FINAL FEASIBILITY STUDY REPORT

Volume 0. Executive Summary

REVIEW OF FEASIBILITY STUDY FOR CONSTRUCTION OF BHOLA BRIDGE ON BARISHAL-BHOLA ROAD OVER KALABADOR AND TENTULIA RIVER

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

April 2024

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

REVIEW OF FEASIBILITY STUDY FOR CONSTRUCTION OF BHOLA BRIDGE ON BARISHAL-BHOLA ROAD OVER KALABADOR AND TENTULIA RIVER

VOLUME 0
EXECUTIVE SUMMARY

VOLUME 1
MAIN REPORT

VOLUME 2
HYDROLOGICAL & MORPHOLOGICAL MATHEMATICAL MODELLING STUDY

VOLUME 3
GEOTECHNICAL INVESTIGATION

VOLUME 4
TRAFFIC STUDY REPORT

VOLUME 5
TECHNICAL REPORT

VOLUME 6
PRELIMINARY DESIGN DRAWINGS

VOLUME 7
LAND ACQUISITION PLAN

VOLUME 8
RESETTLEMENT ACTION PLAN

VOLUME 9
ENVIRONMENTAL ASSESSMENT PLAN

VOLUME 10
MISCELLANEOUS

VOLUME 11
COST ESTIMATION

VOLUME 12
ECONOMIC AND FINANCIAL ANALYSISI

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DOCUMENT	**REVIEW OF FEASIBILITY STUDY FOR CONSTRUCTION OF BHOLA BRIDGE ON BARISHAL-BHOLA ROAD OVER KALABADOR AND TENTULIA RIVER. FINAL REPORT VOLUME 0-EXECUTIVE SUMMARY**			
PROJECT	TR8138-MASTER PLAN BBA			
CODE	TR8138-JV-FS-G103-RP-000001-FFS_Vol0-D02			
AUTHORS:	Signed:	JV		
	Date:	20/03/2024		
VERIFIED	Signed:	MCP	JSJ	JLY
	Date:	04/04/2024	04/04/2024	04/04/2024
RECIPIENT	Bangladesh Bridge Authority (BBA)			
NOTES	Document created by the Joint Venture formed by TYPSA-DOHWA-NIPPON KOEI-DDC-BCL-DEVCON			

Control of Versions

VERSION	CONTROL OF CHANGES
1	First Submission
2	Second Submission

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Contents

List of Volumes

VOLUME 0: Executive Summary

VOLUME 1: Main Report

VOLUME 2: Hydrological and Morphological Mathematical Modelling Study

VOLUME 3: Geotechnical Investigation along Proposed Bridge Alignment

VOLUME 4: Traffic Study Report

VOLUME 5: Preliminary Technical Report

VOLUME 6: Preliminary Design Drawings

VOLUME 7: Land Acquisition Plan

VOLUME 8: Resettlement Action Plan

VOLUME 9: Environmental Assessment Plan

VOLUME 10: Miscellaneous

VOLUME 11: Cost Estimate (BOQ)

VOLUME 12. Economic and Financial Analysis

SANCHEZ JIMENEZ JOSE LUIS
Team leader

List of Figures

SANCHEZ JIMENEZ JOSE LUIS
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List of Tables

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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 (currency)
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
HGV	Heavy Goods Vehicle
HH	Household
IEE	Initial Environmental Examination
IFC	International Finance Corporation
INGO	International Non-Governmental Organization
IoL	Inventory of Losses
IRC	Indian Road Congress

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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
LPV	Light Passenger Vehicle
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
SM	Silty Sand
SP	Poorly Graded Sand
SRD	Social Rate of Discount
TAC	Technical Advisory Committee
ToR	Terms of Reference
USD	United States Dollar
VAT	Value Added Tax
VfM	Value for Money
VGF	Viability Gap Financing
WACC	Weighted Average Cost of Capital
WB	World Bank
WL	Water Level

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Executive Summary

Summary of Key Findings and Recommendations of the Feasibility Study

(Final Report – April 2024)

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1. PROJECT BASIC INFORMATION

Table 1.Basic Information

1.	Name of the Project	:	FEASIBILITY STUDY FOR CONSTRUCTION OF BRIDGE OVER THE RIVER KALABADOR AND TENTULIA AT BARISHAL AND BHOLA DISTRICTS
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 feasibility of a bridge and related infrastructures connecting Barishal to Bhola crossing Kalabador, Tentulia and Arial Khan Rivers. The analysis includes technical, socio-economic, financial, and environmental aspects
4.	Estimated project Cost. (Taka in Crore)	:	Estimated project Cost. 17,466.32 Cr BDT
5.	Sector & Sub-Sector	:	Transport Sector / Bridges Infrastructures
6.	Project Category (Based on Environment Conservation Rules 1997)	:	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: Barishal District: Barishal and Bhola Upazila: Barishal Sadar and Bhola Sadar
8.	Project Duration	:	Investment Period: 8Y – 2025/2032 Construction Period: 6.5Y (78 months) Operation Period: 30 Y – 2033/2062
9.	Previous Feasibility Study by BBA		March 2020 by Consultant Joint Venture of STUP Consultants Pvt. Ltd., India; COWI UK Limited, UK; DDC Ltd. and Dev Consultants Ltd., Bangladesh

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2. INTRODUCTION

2.1. Background

Aiming to boost up the economy of every corner of Bangladesh equally, a roadmap and Master Plan of transport connectivity is being established by Bangladesh Bridge Authority. In response to a long felt need for easy and quick communication among the major cities of Bangladesh, the Master Plan includes the design and construction of several bridges. Among them, one of the most important bridges is the one that would connect Barishal with the island of Bhola, crossing the Kalabador, Tentulia and Arial Khan rivers system located at Barishal and Bhola districts.

The Bhola Island, with an area of 3,400 sq.km and a population of over 20 lakhs, which is situated on the eastern side of Barishal Division, does not have any vehicular connectivity with mainland Barishal. The opening of Padma bridge in 2022 was a key breakthrough in terms of connectivity from Bhola and Barishal to the capital Dhaka. However, Bhola island is still 247 km away by road without a direct connection to mainland. A distance of about 195 km separates the area from Dhaka by waterways.

To connect with mainland, there is currently only one ferry crossing from N-809 Barishal to Bhola Island. Almost all people and goods transportation to and from mainland take place by boats and launches. This fact has undoubtedly affected the social and economic development of the population of Bhola Island.

Aiming to solve and mitigate this problem, Bangladesh Bridge Authority (BBA) engaged the preparation of the feasibility study for the construction of a bridge over the Tentulia river at a suitable location to connect Bhola with mainland. A previous FS was carried out in March 2020 by the JV / STUP Consultants Pvt. Ltd., India; COWI UK Ltd, UK; DDC Ltd. and Dev Consultants Ltd., Bangladesh.

Later, on May 20th ,2021, TYPSA was engaged to carry out the **Feasibility Study for Construction of Bridges over the river Meghna on Shariatpur-Chandpur Road and Gazaria-Munshiganj road and the preparation of Master Plan for Bangladesh Bridge Authority.**

On June 7th, 2022, the BBA communicated via Memo No.: 50.01.0000.671.99.004.21-98 the extension of the assigned scope to the Consultant team, TYPSA and JV partners, including **the review of the previous Feasibility Study for the bridge connecting Barishal with the island of Bhola, crossing the Kalabador and Tentulia rivers at Barishal and Bhola districts**.

This review entailed a complete study including all involved disciplines, it specially focused on the updated hydro-morphological river conditions and the suitability of the selected site and engineering technical selected solution. This area of Bangladesh, lower Meghna River, is particularly prone to severe erosion effects, harsh weather conditions including cyclones and important floodings, that plenty justify the review of the previous study and assumptions taken some years ago.

On July 20th, 2023, the Consultant submitted the Draft Final Report (DFR) and a TAC meeting was held on August 30th, 2023 (TAC No.12). After this meeting, some comments and recommendations were

received from the Client and from the Technical Advisory Members which were incorporated in the Final Report submitted on October 30th, 2023.

The present Executive Summary includes the outcome of the study carried out by the Consultant, at the final stage of the feasibility study and after implementing the comments received during the Final Report stage and the TAC No. 16 meeting held on March 04th, 2024.

2.2. Project Location

At the eastern side, the proposed bridge connects **at Laharhat of Barishal Sadar Upazila of Barishal District** and, at the western side; it connects Veduriya of **Bhola Sadar Upazila of Bhola District**.

Figure 1. Location of the proposed bridge (Barishal Division)

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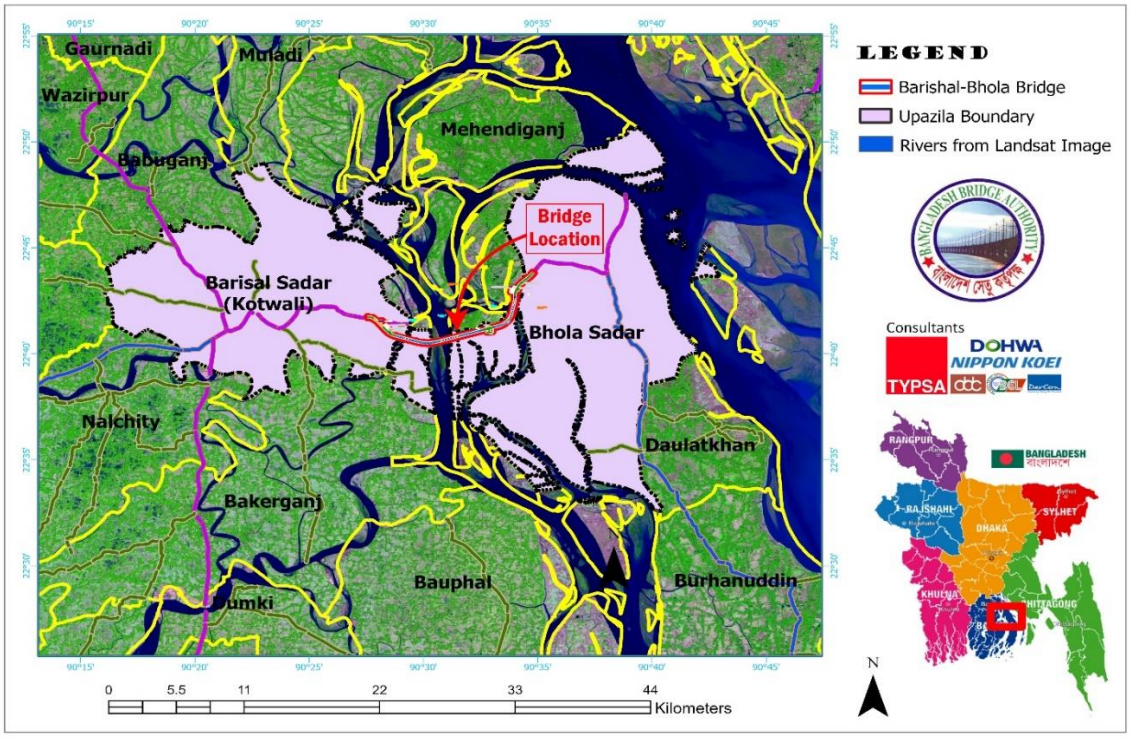

Figure 2. Bhola Sadar and Barishal Sadar Upazilas Location

- **Barishal Sadar Upazila**

Barishal Sadar Upazila is a significant administrative division located in Barishal District of Bangladesh. This Upazila is geographically positioned between 22°45' and 22°47' North latitude and 90°18' and 90°22' East longitude and situated on the northern bank of the Kirtonkhola River. It covers an area of 256.45 sq km, consisting of both urban and rural areas with a total population of 656,550 and households 114,774. The population density is 831 per sq km. The Upazila is well connected to the rest of the country through a network of roads and waterways. Barishal Sadar has a bustling river port, facilitating trade and transportation along the Kirtonkhola River.

- **Bhola Sadar Upazila**

Bhola Sadar is an Upazila of Bhola District in the Barishal Division, Bangladesh, which is located at 22.685409 N 90.643873 E. It has a total area of 413.16 sq km. It is bounded by Mehendiganj and Lakshmipur Sadar Upazila of the north, Bauphal and Burhanuddin Upazilas on the south, Daulatkhan Upazila on the east, Barisal Sadar, Mehendiganj and Bakerganj Upazilas on the West. According to the 2022 Bangladesh census, Bhola Sadar Upazila has 91,124 households and a population of 444,835, 21.5% of whom lived in urban areas. 12.6% of the population was under the age of 5.

The Upazila is characterized by its fertile agricultural land, with farming being the primary occupation of the local population. Major crops cultivated in Bhola Sadar include paddy, jute, wheat, mustard, and various vegetables. The region also has a significant presence of shrimp farming and fishing activities, capitalizing on its proximity to the Bay of Bengal.

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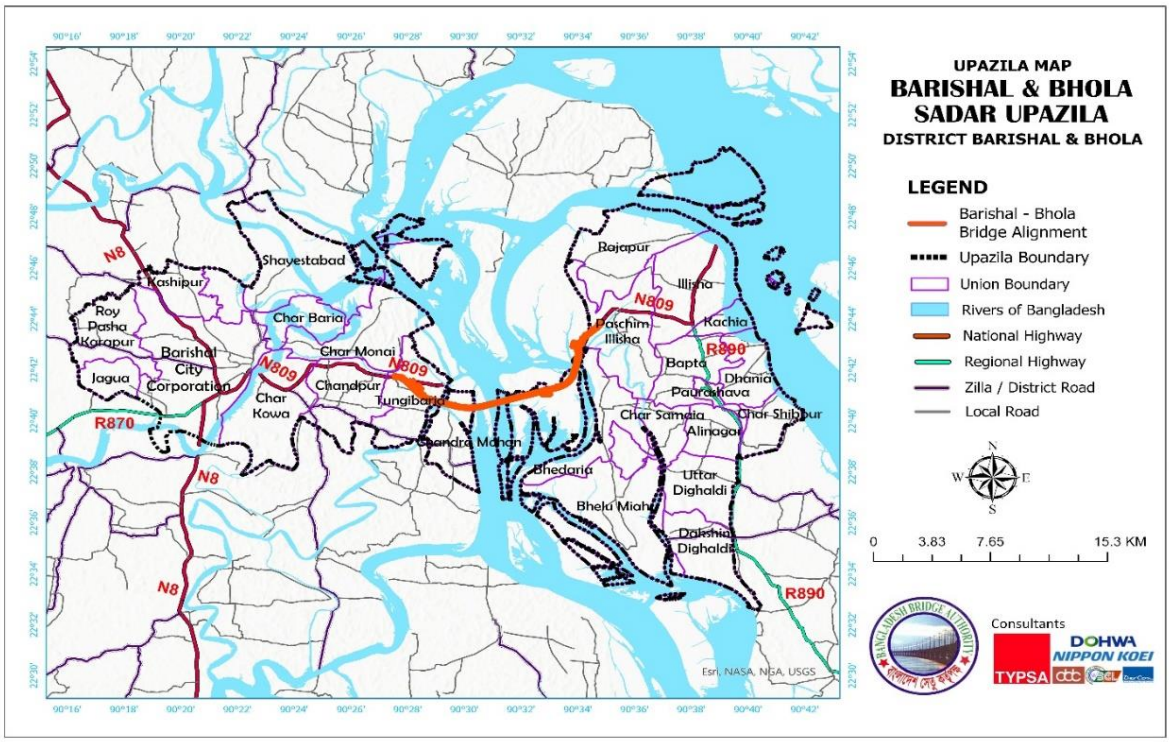

Figure 3. Barishal and Bhola Sadar Upazilas

Figure 4. Image of the proposed bridge over the Kalabador and Tentulia rivers

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Figure 5. Proposed accessing bridges at Barishal side.

2.3. Objectives of the assignment

The objective of this project is to implement a Feasibility Study for the construction of Barishal-Bhola Bridge over the Kalabador and Tentulia Rivers. The assignment also includes the review of the previous Feasibility Study carried out by another Consultant team back in 2020.

The objectives of this study are as follows:

- Find the most suitable location for the bridges out of an alignment multicriteria analysis.
- Identify and propose the optimum engineering solution suitable for the crossing.
- Assess socio-economic status of the area.
- Carry out data collection and field investigations needed to pre-design the selected solution.
- Evaluate technical, social, environmental, economic, and financial viability of the project.
- Recommend the mode of procurement.
- Carry out preliminary design of the bridges and associated facilities.
- Carry out preliminary cost estimate of the bridges and associated facilities.
- Provide a sound conclusion to the Client regarding the viability of the project.

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2.4. Methodology

The assignment has been completed following the scope provided by BBA in Contractual Terms of Reference (ToR).

The specified scope of services for the consultancy assignment consisted of all necessary survey, investigation, planning, design, and documentation necessary for the development of the Feasibility Study of the bridge.

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

- Compilation, analysis and review of previous reports, studies, preliminary or detailed designs referred to the current feasibility study.
- Review available traffic count data and other 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.
- 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.
- Detailed Hydro-morphological study of the river flow characteristics using Mathematical Modelling.
- Determination of the 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).
- Pavement Design for trunk road an auxiliary road.
- Structural Design. Comparative study for investment cost and O-M cost and alternatives study.
- Alternatives investment budget.
- Economic and financial evaluation (30-year benefit stream period).
- Estimate the expected distribution of the project net benefits, based on economic analysis.
- Considering the economic evaluation, social benefits, and environmental impact, recommend the most suitable improvement option for each project road section.
- Undertake sensitive tests for the recommended improvements by appropriately varying benefits, project costs, maintenance costs, and the implementation period.
- Initial Social impact Analysis.
- Public meetings and dialogue with the communities in the project areas.
- Initial environmental examinations (IEE) and Environmental Impact Assessment.
- Resettlement Action Plan (RAP).
- Preparation of Land Acquisition Plans.
- Determination of appropriate construction method, configuration and technology.

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2.5. Key Findings - Salient Features

Table 2. Summary of Project's Findings Salient Figures

Main salient features of Barishal Bhola Bridge		
Main alignment length	Road and bridge	16,367 m
Total bridge length		10,867 m
Balance Cantilever Bridge	Length	(West-East) 420 – 1420 – 1220 m
	Main span	200 m
	Back spans	110 m
	Width of the section	20.25 m
Approach bridge	Length	1,200 m
	Barishal side	600 m
	Bhola side	600 m
	Width of the section	20.25 m
Connecting Spans	Length	(West-East) 2396 – 4211 m
	Width of the section	20.25 m
Approach road	Total length	5,500 m
	Barishal side	2,900 m
	Bhola side	2,600 m
	Total road width	39.5 m
	Main road (2+2-Lane Carriageway)	7.30 m = 2 x 3.65 m
	Service road (both sides)	5.50 m
Elevated Structure	Barishal side	360 m long crossing over the exiting road (From Ch 0+820 to Ch 1+180)
Small bridges		
	Barishal side	40 m long (Ch 0+100)
	Bhola side	48 m long (Ch 14+800) 48 m long (Ch 15+400)
Culverts		Total: 9 nos (1 Vent- 3.00 mx3.00 m)
	Barishal side	6 nos (1 Vent- 3.00 mx3.00 m) (Ch 0+510; Ch 0+725; Ch 0+890; Ch 1+270; Ch 1+785; Ch 1+990)

Main salient features of Barishal Bhola Bridge		
	Bhola side	3 Nos (1 Vent- 3.00 mx3.00 m) (Ch 14+515; Ch 15+055; Ch 16+100)
Toll Plaza		7 Nos booth each side = Total 14 nos (+ Future extendable 3 nos each side)
Weighing scale		1 No each side = Total 2 nos 4 nos Weigh bridge each side (+ Future extendable 2 nos each side)
Engineer's Facilities Service Area		1 No each side = Total 2 nos 2 x 28,97 = 57.94 acres
Construction Yard		
	Permanent Construction Yard 1	Barishal side (37.8 acres)
	Permanent Construction Yard 2 (	Bhola side (20 acres)
	Temporary Construction Yard-1 (	Barishal side (11.2 acres)
	Temporary Construction Yard-2	Char land (12 acres)
	Temporary Stacking Yard	Bhola side (10 acres)
River training works	Total length	18,075 m
	At Laharhat	2,000 m
	At Loraipur	6,450 m
	At Veduriya	2,000 m
	At Sreepur	8,300 m
Land Acquisition		
Right of Way	Width of (ROW)	69.5 m
	Total affected land	507.50 acres
	Barishal side	407.82 acres
	Bhola side	99.67 acres
	Total number of HHs affected by structure	373 Nos

Main salient features of Barishal Bhola Bridge		
	Barishal side	277
	Bhola side	96
	Total number of persons affected	1,406 Nos
	Barishal side	1,030
	Bhola side	376
	Resettlement area	1 No each side = Total 2 Nos 2 x 5 = 10 acre

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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 analyzed hereinafter:

3.1. Problem Statement

The existing improvement to be addressed by this feasibility study is mainly the lack of adequate infrastructure for efficient river crossing between both sides of the proposed project at Barishal District. Whilst the existing ferry service covers part of the need for connectivity, it does in a manner and timing that, for the population living on both sides of the Kalabador and Tentulia rivers, and within Sreepur char land necessarily shall be enhanced. Moreover, this bridge shall be understood and justified, not only as an improvement in the connectivity conditions between the Bhola Island and mainland Barishal, Dhaka and rest of the country, but also as the first leg of a very large East-West corridor crossing the lower Meghna, connecting Barishal to Lakshmipur and the entire Chattogram Division territories.

The matter to be addressed relates to some direct causes:

- Lack of bridge in the zone under study: Currently, only the Ferry Service is enabling to cross the Kalabador and Tentulia River. This is undoubtedly insufficient to meet the currently growing population and the needs of the population, especially living on the Bhola side (healthcare, higher education, business promotion).
- 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 to 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 for understanding the need of the project is analyzing the consequences of a lack of this infrastructure:

- The lack of efficient transportation and connectivity can limit trade, investment, and overall economic growth in the region. The isolation and remoteness conditions of part of the population living in the area.

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- Limited transportation infrastructure can prevent residents from accessing essential services such as healthcare, education, and emergency services, ultimately impacting their quality of life.
- Without the bridge, existing means for crossings will become more congested, leading to longer travel times.
- Limited access to opportunities and services can exacerbate social inequalities, with disadvantaged groups being disproportionately affected.

3.2. Relevance of the Project Idea

Due to the lack of existing bridge in the Barishal-Bhola area, the people living in both sides of the river, normally use ferry service, engine boats and trawler services for crossing the river and transporting of goods and persons.

For these reasons, the construction of a bridge, at the crossing point, would have a very positive impact on local and regional levels, integrating the outlaying Upazilas with the mainland districts. This project will also be deemed to be a component of a broader transportation enhancement approach, together with other initiatives under study.

The list of benefits of the bridge as a need to improve the lack of infrastructure:

- Remote areas connectivity: Bhola Island, with a population of more than 20 lac, is in a remote region of Bangladesh. A bridge in this area would facilitate the movement of people, goods, and services across this major river system, which is subject to very harsh weather conditions during several periods of the year (disaster resilience: Bangladesh is prone to natural disasters such as flooding and cyclones. Improved infrastructure, such as the proposed new bridge, can enhance the region's resilience to these events by providing better access to essential services and support during emergencies).
- Economic development: Barishal and Bhola is an important center for the fishing industry, agriculture, and trade. Bhola is rich in natural gas resources and oil prospections are ongoing. Building a bridge in this region can further stimulate economic growth by improving access to markets and resources, creating new business opportunities, and attracting investment.
- Population density: Both Barishal Sadar and Bhola Sadar subdistricts have a significant population, which is expected to grow in the coming years. A bridge would help meet the increasing transportation demands of the growing population and contribute to improved quality of life for residents (ease of access to high education and healthcare).
- This bridge, as a first piece of a larger corridor to Lakshmipur, would boost the Bangladesh E-W corridor: The bridge would enhance connectivity between those areas and would foster the international transborder corridor. This would enable more efficient transportation and support the development of these regions.

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- Additionally, as shown in the image below, with the proposed configuration of the bridge and the addition of a ramp at the suitable location of the Sreepur Char Land, the access from ground level is enable with the huge benefits for the existing population living in the Char.

Figure 6. Image of the proposed bridge connection at Sreepur char land

3.3. Proposed Project Interventions

The Project implementation would need not only the address main intervention which is the construction of the main infrastructure (main bridge and accessing bridges totalling 10,867 m), but as it is explained within the technical features section, the construction of 5,500 m 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

- Ministry of Road Transport and Bridges: Responsible for overseeing the planning, implementation, and maintenance of transportation infrastructure projects in Bangladesh.
- Local Government authorities: Barishal district administrations would be involved in coordinating and facilitating the project at the local level.
- Bangladesh Water Development Board (BWDB): Responsible of the overseeing and coordination of the river training works.
- LGED: Local roads network authority.
- Road Transport and Highways Division: responsible for roads and highways.

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- The Roads and Highways Department (RHD): an agency of the Government of Bangladesh responsible for the construction and maintenance of highways and bridges across Bangladesh. The Department is a subsidiary of the Road Transport and Highways Division.
- Bangladesh Fisheries Research Institute, (BFRI): Regulatory agency for Hilsha fish protection
- Bangladesh Power Development Board.
- Bangladesh Telecommunication Company Ltd. (BTCL): Responsible for Telephone and Internet connection and maintenance.
- Palli Bidyut Samity (PBS): Responsible for providing electricity in the rural areas.
- Summit Communications Limited.
- Bahon Limited.
- Gas Transmission Company Limited (GTCL).

3.5. Demand Analysis

A transportation model implemented by the Consultant has been utilized along with data obtained from **242** survey points to analyze the demand. Both the current demand (i.e., demand currently crossing by ferry and speed boats) and projected demand (i.e., demand that would use the bridge if it existed) were evaluated. The task was challenging since the two areas (i.e., Barishal and Bhola) are only connected by one ferry with many informal crossings taking place between the two locations. It should further be mentioned that because of the poor connection between Barishal and Bhola the current traffic is low.

To conduct a thorough economic and financial study, it is necessary to carefully analyze the traffic and 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.

Base Year Demand

It is key to understand the different scenarios that are being analyzed, “with project” and “without project”. The “without project” scenario is the scenario where the bridge would not be built, in this case, there would be no bridge but some roads improvements as well as the currently operating ferry ghat.

