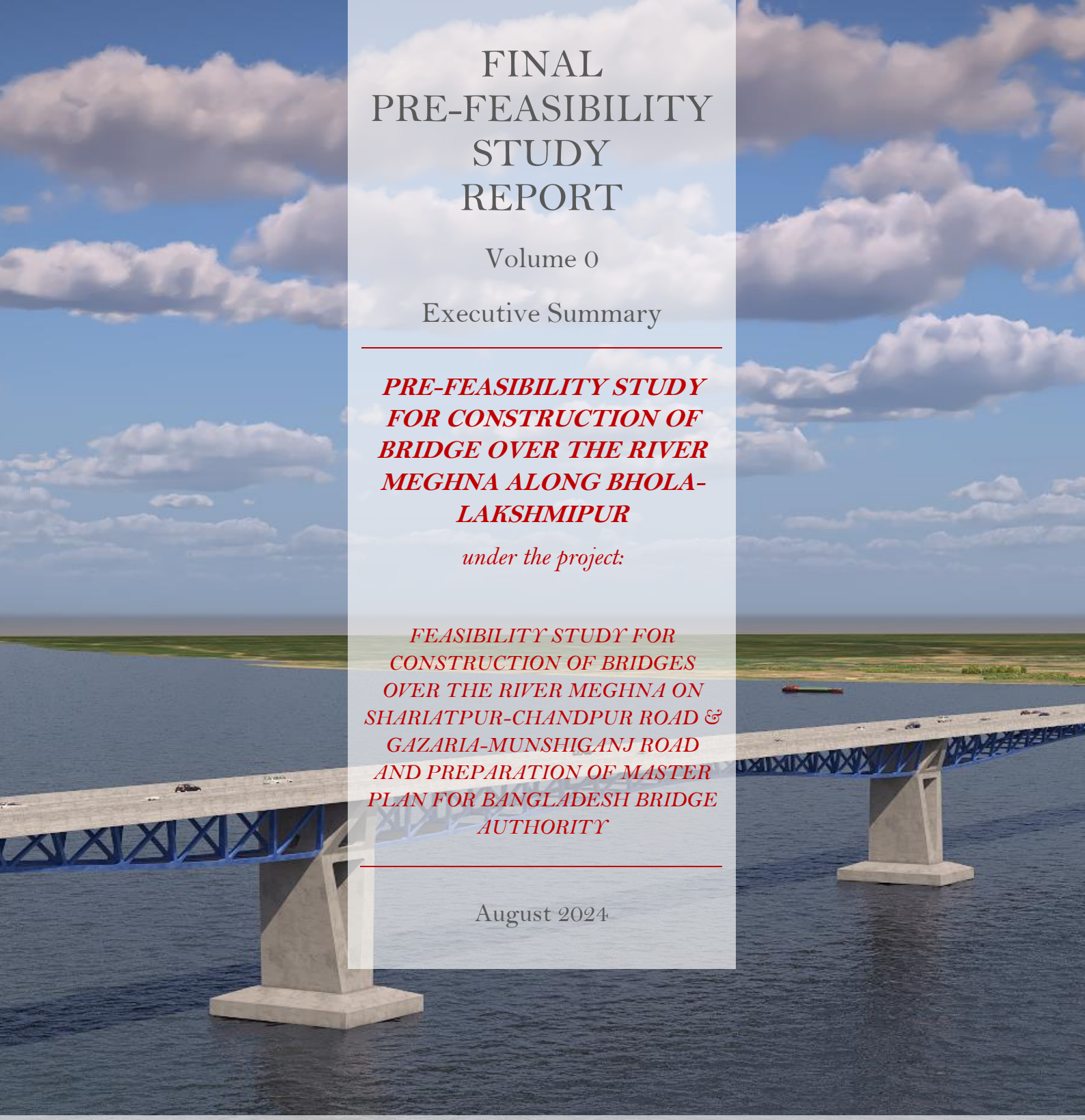

FINAL PRE-FEASIBILITY STUDY REPORT

Volume 0

Executive Summary

PRE-FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ALONG BHOLA-LAKSHMIPUR

under the project:

FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGES OVER THE RIVER MEGHNA ON SHARIATPUR-CHANDPUR ROAD & GAZARIA-MUNSHIGANJ ROAD AND PREPARATION OF MASTER PLAN FOR BANGLADESH BRIDGE AUTHORITY

August 2024

TYPSA

DOHWA NIPPON KOEI

ddc BCL DerCon

Government of the People's Republic of Bangladesh
Ministry of Road Transport & Bridges
Bridges Division
Bangladesh Bridge Authority (BBA)

FINAL PRE-FEASIBILITY STUDY REPORT FOR CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ALONG BHOLA-LAKSHMIPUR

VOLUME 0
EXECUTIVE SUMMARY

VOLUME 1
MAIN REPORT

VOLUME 2
ANNEX A. GEOTECHNICAL FACTUAL REPORT

VOLUME 3
ANNEX B. TOPOGRAPHICAL REPORT AND MAPS

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Quality Control sheet

DOCUMENT	**FINAL PRE-FEASIBILITY STUDY. CONSTRUCTION OF BRIDGE OVER THE RIVER MEGHNA ALONG BHOLA-LAKSHMIPUR** **VOLUME 0. EXECUTIVE SUMMARY**		
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Control of Versions

VERSION	CONTROL OF CHANGES
1	First Submission
2	Second Submission

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List of Abbreviations

1D	One Dimensional
2D	Two Dimensional
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
AP	Affected Person
ARIPA	Acquisition and Requisition of Immovable Property Act
BAU	Business as Usual
BBA	Bangladesh Bridge Authority
BDT	Bangladesh Taka
BFRI	Bangladesh Fisheries Research Institute
BWDB	Bangladesh Water Development Board
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CC	Cement Concrete
CCB	Control Centre Building
CEGIS	Centre for Environmental and Geographic Information Services
CL	Lean Clay
CPR	Common Property Resources
DBFOT	Design-Build-Finance-Operate-Transfer
DC	Deputy Commissioner
DoE	Department of Environment
DSCR	Debt Service Coverage Ratio
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization,
EFP	Economic Financial Plan
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EPC	Engineering, Procurement and Construction
EZ	Economic Zone
FIDIC	The International Federation of Consulting Engineers
FIRR	Project Investment Cost
FNPV	Financial Net Present
FS	Feasibility Study
GDP	Gross Domestic Product
GoB	Government of Bangladesh
HH	Household
IEE	Initial Environmental Examination
IFC	International Finance Corporation
INGO	International Non-Governmental Organization
IoL	Inventory of Losses
IRC	Indian Road Congress

IRR	Inner Ring Road / Inner Circular Elevated Expressway (Dhaka)
IWM	Institute of Water Modelling
JV	Joint Venture
Ke	Cost of equity
Km	Kilometre
LAP	Land Acquisition and Resettlement
LGED	Local Government Engineering Department
LRFD	Load Resistance Factor Design
m	Meter
MDB	Multilateral Development Banks
ML	Silt
MSL	Mean Sea Level
MSS	Movable scaffolding system
MUSD	Million United States Dollar
N1	National One (Dhaka–Chattogram Highway)
NPV	Net Present Value
OPEX	Operating Expenses
PAPs	Project Affected Person
PCM	Public Consultation Meeting
PM	Prime Minister
PPP	Public and Private Partnership
PWD	Public Works Datum
PWD	Public Works Department
RAP	Resettlement Action Plan
RC	Replacement Cost
RHD	Roads and Highways Department
RoW	Right of Way
RTW	River Training Work
SCP	Sand Compaction Pile
SHWL	Standard High-Water Level
SIA	Social Impact Assessment
SM	Silty Sand
SP	Poorly Graded Sand
SRD	Social Rate of Discount
SVL	Slow Vehicle Lane
TAC	Technical Advisory Committee
ToR	Terms of Reference
USD	United States Dollar
VAT	Value Added Tax
VGF	Viability Gap Financing
WACC	Weighted Average Cost of Capital
WB	World Bank
WL	Water Level

Executive Summary

Summary of Key Findings and Recommendations of the Pre-feasibility Study

(Final Report – August 2024)

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1. PROJECT BASIC INFORMATION

Table 1. Basic Information

1.	Name of the Project	:	FINAL PRE-FEASIBILITY STUDY. CONSTRUCTION OF BRIDGE OVER MEGHNA RIVER ALONG BHOLA-LAKHSMIPUR
2.	(a) Sponsoring Ministry/Division (b) Implementing Agency	:	(a) Government of the People's Republic of Bangladesh Ministry of Road Transport & Bridges (b) Bridges Division Bangladesh Bridge Authority (BBA)
3.	Project Objectives (Project to be taken based on the study)	:	To assess the pre-feasibility of a bridge and related infrastructures connecting Bhola with Lakshmipur Analysis shall include technical, socio-economic, financial, and environmental aspects
4.	Estimated project Cost. (Taka in Crore)	:	Estimated project Cost. 46,515.47 BDT
5.	Sector & Sub-Sector	:	Transport Sector / Bridges Infrastructures
6.	Project Category	:	Project Red Category (Based on Environment Conservation Rules 1997)
7.	Project Geographic Location Countrywide Division District Upazila Others (City Corporation/Pourashva)	:	 The People's Republic of Bangladesh Division: Chattogram and Barishal District: Bhola and Lakhsmipur Upazila: Bhola Sadar and Lakshmipur Sadar
8.	Project Duration	:	Investment Period: 8 Y – 2027/2034 Operation Period: 30 Y – 2035/2064

2. INTRODUCTION

2.1. Assignment Background

With a view to boost up the economy of every region of Bangladesh, a roadmap and action plan (Master plan) of transport connectivity is being implemented by the Bangladesh Bridge Authority. In response to a long felt need for easy and quick communication among major cities of Bangladesh, the Master plan, prepared by BBA includes the implementation and construction of several bridge projects. Among these, one of the important infrastructures is the one over the Meghna River connecting Bhola and Lakshmipur.

A transport system contributes to the shaping of a country's foundation for economic growth and development. A bridge, as a major component of a transport system connects roads and turns inaccessible areas easily accessible, thus becoming these areas a pivot for development.

In April 2021, the BBA signed an agreement with the Consultant JV to conduct a series of studies, as part of the contract scope for the Consultancy Services for Feasibility Study for Construction of Bridges over the river Meghna on Shariatpur-Chandpur Road, Gazaria-Munshiganj road and preparation of Master Plan for Bangladesh Bridge Authority. The assignment included amongst other components, four pre-feasibility studies to be carried out as part of the Phase I scope. This Phase referred to the Transport Master Plan to be implemented, including a list of proposed potential projects to be carried out by the BBA within the period 2030-2050 divided in three priority groups, short, mid and long terms.

The four selected projects, to carry out the pre-feasibility studies, were confirmed by the BBA, after the submission of the Master Plan Draft Report, that included the recommended list of potential projects based on multi-criteria analysis. The shortlist was communicated by the BBA via Memo No. 50.01.0000.671.99.004.21 (Part-2)-434 in August 2023.

1. **Construction of Bridge over the river Meghna along Bhola-Lakshmipur.**
2. Construction of bridge over Coxsbazar/Moheshkhali channel.
3. Construction of Bridge over the River Padma along Rajbari-Pabna.
4. Construction of an Elevated Expressway in haor Area along Sunamganj-Netrokona.

This report covers the Final Report of the **Pre-feasibility Study for Construction of Bridge over Meghna River along Bhola and Lakshmipur,** including the following contents for the pre-selected alternatives: preliminary field surveys, technical studies, preliminary design, cost estimating, environmental and social preliminary assessment, economic and traffic evaluations,

This pre-feasibility study consists of an Executive Summary and a Main Report along with two annexes containing information covering the field works undertaken: geotechnical campaign and topographical survey.

- Volume 0: Executive Summary
- Volume 1: Main report
- Volume 2: Annex A Geotechnical Factual Report
- Volume 3: Annex B Topographical Survey Report

2.2. Project Area

The proposed potential project is located at Lakshmipur district surrounded by Bhola Sadar and Lakshmipur Sadar Upazilas over the Meghna River. It will develop connectivity between Regional Highway R890 and Regional Highway R140.

The bridge would provide a link between the Bhola island (which is isolated by the river Meghna on the East, the river Kalabador on the north and West, the river Tentulia on the West and Southwest and the Bay of Bengal on the South) with Lakshmipur, Noakhali and Chattogram.

Figure 1.Location of the Project

Bhola District is an administrative region of Barishal Division in the southern part of Bangladesh. **Bhola Sadar**, the second larger Upazila in Bhola District, population (BBS2022) is 444,828 and covers an area of 413.16 km^2. The Upazila is composed of up of one Paurashavas, nine wards, 19 mahallas, thirteen unions, 92 mouzas, and 108 villages. Bhola District is significant for its gas fields, and the government has plans to establish a special economic zone there.

Lakshmipur Sadar Upazila population (BBS2022) is 814,813 and covers an area of 480.35 km^2. The Upazila is divided into 12 wards, 22 mahallas, 21 unions, 228 inhabited mauzas, and 258 villages.

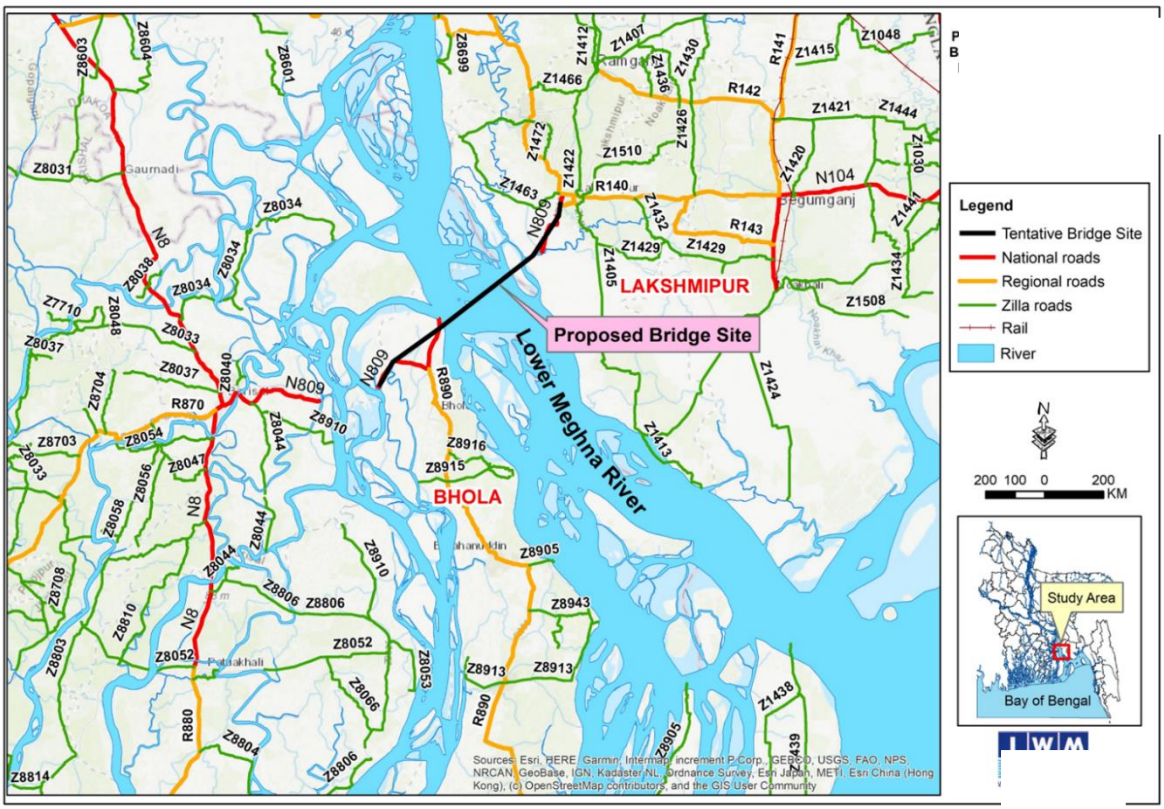


Figure 2.Location of the Project

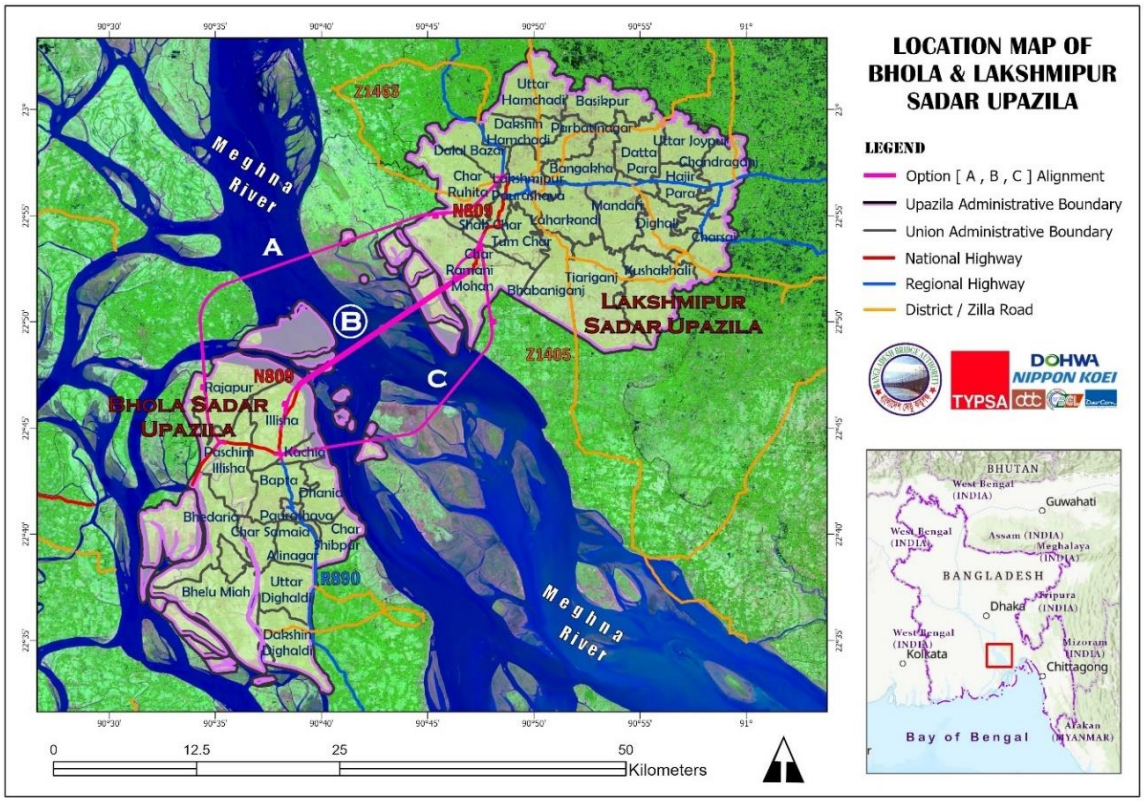


Figure 3.Bhola Sadar and Lakhsmipur Upazilas

2.3. Objectives of the Assignment

The objective of this assignment is to prepare a pre-feasibility study-concept design for the construction of Bridge over Meghna River to provide a safe and permanent connection between Bhola and Lakshmipur.

This study aims to be the precursor of a possible next phase of the project, namely feasibility study, at the BBA criteria and strategic decision. Due to this fact, it has been the purpose of the study, to assess three options and to present within the Main Report volume, the key outcomes from the technical, environmental social and cost standpoints, for the three options. The Consultant is presenting the conclusion of the economic and financial analysis for the pre-selected alignment option.

The main objectives of this study are as follows, including the evaluation of **three different alignment options**:

- Find three the suitable locations for the bridge and accessing roads.
- Carry out fieldworks (topography and geotechnical) campaigns at the initially preselected alignment (one out of three).
- Identify the types of bridge or tunnel suitable for the crossing for each option.
- Carry out preliminary design of the bridge, roads and associated facilities for each option.
- Evaluate a cost estimate for each option.
- Assess socio-economic status of the area.
- Evaluate technical, environmental and social viability of the project at each option.
- Evaluate the economic and financial viability for the pre-selected alignment option.

2.4. Approach and Methodology

This pre-feasibility study presents the outcome of the study that has been carried out by the Consultant JV. The assignment has been carried out following the scope as provided by BBA in the Terms of Reference (ToR).

This includes the following activities according to the ToR of the contract.

- Compilation, analysis and review of previous reports, studies, preliminary or detailed designs referred to the current feasibility study.
- Review available traffic count data and studies and carry out supplementary traffic counts.
- Detail traffic survey with O-D survey, traffic analysis and traffic forecast for a reasonable time horizon establishing traffic model.
- Preliminary Hydro-morphological study of the river flow characteristics.
- Determination of preliminary corridor/site selection (3 options)
- Determination of the pre-selected preferred location of the bridge, (optimization of Length, Location and Alignment of the Bridge).
- Optimization of the approach road. Routes Assessment, Project Road Corridor Alternatives, Geometric Design for the preferred alternative (Typical cross sections, Plan & Profile).
- Mapping, Land Use and Topographical Model for the preferred option.

- Geological and Geotechnical Investigation Campaign for the preferred solution (field studies and Reports) for: cuts and fills geometry, pavements, sources of materials, foundation design for viaducts, bridges, and other structures.
- Pavement Design.
- Structural Design. Comparative study for investment cost and O-M cost. Typological alternatives study.
- Economic and financial evaluation (30-year benefit stream period).
- Estimate the expected distribution of the project net benefits, based on the project economic analysis.
- Considering the economic evaluation, social benefits, and environmental impact, recommend the most suitable improvement option for each project road section.
- Initial Social impact Analysis.
- Meetings and dialogue with the community groups in the project areas.
- Initial environmental examinations (IEE) and Environmental Impact Assessment.
- Social Impact Assessment (SIA).
- Determination of appropriate construction method, configuration, and technology.

2.5. Key Findings - Salient Features

Table 2. Salient features of the project.

Salient Features of Bhola-Lakshmipur Bridge				
		Option A	Option B Selected Option	Option C
Main alignment length	Road and bridge	39,447 m	24,406 m	30,429 m
Total bridge length		19,080 m	19,240m	19,440 m
Cable Stayed Bridge	Length	1,200 m	1,200 m	1,200 m
	Main span	600 m	600 m	600 m
	Back spans	100 + 200 = 300m	100 + 200 = 300m	100 + 200 = 300m
	Width of the section	23.00 m	23.00 m	23.00 m
Truss Bridge	Length	15,000 m	16,600 m	16,800 m
	Main span	1,600 m (8x200) 13,000 m (65x200)	16,400 m (82x200)	3,000 m (15x200) 13,400 m(67x200)
	Back spans	100+100=200 m 100+100=200 m	100+100=200 m	100+100=200 m 100+100=200 m
	Width of the section	20.25 m	20.25 m	20.25 m
Approach bridge (Precast I-Girders)	Length	2,880 m	1,440 m	1,440 m

Salient Features of Bhola-Lakshmipur Bridge				
		Option A	Option B Selected Option	Option C
	Bhola Side	2,160 m (3x18x40)	720 m (18x40)	720 m (18x40)
	Lakshmipur Side	720 m (18x40 m)	720 m (18x40)	720 m (18x40)
	Width of the section	20.25 m	20.25 m	20.25 m
Approach road	Total length	20,367 m	5,166 m	10,989 m
	Bhola Side	11,990 m	3,080 m	1,173.50 m
	Lakshmipur Side	8,377.0 m	2,086.0 m	9,815.50 m
	Total road width	39.5 m	39.5 m	39.5 m
	Main road (2+2-Lane Carriageway)	7.30 m = 2 x 3.65 m	7.30 m = 2 x 3.65 m	7.30 m = 2 x 3.65 m
	Service road (both sides)	5.50 m	5.50 m	5.50 m
Improvement roads				
	Bhola Side	1,008 m	-	1,378 m (888 m + 490 m)
	Lakshmipur Side	1,147 m (825+322 m)	-	-
Connection with the existing roads				
	Bhola Side	N809 (Roundabout)	N809 (Tie-in with existing road)	N809 (Roundabout)
	Lakshmipur Side	R140 (Roundabout)	R140 (Tie-in with existing road)	R140 (Tie-in with existing road)
Other features in approach road				
Culverts		17	4	8
	Bhola Side	9 nos (1V-6.00 m x4.50 m) Ch 1+100 Ch 2+050 Ch 3+220 Ch 3+700 Ch 5+400	3 (1V-6.00 m x4.50 m) Ch 0+950 Ch 1+600 Ch 2+860	2 (1V-6.00 m x4.50 m) Ch 0+450 Ch 0+950

Salient Features of Bhola-Lakshmipur Bridge				
		Option A	Option B Selected Option	Option C
		Ch 6+260 Ch 10+700 Ch 11+100 Ch 12+100 Ch 13+300 Ch 14+900		
	Lakshmipur Side	8 (1V-6.00 m x4.50 m) Ch 31+265 Ch 32+150 Ch 33+300 Ch 34+300 Ch 35+600 Ch 36+500 Ch 37+200 Ch 38+800	-	6(1V-6.00 m x4.50 m) Ch 21+200 Ch 22+925 Ch 25+500 Ch 26+700 Ch 27+700 Ch 29+900
Minor Structures				0
	Bhola Side	-	2 (15 m long) Ch 0+175 Ch 2+100	-
	Lakshmipur Side	-		-
Toll Plaza		7 nos booth each side = Total 14 nos	7 nos booth each side = Total 14 nos	7 nos booth each side = Total 14 nos
	Bhola Side	7 nos booth one direction	7 nos booth one direction	7 nos booth one direction
	Lakshmipur Side	7 nos booth one direction	7 nos booth one direction	7 nos booth one direction
Weighing scale		1 no each side = Total 2 nos 4 nos Weigh bridge each side	1 no each side = Total 2 nos 4 nos Weigh bridge each side	1 no each side = Total 2 nos 4 nos Weigh bridge each side
	Bhola Side	1 no	1 no	1 no
	Lakshmipur Side	1 no	1 no	1 no
Engineer's Facilities and Service Area		1 no each side = Total 2 nos 2 x 22.50 = 45.00 acres	1 no each side = Total 2 nos 2 x 22.50 = 45.00 acres	1 no one side = Total 1 nos 1 x 22.50 = 22.50 acres
	Bhola Side	1 no	1 no	-

Salient Features of Bhola-Lakshmipur Bridge				
		Option A	Option B Selected Option	Option C
	Lakshmipur Side	1 no	1 no	1 no
Construction Yard		50 Acres	50 Acres	50 Acres
River training works	Total length	25,316 m	20,754 m	21,912 m
	LGB	10,880 m	10,868 m	6,360 m
	RGB	14,429 m	9,886 m	15,552 m
Land Acquisition				
	Width of right of way (ROW)	69.5 m	69.5 m	69.5 m
	Total land to be acquired	1,952.6 acre	1,682.8 acre	1,788.3 acre
	Total number (No) of projects affected units (CPRs)	10	9	19
	Total number (No) of persons affected	1,450	1,250	1,005
	Resettlement area	1 no each side = Total 2 nos 2 x 5 = 10 acre	1 no each side = Total 2 nos 2 x 5 = 10 acre	1 no each side = Total 2 nos 2 x 5 = 10 acre

3. MARKET/DEMAND ANALYSIS

This section assesses the need for public investments, as per the study of market and traffic demand that has been implemented. Benefits and need and justification for the implementation of the infrastructure are analysed hereinafter:

3.1. Problem Statement

The existing problem, or potential improvement, to be addressed is mainly the lack of adequate infrastructure for efficient and convenient river crossings in this area of Bangladesh. The existing ferry service is not sufficient to meet the growing demands of transportation and connectivity in this area potentially growing in terms of industrial and tourism development. This results in longer travel times, limited accessibility, and hinders socio-economic development.

