 and other applicable standards	Along the road alignment	Contractor	RHD/ Supervision Consultants (SC)

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C22 EMP	Occupational Health and Safety of Workers	• More structural works, particularly bridge, flyover will impose more health safety risk. • Health risks due to unsafe working conditions	• Adequate awareness and trainings should be organized for workers to work at height and hazardous areas. • Worker's compensation insurance to be taken out for all project staff; • Basic medical training to be given to specified work staff • Basic medical service and supplies to made available for workers; • Appropriate personal protective equipment (hearing protection, safety glasses, helmets, protective footwear and gloves, high visibility vests and other protective clothing) to be provided to all workers; • Provision of adequate sanitation, washing, cooking and dormitory facilities including lighting; • Adequate signage, lighting, barriers, yellow tape and persons with flags during construction to manage traffic at construction sites, haulage and access roads. • Application of preventive and protective measures consistent with international good practices such as the World Bank Group's Environment, Health and Safety Guidelines. • Prepare an OHS plan, including hazard analysis (including COVID-19 hazards as well as the usual construction and transportation hazards), training of all workers on the hazards for their own jobs.	• Equipped first-aid stations • Medical insurance coverage forworkers • Number of accidents • Records of supply of	Compliance to emergency response plan	Construction sites along the full length of the project	Contractor	RHD/ Supervision Consultants (SC)

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
$C23_{EMP}$	Health and Safety of community and accident prevention	• Health andsafety risks due to increased construction activities.	• Post safety signboards, signage, banners and stickers for awareness and precautions and maintain this activity throughout the period. • Provide effective safety barricade/fencing to control traffic within/adjacent to work sites. • Barriers (e.g., temporary fence) to be installed at construction areas to deter pedestrian access to the roadway except at designated crossing points. • Drivers operating construction vehicles and equipment must be trained and certified from the competent authority. • Crossing provision to be	• Number ofaccidents; • Number ofpermanent signage, barricades andflagmen onworksite as per Traffic Management Plan • Number ofcomplaints from sensitive receptors; • Number ofwalkways, signage, andmetal sheets placed a tproject location • Permanent sign boards forhazardous areas • Agreement between landowner and contractors in case of using	Compliance to emergency response plan	Construction sitesalong the full length of the project	Contractor	RHD/ Supervision Consultants (SC)

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			made for pedestrians and vehicles near settlements and market places. • Close consultation with local communities to maintain community integrity and social links and avoid conflict situations with respect to resource use. • To prevent short circuit fires, electric fire alarms (short circuit fire alarms) should be installed inthe necessary locations. Separate the live parts and insulating material from underground water pipes/gas pipes. • The workers with different transmittable diseases should be restricted to the construction site	private lands as work camps, storage areas, etc.				

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			and sent for treatment or replaced as an urgent measure.					
$C24_{EMP}$	Asphalt Hot Mix Plant and Batching Plant	Major pollution sources	• Cleaning regularly the Batching Plant • Appoint 3rd party to collect the residue • Apply 3R policy • Monitoring the mix plant regularly • The furnace of the Asphalt Hot Mix Plant more then 100 feet so that the impact is less due to the height.	Number of accidents; Number of permanent signage, Inspection Green tag	Compliance to emergency response plan	Construction yard along the base camp of the project	Contractor	RHD/SC

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Performance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
C25$_{EMP}$	Site Reinstatement	Degradation of natural settings of the landscape	• The areas besides constructions ROW and camp sites, batching plant areas, etc must be reinstated as soon as construction ends. • All unused materials/waste must be taken away. Site should be cleared. • Top soil has to be restored to right locations and complete the areas with plantation/re-vegetation, provided with erosion control measures, etc.	Visual proofs, photographs	Compliance to ECC	Basecamp, waste dumping site, batching plant area, soil collection sites, etc.	Contractor	RHD/SC

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C26EMP	Safety precaution, including COVID-19, for workers	Workers health safety and emergence of pandemic condition.	1. Contractor to update Occupational Health Safety and Accident Prevention Plan and obtain approval from PMU. 2. Conduct toolbox talk for workers daily at sites. 3. Ensure regular health monitoring (especially extra precaution for COVID-19) and record keeping before starting works at sites. 4. Supply sufficient quantity of PPEs for employees & workers and ensure their appropriate use. 5. Conduct EHS training for workers', Contractor's representatives, Consultant, PIU & PMU once in six months. 6. Conduct hazard and risk mapping and assessment of the potential construction activities of the project. 7. Use alternatives to adopt environ-	• Check implementation of items 1-9 and COVID 19 health safety guidelines of the Directorate General of Health Services of the Government of Bangladesh. • Check compliance with Bangladesh Labor Act (2006)	Compliance to the COVID 19 guidelines of ADB and GoB	Construction sites along thefull length of the project	Contractor	RHD/ Supervision Consultants (SC)

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			mentally and HS wise benign or less harmful construction tasks through design and technology options. 8. Establish safety measures as required by law and by good engineering practice, and provide first aid facilities that are readily accessible by workers. 9. Scheduling of regular (e.g., weekly toolbox talks) to orient the workers on health and safety issues related to their activities.					

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
IMPLEMENTATION PHASE: OPERATION								
O01EMP	Soil	• Erosion due to damage of embankment and during transportation of sand by sand miners along river • Soil contamination due to accidental spillage from vehicular movement.	• Turfing of embankment shall be maintained. • Surveillance to protect the embankment from unauthorized accesses. • Proper measures must be ensured to prevent any oil spillage and leakage from the locomotives. • Efforts will be made to clean the spills of oil, toxic chemicals etc. as early as possible.	No complaints from sensitive receptors	Compliance with National / International guideline limits for soil	Along the road alignment particularly at erosion prone area	RHD	RHD
O02EMP	Noise and Vibration	The noise levels are anticipated to increase due totraffic related noise pollution; vibrations from engines and tires and mainly use of pressure horns.	• Based on monitoring results, additional sound barriers in form of trees and hedges will be discussed with the affected people and planted if agreed; • Signs for sensitive zones (health centres / educational institutions etc.) to disallow the use of pressure horns; • Enforcement and penalties against traffic rules violators; • Monitoring to protect the trees.	• No complaints from sensitive receptors • Levels of noise and vibration	Compliance with National guideline limits for Noise level.	Along the road alignment particularly in the major road intersections and densely settlement areas	RHD	RHD/DOE

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$O03_{EMP}$	Air Quality	Increased traffic levels and congestion will lead to air pollution levels.	• Ambient air quality monitoring should be carried out during operation phase; • Roadside tree plantations as applicable and feasible under harsh climatic conditions; • Regular road maintenance to ensure good surface condition;	• No complaints from sensitive receptors • Levels of H2S, SOx, NOx, CO, CO2, TVOC, SPM, PM10	Compliance with National guideline limits for Air quality.	Along the road alignment particularly in the major road intersections and densely	RHD	RHD/DOE

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
			• Regular vehicle check to control/ensure compliance with air quality standards; • Enforcement and penalties against traffic rules violators.			settlement areas		
O04EMP	Water Quality	▪ Contamination of water bodies from runoff from the roads containing oils & grease; ▪ Groundwater may get polluted due to contaminated road runoff on earthen shoulders and embankments planted with grasses.	• In order to discharge rapid removal of storm-water/road runoff, cross slopes and longitudinal drainage will be provided in the design; • Proper drainage system with sedimentation ponds and oil separators will be provided to avoid contamination by run-off and oil spills; • Retention basins with reed beds provided in the design will improve the quality of polluted storm-water/road runoff; • Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared; • Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.	• No visible degradation to nearby drainages, khals or water bodies due to construction activities • Levels of pH, TOC, PO4, TSS, DO, oil and grease (surface water) • Levels of pH, CaCO3, Cl-, Mn, As, Fe,total coliform, fecal coliform (groundwater)	Compliance with National guideline limits for Surface and Ground water.	Throughout the road alignment particularly in khal /lowland/rivers/pond/ditch areas	RHD	RHD/DOE

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$O05_{EMP}$	Land Use	Development of commercial establishments, educational institutes etc., which may affect the land value	▪ All the facilities except restaurants and petrol/gas filling stations likely to pop up in the future will be prohibited within the RoW. • The permission will be sought from the concerned authority for	• Number of complaints from sensitive receptors •	Compliance with National/International guideline	Along the road alignment particularly in the urban and densely	RHD	RHD

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implement ation	Supervision & Monitoring
			the development of any establishment along the project; • The bridge site may also be developed as tourist spot with further beautification; • The designated RoW shall be maintained free of any encroachment.			settlement areas		
O06EMP	Wildlife	Killing of animals in road accidents	• Raising of dense plantation of shady trees on both sides of the RoW shall provide resting, nestling and roosting habitat to the fauna and especially to the avifauna which is a major positive impact; • Low width under passes with the provision of small net on the both side of the road shall be made where the animal movement is frequent.	• Number of wildlife killed arising from road accidents •	Compliance with National /International guideline for wildlife	Along the road alignment	RHD	RHD/DOE
O07EMP	Fisheries	The damage of 2 ponds, 2 ditches and disturbance to fisheries species during constructionof bridge & culvert over rivers and canals to build the road embankment.	• Provide logistic support to the PAPs of the water bodies to culture fish in other places in the PIA. • Consult with the local fisheries department to enrich the fisheries resources; • Efforts shall be made to maintain deep water stream for certain length on both end of the bridge.	• Number of complaints from sensitive receptors on disturbance of fishing; • Any evidence of fish mortality.	Compliance with National/International guideline	Throughout the road alignment particularly in khal/lowland and and/rivers/ pond/ditch areas	RHD	RHD/DOE

