FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 97

SUNDERBANS WATERWAYS

RIVER: KATAKHALI RIVER (STATE OF WEST BENGAL)

(LEBUKHALI TO BARUNHAT (22.465 KMS)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 29/01/2021




Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 2

JANUARY 2021

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(LEBUKHALI TO BARUNHAT (22.465 KMS)
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Consultant: Egis India Consulting Engineers

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Final DPR

Volume-I Main Report

Volume-II Drawings

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LIST OF VOLUMES

VOLUME – I	**:**	**MAIN REPORT**
VOLUME – II	**:**	**DRAWINGS**
VOLUME – III A	**:**	**HYDROGRAPHIC SURVEY REPORT**
VOLUME – III B	**:**	**HYDROGRAPHIC SURVEY CHARTS**

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

LIST OF ABBREVIATIONS

IWAI	Inland Waterways Authority of India
IWT	Inland Water Transportation
MOS	Ministry of Shipping
NW	National Waterway
DPR	Detailed Project Report
WW	Waterway
AtoN	Aid to Navigation
VC	Vertical Clearance
HC	Horizontal Clearance
CD	Chart Datum
SD	Sounding Datum
MSL	Mean Sea Level
DGPS	Differential Global Positioning System
RTK	Real Time Kinematic
GPS	Global Positioning System
SBES	Single Beam Echo Sounder
TS	Total Station
CRP	Common Reference Point
SBAS	Satellite-based augmentation systems
DGLL	Directorate General of Light House & Light ships
UTM	Universal Transverse Mercator
WGS	World Geodetic System
MT	Metric Ton
GNSS	Global Navigation Satellite System
BM	Bench Mark
TBM	Temporary Bench Mark
HAD	Haldia Development Authority
WBSTC	West Bengal Surface Transport Corporation Ltd.
WBTIDC	West Bengal Transport Infrastructre Development Corporation Ltd.
HNJPSS	Hooghly Nadi Jalpath Paribahan Samabai Samity Ltd.
IMO	International Maritime Organisation
VHF	Very High Frequency
RIS	River Information System

SALIENT FEATURES OF KATAKHALI RIVER (SUNDERBANS WATERWAYS (NW 97)

Sr. No.	Particulars	Details			
A.	**GENERAL**				
1.	***Location***				
a)	Cluster	3			
b)	State(s)	West Bengal			
c)	Co-ordinates & Name of Place	**Start**		**End**	
	Place	Lebukhali		Barunhat	
	Latitude	22°21'48.85"N		22°30'29.56"N	
	Longitude	88° 57'23"E		88°58'18.90"E	
B.	**TECHNICAL**				
1.	***Waterway***				
a)	National Waterway Number	97			
b)	Class	VII			
c)	Type (Tidal/Non-Tidal)	Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		22.465 km	22.465 km	0 km	
d)	Sounding Datum				
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Mayapur and Garden Reach values.			
	Value w.r.t MSL (m)	0 – 10 km	10 – 20 km	20 – 22.465 km	
		-2.36	-2.36	-2.36	
e)	LAD Status (w.r.t. SD)				
		Sub -Stretch 1	**Sub -Stretch 2**	**Sub -Stretch 3**	**Total**
	Stretch Km (From……To……)	**0 – 10 km**	**10 – 20 km**	**20 – 22.465 km**	
	Length with LAD < 1.2 m	2.950	8.325	2.250	13.525
	With LAD from 1.2-1.4 m	0.600	0.400	0.000	1.0
	With LAD from 1.5-1.7 m	1.200	0.200	0.000	1.4
	With LAD from 1.8-2.0 m	1.200	0.000	0.000	1.2
	With LAD > 2.0 m	4.050	1.075	0.444	5.569

Sr. No.	Particulars	Details			
	Total	10	10	2.694	22.465
f)	Target Depth of Proposed Fairway (m)	2.75 m for Class VII waterway			
g)	Conservancy Works Required				
	Type of Work	**0 – 10 km**	**10 – 20 km**	**20 – 22.465 km**	**Total (km)**
	Dredging Required (M. Cum.)	0.851	1.32	-	2.17
	Bandalling	-	-	-	Nil
	Barrages & Locks	-	-	-	Nil
	River Training (Km.)	-	-	-	Nil
	Bank Protection (Km.)	-	-	-	Nil
h)	Existing Cross Structures				
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal Clearance**	**Range of Vertical Clearance w.r.t. MHWS**
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil
	Bridges (at chainage 22.1 Km)	Road Bridge	1	61.41 m	1.84 m
	HT/Tele-communication lines	HT	1	165 m	6.817 m
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil
2.	***Traffic***				
a)	Present IWT Operations (type of services)	Passenger and Vessel ferry services are operated by Government at Dulduli and Lebukhali. In addition to above, locally operated ferry services run from numerous small jetties along the waterway.			
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	There is no big industries exist near to the survey area, however brick kilns are found along the river banks.			
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations	The right river bank of the Katakhali River has Hingalganj-Lebukhali road in the vicinity. SH 2 and the nearest rail head are at Hasnabad which is 8-12 Km away. Private vehicles are available			