There are some direct causes:

- Insufficient number of bridges: currently, lack of bridges in operation, which is inadequate for the growing population and traffic demands.
- Limited investment in infrastructure: a lack of prioritization and allocation of resources for bridge construction in the region may have contributed to the current situation.

And some indirect causes:

- Population growth: an increasing population puts more pressure on existing infrastructure, exacerbating the problem of inadequate river crossings.
- Economic development: as Bangladesh's economy continues to grow, the need for efficient transportation and connectivity becomes more critical for businesses and industries to thrive.
- Urbanization: rapid urbanization in cities like Dhaka has led to increased traffic congestion and greater demand for improved infrastructure, including bridges.

A good way of understanding the need of the project is analysing the situation in which the government would not carry out this investment in the bridge:

- The lack of efficient transportation and connectivity limits trade, investment, and overall economic growth in the region.
- Limited transportation infrastructure prevents residents from accessing essential services such as healthcare, education, or emergency services, ultimately impacting their quality of life.
- Without additional bridges, the existing crossings will become more congested, leading to longer travel times and increased transportation costs.
- Increased congestion can lead to higher emissions, air pollution, and negative impacts on local ecosystems.
- Limited access to opportunities and services can exacerbate social inequalities, with disadvantaged groups being disproportionately affected.

The essential purpose of any development is social investment. A planned project is an idea for an intended future condition regarding social and economic activities, their locations and linkages, and the development of essential land, structures, and mechanisms. Viewed from the implementation angle, however, a planned project is a program of action and pre-determined coordination of legislative, fiscal, and administrative measures designed to achieve the transition from the present situation to that represented by the model. It should be noted that the essential features of both of this situation are as follows:

- a commitment to improve the human condition through economic development and social change.
- a close integration of socio-economic and environmental development in harmony with accepted development strategies. And the complete interdependence between economic, social, and environmental planning on the one hand, and legislative, fiscal, administrative, and political action planning on the other, which together make a truly comprehensive plan.

3.2. Relevance of the Project Idea

The construction of a bridge over the Meghna River at Bhola-Lakshmipur has the potential to bring significant benefits to the region in terms of economic growth, improved connectivity, and enhanced transportation infrastructure. The Meghna River, one of the major rivers in Bangladesh, creates a natural barrier for transportation and communication between the southern districts of Bhola and Lakshmipur. The lack of a bridge connecting these districts has been a major obstacle for residents and businesses, resulting in high transportation costs and limited access to markets, healthcare, education, and other essential services. Chattogram Division does not have any vehicular connectivity with mainland Barishal. There is only one ferry crossing available on Highway N-809 (Barishal-Bhola-Lakshmipur Road). Almost all personnel and goods transportation to and from main land take place by boats and launches. At present, 2 million residents of Bhola District have to reach Barishal or Lakshmipur by river to go to the capital Dhaka and Chattogram.

Bhola- Lakshmipur (Maju Chaudhurir Hat) Ferry Ghat is one of the inter-district transportation routes for people of 21 districts including 12 districts of Khulna and Barishal Division and nine of Chattogram Division. Except for the 2 months of monsoon, the ships and ferries are stuck in the river for at least 3 to 4 hours every day for the rest of the 10 months.

According to the “Final Report of the Pre-feasibility Study for Proposed Economic Zone at Bhola, Bangladesh” of BEZA, Bhola District is geographically different from other Districts of Bangladesh. As a result, significant industrial development is yet to take place in this region, due to lack of proper connectivity and adequate infrastructure. If the road from Chattogram to Sonapur of Noikhali were extended to Motirhat of Kamalnagar Upazila of Lakshmipur by only 24 km, there would be an incredible change in the communication system of the country. Besides, if the Bhola-Lakshmipur bridge were constructed, the road from Chattogram would end directly at Bhola. Then the road would become Chattogram -Bhola road which would end by going to Mongla or Khulna via Bhola-Barishal.

From Motirhat in Kamalnagar Upazila of Lakshmipur, the straight distance across the Meghna River to Ilishaghat in Bhola is only 8 km, and only if this 8 km long bridge would be constructed, excellent

bridging would be established between Bhola-Lakshmipur. And along with that, Chattogram Division would be connected with Barishal Division by road. If this bridge would be built, Bangladesh would move one step further on the path of development.

With the construction of a bridge over the Meghna River, it would be possible to establish a direct road link between Bhola and Lakshmipur, which would significantly reduce travel time and costs for local residents and businesses. The bridge would also enhance the connectivity of the region with the rest of the country, opening up new opportunities for trade and commerce.

Furthermore, the construction of the bridge would create significant employment opportunities for the local population. The construction work would require a large workforce, which would provide direct employment opportunities for local workers. Additionally, the establishment of the bridge would attract new businesses to the region, which could create additional employment opportunities for the local population.

In terms of long-term benefits, the construction of the bridge would improve the overall quality of life for local residents by enhancing access to essential services such as healthcare, education, and markets. The improved transportation infrastructure would also make it easier for people to travel between the districts, promoting social and cultural exchange.

Figure 4. Present Transport System. Source: Bangla Insider, August 19th, 2022

Overall, the Bhola-Lakshmipur Bridge would be a significant infrastructure project that is expected to bring significant economic, social, and environmental benefits to the region, making it an important development project for the country.

The bridge is expected to achieve the following objectives:

- **To enhance transportation and communication**: The bridge would establish a direct road link between Bhola and Lakshmipur as well as National Highway N809 with Z1463, improving access to markets, healthcare, education, and other essential services. It would also provide a reliable and efficient mode of transportation for people and goods between the districts.
- T**o boost economic growth:** The improved connectivity and transportation infrastructure is expected to attract new businesses to the region, creating new job opportunities and promoting trade and commerce. This would contribute to the overall economic growth of the country.
- **To reduce transportation costs and travel time:** Currently, transportation costs between Bhola and Lakshmipur are high due to the lack of a direct road link. The construction of the bridge would reduce transportation costs and travel time, benefiting local residents and businesses.
- **To promote environmental sustainability:** Currently, transportation to Bhola Island is primarily through ferries which have a significant environmental impact. The construction of the bridge would reduce the environmental impact of transportation, promoting sustainable development in the region.
- **To enhance social and cultural exchange:** The improved transportation infrastructure would make it easier for people to travel between the connected areas.

Overall, the proposed bridge is expected to have a significant positive impact on the people and economy of Bangladesh, providing a crucial link between different parts of the country and promoting economic growth and development.

3.3. Proposed Project Interventions

The Project implementation would need not only the address the construction of the main infrastructure, but as it is explained within the technical features section, the construction of approach roads would be needed to connect with the existing road network. Other interventions as two engineers' facilities compound, toll plaza and service buildings would be needed to be implemented by the GoB.

In addition, the necessary and critical river training works would be needed, given the relevant riverbank erosion identified in this area of the Meghna River.

3.4. Stakeholders Management

The list of involved stakeholders to be managed and coordinated for this project would be as follows:

- Ministry of Road Transport and Bridges: Responsible for overseeing the planning, implementation, and maintenance of transportation infrastructure projects in Bangladesh.
- Local Government authorities: Both districts' administrations would be involved in coordinating and facilitating the project at the local level.
- Bangladesh Water Development Board (BWDB): Responsible of overseeing and coordination of the river training works.

- Bangladesh Inland Water Transportation Authority (BIWTA): River navigational conditions and requirements to be coordinated for the project.
- Local Government Engineering Department (LGED): Local roads network authority.
- Roads and Highways Department (RHD): the agency of the Government of Bangladesh responsible for the construction and maintenance of highways and bridges across Bangladesh.

3.5. Demand Analysis

The implemented transportation model has been used along with updated recent data from various survey points to analyse the traffic demand in the area. Both the current demand and projected demand were evaluated.

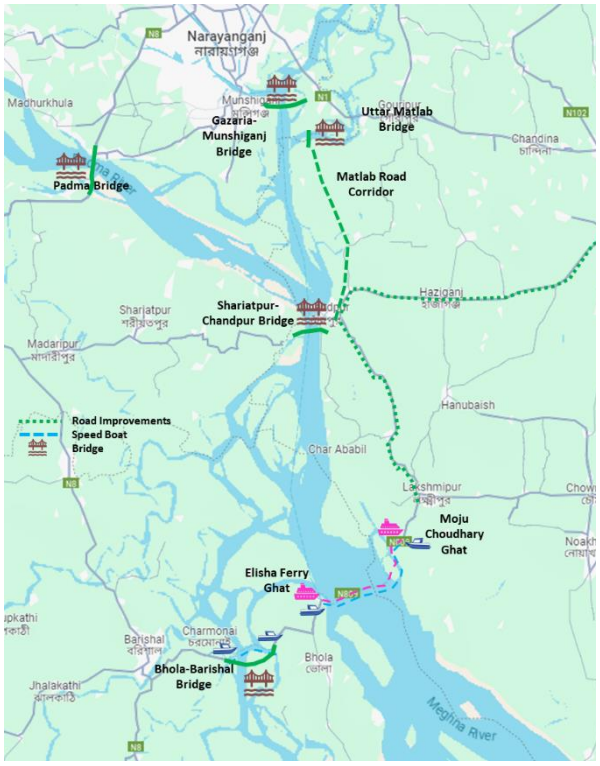
To conduct a thorough economic and financial study, it is necessary to carefully analyse the various traffic scenarios and to compare the situation without the project to the situation with the project. The differences in costs between these two situations will be the benefits of constructing the bridge.

3.5.1. Base Year Demand

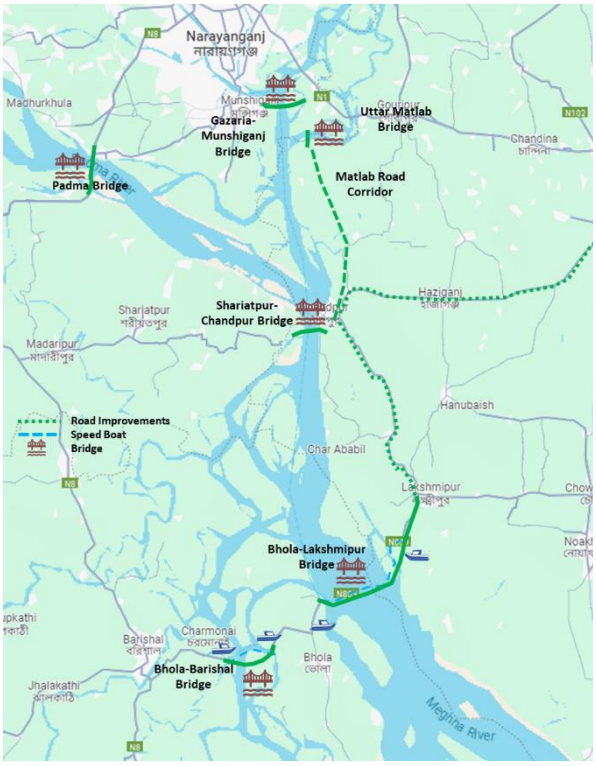
It is important to understand the different scenarios analysed, with and without project. Both scenarios will be compared to understand the benefits from the "with project" scenario compared with the "without project" scenario (case where the bridge is not built, in this case, there is no bridge but there will be some roads improvements, as well as an operating ferry service).

In the following images the difference between both scenarios is clearly shown:

Without Project (ferry service)



With Project (new bridge)



It includes:

- Bhola-Lakshmipur ferry service
- Bhola-Barisal Bridge
- Matlab Uttar Bridge
- Matlab Uttar Road Corridor to Chandpur
- Comilla-Chandpur Road improvement
- Shariatpur-Chandpur Bridge
- Gazaria-Munshiganj Bridge
- Padma Bridge

It includes:

- Bhola-Lakshmipur Bridge
- Bhola-Barishal Bridge
- Matlab Uttar Bridge
- Matlab Uttar Road Corridor to Chandpur
- Comilla-Chandpur Road improvement
- Shariatpur-Chandpur Bridge
- Gazaria-Munshiganj Bridge
- Padma Bridge

For both the traffic with and without the project the Transport Model is applied in its latest update when this estimation is carried out. It is assumed in both scenarios that some roads improvements will also be executed.

3.5.2. Traffic Forecast

The forward traffic estimation comes from the relation between GDP and traffic growth observed during a series of years in different traffic counts where historical data is available. There is a clear relation between GDP and AADT, since GDP is in line with the movement of passenger and freight.

The results of the traffic forecast study by type of traffic are shown below for the scenarios without project and with project (please refer to the main report for more information on the methodology and calculation process for the traffic study).

Table 3. Daily traffic volumes by type of traffic

Year	Normal traffic (without project)				Diverted		Generated		With project	
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	EZ	Road – due to time reduction	Due to additional GDP increment	TOTAL
2022	180	0	0	180						
2023	193	0	0	193						
2024	207	0	0	207						
2025	224	0	0	224						
2026	241	0	0	241						
2027	261	0	0	261						
2028	282	0	0	282						
2029	303	0	0	303						
2030	325	0	0	325						
2031	348	0	0	348						
2032	371	0	0	371						
2033	396	0	0	396						
2034	421	0	0	421						
2035	447	0	0	447	20	56	0	1,341	2	1,866
2036	473	0	0	473	43	119	0	4,497	10	5,141
2037	500	0	0	500	68	188	0	8,443	24	9,222

Year	Normal traffic (without project)				Diverted		Generated		With project	
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	EZ	Road – due to time reduction	Due to additional GDP increment	TOTAL
2038	527	0	0	527	95	265	0	13,722	45	14,653
2039	555	0	0	555	100	279	0	15,421	59	16,414
2040	583	0	0	583	105	293	0	17,231	75	18,288
2041	612	0	0	612	110	307	0	19,153	93	20,276
2042	641	0	0	641	116	322	0	21,188	112	22,379
2043	671	0	0	671	121	337	0	23,336	133	24,598
2044	701	0	0	701	126	352	0	25,597	156	26,932
2045	731	0	0	731	132	367	0	26,691	181	28,101
2046	761	0	0	761	137	382	0	27,793	207	29,279
2047	791	0	0	791	143	397	0	28,900	235	30,465
2048	821	0	0	821	148	412	0	30,010	265	31,657
2049	852	0	0	852	154	427	0	31,123	297	32,853
2050	882	0	0	882	159	443	0	32,237	331	34,052
2051	913	0	0	913	165	458	0	33,350	367	35,252
2052	943	0	0	943	170	473	0	34,461	405	36,453
2053	973	0	0	973	176	489	0	35,569	445	37,652
2054	1,004	0	0	1,004	181	504	0	36,673	487	38,849
2055	1,034	0	0	1,034	186	519	0	37,771	502	40,012
2056	1,064	0	0	1,064	192	534	0	38,863	516	41,168
2057	1,093	0	0	1,093	197	549	0	39,947	531	42,316
2058	1,123	0	0	1,123	203	563	0	41,022	545	43,455

Year	Normal traffic (without project)				Diverted		Generated		With project	
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	EZ	Road – due to time reduction	Due to additional GDP increment	TOTAL
2059	1,152	0	0	1,152	208	578	0	42,087	559	44,584
2060	1,181	0	0	1,181	213	593	0	43,142	573	45,701
2061	1,209	0	0	1,209	218	607	0	44,185	587	46,806
2062	1,237	0	0	1,237	223	621	0	45,216	601	47,898
2063	1,265	0	0	1,265	228	635	0	46,234	614	48,977
2064	1,293	0	0	1,293	233	649	0	47,239	627	50,041

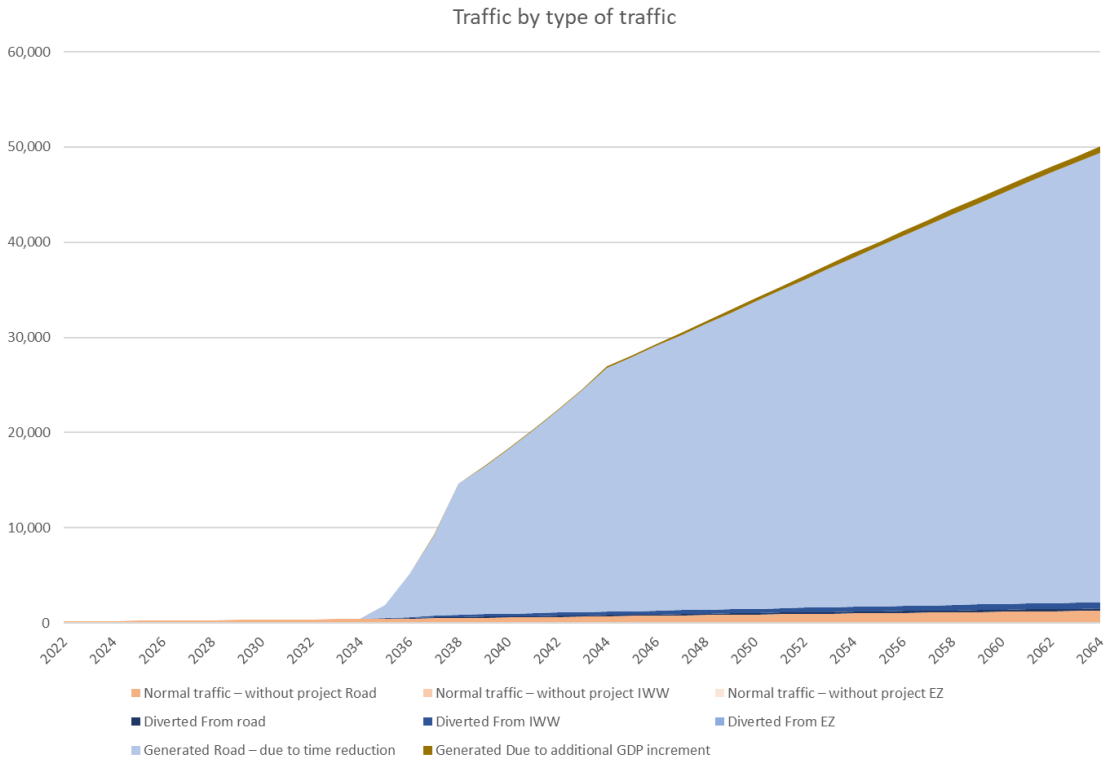


Figure 5. Daily traffic volumes by kind of traffic

The forecast of total motorized traffic (including motorcycles, light vehicles, buses, and trucks) for the scenario with Bhola-Lakshmipur Bridge project shows that the estimated ADT in the year 2064 could reach around 50,041 vehicles per day.

3.6. Need and Justification of the Project / SWOT Analysis

The identified key strengths and weaknesses of the project along with the opportunities and threats are presented in the following table.

Table 4. Project's SWOT

Strengths	Weaknesses
▪ The active participation, willingness, and support of the local gov't and citizens. ▪ The promoting agency BBA possesses previous expertise in similar projects like Padma and Jamuna Bridge, which adds to their capabilities and potential success in executing the current project. ▪ Availability of construction materials, as cement, stone from local market. ▪ Due to the river transport system, construction materials can be transported at low cost. ▪ The project is attracting interest from potential contractors and funding agencies,	▪ High-cost financing challenge. ▪ Supply of some materials source. ▪ Air and noise pollution may have some negative impacts on the environment. ▪ Disturbance to the movement of vehicles and pedestrians may occur during construction. ▪ Flooding, vessel impact and environmental aspects as Hilsa protection may pose risks during construction. ▪ In resettlement and rehabilitation, changes in economic activities, land-use, resource ownership, accessibility of natural resources and common property resources, loss of livelihoods, social disruption.

Opportunities	Threats
▪ To establish better connectivity with the national transport network, particularly in areas that are currently not directly connected due to the lack of proper road infrastructure. ▪ Generation of one of the two legs of the E-W connectivity completion over lower Meghna River (Lakshmipur-Bhola-Barishal axis). ▪ To facilitate smooth inter- and intra-town movement of people, goods, and services, thereby enhancing overall transportation efficiency and accessibility. ▪ To increase trade at both the local and regional levels, fostering economic growth and development in the area. ▪ To bring about improvements to the environment and public health, ensuring a sustainable and healthier living environment for the local communities. ▪ To foster sustainable decentralization, regional development, and resilient climate-adaptive practices, promoting long-term growth and resilience in the face of climate change challenges. ▪ 4.99 Cr population living in 26 districts, in the Chattogram and Barishal Divisions would be benefitted after completion of the proposed bridge.	▪ Influx of migrant people may have a negative impact on the quality of life. ▪ Occurrence of climate change-related and other natural hazards. ▪ The construction process could face hindrance in the event of a sudden natural disaster, impacting its continuity and progress. ▪ Excavation may result in sediments reaching watercourses. ▪ Land acquisition and rehabilitation processes can indeed be time-consuming. Furthermore, social and political obstacles can further complicate and prolong these procedures, potentially impacting the overall progress of the project. ▪ Achieving the target fund for a mega project is a formidable challenge. ▪ Due to various reasons, there is a possibility of not completing the work on time and increasing the cost of the project.

Source: Consultant Team

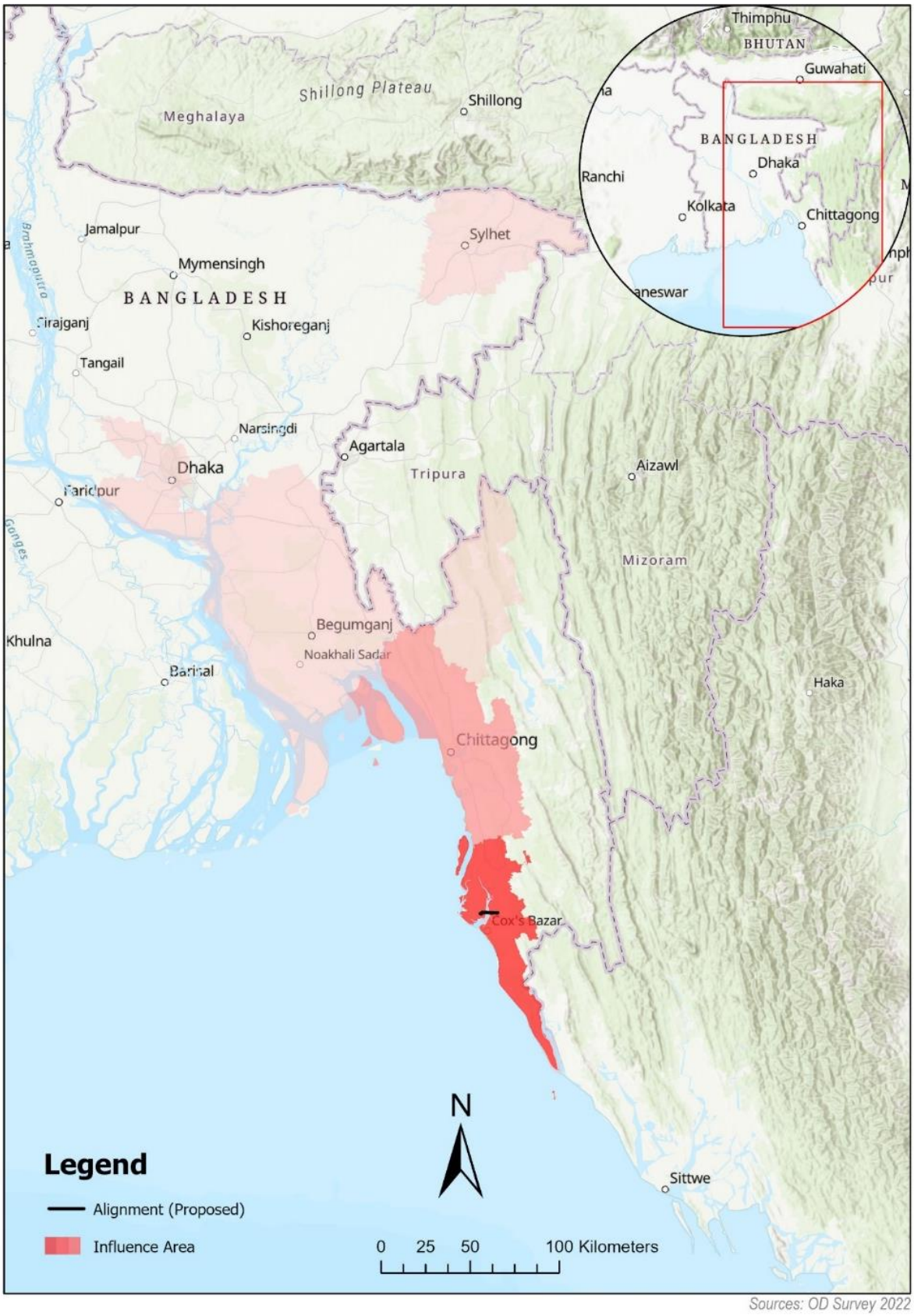


Figure 6. Influence Area Map (Source: Consultant Team based on the Traffic Survey Data)

4. TECHNICAL AND ENGINEERING ANALYSIS

A summary of the proposed project shall be presented with the following headings:

4.1. Design Standards

- The Eurocode has been adopted in the design of the structures: EN 1990, EN 1991-1, EN 1991-2, EN 1993, EN 1994 and EN 1998 along with EN 1337, EN 10080, EN 10138 and EN206.
- Despite being related to building structures; the Bangladesh National Building Code (BNBC) is followed in the determination of wind loads and the earthquake design spectrum. A wind tunnel shall be developed for this bridge during the following stages, given the size of the bridge and the investment. This wind tunnel shall confirm the pressure coefficients and be used to ensure no aeroelastic effects are expected.
- AASHTO LRFD 2017 specifications for Highway Bridges, with interim revisions 2020, 2022 and 2023, is considered appropriate to be used in the determination of stream pressure on piers.
- Geometric Design Standard for Bridges and Approaches and Bridge Design Standard by RHD.
- Geometric Design Standards Manual (Revised) 2005 (GDSM 2005). Roads and Highways Division.
- A policy on Geometric Design of Highway and Streets" 2018, AASHTO
- Manual of Specifications and Standards for Expressways, IRC: SP: 99-2013
- Manual of Specifications and Standards for Four Laning of Highways, IRC: SP: 84-2019
- Pavement Design Guide for Roads and Highways Department 2005 for pavement design works along with "AASHTO Guide for Design of Pavement Structures 1993".