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O09EMP	Road Safety	Increase in the number of road accidents & animal kills	• Speed limits shall be imposed. • Safety signal shall be displayed along the road and speed limits be displayed as well as monitored especially along settlements; • Traffic signs shall be provided to warn road users about speed limits, rest areas, eating establishments etc. • Lanes, median, and sharp bends shall be reflectorized to improve road visibility at night time. • Foot over bridge shall be provided near schools, markets, habitat areas for safe crossing of the roads • Proper lighting shall be provided along the project road.	• No of road accidents	Compliance with national laws on road safety	Along the road alignment particularly at road intersections	RHD	RHD
O08EMP	Cultural Sites	Noise, vibration and whistling near to cultural sites like school, college, madrasa, health complex, temple,etc.	• Proper rehabilitation of the affected people and the religious and cultural monuments and structures; • Noise problem can be mitigated through plantation of trees along the boundary of the cultural sites; • Avoid unnecessary whistling at sensitive cultural sites.	• No complaints from sensitive receptors	Compliance with National guideline limits for noise and dust.	Along the road alignment	RHD	RHD

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EMP Code	Environmental Concerns	Potential Impacts	Mitigation Measures	Monitoring Indicator	Perform-ance Target	Location	Institutional Responsibility	
							Implementation	Supervision & Monitoring
$O09_{EMP}$	Road Safety	Increase in the number of road accidents & animal kills	• Speed limits shall be imposed. • Safety signal shall be displayed along the road and speed limits be displayed as well as monitored especially along settlements; • Traffic signs shall be provided to warn road users about speed limits, rest areas, eating establishments etc. • Lanes, median, and sharp bends shall be reflectorized to improve road visibility at nighttime. • Foot over bridge shall be provided near schools, markets, habitat areas for safe crossing of the roads. • Proper lighting shall be provided along the project road.	• No of road accidents	Compliance with national laws on road safety	Along the road alignment particularly at road intersections	RHD	RHD
$O10_{EMP}$	Tree Planting	Ensuring survival of flora and fauna in the new environment.	• Monitor survival of replanted trees (also compensatory planting) and replant, as necessary. • Undertake proper measures for watering, fertilizing and nursing of trees/ plants/ grasses. • Plantation of additional varieties of trees that supports birds and having high wood value.	• No. of trees that survive	Compliance with guideline of Forest Department and the tree management plan	Along the project corridor	RHD	RHD

Note: Once construction is completed, all unused materials/waste must be taken away. Site should be cleared. No additional payments get for the Contractoor for cleaning the unused materials/waste from the construction site. No payment should be made, if the site is not cleared. The contractors will not get the clearance and the final payment if the Contractor does not clear all unused materials/waste from the construction site.

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C. Implementation Schedule

390. An implementation schedule has been proposed based on the environmental components that may be affected during the construction and operation of the project. A comprehensive EMP implementation schedule is provided in Table 43. Monitoring Plan has been separately suggested for pre-construction, construction, and operation phase. EMP implementation schedule is kept unchanged in this updated IEE considering that proper implementation will be ensured to off-set environmental adverse impacts.

D. Environmental Monitoring Plan

391. Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. The purpose of themonitoring program is to ensure that the envisaged purposes of the project are achieved andresult in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program be designed and carried out. Compliance monitoring has been conducted in accordance with the environmental mitigation measures and monitoring plan provided with this report (Table 44). Same parameters will be monitored with the same frequency as it has been conducted since commencement of the SASEC 2 project.

E. Objectives

392. The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The main objectives of the pre- construction, construction and operation phase monitoring plans are to:

(i) Monitor the actual impact of the works on physical, biological andsocioeconomic receptors within the project corridor for indicating the adequacyof the IEE;
(ii) Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the IEE;
(iii) Ensure compliance with legal and community obligations including safety on construction sites;
(iv) Monitor the rehabilitation of borrow areas and the restoration of construction campsites as described in the EMP;
(v) Ensure the safe disposal of excess construction materials.
(vi) Appraise the adequacy of the IEE with respect to the project's predicted long-term impacts on the corridor's physical, biological and socio-economic environment;
(vii) Evaluate the effectiveness of the mitigation measures proposed in the EMP and recommend improvements, if and when necessary;
(viii) Compile periodic accident data to support analyses that will help minimize future risks; and
(ix) Monitor the survival rate of avenue plantations.

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Table 47: Environmental Management Plan Implementation Schedule

Environmental Issue	EMP	Construction Phase (36 months)								Operation Phase(36 months)											
Technical Support	Updating of environmental guidelines & performance indicators																				
Flora	Tree cutting along the RoW																				
	Compensatory afforestation (Minimum 1:2)																				
Drainage Congestion	Provision of adequate opening																				
	Monitoring analysis of drainage congestion																				
Erosion, Sedimentation & Soil	River bank protection measures																				
	Soil conservation																				
	Monitoring of soil erosion																				
Land	Compensation against land acquisition																				
	Landscaping on approach road and service areas																				
Slope/ Embankment protection at approach Road	Turfing of embankment with grasses and herbs																				
	Embankment protection of the approach road																				
Water & Drinking Water Supply	Monitoring of Surface Water Quality																				
	Monitoring of Ground Water Quality & Levels																				
	Installation of oil and grease traps at construction sites																				
	Construction of soak pits at construction & rehabilitation sites																				
	Ensuring arsenic free drinking water for construction camps																				
Air Quality & Dust Management	Monitoring of Ambient Air Quality																				
	Water Spraying/ Watering																				
Construction Safety	Provision of PPEs																				
Health Issues	Health Check-up Camps																				
Noise Quality and Barriers	Monitoring of Noise & Vibration																				
	Monitoring of Tree Felling & Plantation																				
	Maintenance of tree																				
	Provision of Noise Barriers																				
Establishments	Construction Stage																				
Training	Environmental training & Awareness																				
Management Information System																					

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F. Components to be monitored.

393. Monitoring has two components: compliance monitoring, which checks whether prescribed actions have been carried out, usually by visual observation and use of checklists; and effects monitoring which records the beneficial and adverse consequences of activities on the biophysical and social environment. This is often by repeat measurements of a set of objectivelyverifiable indicators.

394. Monitoring for this project concentrates on compliance monitoring to ensure that measures are being implemented on time and based on sound environmental principles.

395. The detailed program of monitoring of various components is given in Table 3.

1. Construction stage compliance monitoring

396. Compliance monitoring during the construction stage comprises:

(i) EMP which addresses environment details to provide environmentalprotection.
(ii) Contractors' compliance with the environmental clauses in their day-to-day activities.
(iii) Implementation of tree planting and site clearance activities after completion of work.

397. The environmental impacts during construction are highly dependent on (i) the contractors' work practices, especially those related to the storage of construction materials and cleanliness of the work sites; (ii) cooperation by the local authorities with the contractor in terms of traffic management and use of public space and utilities; (iii) project management's strict enforcement of the correct construction practices and standards; and (iv) the incorporation of the mitigating measures identified in the IEE into bid documents and specifications.

398. Direct monitoring during the construction phase involves the following activities:

(i) Review of Contractor's proposed designs and working methods including a review at project start-up to ensure that the designs and working methods proposed by the contractors have taken account of the environmental constraints specified in the tender documents (geotechnical, ecological, social, safety).
(ii) Site- specific review of contractors' temporary facilities; involving the inspection of contractor's worksites and work camps to ensure that the contractor's arrangements regarding temporary facilities are satisfactory.
(iii) Regular site inspection during the construction period, involving scheduled and unannounced inspections to ensure that the stipulated procedures as defined in the EMP are being followed by the contractor(s). This monitoring requires the completion of systematic observations of site activities using checklists to be developed by RHD or its supervising consultants.
(iv) Inspection of the certification of site clearance and restoration, to ensure that actual restoration has taken place, e.g., the temporary sewage works have been adequately disposed of.

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G. Operation stage monitoring

399. The contractor compiles and maintains the environmental data and records gathered during the construction phase for reference during the operation phase. The contractor has been coordinating with government departments and agencies, RHD in particular, is responsible for overseeing monitoring with respect to air quality, water, noise, and traffic.

400. The contractors in collaboration with the concerned department organize monitoring ofair quality and effects of the exhausts along the road project. Sensitive parameters including NO_2,SO_2 and particulate matter is monitored and necessary measures have been taken to keep them within the limits set by government.

401. The noise levels are monitored to see whether they are within the limits. When they arefound to exceed these limits and disturb the nearby settlements, noise abatement measures, likeplantation of trees and construction of sound barriers would be taken.

402. Monitoring has been undertaken to ensure that both surface and groundwater quality will be up to thestandards. Mitigation measures have been considered in the design of new facility from the pointsources related to new developments and industry. Pollution control equipment, including wastewater treatment plants have been recommended for the local industry and accordingly monitored.

403. The contractors have been monitoring that flora and fauna of the area is not disturbed by the increaseof population and other activities in influence. Tree plantation will be done. Any activity ofthe nearby residents (such as disposal of waste, land use change, etc.), which affects the environment, is to be brought to the knowledge of the competent authority for necessary action.

404. The above monitoring system is fully controlled by the project proponent i.e., RHD. A monitoring schedule has been included as guideline for the stakeholders (Table 44).

H. Monitoring Program

405. Monitoring points have been selected based on the sensitivity of the location with respectto sensitive receptors. The schedule has been developed based on the possible occurrence of adverse impacts and required mitigation actions. However, this schedule is subject to change depending on the analysis results obtained. The protocol for changing the monitoring schedule isgiven below.

1. Tree Plantation

406. The 75% survival rate of re-plantation shall be monitored in the first year of the operation phase. If the survival rate is found below 75%, survival rate monitoring shall be again taken up after 3 years. This cycle should continue until the 75% survival rate is achieved.

2. Terrestrial and Aquatic Fauna including Fisheries

407. The fish productivity monitoring is important and sensitive issues. In case any significant decline in terms of fish productivity in the khals/canals or ponds is noticed, the monitoring frequency shall be increased until the effectiveness of mitigation measures is established.

3. Soil Erosion and Drainage Congestion

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408. No significant soil erosion problem is anticipated due to the project either in the construction phase or in the operation phase. However, in the construction phase, some localizedsoil erosion may be noticed owing to construction activities. However, if soil erosion is noticed during construction and operation phase, the corrective action is initiated, and frequency of check is increased to assess the tendency of occurrence.