Sr. No.	Particulars	Details				
	etc.)	in the nearby area.				
d)	Commodities	**In-bound**			**Out-bound**	
		Passenger			Passenger	
e)	Existing and Future Potential					
	Name of Commodity	**Existing**	**5 years**	**10 years**	**15 years**	**20 years**
	Passengers with 8% growth rate (nos. per day)	600	1028	1511	2220	3262
3.	***Terminals/Jetties***					
a)	Terminal/Jetty - 1	Dumrali Ferry Terminal				
	Location	Right Bank				
	Type/Services	Passenger Ferry				
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.				
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform				
	Approach	River Bank Road				
	Land Ownership	Government				
b)	Terminal/Jetty - 2	Rupmari Ferry Terminal				
	Location	Left Bank				
	Type/Services	Passenger Ferry				
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.				
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform				
	Approach	Village road				
	Land Ownership	Government				
c)	Terminal/Jetty - 3	Mamudpur Ferry Terminal				
	Location	Right Bank				
	Type/Services	Passenger Ferry				
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic				

Sr. No.	Particulars	Details	
		amenities for passengers are available.	
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform	
	Approach	River bank road	
	Land Ownership	Government	
d)	Terminal/Jetty - 4	Bishpur Ferry Terminal	
	Location	Left Bank	
	Type/Services	Passenger Ferry	
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.	
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform	
	Approach	River bank road	
	Land Ownership	Government	
4.	***Design Vessel***		
a)	Type	Fibre Boat	
b)	No. & Size	2 Nos. (18.0m L x 3.0m B x 1.58m D) from start date of operation, additional 2 vessels in 10th year of operation and additional 2 vessels in 20th year of operation.	
c)	Loaded Draft	0.80 m	
d)	Capacity	25 passengers	
5.	***Navigation Aids***		
a)	Type	Marking buoys	
b)	Nos.	15	
C.	**FINANCIAL**		
1.	***Cost***	***Capital Cost*** (INR Lakhs)	***O&M Cost*** (INR Lakhs)
	Fairway Development	4,342.93	434.29
	Terminal Structures (4 nos)	294.79	8.84
	Vessels (2 nos.)	70.00	19.03

Sr. No.	Particulars	Details		
	Total Cost including Vessel	**4,830.19**	**491.13**	
	Total Cost without Vessel cost	**4760.19**	**472.10**	
2.	***User Charges***	INR 10.00 per passenger per Km (INR 2.0 per passenger one way per trip)		
3.	***Financial Internal Rate of Return (%)***	**Option 1** Total Capital Cost + Total O&M cost	**Option 2** Option 1 - Vessel Capital & O&M cost	**Option 3** Vessel Capital Cost + Vessel O&M Cost
		Not Calculable (Negative return)	Not Calculable (Negative return)	2.99%
4.	***Economic Internal Rate of Return (%)***	**Option 1** Total Capital Cost + Total O&M cost	**Option 2** Option 1 - Vessel Capital & O&M cost	**Option 3** Vessel Capital Cost + Vessel O&M Cost
		Not Calculable (Negative return)	Not Calculable (Negative return)	9.52%

EXECUTIVE SUMMARY

1.0 INTRODUCTION

Inland Waterways Authority of India appointed M/s Egis India for providing Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 3 National Waterways. Katakhali River is one of the 13 rivers clubbed in Cluster 3.

This detailed project report of 22.465 km stretch of Katakhali River waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI.

2.0 WATERWAY/DETAILED HYDROGRAPHIC SURVEY

The 22.465 km stretch of Katakhali National waterway proposed for DPR study lies from Lebukhali at Lat 22°21'48.85"N, Long 88° 57'23"E to Barunhat at Lat 22°30'29.56"N, Long 88°58'18.90"E. Whole stretch of Katakhali waterway is having tidal influence with a maximum tidal variation of 3.37 m to a minimum tidal variation of 1.59 m.

River width in the waterway stretch varies from 0.07 km to 0.24 km. Average flow velocity in the waterway varies from 0.563 m/sec to 1.28 m/sec.

3.0 FAIRWAY DEVELOPMENT

As obtained from the results of hydrographic survey, by taking into advantage of tidal window, sufficient LAD is available in the complete 22.465 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation. However, on the basis of traffic studies done in this DPR, 17.0 Km stretch of waterway from Chainage 0 Km to chainage 17.0 Km is recommended to be developed as per Class VII. The dredging quantity estimated for Class VII waterway is 21,71,466 cum. The total capital and O&M cost of fairway development works out to INR 4,342.93 Lakh and INR 434.29 Lakh respectively.

4.0 TRAFFIC STUDY

On the basis of detailed traffic survey and study done during DPR stage, following conclusions are made:

a) Proposed Katakhali waterway is directly connected with Sahibkhali National waterway.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
e) Vessel ferry services at Lebukhali and Dulduli are operated and maintained by the State Governmnet.
f) Passenger ferry services are operated privately all along the waterway; however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking.

In view of existing passenger traffic per day and connectivity of Katakhali river with major waterways, 4 passenger ferry ghats, namely, Dumrali, Rupmari, Bishpur and Mamudpur ferry ghats are recommended to be developed for IWT services.

5.0 TERMINALS

Number of existing ferry terminals is located along Katakhali River. The existing ferry terminals lack facilities like embarking/disembarking of vessels, basic amenieties for passengers etc. In this DPR, following terminals are proposed to be developed to be developed with floating pontoons and gangway facilities:

a) Dumrali,
b) Rupmari,
c) Bishpur, and
d) Mamudpur.