4.2. Selection of Bridge location

A preliminary analysis, from hydro-morphological, structural and road connectivity points of view, was undertaken to select the location of the project in which the field works were carried out. For the hydro-morphological study, Institute of Water Modelling (IWM) was engaged. This study presented the primary selection of suitable sites based on the analysis of observed hydro-morphological characteristics of the Meghna River as discussed hereinafter.

As stated earlier, a number of three suitable sites (four as preliminary assessment, in this particular assignment) were selected preliminarily based on the connectivity with the existing road network, rail network, historical available cross-section data and observed bank erosion. In general terms, the following are the factors that were conveniently considered:

- The river reach should be straight; the bridge axis & river flow direction should be at a right angle, steady and uniform river flow without cross currents.
- The width of the river channel should be minimum, narrow channel with stable banks, suitable high banks above high flood level on each side.

- There should be no excessive scouring & silting at the bridge site, rock or other hard in erodible strata close to the riverbed level. There should be the availability of hard strata or non-erodible foundations for the bridge.
- The site should be sufficiently away from the confluence point.
- Economical approaches, the approaches should be free from obstacles such as hills, frequent drainage crossings, scared places, graveyards or built-up areas or troublesome land acquisition, absence of sharp curves in the approaches with minimum obstruction to natural waterways.
- There should not be the necessity for extensive river training works.
- The bridge axis should align with the centreline of the approach road, the bridge should be absolutely on level. If it must be in gradient, it should comply with that of the roadway at both ends of the bridge.
- There should be sufficient clearance for high flood level (HFL).
- Absence of excessive underwater construction works.
- There should be the availability of construction materials.

Based on these factors, the four locations for the probable bridge sites were selected as shown in Figure 7.

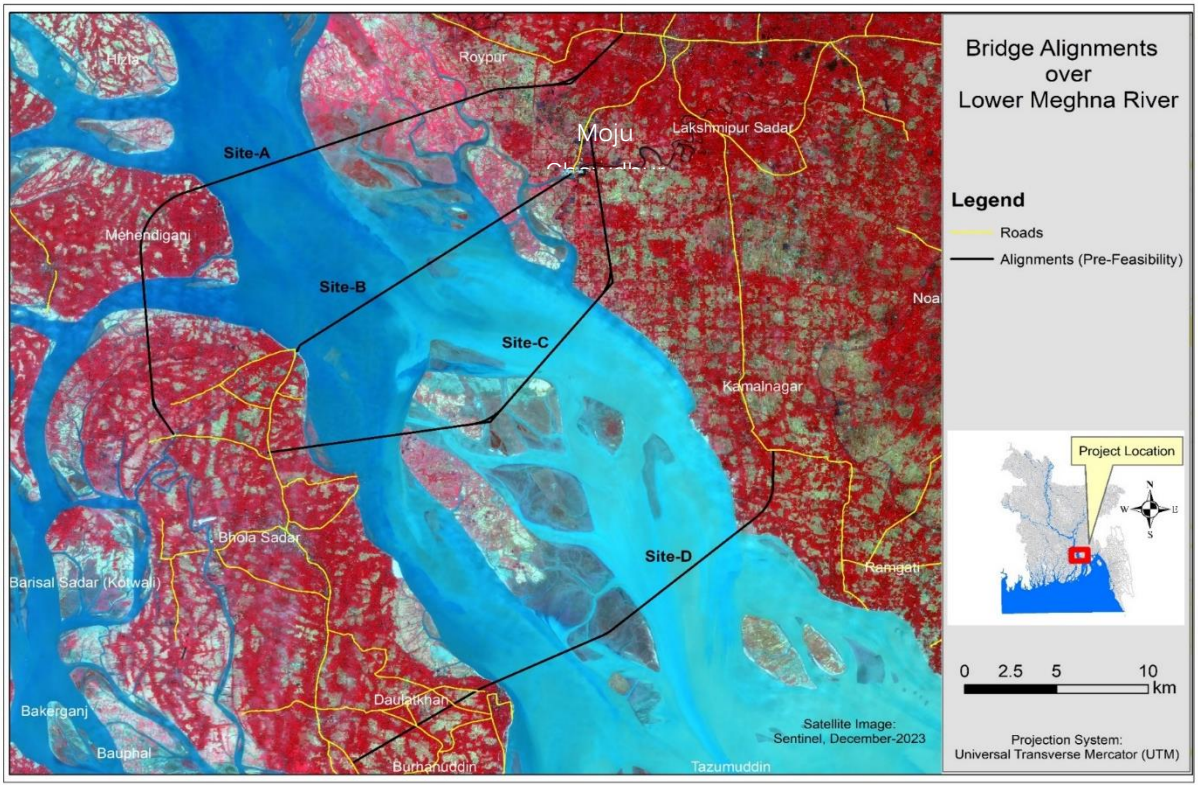


Figure 7. Primarily selected three sites for the Proposed Bridge over Maheshkhali Channel

Table 5. Selecting criteria for choosing different options

Tentative options	Location or Position	Selecting Criteria
Site A	Approximately 8.3 km upstream from Moju Chowdhury Hat that connecting Mehendiganj on the West with Goal Bhaor on the East (Chhagaldi-Lakshmipur Connection)	Minimum river width
Site B	Located at Moju Chowdhury Hat connecting Bhola Sadar on the West with Lakshmipur on the East (Elisha Ghat-Moju Chowdhury Hat Connection via N809)	Comparatively defined main channel. Stable (protected with RTW) right Bank from 2020
Site C	Approximately 7-8 km downstream from Moju Chowdhury Hat that connecting Bhola Sadar on the West with Lakshmipur on the East (Tobghi-Rahmatkhali Connection)	Alternate shortest connectivity via N809 considering the main flow (two separate channels)
Site D	Approximately 22 km downstream from Moju Chowdhury Hat that connecting Daulat Khan on the West with Kamalnagar on the East (Daulatkhan-Char Falcon Connection)	Alternate shortest connectivity along Z8916 with Z1405

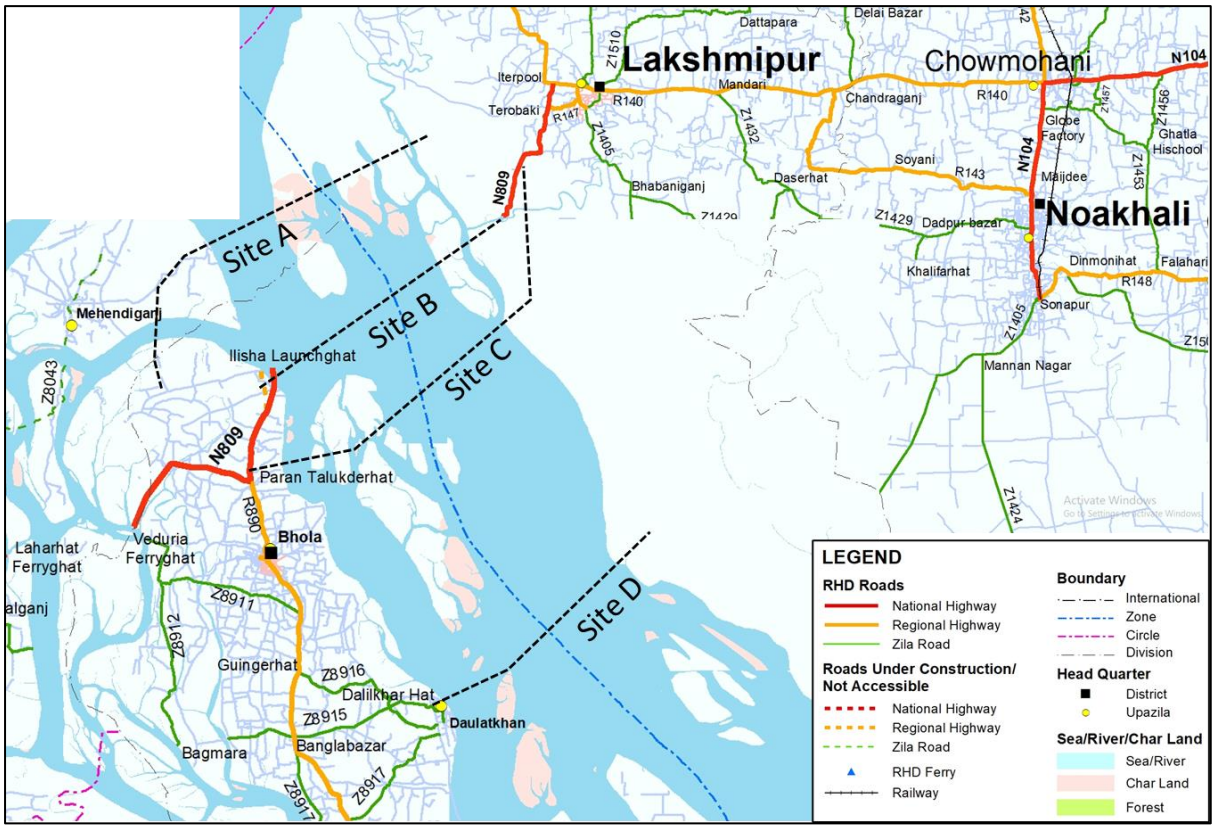


Figure 8. Road Network near Bhola and Lakhsmipur

Table 6.Required Road Length to Connect the Bridge on both sides.

Options	Approximate Length in km (including bridge) for Connecting on Both Sides	Remarks
Site A	39.4	Connecting N809
Site B	17.4	
Site C	30.1	
Site D	28.9	Connecting Z8916 with Z1405

Table 7. Minimum Width of the River Measured from recent Satellite Image

Options	River Width, km	Remarks
Site A	6.0	Satellite Image, Sentinel (December-2023)
Site B	14.1	
Site C	16.7	
Site D	15.1	

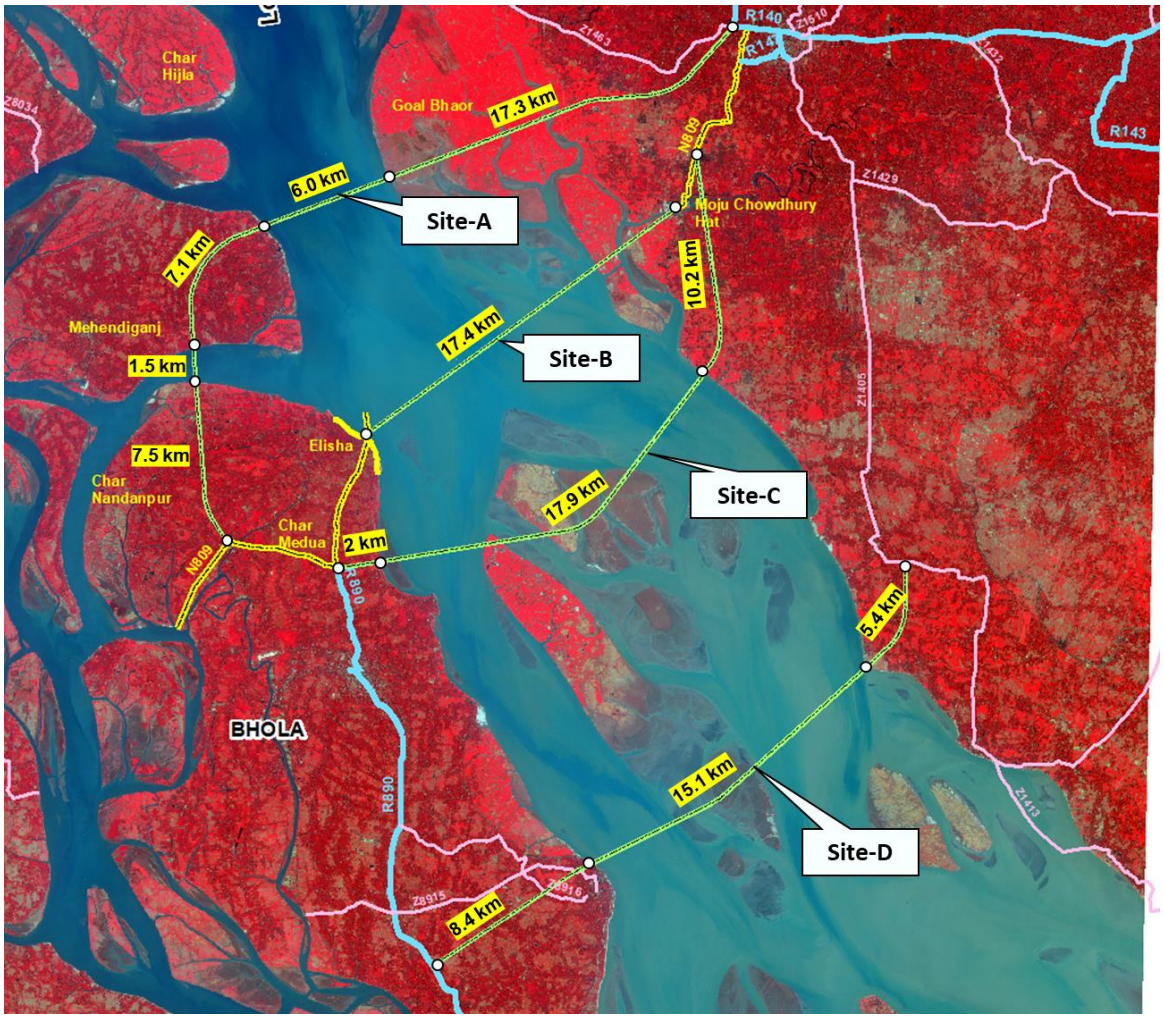


Figure 9. Proposed Options for the bridge with approach road connection.

Table 8.Total Length of Bridge including Approach Road for Four Options

Options	Bridge Length, km	Length of Approach Road, km		Total Length, km
		LB	RB	
Site A	1.5+6=7.5	17.3	7.1+7.5=14.6	39.4
Site B	17.4	-	-	17.4
Site C	17.9	10.2	2	30.1
Site D	15.1	5.4	8.4	28.9

4.3. Hydro-morphological Study

The hydro-morphological study was carried out by the Consultant with the expert collaboration of the local nominated subconsultant IWM. The results from different analyses based on historical data, present data, field observation and previous model results have been summarized in the following table to show the relative advantages and disadvantages of the selected bridge locations in terms of different hydraulic, morphological, and other factors, which lead to the selection of bridge site. For each factor a ranking has been done from 1 to 4.

Full report is included within the Main Report of this pre-feasibility study.

Table 9. Multi-criteria Analysis for selecting potential bridge location.

Sl. No	Hydraulic Condition	Option A	Option B	Option C	Option D
1	Road Connectivity at Left Bank	3	1	2	4
2	Road Connectivity at Right Bank	3	1	2	4
3	Width of River (bank to bank)	1	2	4	3
4	Uniformity in section	2	1	4	3
5	Bed Scour	3	4	2	1
6	Bank erosion (Left Bank), 1989 to 2023	1	2	4	3
7	Bank erosion (Right Bank), 1989 to 2023	4	1	3	2
8	Field Condition	3	1	4	2
9	Required Length of Bank Protection Works	4	2	3	1
10	Cost Estimation	4	2	3	1
	Frequency of top ranked	2	5	0	3

The multi-criteria analysis suggested that **Option B is the most suitable site for the proposed bridge** location. From hydro-morphological point of view all the options are almost similar as bank erosion is found negligible overtime due to the cohesive property at coastal region. Thus hydro-morphological criteria will not be a governing factor to choose the suitable location of the proposed bridge.

As the analysis above are solely based on the available secondary data, during the phase of the feasibility study, a further detailed analysis of these potential sites using state-of-the-art mathematical modelling tools has been felt necessary before finalizing the most suitable site for bridge construction.

Summary findings of the study on selection of suitable bridge location on the Lower Meghna River along with estimation of the hydraulic design parameters of bridge are described in the following sections.

- Analyzing the tentative four sites, Site B shows better results concerning the hydro-morphological viewpoint.
- Site-B has very good road network connectivity in both directions.
- The proposed bridge site falls under Class I navigational route (as per BIWTA 2018 Gazette). It is mentioned worthy that the Navigational Clearance as well as SHWL shall be confirmed by the main authority (BIWTA).

- The Minimum Vertical Clearance from SHWL is 18.3m (as per BIWTA 2018 Gazette). Furthermore, as the deep channel position can move very quickly from one year to the next, the vertical clearance of 30 m in height has been extended to the full navigable length.
- Using Lacey's regime scour depth formula, scour has been calculated and the computed scour depth is found 35.9m. Hence, the maximum scoured depth in river is about 2 times of computed scour depth, which is 71.8m and the scour level is -66.95mPWD.
- The local scour has been calculated using different empirical formula, such as FHWA method, Laursen method, Breusers method etc. The maximum scour at the proposed site (Site B) is found 42.08m using Laursen's method for 600m span length. The total scour level considering the lowest bed level -36.59mPWD will be -78.67mPWD.
- Riverbank protection work for each alternative has been proposed based on planform change of river, historical bankline shifting, the present field condition and previously developed simulated model results. The length of the LGB is 10868m and RGB is 9,886m.

Table 10.Hydraulic Design Parameters

Hydraulic Parameters	Unit	Values	Remarks
Design Discharge	m^3/s	173964	Calculated from 1D Model data (for 1in100 flood event)
Design High water Level	mPWD	4.845	Calculated from 1D Model data (for 1in100 flood event)
Low water Level	mPWD	-0.655	slope interpolation from observed data
Standard High Water Level	mPWD	4.793	slope interpolation from calculation
Maximum velocity	m/s	1.74	Extracted from model
Average Bank Level	mPWD	4.0	from DEM and cross-section
Minimum Bed Level	mPWD	-36.59	BWDB cross-section data at RMML-8
Bed material size, d_{50}	mm	0.049	Surveyed data
Water Depth	m	41.435	HFL-min bed level
Angle of attack	(degree)	23.6	extracted from retrieved model
Fetch Length	m	10,030	calculated

Mainly to guide the flow towards the bridge opening, two bank protection works or guide bunds have been suggested at both banks for all options. Considering no loss of land along the entire protected length, no damage due to oblique flow, flow diversion from riverbank, navigation, minimum maintenance, partial damage does not create non – functional, easy construction and use of dredged material for land reclamation etc.; Bank Protection work with revetment and dredging in the channel appeared to be the most feasible option and hence adopted.

Table 11. Length of Proposed Bank Protection (Guide Bund) Works

Options	River	Length of LGB, m	Length of RGB, m	Total Length, m
Site A	Lower Meghna	5,250	6,709	11,959
	Elisha	5,637	7,720	13,357
Site B	Lower Meghna	=3763+7105=10,868	9,886	20,754
Site C	Lower Meghna	6,360	15,552	21,912
Site D	Lower Meghna	3,470	3,530	7,000

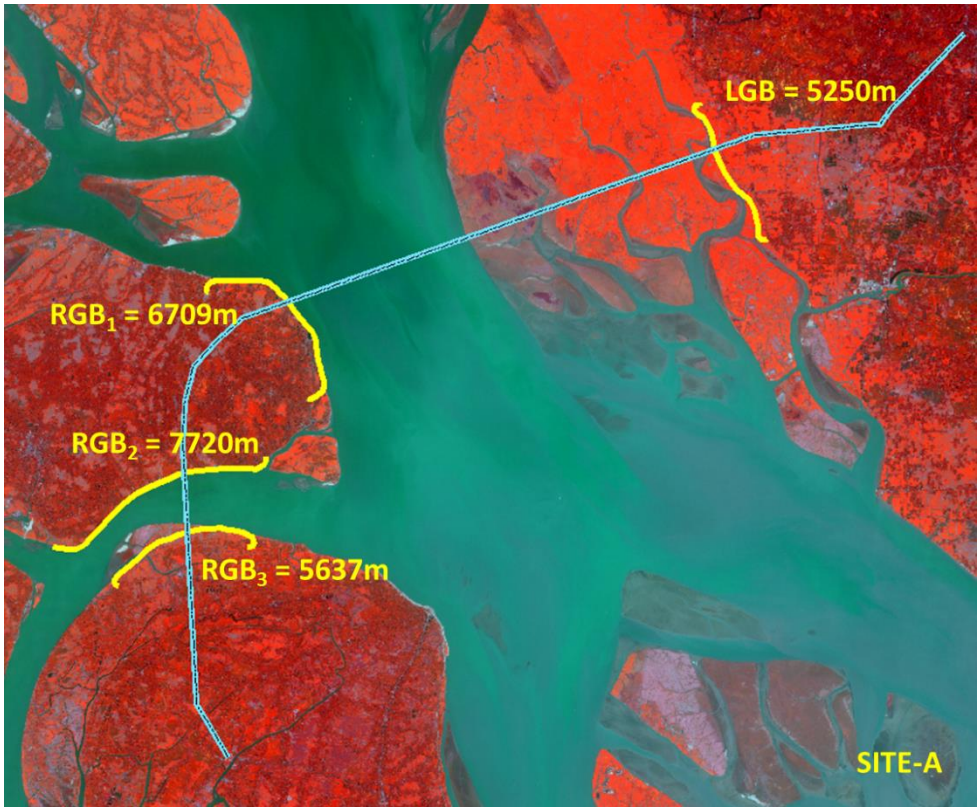


Figure 10. Bank Protection Works (Guide Bund) for Site A

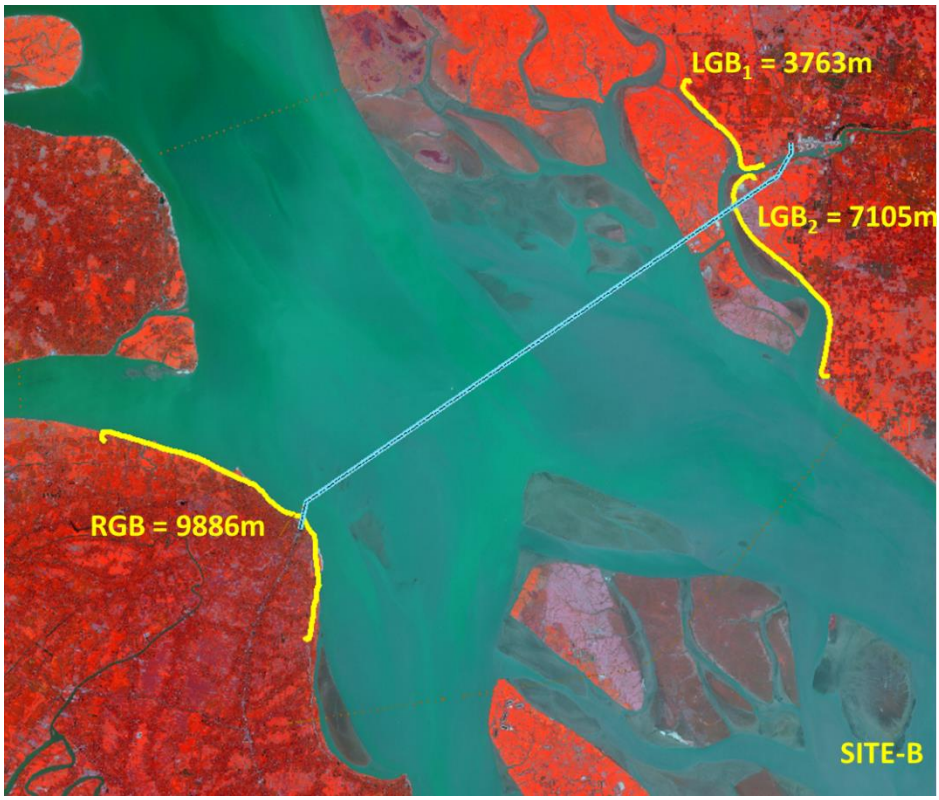


Figure 11. Bank Protection Works (Guide Bund) for Site B

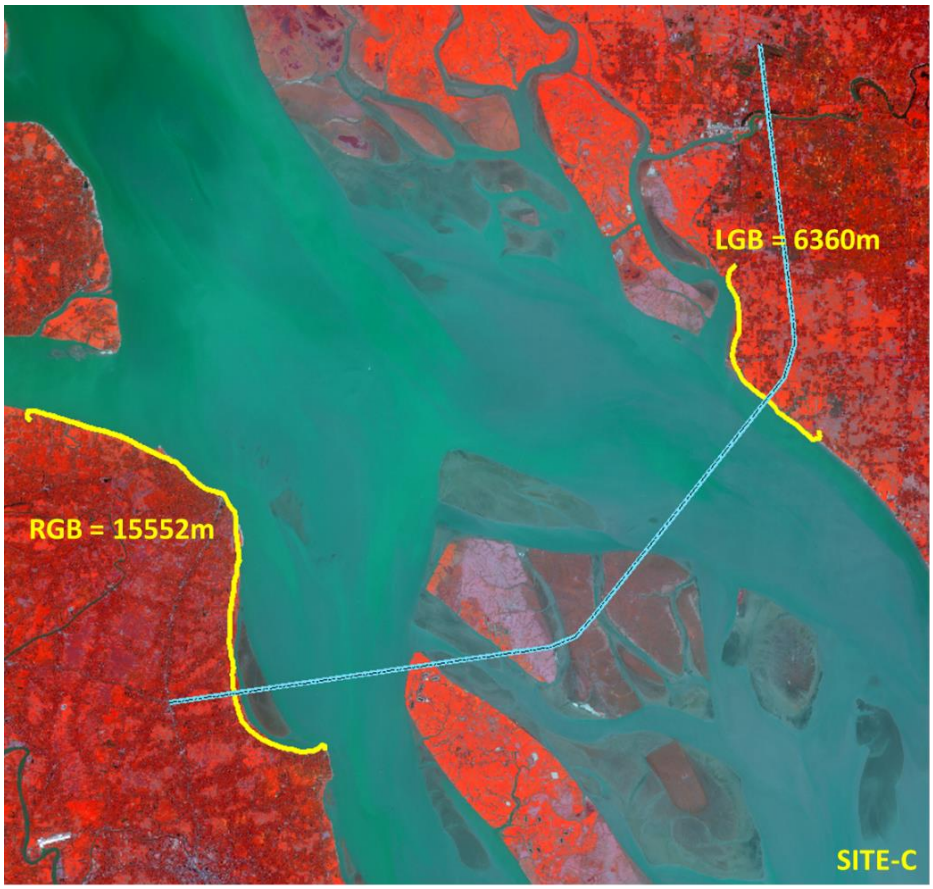


Figure 12. Bank Protection Works (Guide Bund) for Site C

4.4. Fieldworks

The existing field conditions were assessed after the various site visits paid by the Consultant's team. These visits correspond to reconnaissance of the terrain, site and communities, to joint visits arranged with the BBA officials, special supervision of diverse works as geotechnical or topographical works, or regular supervision works done recurrently by the teams in charge or other that relevantly were carried out for this Pre-feasibility Study and reported accordingly.