4. Air and Noise Quality

409. Due to the variability of the construction activities, namely changes in batch composition,type of construction activity and other anthropogenic influences, the ambient air quality of the project area may change. If the air quality with respect to any parameter exceeds by more than 25% of its last monitored value, the monitoring frequency shall be doubled and cause of the increase investigated. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

410. Similarly, due to the variability in traffic movement, namely changes in traffic volume, traffic compositions and other anthropogenic influences, the noise quality in the project area is likely to change. If the noise quality exceeds by 20% of the applicable ambient noise quality standard or 5% of its last monitored value, the monitoring frequency is to be increased and the cause of theincrease investigated. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

5. Water Quality

411. No significant change in water quality is perceived due to the project in the operation phase. However, in the construction phase, the monitored values for pH, BOD, COD, TDS, DO and Oil & Grease might change owing to construction activities. Hence, it is suggested that if themonitored value for any water quality parameter exceeds by more than 20% of its last monitoredstatus the monitoring frequency is to be increased. If the construction activities are found to be the reason for this increase, suitable measures should be adopted.

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Table 48: Environmental Monitoring Plan

EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
Pre-Construction Stage (Not considered in updated IEE)							
$P01_{EMoP}$	Dredged materials	Lead (Pb), Cadmium(Cd), Cromium (Cr), Copper (Cu), Zinc (Zn), Manganese (Mn), Arsenic (As), Selenium (Se), and Mercury (Hg)	Government of Bangladesh(GoB) and international standard	Proposed dredging sites	Once prior to start dredging	Contractor	RHD/Construction Supervision Consultant (CSC)
$P02_{EMoP}$	Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO, NO_2, O_3, VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Major road intersections	Once	Contractor	RHD/CSC
$P03_{EMoP}$	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabitedlocations and sensitiveareas	Once	Contractor	RHD/CSC
$P04_{EMoP}$	Water Quality	Surface water: pH, TOC, PO_4, TSS, Oil and Grease, and DO	Surface water quality standard by DOE, Bangladesh	Surface waternear project site	Once	Contractor	RHD/CSC
$P05_{EMoP}$		Groundwater: pH, Mn, As, Fe, Cl, TotalHardness, TC and FC	Groundwater quality standard by DOE, Bangladesh	Groundwaternear project site	Once	Contractor	RHD/CSC
$P06_{EMoP}$	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside theroad alignment	Once	Contractor	RHD/CSC

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EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
$P07_{EMoP}$	Tree felling	▪ Monitoring activities outlinedin RP; ▪ Check whether proper compensation as mentioned in RP is received by PAPs.	Inspection	ROW along the alignment	During tree felling and site clearing operations	Contractor/ NGOs/RHD	RHD/CSC
Construction Stage							
$C01_{EMoP}$	Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO, NO_2, O_3, VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Hot mix plant, concrete mixing plant/stone crushers at Construction sites	Quarterly per site	Contractor	RHD\CSC
$C02_{EMoP}$	Dust	Dust control	Air quality standard by DOE, Bangladesh	Construction site and ROW along the alignment	Regularly	Contractor	RHD\CSC
$C03_{EMoP}$	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Construction sites and at every sensitive receptors	Quarterly per site	Contractor	RHD\CSC
$C04_{EMoP}$	Water Quality	Surface water: pH, TOC, PO_4, TSS, Oil and Grease, and DO	Water quality standard by MoEF, Bangladesh	Surface waternear project site	Quarterly per site	Contractor	RHD\CSC
$C05_{EMoP}$		Groundwater: pH, Mn, As, Fe, Cl^-, Totalhardness, TC, FC	Water quality standard by MoEF, Bangladesh	Drinking water to made available to construction camps and	Quarterly per site	Contractor	RHD\CSC

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EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
				ground water near project site			
C06$_{EMoP}$	Soil Erosion	Visual check for Soilerosion and siltation	None Specific	All major water bodies	Once during rainy seasons of the constructionperiod.	Contractor	RHD\CSC
C07$_{EMoP}$	Drainage congestion	▪ Check drainage plan implementedcorrectly ▪ Conduct regularinspection	Monitoring	Construction site	Weekly during monsoon	Contractor	RHD\CSC
C08$_{EMoP}$	Soil Pollution	▪ Check liquid wasteis carried out by experienced personnel and in proper way ▪ Careful and properhandling of oil andother hazardous liquids	Monitoring	Construction Yard, dumping site	Regularly	Contractor	RHD\CSC
C09$_{EMoP}$	Wildlife	Wildlife habitat andmovement	None Specific	Areas alongside the road alignment	Quarterly	Contractor	RHD\CSC
C10$_{EMoP}$	Waste	▪ Check storage, transportation, disposal, handling of hazarders waste ▪ Waste and effluents to be collected and disposed safelyfrom all camps. ▪ Wastes and garbage from bridges construction sitesto be disposed safely	Monitoring	Construction Yard, dumping site	Weekly	Contractor	RHD\CSC

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EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
$C11_{EMoP}$	Health and Safety	▪ Check quality of food & accommodation at construction camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site and separate toilet for female workers; ▪ First Aid Box withrequired tools & medicines; ▪ The heavy construction material to handledand stored safely putting due care onpublic safety; ▪ Heavy construction materials at bridges construction sites tobe stored and handled safely; and ▪ Check of personal protective equipment (PPE)for worker at the sites	Monitoring	Construction site and labor camp	Regularly	Contractor	RHD\CSC

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EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
Operation Stage							
$O01_{EMoP}$	Tree Plantation	Check that the planted trees are maintained as mentioned in tree plantation plan	Inspection to ensure proper plantation with proper species	Along the road	Regular during June/July	RHD	RHD\DOE
$O01_{EMoP}$	Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO, NO_2, O_3, VOC, Temperature, Humidity, Wind Speed and Wind Direction	Air quality standard by DOE, Bangladesh	Major Road Intersections	1site/year for 3 years	RHD	RHD\DOE
$O02_{EMoP}$	Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	1site/year for 3 years	RHD	RHD\DOE
$O03_{EMoP}$	Water Quality	Surface water: pH, TOC, PO_4, TSS, Oil and Grease, and DO	Water quality standard by MoEF, Bangladesh	Surface water near project site	1site/year for 3 years	RHD	RHD\DOE
$O04_{EMoP}$		Groundwater: pH, Mn, As, Fe, Cl^-, Total hardness, TC, FC	Water quality standard by MoEF, Bangladesh	Groundwater near project site	1site/year for 3 years	RHD	RHD\DOE
$O05_{EMoP}$	Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	Thought out the project section	----------	RHD	RHD
$O06_{EMoP}$	Soil Erosion	Visual check for soil erosion and siltation	None Specific	All major water bodies	After first precipitation	RHD	RHD

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EMoP Code	Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
						Implementation	Supervision
$O07_{EMoP}$	Soil Quality	Heavy metals	None Specific	At each construction camp post restoration of construction camp site	Once at each construction site	RHD	RHD\DOE
$O08_{EMoP}$	Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Quarterly	RHD	RHD\DOE

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I. Environmental Budget

412. The estimated budget for implementation of the mitigation and monitoring measures proposed in the EMP is presented in Table 45. The overall costs of the EMP will comprise:

- Environmental monitoring through sample collection and analysis.
- Any remedial measures necessary to reduce or avoid environmental damage, including compensatory tree plantation.
- Designing and implementing all mitigating and enhancement measures.
- Supervision staff from RHD and consultants including direct costs and travel subsistence.

413. The total budget for implementation of updated EMP is estimated at US$ 0.3986 million.

Table 49:Environmental Budget for Elenga-Hatikamrul Road

Component	Mitigation and Monitoring Items	Unit (No)	Rate (BDT)	Total Amount (in BDT)	Amount (mil BDT)
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	8	20,000	1,60,000	0.16
Noise	Measuring ambient noise level	16	1500	24000	0.024
	Provision for additional tree plantation / Noise Barriers	No.	Covered in Engineering Cost		
Flora	Clearing of roadside Plantation	No.	Covered in Engineering Cost		
	Compensatory afforestation (Minimum 1:2 (Plantation of 62900 plant saplings & maintenance for two years)	62,900	426/tree	2,68,12,500	26.8125
Water Quality	Surface water quality measurement	8	11000	88,000	0.088
Health	Health checkup camps for construction workers	Camps	Camps/ year	10,00,000	1
Environmental Monitoring in construction phase	Monitoring Tree Felling & Plantation		Lump sum	20,00,000	2
	Fisheries		Lump sum	10,00,000	1
SUB TOTAL (CONSTRUCTION STAGE)				3,10,84,500	31.0845
OPERATION STAGE					
Air Quality	Monitoring air quality	3	3 (1/year) 80,000	2,40,000	0.24
Noise	Monitoring ambient noise level	No.	3 (1/year) 36000	1,08,000	0.108
Water	Monitoring surface water quality	No.	3 (1/year) 44000	1,32,000	0.132
	Monitoring ground water quality & levels	No.	3 (1/year) 25,000	1,32,000	0.132

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Component	Mitigation and Monitoring Items	Unit (No)	Rate (BDT)	Total Amount (in BDT)	Amount (mil BDT)
Fisheries	Maintenance of Derelict Ponds or rehabilitation of Borrow Areas	Lump Sum -		12,50,000	1.25
Tree survival	Provision of additional tree plantation (Plantation and maintenance for two years)	No. of trees	100/tree	3,75,000	0.0375
Monitoring of performance indicators	Monitoring tree felling & plantation	Lump sum	-	6,25,000	0.625
	Fisheries	Lump sum	-	6,25,000	0.625
	Monitoring of waste disposal and management	Lump Sum	-	6,25,000	0.625
SUB TOTAL (OPERATION STAGE)				41,12,000	4.112
ESTABLISHMENT & TRAINING					
Establishment	Construction stage	Per month	24	1,50,000	0.15
	Operation stage	Per month	60	50,000 for first three years of operation and 35000 after three years additional two years	0.085
Training	Environmental training & awareness	Lump sum	As per training details	25,00,000	2.5
Management Information System		Lump sum	-	6,25,000	0.625
SUB TOTAL (ESTABLISHMENT & TRAINING)				3360000	3.36
SUB TOTAL (Construction, Operation, establishment, and training)				3,85,56,500	38.5565
Including 10% CONTINGENCIES on total Environmental Costs				3,85,56,50	3.85565
GRAND TOTAL (in BDT)				4,24,12,150	42.41215
GRAND TOTAL IN MILLION US$ (@ 1 US $ = 106.39 BDT)				3,98,647	0.398647

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VIII. INSTITUTIONAL ARRANGEMENT, CAPACITY BUILDING AND GRIEVANCEREDRESS MECHANISM

B. Institutional Arrangement

414. The Environmental Management Plan (EMP) implementation requires an organization support structure in the form of organizational requirements, training needs and plan, and information management system. The following section captures these institutional arrangements for EMP implementation by concerned officials of RHD, their consultants and working contractors.