- **Scenario Without Barishal-Bhola Bridge Project (without project) (S1):**
  In this scenario, ongoing, future and potential (including an improved corridor along Gazaria - Lakshmipur corridor, Cumilla-Chandpur improvement, Shariatpur-Padma Road improvement, R860 road improvement and accesses to ferry improvements) transport infrastructure developments are considered (as illustrated in the following figure):

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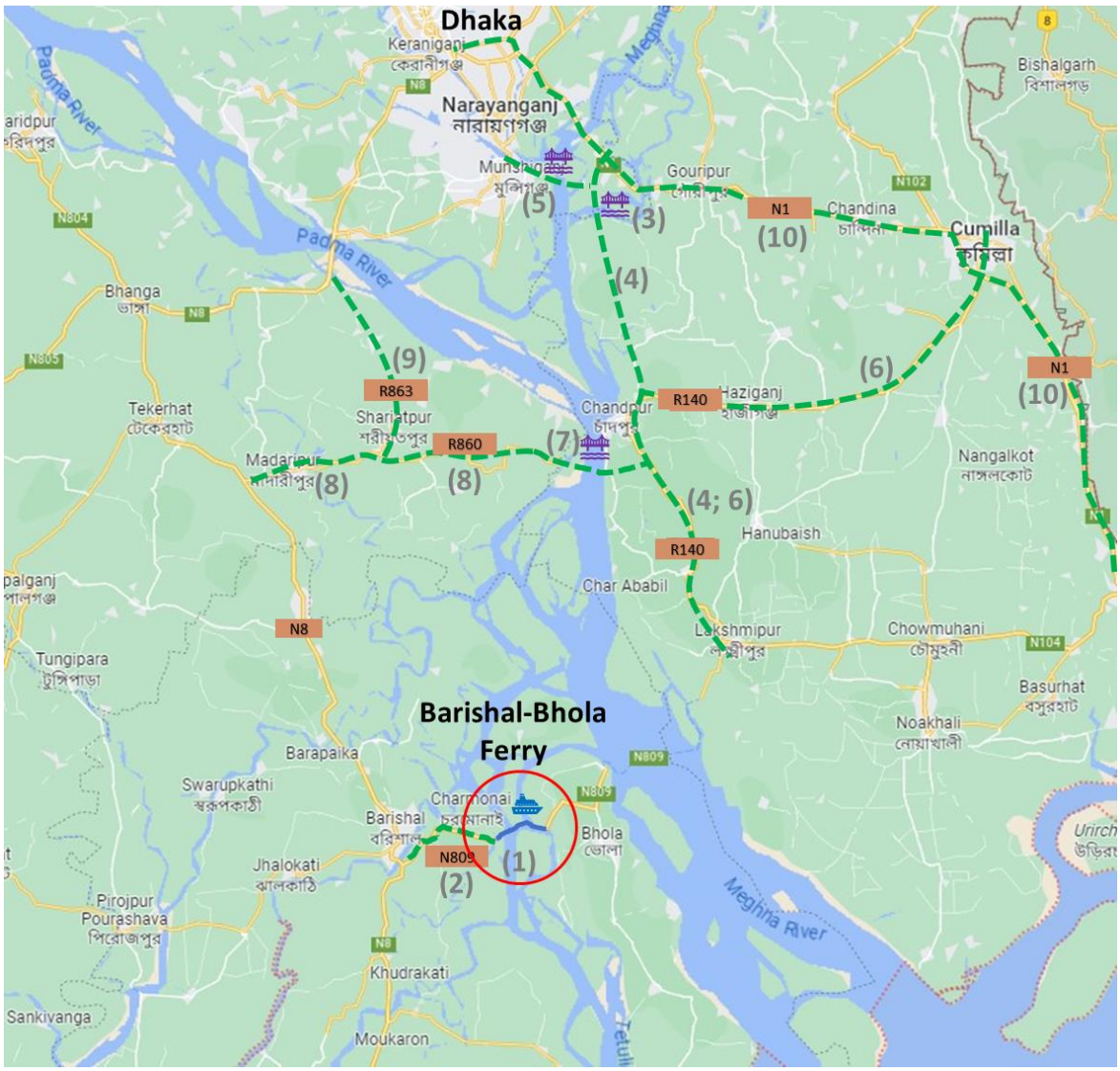

Figure 7: Without Project Scenario (S1)

Without Project Scenario (S1) considers:

1. Barishal-Bhola Ferry Service.
2. Improvement of road N809.
3. Matlab Uttar Bridge.
4. Road corridor Gazaria-Lakshmipur.
5. Gazaria-Mushiganj Bridge.
6. Improvement of R140.
7. Shariatpur-Chandpur Bridge.
8. Improvement of R860.
9. Improvement of R863.
10. Improvement of N1.

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It is not included: Barishal-Bhola Bridge.

As a result of the improvements considered within this scenario, trip time and distance are reduced, and more trips are considered.

- **Scenario With Barishal-Bhola Bridge Project (with project) (S2):**
  The *With Barishal-Bhola Bridge Project scenario* is defined as the previous scenario (*S1*) considering the addition of the construction of the Barishal-Bhola Bridge, without the Ferry service. In the following map the "With project scenario" can be seen with the Barishal-Bhola Bridge.

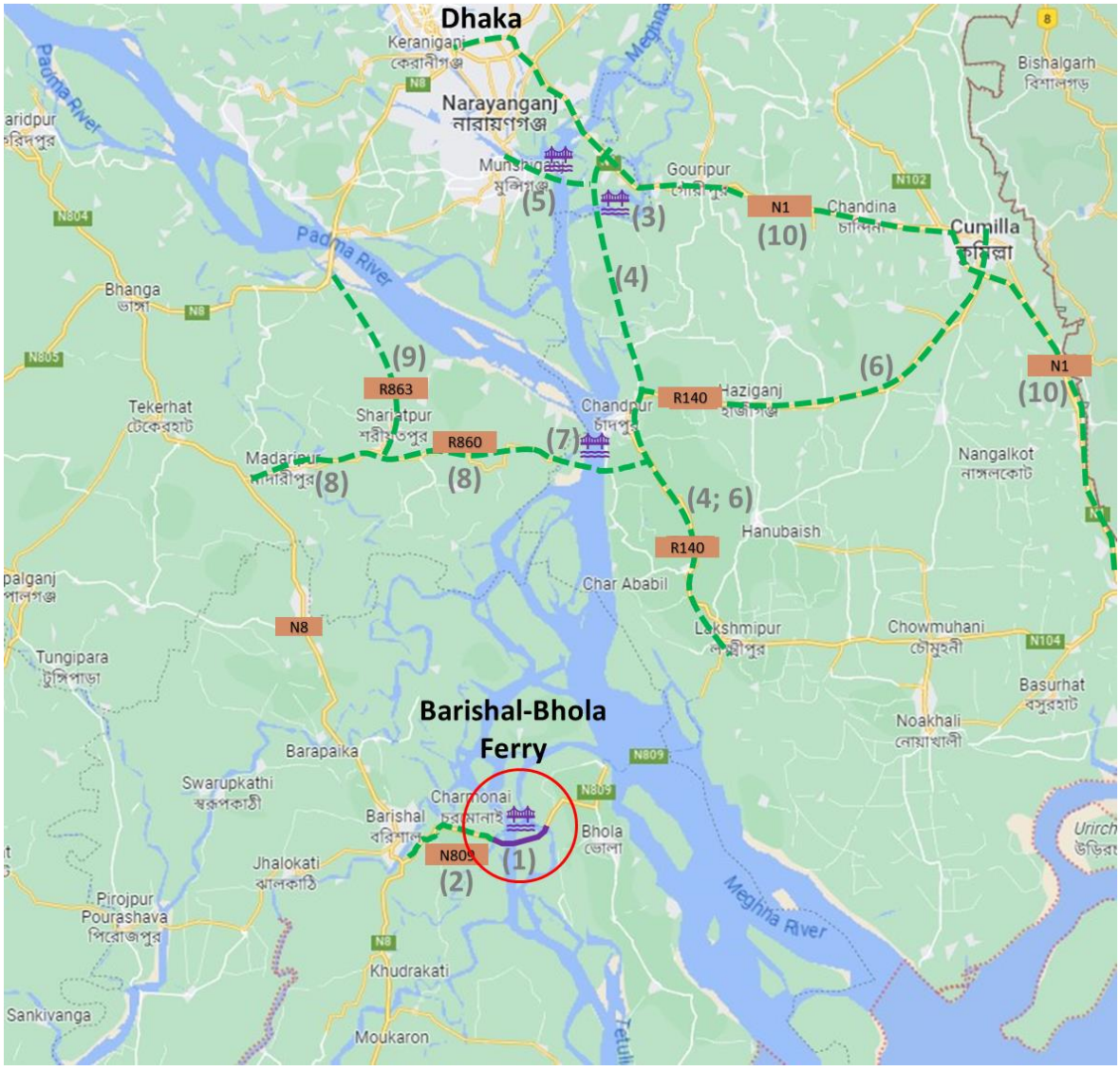

Figure 8: With Project Scenario (S2)

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With Project Scenario (S2) considers:

1. Barishal-Bhola Bridge.
2. Improvement of road N809.
3. Matlab Uttar Bridge.
4. Road corridor Gazaria-Lakshmipur.
5. Gazaria-Mushiganj Bridge.
6. Improvement of R140.
7. Shariatpur-Chandpur Bridge.
8. Improvement of R860.
9. Improvement of R863.
10. Improvement of N1.

It is not included:

1. Barishal-Bhola Ferry Service.

For both the traffic, with and without the project, the Transport Model has been applied in its latest updated version. It is assumed in both scenarios some roads improvements will be carried out.

Regarding the consideration in terms of traffic demand, resulting from the potential future project located nearby and connecting Bhola with Lakshmipur:

The calculated traffic demand has not considered the construction and implementation of the Bhola-Lakshmipur bridge. This approach has been taken due to the following reasons:

- **Conservative approach**: The evaluation of the bridge between Barishal and Bhola in isolation provides a more appropriate conservative approach as it gives an understanding of the movements that have as an origin/destination the island of Bhola, omitting any through traffic that the corridor Barishal-Bhola-Lakshmipur is potentially generating. This conservative scenario has been the most suitable for the economic and financial evaluation of the project.

- **Implementation Timeline**: Considering the implementation timeline, and the fact that a pre-feasibility study (the project shall not be deemed as committed by the GoB) is associated to the Bhola-Lakshmipur project, this has not been considered as implemented in the current study scenario of operation of the Bhola-Barishal Bridge.

In the following image the traffic summary for the base year is presented. "Note that the traffic generated as a result of an additional GDP increment is 0, since there has been no increase in GDP in the base year."

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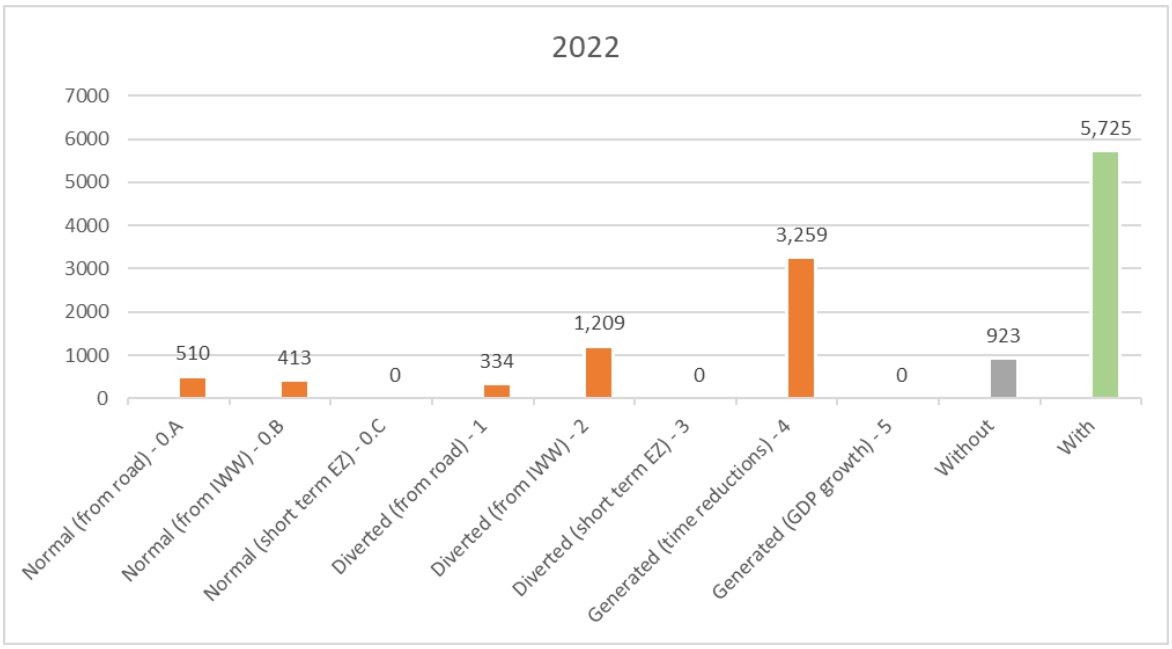

Figure 9. Summary of the base year traffic

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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.

Table 3. Daily traffic volumes (vehs) by kind of traffic

Year	Normal traffic – without project				Diverted			Generated		With project
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	From EZ	Due to time reduction	Due to additional GDP increase	TOTAL
2022	510	413	0	923						
2025	637	516	0	1,153						
2030	933	756	233	1,922						
2033	1,141	925	233	2,299	187	677	51	1,774	7	4,996
2035	1,291	1,046	233	2,570	635	2,297	154	5,826	76	11,558
2040	1,697	1,375	233	3,305	1,113	4,026	205	10,030	368	19,046
2045	2,135	1,730	233	4,098	1,400	5,065	205	12,607	778	24,153

Year	Normal traffic – without project				Diverted			Generated		With project
	Road	IWW	EZ	Total Without Project (Normal traffic)	From road	From IWW	From EZ	Due to time reduction	Due to additional GDP increase	TOTAL
2050	2,589	2,098	233	4,921	1,698	6,143	205	15,271	1,350	29,587
2055	3,044	2,467	233	5,745	1,996	7,223	205	17,948	1,786	34,903
2060	3,487	2,826	233	6,547	2,287	8,275	205	20,562	2,046	39,922
2062	3,659	2,965	233	6,858	2,399	8,682	205	21,574	2,147	41,865

Table 4. Daily traffic volumes (vehs) by type of vehicles

	Without project (normal traffic)					With project				
	M/Cycles	LPV	Buses	Trucks	Total without project	M/Cycles	LPV	Buses	Trucks	Total With project
2022	386	139	74	324	923					
2025	482	173	93	404	1,153					
2030	813	338	179	592	1,922					
2033	970	395	210	725	2,299	2,393	1,208	332	1,064	4,996
2035	1,084	435	232	820	2,570	5,909	3,039	645	1,965	11,558
2040	1,391	546	291	1,077	3,305	9,845	4,988	1,019	3,195	19,046
2045	1,723	665	355	1,355	4,098	12,376	6,283	1,282	4,212	24,153
2050	2,067	789	421	1,644	4,921	15,023	7,643	1,565	5,356	29,587
2055	2,412	913	488	1,933	5,745	17,655	8,990	1,839	6,419	34,903
2060	2,747	1,033	552	2,214	6,547	20,193	10,281	2,095	7,353	39,922
2062	2,877	1,080	577	2,323	6,858	21,175	10,781	2,194	7,715	41,865

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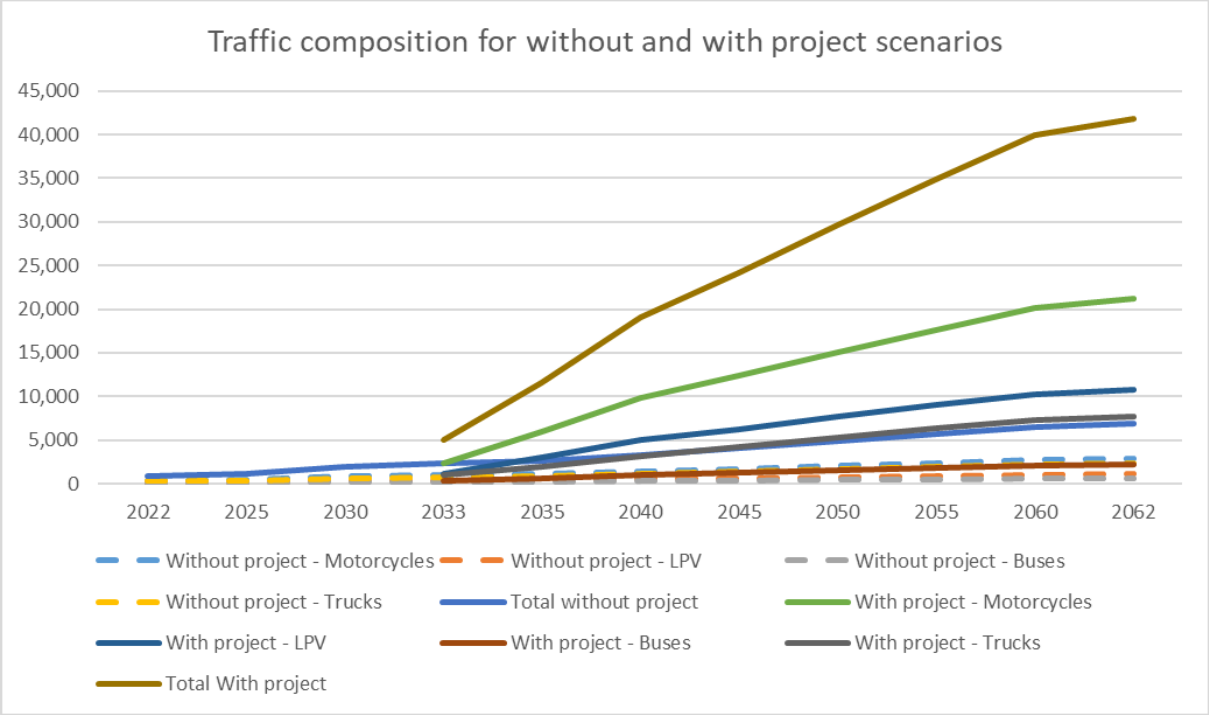

Figure 10. Daily traffic volumes by type of vehicles– Summary

Distance and Time Savings

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

The results are illustrated in the tables below.

Table 5: 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	58.56	87.54	147.43	398.64
With project	18.20	26.47	51.84	104.48
Time Savings	**40.37**	**61.07**	**95.59**	**294.16**

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Table 6: 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	504.15	290.10	59.72	262.58	**1,116.55**
With project	479.62	277.64	53.97	241.31	**1,052.54**
Distance Savings	**24.52**	**12.45**	**5.75**	**21.28**	**64.00**

Constraints

- Some improvements are being made in the transport model considering more social data, these may end in changes in traffic demand forecast.
- The without project scenario is the case where some committed projects are built.

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 7: Project's SWOT

Strengths	Weaknesses
▪ The active participation, willingness, and support of the local government and the citizens involved. ▪ 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 material such as cement, stone, bricks from local market ▪ River transport means that construction materials can be transported at low cost. ▪ The project is attracting interest from potential contractors and funding agencies, and their availability further enhances its prospects for successful implementation.	▪ High-cost financing challenge. ▪ Distance from the capital Dhaka, and distance to some supply of 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. ▪ Tides, salinity and coastal areas can be problems 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 and psychological trauma to affected persons etc. are included.

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Opportunities	Threats
▪ To establish connectivity with the national transport network, particularly in areas that are currently isolated due to the lack of proper road infrastructure. ▪ 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. Ease access to higher healthcare for the population of Bhola. ▪ To facilitate access to high level education (University) for the people of Bhola travelling to Barishal city daily. ▪ To foster sustainable decentralization, regional development, and resilient climate-adaptive practices, promoting long-term growth and resilience in the face of climate change challenges. ▪ To contribute significantly to local economic development, creating employment opportunities for the region. ▪ to distribute Bhola natural gas across the entire country, ensuring its widespread availability and utilization as an essential energy resource.	▪ 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. ▪ The Hilsa protected area poses relevant requirements for the construction process in terms of methods to be used and time restrictions. ▪ Special measures should be taken in construction for tidal, saline, and coastal areas. ▪ 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

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4. TECHNICAL AND ENGINEERING ANALYSIS

4.1. Site and Alignment Selection / Criteria

One of the first and key tasks carried out by the Consultant in the review of the previous Feasibility Study conducted in 2020, has been the analysis and optimization of the selected bridge location to corroborate or modify the location of the proposed infrastructure.

IWM was assigned as specialized and approved subconsultant to conduct the hydro-morphological assessment, critical aspect of this site selection task, and to provide the updated study findings.

The best suitable bridge location should enable safe construction, economical and easily maintainable crossing. In general, best suitable location for bridge crossing should meet the following criteria (Ref: Bridge Manual, IWM-BUET, 2008):

- Close to existing road network to connect the bridge with minimum length of approach road.
- Straight reach of river avoiding bends close to the bridge location.
- Minimum width of river.
- River cross-section having uniform velocity distribution at the mid-reach.
- Little or no riverbank erosion.
- Perpendicular position between bridge alignment and river reach avoiding skewness.
- Minimum impact of bridge on river morphology.

4.2. Selection of Bridge Location for Barishal-Bhola Bridge

Analysis of the proposed corridors

Three possible alternate corridors of the proposed bridge were investigated by IWM as follows:

- **Site-1** connects Bhedaria ferry ghat on Bhola end and Laharhat ferry ghat on Barisal end about 100 m downstream of the existing ghats. This site covers three major river channels, multiple small channels and char land inside, which are about 8 km. Tentative total bridge length including viaduct will be about 9.5 km. The depth of water from SHWL in the main rivers ranges about 6 to 21.9 m. Protective work will be required on both banks and near viaducts.
- **Site-2** connects Bhelu Miah Launch ghat on Bhola end and Dhulia Launch ghat of Bhauphal on Patuakhali end, about 17 km down stream of existing ferry crossing. This site covers Tentulia river including multiple small channels and char land inside about 5.8 km. The depth of water in the main Tentulia River from SHWL is about 21.7 m. Tentative total bridge length including viaduct will be about 6.5 km. Substantial protective work will be required on both extreme banks.
- **Site-3** connects Gazir Char (near Bankerhat) on Bhola end and Tung Char of Bakergonj on Barisal end, in between of the above two alternatives. Width of Tentulia River at this site is about 2.6 km. The depth of water in the Tentulia River from SHWL is 16.7 m. Tentative total

bridge length including viaduct will be about 6 km. Substantial River Training work will be required for this site.

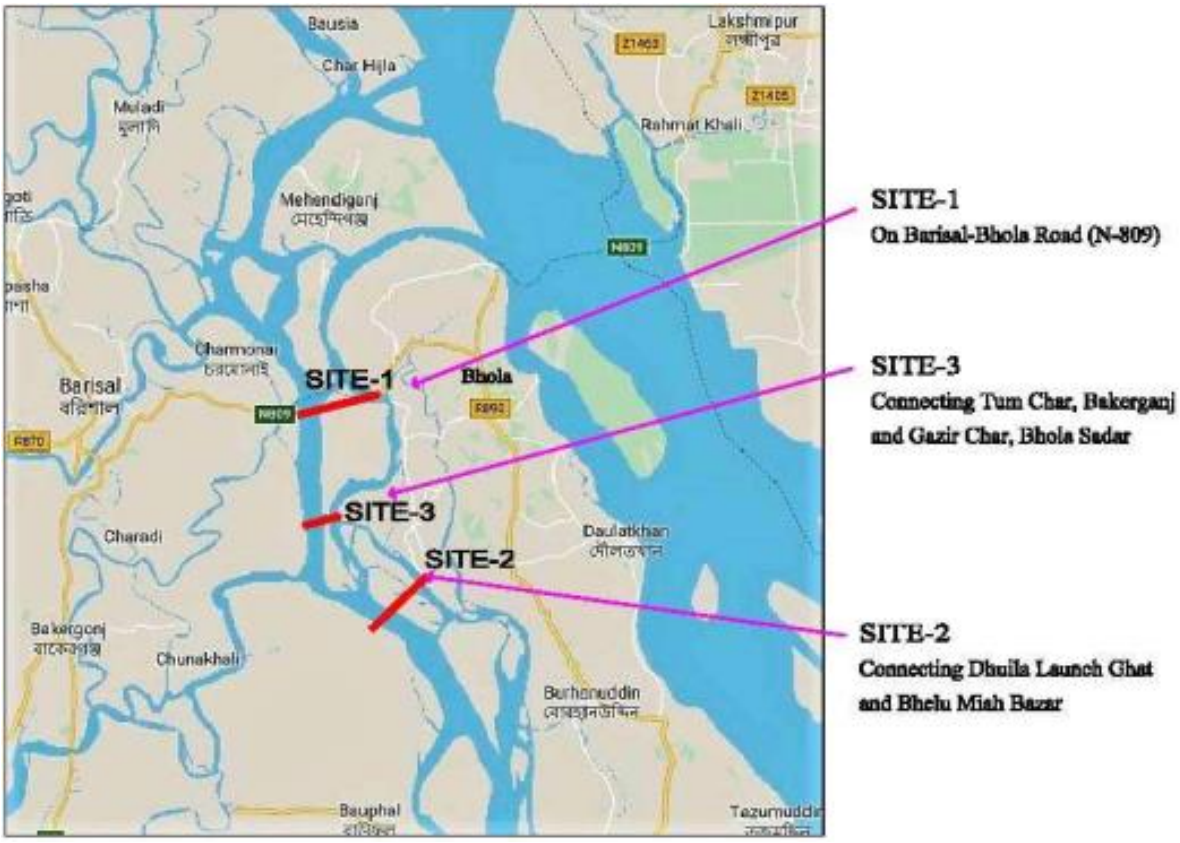

Figure 11. Three alternative locations

As the location of the bridge selected in the previous feasibility study was based in the data corresponding to 2017 and this is a dynamic river, the planform of the lower Meghna has changes within the period from 2017 until now.

Considering the changes, revisiting the suitability locations have been conducted taking satellite images to see bank line migration, channel shifting, cross sections and model generated outputs. Details are presented in the Volume 2 Hydrological & Morphological Mathematical Modelling Study.

The preferred corridor

After the analysis of the detailed satellite images carried out around the vicinity of the proposed bridge, the investigations and field work and the assessment from 2D model, the findings are as follows:

- Bankline within the specified corridor length shows less migration for site 1 than site 2, curvature at upstream bifurcation point poses threat to stability of Site 2.
- Higher bank erosion along right bank at Site 2 than that at Site 1.
- Model generated velocity shows higher intensity for Site 2 than Site 1.
- Both Site 1 and 2 are associated with thalweg shifting.
- Considering the mentioned criteria, **Site 1 is preferable option.**

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Analysis of the alignment within the selected corridor

Once the preferred location of the bridge was confirmed (Site 1 at Laharhat-Bheduria), the alignment of the bridge and approach road was assessed taking into account technical feasibility, social and environmental impacts, land acquisition and resettlement requirements and economic viability.

With this view, three sites were selected for investigation as shown in the figure below. It should be noted that the option A was the one selected in the previous FS (2019).

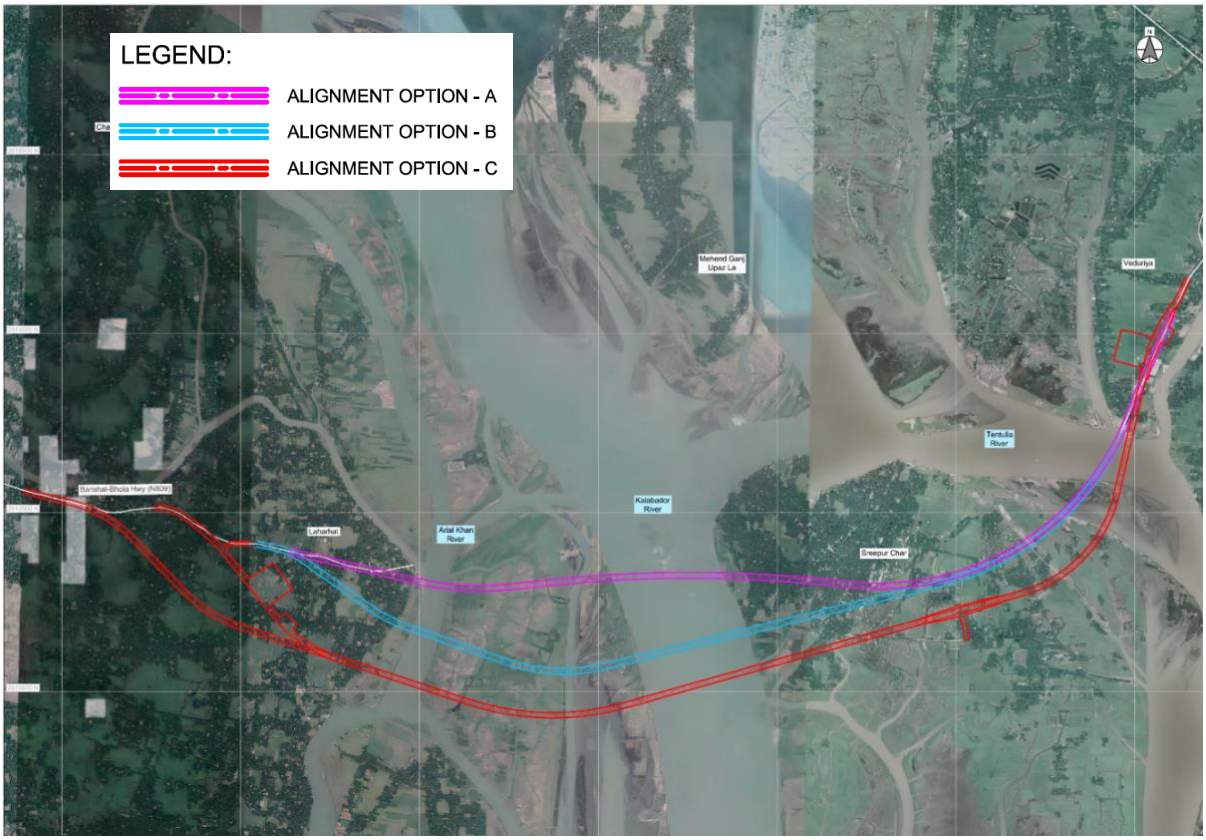

Figure 12. Three proposed bridge sites (Option A, B and C) within the selected corridor Site 1

Conclusion: the selected alignment

From the analyses from past and current study, the suitable site for the proposed bridge has been selected at Laharhat of Barishal, located at the west side of right channel and after crossing the Sreepur Island, it continued over the left channel at Illsha ghat near Bhola. This location is matching with the Site 1 referred in the previous FS developed by JV of STUP Consultants Pvt. Ltd., India; COWI UK Limited, UK; DDC Ltd. and Dev Consultants Ltd. in March 2020.