Table 12. Site Visits Record

No	Location Visited	Start Date	Finish Date	Purpose of the Trip or Site Visit	Consultant JV Participants
1	Coxsbazar and Moheshkhali	15 10 2023	17 10 2023	To visit the projects site in the concerned area to undertake a full environmental and social assessment and a complete reconnaissance task	A team composed by Environmental Lead expert, Social Safeguard lead expert, Resettlement Specialist, socio-ecological Expert and Survey Expert
2	Coxsbazar and Moheshkhali	22 10 2023	26 10 2023	To meet with company coordination issues regarding utilities interface with the bridge project.	Utilities Interface coordination team

4.4.1. Topographical survey

At the preferred pre-selected option, a topographical survey was carried out along the proposed alignment using GPS (Static Method) and Total Station. The other two options have been analysed by the use of aerial images for a preliminary alignment study.

The preliminary alignment for the proposed new approach roads, on either side of the bridge, was designed as per the findings of the surveys undertaken by BSO Associates Ltd. (BSO) during the months of September and October of 2023.

The scope of work of the topographical surveys was follows:

- Collection of information of reference Benchmark.
- Reconnaissance Survey.
- Selection of Reference BM.
- Establishment of control points.
- Fly Levelling.
- Traverse Survey.
- Cross Section Survey.
- Preparation of the report and maps.

4.4.2. Geotechnical Investigation

In order to carry out a comprehensive study, it is essential to get a detailed and thorough understanding of the ground conditions, soil behaviour and interaction between the ground and the proposed foundations and structures.

The main objectives of the GI works are to determine:

- To identify the presence of soft silts and clays on the riverbank.
- To determine the geological stratification along the bridge alignment
- To derive and determine the engineering properties of each soil type for the purpose of designing the main bridge of the project and other components.

The preliminary ground investigation was conducted by Prosoil Foundation Consultant.

The Geotechnical Investigation of this pre-feasibility study comprised of drilling of four (4) boreholes (LBH-01, LBH-02, LBH-03 and LBH-04) during the period between November 26th 2023 to February 12th 2024.

The main objectives of the GI works are to determine:

- Identify the presence of soft silts and clays on the riverbank.
- The geological stratification along the Bridge alignment
- The thickness and distribution of the various sediment layers
- To derive and determine the engineering properties of each soil type for the purpose of undertaking design works for the main bridge of the project.

A total of two (4) numbers of boreholes (LBH-01, LBH-02, LBH-03 and LBH-04) were drilled to determine the profiles and properties of the different soil strata by the rotary drilling method. The depth of the boreholes varies from 85.5 m (LBH-01, LBH-04) to 120.45 m (LBH-03) and 150.45 m (LBH-02) from the existing surface level as shown in Figure 13.

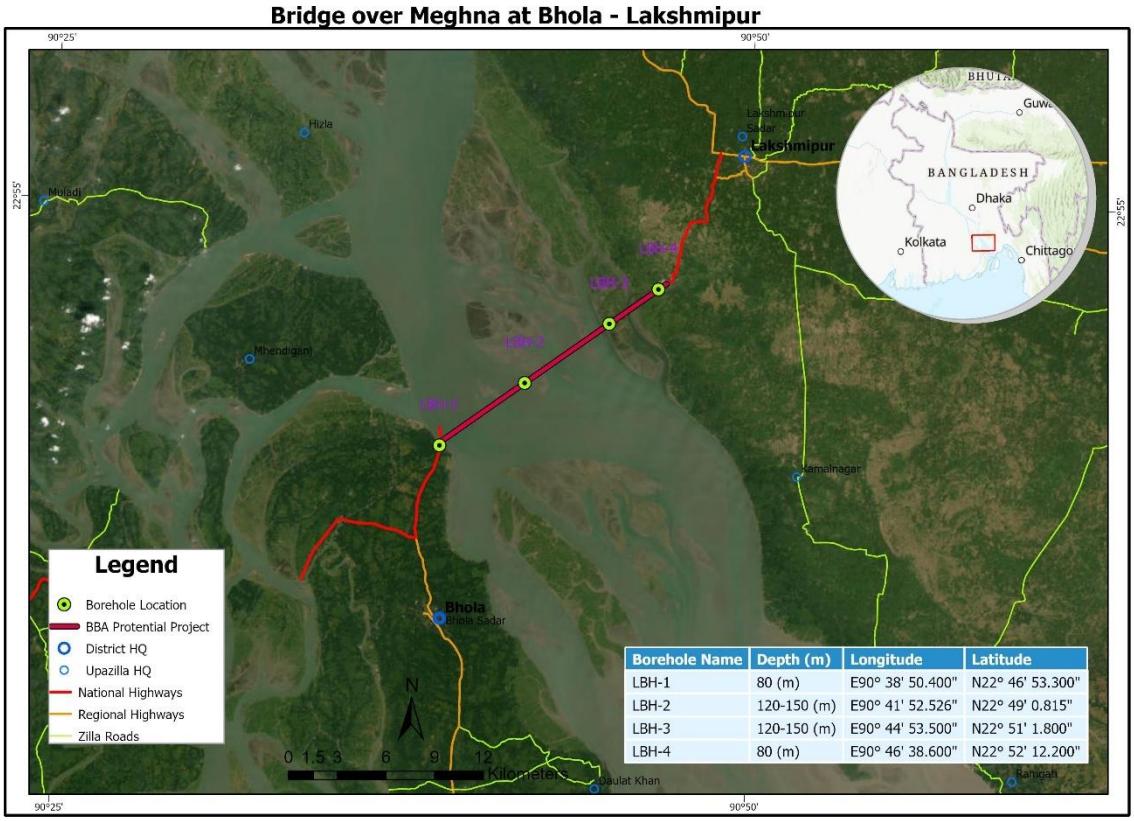


Figure 13. Location of boreholes

4.4.3. Existing Utilities

For identifying the conflicts with the existing public utilities within the project area, some field visits were carried out in coordination with representatives of the utilities' companies. The aim of these inspections was to collect all necessary information related to the interference of the existing utilities in the surrounding of the project. After the site visit and the data collection, there has been identified some conflicts with the existing electrical lines along the proposed alignment, but no conflicts are detected with other public utilities such as PGCB transmission line, gas pipeline, underground water pipeline, submarine cable, optical fiber cable, etc.

4.5. Proposed Engineering Solution

The proposed solution for the bridge over the Lower Meghna River (Bhola-Lakshmipur) includes a truss bridge over the class I navigation area with a cable stayed span for the zone where the riverbed is deeper. **Alignment Option B** has been determined to be the most suitable. Also, among the different solutions analysed for Alignment Option B, the proposed solution for the bridge over the Meghna River is a based on a **cable-stayed bridge with a span arrangement 300 – 600 – 300 followed by a truss bridge with typical spans of 200 m and access spans of precast I beam with 40 m in length**, since the cost of the studied typologies is very similar and the construction period is significantly smaller in the case of truss spans. The total length of the bridge including access spans is 19.24 km

The foundation for the cable stayed section, most of which is planned to be executed in wet conditions, has been estimated to require 42 steel driven piles Φ2.5 m of 130m in length. 12 steel driven piles Φ2.5 m of 120m are planned to be used for the truss bridge. Further development of the current calculation during detailed design may allow for the use of a different diameter for the steel driven piles. In Volume 1, a comparison between steel driven piles and concrete piles for this specific viaduct and geology of the location, and the steel piles have been deemed a better solution. The comparison with the concrete bored piles was undertaken with the conclusion of being this one a more expensive option.

The full bridge alignment where navigable has been designed for a 30 m of vertical clearance.

For the approach spans with I girders, the foundation has been estimated to require 4 reinforced concrete bored piles Φ1.80m of 70m in length. Furthermore, as the deep channel position can move very quickly from one year to the next, the vertical clearance of 30 m in height has been extended to the full navigable length.

Table 13 Bridge length distribution for Bhola-Lakhsmipur Bridge.

Stretch	Lengths in m
West Ramp	720
Class I Main Bridge	**17,800**
East Ramp	720
Total ramp/connecting spans length	1,440
Total Class I spans length	17,800
Total Bridge Length	**19,240**

Typical cross sections of the different stretches are as follows:

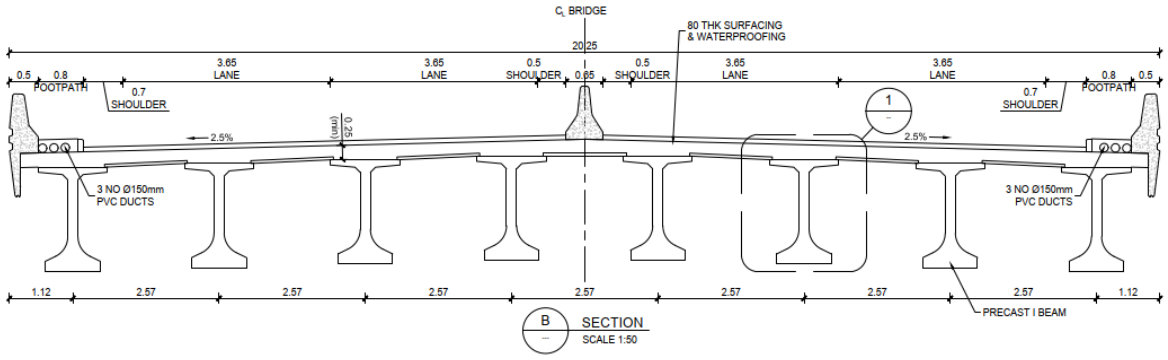


Figure 14. Typical cross section (Precast I-beams) for Bhola-Lakshmipur access spans.

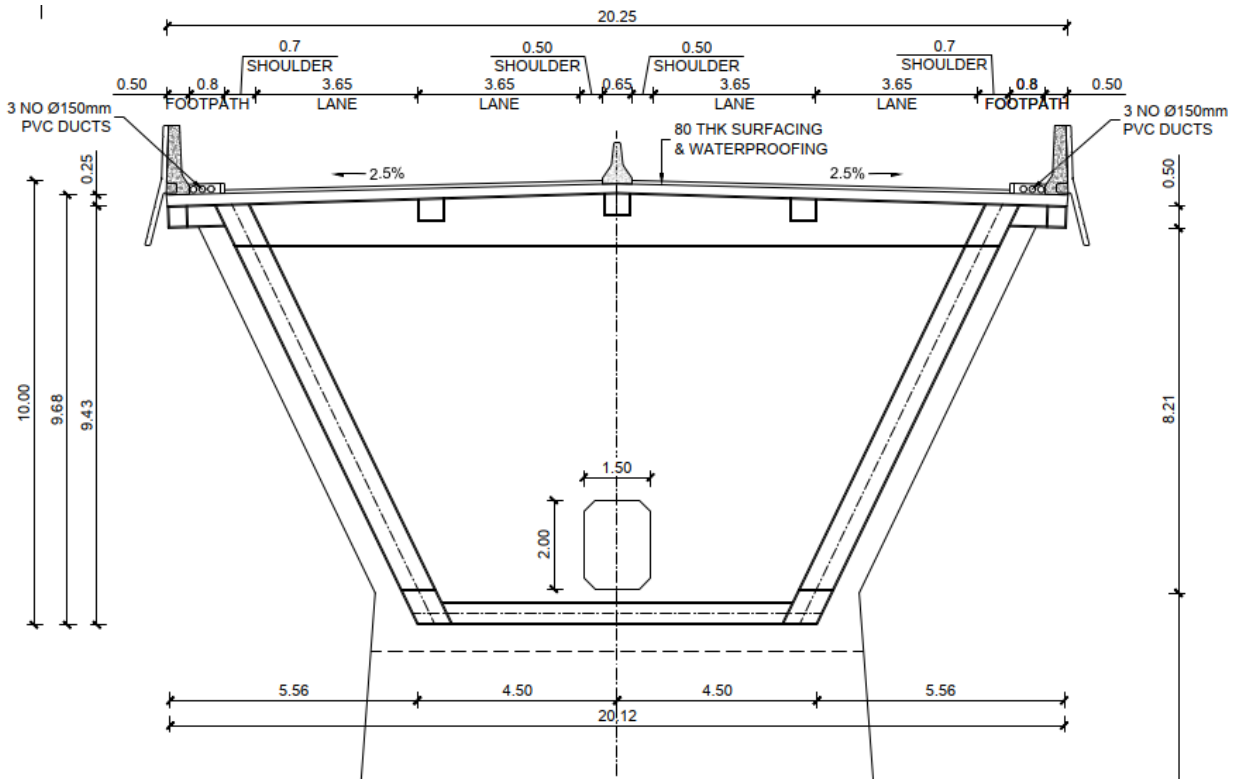


Figure 15. Typical cross section for truss spans over pier (Main span) for Bhola-Lakshmipur.

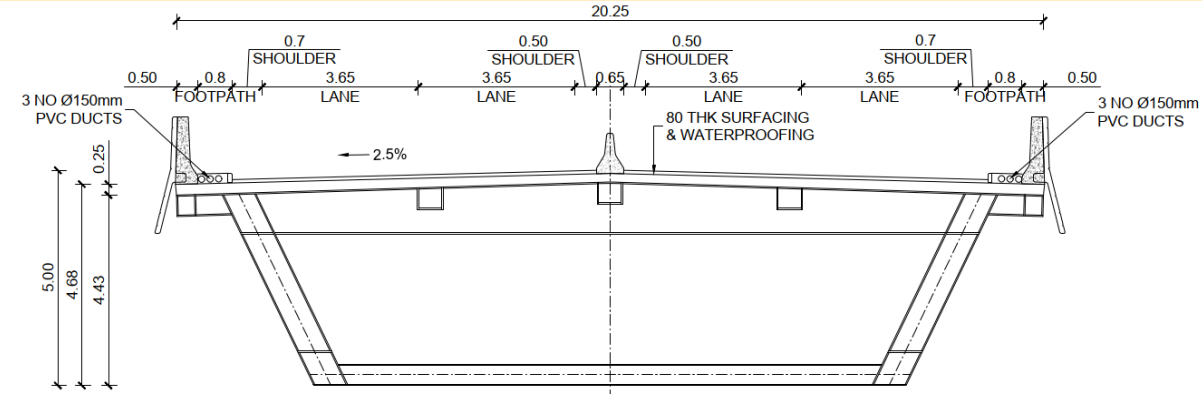


Figure 16. Typical cross section for truss spans in the midspan (Main span) for Bhola-Lakshmipur.

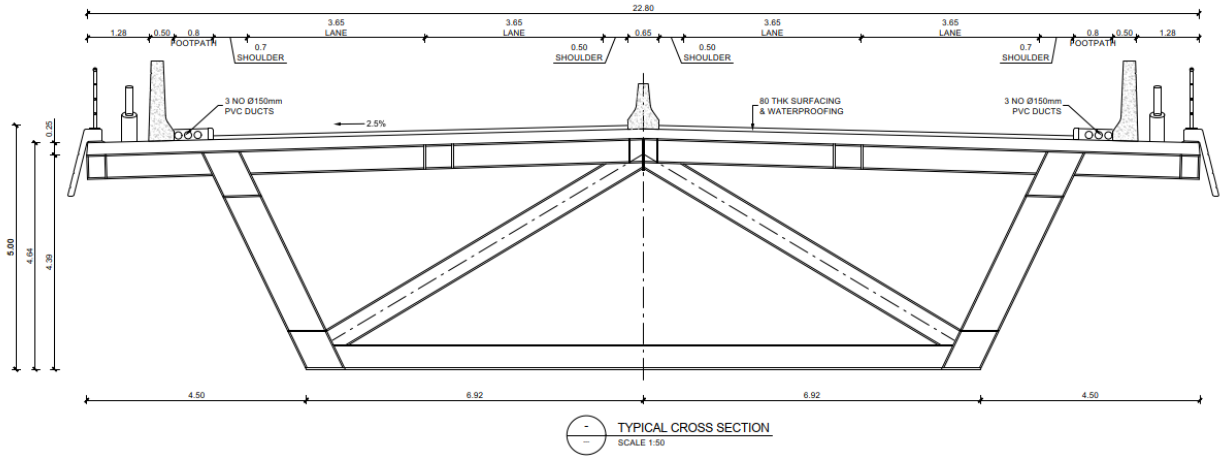


Figure 17. Typical cross section for cable stayed bridge (Main span) for Bhola-Lakshmipur.

The approach road will be a 2-lane dual carriageway with a design speed of 80 Km/h plus 1 service road lane for SVL. The bridge and approach road will connect with the Barisal-Bhola Highway N809 on the west and to the Lakshmipur-Bhola-Barisal Highway N809 on the east. At-Grade connections are proposed on both cases.

Two toll plazas (one per direction) have been located before the crossing of the bridge as well as two axle weight stations and two engineering facilities as BBA required.

Tunnel Alternative:

The possibility to cross under the river by means of a tunnel was explored on a conceptual level. Three options were considered for this purpose:

- Immersed tunnel option
- Double tunnel with transversal galleries
- Two-level tunnel

The tunnel alternative was discarded, as it was estimated to have a cost around four times the one for a bridge, both for construction and maintenance. In addition, the solution of tunnel involves several environmental issues that are added to the higher cost, which is why the solution for the tunnel is not further explored.

Figure 18 Image of Image of the proposed bridge.

Figure 19 Image of Image of the proposed bridge.

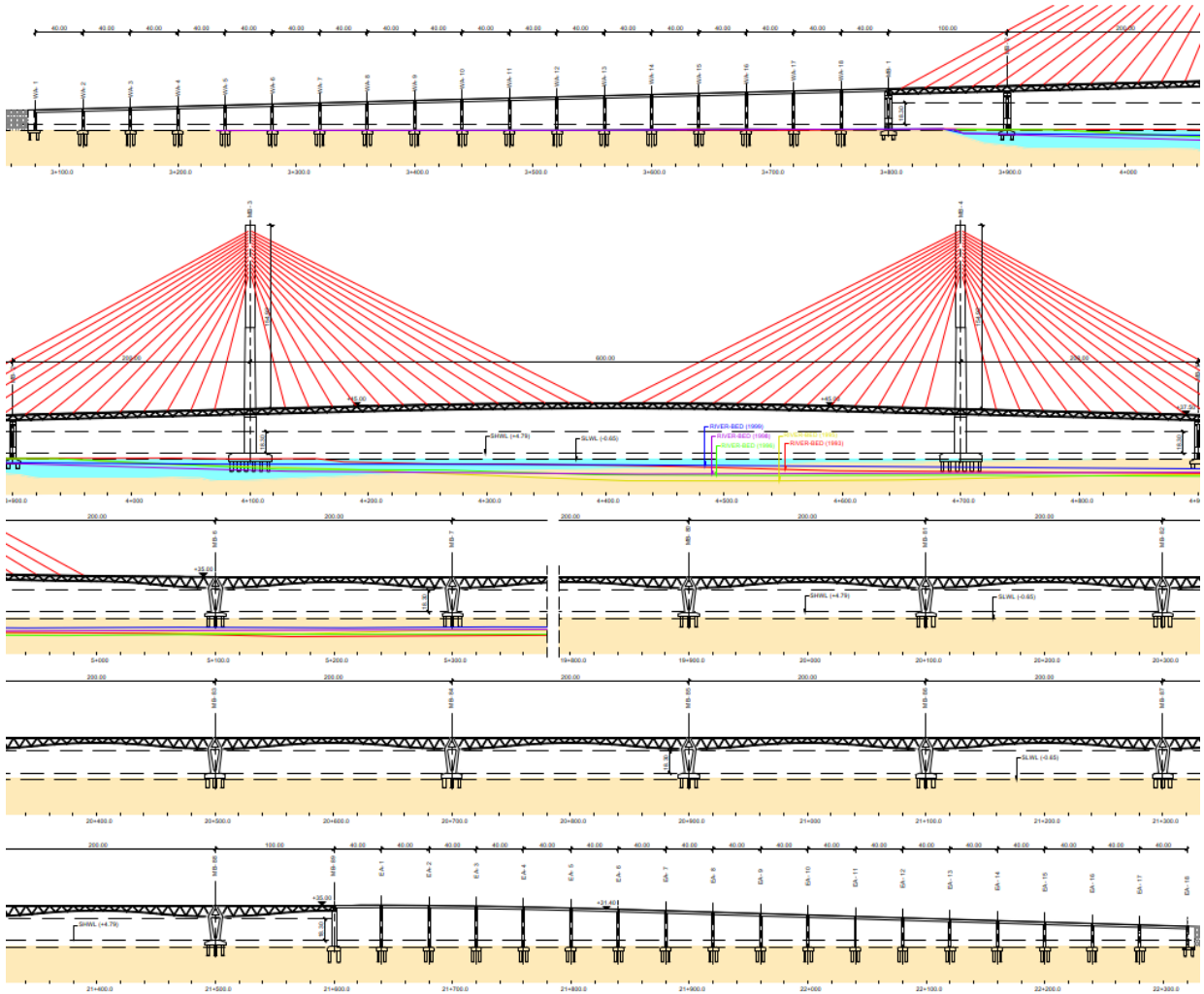


Figure 20. Elevation section of the bridge

4.6. Approach Roads

The provision of the bridge will provide a link between the Bhola island (which is isolated by the river Meghna) with Lakshmipur, Noakhali and Chattogram as a continuation of National Highway N809.

Three alignments have been examined connecting the existing roads (A, B and C) as shown in the image below.

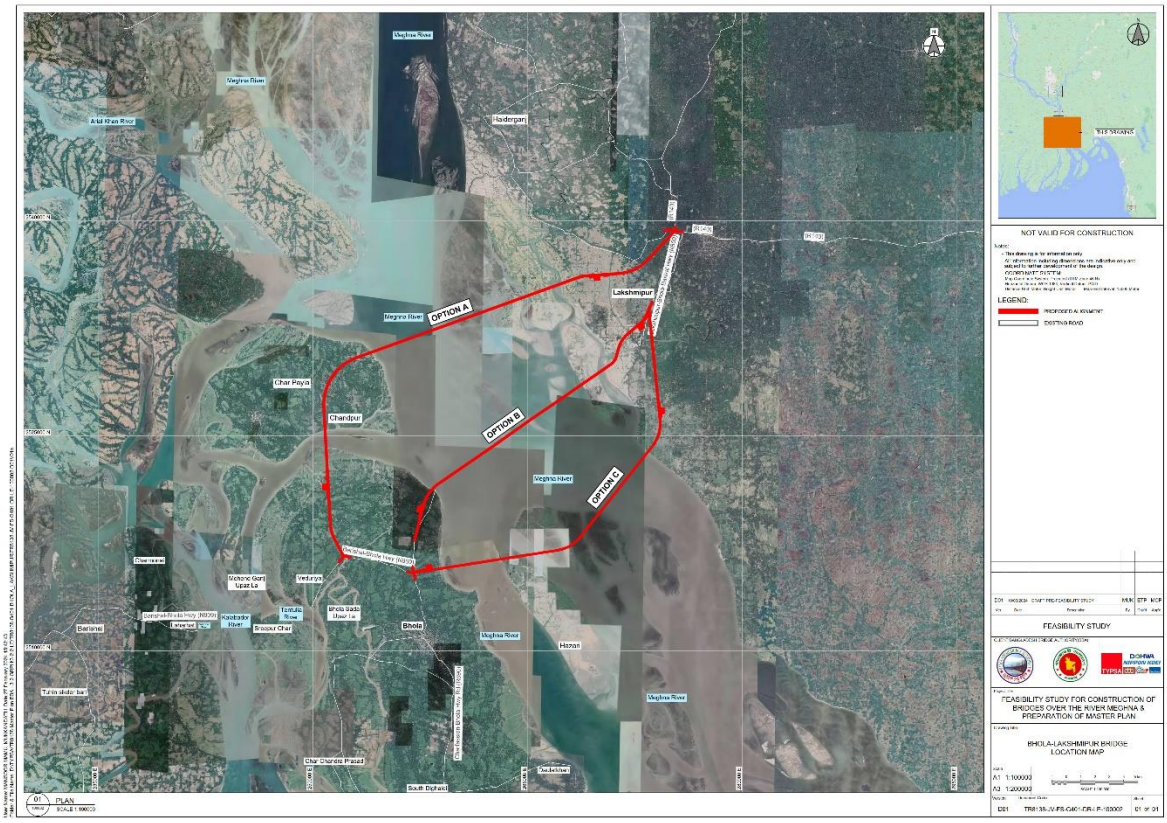


Figure 21. Bhola-Lakshmipur Bridge alignment options layout

A preliminary analysis of these three alternatives was carried out to select the preferred location for undertaking the fieldwork and a multi-criteria analysis shown in section 4.2, being Option B as the selected alignment. The bridge approaches comprise some 3.08 km of road to link the bridge on the west side of N809 (Bhola Side) and 2.086 km road link from the bridge on the East side of N809 (Lakshmipur Side).

Figure 22. Proposed alignment selected Option B

The four-lane approach road has been designed primarily as per RHD standard supplemented by AASHTO specifications where needed.

The design envisages a four-lane dual carriageway with an unpaved median of 3.5 m. The geometric design of the project has been developed for a speed of 80 km/h. The design of curves is compatible with the adopted design speeds and Geometric Standards as laid by the American Association of States Highway and Transportation Officials (AASHTO) 2018 have been incorporated.