415. The organizational structure of RHD is given in Figure 23. However, an organizational structure should be developed at the corporate, regional and site level to aid effective implementation of the EMP document. Various departments would be involved during implementation of the project as shown in Figure 7.2. Contractor is responsible for implementation of EMP during works and Project Implementation Consultant (PIC) is primarily responsible for supervision of monitoring of the implementation of the EMP. RHD has been supported by a Management Consultant (MC) to advise and assist RHD in quality and capacity enhancement and independent quality monitoring. Contractors are responsible for implementation of EMP during the work activities stage. Relevant departments responsible for implementation and supervision of proposed mitigation and monitoring measures are given in the EMP.

416. PIC is responsible for monitoring all activities of all contractors procured under the project. As several contractors have been working simultaneously for timely and speedy implementation of the project, it is important that CSC has an effective environmental unit to effectively supervise and monitor the environmental activities being implemented in the field. The CSC is also responsible to update or make necessary changes to the EMP if required based on the revised designs and locations.

417. A combined grievance redress committee is proposed to address grievances in both socialand environmental issues.

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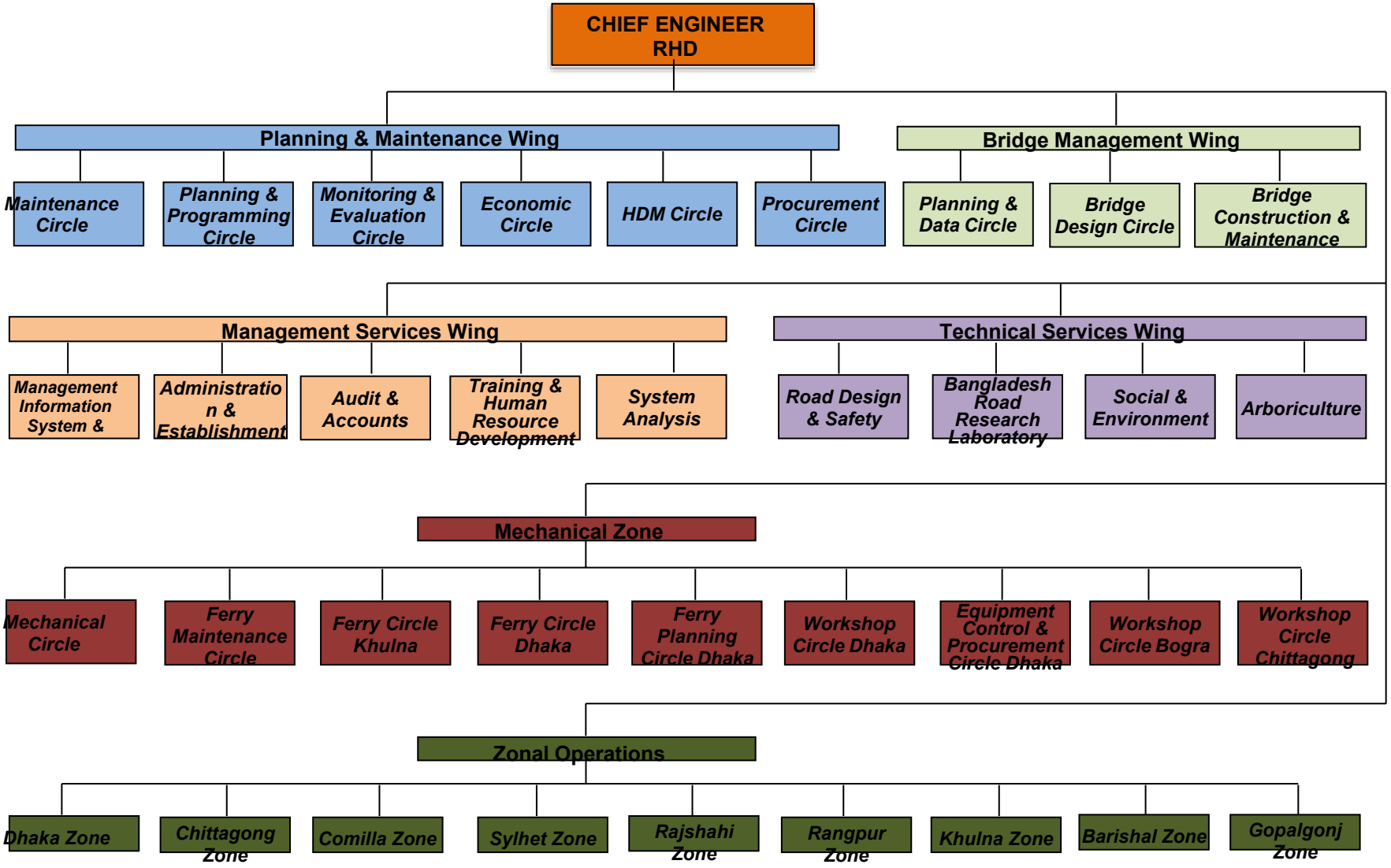

Figure 23: Organisation Structure of RHD

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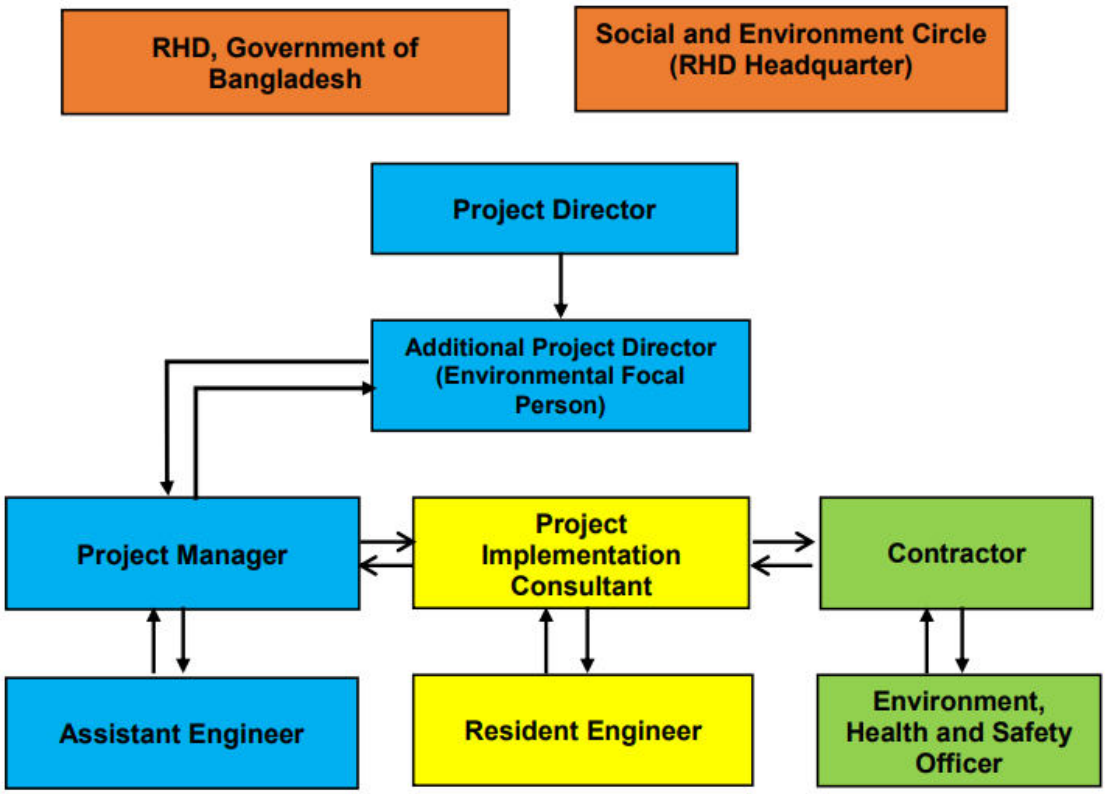

Figure 24: Proposed Organizational Structure for EMP Implementation of RHD for Elenga-Hatikamrul Road Project[25]

C. Institutional Roles and Responsibilities

418. The Roads and Highways Department (RHD) is the Executing Agency (EA) for the MFF and is responsible for ensuring that all the components of the EARF are complied with. The RHD has the responsibility to ensure that the investment follows the legal requirements for environmental assessment. The RHD has an Environmental and Social Circle (ESC) headed by the Superintending Engineer who is supported by the Executive Engineer, Subdivision Engineer,Assistant Engineer, and Sub-assistant Engineer.

419. The Project Implementation Units (PIU) is responsible for implementing phase 2 (Elenga–Hatikamural–Rangpur) of the MFF. PIU is headed by a Project Director (PD) who is supported by Additional Project Directors (APD) and Deputy Project Director (DPD). The PD is supported by 2 APD and 1 DPD. At the site level there are 4 Project Managers (PMs) for the 8 contract packages.

[25] - Roads and Highways Department (RHD); - Project Implementation Unit; - Project Implementation Consultant; - Contractor

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Each PM is furthersupported by Deputy PM, Assistant Engineers, and Sub Assistant engineers.

420. The APDs serve as the environmental focal persons in the PIU. One of the Assistant Engineers serve as the environmental focal person at the site level and support the respective APD on environment safeguard matters. Further the Project Implementation Consultant (PIC) responsible for supervising the civil works contractor provides support to the PIU forday-to-day monitoring and reporting on environment safeguards.

421. The following elaborates the detailed responsibilities on environment safeguards:

1. RHD

422. RHD is responsible for ensuring compliance with all the environment safeguard requirements as provided in the Framework Financing Agreement (FFA), Environment Assessment and Review Framework (EARF) and the respective IEE and EMP.