The Tentulia river has 3 to 4 m tidal fluctuation, and the volumetric flow rate reaches in the order of 28870 m3/s during monsoon. Though there are some changes in the planform of the Tentulia River around the proposed bridge site over last several years, the flow conditions in terms of flow discharge and water levels did not change significantly.

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But due to increased conveyance capacity, the velocity has decreased at both right and left channels of Tentulia River, and at the bridge axis. The salient feature at the proposed bridge site is the large island Sreepur, located at the middle of the left and right channel, has become eroded in the northern part. So, these changes in revisiting the design of the bank protective works have been taken into consideration.

With regards to the preferred alignment within the selected corridor (**Site 1**) IWM has evaluated 3 different alternatives and it can be concluded that **Option C is the most favourable alignment** in comparison with the options A and B.

4.3. Technical Design Criteria

The Consultant has carried out the assignment in accordance with international practice and procedures. However, reference was made to practices followed in Bangladesh and the established standards and procedures of Roads and Highways Department (RHD). The principal International and RHD Standards adopted are:

- AASHTO LRFD 2014 specifications for Highway Bridges. This is currently being followed Bangladesh. The bridge loading standard includes HL-93 trailer truck.
- Geometric Design Standard for Bridges and Approaches and Bridge Design Standard by RHD
- Material Standards – as per AASHTO LRFD 2014 Highway Bridge Design specification
- EuroCode 1990-1999 has also been used as reference, wherever found necessary.

4.4. Approach Road

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 approximate length of the project is 16,367 Km, including the bridge and viaducts and the connections roads with the existing road. The geometric design of the project has been developed for a speed of 80 kph. 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.

Salient elements of the project are as follows:

- **General data:**
    - **Bridge**
        - Total bridge Length: 10,867 m
        - Balance Cantilever Bridge: (West-East) 420 – 1420 – 1220 m; Main Span:200 m; Back Span:110 m
        - Approach Bridge Length:1,200 m

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- Connecting Spans Length: (West-East) 2,396 – 4,211 m

- **Approach road length:** 5,500 m.
  - At Barishal District: 2,900 m (including one viaduct 360 m long)
  - At Bhola District: 2,600 m.
- **Total main alignment: 16,367 m.**

- **Cross section for the approach Road:**

  - Total road RoW variable with a medium value of over 69.5 m width.
  - 2-lane carriageway width 7.30 m plus 1.5 m outer shoulder and 0.50 inner shoulder.
  - Central Median (3.5 m wide).
  - 2-Service Road Lanes 5.5 m, plus 1.5 m outer soft shoulder and 0.50 m inner side safety.
  - 2 additional truck lanes with 7.30 m width for the entry and exit from the axle load stations along 1 Km length approximately.
  - Direct connections with the N-809 on both sides.
  - Access Ramps to Sreepur Char with at-grade intersection (roundabout).
  - 2 Toll Plazas at both Barishal and Bhola ends (7 toll booths plus the reserved areas for 3 future ones).
  - 2 Axle Load Stations and Service Yards at both Barishal and Bhola ends (4 weights bridges/each).
  - 2 Service Area and Engineering Facilities.
  - 360 m long bridge at Ch 0+900 approximately
  - Overbridge at Ch.0+100 (40 m long); Ch.14+800 (48 m long) and Ch.15+400 (48 m long).
  - Box culverts at locations as drainage structures (Ch.0+510; 0+725 ;0+890; 1+270; 1+785; 1+990; 14+515; 15+055 and 16+100)

- **Cross section for the Bridge**

  - Total width of Bridge: 20.25 m.
  - 2-lane carriageway width 7.30 m plus 0.70 m outer shoulder and 0.50 m inner shoulder.
  - 1 footpath of 0.80 m width.
  - Central safety barrier width 0.65 m.
  - Side safety barrier width (each side) 0.50 m.

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- **Road Geometry and Design Standards**

Table 8. Summary of roads and highways parameters

DESIGN STANDARDS			
Design Elements	Unit	Design Parameters	Source
Road Standard		Type 2	Figure 4.1, RHD Standard, Page 12
Design Speed	kmph	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
Embankment Slope (Desirable Min)	H:V	3:1	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

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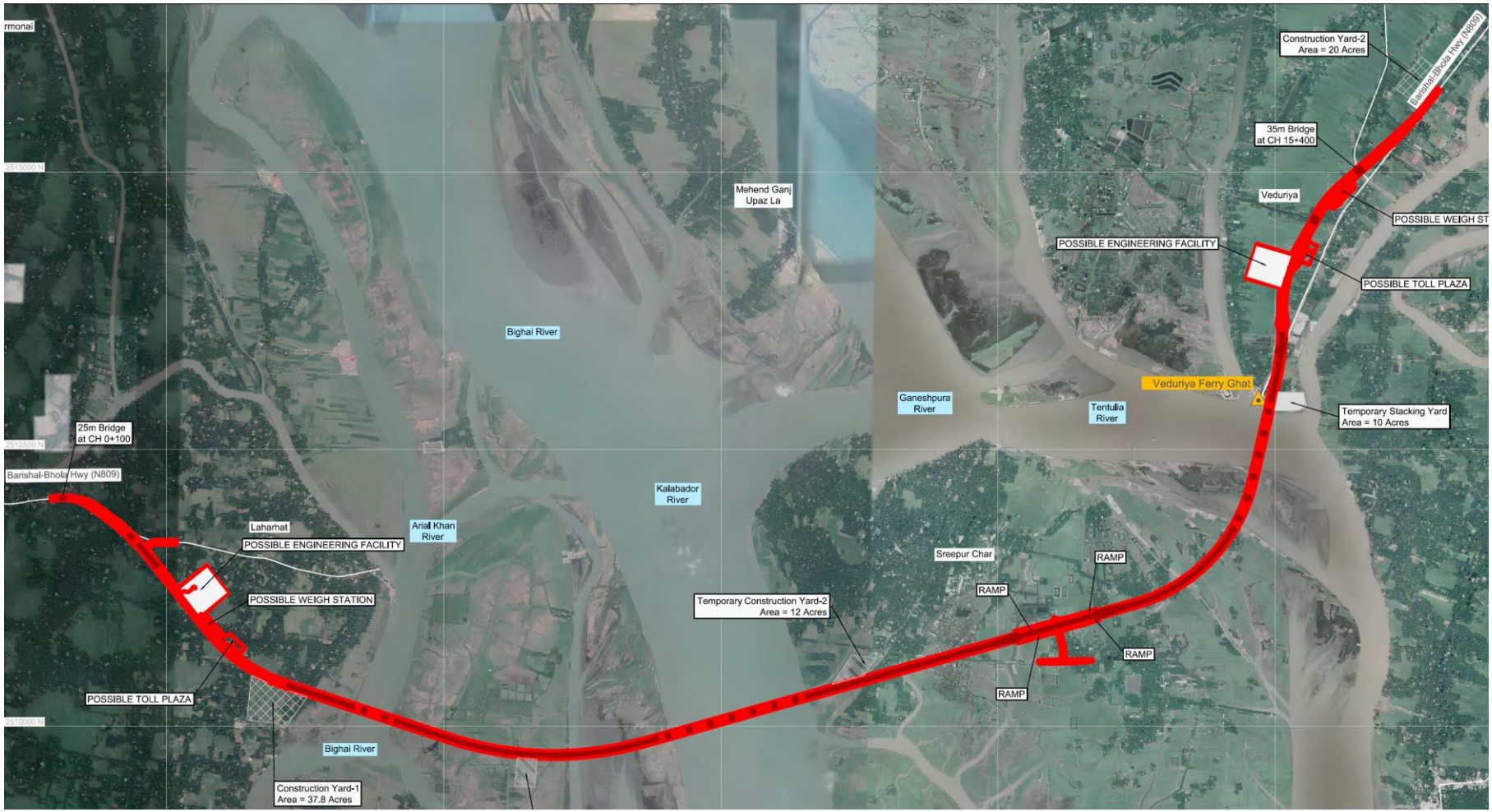

Figure 13 Complete Alignment of the proposed project

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4.5. Proposed Engineering Solution

The proposed solution for the bridge over the Tentulia River is a **Balanced Cantilever bridge with typical spans of 200 m and access/connection bridges of precast I beam with 40 m spans**. The total length of the bridge including access spans is 10.87 km.

The foundation of the piers for the main bridge, which are planned to be executed mainly in the dry area for the end of the 100 m spans but in wet conditions for the 200 m spans, are planned with 6 steel driven piles Ø3.0 m of 90 m in length for the 100 m spans and 14 steel driven piles Ø3.0 m of 90 m in length for the 200 m spans. Further development of the current calculations during detail design may allow for the use of a different diameter for the steel driven piles. For the approach/connection viaducts, the foundations include Ø1.8 m bored reinforced concrete piles of 70 m in length.

Figure 14 Image of balanced cantilever spans proposed for Barishal-Bhola.

The approach road will be 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 national road N809 on both sides. At-grade intersections are proposed on both cases.

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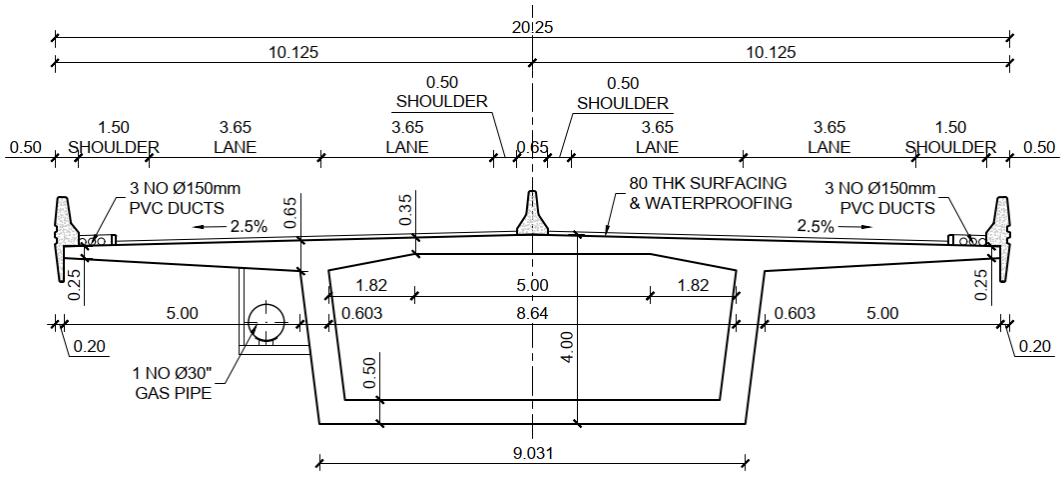

Figure 15 Image and typical cross section at mid-span (Main span) for Barishal-Bhola.

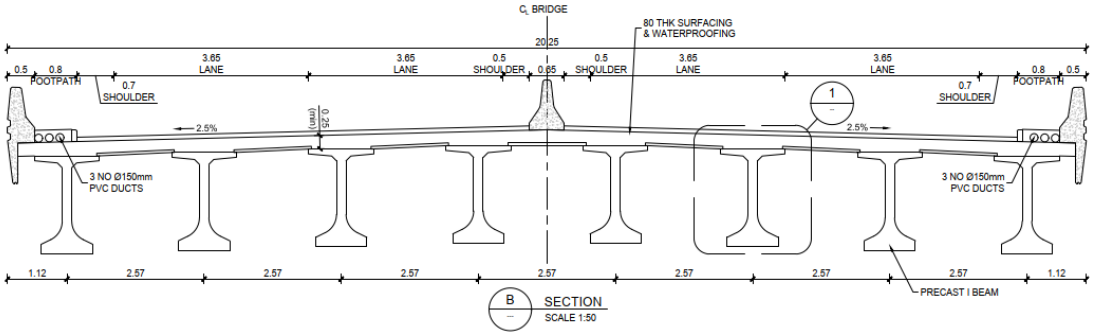

Figure 16 Typical cross section (Precast I-beams) for Barishal-Bhola access spans and connection spans.

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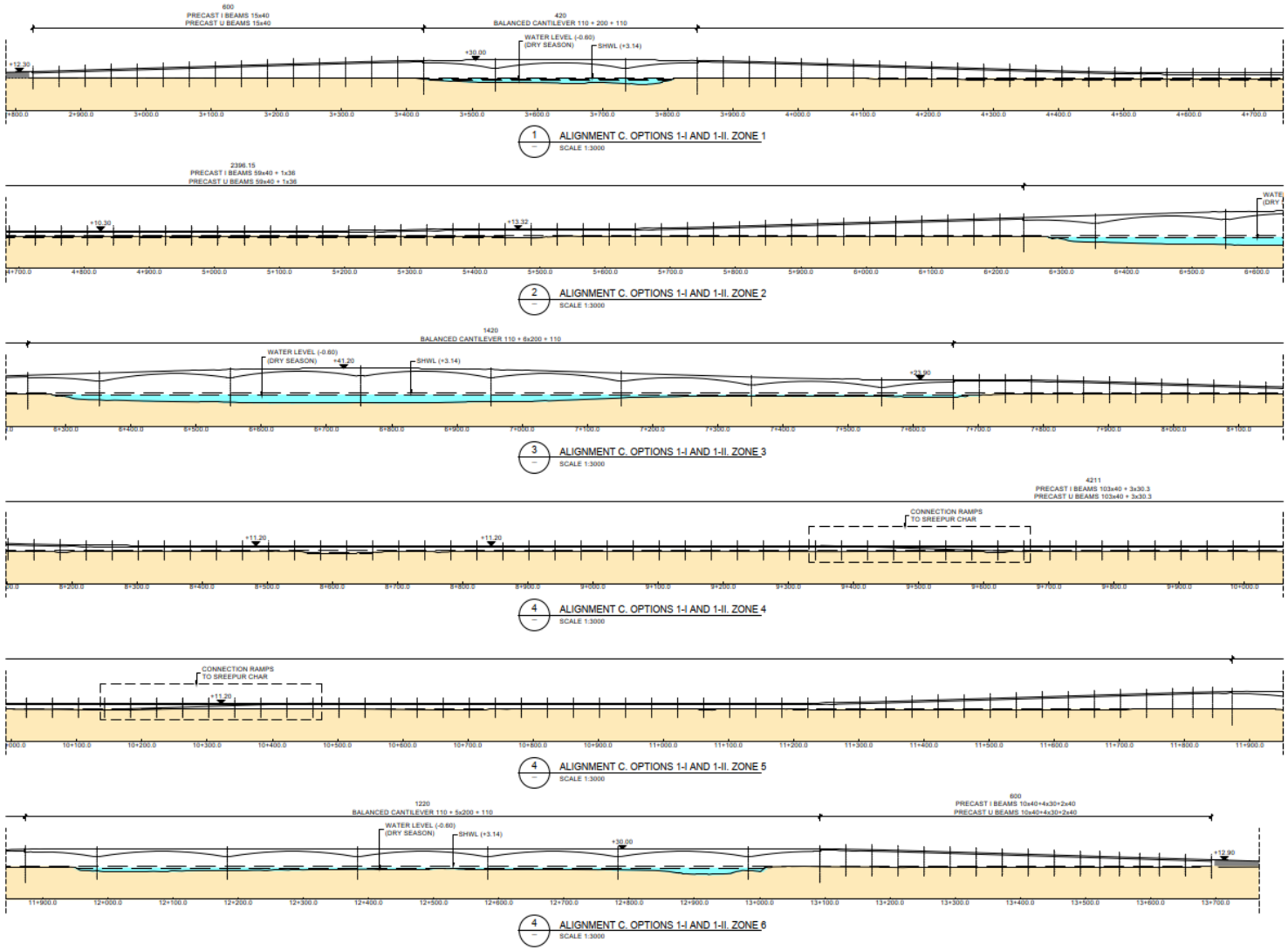

Figure 17 Elevation of the Barishal-Bhola Bridge.

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4.6. Hydro-morphological study summary

Bangladesh is a riverine country with enriched natural resources. People are directly or indirectly dependent on the rivers of this country. River plays a vital role in the livelihood pattern of the people who are mostly influenced by the rivers. So, morphological characteristics of these rivers are very important issues for the life and livelihood of people. The most influential single phenomenon to have deep impacts on its culture and economy is the river system. Ironically, these rivers bring along the perennial threat of floods and riverbank erosion. Riverbank erosion is an endemic and recurrent natural hazard in Bangladesh. In a typical year, about 2,400 km of bank line experience major erosion.

Due to flat terrain and dense population, the Bengal Delta is highly vulnerable to sea level rise. At present the delta building process is active in the Meghna estuary. Each year the rivers of Ganges, Jamuna and Meghna transport more than one billion tonnes of sediment from their catchments in India, China, Nepal, and Bhutan to the delta region.

The hydro-morphological assessment of this project, involving the selection of the optimum alignment, has been carried out by the Institute of Water Modelling (IWM).

To achieve the goals in relation to the hydraulic design of the Bhola Bridge following steps have been taken.

- Collection and Compilation of data and information from different sources mainly from IWM Archive, BWDB, BIWTA. These data included:
    - Bathymetry data of the Tentulia-Kalabador River system.
    - Water level data at Kazir char, Char Paschim, Veduriya, Sreepur and Bakerganj.
    - Historical Cross-sectional data of the Tentulia River.
- Primary data collection including bathymetry survey, char survey, water level, discharge, and sediment measurement.
- Frequency analysis of the flow data and water level data corresponding to different intensity as well as analysis of water level data to determine highest flood level, Standard High-Water Level (SHWL).
- Planform analysis of series satellite images to assess suitable location of the bridge from stability viewpoint, assessment of bank line migration indicating bank erosion.
- The developed two-dimensional(2D) model covers 20 km long stretches of the Tentulia-Kalabador River system.
- Calibration of the two-dimensional model to assess its performance in terms of hydrodynamic as well as morphological outputs.
- Application of 2D model for “Without Bridge” and “With Bridge Condition” to examine the response to design flood condition and present in terms of bed degradation, siltation, flow in different anabranches, velocity, thalweg movement, etc.

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- While General and Constriction scour can be calculated from the model results, results from with and without bridge condition has been used in calculating local scour around the bridge pier using different empirical formula.
- Based on the results of with and without bridge condition, impact at immediate upstream and downstream has been observed. These results were also used to design the bank protection work. In light of past experience and observing the historical bank erosion pattern and the bridge layout prepared by the main consultant, it has been recommended to use four guide bunds along both banks, Sreepur and Loraipur Char to guide the flow of the river. The historical bankline shifting, the present field condition and simulated model results are the key factors to choose the location and length of the bank protection works. Total 18.75 km long RTW, 2 km at two banks at Laharhat and Veduriya named as RTW1 and RTW3, respectively and 8.3 km and 6.45 km at Sreepur Char and Loraipur Char named as RTW2 and RTW4, respectively has been recommended under this study. The location and length of these guide bunds is shown in **Figure 18**.
- The Bay of Bengal hydrodynamic model of IWM has been updated considering the climate change impact and the maximum water level at proposed bridge Bhola-Barishal site due to different pervious cyclones observed in Bay of Bengal has been determined to determine the crest level of the river training work proposed for the Bhola-Barishal bridge.

The detailed description, methodology and results are provided in the report submitted by IWM and is appended to this report. (Volume -2).

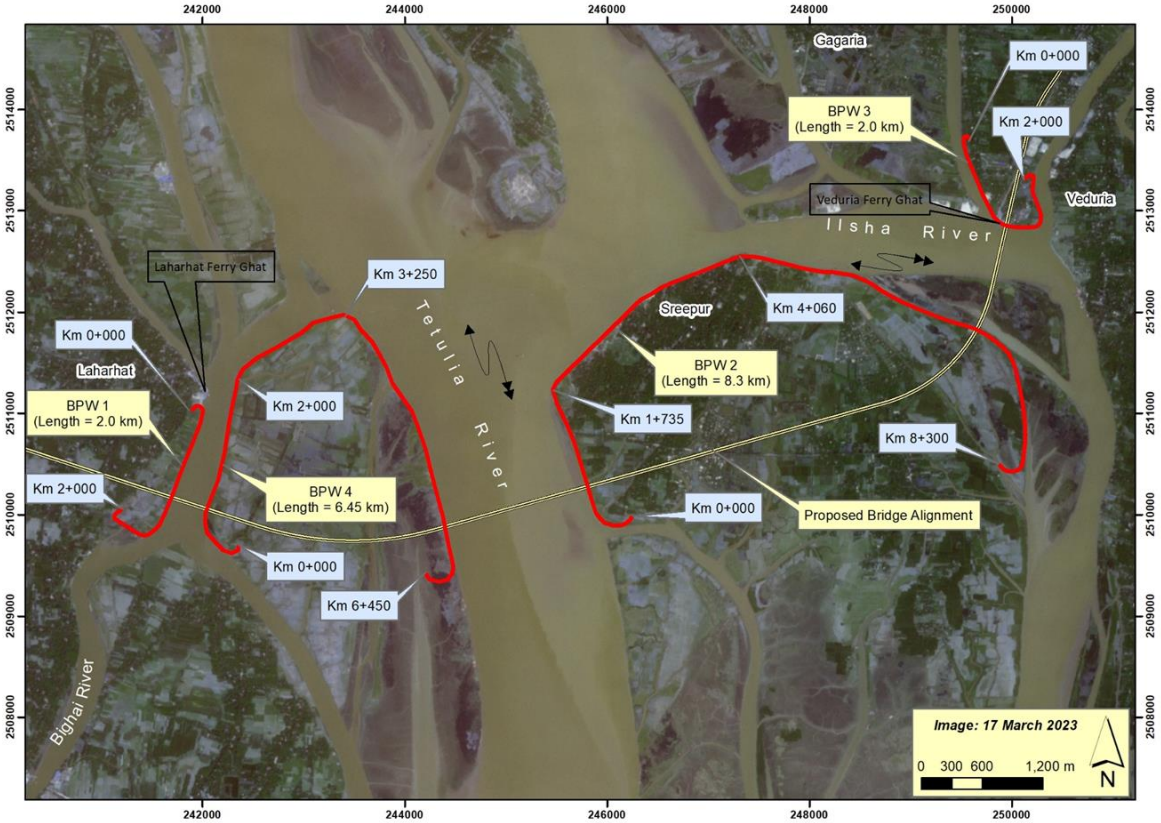

Figure 18. Bank Protection Works along banks of Tentulia-Kalabador River System

Table 9. Summary of hydraulic variables

Hydraulic Parameters	Magnitude	Source
Design Discharge	28870 cumec	1D Model Simulated
Design High Water Level (for Bridge)	3.28 mPWD	1D Model Simulated
Design High Water Level (for RTW)	5.25 mPWD	BoB Model Simulated
Design Low Water Level	-0.50 mPWD	1D Model Simulated
Standard High-Water Level	3.14 mPWD	1D Model Simulated
Degraded Bed level without bridge	-13.46 mPWD	21C Model Simulated
Maximum Velocity at bridge pier	1.95 m/s	21C Model Simulated
General Scour level, m	0.98 m	2D Model Simulated
Constriction Scour, m	2.81 m	2D Model Simulated
Local Scour, m	21.92 m	Using FHWA equation using variables from 2D model and observed data
Design Scour, m	25.71	Using FHWA equation using variables from 2D model and observed data

Figure 19. General aerial view of the bridge over Tentulia-Kalabador rivers

SANCHEZ JIMENEZ JOSE LUIS
Team leader

SANCHEZ JIMENEZ JOSE LUIS
Team leader

4.7. Geotechnical study summary

The Geotechnical Investigation of this study included the drilling of nine boreholes (BBH-1 to BBH-9) and excavation of two (02) trial pits (BBTP-1 to BBTP-2) during the period between March 19th 2023 and May 11th 2023. The main objectives of the GI works are to determine:

- Identify the presence of soft silts and clays on the riverbed.
- The geological stratification along the Bridge alignment.
- The thickness and distribution of the various riverbed 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.

Total nine (9) boreholes were drilled to determine the profiles and properties of the different soil strata by the rotary drilling method. The maximum depth of the borehole is 150 m from the existing surface level.

Information on the type of subsoil stratification, geotechnical parameters, and its behaviors are obtained from a comprehensive soil investigation program that incorporates drilling of boreholes, the geotechnical investigation was carried out on Barishal-Bhola across the Kalabador and Tentulia River and approach road of the Bhola Bridge over Kalabador and Tentulia River.