Table 14. Road Design Criteria

DESIGN STANDARDS			
Design Elements	Unit	Design Parameters	Source
Road Standard		Type 2	Figure 4.1, RHD Standard, Page 12
Design Speed	Km/h	80	RHD, Table 2.2, Page-5
Stopping Sight Distance (SSD)	m	120	RHD, Table 2.3, Page-5
Intermediate Sight Distance (ISD)	m	250	RHD, Table 2.3, Page-6
Cross-Sectional Elements			
Carriageway Width	m	7.30	In each direction
Lane Width	m	3.65	RHD, Table 2.1, Page-4
Service Road/NMT	m	3.0-6.0	RHD, Table 4.1, Page-20
Outer Shoulder Width	m	1.5	RHD, Table 2.1, Page-4
Minimum Inner Shoulder Width	m	0.5	RHD, Table 4.13, Page-72
Central Median	m	1.2	AASHTO
Minimum Median Width with Barrier	m	3.5	RHD, Table 4.12, Page-70
Normal Cross fall	%	3	RHD, Table 4.7, Page-17
Cross fall of Shoulder soft	%	5	RHD, Table 4.7, Page-17
Embankment Slope (Absolute Min)	H:V	2:1	RHD, Table 4.9, Page-18
Horizontal Alignment			
Minimum Radius	m	500	RHD Table 5.1, Page-75
Maximum Super Elevation	%	3 to 5	RHD, Table 5.2, Page-76
Min. Transition Length	m	25 to 65	RHD, Table 5.3, Page-75
Vertical Alignment			
Maximum Grade	%	3 to 6	3 % as per Asian Highway Standard, 6 % maximum on the approach to structures
Minimum K Value			
Crest Vertical curve		35	RHD, Table 6.1, Page-82
Sag Vertical curve		26	AASHTO

4.7. Cost estimate

The cost estimate for the three studied alignment options is rendered in the following table:

Table 15. Summary of Preliminary Cost Estimation

No.	Item	Alignment Option A	Alignment Option B PRE-SELECTED	Alignment Option C
		Amount (Cr BDT)	Amount (Cr BDT)	Amount (Cr BDT)
1	General and Site Facilities	460.13	471.43	473.30
2	Main Span (Balance Cantilever)	25,885.00	28,198.16	28,487.00
3	Approach Bridges	1,195.00	623.41	623.00
4	Approach Road including small structures	2,103.00	644.76	1,154.54
5	Toll Plaza & Engineering Facilities (*)	521.50	521.50	521.50
6	Bank Protection Work	10,596.80	8,730.68	9,172.00
(A)	**Subtotal**	**40,761.43**	**39,189.94**	**40,431.33**
(B)	Provisional Sum for Physical Contingency = 3% of (A)	1,222.84	1,175.70	1,212.94
(C)	**Sub Total (A+B)**	**41,984.28**	**40,365.64**	**41,644.27**
(D)	Provisional Sum for Price Contingency = 6% of (C)	2,519.06	2,421.94	2,498.66
(E)	Engineer's Estimate = (C+D)	44,503.33	42,787.58	44,142.93
(F)	**Land Acquisition and Resettlement Costs**	**2,645.07**	**984.60**	**1,010.02**
(G)	Design Cost = 2% of (A)	815.23	783.80	808.63
(H)	Construction Supervision = 5% of (A)	2,038.07	1,959.50	2,021.57
(I)	**Project Estimate = (E+F+G+H)**	**50,001.70**	**46,515.47**	**47,983.15**

4.8. Implementation timeline

The estimated implementation timeline, in accordance with conversations held with BBA officials is:

PRE-INVESTMENT PERIOD

- After the approval of the Pre-FS, end of 2024, a Feasibility Study process has been assumed to last **15 months** until March 2026.
- From October 2025 to December 2026 - DPP implementation - Procurement process for Detailed Design and RAP+LAP implementation / **15 months.**

TOTAL ROJECT INVESTMENT PERIOD BEFORE OPERATION: 6Y

- Project Detailed Design Phase, including RAP and LAP implementation phase and Main Contractor Tender Process / **18 months** - from January 2027 to June 2028.
- Construction period including Testing and commissioning / **78 months** - from July 2028 to December 2034.
- Defects Notification Period (DNP 1 year) January 2035 to December 2035

Total PROJECT OPERATION PERIOD: 30 Y = January 2035 to December 2064

TOTAL PROJECT PERIOD: 30 + 8 = 38 Y

Figure 23. Image of the proposed bridge

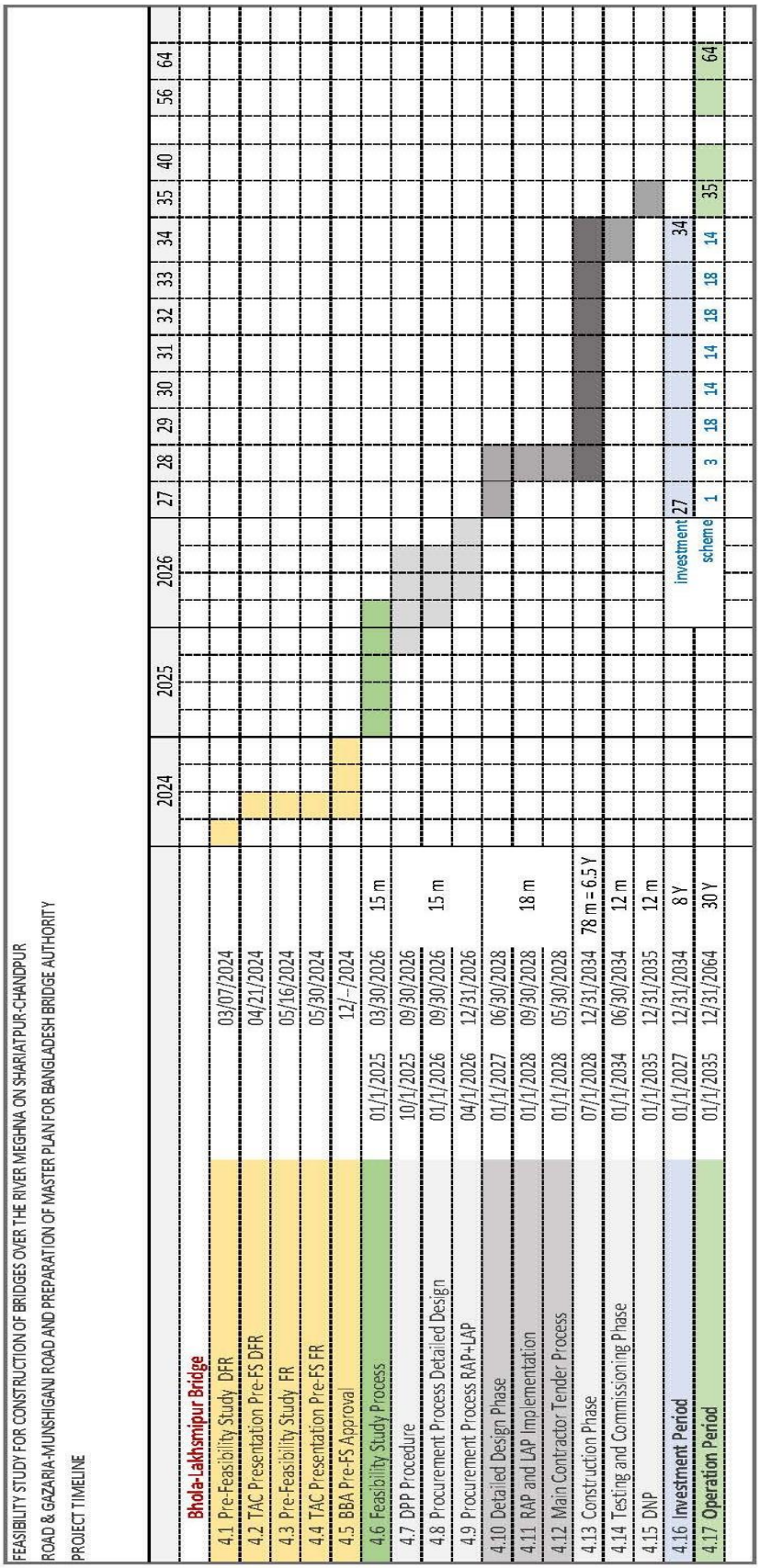


Figure 24. Project Implementation proposed Timeline

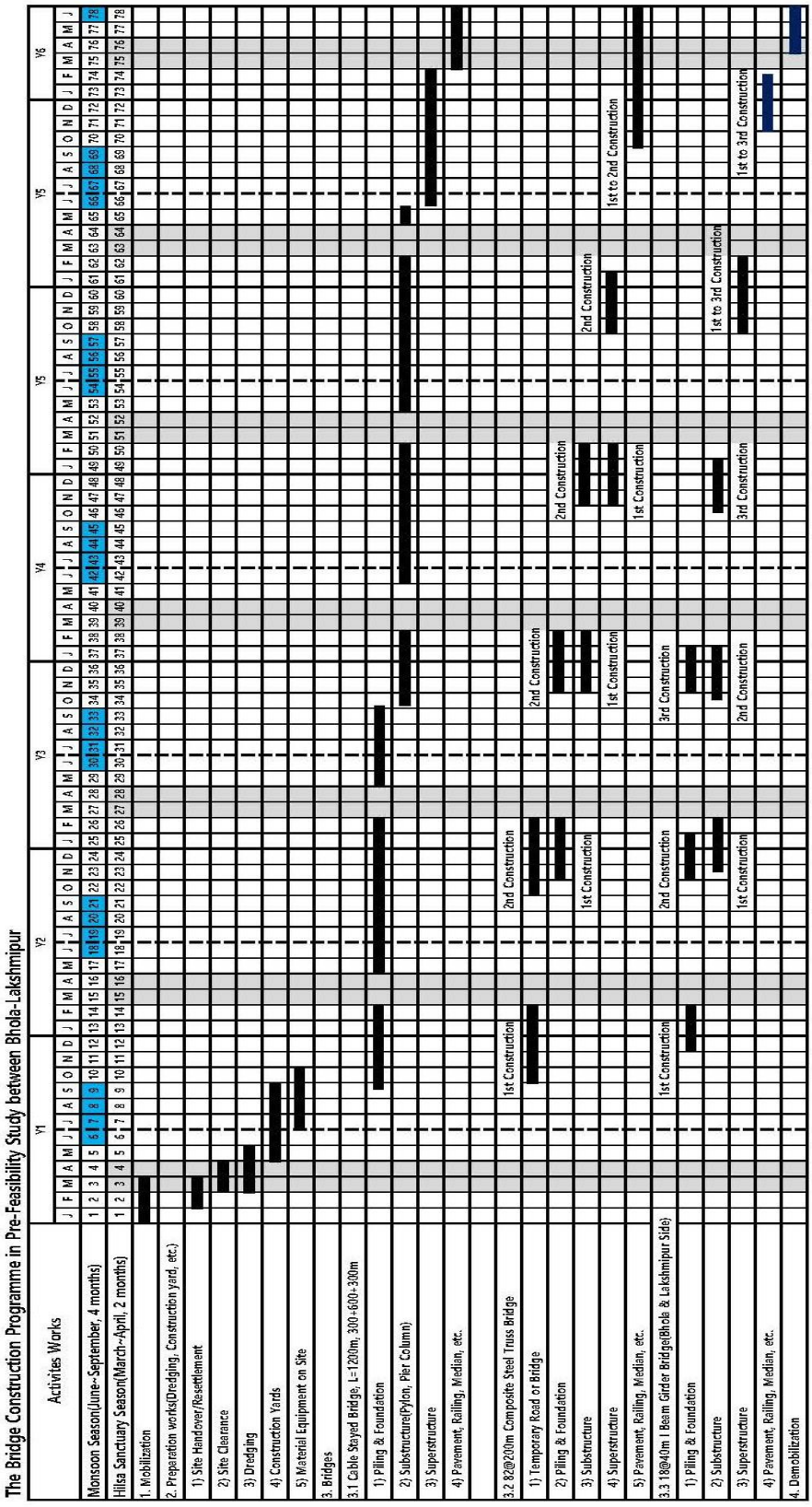


Figure 25. Project Construction Work Programme

5. ENVIRONMENTAL SUSTAINABILITY, CLIMATE RESILIENCE AND DISASTER RISK ANALYSIS

5.1. Environmental, Climate Change and Disaster Risk Analysis

The Bhola-Lakshmipur Bridge project has been assessed to pose some environmental risks. Some of these may only be anticipated during the construction phase while others are anticipated mainly in the operation phase. However, these risks can be mitigated by implementing some counter measures. Anticipated environmental impacts include during construction stages are - loss of trees, impact on fauna and impact on aquatic ecosystem, water pollution, soil pollution, noise pollution, air pollution, vibration, drainage congestion, soil erosion and deterioration of public health. To reduce these impacts, the necessary mitigation measures would be tree plantation, avoiding dumping of wastes, cement, bentonite and other chemicals in water and soil, use of noise barriers and roadside greenbelt, provision of ample drainage, culverts and river protection. To protect public health including workers, necessary steps would be to provide safe water, good food and sanitation facilities for workers in construction camps. By the use of simulation models, it has been found during operation of the bridge beyond 20 m air and Noise quality will not exceed the National standards of Government of Bangladesh for residential areas.

It should be mentioned that as per Environment Conservation Rules (ECR), 2023 of DoE, GoB, construction / reconstruction / extension of bridges with length of 500 m or more is included (under item 39) in the list of Red Category of projects. As per Environment Conservation Rules (ECR), 2023 of DoE, GoB, the proposed bridge (19.240 Km) is in red category and requires environmental Clearance from DoE.

The project is within notified Hilsa sanctuary which has been included in EMP that Department of Fisheries Protection and Conservation of Fish Act, 1950 (E.B Act No. XVIII of 1950) Protection and Conservation of Fish Rules 1985, amended in 2014, Rule 13, will be followed during construction and other measures suggested in EMP for protection of the aquatic system, hence impact aquatic ecosystem will be of low in nature.

Environmental & Social Risk Assessment has been undertaken through a series of consultations and review sessions. The principals in AS/NZS ISO 31000:2009, as well as the proponent's internal risk assessment documentation, guided the risk assessment.

Environmental risk and disaster assessment has been conducted for the Bhola-Lakshmipur Bridge Project. It was found that all the measures needed to protect the bridge and approach road from the impact of Climate change and disaster has been incorporated in design hence the impact of the environmental risk and disasters were found to be low in nature.

5.2. Induced Environmental Impacts at Regional Level

The Induced Environmental Impacts at Regional Level due to the project has been presented in the following table and are developed within the main report in detail.

Table 16. Environmental Scoping Matrix-Impacts due to Project with and without Mitigation Measures

Environmental Items	Without Mitigation	With Mitigation	When to Implement (Project Stage)
A) NATURAL ENVIRONMENT			
• *Physico-Chemical*			
Regional Hydrology	-2	2	Design
River Erosion and Siltation	-2	2	Design, Construction and Operation & Management (O&M)
Drainage Congestion	-2	2	Design and Construction
Air Pollution	-2	3	Design, Construction and O&M
Surface Water Pollution	-2	2	Design, Construction and O&M
Ground Water Pollution	-1	2	Design, Construction and O&M
Noise & Vibration	-2	2	Design, Construction and O&M
Soil Contamination	-1	1	Design, Construction and O&M
Waste (General & Construction)	-1	2	Design, Construction and O&M
• *Ecological Resources*			
Trees/Vegetation	-2	3	Pre-construction and O&M
Wildlife	-1	1	Design and Construction
Environmental Sensitive Areas	-2	2	No environmental sensitive areas in and around the project area
B) HUMAN/SOCIAL ENVIRONMENT			
• *Socio-Economic*			
Land acquisition	-2	1	Pre-construction
Homestead	-2	-1	Pre-construction
Commerce	-2	3	Pre-construction
Industry	-2	3	Construction and operation
Agriculture	-1	2	Pre-construction
Fisheries	-1	2	Pre-construction and O&M
Job opportunities	-2	3	Construction
Community spilt	-2	-1	Design and Construction
Health and safety	-2	3	Design, Construction and O&M
Navigation/ boat communication	-2	3	Design, Construction and O&M
Transport facilities	-2	3	O&M
Cultural & Historical heritage	-1	1	Design and Construction

Environmental Items	Without Mitigation	With Mitigation	When to Implement (Project Stage)
Landscape	-1	2	Design, Construction and O&M
Environmental Risks (cyclone and earthquake and road accident)	-2	2	Design, Construction and P&M
Total Score	- 44	+50	

It is expected that the connectivity of the region with the other part of country will provide increased accessibility to markets, land ports, and growth centers. This will lead to development of business (including agriculture and fisheries), industry, communication, tourism, and urbanization. The induced development has both negative and positive impacts. The positive impacts are increased in the socio-economic conditions of the region through employment generation and poverty reduction. There are also negative impacts like air and noise pollution due to construction activities, increase in traffic levels and industrial development, generation of wastes due to increased living standards, consequent health impacts due to pollution and waste generation, loss of biodiversity, and land acquisition and resettlement which are moderate to low in nature and can be mitigated through EMP implementation.

5.3. Assessment of Disaster Resilience of the Project

Bangladesh is one of the country's most vulnerable to climate change, as well as one of the most disaster prone. Bangladesh's flat topography, low-lying and climatic features, combined with its population density and socio-economic environment, make it highly susceptible to many natural hazards, including floods, droughts, cyclones, and earthquakes. To combat such a situation a contingency plan has been prepared.

5.3.1. Contingency plan

Contingency plan involves anticipating a specific hazard based on specific events or known risks at local, national, regional or even global levels (e.g., earthquakes, floods or disease outbreaks), and establishing operational procedures for response, based on expected resource requirements and capacity. It also means rehearsing our procedures and working out where the gaps are, so that we can be ready when we are needed most. Plans need to be regularly updated and tested through simulations. Steps considered for the disaster management cycle are – Prevention, Preparedness, Response and Recovery

5.3.2. Disaster Management Plan for the project

The disaster management plan of the project will include the preventive measures which will include the following -

- Formulation and strict implementation of safety codes and measures.
- Periodic inspection of safety measures recommended and equipment.
- Preventive Maintenance.
- Aware the workers about electric shock, equipment related accidents and activity related accidents.
- Declaring the project area, a "no smoking zone".
- Mock drill on Emergency plan.
- Mock drills by the firefighting cells/ groups.

- Provision and inspection of firefighting equipment and fire hydrant system in all the sections.
- Proper training of the employees in the importance of codes.
- Training the employees and the residents of the surrounding villages about the actions to be taken during an accident, disaster etc.

It has been recommended to develop the entire facility environment policy and display necessary documentation for ease in accessing information. Some of these documents include Emergency contacts and Emergency response procedures for fires and any other accident. The facilities operations and monitoring will be carried out under the management and help from both the employees and relevant government leading agencies.

5.3.3. Emergency Response

For this project an emergency response procedure that needs to be implemented during typical emergency situations has been included in the emergency response plan. Steps considered in preparation of Emergency Response plan are-

Step-1: Determine the potential hazards associated with the incident, substance or circumstances and take appropriate action identify the type and qualities of dangerous goods involved and any known associated hazards.
Determine potential hazards stemming from local conditions such as inclement weather, water bodies etc. and ensure that the initial response team is aware of these conditions.
Step-2: Determine the source/cause of the event resulting to the emergency and prevent further losses.
Step-3: Assess the incident site for any further information on hazards or remedies.
Step-4: Initiate redress procedures.
Step-5: Report the incidence its nature cause impact applied redress procedures and any further assistance required etc. to the appropriate company, government and/or landowner.
Step-6: Take appropriate steps with respect to hazards to wildlife, other resources and addressing public and media concerns and issues, as applicable. Response priorities are to protect human lives, property and the environment.

The following safety precautions will be taken with respect to the emergency which demand protection to public:

- Immediately block the public road and allow the emergency vehicle only.
- Continuously announce by mike in the nearest community for evacuation if necessary due to the severity of the emergency
- Call external govt. authority (Fire service & Civil defense, Union perished, Police etc.) to take control of the community according to govt. protocol.

5.4. EMP Cost

A comprehensive Environmental Management Plan (EMP) has been developed to reduce and mitigate the impacts of the project. The estimated EMP cost of the project has been estimated as 29.53 million BDT.

Table 17. Environmental Management Plan (EMP) budget

Sl. No.	Activities/ Items	Unit	Rate in BDT	Quantity	Amount in BDT
1	Tree seedling plantation	Nos.	320.00 *	17,067	5,461,440.00
2	Vetiver root plantation	Nos.	50.00 **	82,560	4,128,000.00
3	Maintenance of tree seedling and Vetiver / Bermuda root plantation	Month/ km	8130.00 **	402.48 (5.16 km for 24 month)	1,006,819.20
4	Environmental Monitoring (Air, water, soil, noise and vibration	Month	120,000.00 ***	78	9,360,000.00
5	Dust Control Measure	Month	60,000.00 ****	78	4,680,000.00
6	Arborists/ Caretaker #	Person/ Month	21,119.00	90 (5 Caretaker for 24 months	2,534,280.00
7	Health and Safety provisions ##	LS	-	1	800,000.00
8	Training and Workshops ###	No	78,000.00##	20	1,560,000.00
	Total				**29,530,539.20**

Note:

**Tree plantation cost as considered in EMP of Padma Multipurpose bridge project Bangladesh and South Asia Sub-Regional Economic Cooperation (SASEC) Road Connectivity Project, Bangladesh.*

***Vetiver and Bermuda grass roots plantation rates and plantation maintenance cost considered as per EMP cost of Matarbari Port Development Project (RHD component). Maintenance for 24 months for 5.16 km of the road*

****Environmental monitoring cost as per rate quoted by Development Solutions Consultant Limited (an agency approved by BBA) for Baseline data generation for EIA preparation*

*****Dust suppression by water sprinkling – as per market rate and discussion with BBA*

#Arborists/caretaker rate as per GoB Rules for Outsorcing Services (taxes and fees included)

##Health and safety provisions - assessed by consultant

###Training workshop and awareness - assessed by consultant

5.5. Environmental Studies Conclusion

The Bhola-Lakshmipur Bridge has been proposed to be constructed over Meghna River in between Bhola Sadar Upazila under Bhola District and Lakshmipur Sadar Upazila under Lakshmipur District. The project comprises three major components: a bridge with total length of 19.240 Km, a four-lane approach road of 3.080 km toward Bhola Side and 2.086 km towards Lakshmipur side. Environmental issues pertaining to the project should be incorporated properly in the design and assessed to incur benefits from the project by enhancing the environmental positive impacts and offsetting the negative impacts.

Environmental aspects have been incorporated in the design of the project. A cable stayed bridge has been proposed over the river to minimize the impact on the aquatic ecosystem. Cable Stayed with a span arrangement 300-600-300 followed by a Truss Bridge with typical spans of 200 m and access spans of precast I beam with 40 m spans. Proper navigational clearance has been adopted for movement of ships and to avoid water transport hazards. Piles with improved soil stabilization chemicals adopted in the design will generate minimum noise and vibrations which will create minimum disturbance to the aquatic animals.

The Initial Environment Examination / assessment for the proposed project has been carried out through the following methodologies: screening of the significant environmental impacts, assessing them, enhancing the positive impacts and recommending the mitigation measures for the negative impacts. These have been done on the basis of available secondary data, field data and discussion with the PAPs. On the basis of the impact assessment, it is observed that the project has positive impacts mainly on road transportation, commercial facilities, industrial activities, job opportunities, landscape and biological diversity. Some negative impacts mainly on noise, erosion and siltation, housing and commercial structures loss as well as community split has been anticipated. EMP has been proposed to minimize the negative impacts and achieve sustainable bridge project.

No highly significant negative environmental impacts are expected during the construction period of 78 months except the normal construction hazards. However, during construction close monitoring is required over the following issues: interruption of traffic, contamination of surface and ground water, disruption of drainage, pollution of air, noise and soil, disturbance of wildlife mainly birds, reptiles, aquatic life, health and sanitation hazards and social disruption including split of communities.

It is estimated that around 1,682.8 acres of land will require acquisition for the project. A total of 503 project affected structures (Household-488, business-06 and CPRs-09), will be affected by losing their immoveable assets. Apart from the primary structures a significant quantity of secondary structures will also be affected. All these impacts are compensated as per ARIPA, 2017.

A total of 5,689 nos. of trees including new plantation as saplings are going to be affected due to the project. This loss can be mitigated by plantation of 17,067 tree seedlings and 82,560 vetiver roots on embankment slopes and other vacant lands which will enhance the environmental condition of the area.

It should be mentioned that as per Environment Conservation Rules, 2023 of Department of Environment, Government of Bangladesh, construction / reconstruction / extension of bridges with length of 500 m or more is included in the list of Red Category of projects. The proposed bridge will be having length of more than 500 m in each instance, so it is in the red category as per DoE, GoB and

require environmental clearance from DoE, GoB. Which require various documents – IEE is one of them.

Environmental risk and disaster assessment has been conducted for the Project. It was found that, all the measures needed to protect the bridge and approach road from the impact of Climate change and disaster has been incorporated in design hence the impact of the environmental risk and disasters were found to be low in nature.

The impacts during construction can easily be mitigated by taking advance adequate precautions and some additional measures appropriate to the construction. An EMP has been formulated to control/ mitigate the negative impacts arising from construction related activities. Contractors will be directed to follow the mitigation measures mentioned in the EMP provided in the report. Supervision Consultants will check and ensure that EMP is working well according to the plan.

The impacts associated with the change in landscape after the construction of the project can be negative unless proper landscape plan is formulated by the government and adhered to. The impact on housing and commercial structures can be compensated by providing adequate compensation and alternative job opportunities as per RAP.

To have a sustainable bridge project all the mitigation measures suggested in Chapter 6 and 7 should be implemented in the project. Close monitoring is required at every stage and step of the project for implementation of the EMP of the project.

The impacts after construction of the project, unless regulatory measures are taken in time, will be uncontrolled settlement, environmental pollution from industries and innumerable places of possible access to the road leading to traffic congestion and hazard. It will, therefore, be desirable to institutionalize some form of effective control on the growth of settlements on the ROW land. One of the measures could be to have an exclusion zone up to a certain distance, say 100 m on each side of the road where no structure would be allowed to be erected and no access from any individual property will be allowed directly on the land considering future expansion of roads.

It can therefore be concluded that the proposed Bhola-Lakshmipur Bridge Project is environmentally sound and sustainable. Short term negative impacts identified during project preparation can be managed by the positive impacts through the recommended mitigation measures. The positive impacts will offset the negative impacts.

6. SOCIAL SAFEGUARD ASSESSMENT

6.1. Project Area and socio-economic profile

The proposed Bhola-Lakshmipur Bridge has been assessed under three alternative options - Option A, Option B, and Option C - each with distinct features. This project may impact on 1,932,514 population in Bhola, 2,487,012 in Barishal and 1,937,948 in Lakshmipur. The average household size in Bhola District is reported to be 4.03, while in Barishal and Lakshmipur District, it is slightly higher at 4.10 and 4.22 respectively.

In Option A, a total of 1,450 individuals are affected, constituting 870 males and 580 females. Option B demonstrates a more considerable impact, affecting 1,250 individuals, with 750 males and 500 females. On the other hand, Option C, where 1,005 individuals, including 603 males and 402 females, are affected. The education level in Bhola is about 67.12 %, Barishal is 75.30% and Lakshmipur is about 75.30%. Involving different business and professions. It has been estimated that land required totalling acres 1952.60, for Option A, 1682.88 for Option B and 1788.34 for Option C including approach and connecting roads of 20.367 km, 5.166 km, and 10.989 km respectively. It is identified that total 3845 plot owners affected in Option A, 1746 in option B and 3387 in Option C. According to the detailed census and IOL survey, total affected units become 569 for Option A, 488 for B and 386 for C. The project also affects 10, 9 and 19 CPRs of option A, B and C losing separately their immoveable assets like structures, trees, business, wage earning and livelihoods opportunities.