2. RHD (Environment and Social Circle)

423. The RHD Environment and Social Circle (ESC) is responsible for managing environmentand social safeguards including safeguards related capacity building for all RHD projects. They are not involved in the day-to-day implementation of safeguards for specific projects such as this investment program. The respective PIU seeks their support and advice on needed basis. Their overall responsibilities are:

- Ensure that all RHD works and projects are executed in accordance with appropriate environmental and social standards and practices.
- Liaise with GOB organizations and other line agencies to ensure effective inter- agency cooperation on relevant projects.
- Ensure the provision or procurement of the necessary services for carrying out Environmental Assessment, Land acquisition and Resettlement studies.
- Disseminate the need for high social and environmental standards throughout RHD and to the concerned public through research, publicity, seminars and training.
- Coordination the preparation and implementation of environmental and resettlement management plans for RHD projects as needed.
- Monitor long-term, cumulative environmental impacts and ensure mitigation measures for project sustainability.
- Conduct site inspections on selected RHD projects as needed
- Provide feedback on all environmental issues of existing and ongoing RHDprojects and works.
- Review and preparation of Request for Proposal (RFP) and tender documents for procurement of Environmental Services (IEE, IEE and EMP) for RHD projects.
- Assist the Director of RHD Training Centre in providing training to RHD officers in Environmental and Resettlement issues.
- Review and approve the Environmental Assessment reports and Environmental Monitoring reports produced by consultants/experts under RHD projects as needed.
- Establish and maintain environmental standards, guidelines and manuals in RHD.

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- Identify environmental issues and constraints at project planning stage, suggest alternatives, options.
- Establish a reference library, containing relevant environmental documents (hardand soft copies) of domestic and overseas sources.
- Monitor long term environmental impacts on relevant RHD Projects
- Liaise with Road Safety Circle, Arboriculture Head and maintain intra-departmentalco-ordination.

3. PIU (Environmental Focal Persons at Project Head Quarter and Site level)

424. The Additional Project Directors under the respective PIU serve as the EnvironmentalFocal Person at the Project Head Quarter level. At the site level an Assistant Engineer supportingthe Project Manager serves as the environmental focal person. The PIU is responsible forensuring proper implementation of environment safeguards in their respective projects includingimplementation of the EMP and EMoP, timely reporting and timely resolution of complaints and grievances. Their detailed responsibilities are:

- Prepare or engage consultants to prepare environmental assessment reports (IEE, IEE, EMP) for project components as necessary;
- Review and comment on the environmental assessment reports and environmental monitoring reports prepared by consultants and ensure they are prepared in accordance with requirements of RHD, DOE and ADB;
- Ensure that the consultants while carrying out work at site follow the environmental standards, guidelines and manual of RHD;
- Take necessary steps to ensure timely receipt of DoE Environmental Clearance
- Ensure that the EMP and relevant environmental clauses are included in the contractors bidding documents;
- Conduct spot checks on-site to monitor contractor's compliance with the EMP;
- Review and endorse quarterly monitoring reports prepared by the PIC;
- Review and endorse annual environmental monitoring reports prepared by the PIC for further submission to ADB for disclosure on the ADB website;
- If there are any non-compliance issues or unanticipated environmental impacts ensure that necessary corrective actions are taken and IEE and/or EMP is updated as necessary;
- Ensure that all grievances and complaints received are addressed in a timely manner and properly documented;
- Carry out all other activities on environment safeguards on behalf of the PIU as needed.

4. Project Implementation Consultant (Environment Safeguards Team)

425. The proposed framework for implementation of the project utilizes consultancyservices from both international (1 intermittent position) and national individuals (4 fulltime positions) for the overall management and supervision of construction work on behalf of the EA. In addition to supervising the construction work of the contractor their role is to check conformity with the relevant clauses in construction contracts and national legislation and regulations. The following are the detailed responsibilities of the PIC.

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- Review the IEE and EMPs of respective subprojects to understand the context and environmental issues of the project
- Establish monitoring and reporting protocols within the environment safeguards team at the site level and project headquarter level
- Require the civil works contractor to prepare sub-plans on environment safeguards such as camp layout plan, borrow area management plan, construction debris management plan, traffic management plan etc. as needed
- Review and approve all sub-plans on environment safeguards submitted by the civil works contractor
- Conduct regular (minimum of weekly) onsite inspections on implementation of the EMP by the contractor
- Ensure the contractor obtains all clearances, permits etc. related to environment safeguards on a timely basis
- Ensure the contract collects required environmental monitoring data (air, water, noise) as stipulated in the respective IEE report
- Provide on-site technical advice and training to the contractor as needed
- Organize training workshops on implementation of environment safeguards for the project team including PIU, RHD site offices, members of the PIC and civil works contractor
- Facilitate proper functioning of the grievance redress mechanism and maintain records of all complaints received and actions taken for inclusion in the environmental monitoring reports
- If there are any non-compliance issues or unanticipated environmental impacts ensure that necessary corrective actions are taken and update the IEE and/or EMPas necessary
- Review and approve the monthly progress reports submitted by the contractor
- Based on monthly progress reports submitted by the contractor and site inspections prepare quarterly environmental monitoring reports for review and approval by the PIU
- Based on the quarterly monitoring reports prepare annual environmental monitoring reports for review and approval by the PIU and further submission to ADB for disclosure on the ADB website
- Provide necessary technical support to the PIU on implementation of environment safeguards.

5. Contractor (Environment Safeguards Team)

426. The tenders for the construction of the project were national/international competitive bidding contractors. The Contractor is legally mandated to implement the EMP and EMoP and obtain all environment related permits and clearances required for construction. The detailed responsibilities of the contractor on environment safeguards are the following:

- Recruit and appoint environmental focal persons and/or environmental health and safety officers on the construction site;
- The contractor complies with all statutes and regulations concerning the execution of works as mentioned in DoE and RHD environmental guidelines;
- The contractors are responsible for familiarizing themselves with all legislation relating to environmental protection that is relevant to his activities. Reference to rational environmental quality guidelines should be made;
- Implement the EMP approved by the PIC;

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- Prepare all sub-plans related environment safeguards such as camp layout plan, borrow area management plan, construction debris management plan, traffic management plan etc. as needed and submit for approval by the PIC;
- Obtain all statutory clearances and permits on environment safeguards in a timely manner;
- Conduct environmental quality monitoring (air, noise, water) as stipulated in the Environmental Monitoring Plan of the respective IEE report;
- Take necessary measures to immediately address any complaints or grievances raised by local community or other stakeholders;
- Prepare monthly progress reports on implementation of the EMP for approval by the PIC;
- The contractor is responsible for the costs of cleaning up any environmental pollution resulting from his activities if methods for doing so are available and effective.

6. ADB

427. As a funding agency ADB is responsible for monitoring the implementation of environment safeguards, providing technical guidance to the EA as necessary. Specific responsibilities entail the following:

- Review IEE reports including EMP provide feedback and disclose the reports on the ADB website as required by the ADB SPS;
- Provide assistance to RHD, if required, in carrying out its responsibilities and for building capacity for safeguard compliance;
- Monitor overall compliance of the MFF tranches and components to respective IEE and EMP through review missions;
- Review all environmental monitoring reports submitted by RHD, provide feedback, and disclose the reports on the ADB website as required by the ADB SPS
- Provide guidance to the RHD and the PIU on issues related to inclusion of new component components, changes in component design, occurrence of unanticipated environmental impacts during component implementation, emergency situations and others as necessary.

D. Capacity Building

428. In Bangladesh, the environmental assessment process is established, but environmental awareness and capability for implementation of EMP in infrastructure projects are still developing.The project implementation unit (PIU) of RHD had some officers in the Environment and Social Circle Department (ESC) that delegated environmental duties. The delegated officers have responsibility to bring environmental issues to the notice of senior management. Typically, the delegated officers have been moved to different departments due to promotions and operationalneeds after about every 3 years, and they move on to other engineering departments in RHD. The status quo is that ESC engineering officers are delegated to check environmental assessments prepared by consultants. The IEE and EMP are referred to the DOE in the Ministryof Environment and Forests (MOEF) for approval. The ESC in RHD is not directly involved with project implementation but has more administrative responsibility to ensure environmentalcompliance and a general role to increase environmental awareness for RHD. It is therefore not clear if RHD/ESC has the capacity to check the adequacy of the developed EMP for this project.

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429. The most significant challenge for environmental management on this project is the lack of human and financial resources and necessary infrastructure in PIU. To enhance the capacity of the RHD Environmental and Social Circle and PIU for effective implementation of proposed mitigation measures and monitoring the resultant effect, some training programs and awareness worskshops are proposed. The detailed training plan is provided in Table 46.

Table 50: Training Plan

Target Group	Subject(s)	Method	Time Frame
Planning and Construction Stage			
All concerned PIU/RHD project staff	**Environmental Overview:** Environmental regulations, and nationalstandards, process of impact assessment and identification of mitigation measures, importance of EMP & monitoring, and monitoring Methodology	Lectures	Before beginning of the implementation of the project
Environmental engineers, field officers, contractors, supervision consultants	**Implementation of EMPs:** Basic features of an EMP, planning, designing and execution of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions – during construction and Operation	Workshops and Seminars	Before the construction begins
Environmental Engineers, field officers, contractors, supervision consultants	**Environmentally Sound Construction Practices:** Waste management and minimization in construction, pollution control devices and methods for construction sites and equipment, Environmental clauses in contract documents and their implications, Environmental monitoring during construction	Seminars, Lectures and Site visits	Before the construction
Project staff dealing in social/lands matters	**Social awareness:** Monitoring consultants/organizations specializing in social management and monitoring can provide training on social awareness and land acquisition and resettlement issues	Lectures, Workshops and Seminars	Before the construction begins
Environmental engineers, field officers, contractors, supervision consultants	**Monitoring Environmental Performance during Construction:** Monitoring, Air, Water, Soil Erosion, Noise, and effect on wild life and fisheries, Evaluation and Review of results, Performance indicators andtheir applicability, possible corrective actions, reporting requirements and mechanisms	Lectures, Workshop and site visits	During initial phases of construction

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Target Group	Subject(s)	Method	Time Frame
Contractor's staff, construction labourers	**Occupational Safety and Health:** Monitoring consultants/ organizations specializing in occupational, health and safety issues can provide training on this Issue	Workshops and seminars	During initial phases of construction
Construction labourers	Waste handling and sanitation at construction sites/construction camps	Workshops and signage	During initial phases of construction
During Operation Phase			
Environmental engineers, field officers, contractors,	**Long-term Environmental Issues in Project Management:** Designing and implementing environmental surveys for ambient air, noise, biological and water quality, data storage, retrieval and analysis, contract documents and environmental clauses, risk assessment and management, contingency planning and management and value addition	Workshops and seminars	During implementation of the project
General public and bridge users	Wildlife protection and environmental protection awareness programme	Signage, workshops	Construction and operation stage

430. It would be essential to understand the legislative framework and enhance capacity of Environmental and Social Unit of RHD and Field Officer (Environment) for analyzing the applicability of various environmental legislations and clearances, approvals, and compliance monitoring requirements. An environmental legislation applicability matrix framework has already been given in Chapter 2 above for ready reference.