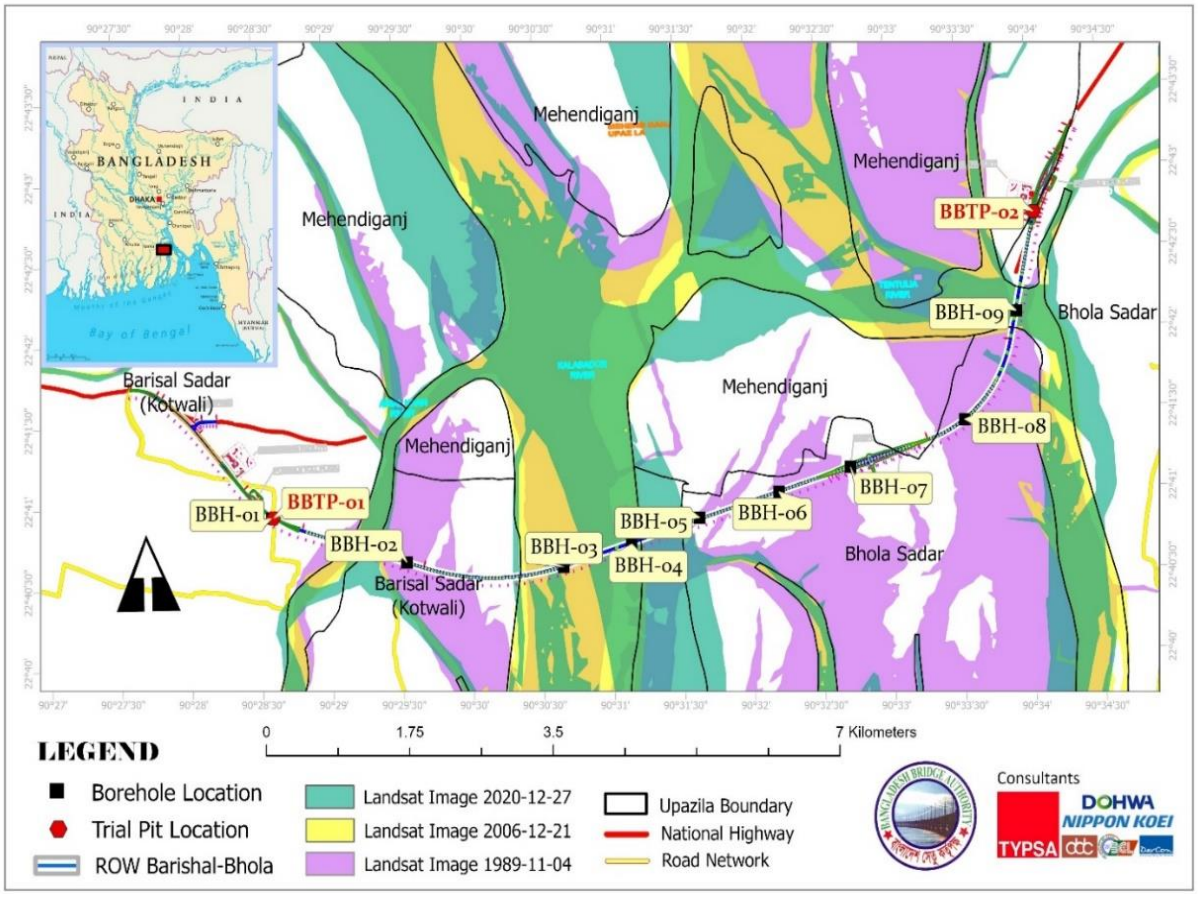

Figure 20. The location of soil investigation campaign

The soil properties presented 6 layers, which properties were determined from a series of field and laboratory tests in order to assess the site conditions. It was found that sub soil deposits comprise of some cohesive and cohesionless layers from the soil layers encountered in the project site. The cohesive layers (Layer 3 and 4) are mostly consisting of low plastic to high plastic, CLAY(CL/CH)/ Silty CLAY/ Lean inorganic CLAY/ Sandy CLAY and SILT (CL/ML)/ Clayey SILT/ Sandy SILT. The layers are combination of cohesionless soil consisting of various types of SAND with some silt SP/SM/ SP-SM/SC.

As it is shown in detail, within vol. 03, and after carrying out detailed analysis, several lean clay layers from the geological profile with variable depths were found. Bored/driven pile with diameter 3.0 m are recommended considering the bridge type along the alignment. The pile depth 85 m to 90 m with pile diameter 3.0 m at the riverbed and 80.0 m to 85.0 m with pile diameter 1.80 m to 2.5 m at the approach bridge.

Table 10. Summary of soil investigations

Type of Investigation	Quantities	Depth (m)
Boring	9	80-150
Trial Pit	2	

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4.8. Cost estimate

The estimated project cost is based on several sources, mainly RHD Schedule of Rates (August 2022), Public Works Department (PWD) (June 2022) and Bangladesh Water Development Board (BWDB) (September 2022), but also by benchmarking from current market rates analysis and from previous feasibility studies implemented by the BBA in recent years.

The detailed estimate is: Based on 1 USD = 108 BDT according to selling rate of Bangladesh Bank on May 14th, 2023.

Table 11. Summary of Preliminary Cost Estimation

No.	Item	Amount (BDT)	Amount (Cr BDT)	Amount (Million USD)
1	General and Site Facilities	6,104,494,865	610.45	56.52
2	Main Bridge	48,328,839,792	4,832.88	447.49
3	Approach Bridges (access and connecting spans and char access ramps)	35,432,777,787	3,543.28	328.08
4	Approach Road including small structures	9,025,952,111	902.60	83.57
5	Toll Plaza & Engineering Facilities	5,385,274,694	538.53	49.86
6	Bank Protection Work	42,275,737,971	4,227.57	391.44
(A)	**Subtotal**	**146,553,077,219**	**14,655.31**	**1,356.97**
(B)	Provisional Sum for Physical Contingency = 3% of (A)	4,396,592,317	439.66	40.71
(C)	**Sub Total (A+B)**	**150,949,669,536**	**15,094.97**	**1,397.68**
(D)	Provisional Sum for Price Contingency = 6% of (C)	9,056,980,172	905.70	83.86
(E)	Engineer's Estimate = (C+D)	160,006,649,708	16,000.66	1,481.54
(F)	**Land Acquisition and Resettlement Costs**	**4,397,884,805**	**439.79**	**40.72**
(G)	Design Cost = 2% of (A)	2,931,061,544	293.11	27.14
(H)	Construction Supervision = 5% of (A)	7,327,653,861	732.77	67.85
(I)	**Project Estimate = (E+F+G+H)**	**174,663,249,918**	**17,466.32**	**1,617.25**

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4.9. Implementation timeline

The considered implementation project timeline, according to the criteria based on other recent studies undertaken by the Consultant and after conversations held with BBA officials was estimated as follows:

PRE-CONSTRUCTION PHASE

- GOB's Approval of the Project – End of 2023
- Y0 Jan 2024 to Dec 2025 - DPP implementation – Procurement process for Detailed Design and RAP+LAP implementation - **24 months**.

INVESTMENT PERIOD (BEFORE OPERATION): 8 Y

- Starting year of investment: Y1 - Jan 2025. / Financial Arrangement.
- Project Detailed Design Phase - **12 months.**
- RAP and LAP implementation phase - **12 months.**
- Main Contractor Tender Process - **6 months.**
- **Construction period** including Testing and commissioning - **78 months**.
  Starting: Jul 2026. Finishing (78 months) including T&C: Y5 = Dec 2032.
- Defects Notification Period (DNP 1 year) Jan 2033 to Dec 2033.
  OPERATION PERIOD: 30 Y = Jan 2033 to Dec 2062.

- **TOTAL PROJECT PERIOD: 30 + 8 = 38 Y**

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FEASIBILITY STUDY - PROJECT TIMELINE	start	finish	
G103 Barishal-Bhola Bridge			
2.1 Feasibilty Study FR		8/1/2023	
2.2 TAC Presentation FS FR		--/09/2023	
2.3 BBA FS Approval		--/12/2023	
2.4 DPP Procedure	1/1/2024	9/30/2024	24 m
2.5 Procurement Process Detailed Design	7/1/2024	12/31/2024	
2.6 Procurement Process RAP+LAP	7/1/2025	12/31/2025	
2.7 Detailed Design Phase	1/1/2025	12/31/2025	24 m
2.8 RAP and LAP Implementation	1/1/2026	12/31/2026	
2.9 Main Contractor Tender Process	1/1/2026	6/30/2026	
2.10 Construction Phase	7/1/2026	12/31/2032	78 m = 6.5 Y
2.11 Testing and Commissionning Phase	1/1/2032	12/31/2032	12 m
2.12 DNP	1/1/2033	12/31/2033	12 m
2.13 **Investment Period**	1/1/2025	12/31/2032	8 Y
2.14 **Operation Period**	1/1/2033	12/31/2062	30 Y

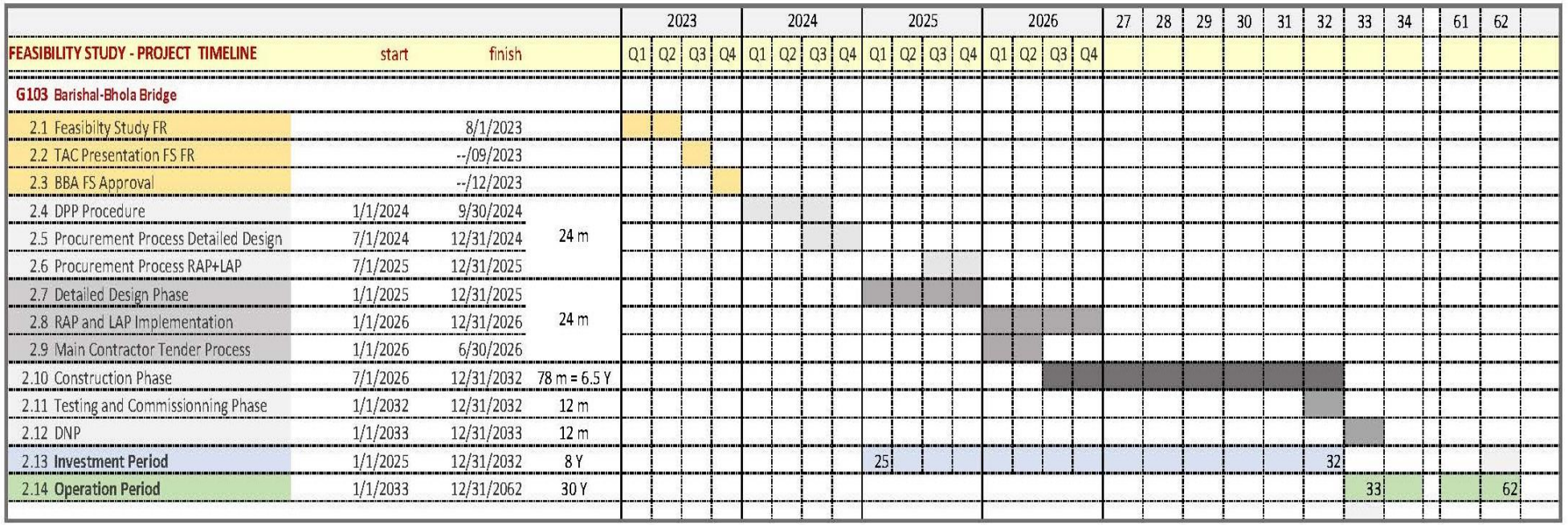

Figure 21. Project proposed implementation timeline.

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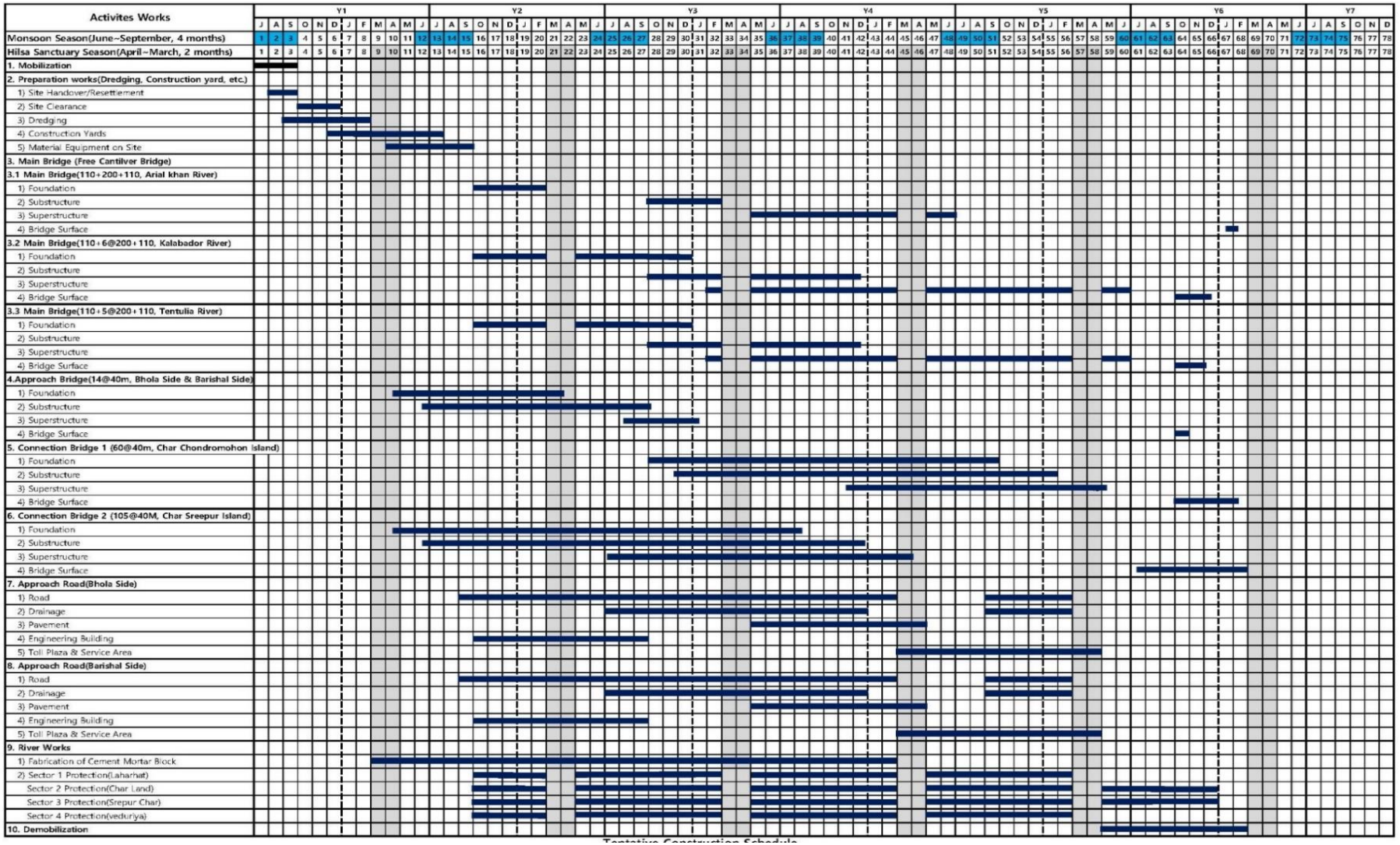

Figure 22. Project proposed construction schedule (78 months)

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5. ENVIRONMENTAL SUSTAINABILITY, CLIMATE RESILIENCE AND DISASTER RISK ANALYSIS

5.1. Environmental Assessment Considerations

The bridge over Kalabador and Tentulia River at Barishal-Bhola Road has been proposed to be constructed at 1.8 km downstream from the Laharhat Ferry Ghat at Barishal end and a little downstream to the Veduriya Ferry Ghat at Bhola end. The project comprises two major components: a bridge with total length of 10.867 km (width of 20.25m) and approach roads of 5.500 km (width of 39.5 m). Environmental issues pertaining to the project has been incorporated properly in the design and assessed to incur benefits from the project by enhancing the environmental positive impacts and offsetting the negative impacts.

A balance cantilever Bridge has been proposed to minimize the impact on the aquatic ecosystem. 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 including Dolphin and Hilsa fish. The bridge is located within the government declared Hilsa Sanctuaries in Kalabador and Tetulia rivers systems. However, it has less impact on the river ecosystem by having the minimum number of pillars in the river. The guidelines for minimizing impacts on Hilsa and Dolphin during construction will be incorporated in contract document which will minimize the impact on Hilsa sanctuary and Dolphins.

The Initial Environment Examination (IEE) / 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 based on available secondary data, field data and discussion with the project affected peoples (PAPs). Based on the impact assessment, it is observed that the project has positive impacts mainly on commercial facilities, industrial activities, job opportunities, landscape and professional diversity, and some negative impacts mainly on noise, erosion and siltation, housing and commercial structures loss as well as community split. Environmental Management Plan (EMP) has been proposed to minimize the negative impacts and achieve sustainable bridge project.

Asian Development Bank (ADB), World Bank (WB), Department of Environment (DoE), Roads and Highway Department (RHD) and Local Government Engineering Department (LGED) guidelines have been followed for IEE preparation of the proposed Bridge Projects. Checklists for IEE have been completed and found no significant negative environmental impacts due to the project.

No highly significant negative environmental impacts are expected during the construction period of 66 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,

SANCHEZ JIMENEZ JOSE LUIS
Team leader

disruption of drainage, pollution of air, noise and soil, disturbance of wildlife mainly water birds and reptiles, aquatic life, health and sanitation hazards and social disruption including split of communities.

About 863.09 acres of land acquisition is required for the proposed project. A total of 373 HHs and 19 CPRs will be affected by the project who will be compensated as per provisions of the RAP of this project. A total of 39,348 nos. of trees are going to be affected due to the project. This loss can be mitigated by planting 118,044 nos. of seedlings and 215,107 nos. of vativer roots on the 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 (ECR), 2023 of DoE, GoB, construction / reconstruction / extension of bridges with length of 500 m or more is included (under item 68) in the list of Red Category of projects.

The proposed bridge falls within RED category as per DoE, GoB and require environmental Clearance from DoE. Which require various documents – IEE is one of them.

The impacts during construction can easily be mitigated by taking advance adequate precautions and some additional measures appropriate to the construction. An Environment Management Plan (EMP) has been formulated to control/mitigate the negative impacts arising from construction related activities. Contractors will be directed to follow the suggestions mentioned in Chapter 7 and 8 of the Environmental Assessment Plan (Initial Environmental Examination) 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 compensations and alternative job opportunities as proposed in Resettlement Action Plan (RAP) of the project.

Environmental risk and disaster assessment has been conducted for the Barishal-Bhola Bridge. 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 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 Right of Way (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 road.

It can, therefore, be concluded that the proposed Barishal-Bhola Bridge Project would be, under the implementation of preventive measures, environmentally sound and sustainable. It can be said in the

SANCHEZ JIMENEZ JOSE LUIS
Team leader

context of Barishal-Bhola Bridge Project that aggregated positive impacts outweigh the negative impacts through the recommended mitigation measures.

5.2. Risks Assessment (Group I) / Environmental and Social

Environmental & Social Risk Assessment have been undertaken through a series of consultations and review sessions. The principals in AS/NZS ISO 31000:2009, as well as the proponent of internal risk assessment documentation, guided the risk assessment.[1]

S. No.	Activities	Impacts	Negative Impact		Mitigation Measures
			Short Term	Long Term	
A	**Pre-Construction Phase**				
i	Land Acquisition for site, access road and utility and Supply System	Change in land use pattern		√	A Land Acquisition plan (LAP) will have to be prepared for proper compensation for land loss and rehabilitation of the Project Affected Persons (PAPs) according to GoB rules and regulations as well as other relevant guidelines. A Resettlement Action Plan (RAP) will be prepared for proper resettlement of the affected people. About 373 households will be involuntarily resettled. However, there will also be a high positive impact since all the affected people will be shifted to 'Resettlement Sites' that will cater to all infrastructure facilities including environmental sanitation and health facilities.

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[1] AS/NZS ISO 31000:2009. This Joint Australian/New Zealand Standard was prepared by Joint Technical. Committee OB-007, Risk Management. ISO 31000:2009 **provides principles and generic guidelines on risk management**. ISO 31000:2009 can be used by any public, private or community enterprise, association, group or individual. Therefore, ISO 31000:2009 is not specific to any industry or sector.

S. No.	Activities	Impacts	Negative Impact		Mitigation Measures
			Short Term	Long Term	
		Impact on livelihood		√	All direct income loss must be adequately compensated within the RAP. Moreso, income loss can be mitigated by providing alternative job opportunities for PAPs. Due to the nature of their profession, the fishermen should be rehabilitated as near as possible to the riverbank. A fish landing site should be incorporated in the design of the RTW. Alternative job opportunities should be arranged specially for the affected persons during the construction of the project.
		Shifting of utilities	√		Adequate protection (vertical clearance) for electric transmission line as per EE Rules 2020[2] and for telecommunication line culvert to be constructed for insulation of the pipelines.
ii	Site Preparation	Removal of vegetation.		√	This is a permanent ecological loss. Steps should be taken to convert the unplanted/unused lands in the vicinity into agricultural land.
		Impact on aesthetic aspects		√	Alternative locations and facilities should be provided for the cultural infrastructure such as family graves/graveyards, educational institutes, mosques/ temples, burning yard, However, if the relocation takes place before the establishments are broken down, then this will help to reverse many negative impacts.

[2] *Bangladesh Gazette: November 4, 2020; page 11246*

SANCHEZ JIMENEZ JOSE LUIS
Team leader

S. No.	Activities	Impacts	Negative Impact		Mitigation Measures
			Short Term	Long Term	
		Impact on ecosystem		√	To compensate for the loss of trees, the project will provide opportunities for new plantation. A buffer strip of 20-meter width for RTW has be planned for tree plantation. There will be opportunities for plantation on the roadside slopes of the approach roads and in the service area. As compensation for the loss of wildlife biotopes and biodiversity conservation through project activities a protected sanctuary or nature reserve is necessary to be established on a suitable location close to the project site, where the main biodiversity hotspots are located.
B		**Construction Phase**			
i	Development of the Bridge, Service Areas including Facilities and Construction of Boundary Wall, Guide Bandh, Approach Road, Electrical & Water Supply System	Loss of topsoil		√	Topsoil is a very good alternative to organic fertilizer. With this topsoil Adjacent agricultural lands are to be fertilized for more production.
		Soil contamination due to spillage of material	√		Handling and storage of the potential contaminants must be organized under strict conditions to avoid water pollution during construction of the bridge.
		Surface wáter	√		
		Air pollution	√		To keep the pollution level within an acceptable limit, construction-related emissions should be regulated. Regular water spray on dry surfaces to reduce dust generation must be practiced.

SANCHEZ JIMENEZ JOSE LUIS
Team leader

S. No.	Activities	Impacts	Negative Impact		Mitigation Measures
			Short Term	Long Term	
		Noise pollution	√		Since noise pollution exceeds the standard, strict measures for noise pollution control need to be undertaken during construction activities. Implementation of these measures may be expensive and difficult. The Contractor should be asked for consideration of these aspects and should apply optimum site activities and site layout so as not to exacerbate existing noise levels at sensitive receptor sites (e.g., mosques, schools).
		Increase in traffic	√		Proper traffic management needs to be put in place to minimize the disruption/risk of accidents during the construction stage.
		Impact on health & safety	√		During Construction: Adequate facilities should be provided for quality water supply, hygienic toilets. in the construction camps and in the resettlement area of PAPs to ensure good health. Drinking Water: Drainage and Sewerage: Solid Wastes. Transmission of Diseases: Awareness.

S. No.	Activities	Impacts	Negative Impact		Mitigation Measures
			Short Term	Long Term	
C		**Operational Phase**			
i	Development of Infrastructure, i.e. Bridge, Service Areas including Facilities and Construction of Boundary wall, Guide Bandh, Approach Road, Electrical & Water Supply System	Impact on the Air Quality		√	Air quality should be monitored regularly after the opening of the bridge. During the operation period, if the air quality deteriorates, several mitigation measures can be conceived.
		Noise Pollution		√	In the detail design stage, the sections of the approach road will be identified where cumulative noise would exceed the standard. After opening of the bridge continuous monitoring should be conducted in the location and whenever a section's noise level crosses the standard, BBA may also place noise barriers at that section.
		Potential surface water pollution due to		√	Sewerage Treatment Plant (STP) to be constructed to avoid possible surface water pollution due to sewage discharge
		Groundwater abstraction		√	Treat and use of surface water setting. treatment plant is the best possible way to keep the ground water intact in the vicinity of the project site. Another way is Rainwater Harvesting.
		Traffic growth		√	BRTA rules and regulations will need to be strictly followed to minimize the risk of traffic accidents.

SANCHEZ JIMENEZ JOSE LUIS
Team leader

5.3. Risks Assessment (Group II) / Natural Disaster and Climate Change.

Bangladesh is a country prone to natural disasters such as floods, cyclones, and earthquakes. The government and various organizations have implemented disaster mitigation strategies to reduce the impact of such disasters. Here are some of the strategies that have been implemented in Bangladesh:

Early warning systems: The government has established a network of early warning systems to provide timely alerts about impending disasters. This includes the use of sirens, text messages, and radio broadcasts.

Emergency response plans: The government has developed emergency response plans that outline how different agencies should respond to disasters. This includes the deployment of rescue teams, medical teams, and the provision of relief supplies.

Infrastructure development: The government has invested in infrastructure development to reduce the impact of disasters. For example, the construction of embankments and cyclone shelters has helped to protect coastal communities from storm surges.

Community-based disaster risk reduction: The government has encouraged community-based disaster risk reduction initiatives. This includes the formation of community disaster response teams, the development of evacuation plans, and the identification of safe places to take shelter during disasters.

Climate change adaptation: Bangladesh is one of the most vulnerable countries to climate change. The government has developed strategies to adapt to climate change, including the promotion of climate-resilient agriculture and the implementation of flood-resistant housing.

Education and awareness: The government has launched education and awareness campaigns to inform people about the risks of disasters and how to prepare for them. This includes the development of educational materials and the use of media campaigns.

These strategies have helped to reduce the impact of disasters in Bangladesh, but more work needs to be done to improve disaster preparedness and response.

SANCHEZ JIMENEZ JOSE LUIS
Team leader

Table 12. Natural Disaster Risk Matrix

District/Risk Area	Bhola	Barishal	Impact	Strategic Planning for Risk Hedge
	Risk Index			
Cyclone	Moderate	Very High	Very high negative impact	To follow Bangladesh National Building Code (BNBC) 2020, Indian Roads Congress Standard (IRC) code for urban roads, American Association of State Highway and Transportation Officials (AASHTO) specifications and manual for design.
Drought (Kharif)	Low	Low	No impact	No strategy is required.
Drought (Pre Kharif)	Low	High	No impact	No strategy is required.
Earthquake	Very Low	Low	Low impact. As per BNBC, Bhola and Barishal fall under Seismic Zone 1 (Coefficient Z: 12)	To follow Bangladesh National Building Code (BNBC) 2020, Indian Roads Congress Standard (IRC) code for urban roads, American Association of State Highway and Transportation Officials (AASHTO) specifications and manual for design.
Erosion	Very High	Very High	Very high negative impact	Guide Bandth (DAM) will be the possible solution for mitigation of erosion.
Flood	High	Low	Very high negative impact	Vertical clearance for Class -I navigation must be maintained for the bridge and maximum flood level for approach road considering return periods,
Flash flood	Very Low	Very Low	No impact	No strategy is required.
Salinity	High	Moderate	High negative impact	Measures to be taken while constructing piers.
Sea-level rise	Very High	High	High negative impact	Vertical clearance for Class -I navigation must be maintained for the bridge.
Landslide	Very Low	Very Low	No Impact	No strategy is required.
Storm Surge	Very High	Moderate	High negative impact	To follow Bangladesh National Building Code (BNBC) 2020, Indian Roads Congress Standard (IRC) code for urban roads, American Association of Highway and Transportation Officials (AASHTO) specifications and manual for design.

5.4. Risks Assessment (Group III) / Project Implementation

Category of Risk	Description of Risk	C[3]	L[4]	R[5]	Mitigation Measures/Risk Hedge
Financial risk	High impact on the project. This type of risk frequently happens. Value leakage and missed contract renewal/ extension are come under financial contract risk.	4	B	4B	**Protect contracts (and their data)** Agencies as well as Contractors are obliged to store contracts and their data more securely to reduce contract risk. **Monitor contract closing deadline/extension reminders.** This helps to ensure that contracts are only extended /renewed when want them to be, which is important for financial efficiency.
Legal risk	Most often, this type of contract risk can result in legal action, or a threat of it.	3	C	3C	**Include limitation of liability clauses** These clauses will be used to impose a limit on the value of damages that can ask for in the event of negligence or breach. Alternatively, they will be used to exclude liability in certain circumstances. Either way, limitation of liability clauses can reduce contract risk by capping it. **Improve visibility into contracts.** By making visibility into contracts, it becomes easier to search for and find contracts, can reduce all types of contract risk. **Follow thorough review processes.** A robust review process helps to identify contract risk before the agreement is pushed out to counterparties for negotiation. It provides legal and business teams with the opportunity to: • Ensure contracts are clearly written. • Identify any mistakes within a contract.