6.2. Objectives of the Social Impact Assessment (SIA)

The primary goal of the Social Impact Assessment (SIA) is to evaluate the potential social consequences and implications of a proposed alternatives systematically and comprehensively. The overarching aim is to inform decision-makers, stakeholders, and the public about the anticipated impacts on communities, cultures, and individuals, facilitating the development of strategies to enhance positive outcomes and mitigate adverse effects.

The specific objectives are:

- Evaluate and analyse the social impact of the Bhola-Lakshmipur Bridge construction project.
- Examine the potential effects of three alternative alignments on local communities.
- Assess the impact on socio-economic structures in the project area.
- Evaluate the potential impact on cultural heritage and local traditions.
- Analyze the overall well-being of the communities in the vicinity of the proposed bridge.
- Provide insights and recommendations to minimize adverse social impacts.
- Offer guidance for maximizing positive outcomes during the planning, construction, and operation phases of the bridge project.

The various types of land are getting affected in all the options.

Table 18. Impact on land

District	Type of land	Quantity of Land in Decimal		
		Option A	Option B	Option C
Bhola	River	-	19,019	19,884
	Khal	865	692	865
	Null/Agricultural Land	5,108	1,893	2,098
	Homestead	767	890	1,034
	Highland/Vita	1,198	345	450
	Orchard	769	205	109
	Pond/Ditch	683	100	631
	Fallen Land	120	25	-
	Subtotal	**9,510**	**23,169**	**25,070**
Barishal	River	12,103	-	-
	Khal	5,187	-	-
	Null/Agricultural Land	8,456	-	-
	Homestead	2,308	-	-
	Highland/Vita	2,000	-	-
	Orchard	430	-	-
	Pond/Ditch	309	-	-
	Fallen Land	2,058	-	-
	Subtotal	**32,851**	**-**	**-**
Lakshmipur	River	10,374	11,239	7,781
	Khal	4,323	865	865
	Null/Agricultural Land	6,457	3,907	13,235
	Homestead	1,030	904	1,246
	Highland/Vita	2,607	793	2,873
	Orchard	1,642	298	24
	Pond/Ditch	367	950	1,098
	Fallen Land	-	64	543
	Subtotal	**26,800**	**19,019**	**27,664**
Total, Land in Acres		**691.60**	**421.876**	**527.345**
Land required for various purposes in Acres		1261	1261	1261
Grand total in Acres		1,952.60	1,682.88	1,788.34

6.3. Cost and Budget

The total estimated Budget required for each one of the three options is:

Table 19. Overall land acquisition & resettlement Budget in BDT

Item-wise particulars	Alignment-A	Alignment-B	Alignment-C
Total Land Budget	9,285,197,164	736,479,203	865,506,355
Total Structure Budget	231,381,407	143,882,831	222,170,855
Total Tree Budget	53,790,040	26,537,960	39,026,800
Business Loss & Utility	1,200,000	640,000	2,095,000
Sub-total	**9,571,568,611**	**907,539,994**	**1,128,799,010**
Land for construction yard (50 acres)	2,931,180,000	315,000,000	321,240,000
Land cost for River training (1130 acres)	7,119,000,000	7,119,000,000	7,119,000,000
Land for Toll Plaza (7 acres)	410,365,200	44,100,000	44,973,600
Land for Engineering facility (56 acres)	3,282,921,600	352,800,000	359,788,800
Land for weigh station (8 acres)	468,988,800	50,400,000	51,398,400
Land for resettlement (10 acres)	586,236,000	63,000,000	64,248,000
Provision for construction of resettlement area	200,000,000	200,000,000	200,000,000
Other Resettlement Benefits	50,000,000	50,000,000	50,000,000
Operation cost for RAP Implementing Agency /INGO	80,000,000	80,000,000	80,000,000
Operation cost of External Monitoring Agency	20,000,000	20,000,000	20,000,000
Sub-total	**15,148,691,600**	**8,294,300,000**	**8,310,648,800**
Total	**24,720,260,211**	**9,201,839,994**	**9,439,447,810**
Administrative and Contingency cost @% 7%	1,730,418,215	644,128,800	660,761,347
Grand Total	**26,450,678,425**	**9,845,968,793**	**10,100,209,157**

7. ECONOMIC AND FINANCIAL ANALYSIS

7.1. Economic Analysis

7.1.1. Introduction

In this section the consultant presents **the socio- economic evaluation of the Bhola-Lakshmipur bridge project.** Economic analysis or Cost-Benefit Analysis (CBA) is a **method used to calculate the profitability of a project from a social point of view, by quantifying the costs and benefits of an investment project in monetary terms to allocate society resources in an efficient way**[1].

7.1.2. Methodology

7.1.2.1. Incremental scenarios for appraisal

Prior to any other element it is needed to identify the **incremental scenarios to be considered:** estimating the effects when carrying out the project with respect to a reference scenario ("without project" scenario, or counterfactual scenario of not implementing the bridge program):

- ***"Without project" scenario***: no bridge project is implemented in the area. Instead, existing traffic structures and travel times to be projected will follow current conditions. In other words, existing transport operating features will be maintained.
- ***"With project" scenario***: the bridge program is implemented. Traffic projections considered will prevail and new infrastructure section (bridge) will add transport capacity to the system.

7.1.2.2. Key economic impacts

We need to measure the change in the total social surplus created by the project, which is the sum of the changes in producer surplus, consumer surplus and external effects. The following illustration framework of the calculation process addresses the below set of **generic economic impacts**:

Overall Economic mpact	**=**	**Change in transport user benefits (Consumer Surplus)**	**+**	**Change in system operating costs and revenues (Producer Surplus and Gov impacts)**	**+**	**Change in costs of externalities (Environmental costs, accidents, etc.)**	**-**	**Investment costs (including mitigation measures)**

Figure 26: Economic analysis by categories of impacts

7.1.3. Project capital expenses

Required project capital expenses are basically composed of the main infrastructure components of the crossing and its access roads at both sides, Bhola and Lakshmipur. The most relevant

[1] *Economic appraisal differs from financial analysis since many of the social/ economic impacts are public goods (health, security, time) or goods without a clear market, and some technical corrections need to be made: conversion factors, shadow prices, etc.*

components are the bank protection work and the main bridge, including several sub-components (i.e., main span, access spans and approach road including small structures).

The table below summarizes some basic elements that compose capital expenses. These costs are indicated without VAT and based (capitalized accordingly) on year 2027, when the estimation is carried out:

Table 20. Basic elements that compose total project Capex (2027 monetary units)

Number	Item	Cr BDT
1	General and Site Facilities	666.76
2	Main Span	29,647.34
3	Access Spans	655.45
4	Approach Road including small structures	647.82
5	Toll Plaza & Engineering Facilities	548.30
6	Bank Protection Work	9,196.28
7	Provisional Sum for Physical Contingency	1,240.86
8	Provisional Sum for Price Contingency	2,556.17
9	Land Acquisition and Resettlement Costs	1,112.84
10	Design Cost	773.29
11	Construction Supervision	1,933.22
	TOTAL	48,978.32

For purposes of economic modelling, the consultant has assumed a specific time frame for the deployment of capital expenses, which is presented below.

Table 21. Capital expenses deployment with project.

	2027	2028	2029	2030	2031	2032	2033	2034
Split by year of the CAPEX	1%	3%	18%	14%	14%	18%	18%	14%

7.1.4. Other assumptions

7.1.4.1. Period of analysis

The base year for study projections has been set in 2027 (1st January) and the horizon year in 2064 (31st December)

- Total Investments period: 6 years (2027 – 2034)
- Total operations period: 30 years (2035 – 2064)

Value of Time (VoT)

Value of time is one of the most determining inputs that are related with project appraisal. Since the bridge project offers significant time savings, the value of time helps to estimate an important part of the potential benefits of the project from the user point of view.

Table 22. Values for VoT

Mode	VoT BDT/pass-h (2022)	VoT BDT/pass-h (2027)
Motorcycles	93.5 BDT/pass-h	112.04 BDT/pass-h
Light vehicles	104.5 BDT/pass-h	125.22 BDT/pass-h
Buses	82.5 BDT/pass-h	98.86 BDT/pass-h
Truck	3.85BDT/ton-h	4.61BDT/ton-h

7.1.4.2. Vehicle operating costs

Vehicle Operating costs (VOC's) adopted were obtained on a case- by- case modal basis. It has been adopted a conservative approach when selecting VOC values. The figures adopted are:

Table 23. Vehicle operating costs by mode

Mode	BDT / veh – km (2022)	BDT / veh – km (2027)
Motorcycles	11.00	14.35
Light vehicles	15.40	20.1
Buses	33.00	43.06
Truck	44.00	57.42

7.1.4.3. Externalities

Costing estimation for externalities was undertaken using data extracted from "*Update of the Handbook on External Costs of Transport" – European Commission – 2019*[2]. This Handbook summarizes the external costs, providing a cost expressed in economic units for each vehicle or passenger per kilometer:

Table 24. Unitary average costs for externalities applied.

	Accidents [BDT/pass-km]	Air Pollution [BDT/veh-km]	Climate Change [BDT/veh-km]	Well o tank [BDT/veh-km]
Motorcycles	5.14	0.47	0.38	0.22
Light vehicles	1.80	0.46	0.77	0.25

[2] https://ec.europa.eu/transport/themes/sustainable/studies/sustainable_en

	Accidents [BDT/pass-km]	Air Pollution [BDT/veh-km]	Climate Change [BDT/veh-km]	Well o tank [BDT/veh-km]
Buses	0.40	5.81	3.51	1.15
Trucks	0.51	3.80	2.62	1.01

7.1.4.4. Average annual time savings during the operation of the bridge

The distance and time savings, due to the construction and operation of the bridge are key elements used in the cost benefit analysis. An estimation has been done for each vehicle type, identifying the average yearly savings for the 30 years of the operation of the project.

It should be noted that based on the survey done at the Elisha Ghat, the waiting and crossing time for the ferry has been calculated to be around seven hours on average. Nevertheless, to account for the further disruptions that are taking place during the raining season, it has been assumed that the waiting and crossing time during these three months will reach one day.

The results are illustrated in the tables below.

Table 25. Average annual time savings during the operation of the bridge

	Motorcycles (M pass-hour per year of operation)	LPV (M pass-hour per year of operation)	Bus (M pass-hour per year of operation)	Trucks (M Ton-hour per year of operation)
Without project	5.42	261.46	851.69	1,128.96
With project	1.07	76.34	260.28	335.81
Time Savings	**4.35**	**185.12**	**591.40**	**793.15**

Table 26. Average annual distance savings during the operation of the bridge

	Motorcycles (M veh-km per year of operation)	LPV (M veh-km per year of operation)	Bus (M veh-km per year of operation)	Trucks (M veh-km per year of operation)	Total (M veh-km per year of operation)
Without project	35.61	912.36	309.48	945.39	**2,202.84**
With project	28.01	767.96	307.22	935.62	**2,038.81**
Distance Savings	**7.60**	**144.40**	**2.27**	**9.77**	**164.03**

7.1.5. Economic Analysis Results

7.1.5.1. Projection of economic flows

The projection of economic flows for the different years considered in the period have been estimated and projected (in Cr BDT). They are represented in the following subsections.

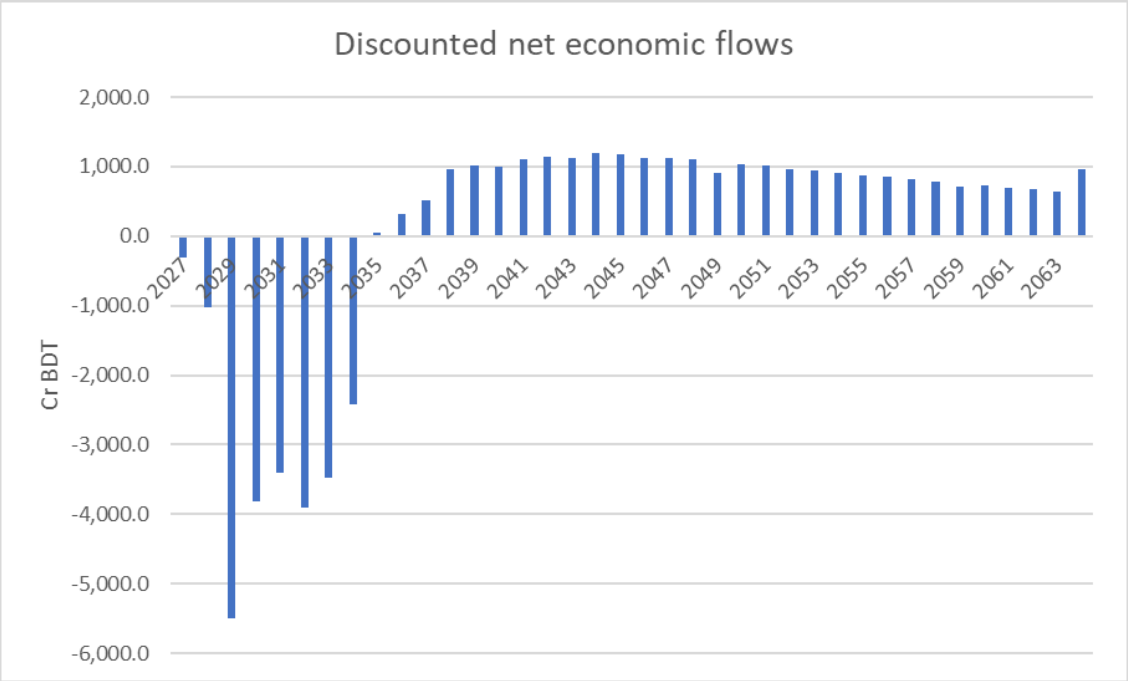


Figure 27. Discounted economic flows (Cr BDT)

It is observed that main net costs arise during construction period (2027 - 2034) and then, during the first operations years, flows start to become positive and grow yearly[3]. When the cumulative discounted flows are represented, it is observed that after some construction phase outflows the cumulative flow reaches a minimum peak financing (in 2034) and then with increasing operation growth the cumulative economic flows increase.

The cumulative discounted net economic flows turn into positive values from 2061 onwards, as it can be seen below:

[3] *It must be noted that operational economic flows have a* ***certain declining timeframe due to the application of a social rate of discount***

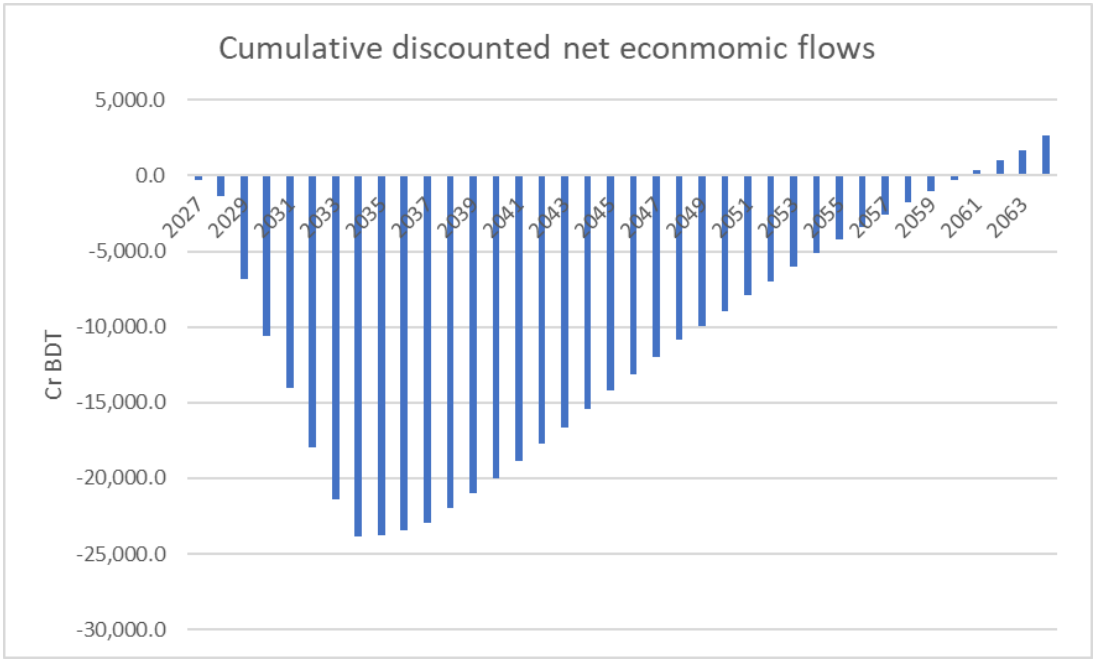


Figure 28. Discounted economic flows (Cr BDT)

In terms of distribution of impacts, the following figures show the split of the main positive NPV flows, showing that change in Consumer Surplus for transport users is the element with the highest impact: around 88% (more precisely, passenger time savings represents 89% of positive impacts).

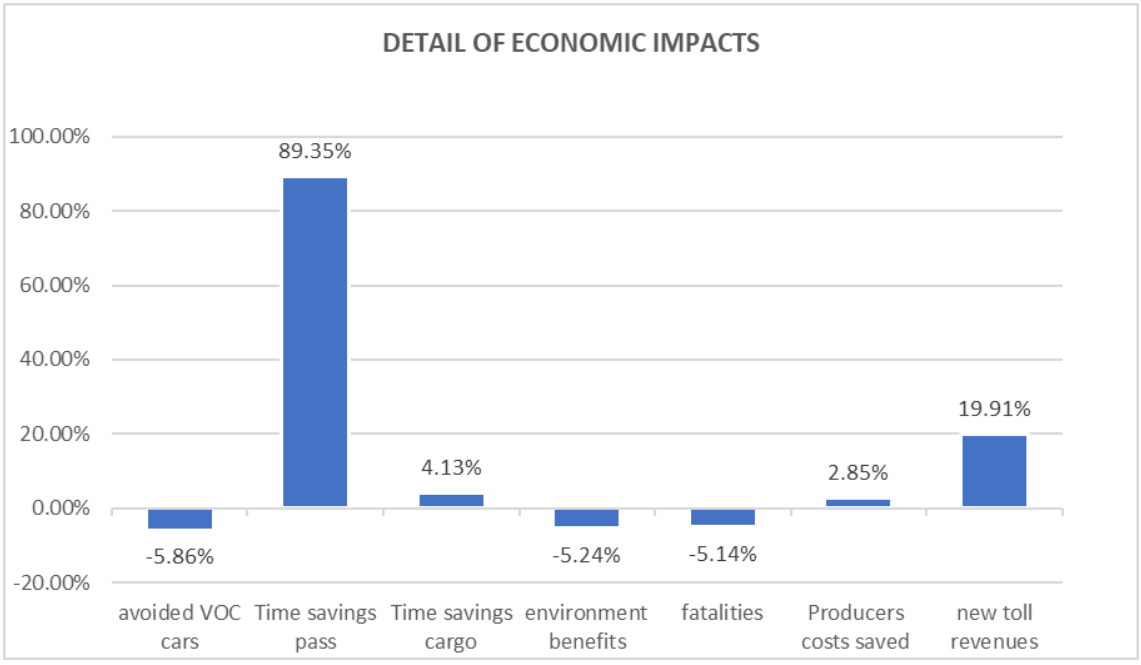


Figure 29. Detail of economic impacts

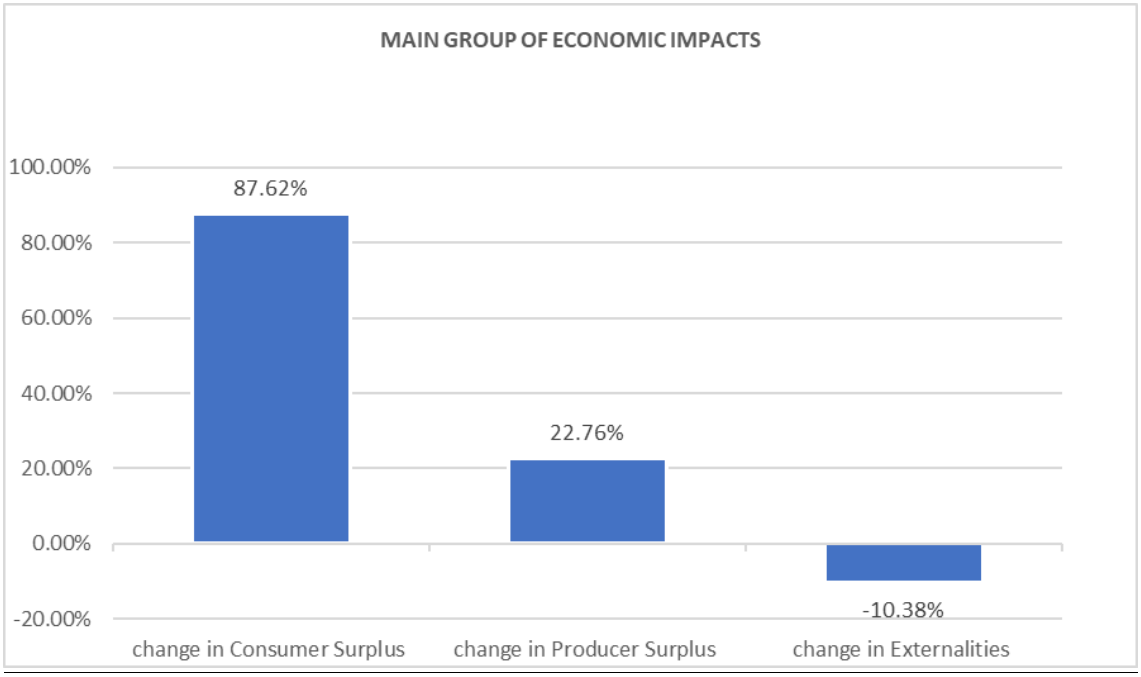


Figure 30. Main group of economic impacts

7.1.5.2. Conclusion

With the assumptions and the results computed it can be concluded that the Bhola-Lakshmipur bridge would be, taking everything into account, a feasible project from a socio-economic point of view. All economic indicators show a positive potential impact in economic terms.

Economic Net Present Value (Cr BDT):	2,648.08
Economic Internal Rate of Return (E-IRR):	12.64%
Benefit / Cost ratio	1.14
Pay back (year)	2061

The project is essentially intended to save time for road and ferry users since that is the main positive impact derived from project implementation.[4]

[4] *Although newly generated economic activities (among them traffic) could bring some diseconomies in terms of incremental external effects.*

7.2. Financial Analysis

7.2.1. Introduction

As part of the pre-feasibility studies of the Bhola-Lakshmipur bridge project ("the Project"), a financial analysis has been done to check whether the Project is capable to generate operating revenues enough to cover the operating expenses and to amortize the initial investments during the period of analysis. The **unlevered analysis** that has been carried out, refers to the operating and investment cash flows of the Project itself: operating revenues, operating expenses, initial investments and overhaul investments. Therefore, it does not include the financial cash flows: capital contributions, financial debt, dividends distribution, etc.

In the event the Project requires non-refundable Capital Grant to make it feasible, even as a payment during the investment phase and/or as periodic payments during the operation phase, the amount of these grants, known as "Viability Gap Financing" ("VGF"), should not be higher than 40 % of total Project costs.

The final objective of the study is to estimate the financial feasibility and profitability of the Project based on the following indicators:

- Financial Net Present Value (FNPV). This is the value resulting from adding the discounted values of the Project inflows or positive cash flows (income) and the Project outflows or negative cash flows (investments and expenses) of the Project. For the discount of the flows, a 12.00% Financial Discount Rate (FDR) is used.
- Financial Internal Rate of Return (FIRR). This value represents the rate at which the investments made are remunerated by the Project during its term. Said rate would be the one that, applied as a discount rate of the cash flows, would result in a net present value equal to zero.
- Financial Benefit-Cost Ratio (F-BCR). It is a financial indicator used to assess the profitability and feasibility of an investment project. If a project has a BCR greater than 1.00, the project is expected to deliver a positive net present value; this means that the FNPV of the project's cash flows outweighs the FNPV of the costs, and the project should be considered.

The Project can be implemented and operated through diverse contract structures, such as traditional procurement, where the Project is implemented and operated by the Government (i.e., Public Project), or as Public Private Partnership (i.e., PPP Contract). If VGF needed to make the Project viable is higher than 40%, the PPP contract is not viable and so, the Project will be implemented as a Traditional procurement or Public Project structure.

7.2.2. Project cash flows

First, the implementation period considers the total investment budget of Option B, which amounts 46,690 Cr BDT, VAT included, while total budget increased with expected inflation up to early 2027 (first year of implementation) and VAT not included is 50,300.30 Cr BDT. The initial investments during the 8 years of implementation are shown in the following chart.:

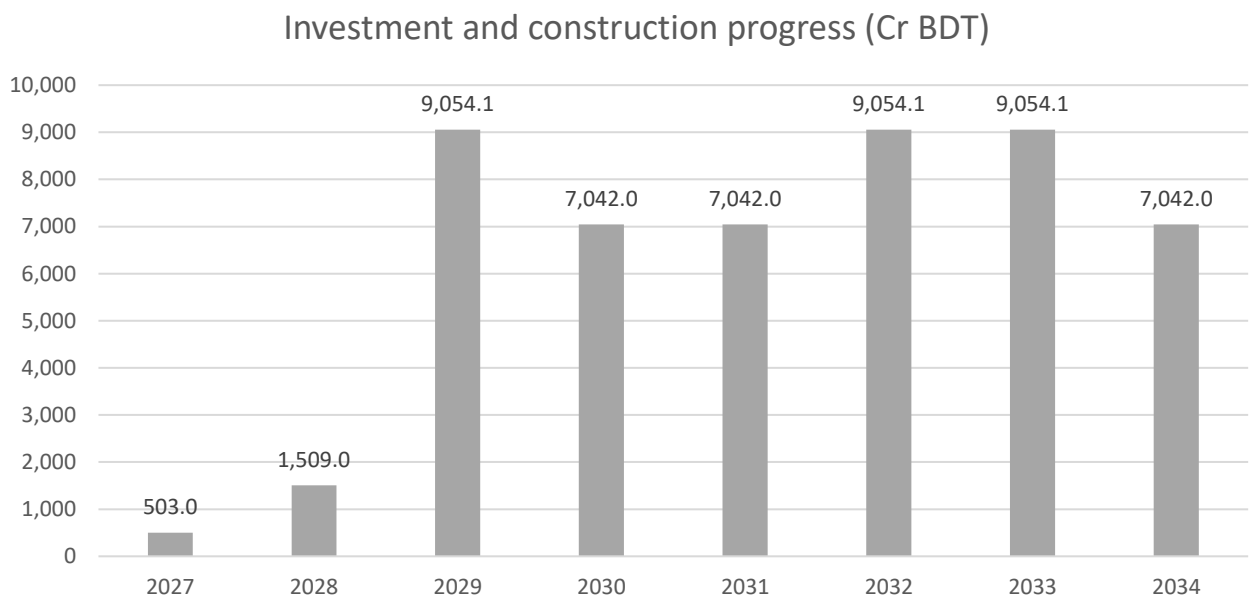


Figure 31. Implementation schedule

During the 30 years of operation period, the Project will generate operating revenues, mainly from toll fares to the users, and operating expenses, mainly from ordinary and extraordinary maintenance. Toll revenues are expected to come mainly from trucks (56% of total toll revenues). Additional commercial revenues will be produced from the lease of the infrastructure to cross service telecommunication lines and other services. For conservative reasons, no commercial revenues have been considered in the financial analysis.