The total cost of works on the basis of preliminary engineering design is provided as below:

Sl. No.	Item	Amount in Lakh (INR)
1.0	Capital cost for Terminals excluding land cost	294.79
2.0	O&M cost for Terminals	8.84

6.0 PRELIMINARY ENGINEERING DESIGNS

Preliminary engineering design is done for terminal structures and necessary infrastructure required for waterway development. Following basic facilities are provided for both the passenger ferry terminal structures:

- Floating Pontoon
- Gangway

Relevant Indian and International codes are used for preliminary design of all structures.

7.0 VESSEL DESIGN

Ferry vessels developed by West Bengal Transport Infrastructure Development Corporation (WBTIDC) or other local manufacturers, with carrying capacity of 25 passengers are proposed to be operated on Katakhali waterway for passenger ferry services. On the basis of traffic studies done in DPR, it is recommended that the ferry services shall be started with 2 vessels initially and in 10th year of operation additional 2 vessels and in 20th year of operation additional 2 vessels shall be incorporated to cater the growing traffic demand. The procurement and O&M cost of ferry vessels works out to INR 70.00 lakh and INR 19.03 lakh in phase 1. Additional procurement and O&M cost of ferry vessels in 10th year works out to INR 70.0 lakh and INR 19.03 lakh and in 20th year works out to INR 70.0 lakh and INR 19.03 lakh respectively.

8.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like marine lantern/bouys are proposed along the channel alignment. Capital and maintenance cost for the same works out to INR 30.90 Lakh and INR 3.09 Lakh respectively

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Katakhali River through available data /information supported by field studies to evaluate the impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize / reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable. The study basically includes:

- Establishment of the present environmental scenario
- Study of the specific activities related to the project
- Evaluation of the probable environmental impacts
- Recommendations of necessary environmental control measures.
- Preparation of Environmental Management Plan

The study stretch passes through North 24 Parganas District of West Bengal State. North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends from latitude 22º11'6" North to 23º15'2" North and from longitude 88º20' East to 89º5' East. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district. It is also the tenth-largest district in the State by area.

The project falls under the lies in Earthquake high damage risk zone-IV as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability. The maximum temperature as recorded is 41°C and the minimum is 10°C.

Assessments of impact on environment including social considerations are done in the DPR. The total environmental estimated cost for the project is Rs. 117.45 lakh.

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Katakhali waterway, it is recommended that the development of Katakhali waterway shall be handled by Project Management Unit (PMU) proposed for development of Sahibkhali waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata. Accordingly, the cost of development of Instituional requirement is considered in Sahibkhali waterway DPR.

11.0 PROJECT COSTING

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal.

b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultants experience on various projects sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires
f) Approved DPR's by IWAI of other National waterways

Katakhali waterway is proposed to be developed as Class VII waterway. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) Cost of jetties and terminal buildings
c) Vessel Cost
d) EMP cost

The waterway is proposed to be developed for Class VII, with with pontoon and gangway facilities at 4 ferry ghats and 2 passenger ferry vessels at the inception stage. The ferry ghats proposed to be developed for Passenger ferry services for river crossing, in this DPR are Dumrali, Rupmari, Bishpur and Mamudpur ferry ghats. The capital cost for development of the system components of the project viz., development of the designed waterway, facilities for passenger ferry services and purchasing of vessels has been worked out as INR 4,792.81 Lakh with 2 vessels. In 20th year of operation capital cost of purchasing additional 2 vessels is INR 32.62 Lakh. The additional vessels shall be purchased on the basis of growing passenger traffic. Correspondingly, O&M cost for Katakhali waterway works out to INR 516.66 Lakh from inception stage and and from 11th year onwards the O&M cost is estimated as INR 19.03 Lakh.

12.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 12 months from the start date of construction.

13.0 ECONOMIC & FINANCIAL ANALYSIS

An attempt has been made to estimate the possible revenue available from this service. Although this has been calculated in a thorough and logical manner the study is based on many assumptions and it should therefore be taken as a guide to the magnitude of possible revenue.

The techno-economic model has been run with the assumption that passenger ferry services will operate for 12 hours from 6:00 AM to 6:00 PM.

A downtime of about 2 months is assumed, which could be occurred due to weather, operational or other factors. Hence, it is assumed that the full service is operating for 300 days annually. The calculated FIRR and EIRR for varying fare are shown as below:

Sr. No.	Fare (INR) per passenger per KM	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
		FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)
1	5.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable
2	10.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	2.99%	9.52%
3	15.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	14.14%	19.25%
4	20.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	21.40%	26.41%
5	25.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	27.52%	32.73%
6	100.00	Not Calculable	Not Calculable	-14.56%	-13.94%	112.34%	120.62%
7	150.00	-4.07%	-3.83%	-2.91%	-2.68%	171.31%	180.12%
8	200.00	1.30%	1.46%	2.07%	2.23%	230.80%	239.86%
9	250.00	4.78%	4.90%	5.40%	5.53%	290.49%	299.70%
10	300.00	7.42%	7.53%	7.97%	8.08%	350.29%	359.59%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Katakhali waterway is financially and economically viable for option 3 with a tarrif of INR 10.00 per passenger per Km and above for proposed OD pairs. Accordingly, for proposed OD-Pairs of 0.2 Km trip length each, with option 3, the tariff on the basis of economic analysis is estimated as INR 2.0 per passenger one way per trip.