[3] *C: Consequence*
[4] *L: Likelihood* — *5: Almost Certain; 4: Likely; 3: Possible; 2: Unlikely, 1: Rare*
[5] *R: Risk* — *A: Extreme; B: High; C: Moderate: D: Low, E=Very Low*

SANCHEZ JIMENEZ JOSE LUIS
Team leader

Category of Risk	Description of Risk	C[3]	L[4]	R[5]	Mitigation Measures/Risk Hedge
					• Allocate contract risk more fairly. • Receive approval from higher officials on contentious terms. **Standardize contracts.** This helps to ensure consistency across legal documents and prevent costly mistakes when procurement team self-serves on contracts.
Reputational risk	This type of risk occurs when a company is portrayed badly or is discussed in a negative light. Including controversial or unreasonable terms within a contract is one way that reputational risk can occur.	3	C	3C	**Be realistic about capacity/ resources.** It's important to be realistic about the capacity when entering into a contract. The best way to ensure that promises should be aligned with the resources is by getting the relevant stakeholders involved early on in the process. This cross-collaboration helps to ensure that the promises make are consistent with capacity right across the business.
Security risk	One of the biggest contract management mistakes that entity may make is failing to secure contracts and the data within them.	5	A	5A	**Data management** This is a significant source of risk within contracts, and that should be mitigated at all costs. **Establish contract approval workflows.** Way to do this is by setting up an approval workflow whereby senior officials are asked to approve the contents of a contract before it can be sent out for signing.

5.5. Risks Assessment (Group IV) / Vessel impact - Infrastructure

The construction of a balanced cantilever bridge presents several risks that need to be addressed to ensure safety and successful completion of the project. Some potential risks include:

To mitigate these risks, detailed engineering analysis, thorough planning, and strict adherence to safety protocols are essential. Regular inspections, quality control measures, and collaboration among the project team can help identify and address any potential risks throughout the construction process.

Vessel Impact Risk detailed assessment has been included in Vol 01 and Vol 10 of this FS.

SANCHEZ JIMENEZ JOSE LUIS
Team leader

6. SOCIAL SAFEGUARD ASSESMENT

Social considerations and community-driven aspects of the project have been assessed accordingly: the river Kalabador and the Tentulia rivers divide Bangladesh into two distinct districts – namely the Barishal and Bhola. Due to this division, there are now large sociocultural gaps between the people, which is also a sign of slower economic development in the southern regions. Direct road access between Barishal and Bhola will offer a more efficient alternative mode of transportation and have a significant socioeconomic impact.

The construction of a bridge over the river Barishal-Bhola crossing link has been identified as a High Priority Project by BBA, and this fact is completely supported by our social aspects assessment being carried out in this assignment.

- **Displacement and impact of the project**

It was identified that the project occupies a total of 863.09-acre land within its boundary. According to the current design for this project, it is estimated that around 507.50 acres of land will be required for several intervention of the project, 10 acres for resettlement area and 345.58-acre river land out of mouza boundary. Of the total land (507.50 acres), 407.82 acres from Barishal district and 99.67 acres from Bhola district will be required for acquisition. Of the total 507.50 acre in mouza boundary land, 164.98-acre land will be necessary for Right of Way (RoW), 58.67 acre for Construction Yards (CY), 57.96 acre for Engineering Facilities Area, 213.37 acre for River Training Work (RTW), 8.73 acre for Toll Plaza, and 3.77 acre for Weigh Station. It was also estimated that about 10 acres of land would be required for two-resettlement areas. It is identified that the land acquisition will affect 1,546 plots of 20 administrative mouzas.

According to the detailed census and IOL survey, a total of 392 project affected units including 373 HHs and 19 CPRs will be affected by losing their immoveable assets. Apart from the primary structures, a significant quantity of secondary structures will also be impacted. The assessment also identified that 124 business premises including running business will be affected by the project interventions.

The table below shows summary of land acquisition and resettlement impacts by Interventions.

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Table 13. Summary of project impact on land acquisition

Sl. No.	Project Impacts	Barishal	Bhola	Total
A.1	Amount of affected land (acre)	414.82	102.67	517.50
A.1.1	Amount of affected private land as per design (acre)	257.14	76.40	333.55
A.1.2	Amount of affected govt. land as per design (acre)	150.67	23.27	173.95
B	Number of total HHs affected by Structure	277	96	373
B.1	Total number of households requiring relocation	210	80	290
B.1.1	Number of titled HHs losing res/com requiring relocation	182	57	239
B.1.2	Number of non-titled losing res/com and structures requiring relocation	28	23	51
B.2	Number of titled HHs losing res/com and other structures requiring No-relocation	51	13	64
B.3	Number of non-title losing structures requiring No relocation	1	3	4
C	Number of CPRs affected	12	7	19
D	Total number of Project Affected Units (B+C)	304	103	392
E	Number of businesses affected	90	34	124
K	Number of Vendors affected	0	0	0
L	Number of trees affected	50,959	7,274	58,233
M	Total number of persons affected	1,030	376	1,406
N	Total affected primary structure from HHs and CPRs (sft)	199,658	63,576	263,234

Table 14. Summary of affected land

Intervention	Barishal	Bhola	Grand Total	Out of mouza boundary	Total Area (Acres)
Construction Yard	37.58	21.08	58.67		58.67
Engineering Facilities area	57.96		57.96		57.96
ROW	133.56	31.41	164.98	113.73	278.71
RTW	166.19	47.17	213.37	231.85	445.22
Toll Plaza	8.73		8.73		8.73
Weigh Station	3.77		3.77		3.77
Total Area as per LAP	**407.82**	**99.67**	**507.50**	**345.58**	**853.09**
Resettlement area	7.00	3.00	10.00		10.00
Total	414.82	102.67	517.50	345.58	863.09

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- **Socio-economic profile**

The total project affected HHs is 373 including 290 HHs that will be physically displaced. The total number of projects affected person is 1,406. Of the total PAPs 52.70% are male (741) and 47.30% are female (665). The project would have an impact on 49 vulnerable households in total, or 13% of all HHs (373). The population designated as vulnerable for this project has a monthly income below BDT 10,000.

- **Consultation and participation**

During the stakeholder's consultation meetings, people were briefed about the project benefits, roles and responsibilities of the project authority, local government institutions and other stakeholders. Mitigation measures of potential adverse impacts including compensation at replacement cost, resettlement benefits, income and livelihood restoration, grants to vulnerable people and employment opportunity of the eligible PAPs in project civil works were also discussed in the meetings. Upon disseminating information by the consultant/project authority, stakeholders identified some pertinent issues relating to the compensation, displacement, resettlement, livelihood restoration, etc.

- **Legal and Policy Framework**

To address the legal framework for land acquisition and resettlement of the affected people by the project, the Acquisition and Requisition of Immovable Property Act, 2017 (ARIPA) would be endorsed. BBA aims to promote environmentally sound, socially acceptable, and economically viable projects. It believes that each of its projects will improve the living standards of populations affected by the projects. BBA recognizes the importance of addressing environmental and social issues and seeks to promote stakeholder involvement in the pursuit of sustainable projects. Compensation of the affected land and other assets would be paid following the GoB law and policy. It also recognizes that displacement of households from private and government land along the project design and disruption of their livelihood is likely to occur. Where such displacement and disruption are inevitable, BBA aims to ensure that affected households are appropriately relocated by their own, and their livelihoods are restored in a fair and transparent manner, and to link mitigation measures with project development opportunities (civil works of the project).

- **Grievance Redress Mechanism**

A two-tier bottom up GRC system would be established in this Project. First, there would be GRCs at the local level, hereafter called Local GRC upazila level); and second, GRC at the project level to give room for grievances to be reviewed. The APs would be informed through public consultation that they have the right to have their grievances redressed by the local committees as well as by the project management. The APs can also call upon the support of the implementing NGO (INGO) engaged to implement the RAP to assist them in presenting their grievances or queries to the GRC. Other than disputes relating to ownership right under the court of law, the GRC will review grievances involving all resettlement assistance, relocation, and other support. The local GRCs (at the upazila/municipal level) will hear the grievances first. Only unresolved cases will be forwarded to the next tier – Project level GRC

for further review and resolution. Grievances will be redressed within a month of the date of lodging the complaints. GRC decisions will be on a majority basis and will be disclosed and available for review by the stakeholders. If any disputant is unhappy or unsatisfied with the outcome of the Project level GRC, he/she may file cases in court.

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- **Cost and Budget**

It was identified that the project occupies a total of 863.09-acre land within its boundary. According to the current design for this project, it is estimated that around 517.50 acres of land will be required for several intervention of the project, 10 acres for resettlement area and 345.58-acre river land out of mouza boundary. Of the total land (517.50 acres), 414.82 acres from Barishal district and 102.67 acres from Bhola district will be required for acquisition. Of the total 517.50 acre in mouza boundary land, 164.98-acre land will be necessary for Right of Way (RoW), 58.67 acre for Construction Yards (CY), 57.96 acre for Engineering Facilities Area, 213.37 acre for River Training Work (RTW), 8.73 acre for Toll Plaza, and 3.77 acre for Weigh Station. It was also estimated that about 10 acres of land would be required for two-resettlement areas. It is identified that the land acquisition will affect 1546 plots of 20 administrative mouzas. The preliminary cost identified **Land acquisition and Resettlement budget for the project is BDT 4,397,298,835.** The total estimated DC budget is BDT 1,838,241,889. Top-up cost is BDT 2,559,056,946 considered as resettlement benefit.

Table 15. Summary of cost estimate

SL.	Category of Loss	DC	Additional	Estimated RC amount in BDT
A	Compensation For Land	1,260,653,683	488,831,238	1,749,484,921
B	Compensation for structure	215,428,180		215,428,180
C	Compensation for Trees	167,202,780		167,202,780
	Impact Budget (A+C)	**1,643,284,643**	**488,831,238**	**2,132,115,881**
E	Other Resettlement Benefits		347,176,041	347,176,041
F	Operation cost for RAP Implementing Agency/ INGO		40,000,000	40,000,000
G	Operation cost for External Monitoring Agency		10,000,000	10,000,000
H	Construction of Resettlement area		1,250,000,000	1,250,000,000
i	Provision for unforeseen Impacts- Temporary Construction Yard Lease		368,000,000	368,000,000
j	Contingency @5% of the Sub-total	160,768,977	46,595,619	207,364,596
K	Administrative cost @ 2% on the DC budget	34,188,269	8,454,049	42,642,318
	Grand Total	1,838,241,889	2,559,056,946	4,397,298,835

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7. COST-BENEFIT ANALYSIS

7.1. Economic Analysis

The methodology is based on economic adjustments during the life of the project, considering initial required investment plus transportation operational impacts during period of analysis. Capital expenditures are estimated and valued from market (financial) figures and reevaluated applying standard conversion factors. Then, direct social costs and benefits, as well as externalities are appraised from the point of view of the entire country's economy.

(a) Identify the direct, indirect, and associated cost and benefit components.

In the case of the implementation of a new public transport infrastructure, within a pre-existing network transport system, the sources of benefits to be studied could a priori are the following:

- Change in travel time costs (savings), for users in the system, before and after the construction of bridge. Diverted traffic and generated traffic should be analysed separately.
- Net savings in system vehicle operating costs of all modes involved: energy, fuel, lubricants, etc.
- Lower accident costs for travellers
- Investment and conservation cost variation (maintenance and repairs) in infrastructures
- Lower environmental costs (emissions reduction, pollution reduction, etc.).

In the table below are summarized some basic elements that compose total project Capital expenses (financial terms). These costs are indicated without VAT and based on year 2025 (year one of period of analysis) when the estimation was carried out:

Table 16. Basic elements that compose total project Capex (2025 monetary units)

Number	Item	Cr BDT
1	General and Site Facilities	595.1
2	Main Bridge	4711.5
3	Approach Bridges	3454.3
4	Approach Road including small structures	879.9
5	Toll Plaza & CCB	525.0
6	Bank Protection Work	4121.4
7	Land acquisition and Resettlement costs	460.9
8	Design costs	267.1
9	Supervision costs	667.8
10	Contingencies	1311.6
	TOTAL	16,994.6

(b) Adjust them where necessary.

Capex costs are adjusted considering inflation dynamics from 2022 to 2025 (starting year of investments) and other correction factors. Also, a realistic chronogram of investment disbursements is required (expenses split by years 2025 to 2032) and the following deployment was applied:

Table 17. Capital expenses deployment with project.

	2025	2026	2027	2028	2029	2030	2031	2032
Split by year of the CAPEX	3%	22%	10%	14%	18%	18%	10%	5%

Below are presented the different components of the capital expenses (with and without the project).

Table 18. Capital expenses deployment with project (Cr BDT)

Capital expenditures	2025	2026	2027	2028	2029	2030	2031	2032
TOTAL	510	3,739	1,699	2,379	3,059	3,059	1,699	850

Table 19. Capital expenses deployment without project (Cr BDT)

Capital expenditures	2025	2026	2027	2028	2029	2030	2031	2032
TOTAL	152	793	361	505	649	649	361	181

Table 20. Maintenance expenses with and without project. Values per year (Cr BDT)

	With project		Without project	
Maintenance	Ordinary maintenance [Cr BDT/year]	Extraordinary [Cr BDT/year (when applied)]	Ordinary maintenance [Cr BDT/year]	Extraordinary [Cr BDT/year (when applied)]
Main bridge	47.11	282.69 (Y15, Y25)	-	-
Approaching viaducts	34.54	138.17 (Y10, Y20, Y30)	-	-
Approaching roads	8.80	52.80 (Y10, Y20, Y30)	4.05	24.30 (Y10, Y20, Y30)
Bank protection and river training	82.43	247.28 (every 3Y)	32.97	98.91 (every 3Y)
Toll Plaza & Facilities	10.50	42.00 (Y15, Y25)	-	-
Ferry-ghat terminal	-	-	19.52	-
TOTAL (sum during Operation period (30Y)	**5,501.55**	**3,695.12**	**1,696.20**	**1,062.03**

The following figures shows the split of the main positive NPV flows, showing that the *time saving for passengers* is the elements with the highest impact: around 82% in total.

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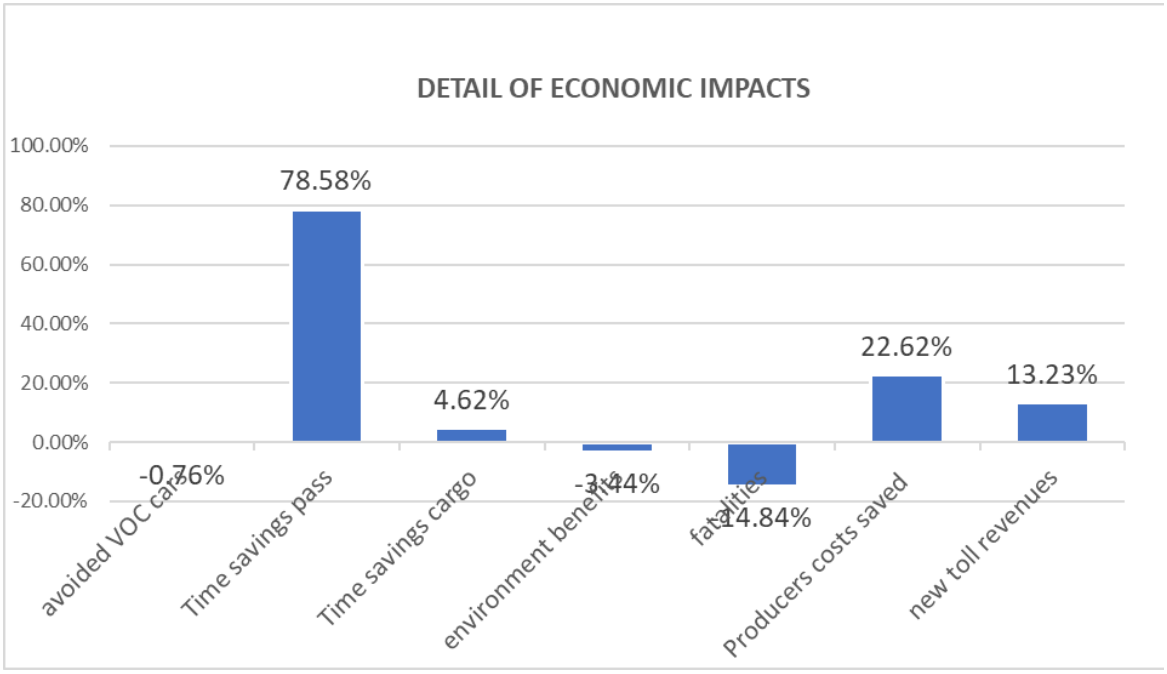

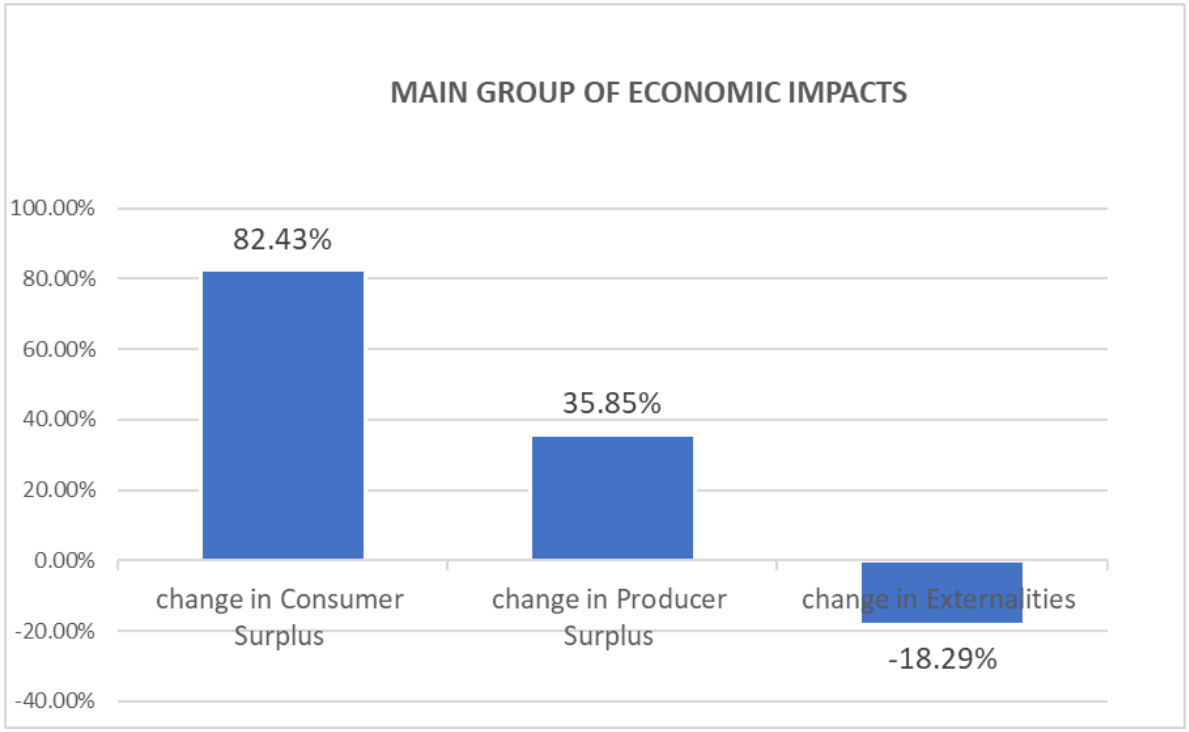

Figure 23: Main groups of economic impacts

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(c) Convert the value of cost and benefit components into economic price by using Standard Conversion Factors (SCF) determined by the Government.

The conversion factors (CF) are employed to transform the market input prices into shadow prices. They represent ratios that connect both prices and they consider a more realistic value for the considered inputs. The values used frequently in ADB's Technical Assistance Consultants reports[6] have been applied for some of the outflows in this socioeconomic analysis. In particular:

Table 21. Considered Conversion factors.

Item	CF
Initial Capex	0.90
O&M costs	0.88
Reinvestment costs	0.88
Residual Value	0.90

(d) Construct the cash flow.

After having presented and described the main assumptions, as well as some methodologic elements, the project economic flows were calculated and projected for the period of analysis Project economic flows for the different years considered in the period have been estimated and projected (in Cr BDT).

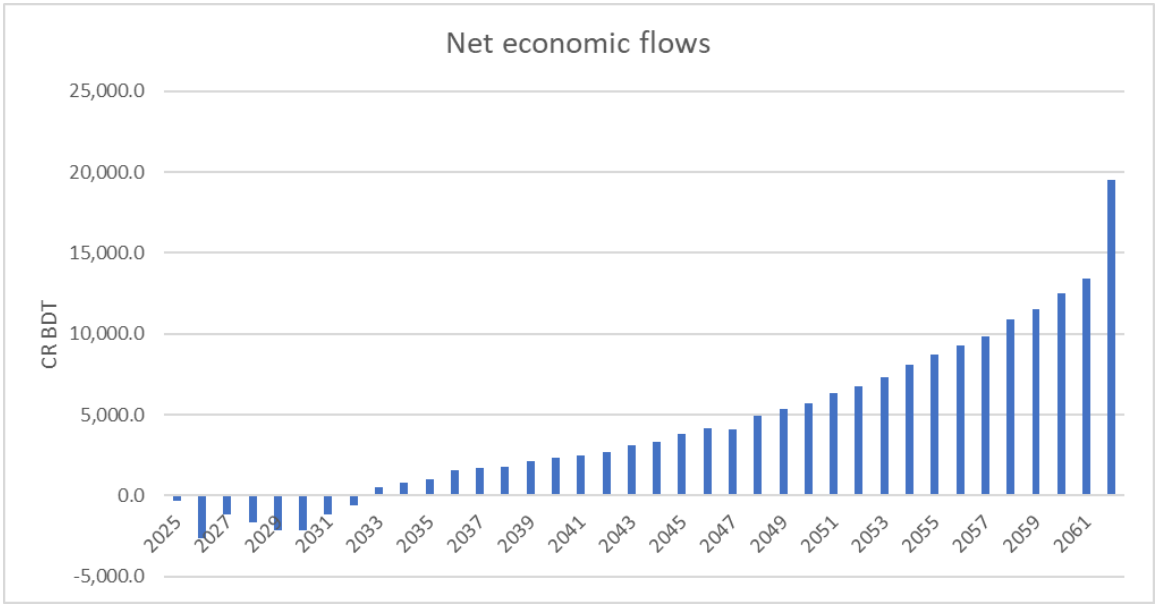

Figure 24: Undiscounted economic flows (Cr BDT)

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[6] *For instance, ADB TAC report: "supporting Sustainable Urban transport I Aizawl City" (2016). Same CF values are present for instance in: "Detailed Project Report for Rail Based Mass Transit system in Kanpur" (RITES, 2019)*

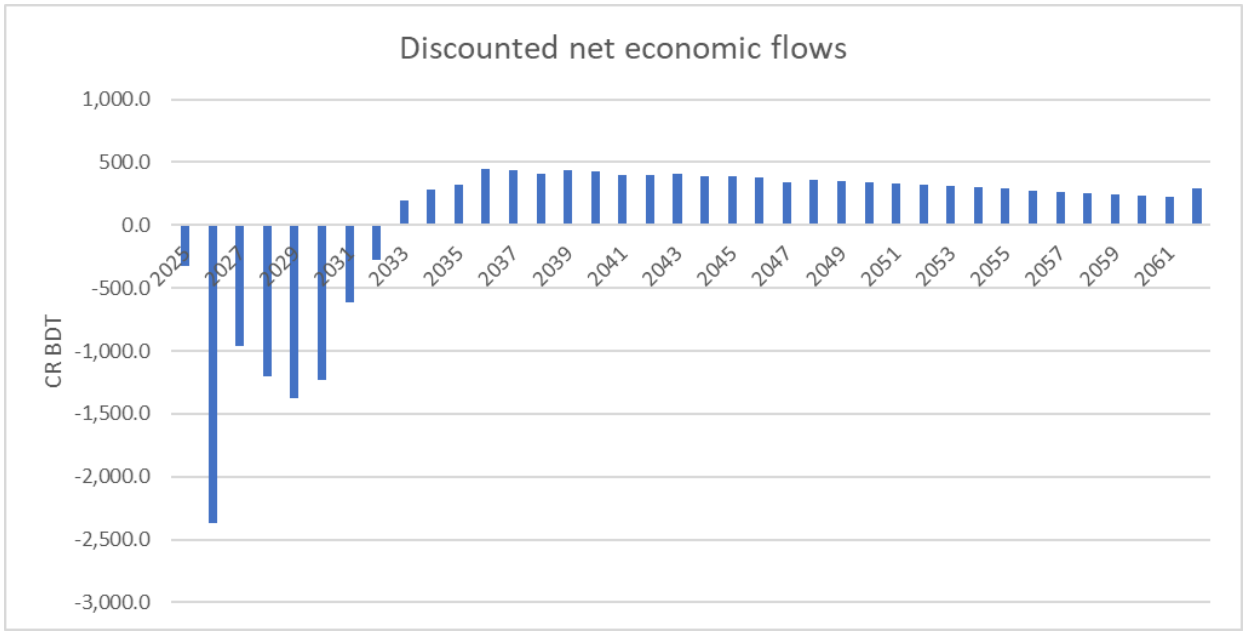

Figure 25: Discounted economic flows (Cr BDT)

(e) Mention the Assumption.

The base year has been set in 2025 and the horizon year in 2062.

- Total Investments period: 8 years (2025 - 2032)
- Total operations period: 30 years (2033 - 2062)

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Since socioeconomic analysis is referred to the first year of operation, prices and costs initially estimated to 2023 have been converted to 2025 applying the foreseen inflation.

The Values used for VoT in the model are clearly conservative values considering the different recent studies (ADB, JICA, etc.) and projects analysed in Bangladesh as well as other international references.

Table 22. Values for VoT

Mode	VoT BDT/pass-h (2022)	VoT BDT/pass-h (2025)
Motorcycles	91.8 BDT/pass-h	100 BDT/pass-h
Light vehicles	102.6 BDT/pass-h	111.76 BDT/pass-h
Buses	81 BDT/pass-h	88.23 BDT/pass-h
Truck	3.78 BDT/ton-h	4.12 BDT/ton-h

Value of time is escalated by 4.50 % yearly. The value is obtained by applying some conservative real GDP per capita long run growth rate and assuming elasticity of 70 %. This is the result of applying 70

% to 6.43 % that is the real GDP pc growth foreseen in 2024 according to data provided by Bangladesh bank to International Monetary Fund:

Vehicle Operating costs (VOC's) adopted were obtained in a case- by- case modal basis, undertaking a comparative study with cases mostly from Bangladesh, but also from India, or other international benchmarks references. In general, it has been adopted (likewise the adoption of figures for Value of Time) a quite 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 (2025)
Motorcycles	10.80	12.58
Light vehicles	15.12	17.61
Buses	32.40	37.73
Truck	43.20	50.31

As proposed Social Rate of Discount a reference of 12.00 % for the economic analysis is selected following the Memo no 20.804.014.00.00.014.027.18-177 sent by the Planning Division of the *Ministry of Planning of Bangladesh*.

Residual value has been estimated according to traditional procedures and international best practices: EU Cost- Benefit handbook, ADB guidelines, World Bank, etc. More precisely a standard approach of estimating the amount of depreciation not computed in the analysis period (*net book value or remaining depreciation costs method) was adopted*. In general, the "Net Book Value" approach[7] is a less distorting approach compared with the alternatives.

(f) Compute the following indicators and interpret the results:

(i) Economic Net Present Value (ENPV)

The project Net Present Value was estimated taking as reference the first year of the considered period (2025) when investments would start. **ENPV estimated** in real terms would reach **1,735.19 Cr BDT,** which is a positive economic result: in economic terms the benefits generated by the project are sufficient to compensate for the rise in costs, both in construction and operation of the bridge.