Table 27. Maintenance expenses

Maintenance (Cr BDT. VAT not included)	Investment	Mainten. / year
Main span (cable stayed)	30,331	424.60
Approaching viaducts	671	9.40
Approaching roads	663	10.60
Bank protection and river training	9,408	376.30
Toll Plaza	561	14.20
Total		835.16

As a result of the above cash inflows and outflows, and regardless of the financing or contract structure, the following table shows the Project cash flows projected during the 38 years of period of analysis valid for both procurement alternatives above explained:

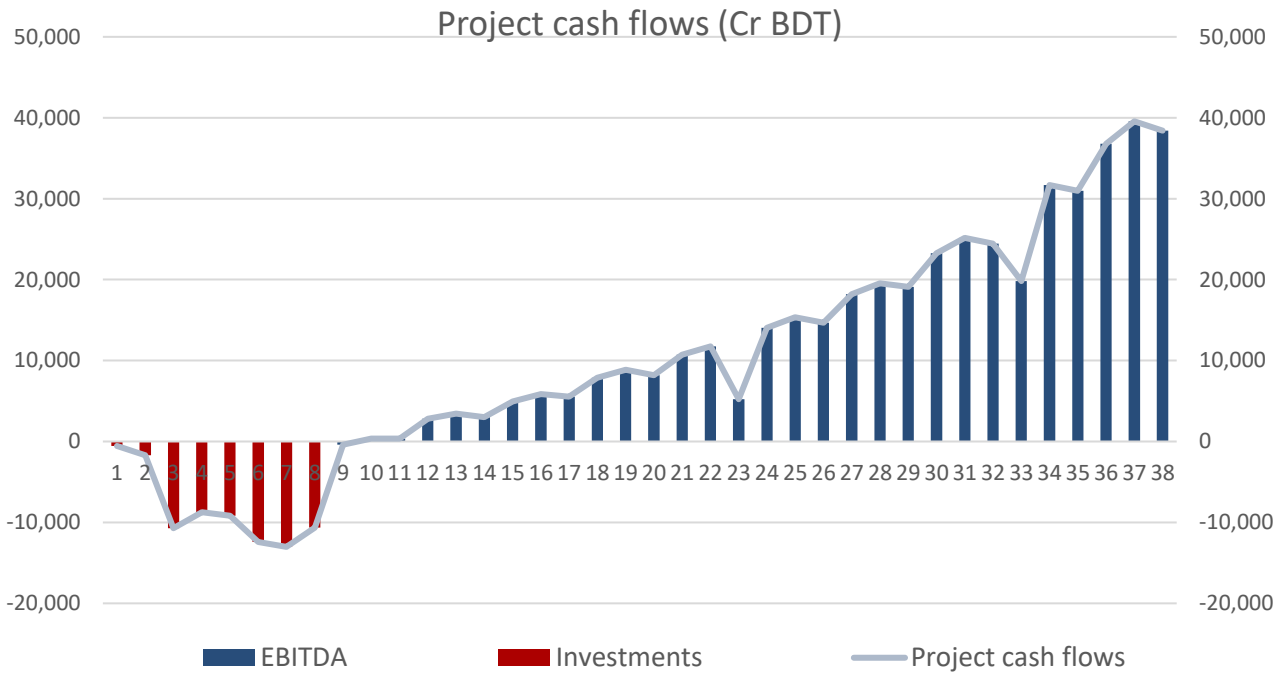


Figure 32. Project cash flows

Toll revenues generate a growing trend of EBITDA during the operation period due to both the increasing annual traffic and the growing toll fares with inflation. Operating expenses are substantially lower than revenues. Years 23 and 33 of the analysis periods show high extraordinary maintenance costs due to renewals.

7.2.3. Financial Results

The financial indicators of the Project resulting from the projected cash flows are as follows:

Table 28. Financial indicators. PPP contract structure

FINANCIAL RESULTS	Bf Grants	After Grants
F-IRR Project (unlevered)	7.49%	12.00%
NPV (@ 12.0 %). Cr BDT	-20,416.90	0.0
GoB Grants required. Cr BDT		36,554.40
VGF required (% over total Project costs)		25.87%

As shown in the above table, results for the PPP Contract structure before and after grants have different values because of the capital grants. Results before grants are not sustainable. Both FIRR and FNPV for the project after capital grants are positive and they show that the feasibility of the Project is

reached with 36,554 Cr BDT of GoB grants with a VGF estimated in 25.87% (< 40%), which means that the Project could be implemented with a PPP contract structure involving private investors.

This alternative procurement (Public Project) generates the following financial indicators:

Table 29. Financial indicators. Public Project contract structure

FINANCIAL RESULTS	After Grants
F-IRR Project (unlevered)	8.46%
F-NPV (@ 12.0 %). Cr BDT (unlevered)	-20,593.50
F-BCR (@ 12.0 %) (unlevered)	0.59 x

As detailed in the table above, the Project cash flows after GoB contributions generate a positive F-IRR of 8.46%, although not reaching the FDR of 12.00 %, thus generating a negative F-NPV of -20,593.50 Cr BDT. F-BCR reached 0.59x, which is lower than 1.0 x for the unlevered scenario.

The conclusions arisen from this unleveraged approach of the financial assessment of the Option B are the following ones:

- Operating result (EBITDA) is expected to be positive and growing during the period of analysis, with years 23 and 33 showing high extraordinary maintenance costs due to renewals.
- The financial analysis with the PPP Contract structure, including the GoB grant, shows positive 12.00% FIRR of the project. However, the Project, despite the positive EBITDA, requires capital grants (VGF) amounting 36,554.40 Cr BDT, which represents 25.87% of total project costs, lower than the legal limit of 40%, which means that the Project could be implemented as a PPP Contract.
- Financial indicators, with the Public Project contract structure, in the unlevered scenario, show a Project with a positive FIRR of 8.46 %, which is lower the FDR (12.00 %), so generating a negative F-NPV of -20,593.50 Cr BDT.

8. CONCLUSION

The essential purpose of any investment is the socio-economic development and contribution to the growth of the country. In this regard, a pre-feasibility study assesses a preliminary plan at its first stage of the study. After being previously identified as a project of potential interest for the country., the study analyses a proposal for an intended future condition considering social and economic activities, their locations and linkages, and the development of an infrastructure within the existing and prospected conditions.

The bridge project that would connect Bhola Sadar and Lakshmipur upazilas over the Lower Meghna River, was shortlisted within the Master Plan potential projects recommended to be implemented by the BBA in the short-term. The Consultant after evaluating the key features of this project, has presented the main conclusions of the pre-feasibility study in this Executive Summary report.

This study aims to be the precursor of its next phase, namely feasibility study, subject to the BBA criteria and strategic approach. Based on this, it has been the purpose of the study, to assess three options and to present within this report, the key outcomes from the technical, environmental social and cost standpoints, for the three of them. The Consultant is presenting the conclusion from the economic and financial analysis for the pre-selected alignment option.

The proposed solution, **a bridge 19.24 km long**, crossing the Meghna River at the selected **alignment B**, through the designed solution based on: **cable-stayed bridge 1.20 km long (300m x 1 + 600m x 1 + 300m x 1), plus 16.60 km (truss bridge 200m x 82 + 100m x 2) and 1.44 km approach bridges (40m x 36) plus 5.16 km of approach roads,** was selected amongst several options, covering four different alignments, and after assessing several technical options for the bridge at each site. The selected option was assessed as the optimum one considering all the multi-criteria factors. The assessment from all aspects of the feasibility study was undertaken over the three pre-selected options (A, B and C) after discarding option D.

Additionally, and as a preliminary approach assessment, the tunnel solution was discarded due to the high complexity and increase in cost (considering both, the investment stage and the operation and maintenance stage expenses).

The Consultant recommends this project, with the proposed bridge solution, to be implemented by the BBA, as it would provide sound social and economic progress and benefits to the population living in the directly related areas. It would also promote and enhance potential connectivity in this part of the country.

The regional connectivity improved by the bridge would function as a key linkage between both areas, of potential interest for industrial growth and social benefits objectives, now only connected by ferry. If the proposed bridge is built, a population of near 4.99 Cr, living in 29 districts belonging to Chattogram and Barishal divisions would benefit from this major transportation improvement. The population belonging to the two directly connected 2 upazilas, Bhola Sadar and Lakhsmipur Sadar, that would be benefited from the project is estimated to be 12 lakhs.

The project and its implementation should be approached with careful planning, considering various aspects such as environmental impact, infrastructure investment, and social implications. Engaging with local communities and stakeholders during the planning and implementation stages is essential for the success of such a project.

An Initial Environmental Examination (IEE) was carried out accordingly with the current DOE guidelines and recommendations, falling the project under red category. The identified risks would be duly mitigated through the implementation of the proper Environmental Impact Assessment (EIA) and Environmental management Plan (EMP) during the construction phase.

Social safeguard aspects have been assessed through a Social Impact Assessment (SIA), following the current legislation and guidelines. The project impact would require resettlement of part of the affected areas and would be mitigated by the implementation of a Social Impact Assessment Action Plan. Consultation to the community of the affected area was carried out with a positive response.

The completion of this project construction has been estimated in 78 months. It has been assumed that, after 8 years of investment phase (2027 to 2034), the operation phase would start in 2035 and would end in 2064 (30 years).

The investment **cost for the selected option (B)** has been estimated to be **46,515 Cr BDT**. Values of project cost for other options, A and C, were assessed as 50,001 Cr BDT and 47,983 BDT respectively, which would entail slightly improved economic and financial results, however, and as explained within the section 4.2, option B was pre-selected aiming to minimize social impact and due to other considerations.

Traffic surveys were undertaken covering the area of influence of the project, and a traffic model was implemented by the Consultant, enabling to generate the necessary traffic estimations at various scenarios. As a summarized output, the traffic forecast for the final year of operation (2064) was estimated as **50,041 veh/day** (the use 3 wheelers was precluded from the study).

Economic Cost-Benefit Analysis (CBA), was carried out at the selected option (B), considering two scenarios.[5] The results obtained from the economic model are clearly positive from the socio-economic standpoint: **EIRR 12.64 %, ENPV 2,648.08 Cr BDT, C/B ratio 1.14.**

The Financial indicators, in the case of Public Project contract structure, show a Project with a positive **FIRR 8.46 %** in the unlevered scenario. However, this value is lower than the targeted FDR of 12.00 %; the estimated FNPV is -20,593 Cr BDT and the F-BCR reaches 0.59x.

The Project could show financial feasibility under a PPP structure as it would require a grant of 36,554 Cr BDT, which represents 25.87 % of total project costs (VGF), not exceeding the limit of 40% set up by

[5] *Two scenarios were considered in the socio-economic and financial assessment, "with project" case and "without project" case (ferry-ghat).*

law for PPP contract structures and therefore the PPP Contract structure could be implemented according to VGF regulation.

Viewed from the implementation standpoint and as a summarizing outcome derived from this pre-feasibility study, considering all technical, social, and environmental standpoints, it may be concluded that the project, located at Bhola Sadar and Lakshmipur Sadar upazilas, consisting of the 19.24 km long bridge, crossing the mighty lower Meghna at the selected alignment B, through the designed 1.2 km cable-stayed bridge combined with the 16.60 km steel truss bridge and a series of other needed associated components would be technically and financially feasible.

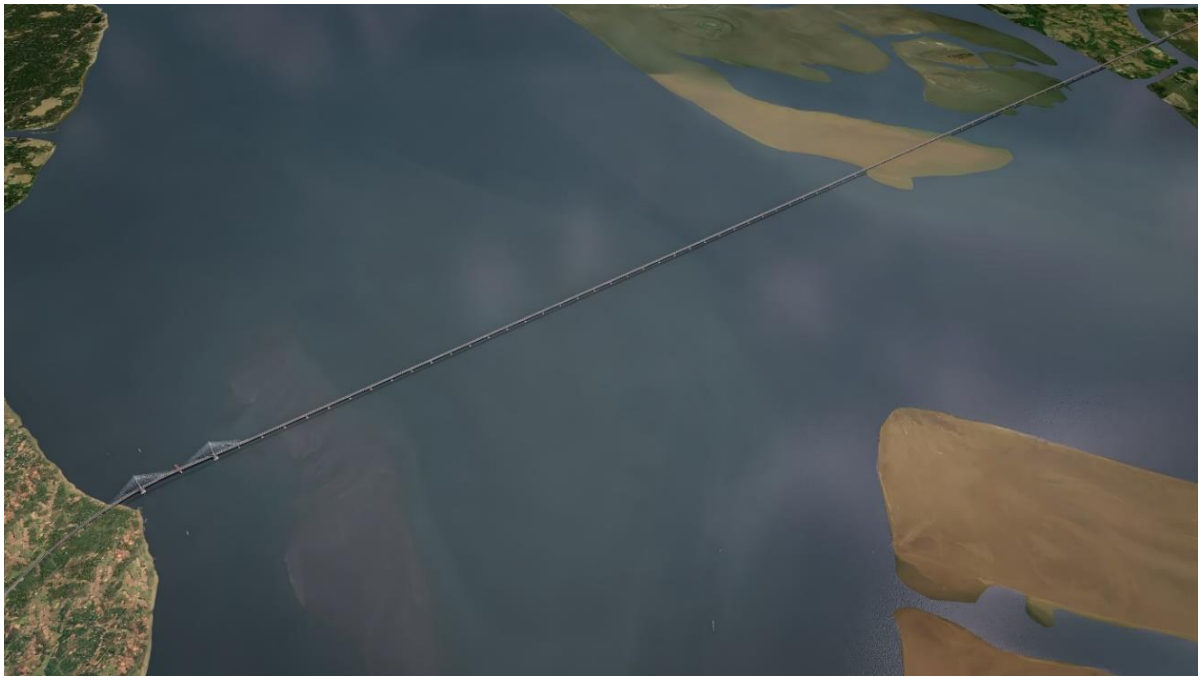


Figure 33 Virtual render of the general view of the project at Bhola-Lakhsmipur

Figure 34 Virtual render of the proposed Bridge for Bhola-Lakhsmipur

Annexure 01 – Economic and Financial Model Calculation Sheets

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Economic Analysis

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CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2027	2028	2029	2030	2031
		Year 1	Year 2	Year 3	Year 4	Year 5
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Existing traffic	**1,125.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	986.50	0.00	0.00	0.00	0.00	0.00
User freight time savings	102.05	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	37.33	0.00	0.00	0.00	0.00	0.00
Diverted traffic	**917.30**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	692.16	0.00	0.00	0.00	0.00	0.00
User freight time savings	4.62	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	220.51	0.00	0.00	0.00	0.00	0.00
Generated traffic	**22,601.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User time costs savings	23,210.11	0.00	0.00	0.00	0.00	0.00
User freight time savings	1,016.91	0.00	0.00	0.00	0.00	0.00
Additional Vehicle Operating Costs (VOC)	-1,625.32	0.00	0.00	0.00	0.00	0.00
Variation in Externalities	**-2,811.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Accidents	-1,391.49	0.00	0.00	0.00	0.00	0.00
Emissions	-1,230.81	0.00	0.00	0.00	0.00	0.00
Air polution	-709.88	0.00	0.00	0.00	0.00	0.00
Climate change	-520.92	0.00	0.00	0.00	0.00	0.00
Well to tank	-188.74	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**-313.59**	**-1,147.78**	**-6,886.67**	**-5,356.30**	**-5,356.30**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Change in Producer Surplus:	**6,164.51**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Producers costs savings for the system	729.08	0.00	0.00	0.00	0.00	0.00
Existing traffic	510.62	0.00	0.00	0.00	0.00	0.00
Diverted traffic	218.47	0.00	0.00	0.00	0.00	0.00
Toll revenues (generated traffic)	5,391.62	0.00	0.00	0.00	0.00	0.00
Vehicle Op costs (generated traffic)	43.80	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**-313.59**	**-1,147.78**	**-6,886.67**	**-5,356.30**	**-5,356.30**
NET BENEFITS (Cr BDT)	**2,648.08**	**-313.59**	**-1,147.78**	**-6,886.67**	**-5,356.30**	**-5,356.30**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2032	2033	2034	2035	2036
		Year 6	Year 7	Year 8	Year 9	Year 10
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**0.00**	**0.00**	**0.00**	**375.58**	**1,008.25**
Existing traffic	**1,125.87**	**0.00**	**0.00**	**0.00**	**119.57**	**134.89**
User passenger time savings	986.50	0.00	0.00	0.00	104.56	118.02
User freight time savings	102.05	0.00	0.00	0.00	10.75	12.15
Vehicle Operating Costs (VOC) savings	37.33	0.00	0.00	0.00	4.25	4.72
Diverted traffic	**917.30**	**0.00**	**0.00**	**0.00**	**27.13**	**60.63**
User passenger time savings	692.16	0.00	0.00	0.00	20.26	45.38
User freight time savings	4.62	0.00	0.00	0.00	0.13	0.29
Vehicle Operating Costs (VOC) savings	220.51	0.00	0.00	0.00	6.75	14.96
Generated traffic	**22,601.70**	**0.00**	**0.00**	**0.00**	**228.89**	**812.73**
User time costs savings	23,210.11	0.00	0.00	0.00	235.57	837.35
User freight time savings	1,016.91	0.00	0.00	0.00	10.34	36.52
Additional Vehicle Operating Costs (VOC)	-1,625.32	0.00	0.00	0.00	-17.02	-61.14
Variation in Externalities	**-2,811.04**	**0.00**	**0.00**	**0.00**	**-37.37**	**-169.80**
Accidents	-1,391.49	0.00	0.00	0.00	-17.10	-82.89
Emissions	-1,230.81	0.00	0.00	0.00	-17.55	-75.32
Air polution	-709.88	0.00	0.00	0.00	-9.97	-43.29
Climate change	-520.92	0.00	0.00	0.00	-7.58	-32.03
Well to tank	-188.74	0.00	0.00	0.00	-2.72	-11.59
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**0.00**	**0.00**	**0.00**	**338.21**	**838.46**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**-6,886.67**	**-6,864.59**	**-5,356.30**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**0.00**	**0.00**	**0.00**	**-371.35**	**-371.35**
Change in Producer Surplus:	**6,164.51**	**0.00**	**0.00**	**0.00**	**171.68**	**435.42**
Producers costs savings for the system	729.08	0.00	0.00	0.00	64.88	79.36
Existing traffic	510.62	0.00	0.00	0.00	58.20	64.54
Diverted traffic	218.47	0.00	0.00	0.00	6.68	14.82
Toll revenues (generated traffic)	5,391.62	0.00	0.00	0.00	106.31	354.38
Vehicle Op costs (generated traffic)	43.80	0.00	0.00	0.00	0.49	1.69
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**-6,886.67**	**-6,864.59**	**-5,356.30**	**-199.67**	**64.07**
NET BENEFITS (Cr BDT)	**2,648.08**	**-6,886.67**	**-6,864.59**	**-5,356.30**	**138.54**	**902.53**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2037	2038	2039	2040	2041
		Year 11	Year 12	Year 13	Year 14	Year 15
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**1,853.93**	**3,054.04**	**3,587.54**	**4,193.49**	**4,879.56**
Existing traffic	**1,125.87**	**149.96**	**166.40**	**184.33**	**203.84**	**225.04**
User passenger time savings	986.50	131.22	145.63	161.34	178.44	197.02
User freight time savings	102.05	13.52	15.01	16.63	18.40	20.33
Vehicle Operating Costs (VOC) savings	37.33	5.22	5.77	6.36	7.00	7.69
Diverted traffic	**917.30**	**100.86**	**148.85**	**164.46**	**181.39**	**199.74**
User passenger time savings	692.16	75.53	111.55	123.33	136.12	149.98
User freight time savings	4.62	0.49	0.72	0.80	0.89	0.98
Vehicle Operating Costs (VOC) savings	220.51	24.84	36.58	40.33	44.39	48.77
Generated traffic	**22,601.70**	**1,603.11**	**2,738.79**	**3,238.75**	**3,808.25**	**4,454.77**
User time costs savings	23,210.11	1,652.12	2,822.78	3,337.40	3,923.38	4,588.33
User freight time savings	1,016.91	71.95	122.83	145.24	170.79	199.79
Additional Vehicle Operating Costs (VOC)	-1,625.32	-120.96	-206.82	-243.90	-285.92	-333.35
Variation in Externalities	**-2,811.04**	**-335.94**	**-558.96**	**-630.46**	**-706.73**	**-787.81**
Accidents	-1,391.49	-165.48	-276.43	-311.97	-349.89	-390.21
Emissions	-1,230.81	-147.76	-244.93	-276.12	-309.38	-344.73
Air polution	-709.88	-85.09	-141.18	-159.19	-178.40	-198.82
Climate change	-520.92	-62.67	-103.75	-116.93	-130.98	-145.91
Well to tank	-188.74	-22.70	-37.60	-42.37	-47.46	-52.87
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**1,517.99**	**2,495.08**	**2,957.07**	**3,486.76**	**4,091.74**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**-662.69**	**-371.35**	**-371.35**	**-662.69**	**-371.35**
Change in Producer Surplus:	**6,164.51**	**763.90**	**1,200.04**	**1,346.65**	**1,503.12**	**1,669.62**
Producers costs savings for the system	729.08	96.03	115.13	126.94	139.72	153.52
Existing traffic	510.62	71.42	78.89	86.98	95.74	105.20
Diverted traffic	218.47	24.61	36.24	39.96	43.98	48.32
Toll revenues (generated traffic)	5,391.62	664.57	1,079.30	1,213.10	1,355.68	1,507.12
Vehicle Op costs (generated traffic)	43.80	3.30	5.61	6.60	7.72	8.99
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**101.21**	**828.69**	**975.29**	**840.43**	**1,298.27**
NET BENEFITS (Cr BDT)	**2,648.08**	**1,619.20**	**3,323.77**	**3,932.37**	**4,327.19**	**5,390.01**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2042	2043	2044	2045	2046
		Year 16	Year 17	Year 18	Year 19	Year 20
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**5,654.02**	**6,525.81**	**7,504.52**	**8,240.08**	**9,034.91**
Existing traffic	**1,125.87**	**248.05**	**272.99**	**299.97**	**329.14**	**360.63**
User passenger time savings	986.50	217.20	239.06	262.73	288.31	315.93
User freight time savings	102.05	22.42	24.69	27.14	29.80	32.66
Vehicle Operating Costs (VOC) savings	37.33	8.44	9.24	10.10	11.03	12.03
Diverted traffic	**917.30**	**219.58**	**241.01**	**264.13**	**289.05**	**315.86**
User passenger time savings	692.16	164.99	181.22	198.74	217.64	237.99
User freight time savings	4.62	1.08	1.19	1.31	1.44	1.58
Vehicle Operating Costs (VOC) savings	220.51	53.50	58.60	64.08	69.97	76.29
Generated traffic	**22,601.70**	**5,186.39**	**6,011.81**	**6,940.42**	**7,621.90**	**8,358.42**
User time costs savings	23,210.11	5,340.50	6,188.76	7,142.67	7,840.86	8,595.11
User freight time savings	1,016.91	232.63	269.69	311.39	342.13	375.37
Additional Vehicle Operating Costs (VOC)	-1,625.32	-386.74	-446.63	-513.64	-561.10	-612.06
Variation in Externalities	**-2,811.04**	**-873.75**	**-964.55**	**-1,060.24**	**-1,106.40**	**-1,152.93**
Accidents	-1,391.49	-432.95	-478.11	-525.70	-548.56	-571.60
Emissions	-1,230.81	-382.20	-421.78	-463.49	-483.70	-504.07
Air polution	-709.88	-220.46	-243.33	-267.42	-279.08	-290.84
Climate change	-520.92	-161.74	-178.45	-196.07	-204.61	-213.22
Well to tank	-188.74	-58.60	-64.66	-71.04	-74.14	-77.26
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**4,780.27**	**5,561.26**	**6,444.29**	**7,133.68**	**7,881.98**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**-371.35**	**-662.69**	**-420.44**	**-371.35**	**-662.69**
Change in Producer Surplus:	**6,164.51**	**1,846.27**	**2,033.20**	**2,230.47**	**2,337.99**	**2,447.66**
Producers costs savings for the system	729.08	168.41	184.44	201.70	220.24	240.14
Existing traffic	510.62	115.40	126.39	138.21	150.91	164.55
Diverted traffic	218.47	53.01	58.06	63.49	69.32	75.59
Toll revenues (generated traffic)	5,391.62	1,667.46	1,836.75	2,015.00	2,102.70	2,191.09
Vehicle Op costs (generated traffic)	43.80	10.41	12.00	13.78	15.06	16.43
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**1,474.92**	**1,370.50**	**1,810.03**	**1,966.64**	**1,784.97**
NET BENEFITS (Cr BDT)	**2,648.08**	**6,255.20**	**6,931.76**	**8,254.32**	**9,100.33**	**9,666.95**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2047	2048	2049	2050	2051
		Year 21	Year 22	Year 23	Year 24	Year 25
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**9,892.76**	**10,817.58**	**11,813.50**	**12,884.86**	**14,036.17**
Existing traffic	**1,125.87**	**394.58**	**431.14**	**470.48**	**512.76**	**558.14**
User passenger time savings	986.50	345.72	377.81	412.33	449.44	489.28
User freight time savings	102.05	35.76	39.09	42.68	46.54	50.69
Vehicle Operating Costs (VOC) savings	37.33	13.10	14.24	15.47	16.78	18.17
Diverted traffic	**917.30**	**344.68**	**375.64**	**408.84**	**444.41**	**482.50**
User passenger time savings	692.16	259.88	283.41	308.67	335.76	364.78
User freight time savings	4.62	1.73	1.89	2.07	2.25	2.46
Vehicle Operating Costs (VOC) savings	220.51	83.07	90.33	98.10	106.40	115.26
Generated traffic	**22,601.70**	**9,153.50**	**10,010.80**	**10,934.19**	**11,927.69**	**12,995.53**
User time costs savings	23,210.11	9,408.96	10,286.11	11,230.47	12,246.12	13,337.31
User freight time savings	1,016.91	411.28	450.02	491.76	536.70	585.03
Additional Vehicle Operating Costs (VOC)	-1,625.32	-666.74	-725.33	-788.05	-855.13	-926.81
Variation in Externalities	**-2,811.04**	**-1,199.77**	**-1,246.85**	**-1,294.11**	**-1,341.50**	**-1,388.97**
Accidents	-1,391.49	-594.79	-618.10	-641.49	-664.95	-688.43
Emissions	-1,230.81	-524.57	-545.19	-565.89	-586.64	-607.44
Air polution	-709.88	-302.68	-314.58	-326.53	-338.51	-350.52
Climate change	-520.92	-221.89	-230.61	-239.36	-248.13	-256.92
Well to tank	-188.74	-80.40	-83.56	-86.73	-89.91	-93.10
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**8,692.99**	**9,570.73**	**10,519.39**	**11,543.36**	**12,647.21**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**-371.35**	**-371.35**	**-2,266.67**	**-371.35**	**-371.35**
Change in Producer Surplus:	**6,164.51**	**2,559.44**	**2,673.30**	**2,789.21**	**2,907.17**	**3,027.15**
Producers costs savings for the system	729.08	261.47	284.32	308.76	334.89	362.78
Existing traffic	510.62	179.17	194.82	211.57	229.48	248.59
Diverted traffic	218.47	82.30	89.49	97.19	105.41	114.19
Toll revenues (generated traffic)	5,391.62	2,280.06	2,369.49	2,459.27	2,549.28	2,639.43
Vehicle Op costs (generated traffic)	43.80	17.91	19.49	21.19	23.00	24.94
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**2,188.09**	**2,301.95**	**522.55**	**2,535.82**	**2,655.80**
NET BENEFITS (Cr BDT)	**2,648.08**	**10,881.08**	**11,872.68**	**11,041.94**	**14,079.17**	**15,303.01**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2052	2053	2054	2055	2056
		Year 26	Year 27	Year 28	Year 29	Year 30
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**15,272.19**	**16,597.88**	**18,018.43**	**19,524.40**	**21,133.65**
Existing traffic	**1,125.87**	**606.81**	**658.96**	**714.78**	**774.48**	**838.27**
User passenger time savings	986.50	532.02	577.81	626.83	679.26	735.29
User freight time savings	102.05	55.13	59.90	65.01	70.47	76.31
Vehicle Operating Costs (VOC) savings	37.33	19.66	21.25	22.95	24.75	26.66
Diverted traffic	**917.30**	**523.23**	**566.75**	**613.22**	**662.79**	**715.62**
User passenger time savings	692.16	395.84	429.05	464.54	502.41	542.81
User freight time savings	4.62	2.67	2.91	3.15	3.42	3.71
Vehicle Operating Costs (VOC) savings	220.51	124.71	134.79	145.53	156.95	169.10
Generated traffic	**22,601.70**	**14,142.15**	**15,372.16**	**16,690.43**	**18,087.14**	**19,579.76**
User time costs savings	23,210.11	14,508.52	15,764.43	17,109.93	18,535.39	20,058.25
User freight time savings	1,016.91	636.95	692.68	752.43	815.67	883.26
Additional Vehicle Operating Costs (VOC)	-1,625.32	-1,003.32	-1,084.94	-1,171.93	-1,263.92	-1,361.75
Variation in Externalities	**-2,811.04**	**-1,436.45**	**-1,483.89**	**-1,531.25**	**-1,577.11**	**-1,622.68**
Accidents	-1,391.49	-711.92	-735.39	-758.82	-781.54	-804.13
Emissions	-1,230.81	-628.24	-649.03	-669.79	-689.84	-709.78
Air polution	-709.88	-362.53	-374.53	-386.52	-398.09	-409.59
Climate change	-520.92	-265.71	-274.50	-283.27	-291.75	-300.18
Well to tank	-188.74	-96.28	-99.47	-102.65	-105.72	-108.78
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**13,835.75**	**15,113.99**	**16,487.18**	**17,947.30**	**19,510.96**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**-662.69**	**-371.35**	**-420.44**	**-662.69**	**-371.35**
Change in Producer Surplus:	**6,164.51**	**3,149.16**	**3,273.20**	**3,399.28**	**3,524.85**	**3,652.32**
Producers costs savings for the system	729.08	392.55	424.27	458.06	494.01	532.25
Existing traffic	510.62	268.99	290.72	313.88	338.52	364.72
Diverted traffic	218.47	123.56	133.55	144.18	155.50	167.53
Toll revenues (generated traffic)	5,391.62	2,729.61	2,819.71	2,909.65	2,996.78	3,083.38
Vehicle Op costs (generated traffic)	43.80	27.01	29.22	31.57	34.05	36.69
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**2,486.47**	**2,901.84**	**2,978.84**	**2,862.16**	**3,280.97**
NET BENEFITS (Cr BDT)	**2,648.08**	**16,322.21**	**18,015.83**	**19,466.02**	**20,809.45**	**22,791.93**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2057	2058	2059	2060	2061
		Year 31	Year 32	Year 33	Year 34	Year 35
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**					
Change in Consumer Surplus	**24,644.87**	**22,851.80**	**24,684.74**	**26,638.61**	**28,719.84**	**30,935.10**
Existing traffic	**1,125.87**	**906.37**	**979.01**	**1,056.45**	**1,138.93**	**1,226.72**
User passenger time savings	986.50	795.12	858.95	926.99	999.48	1,076.63
User freight time savings	102.05	82.55	89.20	96.30	103.87	111.92
Vehicle Operating Costs (VOC) savings	37.33	28.70	30.86	33.15	35.59	38.16
Diverted traffic	**917.30**	**771.89**	**831.77**	**895.46**	**963.15**	**1,035.03**
User passenger time savings	692.16	585.87	631.72	680.51	732.40	787.54
User freight time savings	4.62	4.01	4.34	4.68	5.05	5.44
Vehicle Operating Costs (VOC) savings	220.51	182.01	195.72	210.27	225.70	242.05
Generated traffic	**22,601.70**	**21,173.54**	**22,873.95**	**24,686.70**	**26,617.76**	**28,673.35**
User time costs savings	23,210.11	21,683.79	23,417.55	25,265.29	27,233.05	29,327.13
User freight time savings	1,016.91	955.46	1,032.52	1,114.68	1,202.24	1,295.46
Additional Vehicle Operating Costs (VOC)	-1,625.32	-1,465.71	-1,576.11	-1,693.27	-1,817.53	-1,949.24
Variation in Externalities	**-2,811.04**	**-1,667.93**	**-1,712.81**	**-1,757.29**	**-1,801.33**	**-1,844.89**
Accidents	-1,391.49	-826.55	-848.79	-870.84	-892.66	-914.24
Emissions	-1,230.81	-729.57	-749.20	-768.66	-787.92	-806.97
Air polution	-709.88	-421.02	-432.35	-443.57	-454.69	-465.68
Climate change	-520.92	-308.55	-316.86	-325.09	-333.23	-341.29
Well to tank	-188.74	-111.81	-114.82	-117.80	-120.75	-123.67
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**21,183.86**	**22,971.92**	**24,881.32**	**26,918.51**	**29,090.21**
SOCIO ECONOMIC COSTS (Cr BDT)						
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-1,853.14**	**-371.35**	**-662.69**	**-1,975.33**	**-371.35**	**-662.69**
Change in Producer Surplus:	**6,164.51**	**3,781.74**	**3,913.15**	**4,046.62**	**4,182.21**	**4,320.01**
Producers costs savings for the system	729.08	572.88	616.04	661.83	710.39	761.87
Existing traffic	510.62	392.56	422.13	453.51	486.79	522.06
Diverted traffic	218.47	180.32	193.91	208.32	223.61	239.81
Toll revenues (generated traffic)	5,391.62	3,169.37	3,254.65	3,339.17	3,422.85	3,505.62
Vehicle Op costs (generated traffic)	43.80	39.49	42.46	45.62	48.97	52.51
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**3,410.39**	**3,250.46**	**2,071.29**	**3,810.86**	**3,657.32**
NET BENEFITS (Cr BDT)	**2,648.08**	**24,594.25**	**26,222.38**	**26,952.61**	**30,729.36**	**32,747.53**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