E. Grievance Redress Mechanism

431. To facilitate the resolution of affected people's concerns, complaints, and grievances about the social and environmental performance of the project, a Grievance Redress Mechanism(GRM) is established which aims to provide a time bound and transparent mechanism to voice and resolve social and environmental concerns.

432. Grievances related to the implementation of the project, particularly regarding the environmental management plan is acknowledged, evaluated, and responded to the complainant with corrective actions proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. The responsibility for addressing the grievances along with proper timelines is clearly indicated. Records of grievances received, corrective actions taken, and their outcomesare properly maintained and form part of the environmental monitoring report for submission to ADB.

433. The Project Implementation Unit (PIU) of RHD makes the public aware of the GRM with the support of PIC through methods such as public awareness campaigns. Grievances can be filed in writing or by phone with any member of the PIU or PIC. The following steps procedures are followed under the GRM.

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434. **First tier of GRM:** The Site Project Manager (PM) under the PIU is the designatedofficer for grievance redress at the first tier. Resolution of complaints is done within 7 workingdays. Investigation of grievances involves site visits and consultations with relevant parties (e.g., affected persons, contractors, traffic police, etc.) Grievances are documented and personal details (name, address, date of complaint, etc.) are included, unless anonymity is requested. A tracking number should be assigned for each grievance, including the following elements:

- initial grievance sheet (including the description of the grievance), with an acknowledgement of receipt handed back to the complainant when the complaint is registered;
- grievance monitoring sheet, mentioning actions taken (investigation, corrective measures); and
- closure sheet, one copy of which is handed to the complainant after he/she has agreed to the resolution and signed off.

435. The updated register of grievances and complaints is available to the public at the PM office, construction site, and other key public offices along the project area. Should the grievance remain unresolved within 7 working days, it is elevated to the second tier.

436. **Second tier of GRM:** The respective site level PM is activating the second tier of GRM by referring the unresolved issue (with written documentation). The GRC was established by thePIU before commencement of site works. The GRC consists of the following persons: (i) project director; (ii) representative of city ward; (iii) representative of the affected persons; (iv) representative of the local deputy commissioner's office (land); and (v) representative of the Department of Environment (DoE) for environmental related grievances. A hearing is calledwith the GRC, if necessary, where the affected person can present his or her concerns and issues.The process facilitates resolution through mediation. The local GRC meets as necessary when there are grievances to be addressed. The local GRC suggests corrective measures at the field level and assign clear responsibilities for implementing its decision within 15 working days.

437. The contractor has observer status on the committee. If unsatisfied with the decision,the existence of the GRC does not impede the complainant's access to the government's judicial or administrative remedies.

438. The functions of the local GRC are as follows: (i) resolve problems and provide support to affected persons arising from various environmental issues, including dust, noise, utilities, powerand water supply, waste disposal, traffic interference, and public safety, as well as social issues such as land acquisition, asset acquisition, and eligibility for entitlements, compensation, and assistance; (ii) reconfirm grievances of displaced persons, categorize and prioritize them, and aim to provide solutions within a month; and (iii) report to the aggrieved parties about developments regarding their grievances and decisions of the GRC.

439. The respective APD and PM are responsible for processing and placing all papers before the GRC, maintaining database of complaints, recording decisions, issuing minutes of themeetings, and monitoring to see that formal orders are issued, and the decisions carried out.

440. **Third tier of GRM**: If a grievance cannot be resolved directly by the Project Implementation Unit (PIU) (first tier) or GRC (second tier), the affected person can seek alternative redress through the city ward committees or in appropriate courts. The PIU or GRC is kept informed by the city mayor authority.

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441. The monitoring reports of the EMP and the resettlement plan implementation include the following aspects pertaining to progress on grievances: (i) number of cases registered with the GRC, level of jurisdiction (first, second, and third tiers), number of hearings held, decisions made, and the status of pending cases; and (ii) lists of cases in process and already decided upon, which may be prepared with details such as name, identification (I.D.) with unique serial number, date of notice, date of application, date of hearing, decisions, remarks, actions taken to resolve issues, and status of grievance (i.e., open, closed, or pending). For updating the IEE public consultation meeting and Focus Group Discussion (FGD) several times done in the various work packages between Elenga-Hatikamrul Road. No remarkable new scope found in the FGD and consultation.

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IX. INFORMATION DISCLOSURE, AND PARTICIPATION

F. Background

442. This section deals with the information disclosure to the public and consultation sessionsheld with the different stakeholder groups that are likely to be affected by the implementation of the proposed project. The consultation process was carried out as per the guidelines of ADB's SPS 2009 and DOE environmental guidelines.

443. This consultation process conducted during IEE study from February to May 2013 had the following objectives:

- Share information with stakeholders on proposed improvement works and expected impacts on the physical, biological and socio-economic environment of the project corridor;
- Understand stakeholders' concerns regarding various aspects of the project, including the existing condition of the road, upgrading requirements, and the likelyimpact of construction related activities and operation of the improved road;
- Provide an opportunity to the public to influence project design in a positive manner;
- Obtain local and traditional knowledge, before decision making;
- Increase public confidence about the proponent, reviewers and decision makers;
- Reduce conflict through the early identification of controversial issues, and workthrough them to find acceptable solutions;
- Create a sense of ownership of the proposal in the mind of the stakeholders; and
- Develop the proposal which is truly sustainable.

G. Identification of Stakeholder

444. During the field survey, significant efforts were made to identify the possible categories of stakeholders and their stakes. During the field survey, different stakeholders identified were the villagers, local residents, government officials, shop owners, public representatives and general public.

H. Information Disclosure

445. The discussions were primarily focused on receiving maximum input from the participants regarding the project's acceptability and environmental concerns. The purpose of stakeholder consultations is to identify the views of major institutional and project affected persons (PAPs) tothe project area being examined, and to identify issues of relevance to the study, as well as any impacts which the project may have on project planned by the stakeholders, and to assess any mitigation measures which may be undertaken to minimize any adverse impacts of the proposals under consideration. This project indeed is helpful for socio-economic development for central region of the country by timely transporting of essential goods and products required for agricultural and industrial development. Subsequently, stakeholder consultation is one of the important parts of the IEE to address the environmental aspects as well as socio-economic issuesfrom stakeholders' point of view.

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446. Series of Public Consultations, Focus Group Discussions (FGDs), Government Officials, Individual Local People were conducted during preparation of the IEE report from February to May 2013 in conformity with the ADB and DoE guidelines. Project staffs have carried out a series of stakeholder consultations at different locations of the project during information and data collection, disclosure of information and draft IEE report to obtain feedback from the community, government agencies, civil society and project affected people before finalization of the IEE report.

447. To update the IEE of Elenga to Hatikamrul, no public consultation or Focus Group Discussions (FGDs) has been conducted. The variation of orders proposed for Phase 2 and Tranche 3 project are to be implemented within the existing RoW and are unlikely to cause any new environmental impacts with significant intensity and different dimensions. All anticipated impacts are known, reversible and as usual short term through implementation of EMP properly. Hence, there is no requirement of public consultations engaging local community, government officials, or particular stakeholders of the road project. Rather, from the stakeholder discussions during conducting IEE study and construction period, it has been noted that the project will indeed be helpful for socio-economic development for central region of the country by timely transporting of essential goods and products required for agricultural and industrial development which will bring direct benefit to the wellbeing of the people of northern Bangladesh.

448. The project periodically has conducted meetings with participation of representatives from PMU, PIC, and contractors where environment safeguard impacts and safety issues, and status of environmental compliance with respect to implementation of EMP are discussed for adhering to environmental safeguard activities. Environmental monitoring reports are being submitted to ADB in line with the requirements ADB SPS 2009 and contractual obligation of the project. Necessary corrective action plans are produced and implemented, rigorous monitoring and surveillance efforts from the safeguard staff of contractors and project engineers have been provided throughout the construction period. Several minutes and attendance list of project meetings are included in Appendix K.

I. Compliance with Relevant Regulatory Requirements

449. Stakeholder consultation was undertaken as per the ADB and DoE requirements. All the five principles of information dissemination, information solicitation, integration, coordination, and engagement into dialogue were incorporated during the task. A framework of different environmental impacts likely from the project was strengthened and modified based on opinions of all those consulted, especially in the micro level by setting up dialogues with the village peoplefrom whom information on site facts and prevailing conditions were collected. The requirement of public consultation during the implementation of the project is proposed as part of the mitigation plan.

J. Major Comments Received

450. While a wide range of people from different administrative, social and economic backgrounds were consulted, their concerns and the outcome of the consultation along with suggestions made by them are detailed in the following section.