Project life cycle cost analysis is also done for Katakhali waterway DPR and for 20 years of project life cycle with a tariff of INR 15.00 per passenger per Km the results concluded are as below:

Option 1: Total Capital Cost + Total O&M cost

With project life cycle cost of INR 22,752 Lacs, the breakeven will not occur in 20 years' period.

Option 2: Option 1 - Vessel Capital & O&M cost

With project life cycle cost of INR 21,623 Lacs, the breakeven will not occur in 20 years' period.

Option 3: Vessel Capital Cost + Vessel O&M Cost

With project life cycle cost of INR 1,129 Lacs, the breakeven occurs during 15th year of operation.

14.0 CONCLUSION

On the basis of studies done in this DPR following conclusions are made:

a) Proposed Katakhali waterway is directly connected with Sahibkhali National waterway.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
e) Vessel ferry services at Lebukhali and Dulduli are operated and maintained by the State Government.
f) Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking

The cost benefit analysis, calculations done for financial internal rate of return (FIRR) and Economic internal rate of return (EIRR) concludes that the project is financially and economically viable for option 3 with a tarrif of INR 10.00 per passenger per Km and above for proposed OD pairs. Accordingly, for proposed OD-Pairs of 0.2 Km trip length each, with option 3, the tariff on the basis of

economic analysis is estimated as INR 2.0 per passenger one way per trip. Hence, it is recommended that the implementation of the whole project may be taken up as two packages:

Package – 1 : Construction, Operation & Maintenance of fairway and jetties

Package – 2 : Procurement, operation & maintenance of Ferry Vessel.

Also, as part of community development to provide safe and reliable water transport facilities for locals and as part of cumulative development of Sunderbans waterways, the proposed project may be recommended for development by higher authorities.

1.0 INTRODUCTION

Inland Waterways Authority of India (IWAI), an undertaking of Ministry of Shipping, Government of India intends to develop 106 new National Waterways in addition to the exiting 5 National waterways. The National waterways are proposed to be developed as a composite and integrated water transport system with the existing rail and road infrastructure across the country.

In view of this, IWAI invited online bids for "Consultancy Services for preparation of Two Stage Detailed Project Report of the 106 National Waterways in a set of eight clusters. Each waterway is to be explored for the potential of year round commercial navigation during Stage-1 (Feasibility Studies) of the project. The second stage comprises of preparation of techno-commercial detailed project report of the river/stretches approved by IWAI for stage -2 studies. Egis India Consulting Engineers Pvt. Ltd (EICEPL) was awarded the work for two stage DPR studies of two out of eight clusters respectively. Katakhali River was clubbed under Cluster -3 for the two stage DPR studies.

This detailed project report of 22.465 km stretch of Katakhali waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI. The report is prepared in accordance with detailed ToR as per the agreement **(Refer Annexure 1)**.

1.1 PROJECT BACKGROUND AND SUMMARY OF PREVIOUS STUDY

Katakhali River (under Sunderbans Waterways) is declared as National Waterway-97 as per "The National Waterway Act, 2016", No. 17 of 2016, published in the Gazette of India, Part – II-Section 1 no. 18, New Delhi, Saturday, March 26/2016/Chaitra 6, 1938 (Saka), by Ministry of Law and Justice (Legislative Department).

As per the Gazette notification, total 13 rivers (including Katakhali River) were covered in the Sunderbans waterways (NW-97). Following section of the Katakhali River is declared as National Waterway and recommended for feasibility studies by IWAI:

Length	Co-ordinate at Start	Start Location	Co-ordinate at End	End Location
22.465 km	22°21'48.8533"N 88° 57'23"E	Lebukhali	22°30'29.56"N 88°58'18.90"E.	Barunhat

A single feasibility report was prepared for all the 13 rivers covered under Sunderbans Waterways. Following conclusions were made for Katakhali River in the feasibility report.

- The waterway is a tidal river having year round navigational possibility.
- The river can be recommended for DPR studies.

The above conclusions were made on the basis of findings during the feasibility study stage. Detailed survey and investigations are done including preliminary engineering studies as per the scope of work defined in the ToR to validate above conclusions and to identify the development works required for making a techno-economically viable IWT in Katakhali WW.

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Katakhali River for second stage of the studies i.e. for detailed project report.

Length	Co-ordinate at Start	Start Location	Co-ordinate at End	End Location
22.465 km	22°21'48.8533"N 88° 57'23"E	Lebukhali	22°30'29.56"N 88°58'18.90"E.	Barunhat

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 22.465 km stretch of Katakhali waterway is located in South 24 Parganas district of West Bengal. As observed during the feasibility studies, complete stretch of waterway is having tidal influence. Locally operated jetties/ferry ghats are also available at various locations all along the river stretch.

Katakhali waterway project location as per DPR is shown in **Figure 1**. The detailed layout plan of waterway is provided in Drawing attached as **Volume-II**.