CBA

PRE-FEASIBILITY STUDY OF BHOLA-LAKSHMIPUR BRIDGE		2062 Year 36	2063 Year 37	2064 Year 38
SOCIO ECONOMIC BENEFITS (Cr BDT)	**NPV**			
Change in Consumer Surplus	**24,644.87**	**33,291.40**	**35,796.04**	**38,456.63**
Existing traffic	**1,125.87**	**1,320.09**	**1,419.33**	**1,524.75**
User passenger time savings	986.50	1,158.70	1,245.94	1,338.62
User freight time savings	102.05	120.49	129.60	139.29
Vehicle Operating Costs (VOC) savings	37.33	40.90	43.79	46.85
Diverted traffic	**917.30**	**1,111.34**	**1,192.28**	**1,278.09**
User passenger time savings	692.16	846.10	908.25	974.18
User freight time savings	4.62	5.86	6.31	6.78
Vehicle Operating Costs (VOC) savings	220.51	259.38	277.72	297.13
Generated traffic	**22,601.70**	**30,859.98**	**33,184.42**	**35,653.78**
User time costs savings	23,210.11	31,554.08	33,920.78	36,434.38
User freight time savings	1,016.91	1,394.66	1,500.13	1,612.20
Additional Vehicle Operating Costs (VOC)	-1,625.32	-2,088.76	-2,236.48	-2,392.81
Variation in Externalities	**-2,811.04**	**-1,887.94**	**-1,930.46**	**-1,972.41**
Accidents	-1,391.49	-935.58	-956.65	-977.44
Emissions	-1,230.81	-825.81	-844.40	-862.75
Air polution	-709.88	-476.55	-487.28	-497.87
Climate change	-520.92	-349.25	-357.12	-364.88
Well to tank	-188.74	-126.56	-129.41	-132.22
TOTAL ECONOMIC BENEFITS (Cr BDT)	**21,833.83**	**31,403.46**	**33,865.58**	**36,484.22**
SOCIO ECONOMIC COSTS (Cr BDT)				
Project initial investments	**-23,853.34**	**0.00**	**0.00**	**0.00**
Residual value	**356.21**	**0.00**	**0.00**	**23,592.64**
Renovation works	**-1,853.14**	**-371.35**	**-371.35**	**-711.78**
Change in Producer Surplus:	**6,164.51**	**4,460.11**	**4,602.61**	**4,747.64**
Producers costs savings for the system	729.08	816.41	874.15	935.25
Existing traffic	510.62	559.43	598.99	640.86
Diverted traffic	218.47	256.98	275.15	294.38
Toll revenues (generated traffic)	5,391.62	3,587.43	3,668.21	3,747.93
Vehicle Op costs (generated traffic)	43.80	56.27	60.25	64.46
TOTAL ECONOMIC COSTS (Cr BDT)	**-19,185.75**	**4,088.75**	**4,231.26**	**27,628.50**
NET BENEFITS (Cr BDT)	**2,648.08**	**35,492.22**	**38,096.84**	**64,112.71**

IRR (%)	**12.64%**
NPV (Cr BDT)	**2,648.08**
Pay Back	**2,061**
Benefit / Cost	**1.14**

Financial Analysis – Project and Government Cash Flow

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BHOLA - LAKSHMIPUR

			2027 Year 1	2028 Year 2	2029 Year 3	2030 Year 4	2031 Year 5
Construction period	8 years		1	1	1	1	1
Operation period	30 years		0	0	0	0	0
Term of analysis	38 years		1	1	1	1	1
Price indexation	5.00%		1.00	1.05	1.10	1.16	1.22

PROJECT CASH FLOWS (Cr BDT)			2027 Year 1	2028 Year 2	2029 Year 3	2030 Year 4	2031 Year 5
Operating revenues			**0**	**0**	**0**	**0**	**0**
Toll revenues			0	0	0	0	0
Other commercial revenues			0	0	0	0	0
Operation & Maintenance expenses			**0**	**0**	**0**	**0**	**0**
Maintenance & Overhaul			0	0	0	0	0
Operation			0	0	0	0	0
Net Cash Flows due to Operations		**23,225.4**	**0**	**0**	**0**	**0**	**0**
Cash Flows due to Investments			**-768**	**-1,742**	**-10,956**	**-9,158**	**-9,772**
Initial CAPEX		-71,665	-768	-1,742	-10,956	-9,158	-9,772
Other CAPEX		0	0	0	0	0	0
Residual Value of Investments		1,220	0	0	0	0	0
Project cash flows	**8.5%**	**-20,593.5**	**-768**	**-1,742**	**-10,956**	**-9,158**	**-9,772**
Financial benefits			0	0	0	0	0
Financial costs			768	1,742	10,956	9,158	9,772
Financial Benefit/Cost ratio	**@12%**	**0.59 x**					
Financial Benefit/Cost ratio	**@WACC**	**1.58 x**					

GOVERNMENT CASH FLOWS (Cr BDT)			2027 Year 1	2028 Year 2	2029 Year 3	2030 Year 4	2031 Year 5
Outflows			**-768**	**-1,742**	**-10,956**	**-9,158**	**-9,772**
Project Development (Initial CAPEX)		-36,707	-540	-1,701	-10,714	-8,750	-9,187
Financing Fees			-228	-41	-242	-408	-585
Operating expenses			0	0	0	0	0
Loan Repayments							
Interest		-5,244	0	0	0	0	0
Principal Repayments		-4,936	0	0	0	0	0
Inflows			**628**	**1,322**	**8,434**	**7,197**	**7,811**
Borrowings		31,317	628	1,322	8,434	7,197	7,811
Operating revenues		26,926	0	0	0	0	0
Future Developments		0	0	0	0	0	0
Government cash flows	**13.2%**	**2,732.9**	**-140**	**-420**	**-2,521**	**-1,961**	**-1,961**

BHOLA - LAKSHMIPUR

	2032 Year 6	2033 Year 7	2034 Year 8	2035 Year 9	2036 Year 10	2037 Year 11	2038 Year 12
Construction period	1	1	1	0	0	0	0
Operation period	0	0	0	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	1.28	1.34	1.41	1.48	1.55	1.63	1.71

PROJECT CASH FLOWS (Cr BDT)	2032 Year 6	2033 Year 7	2034 Year 8	2035 Year 9	2036 Year 10	2037 Year 11	2038 Year 12
Operating revenues	**0**	**0**	**0**	**430**	**1,215**	**2,275**	**3,785**
Toll revenues	0	0	0	430	1,215	2,275	3,785
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**0**	**0**	**0**	**-832**	**-874**	**-1,906**	**-964**
Maintenance & Overhaul	0	0	0	-820	-861	-1,892	-949
Operation	0	0	0	-13	-13	-14	-15
Net Cash Flows due to Operations	**0**	**0**	**0**	**-403**	**341**	**369**	**2,821**
Cash Flows due to Investments	**-13,230**	**-14,107**	**-11,932**	**0**	**0**	**0**	**0**
Initial CAPEX	-13,230	-14,107	-11,932	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**-13,230**	**-14,107**	**-11,932**	**-403**	**341**	**369**	**2,821**
Financial benefits	0	0	0	430	1,215	2,275	3,785
Financial costs	13,230	14,107	11,932	832	874	1,906	964
Financial Benefit/Cost ratio							
Financial Benefit/Cost ratio							

GOVERNMENT CASH FLOWS (Cr BDT)	2032 Year 6	2033 Year 7	2034 Year 8	2035 Year 9	2036 Year 10	2037 Year 11	2038 Year 12
Outflows	**-13,230**	**-14,107**	**-11,932**	**-4,341**	**-4,330**	**-5,309**	**-4,313**
Project Development (Initial CAPEX)	-12,403	-13,023	-10,635	0	0	0	0
Financing Fees	-827	-1,085	-1,297	0	0	0	0
Operating expenses	0	0	0	-832	-874	-1,906	-964
Loan Repayments							
Interest	0	0	0	-1,991	-1,938	-1,885	-1,832
Principal Repayments	0	0	0	-1,517	-1,517	-1,517	-1,517
Inflows	**10,709**	**11,586**	**9,971**	**430**	**1,215**	**2,275**	**3,785**
Borrowings	10,709	11,586	9,971	0	0	0	0
Operating revenues	0	0	0	430	1,215	2,275	3,785
Future Developments	0	0	0	0	0	0	0
Government cash flows	**-2,521**	**-2,521**	**-1,961**	**-3,912**	**-3,115**	**-3,034**	**-528**

BHOLA - LAKSHMIPUR

	2039 Year 13	2040 Year 14	2041 Year 15	2042 Year 16	2043 Year 17	2044 Year 18	2045 Year 19
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	1.80	1.89	1.98	2.08	2.18	2.29	2.41

PROJECT CASH FLOWS (Cr BDT)	2039 Year 13	2040 Year 14	2041 Year 15	2042 Year 16	2043 Year 17	2044 Year 18	2045 Year 19
Operating revenues	**4,451**	**5,206**	**6,059**	**7,021**	**8,102**	**9,313**	**10,204**
Toll revenues	4,451	5,206	6,059	7,021	8,102	9,313	10,204
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-1,012**	**-2,207**	**-1,115**	**-1,171**	**-2,554**	**-1,455**	**-1,356**
Maintenance & Overhaul	-996	-2,190	-1,098	-1,153	-2,536	-1,436	-1,335
Operation	-16	-16	-17	-18	-19	-20	-21
Net Cash Flows due to Operations	**3,439**	**2,999**	**4,944**	**5,850**	**5,547**	**7,857**	**8,848**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**3,439**	**2,999**	**4,944**	**5,850**	**5,547**	**7,857**	**8,848**
Financial benefits	4,451	5,206	6,059	7,021	8,102	9,313	10,204
Financial costs	1,012	2,207	1,115	1,171	2,554	1,455	1,356
Financial Benefit/Cost ratio							
Financial Benefit/Cost ratio							

GOVERNMENT CASH FLOWS (Cr BDT)	2039 Year 13	2040 Year 14	2041 Year 15	2042 Year 16	2043 Year 17	2044 Year 18	2045 Year 19
Outflows	**-4,308**	**-5,450**	**-4,306**	**-4,308**	**-5,638**	**-4,486**	**-4,334**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-1,012	-2,207	-1,115	-1,171	-2,554	-1,455	-1,356
Loan Repayments							
Interest	-1,779	-1,726	-1,673	-1,620	-1,567	-1,514	-1,460
Principal Repayments	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517
Inflows	**4,451**	**5,206**	**6,059**	**7,021**	**8,102**	**9,313**	**10,204**
Borrowings	0	0	0	0	0	0	0
Operating revenues	4,451	5,206	6,059	7,021	8,102	9,313	10,204
Future Developments	0	0	0	0	0	0	0
Government cash flows	**143**	**-244**	**1,754**	**2,713**	**2,463**	**4,827**	**5,870**

BHOLA - LAKSHMIPUR

	2046 Year 20	2047 Year 21	2048 Year 22	2049 Year 23	2050 Year 24	2051 Year 25	2052 Year 26
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	2.53	2.65	2.79	2.93	3.07	3.23	3.39

PROJECT CASH FLOWS (Cr BDT)	2046 Year 20	2047 Year 21	2048 Year 22	2049 Year 23	2050 Year 24	2051 Year 25	2052 Year 26
Operating revenues	**11,164**	**12,198**	**13,310**	**14,504**	**15,786**	**17,161**	**18,634**
Toll revenues	11,164	12,198	13,310	14,504	15,786	17,161	18,634
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-2,957**	**-1,495**	**-1,570**	**-9,287**	**-1,730**	**-1,817**	**-3,963**
Maintenance & Overhaul	-2,935	-1,472	-1,545	-9,262	-1,704	-1,789	-3,933
Operation	-22	-23	-24	-25	-27	-28	-29
Net Cash Flows due to Operations	**8,207**	**10,703**	**11,740**	**5,217**	**14,056**	**15,344**	**14,671**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**8,207**	**10,703**	**11,740**	**5,217**	**14,056**	**15,344**	**14,671**
Financial benefits	11,164	12,198	13,310	14,504	15,786	17,161	18,634
Financial costs	2,957	1,495	1,570	9,287	1,730	1,817	3,963
Financial Benefit/Cost ratio							
Financial Benefit/Cost ratio							

GOVERNMENT CASH FLOWS (Cr BDT)	2046 Year 20	2047 Year 21	2048 Year 22	2049 Year 23	2050 Year 24	2051 Year 25	2052 Year 26
Outflows	**-5,882**	**-4,366**	**-4,388**	**-12,052**	**-4,443**	**-4,476**	**-6,569**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-2,957	-1,495	-1,570	-9,287	-1,730	-1,817	-3,963
Loan Repayments							
Interest	-1,407	-1,354	-1,301	-1,248	-1,195	-1,142	-1,089
Principal Repayments	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517
Inflows	**11,164**	**12,198**	**13,310**	**14,504**	**15,786**	**17,161**	**18,634**
Borrowings	0	0	0	0	0	0	0
Operating revenues	11,164	12,198	13,310	14,504	15,786	17,161	18,634
Future Developments	0	0	0	0	0	0	0
Government cash flows	**5,282**	**7,831**	**8,922**	**2,452**	**11,344**	**12,685**	**12,065**

BHOLA - LAKSHMIPUR

	2053 Year 27	2054 Year 28	2055 Year 29	2056 Year 30	2057 Year 31	2058 Year 32	2059 Year 33
Construction period	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1
Price indexation	3.56	3.73	3.92	4.12	4.32	4.54	4.76

PROJECT CASH FLOWS (Cr BDT)	2053 Year 27	2054 Year 28	2055 Year 29	2056 Year 30	2057 Year 31	2058 Year 32	2059 Year 33
Operating revenues	**20,211**	**21,898**	**23,681**	**25,584**	**27,612**	**29,773**	**32,073**
Toll revenues	20,211	21,898	23,681	25,584	27,612	29,773	32,073
Other commercial revenues	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-2,003**	**-2,371**	**-4,587**	**-2,319**	**-2,435**	**-5,311**	**-12,236**
Maintenance & Overhaul	-1,972	-2,338	-4,553	-2,283	-2,397	-5,271	-12,195
Operation	-31	-32	-34	-36	-37	-39	-41
Net Cash Flows due to Operations	**18,208**	**19,527**	**19,094**	**23,265**	**25,177**	**24,462**	**19,837**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0
Project cash flows	**18,208**	**19,527**	**19,094**	**23,265**	**25,177**	**24,462**	**19,837**
Financial benefits	20,211	21,898	23,681	25,584	27,612	29,773	32,073
Financial costs	2,003	2,371	4,587	2,319	2,435	5,311	12,236
Financial Benefit/Cost ratio							
Financial Benefit/Cost ratio							

GOVERNMENT CASH FLOWS (Cr BDT)	2053 Year 27	2054 Year 28	2055 Year 29	2056 Year 30	2057 Year 31	2058 Year 32	2059 Year 33
Outflows	**-4,556**	**-4,870**	**-7,034**	**-4,713**	**-4,775**	**-7,598**	**-14,470**
Project Development (Initial CAPEX)	0	0	0	0	0	0	0
Financing Fees	0	0	0	0	0	0	0
Operating expenses	-2,003	-2,371	-4,587	-2,319	-2,435	-5,311	-12,236
Loan Repayments							
Interest	-1,036	-982	-929	-876	-823	-770	-717
Principal Repayments	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517	-1,517
Inflows	**20,211**	**21,898**	**23,681**	**25,584**	**27,612**	**29,773**	**32,073**
Borrowings	0	0	0	0	0	0	0
Operating revenues	20,211	21,898	23,681	25,584	27,612	29,773	32,073
Future Developments	0	0	0	0	0	0	0
Government cash flows	**15,655**	**17,027**	**16,647**	**20,871**	**22,837**	**22,175**	**17,603**

BHOLA - LAKSHMIPUR

	2060 Year 34	2061 Year 35	2062 Year 36	2063 Year 37	2064 Year 38
Construction period	0	0	0	0	0
Operation period	1	1	1	1	1
Term of analysis	1	1	1	1	1
Price indexation	5.00	5.25	5.52	5.79	6.08

PROJECT CASH FLOWS (Cr BDT)	2060 Year 34	2061 Year 35	2062 Year 36	2063 Year 37	2064 Year 38
Operating revenues	**34,521**	**37,123**	**39,889**	**42,827**	**45,945**
Toll revenues	34,521	37,123	39,889	42,827	45,945
Other commercial revenues	0	0	0	0	0
Operation & Maintenance expenses	**-2,819**	**-6,148**	**-3,108**	**-3,263**	**-7,552**
Maintenance & Overhaul	-2,775	-6,102	-3,060	-3,213	-7,499
Operation	-43	-46	-48	-50	-53
Net Cash Flows due to Operations	**31,702**	**30,976**	**36,782**	**39,564**	**38,394**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**1,220**
Initial CAPEX	0	0	0	0	0
Other CAPEX	0	0	0	0	0
Residual Value of Investments	0	0	0	0	1,220
Project cash flows	**31,702**	**30,976**	**36,782**	**39,564**	**39,613**
Financial benefits	34,521	37,123	39,889	42,827	45,945
Financial costs	2,819	6,148	3,108	3,263	6,332
Financial Benefit/Cost ratio					
Financial Benefit/Cost ratio					

GOVERNMENT CASH FLOWS (Cr BDT)	2060 Year 34	2061 Year 35	2062 Year 36	2063 Year 37	2064 Year 38
Outflows	**-5,000**	**-8,276**	**-5,183**	**-5,285**	**-9,521**
Project Development (Initial CAPEX)	0	0	0	0	0
Financing Fees	0	0	0	0	0
Operating expenses	-2,819	-6,148	-3,108	-3,263	-7,552
Loan Repayments					
Interest	-664	-611	-558	-505	-451
Principal Repayments	-1,517	-1,517	-1,517	-1,517	-1,517
Inflows	**34,521**	**37,123**	**39,889**	**42,827**	**45,945**
Borrowings	0	0	0	0	0
Operating revenues	34,521	37,123	39,889	42,827	45,945
Future Developments	0	0	0	0	0
Government cash flows	**29,521**	**28,848**	**34,707**	**37,542**	**36,425**