1. Government Officers' Comment

451. Stakeholders from different departments and institutes were consulted. Their concernsare summarized in Table 47.

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Table 51: Details of Consultation with Government Authorities for Elenga-Hatikamrul Road Project

Department	Name and Designation of the Government Official	Comments	Suggestions
Roads and Highways Department (RHD)	Rowshan Ara Khanam Superintending Engineer A. K. M. Mozammel Haque Executive Engineer	• Priority Roads are priority. • Department will be open to incorporate feasible environmental protection measures in road design.	• Mitigation measures shall be simple and implementable. • RHD is open for the implementable ideasfor institutional capacity building
Department of Environment (DOE)	Md. Shahjahan Additional Director General Sayed Nazmul Ahsan Deputy Director (Environmental Clearance) Md. Monirul Islam Assistant Director Md. Samsuzzaman Sarker Assistant Director	• Sourcing of borrow area earth is a concern in Bangladesh • Needs adequate Baseline Environment Quality Determination for construction and borrow areas. • Effective Measures must be developed for construction and operation stage both. • Sourcing borrow earth from agriculture area is acceptable provided top soil is preserved.	• Obtain prior environmental clearance being it a red category Project. • Collect Soil from Multiple sources such as Char area or from riverbed, which will increase water depth in river and improve navigability of the river.
Department of Agriculture Extension (DAE)	Dr. Salma Laizu Upazila Agriculture Officer Sirajganj Sadar, Sirajganj Gowro Gobindo Das Upazila Agriculture Officer Kalihati Upazila, Tangail Banani Karmakar Agricultural Extension Officer Kalihati Upazila, Tangai	• Agricultural land will be affected due to the project implementation • Livelihoods of the families will be affected severely due to acquiring agricultural land. • Noise pollution & Air pollution will be increased during bringing heavy machinery at the stage of construction.	• Avoid agricultural landas much as possible. • Take proper measureto avoid pollution of water reservoirs as these are sources of irrigation. • Tree plantation programme should be according to the government rule and must be in 1:2 ratio. • Ensure the proper sprinkling of water during construction stage to control dust pollution.
Department of Fisheries (DoF)	Alok Kumar Shaha Upazila Fisheries Officer	• Small water channels/ watercourses may be	• Adopt measures to minimise dust, smoke,

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Department	Name and Designation of the Government Official	Comments	Suggestions
	Sirajganj Sadar, Sirajganj Habibur Rahman Talukdar Upazila Fisheries Officer Kalihati Upazila, Tangail	abandoned due to non-availability of passages across the road.	and noise pollution, and to control spillages from construction machinery • Drainage system will be provided to control surface runoff • Do not wash the construction materials in ponds and ditches. Try to use a fixed place. • Ensure the proper sprinkling of water during construction stage to control dust pollution.
Local Government Engineering Department (LGED)	Moinul Islam Khan Sub Assistant Engineer Sirajganj Sadar, Sirajganj Shahiduzzaman Khan Upazila Engineer Kalihati Upazila, Tangail	• This project will reduce some agricultural land because of land acquisition. • Construction activities will cause noise and air pollution. • Tree cutting will create imbalance to local environment.	• Improve general standards of construction • Plant trees along the highway that could reduce air and noise pollution. • To prevent impacts due to noise all the noisy construction activities will be carried out in day time. • Drainage system will be provided to control surface runoff.

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Photograph 11: Consultation with Government Officials

452. The summary of the stakeholder consultations conducted with some government officials during the preparation of Initial Environmental Examination (IEE) and their opinions andsuggestions are detailed in the following paragraphs.

453. Department of Environment, Ministry of Environment and Forests has highlighted that sourcing borrow earth is a concern in Bangladesh. Preference must be given to sources borrow earth from char area or riverbed. They also highlight the need to establish adequate BaselineEnvironment Quality conditions around borrow areas and road construction areas. They also emphasized that adequate mitigation measures must be planned incorporated in the road design.RHD must also obtain prior environmental clearance before the start of construction.

454. Department of Agriculture Extension advised avoiding the agricultural land. They also emphasized that though there is enough land under RHD but it would require additional land which will affect farmers' livelihood. They also indicated twice the number of trees should be planted against the number of trees cut.

455. Fisheries officers indicated that most of the ponds in this area are seasonal in nature androad development may not have direct impact on fisheries. However, there are some reserved ponds, and rivers area for fish breeding and culture in the project location but those are farfrom the ROW. The project activity does not impact on the fisheries practices directly.

2. Focus Group Discussions

456. A focus group is a group of individuals selected and assembled by the environmental specialists to discuss and comment on, from personal experience. Central to successful group discussion was capturing a wide range of opinions about the impact and mitigation because of the road project. The groups consisted of more than five people and they were discussed for approximately half an hour to gather information and opinions they have. Altogether 8 FGDs were held on 10 to 11 May 2013 and 22 March 2017. Approximately 96 participants, including several women, from different locations have taken part in those consultations. The schedules, venues and the participant's lists are given in Appendix K.

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457. During the consultation, the participants spontaneously expressed their feelings about the importance of developing the road. They said that the project removes current stress on road traffic and eases their turmoil and reduce their commuting time. Moreover, business sectors are greatly benefitted due to the improvement of the communication system.

458. Most of them said that the local air quality has been degraded from the emission of vehiclesand local small industries and other man-made sources. The participants expressed that the dredging materials should not be collected from the agricultural land since people are cultivatingthere. They belief that there are no major environmentimpactcts due to the project except a temporary impact of noise and dust from the engine of the construction transport and materials. Most of the people argued that they are willing to endure the temporary negative impact for the sake of the improvement of communication system which improves their livelihood.

459. During the focus group discussion, people said that there are no impacts on ground water and surface water. In accordance with people's information there are some wildlife found in the area and rarely cross the road or die because of run over by the transport. People also confirmed that there is no Environmental Protected Area in the project area. Finally, all of them were in favour of the project.

Photograph 12: Photos of Focus Group Discussion at Various Locations

460. **Suggestions.** The following suggestions received from the consultation:

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- The dredging materials should be properly managed as though local inhabitants face no troubles.
- Dredging materials should be deposited in a proper place that does not harm the local people and agricultural land.
- There should be effective mitigation measures in order to reduce noise pollutionand emission from construction vehicles engine and materials.
- Initiatives need to be taken to stop surface water pollution.
- Water should be sprayed 2-3 times in a day to reduce the dust pollution.
- Tree should be planted in 1:2 ratio.
- The road should be straight or dangerous curve should be minimised.
- Keep provision of foot over bridges and flyovers at busy locations.

3. Local People's Comments

461. A number of informal public consultations were held along the priority roads. In all the places, respondents mostly welcomed the project. However, they pointed out a few issues of concern like, noise & air pollution, accident hazard along with loss of land and compensation. In the time of the field survey 16 local people were interviewed.

Table 52: Details of Consultation with Public in Elenga-Hatikamrul Road Sections

Location	Person Name, Occupation and Contact	Comments	Suggestions
Kalihati, Tangail	Md. Abdus Salam, Cleaner, 01747322624 Md. Rohis Uddin, Labour, 01755084699 Md. Abdur Sabur, Cleaner, 01727322434	• It is good news and we welcome the project. • Construction stage will create some inconvenience to people but that is tolerable. • Increased traffic may cause air and noise pollution. • Local people will be benefited economically due to more employment opportunities. • Traveling will be fast which will help improve business environment	• Footpath and over-bridge should be constructed in appropriate and convenient(heavily used) locations so that people may use it to avoid accident during road crossing. • Speed-breakers should be constructed near schools, hospitals and religious places. • Tree shall be planted wherever there is space available. • Water should be sprayed2-3 times in a day to reduce the dust pollution.
Sirajganj Sadar, Sirajganj	Md. Shoriful Islam, Business, 01735671741 Md. Nidan Ali Shak, Business, 01915914416 Md. Shafiqul Islam, Business, 01765021257	• Accident prone area • Improved road is essential and we welcome the road.	• Road should be straight asit is sharply turning at this place or road ROW shouldbe reduced. • Require safe passagebeing a growth centre. • Provide underpass at this location to facilitate easy

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Location	Person Name, Occupation and Contact	Comments	Suggestions
	Md. Abu Shama, Labour, 01734381832 Md. Obaydul Islam, Business, 01760429673 Monowarul Islam, Business, 01718929979 Md. Abdul Motaleb, Van Puller Md. Ismail Hossain, Driver, 01710133032		movement of people who are moving in large number currently.
Kamarkhand, Sirajganj	Md. Nurnobi Sarkar, Farmer, 01745081266 Md. Jakir Hossain, Student, 01717423571 Md. Jahadul Islam, Business, 01719617522 Munjur Rahman, Employee, 01713731581	• Very welcome step from Govt. • Local people will be benefited economically due to more employment opportunities. • Commuting will be fast which will help improve business environment	• Provision shall be made for safe passage of kids. • A foot over bridge may be provided near school. • Water should be sprayed 2-3 times in a day to reduce the dust pollution. • Tree should be planted in 1:2 ratio.
Royganj, Sirajganj	Md. Alauddin, Student, 01735660100	• Difficult to cross the road due to heavy traffic, accident prone • Road development is welcome	• Make appropriate measures in road design for safe passage. • Water should be sprayed 2-3 times in a day to reduce the dust pollution. • Tree should be planted in 1:2 ratio.

462. A brief summary of comments of local people is presented in the following sections:

- Most of the people who were interviewed in the project area welcome the road expansion project as this is expected to improve the connectivity. Farmers have positively reacted to the development considering that better communicationfacility will fetch them better farm price. However, roadside shopkeepers and farmers have concern of loss of business due to widening of road and loss of livelihood.
- The people in the project areas were less concerned about the environmental problems, such as, air and noise pollution, top soil removal problem that may arisedue to pre and post operation of road construction. However, they have raised concern regarding dust pollution and noise pollution near religious places and schools and suggested for adoption of appropriate mitigation measures for the control of it.

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- The local people also mentioned that the environmental impact due to the proposed project is minor and short term. However, some mitigation measures should be taken during construction of the road, such as water spray to reduce dust pollution, tree plantation, and working hours should be onldaytime time and particularly if it will near the residential area.
- People have raised concern of accidents during road crossing near village due to increasing traffic. They have strongly demanded provision of foot over bridge and speed breaker. They also demanded traffic management near big junctions like Elenga, Kodda Moor and Hatikamrul.
- Local people are of strong opinion for the early implementation of the project.

4. Findings of Public Consultation

463. Public consultation is one of the key components of the environmental assessment. A number of informal public consultations were held along the priority road. Two consultation meetings were arranged at Kodda Moor and Pachlia Bazar Sirajganj to inform the potential affected people about goals and objective of the project, probable timeline of starting civil construction, roles and responsibilities of the project authority and affected people/stakeholders, probable impacts and mitigation measures. The local people including representative of the Bazar Committee, local residence, businessmen and potential affected people were present in the meeting. Attendance sheet, consultation outcome are briefly described in Appendix G.