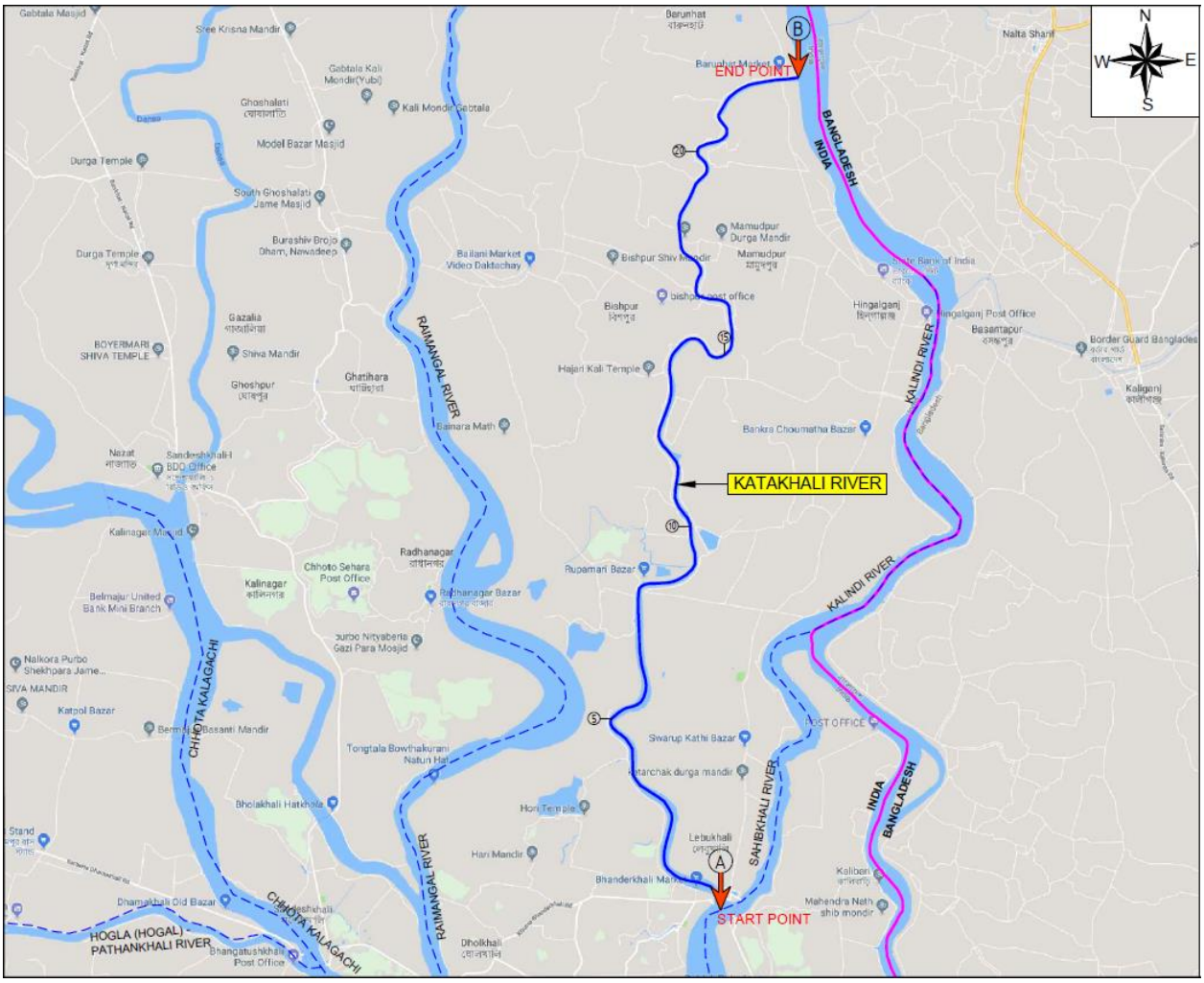


Figure 1: Katakhali National Waterway Project Location

1.3 BRIEF SCOPE OF WORK AND COMPLIANCE STATEMENT

The brief scope of work for the project comprises of:

a) Hydrographic and Hydro-morphological Survey and Investigations

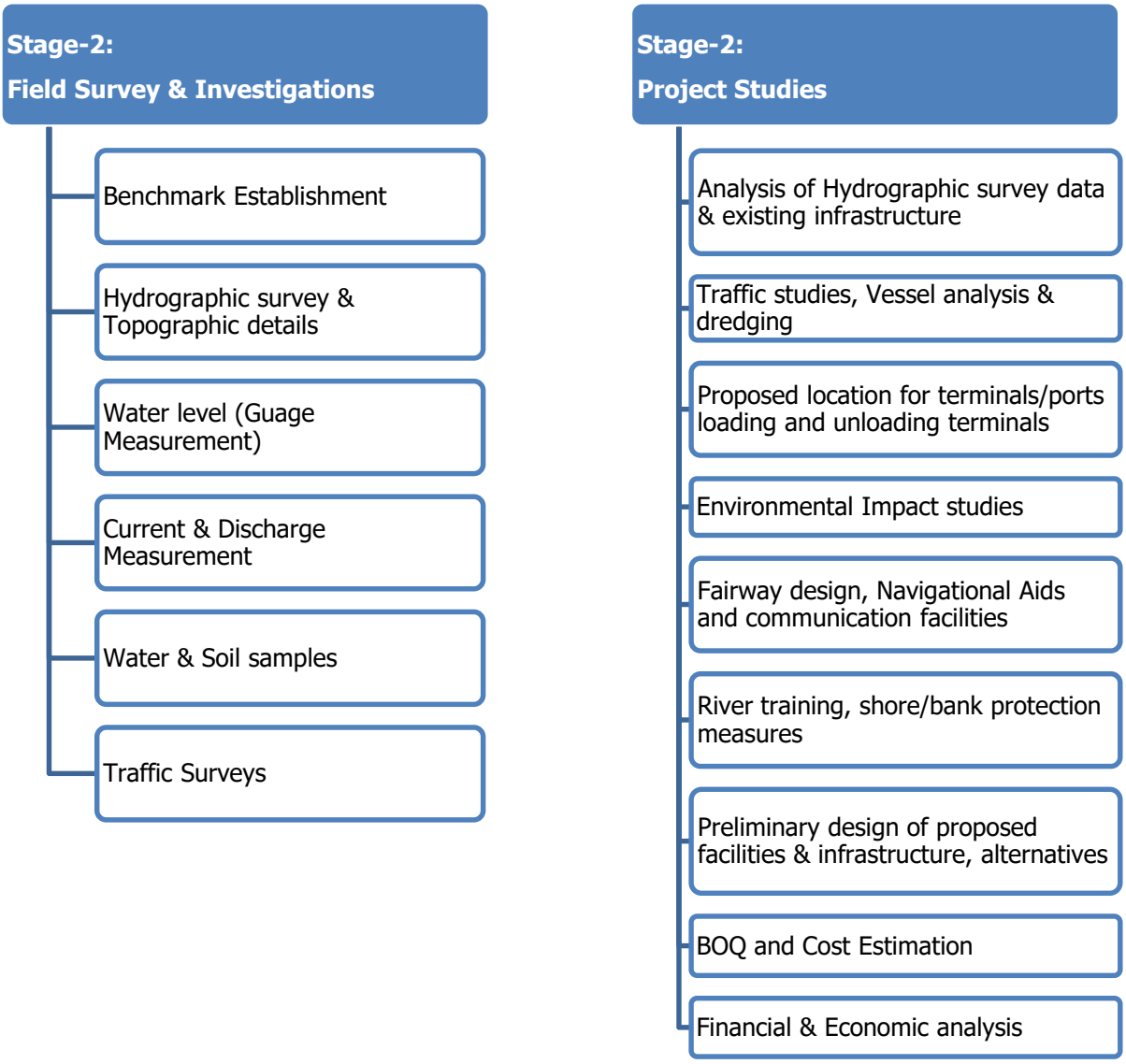
i. Installation of bench mark pillars
ii. Installation of water level gauges and observations as per TOR
iii. Bathymetric & Topographic Survey
iv. Current velocity and discharge measurements
v. Collection of water & bottom samples and analysis as per TOR
vi. Collection of Topographical features.
vii. Survey chart preparation

b) Traffic Survey
c) Geotechnical investigations
d) Environmental & social impact assessment
e) Analysis of collected data and preliminary engineering design
f) Scheduling and costing
g) Economic & Financial analysis for assessment of techno economic feasibility
h) Conclusion and recommendations.

The scope of work mentioned above, under Hydrographic and hydro-morphological survey was covered in the Hydrographic Survey Charts and Report, submitted as part of first deliverable under Stage-II of the project. The compliance statement of detailed project report covering the remaining scope of work as per TOR is provided as below:

Sr. No.	Section – 6 Terms of Reference Clause No. 1.2	Covered under Chapter No./ Title
1.0	Assessment of Hydrographic Survey Report	Chapter 2: Waterway/Detailed Hydrographic Survey
2.0	Traffic Survey	Chapter 4: Traffic Study
3.0	Geotechnical investigations	Chapter 5: Terminals
4.0	Environmental & Social impact assessment	Chapter 9: Environmental and Social Aspects
5.0	Analysis of collected data and preliminary engineering design	Chapter 6: Preliminary engineering Designs
6.0	Scheduling and costing	Chapter 11: Project Costing Chapter 12: Implementation Schedule
7.0	Economic & Financial analysis for assessment of techno economic feasibility	Chapter 13: Economic and Financial Analysis
8.0	Conclusion and recommendations.	Chapter 14: Conclusion and Recommendations

The above scope of works shall be executed as per the framework shown below;



1.4 BRIEF METHODOLOGY & APPROACH

The stretch of waterway, recommended for DPR studies is surveyed and studied in detail for techno-economic development of IWT along the proposed stretch.

Detailed hydrographic, hydro-morphological survey and investigations, traffic, environment and social survey is done out along the stretch. The data collected from survey is further analysed in detail for design of waterway, estimating of dredging quantity and finalising location and type of jetties/terminals required along the waterway. On the basis of DPR level design and drawings, cost

estimate, financial and economic evaluation is done. The techno-economic viability of IWT development along the proposed stretch is assessed and concluded in the report.

DPR studies have been construed as a means to establish the techno-commercial viability of the development of waterway, and accordingly have been taken–up in two stages:

Stage-I: Establishment of Technical Viability

Stage-II: Assessment of Financial/Economic viability, in case the technical viability is established.