In more precise economic terms: potential social benefits, understood as what society is willing to pay to have access to the new bridge, are higher than social costs, or the group of goods and services to which society must renounce if it decides to implement the new bridge.

[7] *CBA handbook EU 2014, pages 34, 35*

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(ii) Economic Benefit Cost Ratio (EBCR) and Pay- Back Period (PBP)

Project benefit cost ratio reaches **1.29 (> 1)** indicating the positive economic value creation from the projection of economic discounted flows.

In terms of Pay Back period it is estimated that the initial investments will be fully recovered by **2056.**

(iii) Economic Internal Rate of Return (EIRR)

Project Economic IRR was obtained from the economic flows estimated for each year. **The result is an E-IRR equal to 13.17%.** This figure is higher than the considered social rate of discount (12%) or opportunity cost of capital, so t**he project could be considered as feasible (IRR >SRD and E-NPV positive)**

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7.2. Financial Analysis

A financial analysis has been implemented to evaluate whether Barishal-Bhola bridge project can generate enough operating income above operating expenses, repay easily external funding and remunerate equity investors under market conditions.

The procurement alternatives considered in the financial analysis are the following ones:

- Traditional procurement or Public Project: The Government of Bangladesh ("GoB") oversees project implementation as well as of the operation and maintenance of the Bridge and related works. During operation period, GoB collects toll fares from users.
- PPP procurement or PPP Contract: A private PPP company oversees the construction, operation and maintenance of the Bridge and collects tolls from users. Should expected revenues are not enough to cover total project costs, GoB grants and equity (from Public Budgets) will be part of the funding to implement the Project, in addition to those funds provided by a combination of the PPP investors and banks term loans.

In the case of the PPP contracts, the government has designed by law a viability gap funding (VGF) to estimate the required grant to support projects that are economically feasible and necessary but financially unviable. The aim of VGF is to make commercially nonviable infrastructure projects attractive to private investor through PPP arrangement. But the VGF in the form of the capital grant or annuity or both shall not exceed 40% of the total estimate project cost.

The approach to determining the most effective contract structure is as follows:

- Firstly, the project is analyzed as a Public Project or Traditional Procurement, as more reasonable for this type of projects.
- Besides, the PPP contract alternative is analyzed as it is typically more efficient to alleviate the use of GoB resources, and to shorten construction schedule.
- If the PPP contract is not viable on its own, the Viability Gap Funding ("VGF") needed to make it viable is calculated:
    - If it does not exceed 40%, the PPP structure is considered viable.
    - If the VGF required exceeds 40%, PPP structure is discarded.

(a) Components of cost & revenues

From the point of view of the revenues, the implementation of a user toll system is planned to minimize the budgetary resources from the GoB. The toll revenues should be used to cover the operation and maintenance expenses during the life of the Project as well as part of the initial investments, considering the forecasted demand and the toll fares structure.

Concerning the toll fares, four categories or vehicle classes have been considered: motorcycles, light vehicles, buses and trucks.

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(b) Cost & revenues in monetary value

Costs are presented in monetary values, starting by the initial investments and, secondly, by operation and maintenance expenses.

Table 24. Investment budget

Investment budget (VAT included)	Cr BDT (2023)	Cr BDT (2025)
General and Site facilities	610.4	639.8
Main Bridge	4,832.9	5,064.9
Approach Bridges and Connection Bridge	3,543.3	3,713.4
Approach Road including small structures	902.6	945.9
Toll plaza & CCB	538.5	564.4
Bank protection work	4,227.6	4,430.5
Land acquisition and Resettlement costs	439.8	460.9
Design costs	293.1	307.2
Supervision costs	732.8	767.9
Contingencies	1,345.4	1,409.9
CAPEX	17,466.3	18,304.7

The following table shows the detail of the sources and application of funds during the construction schedule:

Table 25. Sources and application of funds year by year. PPP contract structure

Sources & Application of Funds (Cr BDT)	2025	2026	2027	2028	2029	2030	2031	2032
Government grants	551.1	4,041.8	1,837.2	2,572.0	3,306.9	3,306.9	1,837.2	918.6
Private equity	96.3	-26.8	9.8	49.3	112.3	165.8	130.1	91.4
Long term financing resources (debt)	289.0	-80.5	29.5	147.8	336.8	497.5	390.2	274.2
Investments	511.8	3,940.8	1,880.8	2,764.8	3,732.5	3,919.2	2,286.2	1,200.2
Other initial costs (capitalized interests)	424.7	-6.3	-4.3	4.3	23.5	51.0	71.2	83.9
Total	936.5	3,934.5	1,876.5	2,769.2	3,756.0	3,970.2	2,357.4	1,284.2

Table 26. Operating expenses

Operating expenses (VAT included)	Cr BDT / year
Operation	7.50
Overall expenses. Company structure	5.00

The resulting ordinary and extraordinary maintenance amount per year is shown in the following table:

Table 27. Maintenance expenses. Amount per year.

Maintenance (Cr BDT. VAT included)	Investment	Maintenance / year
Main bridge	4,711	66.0
Approaching viaducts	3,454	48.4
Approaching roads	880	14.1
Bank protection and river training	4,121	164.9
Toll Plaza	525	13.3
Total		306.56

Once detailed de project costs, the revenues are detailed. They come from the tolls to users and are projected in four categories of vehicles, as shown in the following chart:

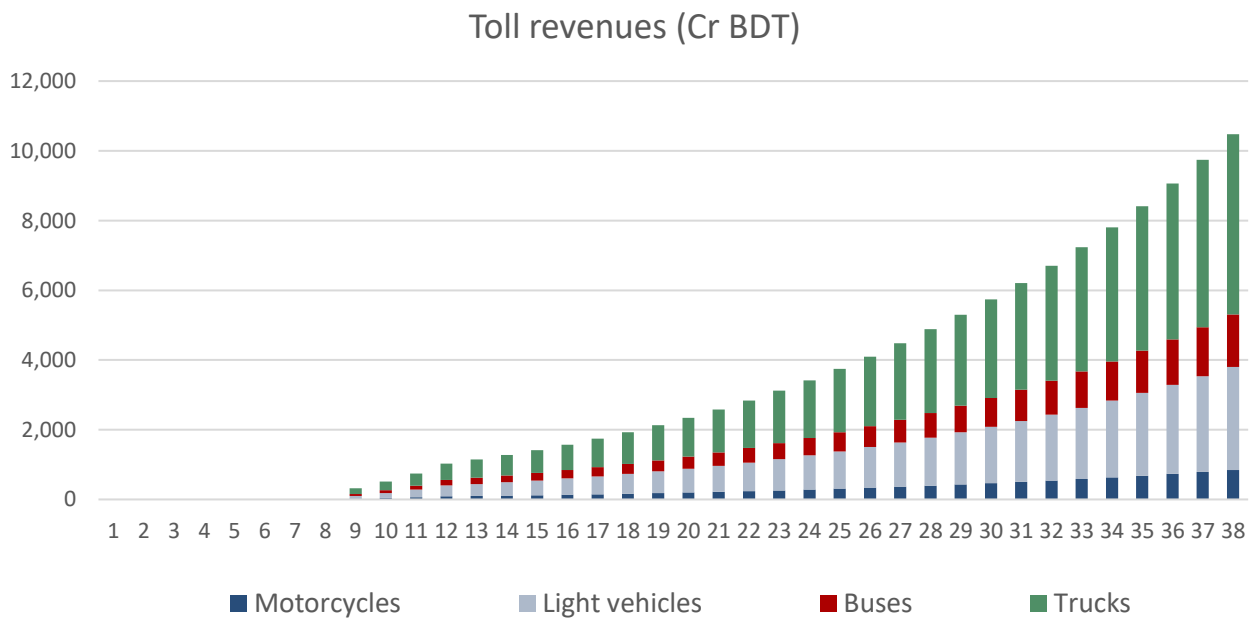

Figure 26: Toll revenues.

Despite of the number of vehicles projected, the toll revenues have different impacts on the Project cash flows: both trucks and light vehicles are the most important classes, representing almost 50% and 30% of total revenues, respectively.

(c) Cash flow.

The following tables show the 38 years of projected cash flows during the period of analysis for both contract alternatives: Public Project and PPP Contract, respectively. Notice that the cash flow projections include the construction period, the first two years of operation and every five years of the operation period:

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Team leader

Table 28. Project cash flows. Public Project or Traditional procurement

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2039 Year 15	2044 Year 20	2049 Year 25	2054 Year 30	2059 Year 35	2062 Year 38
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**317**	**510**	**1,417**	**2,345**	**3,744**	**5,736**	**8,414**	**10,473**
Toll revenues	0	0	0	0	0	0	0	0	317	510	1,417	2,345	3,744	5,736	8,414	10,473
Other commercial revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-303**	**-318**	**-406**	**-1,190**	**-661**	**-844**	**-2,473**	**-4,112**
Maintenance & Overhaul	0	0	0	0	0	0	0	0	-291	-306	-390	-1,170	-636	-811	-2,432	-4,064
Operation	0	0	0	0	0	0	0	0	-12	-12	-16	-20	-25	-32	-41	-48
Net Cash Flows due to Operations	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**14**	**192**	**1,011**	**1,155**	**3,083**	**4,892**	**5,940**	**6,362**
Cash Flows due to Investments	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**594**
Initial CAPEX	-777	-4,313	-2,140	-3,143	-4,256	-4,536	-2,831	-1,691	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	594
Project cash flows	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**	**14**	**192**	**1,011**	**1,155**	**3,083**	**4,892**	**5,940**	**6,956**

GOVERNMENT CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2039 Year 15	2044 Year 20	2049 Year 25	2054 Year 30	2059 Year 35	2062 Year 38
Outflows	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**	**-1,426**	**-1,424**	**-1,427**	**-2,126**	**-1,512**	**-1,610**	**-3,154**	**-4,147**
Project Development (CAPEX)	-549	-4,228	-2,018	-2,967	-4,005	-4,205	-2,453	-1,288	0	0	0	0	0	0	0	594
Interest expenses and fees during constru	-228	-85	-122	-176	-251	-331	-378	-404	0	0	0	0	0	0	0	0
Operation and maintenance expenses	0	0	0	0	0	0	0	0	-303	-318	-406	-1,190	-661	-844	-2,473	-4,112
Loan Repayments																
Interest	0	0	0	0	0	0	0	0	-637	-620	-535	-450	-365	-280	-195	-144
Principal Repayments	0	0	0	0	0	0	0	0	-485	-485	-485	-485	-485	-485	-485	-485
Inflows	**620**	**3,161**	**1,616**	**2,409**	**3,313**	**3,593**	**2,307**	**1,429**	**317**	**510**	**1,417**	**2,345**	**3,744**	**5,736**	**8,414**	**10,473**
Borrowings	620	3,161	1,616	2,409	3,313	3,593	2,307	1,429	0	0	0	0	0	0	0	0
Operating revenues	0	0	0	0	0	0	0	0	317	510	1,417	2,345	3,744	5,736	8,414	10,473
Future Developments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-157**	**-1,153**	**-524**	**-734**	**-943**	**-943**	**-524**	**-262**	**-1,108**	**-913**	**-9**	**219**	**2,232**	**4,126**	**5,259**	**6,326**

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Table 29. Project cash flows. PPP Contract

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8	2033 Year 9	2034 Year 10	2039 Year 15	2044 Year 20	2049 Year 25	2054 Year 30	2059 Year 35	2062 Year 38
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**317**	**510**	**1,417**	**2,345**	**3,744**	**5,736**	**8,414**	**10,473**
Toll revenues	0	0	0	0	0	0	0	0	317	510	1,417	2,345	3,744	5,736	8,414	10,473
Other revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating expenses	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-290**	**-305**	**-389**	**-1,121**	**-634**	**-809**	**-2,331**	**-3,860**
Maintenance	0	0	0	0	0	0	0	0	-271	-284	-363	-1,088	-591	-755	-2,262	-3,780
Operation	0	0	0	0	0	0	0	0	-12	-12	-16	-20	-25	-32	-41	-48
SPV Structure	0	0	0	0	0	0	0	0	-8	-8	-10	-13	-17	-22	-28	-32
Corporate tax	0	0	0	0	0	0	0	0	0	0	0	-243	-763	-1,271	-1,603	-1,749
EBITDA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**27**	**206**	**1,028**	**1,223**	**3,111**	**4,927**	**6,082**	**6,613**
Investments	**-937**	**-3,949**	**-1,911**	**-2,817**	**-3,822**	**-4,057**	**-2,462**	**-1,399**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	-937	-3,949	-1,911	-2,817	-3,822	-4,057	-2,462	-1,399	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Project cash flows	**-937**	**-3,949**	**-1,911**	**-2,817**	**-3,822**	**-4,057**	**-2,462**	**-1,399**	**27**	**206**	**1,028**	**981**	**2,348**	**3,656**	**4,479**	**4,864**
Public Contributions	**469**	**3,440**	**1,563**	**2,189**	**2,814**	**2,814**	**1,563**	**782**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	235	1,720	782	1,094	1,407	1,407	782	391	0	0	0	0	0	0	0	0
Multilateral capital contributions	235	1,720	782	1,094	1,407	1,407	782	391	0	0	0	0	0	0	0	0
Project cash flows (after contributions)	**-467**	**-510**	**-348**	**-628**	**-1,008**	**-1,243**	**-899**	**-617**	**27**	**206**	**1,028**	**981**	**2,348**	**3,656**	**4,479**	**4,864**
Funding	**467**	**510**	**348**	**628**	**1,008**	**1,243**	**899**	**617**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Equity	117	127	87	157	252	311	225	154	0	0	0	0	0	0	0	0
Multilateral term loan	351	382	261	471	756	932	674	463	0	0	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**27**	**206**	**1,028**	**981**	**2,348**	**3,656**	**4,479**	**4,864**
Debt service. Multilateral term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-257**	**-257**	**-791**	**-104**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0	-257	-257	-192	-3	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0	0	0	-599	-101	0	0	0	0
Cash flow after debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-230**	**-52**	**237**	**877**	**2,348**	**3,656**	**4,479**	**4,864**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0	0	0	230	52	0	0	0	0	0	0
Cash flow before debt service (commercial)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**237**	**877**	**2,348**	**3,656**	**4,479**	**4,864**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-6**	**-183**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0	0	-6	-5	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0	0	0	-177	0	0	0	0	0
Free cash flows	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-6**	**55**	**877**	**2,348**	**3,656**	**4,479**	**4,864**
Dividends	0	0	0	0	0	0	0	0	0	0	0	-640	-2,010	-3,351	-4,227	-4,864
Annual cash	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-6**	**55**	**237**	**338**	**304**	**252**	**0**
Initial cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**89**	**771**	**2,359**	**4,014**	**5,483**	**6,239**
Cash movements of the year	0	0	0	0	0	0	0	0	0	-6	55	237	338	304	252	0
Ending cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-6**	**144**	**1,007**	**2,696**	**4,318**	**5,735**	**6,239**

The projected cash flows of the above table, as well as in the following chart, can be classified in two periods: investment cash flows during the construction period and operating cash flows (EBITDA) during the operation period. The resulting Project Cash Flows are negative during the construction period, because the annual investment costs are higher than annual capital grants, while positive during the operation period:

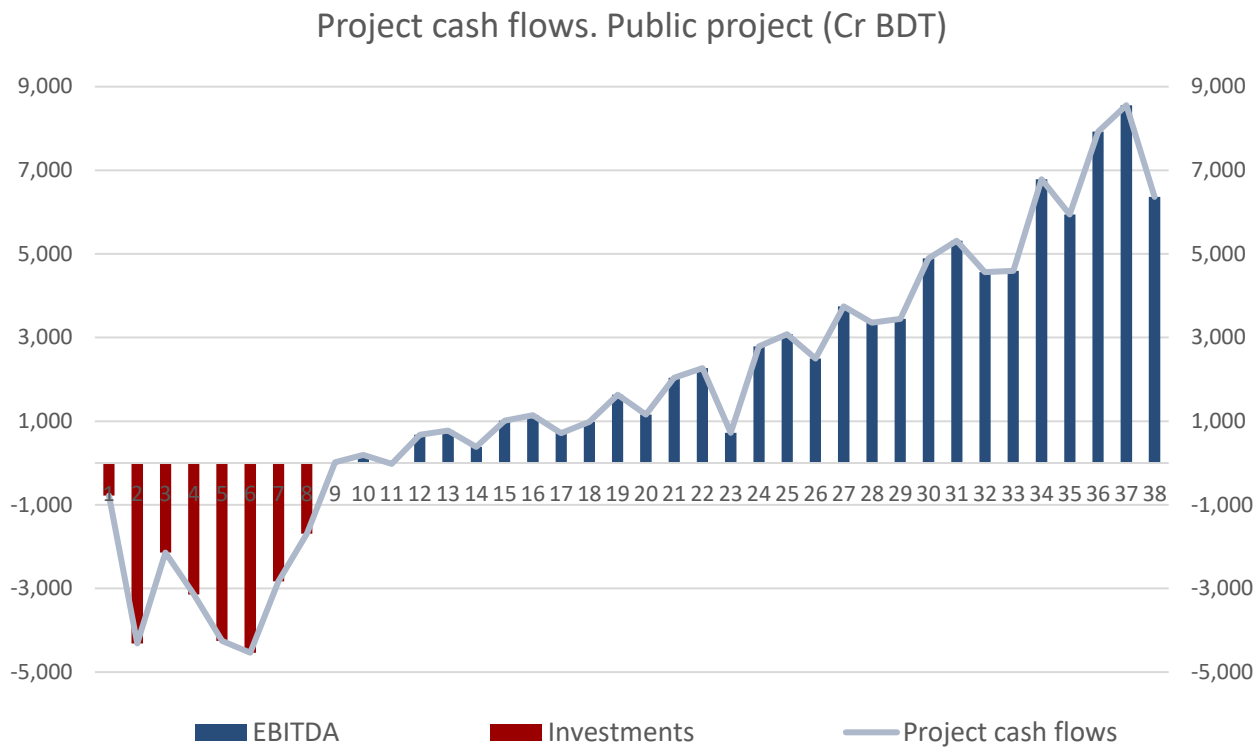

Figure 27: Projected cash flows. PPP Contract

As above mentioned, first years represent the investment period, with cash outflows and negative project cash flows; these cash outflows represent the amount of investments. From year 9 to year 12, EBITDA is changing from negative to positive several times. Since year 12, EBITDA becomes positive, with operating revenues higher than operating expenses, generating positive project cash flows (right-hand vertical axel of the above figure) during the remaining period of analysis, except in year 23, with positive EBITDA but with sharp decrease since certain extraordinary maintenance costs are considered.

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(d) Key Assumptions considered.

Table 30. General assumptions. Macroeconomic assumptions.

General assumptions	
Inflation rate	5.00%
Financial Discount Rate (Project). WACC	12.0% [8]
Exchange rate USD / BDT	108

Following Government regulation[9], financial discount rate ("FDR") is fixed at 12.00 %. It will be used as a financial discount rate to estimate the financial indicators in the financial analysis of all contract structures. Considering that the average FDR being used in this analysis is 12.00 %, a reasonable estimation of the cost of equity for investors could be around 16.00%.

Table 31. General assumptions. Terms related to assumptions.

Terms	Years
Analysis	38
Construction period (including Detail design)	8
Operation	30
Base year for analysis	2025
Starting year of operations	2033

Maintenance expenses have been estimated as an annual percentage over the respective investment amount, for ordinary maintenance. In the case of extraordinary maintenance, a percentage over the respective investment amount has been calculated every certain period, as detailed in the following table:

Table 32. Maintenance expenses. Assumptions.

Maintenance expenses	Over CAPEX
Main bridge	
Ordinary	1.0%
Extraordinary (years 15, 25, 35, 45...)	6.0%
Approaching viaducts	
Ordinary	1.0%

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[8] *Nonetheless, in case of a traditional procurement (Public Project scheme) there are no private funds whereas the institutional funds (multilateral funds) complete funds from the GoB (budgetary contributions).*

9 Memo no 20.804.014.00.00.014.027.18-177, dated 04/09/2018

Maintenance expenses	Over CAPEX
Extraordinary (years 10, 20, 30, 40...)	4.0%
Approaching roads	
Ordinary	1.0%
Extraordinary (years 10, 20, 30, 40...)	6.0%
Bank protection and river training	
Ordinary	2.0%
Extraordinary (every three years)	6.0%
Toll plaza	
Ordinary	2.0%
Extraordinary (years 15, 25, 35, 45...)	8.0%

From the point of view of the revenues, the assumptions considered are those related to the demand projections as well as the toll rates, as described below:

Table 33. Toll fares' structure

Toll rates (BDT)	BDT (with VAT 2023)	BDT (w/o VAT 2023)	BDT (w/o VAT 2025)
Motorcycles	168.00	146.09	180.35
Light vehicles	1,150.00	1,000.00	1,234.53
Buses	2,880.00	2,504.35	3,091.70
Trucks	2,810.00	2,443.48	3,016.56

Toll fares will be annually increased based on the CPI rate during the operation period. Since original toll values are as of 2023, they have been increased with the corresponding CPI from 2023 to 2025.

In the alternative of Public Project, GoB will provide funds (grants) to the project company during implementation period. The remaining funding would be provided to the project company by the private investors, as private equity (share capital), and as long-term financing (from multilateral and commercial banks) in the typical 25%/75% structure, respectively, of project financing.

(e) Financial indicators and results:

Above cash flows generate the following financial indicators for the Project,

(i) Public Project or Traditional procurement

The following table shows the financial indicators for the Traditional procurement structure:

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Table 34. Financial outcomes. Traditional procurement

FINANCIAL RESULTS	After Grants
Project F-IRR (unlevered)	5.51%
Project F-NPV (@ 12.0%). Cr BDT	-11,633.9
GoB F-IRR (levered)	8.15%
GoB net contributions (Cr BDT)	-2,877.8
Financial Benefit-Cost ratio (F-BCR)	0.38x
Term of multilateral loan (drawdown + repayment)	38 years

As detailed in the table above, the Project (unlevered scenario) cash flows after GoB contributions generate a positive Project FIRR of 5.51%, not reaching the FDR of 12.00%, generating a negative FNPV (-11,633.9 Cr BDT). In the levered scenario, FIRR reaches 8.15%, and the total net GoB contribution from the Government, in discounted BDT is estimated in -2,878 Cr BDT. As a conclusion, the Project is not feasible from the financial point of view considering the FDR of 12.0%.

(ii) PPP Contract

The following table shows the financial indicators for the PPP Contract structure:

Table 35. Financial outcomes. PPP Contract

FINANCIAL RESULTS	Bf Grants	After Grants
F-IRR. Project	4.94%	12.00%
NPV (@ 12.0%). Cr BDT	-9,710	0.0
GoB Grants required. Cr BDT		15,635
VGF (% over total Project costs)		39.37%
F-IRR. Investors		15.85%
NPV (@ Ke%). Cr BDT		-19
Term of multilateral loan (drawdown + repayment)		20 years
DSCR. Minimum		1.30x
DSCR. Average		2.20 x

As shown in the above table, results 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 15,635 Cr BDT of GoB grants, representing a VGF of 39.37%, below the limit of 40% by law, which means that the Project could be implemented with a PPP contract structure involving private investors.

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(iii) Value for Money (VfM)

The VfM involves estimating the net cost to the GOB of implementing and operating the project in two alternative processes:

- Alternative A: the Project is developed as a public project with the resulting CAPEX and OPEX payments by the BBA as well as the corresponding toll revenues to be collected.
- Alternative B: the Project is developed as a PPP contract, with the resulting VGF payments by the BBA. In this case, neither CAPEX nor OPEX are costs for the GoB, but for the PPP project company. Furthermore, the operating revenues from tolls are also revenues from the PPP project company rather than GoB revenues.

Results generated by VfM analysis are shown in the following figure and table:

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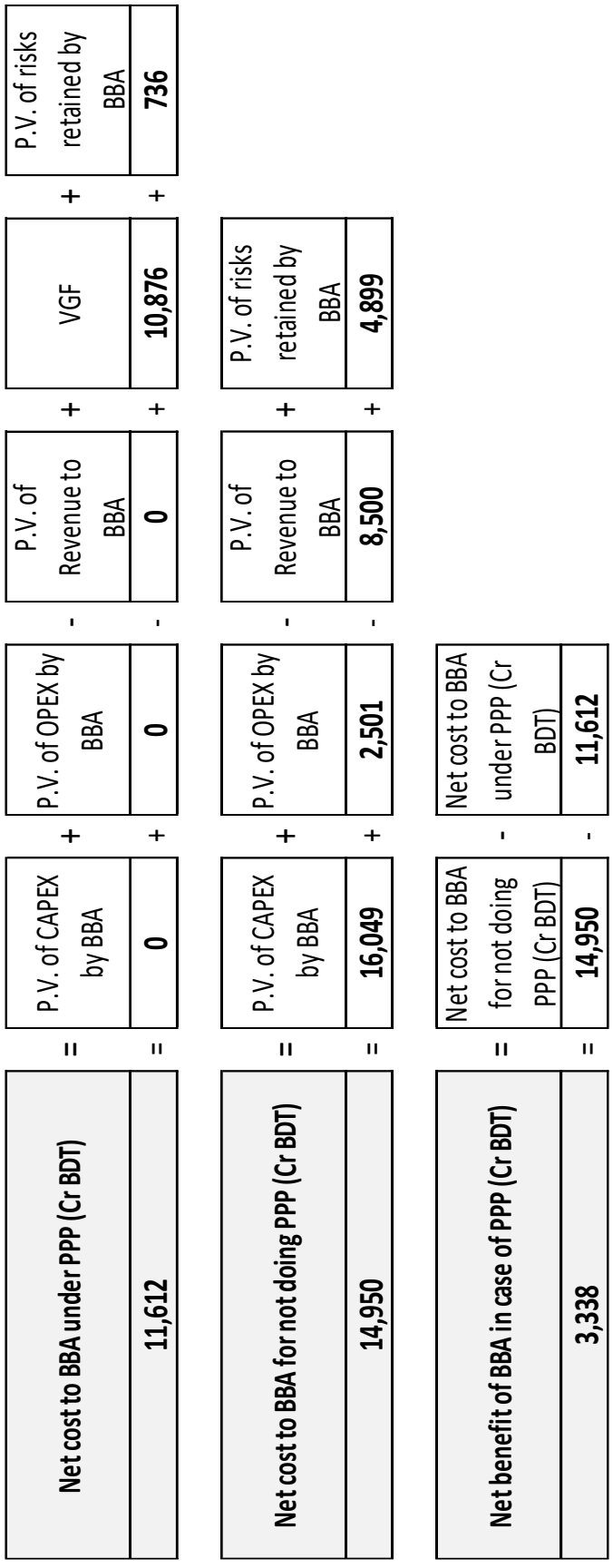

Figure 28: Value for Money process of calculation

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Results of the above chart are summarised in the following table.

Table 36. Value for Money results

Total costs (NOT including cost of risks)	Cr BDT
[1] 'Net costs to BBA (Traditional procurement)	14,950
[2] Net costs to BBA (PPP Contract)	11,612
Net benefit of BBA in case of PPP ([3] = [1] - [2])	3,338
Net benefit of BBA / Total CAPEX (= [3] / CAPEX)	20.80%

The Table above shows that there is a potential benefit for the GoB in case the Project is implemented through a PPP contract, estimated in 3,338 Cr BDT (equivalent to 20.80% of CAPEX) since most of the risks would be assigned to the private partner. This difference means that, in case the Project is implemented, it should be more convenient for the GoB to implement it as a PPP Contract. This is consistent with the fact that VGF maximum limit of 45% is not reached.