464. In the consultation meeting both environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes poverty and environmental degradation by declining the homestead forests, depleting biodiversity and decreasing livelihood of people. The issue of the potential impact of construction works has alsobeen raised.

465. **Suggestions.** The following suggestions received from the public consultations:

- As most of the people engaged in business on the roadsides so rehabilitation program should consider appropriate measure with decent compensation.
- Local employment needs to be created during the construction phases which can be a good option for the livelihood development.
- There should be acceptable and effective mitigation measures to reduce noise and dust pollution. Tree plantation and construction of noise protection walls is suggested.
- Improved technology can be used to mitigate noise pollution.
- Proper drainage system should be developed to prevent water logging in that urban area.
- Water could be sprayed at the construction site i to reduce dust, particularlyduring the construction phase.

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Photograph 13: Photos of Public Consultation

5. Integration of comments

466. As observed from their responses, almost everyone interviewed was supportive of the project and believes that it will help to provide much-needed connectivity and development tothe region.

467. During discussions, notes were taken for any issues raised and suggestions made. These were collated for a comprehensive analysis of the concerns raised. References have been takenfrom public opinion where no official data were available, while the officially available data have been extensively used for understanding the project area characteristics. Each of the issues was then analyzed on practical and scientific basis and accorded a likewise importance in termsof their magnitude in impacts and mitigation. For any significant concern, preventive or mitigationmeasures have been suggested drawing points from all the suggested measures.

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X. CONCLUSIONS AND RECOMMENDATIONS

K. Conclusions

468. The conclusions are, in fact, summaries of findings of the IEE study, which provide valuable input to the decision-makers to take informed decisions. This Initial Environmental Examination (IEE) concludes that the environmental impacts are manageable if the mitigation measures are implemented thoroughly. The EMP is based on the type, extent, and duration of the identified environmental impacts. The EMP has been prepared with close reference to best practices and in line with the ADB's Safeguards Policy Statement (SPS) and DoE environmental guidelines.

469. The project is classified 'B' in accordance with ADB's Safeguard Policy Statement 2009 requiring preparation of an Initial Environmental Examination Report. As per the Environmental Conservation Act, 1995 of Bangladesh, the project falls under Red category and requires preparation of an IEE. This report has been prepared following the ADB and GOB environmental requirements.

470. The first IEE study was carried out when the Elenga-Hatikamrul road project was at the detailed design stage of ADB Loan 2688-BAN. Essentially primary data was used to assess the environmental impacts in a comprehensive manner. Site surveys for environmental data collection, consultation,ltation and specific studies (flora, fauna, land use, hydrology) were carried out to complete the environmental impact assessments and recommend suitable mitigation measures.The potential environmental impacts were assessed in a comprehensive manner. The IEE report assesses the potential environmental impacts associated with the Elenga-Hatikamrul road project, and suitable mitigation measures have been recommended. In case any design details of the Elenga-Hatikamrul are changed, the IEE and EMP must be reviewed and revised accordingly and submitted to DOE & ADB for acceptance. Due to proposed variations in designs of the structures, such as SMVT, bridge, culverts, overpass and flyover within the Elenga-Hatikamrul road section (WP 5 to WP 7), this IEE has been updated so that environmental impacts to be generated by the change in scope of works are addressed through implementation of the updated EMP.

1. Environmental Gains Due to Proposed Work Justifying Implementation

471. The project entails various impacts on the project setting. There are many impacts bearing benefits to the area against the limited number and magnitude of negative impacts. These includethe following: (i) the project will substantially improve the transport efficiency on the road linking the North and North-west region of Bangladesh to Dhaka and the southeast road corridor (to Chittagong). (ii) This will also contribute to integrating the southwest region into the national economy. (iii) The project once implemented will improve the overall environmental conditions with better roads and environmental protection measures (iv) will reduce traffic congestion and related air pollution due to idling of the vehicles and widening as well as provision of flyover and underpasses.

2. Potential Impacts, Mitigation, Management and Monitoring

472. The Elenga-Hatikamrul Road, including proposed variation of orders offers a robust option for the enhancement of the existing road-based transportation network. Several actions are required during the detailed design stage to minimize impacts to acceptable levels. The negative environmental impacts from the project mostly take place during the construction stage since there are no significant cumulative adverse impacts during operation that are identifiable at this stage. The construction impacts should be very predictable and manageable, and with appropriate mitigation, few residual impacts are likely. Deployment of full environmental team of the PIC and contractors and financial resources are required to achieve necessary statutory compliance, and to renew

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environmental clearance certification for the Elenga-Hatikamrul road project or associated activities that also require environmental assessment and environmental permits under the environmental laws of Bangladesh.

473. Both the findings of earlier IEE and present environmental assessment indicate that the project is unlikely to cause any significant adverse environmental impacts. The proposed project road expansion does not pass through or located nearby any national park, wildlife sanctuary, reserved forests, or any other ecologically sensitiveor areas. No archaeological/protected monument is located in the project vicinity. The land use pattern around the alignment is predominantly agricultural.

474. However, there are some negative impacts but many bearing benefits to the area. Most of the negative impacts are likely to occur during construction stage and are temporary in nature.Some impacts require design consideration and are suitably addressed. The land use pattern around the road alignment primarily includes fallow land, agriculture land, rural settlement, and perennial or non-perennial water bodies. Urban settlement is also there but in most of the populatedlocations either provision of flyover has been made or best engineering measures like RCC wall are taken to minimize the social impact. The impact is primarily caused due to land clearing for widening the carriageway, cutting of roadside full-grown trees, borrowing of earth, transportationof construction material, loss of water bodies/fishponds, and construction of bridge. The impactsare with regard to loss of terrestrial flora, impact on aquatic fauna, soil compaction, water contamination, and change in ambient air quality, water quality, and increase in ambient noise levels. During the operation, direct local impacts are mostly related to noise levels, air quality androad accidents. Some sections of the entire road are threatened by floods of average flood returnperiod of 2.33 years. Provisions have been recommended for the road elevation keeping the HFLlevel keeping this threat in view. Implementation of the prescribed mitigation measures will minimize the adverse impacts. Moreover, the impacts shall be monitored continually by implementing and updating the Environmental Management Plan and Environmental Monitoring Plan.

475. During the construction stage, some 31450 number of trees along the road have been cut. The project is obligated to plant as much as twice the number of plants to reverse the vegetation quantity and quality as a compensation. The project will monitor the survival rate until the positive benefits are accrued. Some old trees are located along the project road. These trees play a vital role for the environmental conditions of the area. Efforts are proposed to minimize cutting of these trees with suitable modifications in the road alignment/widening options. However, there are no legislative restrictions in cutting these trees. There are no other environmentally sensitive resources found in the project area, which is likely tobe affected due to the project.

476. The project is welcomed by all the stakeholders and receives immense support from local people. The local people appreciated that besides providing an all-weather efficient connectivity to large rural populations and improving the traffic scenario in the region, it will bear out several other socio-economic positive benefits. The suggestions received from the public/stakeholders have been integrated while developing the mitigation measures and Environmental Managementand Monitoring Plan.

3. Post IEE Surveillance, Monitoring and Updated IEE

477. While an IEE is meant to provide a comprehensive understanding of the environment status of the area under the study, post IEE surveillance is the means to ensure that the significantimpacts identified are adequately mitigated as per the proposed mitigation plan. In addition, since the project has proposed significant variations in the designs of the structures and quantities of construction

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works, it has been found as an immense importance to update the IEE so that environmental issues to be emerged due to changed works are adequately addressed in the upcoming days of project implementation. To this motto, the earlier EMP has been updated as necessary.

478. Environmental impact and compliance monitoring activities focus on compliance with conditions of licenses from DOE and EMP provisions, recording implementation of mitigation measures, recording environmental parameters, reviewing contractor environmental performance, and proposing remedial actions to address unexpected impacts and complaints.

479. The updated EMP prepared for the project (Chapter 6) will be used as basis for an environmental compliance program in a regular program of environmental monitoring and auditing. In addition, any conditions included as part of the environmental compliance certificate from the government(MOEF/DOE) is also included as a basis for environmental monitoring and compliance. Therefore, monitoring of (i) the implementation of mitigation measures and (ii) the implementation of the conditions of environmental compliance is carried out regularly as scheduled in the EMP, and results are reported semi-annually to ADB and DOE.

4. Public Consultations

480. The project received support and consent from most of local people including those who have been rehabilitated, provided adequate compensation is paid. The local people did not perceive any adverse impact due to the proposed project. Environmental awareness and likewise concernwere found generally low. Nevertheless, local stakeholders did raise concern regarding cutting ofold trees of the area. However, the project has not conducted public consultation to update the IEE for processing MFF for Phase 2 Tranche 3 of the project.

L. Recommendations

481. The updated EMP, its mitigation and monitoring programs, contained herewith shall be considered as integral part of the Bidding documents for project works. The contractor shall be responsible for the implementation of the requirements of the updated EMP through his own Site-Specific Environmental Management Plan which adopts all the conditions of the updated EMP.This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

482. The updated EMP and all its requirements shall be part of the contractor's contract, thereby making implementation of the updated EMP a legal requirement according to the contract. Contractors then update their respective CEMP which would be approved and monitored by the Engineer/Environmental Specialist. To ensure compliance with the CEMP the contractor should employ a full-time environmental monitoring officer to monitor and report project activities throughout the project construction phase.

483. RHD has a Social and Environmental Circle but they need capacity building and practical exposure. Adequate training is imparted as proposed under the environmental management plan to enhance the capability of concerned EA officials. It is recommended to update environmental guidelines focused on effective implementation of mitigation measures.Performance indicators may also be developed as part of these guidelines to monitor and assess theeffectiveness of the mitigation measures.

484. The Initial Environmental Examinations and Environmental Management Plans for the establishment of Research and Training Centre (RRTC) has been prepared and being implemented by

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the contractors under supervision of Project Implementation Consultant (Supervision Consultant).

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