(iv) Factors of potential financial improvement

Even though the Project shows financial results that indicate that it is not financially viable, there are a number of factors that may have a positive influence on such indicators and, therefore, could facilitate financial viability. These factors have been classified into two types: endogenous and exogenous.

- Endogenous factors: One of the most relevant factors is the tax treatment of the Project, which could favour its profitability. Furthermore, other endogenous factors of the Project are potential activities to be operated by the tolled bridge operator itself, such as service areas, parking areas (mainly for truck and buses), etc.
- Exogenous factors: These factors are mainly related to the economic development of towns and poles in the Project's area of influence, which would favour the movement of people and goods and, therefore, increase the demand for the use of the Bridge.

The conclusions arisen from the financial assessment are the following ones:

- The projected demand is mainly coming from the motorcycles, but their revenues will be reduced due to the low toll rates. However, trucks, with higher toll rates, are expected to generate around 50% of total toll revenues.
- Operating expenses come mainly from maintenance of the infrastructure and installations, with several years of particularly high extraordinary maintenance costs (years 6, 15 and 25 of operation).
- Operating result (EBITDA) is expected to be positive and growing during the period of analysis, with several years of reduced EBITDA due to the high extraordinary maintenance costs (years 6, 15 and 25 of operation).

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- The Project requires significative GoB grants to reach the target FDR of 12.00% in case of PPP Contract, amounting 15,635 Cr BDT, which represents 39.37% of total project costs.
- Financial indicators, with the Public Project contract structure, show a Project with a positive FIRR of 5.51%, which is lower the FDR (12.00%), representing that the total net GoB contributions to the Project during the period analyzed are 2,877.8 Cr BDT.
- The financial analysis with the PPP Contract structure, including the GoB grant, shows positive financial indicators. 12.00% FIRR of the project (unlevered) and 15.85% FIRR for investors, being slightly lower than the target opportunity cost for investors IRR of 16.00%. The high amount of investments of the Project, despite the positive EBITDA series, require capital grants (VGF) to reduce the net investment cost and to make the Project feasible, as above mentioned, amounting 15,635 Cr BDT, which represents 39.37% of total project costs.
- Such estimated VGF is lower than the maximum of 40% set up by law for PPP Contract structures and so, the PPP Contract structure could be implemented according to the VGF regulations.
- VfM analysis generates a potential benefit for the GoB in case the Project is implemented through a PPP contract, estimated in 3,338 Cr (equivalent to 20.80% of CAPEX). This benefit would recommend implementing and operating the Project under a PPP contract structure should the VGF rule is accomplished.
- There are several factors that can make the project more attractive to private investors by increasing the economic activity in the zone and, consequently, increasing the demand of the tolled bridge Besides, there are fiscal issues which could increase Project's profitability.

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8. INSTITUTIONAL AND LEGAL ANALYSIS

When addressing the approach considerations for a specific procurement strategy plan, the following aspects of a project need to be carefully examined:

- Expediting the procurement process is a key aspect.
- Cost Uncertainty: Rates and construction cost estimate certainty is a challenging matter given today the current global macro-economic environment of high inflation and raw materials scarcity. In any case during the forecasting stages of the financial model implemented it has been taken into consideration this abnormal level of prices increases.
- Time certainty for completion of the project (Client and the Contractor/Concessionaire). Minimum time over-run should be a key fact to be considered within the type of contract being implemented. Schedule constraints and responsibility to be very well determined in the type of contract (delay damages/penalty clauses).
- Design aspects: the Detailed Design to be provided by the BBA to the awarded contractor. The Ability to contractually cope and to technically accommodate design changes in the final set of shop drawings at construction phase shall be considered within the type of contract.
- Responsibility: throughout the project's life, each party's accountability must be very critically stipulated within the contract documents.
- Complexity: Client may involve a specific innovative component to be executed or finally design. The option of awarding the project to a joint venture, led by a top worldwide international contractor together with domestic subcontractors for some sections of the project is a recommended.
- Quality Assurance: Client may involve an independent agency to regulate and monitor Quality Controls during execution and maintenance of work.
- Risk Allocation: Clearly defined areas of risk allocation, a thorough risk assessment to be implemented before tendering the project. Main risks could be considered the following ones: construction risks (cost or time overrun risk, geotechnical risk) and demand risk.

From financial perspective, the project cannot reach by itself operating or financial sustainability, which leads to a strong problem of credit solvency, requiring therefore an important support from GoB. But the high level of required grant (VGF higher than the limit 40%) leads one to not to recommend a toll-based PPP Concession Agreement.

A simple Government Contract following open international bidding process for construction and a year of maintenance is recommended to be adopted. After the completion of works, mandatory maintenance period of 1-2 years. BBA to decide. Demand risk should be retained by the Government to avoid that this relevant risk implies a high additional cost in case it is transferred to a private operator.

The classic risk sharing format for such a contract shall be as follows.

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Table 30. Risk sharing format.

BBA-Government	EPC-Contractor
Arrange for funding	Design review and proof checking
Land Acquisition	Construction and timely completion
Open bidding process and contract award for Construction and Long-term maintenance and toll collection	Maintenance for a period of 1-2 years

It is recommended that BBA may opt for a FIDIC Multilateral Development Bank Harmonized (MDB) Edition (June 2010) for General & Particular Conditions of Contract as it opts for open bidding process.

Two main factors must not be overlooked while preparing the bidding documents.

1. Proof checking of structural design by an independent consultant selected by the BBA.
2. The successful bidder shall carry out his own Geo Technical investigation to confirm the accuracy of the data furnished in the FS. Design work to proceed only after such confirmation in writing by the successful bidder. BBA may provide a supervision consultant to ensure monitoring of the quality, progress, and cost of the project during construction.

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9. CONCLUSION

As a summarizing outcome derived from this Feasibility Study, considering all Technical, Social, and Environmental standpoints, it may be concluded that the project, located at Barishal district, consisting of the 10.87 km long bridge, crossing the Kalabador/Tentulia River at the selected alignment C, through the designed balance cantilever concrete bridge and a series of other needed associated components would be technically viable. The economic analysis concludes that the project would bring relevant socio-economic benefits to the society and could be financially viable under PPP scheme or Public Government implementation (under certain considerations).

The Consultant recommends this project 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 upazilas Bhola Sadar and Barishal Sadar, to the whole Barishal district, and to the entire southern region of Bangladesh. It would also promote and enhance potential connectivity corridors, as the East-West one through the southern part of the country.

Environmental assessment has been carried out accordingly with the current DOE guidelines and recommendations, being the project under red category, and its 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 following the current legislation and guidelines. Any project impact, as the need of resettlement plan for part of the affected areas, would be mitigated by implementing the Social Impact Assessment Action Plan. Consultation to the community of the affected area was carried out with a positive response from both local authorities and population.

The completion of this project construction has been estimated in 78 months. After 8 years of investment phase (2025 to 2032), operation phase would start in 2033 and end in 2062 (30 years).

The estimated cost investment is **17,466 Cr BDT**. Economic Cost-Benefit Analysis (CBA) has been assessed running the traffic scenario detailed in Section 3.5, without considering 3 wheelers and with the final version of revised toll fares.

The results obtained from the socio-economic study, after running the Cost-Benefit Model (CBA) are as follows: **EIRR 13.17%,** C/B ratio **1.29** and pay-back year **2056.**

The Financial indicators, in the case of **Public Project** contract structure, show a project with a positive **FIRR of 5.51% (unlevered case)** and **8.15% (levered case)**, which are lower than the FDR (12.00%). In the levered case, the total net Government contribution to the Project during the period analysed is estimated as 2,877.8 Cr BDT.

The project shows financial feasibility under a **PPP structure** provided that the grant required 15,635 Cr BDT is achieved, which represents **39.4 % (VGF)** of the total project costs. This level of required grant (or VGF) does not exceed the limit of 40 % set up by law for PPP contract structures and therefore the PPP Contract structure could be implemented according to VGF regulation.

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Annexure 01 – Economic and Financial Model Calculation Sheets

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Economic Analysis

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CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Existing traffic	**3,342.95**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	3,089.06	0.00	0.00	0.00	0.00	0.00
User freight time savings	236.47	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	17.43	0.00	0.00	0.00	0.00	0.00
Diverted traffic	**2,364.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User passenger time savings	1,425.24	0.00	0.00	0.00	0.00	0.00
User freight time savings	169.32	0.00	0.00	0.00	0.00	0.00
Vehicle Operating Costs (VOC) savings	769.51	0.00	0.00	0.00	0.00	0.00
Generated traffic	**3,475.35**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
User time costs savings	3,410.27	0.00	0.00	0.00	0.00	0.00
User freight time savings	145.70	0.00	0.00	0.00	0.00	0.00
Additional Vehicle Operating Costs (VOC)	-80.62	0.00	0.00	0.00	0.00	0.00
Variation in Externalities	**-1,512.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Accidents	-1,227.69	0.00	0.00	0.00	0.00	0.00
Emissions	-235.94	0.00	0.00	0.00	0.00	0.00
Air polution	-116.15	0.00	0.00	0.00	0.00	0.00
Climate change	-119.79	0.00	0.00	0.00	0.00	0.00
Well to tank	-48.82	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**-322.19**	**-2,650.05**	**-1,204.57**	**-1,686.40**	**-2,168.22**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Change in Producer Surplus:	**2,965.61**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Producers costs savings for the system	1,960.48	0.00	0.00	0.00	0.00	0.00
Existing traffic	261.00	0.00	0.00	0.00	0.00	0.00
Diverted traffic	1,699.48	0.00	0.00	0.00	0.00	0.00
Toll revenues (generated traffic)	1,094.50	0.00	0.00	0.00	0.00	0.00
Vehicle Op costs (generated traffic)	-89.37	0.00	0.00	0.00	0.00	0.00
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**-322.19**	**-2,650.05**	**-1,204.57**	**-1,686.40**	**-2,168.22**
NET BENEFITS CrBDT	**1,735.19**	**-322.19**	**-2,650.05**	**-1,204.57**	**-1,686.40**	**-2,168.22**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2030	2031	2032	2033	2034
		Year 6	Year 7	Year 8	Year 9	Year 10
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**0.00**	**0.00**	**0.00**	**557.79**	**807.20**
Existing traffic	**3,342.95**	**0.00**	**0.00**	**0.00**	**383.73**	**423.62**
User passenger time savings	3,089.06	0.00	0.00	0.00	355.70	392.46
User freight time savings	236.47	0.00	0.00	0.00	25.48	28.41
Vehicle Operating Costs (VOC) savings	17.43	0.00	0.00	0.00	2.54	2.75
Diverted traffic	**2,364.07**	**0.00**	**0.00**	**0.00**	**74.78**	**165.55**
User passenger time savings	1,425.24	0.00	0.00	0.00	42.37	94.29
User freight time savings	169.32	0.00	0.00	0.00	4.87	10.87
Vehicle Operating Costs (VOC) savings	769.51	0.00	0.00	0.00	27.53	60.39
Generated traffic	**3,475.35**	**0.00**	**0.00**	**0.00**	**99.28**	**218.04**
User time costs savings	3,410.27	0.00	0.00	0.00	98.55	216.18
User freight time savings	145.70	0.00	0.00	0.00	3.41	7.58
Additional Vehicle Operating Costs (VOC)	-80.62	0.00	0.00	0.00	-2.68	-5.73
Variation in Externalities	**-1,512.44**	**0.00**	**0.00**	**0.00**	**-80.26**	**-162.53**
Accidents	-1,227.69	0.00	0.00	0.00	-65.42	-133.26
Emissions	-235.94	0.00	0.00	0.00	-12.27	-24.18
Air polution	-116.15	0.00	0.00	0.00	-5.93	-11.66
Climate change	-119.79	0.00	0.00	0.00	-6.34	-12.53
Well to tank	-48.82	0.00	0.00	0.00	-2.56	-5.10
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**0.00**	**0.00**	**0.00**	**477.53**	**644.67**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**-2,168.22**	**-1,204.57**	**-601.38**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**0.00**	**0.00**	**0.00**	**-120.67**	**-120.67**
Change in Producer Surplus:	**2,965.61**	**0.00**	**0.00**	**0.00**	**138.28**	**264.64**
Producers costs savings for the system	1,960.48	0.00	0.00	0.00	86.67	157.00
Existing traffic	261.00	0.00	0.00	0.00	31.12	34.34
Diverted traffic	1,699.48	0.00	0.00	0.00	55.55	122.66
Toll revenues (generated traffic)	1,094.50	0.00	0.00	0.00	53.82	112.55
Vehicle Op costs (generated traffic)	-89.37	0.00	0.00	0.00	-2.21	-4.91
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**-2,168.22**	**-1,204.57**	**-601.38**	**17.60**	**143.97**
NET BENEFITS CrBDT	**1,735.19**	**-2,168.22**	**-1,204.57**	**-601.38**	**495.13**	**788.64**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**1,099.89**	**1,440.59**	**1,591.34**	**1,755.32**	**1,933.43**
Existing traffic	**3,342.95**	**467.12**	**514.50**	**566.02**	**621.97**	**682.63**
User passenger time savings	3,089.06	432.54	476.19	523.66	575.21	631.12
User freight time savings	236.47	31.62	35.11	38.91	43.05	47.53
Vehicle Operating Costs (VOC) savings	17.43	2.97	3.20	3.44	3.70	3.98
Diverted traffic	**2,364.07**	**274.31**	**403.20**	**443.64**	**487.21**	**534.10**
User passenger time savings	1,425.24	157.04	232.00	256.55	283.15	311.93
User freight time savings	169.32	18.14	26.86	29.77	32.94	36.38
Vehicle Operating Costs (VOC) savings	769.51	99.12	144.33	157.31	171.12	185.80
Generated traffic	**3,475.35**	**358.47**	**522.89**	**581.68**	**646.14**	**716.69**
User time costs savings	3,410.27	354.98	517.18	574.83	637.98	707.03
User freight time savings	145.70	12.61	18.59	21.11	23.92	27.05
Additional Vehicle Operating Costs (VOC)	-80.62	-9.13	-12.88	-14.26	-15.76	-17.38
Variation in Externalities	**-1,512.44**	**-252.66**	**-350.69**	**-372.52**	**-395.02**	**-418.18**
Accidents	-1,227.69	-207.61	-288.54	-305.98	-323.90	-342.28
Emissions	-235.94	-37.18	-51.27	-54.93	-58.75	-62.73
Air polution	-116.15	-17.93	-24.74	-26.58	-28.51	-30.52
Climate change	-119.79	-19.26	-26.53	-28.35	-30.24	-32.21
Well to tank	-48.82	-7.87	-10.87	-11.61	-12.38	-13.17
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**847.23**	**1,089.90**	**1,218.82**	**1,360.30**	**1,515.25**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**-251.24**	**-120.67**	**-120.67**	**-251.24**	**-120.67**
Change in Producer Surplus:	**2,965.61**	**408.50**	**571.13**	**619.27**	**670.35**	**724.49**
Producers costs savings for the system	1,960.48	240.56	338.83	371.88	407.41	445.54
Existing traffic	261.00	37.84	41.61	45.70	50.10	54.84
Diverted traffic	1,699.48	202.72	297.22	326.19	357.31	390.70
Toll revenues (generated traffic)	1,094.50	176.09	244.30	260.93	278.21	296.12
Vehicle Op costs (generated traffic)	-89.37	-8.15	-12.00	-13.55	-15.27	-17.17
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**157.26**	**450.46**	**498.60**	**419.11**	**603.81**
NET BENEFITS CrBDT	**1,735.19**	**1,004.49**	**1,540.36**	**1,717.42**	**1,779.41**	**2,119.07**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2040 Year 16	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**2,126.63**	**2,335.91**	**2,562.33**	**2,807.00**	**3,071.06**
Existing traffic	**3,342.95**	**748.33**	**819.38**	**896.12**	**978.91**	**1,068.11**
User passenger time savings	3,089.06	691.66	757.14	827.88	904.19	986.42
User freight time savings	236.47	52.39	57.65	63.33	69.46	76.06
Vehicle Operating Costs (VOC) savings	17.43	4.28	4.59	4.91	5.26	5.62
Diverted traffic	**2,364.07**	**584.48**	**638.54**	**696.45**	**758.43**	**824.66**
User passenger time savings	1,425.24	343.01	376.54	412.64	451.48	493.19
User freight time savings	169.32	40.10	44.13	48.48	53.18	58.24
Vehicle Operating Costs (VOC) savings	769.51	201.37	217.87	235.33	253.77	273.23
Generated traffic	**3,475.35**	**793.81**	**877.99**	**969.76**	**1,069.66**	**1,178.29**
User time costs savings	3,410.27	782.43	864.65	954.20	1,051.59	1,157.39
User freight time savings	145.70	30.53	34.39	38.66	43.37	48.58
Additional Vehicle Operating Costs (VOC)	-80.62	-19.14	-21.04	-23.09	-25.30	-27.68
Variation in Externalities	**-1,512.44**	**-441.97**	**-466.37**	**-491.37**	**-516.93**	**-543.03**
Accidents	-1,227.69	-361.11	-380.36	-400.01	-420.04	-440.42
Emissions	-235.94	-66.87	-71.17	-75.63	-80.25	-85.04
Air polution	-116.15	-32.62	-34.82	-37.10	-39.47	-41.93
Climate change	-119.79	-34.24	-36.35	-38.53	-40.78	-43.10
Well to tank	-48.82	-14.00	-14.85	-15.73	-16.64	-17.57
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**1,684.66**	**1,869.54**	**2,070.97**	**2,290.07**	**2,528.03**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**-120.67**	**-251.24**	**-267.34**	**-120.67**	**-251.24**
Change in Producer Surplus:	**2,965.61**	**781.78**	**842.34**	**906.27**	**973.70**	**1,044.72**
Producers costs savings for the system	1,960.48	486.40	530.12	576.85	626.72	679.88
Existing traffic	261.00	59.94	65.41	71.29	77.58	84.30
Diverted traffic	1,699.48	426.46	464.71	505.56	549.14	595.58
Toll revenues (generated traffic)	1,094.50	314.66	333.83	353.60	373.98	394.94
Vehicle Op costs (generated traffic)	-89.37	-19.28	-21.61	-24.17	-27.00	-30.10
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**661.11**	**591.10**	**638.93**	**853.02**	**793.48**
NET BENEFITS CrBDT	**1,735.19**	**2,345.76**	**2,460.64**	**2,709.90**	**3,143.09**	**3,321.51**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24	2049 Year 25
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**3,355.72**	**3,662.26**	**3,992.01**	**4,346.36**	**4,726.76**
Existing traffic	**3,342.95**	**1,164.10**	**1,267.30**	**1,378.11**	**1,496.97**	**1,624.33**
User passenger time savings	3,089.06	1,074.93	1,170.08	1,272.27	1,381.90	1,499.38
User freight time savings	236.47	83.17	90.81	99.00	107.80	117.21
Vehicle Operating Costs (VOC) savings	17.43	6.01	6.41	6.83	7.27	7.74
Diverted traffic	**2,364.07**	**895.36**	**970.74**	**1,051.03**	**1,136.46**	**1,227.27**
User passenger time savings	1,425.24	537.94	585.89	637.21	692.08	750.67
User freight time savings	169.32	63.69	69.55	75.83	82.57	89.80
Vehicle Operating Costs (VOC) savings	769.51	293.73	315.31	337.99	361.81	386.80
Generated traffic	**3,475.35**	**1,296.26**	**1,424.22**	**1,562.87**	**1,712.93**	**1,875.17**
User time costs savings	3,410.27	1,272.17	1,396.57	1,531.22	1,676.82	1,834.09
User freight time savings	145.70	54.32	60.64	67.58	75.20	83.55
Additional Vehicle Operating Costs (VOC)	-80.62	-30.24	-32.99	-35.94	-39.10	-42.48
Variation in Externalities	**-1,512.44**	**-569.64**	**-596.75**	**-624.33**	**-652.34**	**-680.77**
Accidents	-1,227.69	-461.14	-482.17	-503.49	-525.08	-546.91
Emissions	-235.94	-89.97	-95.07	-100.31	-105.71	-111.25
Air polution	-116.15	-44.48	-47.12	-49.85	-52.67	-55.57
Climate change	-119.79	-45.49	-47.94	-50.46	-53.04	-55.68
Well to tank	-48.82	-18.53	-19.51	-20.52	-21.56	-22.62
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**2,786.08**	**3,065.51**	**3,367.69**	**3,694.02**	**4,045.99**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**-120.67**	**-120.67**	**-536.97**	**-120.67**	**-120.67**
Change in Producer Surplus:	**2,965.61**	**1,119.46**	**1,198.03**	**1,280.56**	**1,367.16**	**1,457.97**
Producers costs savings for the system	1,960.48	736.49	796.69	860.64	928.52	1,000.49
Existing traffic	261.00	91.49	99.17	107.35	116.06	125.33
Diverted traffic	1,699.48	644.99	697.52	753.30	812.46	875.16
Toll revenues (generated traffic)	1,094.50	416.48	438.59	461.25	484.45	508.17
Vehicle Op costs (generated traffic)	-89.37	-33.51	-37.25	-41.34	-45.81	-50.69
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**998.79**	**1,077.36**	**743.59**	**1,246.49**	**1,337.30**
NET BENEFITS CrBDT	**1,735.19**	**3,784.86**	**4,142.87**	**4,111.28**	**4,940.51**	**5,383.29**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**5,134.75**	**5,571.91**	**6,039.94**	**6,524.55**	**7,040.75**
Existing traffic	**3,342.95**	**1,760.66**	**1,906.47**	**2,062.25**	**2,228.53**	**2,405.89**
User passenger time savings	3,089.06	1,625.15	1,759.68	1,903.43	2,056.90	2,220.59
User freight time savings	236.47	127.29	138.06	149.55	161.82	174.90
Vehicle Operating Costs (VOC) savings	17.43	8.22	8.73	9.26	9.82	10.39
Diverted traffic	**2,364.07**	**1,323.69**	**1,426.00**	**1,534.45**	**1,649.32**	**1,770.89**
User passenger time savings	1,425.24	813.19	879.83	950.78	1,026.28	1,106.54
User freight time savings	169.32	97.53	105.79	114.61	124.02	134.06
Vehicle Operating Costs (VOC) savings	769.51	412.98	440.39	469.06	499.01	530.30
Generated traffic	**3,475.35**	**2,050.39**	**2,239.45**	**2,443.24**	**2,646.69**	**2,863.97**
User time costs savings	3,410.27	2,003.79	2,186.72	2,383.73	2,582.15	2,794.05
User freight time savings	145.70	92.69	102.69	113.60	122.92	132.86
Additional Vehicle Operating Costs (VOC)	-80.62	-46.10	-49.96	-54.09	-58.37	-62.93
Variation in Externalities	**-1,512.44**	**-709.60**	**-738.78**	**-768.31**	**-793.24**	**-818.08**
Accidents	-1,227.69	-568.96	-591.20	-613.63	-633.56	-653.42
Emissions	-235.94	-116.94	-122.78	-128.75	-132.91	-137.05
Air polution	-116.15	-58.55	-61.63	-64.78	-66.86	-68.94
Climate change	-119.79	-58.39	-61.15	-63.97	-66.04	-68.11
Well to tank	-48.82	-23.70	-24.80	-25.93	-26.77	-27.61
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**4,425.15**	**4,833.13**	**5,271.62**	**5,731.31**	**6,222.67**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**-251.24**	**-120.67**	**-267.34**	**-251.24**	**-120.67**
Change in Producer Surplus:	**2,965.61**	**1,553.11**	**1,652.73**	**1,756.94**	**1,860.65**	**1,968.99**
Producers costs savings for the system	1,960.48	1,076.72	1,157.40	1,242.72	1,332.87	1,428.04
Existing traffic	261.00	135.18	145.65	156.75	168.53	181.01
Diverted traffic	1,699.48	941.54	1,011.75	1,085.97	1,164.34	1,247.04
Toll revenues (generated traffic)	1,094.50	532.40	557.13	582.33	601.28	620.17
Vehicle Op costs (generated traffic)	-89.37	-56.01	-61.80	-68.11	-73.50	-79.22
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**1,301.88**	**1,532.05**	**1,489.60**	**1,609.41**	**1,848.32**
NET BENEFITS CrBDT	**1,735.19**	**5,727.03**	**6,365.18**	**6,761.22**	**7,340.72**	**8,070.98**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2055 Year 31	2056 Year 32	2057 Year 33	2058 Year 34	2059 Year 35
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**					
Change in Consumer Surplus	**9,182.38**	**7,590.15**	**8,174.42**	**8,795.30**	**9,454.58**	**10,154.15**
Existing traffic	**3,342.95**	**2,594.88**	**2,796.11**	**3,010.21**	**3,237.83**	**3,479.63**
User passenger time savings	3,089.06	2,395.06	2,580.85	2,778.53	2,988.73	3,212.05
User freight time savings	236.47	188.83	203.64	219.40	236.14	253.91
Vehicle Operating Costs (VOC) savings	17.43	11.00	11.62	12.28	12.96	13.67
Diverted traffic	**2,364.07**	**1,899.46**	**2,035.34**	**2,178.84**	**2,330.30**	**2,490.05**
User passenger time savings	1,425.24	1,191.78	1,282.26	1,378.23	1,479.94	1,587.66
User freight time savings	169.32	144.75	156.12	168.22	181.07	194.72
Vehicle Operating Costs (VOC) savings	769.51	562.93	596.95	632.39	669.29	707.67
Generated traffic	**3,475.35**	**3,095.81**	**3,342.97**	**3,606.24**	**3,886.46**	**4,184.46**
User time costs savings	3,410.27	3,020.14	3,261.18	3,517.93	3,791.19	4,081.81
User freight time savings	145.70	143.44	154.70	166.67	179.39	192.90
Additional Vehicle Operating Costs (VOC)	-80.62	-67.77	-72.91	-78.35	-84.13	-90.24
Variation in Externalities	**-1,512.44**	**-842.82**	**-867.42**	**-891.86**	**-916.12**	**-940.17**
Accidents	-1,227.69	-673.20	-692.87	-712.41	-731.80	-751.04
Emissions	-235.94	-141.18	-145.28	-149.36	-153.40	-157.41
Air polution	-116.15	-71.01	-73.07	-75.11	-77.14	-79.16
Climate change	-119.79	-70.17	-72.21	-74.24	-76.26	-78.26
Well to tank	-48.82	-28.44	-29.27	-30.10	-30.91	-31.73
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**6,747.33**	**7,307.00**	**7,903.44**	**8,538.46**	**9,213.97**
SOCIO ECONOMIC COSTS CrBDT						
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Renovation works	**-642.36**	**-120.67**	**-251.24**	**-406.40**	**-120.67**	**-251.24**
Change in Producer Surplus:	**2,965.61**	**2,082.13**	**2,200.25**	**2,323.53**	**2,452.17**	**2,586.38**
Producers costs savings for the system	1,960.48	1,528.46	1,634.33	1,745.87	1,863.32	1,986.92
Existing traffic	261.00	194.21	208.18	222.96	238.56	255.04
Diverted traffic	1,699.48	1,334.25	1,426.14	1,522.91	1,624.76	1,731.88
Toll revenues (generated traffic)	1,094.50	638.97	657.67	676.25	694.70	712.98
Vehicle Op costs (generated traffic)	-89.37	-85.30	-91.75	-98.59	-105.84	-113.52
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**1,961.46**	**1,949.01**	**1,917.13**	**2,331.50**	**2,335.14**
NET BENEFITS CrBDT	**1,735.19**	**8,708.79**	**9,256.01**	**9,820.57**	**10,869.96**	**11,549.11**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

CBA

FEASIBILITY STUDY OF BARISHAL-BHOLA BRIDGE		2060 Year 36	2061 Year 37	2062 Year 38
SOCIO ECONOMIC BENEFITS CrBDT	**NPV**			
Change in Consumer Surplus	**9,182.38**	**10,895.95**	**11,682.04**	**12,514.51**
Existing traffic	**3,342.95**	**3,736.33**	**4,008.66**	**4,297.38**
User passenger time savings	3,089.06	3,449.16	3,700.74	3,967.49
User freight time savings	236.47	272.77	292.76	313.93
Vehicle Operating Costs (VOC) savings	17.43	14.40	15.16	15.96
Diverted traffic	**2,364.07**	**2,658.46**	**2,835.90**	**3,022.75**
User passenger time savings	1,425.24	1,701.69	1,822.31	1,949.82
User freight time savings	169.32	209.19	224.54	240.81
Vehicle Operating Costs (VOC) savings	769.51	747.58	789.05	832.11
Generated traffic	**3,475.35**	**4,501.16**	**4,837.48**	**5,194.38**
User time costs savings	3,410.27	4,390.65	4,718.62	5,066.66
User freight time savings	145.70	207.23	222.42	238.52
Additional Vehicle Operating Costs (VOC)	-80.62	-96.71	-103.56	-110.80
Variation in Externalities	**-1,512.44**	**-964.00**	**-987.59**	**-1,010.91**
Accidents	-1,227.69	-770.09	-788.94	-807.59
Emissions	-235.94	-161.39	-165.32	-169.21
Air polution	-116.15	-81.15	-83.12	-85.07
Climate change	-119.79	-80.24	-82.20	-84.14
Well to tank	-48.82	-32.53	-33.32	-34.11
TOTAL ECONOMIC BENEFITS CrBDT	**7,669.94**	**9,931.95**	**10,694.45**	**11,503.60**
SOCIO ECONOMIC COSTS CrBDT				
Project initial investments	**-8,339.49**	**0.00**	**0.00**	**0.00**
Residual value	**81.49**	**0.00**	**0.00**	**5,397.07**
Renovation works	**-642.36**	**-120.67**	**-120.67**	**-397.91**
Change in Producer Surplus:	**2,965.61**	**2,726.36**	**2,872.35**	**3,024.57**
Producers costs savings for the system	1,960.48	2,116.92	2,253.57	2,397.15
Existing traffic	261.00	272.43	290.77	310.10
Diverted traffic	1,699.48	1,844.49	1,962.80	2,087.05
Toll revenues (generated traffic)	1,094.50	731.10	749.02	766.75
Vehicle Op costs (generated traffic)	-89.37	-121.65	-130.25	-139.33
TOTAL ECONOMIC COSTS CrBDT	**-5,934.74**	**2,605.69**	**2,751.67**	**8,023.73**
NET BENEFITS CrBDT	**1,735.19**	**12,537.64**	**13,446.12**	**19,527.33**

IRR (%)	**13.17%**
NPV CrBDT	**1,735.19**
Pay Back	**2,056**
Benefit / Cost	**1.29**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

Financial Analysis-Project and Government Cash Flows

SANCHEZ
JIMENEZ
JOSE LUIS
Team leader

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BARISHAL-BHOLA BRIDGE

	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8
Construction period	1	1	1	1	1	1	1	1
Operation period	0	0	0	0	0	0	0	0
Term of analysis	1	1	1	1	1	1	1	1
Price indexation	1.00	1.05	1.10	1.16	1.22	1.28	1.34	1.41

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Toll revenues	0	0	0	0	0	0	0	0
Other commercial revenues	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Maintenance & Overhaul	0	0	0	0	0	0	0	0
Operation	0	0	0	0	0	0	0	0
Net Cash Flows due to Operations	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cash Flows due to Investments	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**
Initial CAPEX	-777	-4,313	-2,140	-3,143	-4,256	-4,536	-2,831	-1,691
Other CAPEX	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0
Project cash flows	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**

GOVERNMENT CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8
Outflows	**-777**	**-4,313**	**-2,140**	**-3,143**	**-4,256**	**-4,536**	**-2,831**	**-1,691**
Project Development (CAPEX)	-549	-4,228	-2,018	-2,967	-4,005	-4,205	-2,453	-1,288
Interest expenses and fees during constru	-228	-85	-122	-176	-251	-331	-378	-404
Operation and maintenance expenses	0	0	0	0	0	0	0	0
Loan Repayments								
Interest	0	0	0	0	0	0	0	0
Principal Repayments	0	0	0	0	0	0	0	0
Inflows	**620**	**3,161**	**1,616**	**2,409**	**3,313**	**3,593**	**2,307**	**1,429**
Borrowings	620	3,161	1,616	2,409	3,313	3,593	2,307	1,429
Operating revenues	0	0	0	0	0	0	0	0
Future Developments	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-157**	**-1,153**	**-524**	**-734**	**-943**	**-943**	**-524**	**-262**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

BARISHAL-BHOLA BRIDGE

	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16
Construction period	0	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1	1
Price indexation	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08

CASH FLOWS (Cr BDT)	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16
Operating revenues	**317**	**510**	**745**	**1,028**	**1,146**	**1,276**	**1,417**	**1,572**
Toll revenues	317	510	745	1,028	1,146	1,276	1,417	1,572
Other commercial revenues	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-303**	**-318**	**-767**	**-351**	**-368**	**-888**	**-406**	**-426**
Maintenance & Overhaul	-291	-306	-754	-337	-354	-873	-390	-410
Operation	-12	-12	-13	-13	-14	-15	-16	-16
Net Cash Flows due to Operations	**14**	**192**	**-22**	**677**	**778**	**388**	**1,011**	**1,146**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0
Project cash flows	**14**	**192**	**-22**	**677**	**778**	**388**	**1,011**	**1,146**

GOVERNMENT CASH FLOWS (Cr BDT)	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16
Outflows	**-1,426**	**-1,424**	**-1,856**	**-1,422**	**-1,423**	**-1,926**	**-1,427**	**-1,430**
Project Development (CAPEX)	0	0	0	0	0	0	0	0
Interest expenses and fees during constru	0	0	0	0	0	0	0	0
Operation and maintenance expenses	-303	-318	-767	-351	-368	-888	-406	-426
Loan Repayments								
Interest	-637	-620	-603	-586	-569	-552	-535	-518
Principal Repayments	-485	-485	-485	-485	-485	-485	-485	-485
Inflows	**317**	**510**	**745**	**1,028**	**1,146**	**1,276**	**1,417**	**1,572**
Borrowings	0	0	0	0	0	0	0	0
Operating revenues	317	510	745	1,028	1,146	1,276	1,417	1,572
Future Developments	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-1,108**	**-913**	**-1,110**	**-395**	**-277**	**-650**	**-9**	**142**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

BARISHAL-BHOLA BRIDGE

	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24
Construction period	0	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1	1
Price indexation	2.18	2.29	2.41	2.53	2.65	2.79	2.93	3.07

CASH FLOWS (Cr BDT)	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24
Operating revenues	**1,742**	**1,926**	**2,127**	**2,345**	**2,582**	**2,839**	**3,117**	**3,418**
Toll revenues	1,742	1,926	2,127	2,345	2,582	2,839	3,117	3,418
Other commercial revenues	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-1,028**	**-940**	**-493**	**-1,190**	**-544**	**-571**	**-2,398**	**-630**
Maintenance & Overhaul	-1,011	-922	-474	-1,170	-523	-549	-2,375	-606
Operation	-17	-18	-19	-20	-21	-22	-23	-24
Net Cash Flows due to Operations	**714**	**986**	**1,633**	**1,155**	**2,038**	**2,268**	**719**	**2,789**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0
Project cash flows	**714**	**986**	**1,633**	**1,155**	**2,038**	**2,268**	**719**	**2,789**

GOVERNMENT CASH FLOWS (Cr BDT)	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24
Outflows	**-2,014**	**-1,910**	**-1,446**	**-2,126**	**-1,463**	**-1,473**	**-3,283**	**-1,497**
Project Development (CAPEX)	0	0	0	0	0	0	0	0
Interest expenses and fees during constru	0	0	0	0	0	0	0	0
Operation and maintenance expenses	-1,028	-940	-493	-1,190	-544	-571	-2,398	-630
Loan Repayments								
Interest	-501	-484	-467	-450	-433	-416	-399	-382
Principal Repayments	-485	-485	-485	-485	-485	-485	-485	-485
Inflows	**1,742**	**1,926**	**2,127**	**2,345**	**2,582**	**2,839**	**3,117**	**3,418**
Borrowings	0	0	0	0	0	0	0	0
Operating revenues	1,742	1,926	2,127	2,345	2,582	2,839	3,117	3,418
Future Developments	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**-273**	**16**	**680**	**219**	**1,119**	**1,366**	**-166**	**1,921**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

BARISHAL-BHOLA BRIDGE

	2049 Year 25	2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32
Construction period	0	0	0	0	0	0	0	0
Operation period	1	1	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1	1	1
Price indexation	3.23	3.39	3.56	3.73	3.92	4.12	4.32	4.54

CASH FLOWS (Cr BDT)	2049 Year 25	2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32
Operating revenues	**3,744**	**4,096**	**4,476**	**4,886**	**5,297**	**5,736**	**6,205**	**6,705**
Toll revenues	3,744	4,096	4,476	4,886	5,297	5,736	6,205	6,705
Other commercial revenues	0	0	0	0	0	0	0	0
Operation & Maintenance expenses	**-661**	**-1,594**	**-729**	**-1,532**	**-1,846**	**-844**	**-886**	**-2,137**
Maintenance & Overhaul	-636	-1,568	-701	-1,502	-1,815	-811	-852	-2,101
Operation	-25	-27	-28	-29	-31	-32	-34	-36
Net Cash Flows due to Operations	**3,083**	**2,502**	**3,747**	**3,354**	**3,451**	**4,892**	**5,319**	**4,569**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	0	0	0
Project cash flows	**3,083**	**2,502**	**3,747**	**3,354**	**3,451**	**4,892**	**5,319**	**4,569**

GOVERNMENT CASH FLOWS (Cr BDT)	2049 Year 25	2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32
Outflows	**-1,512**	**-2,428**	**-1,546**	**-2,332**	**-2,629**	**-1,610**	**-1,635**	**-2,868**
Project Development (CAPEX)	0	0	0	0	0	0	0	0
Interest expenses and fees during constru	0	0	0	0	0	0	0	0
Operation and maintenance expenses	-661	-1,594	-729	-1,532	-1,846	-844	-886	-2,137
Loan Repayments								
Interest	-365	-348	-331	-314	-297	-280	-263	-246
Principal Repayments	-485	-485	-485	-485	-485	-485	-485	-485
Inflows	**3,744**	**4,096**	**4,476**	**4,886**	**5,297**	**5,736**	**6,205**	**6,705**
Borrowings	0	0	0	0	0	0	0	0
Operating revenues	3,744	4,096	4,476	4,886	5,297	5,736	6,205	6,705
Future Developments	0	0	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**2,232**	**1,668**	**2,930**	**2,554**	**2,668**	**4,126**	**4,570**	**3,837**

SANCHEZ JIMENEZ JOSE LUIS
Team leader

BARISHAL-BHOLA BRIDGE

	2057 Year 33	2058 Year 34	2059 Year 35	2060 Year 36	2061 Year 37	2062 Year 38
Construction period	0	0	0	0	0	0
Operation period	1	1	1	1	1	1
Term of analysis	1	1	1	1	1	1
Price indexation	4.76	5.00	5.25	5.52	5.79	6.08

CASH FLOWS (Cr BDT)	2057 Year 33	2058 Year 34	2059 Year 35	2060 Year 36	2061 Year 37	2062 Year 38
Operating revenues	**7,239**	**7,808**	**8,414**	**9,059**	**9,744**	**10,473**
Toll revenues	7,239	7,808	8,414	9,059	9,744	10,473
Other commercial revenues	0	0	0	0	0	0
Operation & Maintenance expenses	**-2,640**	**-1,026**	**-2,473**	**-1,131**	**-1,187**	**-4,112**
Maintenance & Overhaul	-2,603	-986	-2,432	-1,087	-1,142	-4,064
Operation	-37	-39	-41	-43	-46	-48
Net Cash Flows due to Operations	**4,599**	**6,782**	**5,940**	**7,928**	**8,557**	**6,362**
Cash Flows due to Investments	**0**	**0**	**0**	**0**	**0**	**594**
Initial CAPEX	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0
Residual Value of Investments	0	0	0	0	0	594
Project cash flows	**4,599**	**6,782**	**5,940**	**7,928**	**8,557**	**6,956**

GOVERNMENT CASH FLOWS (Cr BDT)	2057 Year 33	2058 Year 34	2059 Year 35	2060 Year 36	2061 Year 37	2062 Year 38
Outflows	**-3,355**	**-1,724**	**-3,154**	**-1,795**	**-1,834**	**-4,147**
Project Development (CAPEX)	0	0	0	0	0	594
Interest expenses and fees during constru	0	0	0	0	0	0
Operation and maintenance expenses	-2,640	-1,026	-2,473	-1,131	-1,187	-4,112
Loan Repayments						
Interest	-229	-212	-195	-178	-161	-144
Principal Repayments	-485	-485	-485	-485	-485	-485
Inflows	**7,239**	**7,808**	**8,414**	**9,059**	**9,744**	**10,473**
Borrowings	0	0	0	0	0	0
Operating revenues	7,239	7,808	8,414	9,059	9,744	10,473
Future Developments	0	0	0	0	0	0
GoB net cash flows (FIRR / FNPV)	**3,884**	**6,084**	**5,259**	**7,264**	**7,910**	**6,326**

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Financial Analysis-PPP Contract Structure

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BARISHAL-BHOLA BRIDGE

CASH FLOWS (Cr BDT)	2025 Year 1	2026 Year 2	2027 Year 3	2028 Year 4	2029 Year 5	2030 Year 6	2031 Year 7	2032 Year 8
Operating revenues	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Toll revenues	0	0	0	0	0	0	0	0
Other revenues	0	0	0	0	0	0	0	0
Operating expenses	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Maintenance	0	0	0	0	0	0	0	0
Operation	0	0	0	0	0	0	0	0
SPV Structure	0	0	0	0	0	0	0	0
Corporate tax	0	0	0	0	0	0	0	0
EBITDA	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Investments	**-937**	**-3,949**	**-1,911**	**-2,817**	**-3,822**	**-4,057**	**-2,462**	**-1,399**
Initial CAPEX	-937	-3,949	-1,911	-2,817	-3,822	-4,057	-2,462	-1,399
Other CAPEX	0	0	0	0	0	0	0	0
Project cash flows	**-937**	**-3,949**	**-1,911**	**-2,817**	**-3,822**	**-4,057**	**-2,462**	**-1,399**
Public Contributions	**469**	**3,440**	**1,563**	**2,189**	**2,814**	**2,814**	**1,563**	**782**
Government capital contributions	235	1,720	782	1,094	1,407	1,407	782	391
Multilateral capital contributions	235	1,720	782	1,094	1,407	1,407	782	391
Project cash flows (after contributions)	**-467**	**-510**	**-348**	**-628**	**-1,008**	**-1,243**	**-899**	**-617**
Funding	**467**	**510**	**348**	**628**	**1,008**	**1,243**	**899**	**617**
Equity	117	127	87	157	252	311	225	154
Multilateral term loan	351	382	261	471	756	932	674	463
Cash flow before debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Debt service. Multilateral term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0
Cash flow after debt service (multilateral)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0	0	0
Cash flow before debt service (commercial)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0
Free cash flows	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Dividends	0	0	0	0	0	0	0	0
Annual cash	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cash movements of the year	0	0	0	0	0	0	0	0
Ending cash balance	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

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BARISHAL-BHOLA BRIDGE

CASH FLOWS (Cr BDT)	2033 Year 9	2034 Year 10	2035 Year 11	2036 Year 12	2037 Year 13	2038 Year 14	2039 Year 15	2040 Year 16
Operating revenues	**317**	**510**	**745**	**1,028**	**1,146**	**1,276**	**1,417**	**1,572**
Toll revenues	317	510	745	1,028	1,146	1,276	1,417	1,572
Other revenues	0	0	0	0	0	0	0	0
Operating expenses	**-290**	**-305**	**-723**	**-336**	**-353**	**-837**	**-389**	**-408**
Maintenance	-271	-284	-702	-314	-329	-812	-363	-381
Operation	-12	-12	-13	-13	-14	-15	-16	-16
SPV Structure	-8	-8	-9	-9	-9	-10	-10	-11
Corporate tax	0	0	0	0	0	0	0	0
EBITDA	**27**	**206**	**22**	**692**	**793**	**439**	**1,028**	**1,164**
Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Project cash flows	**27**	**206**	**22**	**692**	**793**	**439**	**1,028**	**1,164**
Public Contributions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	0	0	0	0	0	0	0	0
Multilateral capital contributions	0	0	0	0	0	0	0	0
Project cash flows (after contributions)	**27**	**206**	**22**	**692**	**793**	**439**	**1,028**	**1,164**
Funding	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Equity	0	0	0	0	0	0	0	0
Multilateral term loan	0	0	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**27**	**206**	**22**	**692**	**793**	**439**	**1,028**	**1,164**
Debt service. Multilateral term loan	**-257**	**-257**	**-257**	**-532**	**-610**	**-338**	**-791**	**-895**
Interest	-257	-257	-257	-249	-229	-214	-192	-152
Debt repayment	0	0	0	-283	-381	-124	-599	-743
Cash flow after debt service (multilateral)	**-230**	**-52**	**-235**	**160**	**183**	**101**	**237**	**269**
Commercial banks credit line. Drawdowns	230	52	235	0	0	0	0	0
Cash flow before debt service (commercial)	**0**	**0**	**0**	**160**	**183**	**101**	**237**	**269**
Debt service. Commercial term loan	**0**	**-6**	**-7**	**-123**	**-141**	**-78**	**-183**	**-30**
Interest	0	-6	-7	-13	-10	-7	-5	-1
Debt repayment	0	0	0	-110	-130	-71	-177	-29
Free cash flows	**0**	**-6**	**-7**	**37**	**42**	**23**	**55**	**239**
Dividends	0	0	0	0	0	0	0	0
Annual cash	**0**	**-6**	**-7**	**37**	**42**	**23**	**55**	**239**
Initial cash balance	**0**	**0**	**-6**	**-13**	**24**	**66**	**89**	**144**
Cash movements of the year	0	-6	-7	37	42	23	55	239
Ending cash balance	**0**	**-6**	**-13**	**24**	**66**	**89**	**144**	**383**

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BARISHAL-BHOLA BRIDGE

CASH FLOWS (Cr BDT)	2041 Year 17	2042 Year 18	2043 Year 19	2044 Year 20	2045 Year 21	2046 Year 22	2047 Year 23	2048 Year 24
Operating revenues	**1,742**	**1,926**	**2,127**	**2,345**	**2,582**	**2,839**	**3,117**	**3,418**
Toll revenues	1,742	1,926	2,127	2,345	2,582	2,839	3,117	3,418
Other revenues	0	0	0	0	0	0	0	0
Operating expenses	**-969**	**-888**	**-473**	**-1,121**	**-521**	**-547**	**-2,248**	**-604**
Maintenance	-940	-858	-441	-1,088	-487	-511	-2,210	-563
Operation	-17	-18	-19	-20	-21	-22	-23	-24
SPV Structure	-11	-12	-13	-13	-14	-15	-15	-16
Corporate tax	0	-132	-352	-243	-474	-537	-146	-681
EBITDA	**773**	**1,038**	**1,654**	**1,223**	**2,060**	**2,291**	**869**	**2,815**
Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Project cash flows	**773**	**905**	**1,301**	**981**	**1,587**	**1,754**	**723**	**2,134**
Public Contributions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	0	0	0	0	0	0	0	0
Multilateral capital contributions	0	0	0	0	0	0	0	0
Project cash flows (after contributions)	**773**	**905**	**1,301**	**981**	**1,587**	**1,754**	**723**	**2,134**
Funding	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Equity	0	0	0	0	0	0	0	0
Multilateral term loan	0	0	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**773**	**905**	**1,301**	**981**	**1,587**	**1,754**	**723**	**2,134**
Debt service. Multilateral term loan	**-594**	**-696**	**-1,001**	**-104**	**0**	**0**	**0**	**0**
Interest	-115	-82	-35	-3	0	0	0	0
Debt repayment	-479	-614	-966	-101	0	0	0	0
Cash flow after debt service (multilateral)	**178**	**209**	**300**	**877**	**1,587**	**1,754**	**723**	**2,134**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0	0	0
Cash flow before debt service (commercial)	**178**	**209**	**300**	**877**	**1,587**	**1,754**	**723**	**2,134**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0
Free cash flows	**178**	**209**	**300**	**877**	**1,587**	**1,754**	**723**	**2,134**
Dividends	0	0	-300	-640	-1,249	-1,416	-385	-1,796
Annual cash	**178**	**209**	**0**	**237**	**338**	**338**	**338**	**338**
Initial cash balance	**383**	**562**	**771**	**771**	**1,007**	**1,345**	**1,683**	**2,021**
Cash movements of the year	178	209	0	237	338	338	338	338
Ending cash balance	**562**	**771**	**771**	**1,007**	**1,345**	**1,683**	**2,021**	**2,359**

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BARISHAL-BHOLA BRIDGE

CASH FLOWS (Cr BDT)	2049 Year 25	2050 Year 26	2051 Year 27	2052 Year 28	2053 Year 29	2054 Year 30	2055 Year 31	2056 Year 32
Operating revenues	**3,744**	**4,096**	**4,476**	**4,886**	**5,297**	**5,736**	**6,205**	**6,705**
Toll revenues	3,744	4,096	4,476	4,886	5,297	5,736	6,205	6,705
Other revenues	0	0	0	0	0	0	0	0
Operating expenses	**-634**	**-1,503**	**-699**	**-1,447**	**-1,740**	**-809**	**-849**	**-2,014**
Maintenance	-591	-1,458	-652	-1,398	-1,688	-755	-793	-1,954
Operation	-25	-27	-28	-29	-31	-32	-34	-36
SPV Structure	-17	-18	-19	-20	-21	-22	-23	-24
Corporate tax	-763	-620	-946	-853	-894	-1,271	-1,389	-1,206
EBITDA	**3,111**	**2,593**	**3,777**	**3,439**	**3,557**	**4,927**	**5,356**	**4,691**
Investments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0	0	0
Project cash flows	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Public Contributions	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	0	0	0	0	0	0	0	0
Multilateral capital contributions	0	0	0	0	0	0	0	0
Project cash flows (after contributions)	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Funding	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Equity	0	0	0	0	0	0	0	0
Multilateral term loan	0	0	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Debt service. Multilateral term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0
Cash flow after debt service (multilateral)	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0	0	0
Cash flow before debt service (commercial)	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0	0	0
Free cash flows	**2,348**	**1,973**	**2,832**	**2,586**	**2,662**	**3,656**	**3,966**	**3,485**
Dividends	-2,010	-1,635	-2,494	-2,248	-2,358	-3,351	-3,662	-3,181
Annual cash	**338**	**338**	**338**	**338**	**304**	**304**	**304**	**304**
Initial cash balance	**2,359**	**2,696**	**3,034**	**3,372**	**3,710**	**4,014**	**4,318**	**4,623**
Cash movements of the year	338	338	338	338	304	304	304	304
Ending cash balance	**2,696**	**3,034**	**3,372**	**3,710**	**4,014**	**4,318**	**4,623**	**4,927**

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BARISHAL-BHOLA BRIDGE

CASH FLOWS (Cr BDT)	2057 Year 33	2058 Year 34	2059 Year 35	2060 Year 36	2061 Year 37	2062 Year 38
Operating revenues	**7,239**	**7,808**	**8,414**	**9,059**	**9,744**	**10,473**
Toll revenues	7,239	7,808	8,414	9,059	9,744	10,473
Other revenues	0	0	0	0	0	0
Operating expenses	**-2,483**	**-983**	**-2,331**	**-1,084**	**-1,138**	**-3,860**
Maintenance	-2,421	-918	-2,262	-1,012	-1,062	-3,780
Operation	-37	-39	-41	-43	-46	-48
SPV Structure	-25	-26	-28	-29	-30	-32
Corporate tax	-1,224	-1,808	-1,603	-2,124	-2,297	-1,749
EBITDA	**4,756**	**6,825**	**6,082**	**7,975**	**8,606**	**6,613**
Investments	**0**	**0**	**0**	**0**	**0**	**0**
Initial CAPEX	0	0	0	0	0	0
Other CAPEX	0	0	0	0	0	0
Project cash flows	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Public Contributions	**0**	**0**	**0**	**0**	**0**	**0**
Government capital contributions	0	0	0	0	0	0
Multilateral capital contributions	0	0	0	0	0	0
Project cash flows (after contributions)	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Funding	**0**	**0**	**0**	**0**	**0**	**0**
Equity	0	0	0	0	0	0
Multilateral term loan	0	0	0	0	0	0
Cash flow before debt service (multilateral)	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Debt service. Multilateral term loan	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0
Cash flow after debt service (multilateral)	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Commercial banks credit line. Drawdowns	0	0	0	0	0	0
Cash flow before debt service (commercial)	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Debt service. Commercial term loan	**0**	**0**	**0**	**0**	**0**	**0**
Interest	0	0	0	0	0	0
Debt repayment	0	0	0	0	0	0
Free cash flows	**3,532**	**5,017**	**4,479**	**5,851**	**6,309**	**4,864**
Dividends	-3,227	-4,765	-4,227	-5,599	-6,057	-4,864
Annual cash	**304**	**252**	**252**	**252**	**252**	**0**
Initial cash balance	**4,927**	**5,231**	**5,483**	**5,735**	**5,987**	**6,239**
Cash movements of the year	304	252	252	252	252	0
Ending cash balance	**5,231**	**5,483**	**5,735**	**5,987**	**6,239**	**6,239**

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Annexure 02 – GDP Impact Justification

The GDP impact calculation has been carried out following international methodology for economic impact estimation studies and as implemented in previous international projects. It has been estimated as a sum of the three impacts: direct, indirect and induced, as follows:

GDP IMPACT CALCULATION		Million BDT
GDP economic impact. Direct Impact		**60,734**
Personnel expenses. Construction	22%	54,165
Personnel expenses. Operation	65%	986
EBITDA. Construction & Maintenance	8%	5,355
EBITDA. Operation	15%	227
GDP economic impact. Indirect Impact		**172,648**
Suppliers. Construction	70%	172,345
Suppliers. Operation	20%	303
GDP economic impact. Induced Impact		**181,869**
Bridge activity		55,151
Induced activity of the bridge		112,221

- Right-hand column is the addition of all the economic projections generated, in constant BDT (not considering inflation)
- Direct impact is the impact generated by the project itself and is similar to the Gross Added Value, which means the addition of personnel expenses and EBITDA both in the implementation phase and in the operation phase.
- Indirect impact is the impact generated by the suppliers of the project, also in both the implementation phase and the operation phase.

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- Induced impact is the impact generated by all the personnel expenses with the money spent in any other activity in the region / country. It has been calculated as the induced impact of the bridge activity, based on the personnel expenses of the bridge itself (in construction and in operation), and the induced impact of the activity of the bridge, based on the personnel expenses of the indirect impact multiplied by the 65% estimated of personnel expenses of any service activity.

In summary, it is the sum of the effects generated by the bridge, either by its construction or by its operation, both directly and those produced by each of the activities derived from the bridge itself:

Total impact on GDP (million BDT 2022)	415,251
Direct impact	60,734
Indirect impact	172,648
Induced impact	181,869
GDP Bangladesh (million USD 2022)	453,852
GDP Bangladesh (million BDT 2022)	49,016,016
Project impact on GDP	0.85%

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