A detailed DPR methodology and the expected outcome in fulfilling the assignment are presented as below:

Stage-I: Establishment of Technical Viability

Technical viability has been established on the survey & investigations, as per Volume-III of this report. Following of two major parameters have been considered to establish the technical viability:

- Availability of LAD (Least Available Depth) & dredging quantity for proposed Class of waterway
- Availability of Traffic (cargo/RO-RO/passenger)

In case, the traffic is available, all technical possibilities shall be explored to ensure the required LAD and further studies for assessment of financial viability (Stage-II) shall be performed to assess the complete techno-commercial viability.

However, in case, no traffic is available, the development of waterway in the specific reach of the river shall be considered as "Technically Not-Viable" and stage –II studies are not warranted.

Stage-II: Assessment of Financial/Economic Viability

Stage-II studies shall comprise of the following:

a) Design, Analysis and Costing

- Fairway Development
- Terminal

- Vessel
- Environmental and Social Studies
- Navigation and Communication Facilities
- Institutional Requirement
- Project Costing
- Implementation Schedule

b) <u>Commercial Viability</u>

- Estimation of economic and financial Returns

For Commercially viable project, the DPR will be concluded with providing recommendations for development.

For Commercially non-viable project, the DPR will be concluded declaring the project as commercially non-viable.

Above methodology is also presented as a flow chart in **Figure 2** as below:

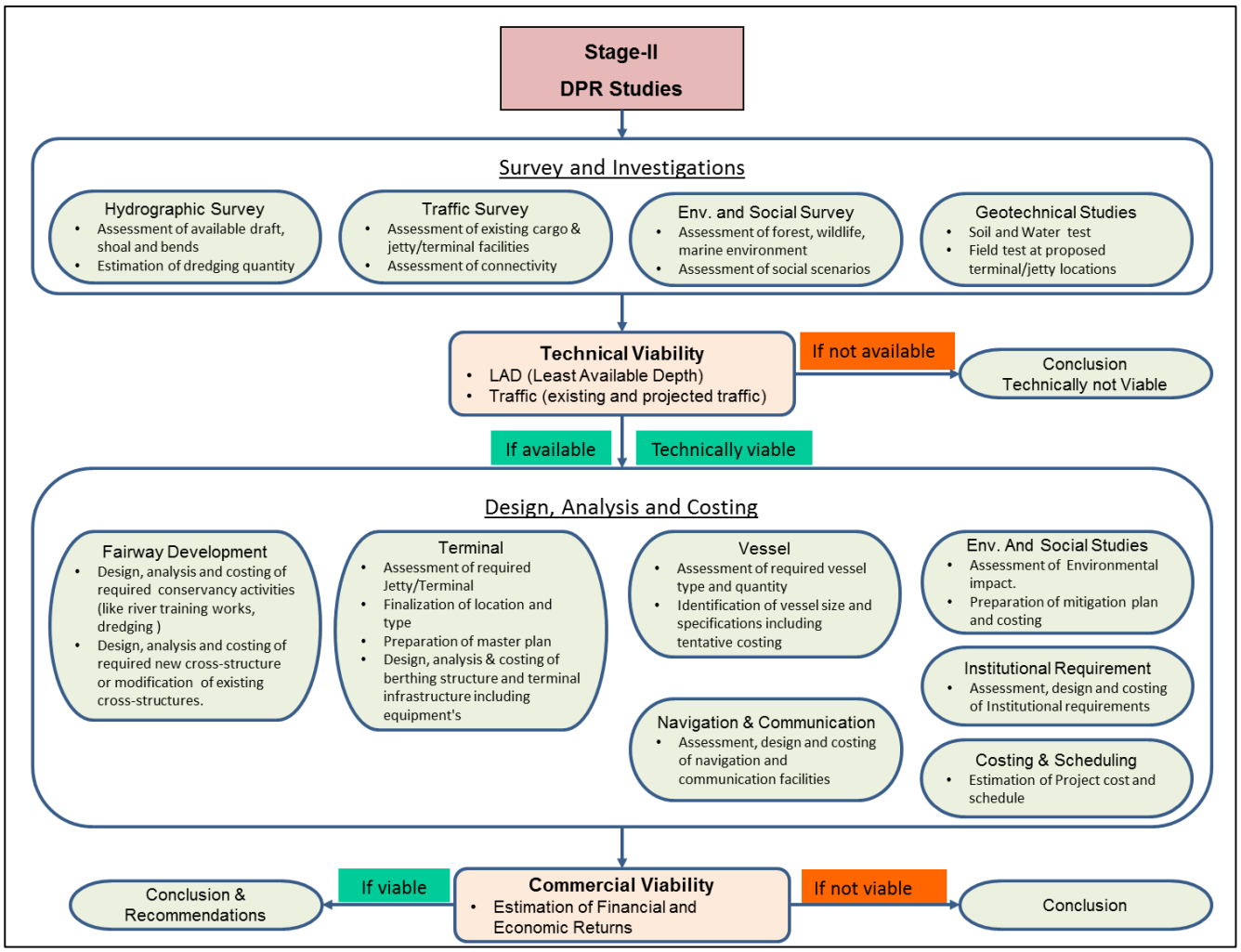


Figure 2: DPR Approach and Methodology Flow Chart

1.4.1 Classification of Waterways

For safe plying of self- propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in push tow units of carrying capacity up to 8000 tonne, National waterways can be classified in the following categories as suggested by IWAI:

Table 1: Classification of National Waterway -Rivers

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self-propelled vessel Carrying Capacity
CLASS-I	1.2	30	300	4	30	100 tonne Dead Weight Tonnage (approx. size 32m overall length, 5m moulded breadth and 1.0m loaded draft or one tug and two barges combination of 200 tonne Dead Weight Tonnage (approx. size 80m overall length, 5m moulded breadth and 1.0m loaded draft).
CLASS-II	1.4	40	500	5	40	300 tonne Dead Weight Tonnage (approx. size 45m overall length, 8m moulded breadth and 1.2m loaded draft or one tug and two barges combination of 600 tonne Dead Weight Tonnage (approx. size 110m overall length, 8m moulded breadth and 1.2m loaded draft).
CLASS-III	1.7	50	700	6	50	500 tonne Dead Weight Tonnage (approx. size 58m overall length, 9m moulded breadth and 1.5m loaded draft or one tug and two barges combination of 1000 tonne Dead Weight Tonnage (approx. size 141m overall length, 9m moulded breadth and 1.5m loaded draft).
CLASS-IV	2.0	50	800	8	50	1000 tonne Dead Weight Tonnage (approx. size 70m overall length, 12m moulded

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self-propelled vessel Carrying Capacity
						breadth and 1.8m loaded draft or one tug and two barges combination of 2000 tonne Dead Weight Tonnage (approx. size 170m overall length, 12m moulded breadth and 1.8m loaded draft).
CLASS-V	2.0	80	800	8	80	1000 tonne Dead Weight Tonnage (approx. size 70m overall length, 12m moulded breadth and 1.8m loaded draft or one tug and two barges combination of 4000 tonne Dead Weight Tonnage (approx. size 170m overall length, 24m moulded breadth and 1.8m loaded draft).
CLASS-VI	2.75	80	900	10	80	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 4000 tonne Dead Weight Tonnage (approx. size 210m overall length, 14m moulded breadth and 2.5m loaded draft).
CLASS-VII	2.75	100	900	10	100	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 8000 tonne Dead Weight Tonnage (approx. size 210m overall length, 28m moulded breadth and 2.5m loaded draft or with higher dims).

In addition to the above, IWAI also given guidelines regarding vertical clearances with respect to transmission lines for National waterways as below:

Type of Transmission Lines	Vertical Clearance
Low voltage transmission lines including telephone lines	16.5
High voltage transmission lines, not exceeding 110 kilo volt	19.0
High voltage transmission lines, exceeding 110 kilo volt	19.0
	+1 centimetres extra for each additional 1 kilovolt

Also:

a) Waterway side slopes should be kept as 1(V): 5(H);
b) Minimum depth of channel should normally be available for about 330 days of the year;
c) Vertical clearance at cross structure over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway;
d) For rivers, vertical clearance should be kept over Navigational High Flood Level (NHFL), which is the highest flood level at a frequency of 5% in any year over a period of last twenty years.

1.4.2 Measures to Improve the Depth

The basic parameters considered for the fairway design are:

- Depth
- Width
- Side slopes
- Bends

As explained above, as the classification of waterways in India is based on the experience gained in various waterways, the characteristic features of the design waterways based on studies carried out by IWAI are furnished below and the same shall be followed.

Fairway Design

The fairway depth should be good enough to ensure steerability of the vessel and to prevent bottom feel. To meet this requirement, the minimum depth that is needed in a channel would commonly be the sum of the draught (draft) of the vessel and other tolerance factors. The tolerance factors to be considered are listed as:

- Factor of keel clearance to avoid touching of the vessel to the ground and minimum free water below the keel for maintaining control on manoeuvring,
- Wave tolerance for the heaving and pitching of the vessel due to wave motion,
- Squat, increase of draft due to ship motion,
- Tolerance for siltation and dredging,
- Increase of draught due to trim and heaving due to unequal loading and steering manoeuvre respectively, and
- Tolerance for the change of draught during the transition from salt water to fresh water.

The keel clearance factor is the prime concern of the all tolerance factors considered. As per the standards laid down by German Code of practice (EAU 80), a 0.3 m layer of water column below the keel of the loaded ship is sufficient for free manoeuvrability of the vessel.

IWAI's experience in inland waterways in India and sub-continent (Bangladesh and Myanmar) shows that the under keel clearance for free manoeuvrability of the vessel varies between 0.2 and 0.5 m depending upon the soil characteristics of the channel bed and other parameters.

Width of a Channel

The total width of a navigation waterway (W) in general is expressed in terms of a beam of a vessel (B). The design width for the proposed two-way navigation can be obtained as:

$$W = BM + BM1 + C + 2C1$$

Where: W = Navigation channel width for two-way navigation.

BM = Maneuvering zone for the design vessel which takes into account the directional stability of vessel.

BM1 = Maneuvering zone for the upcoming vessel which takes into account the directional stability of vessel.

C = Width of separating zone.

C1 = Width of the security area, between the maneuvering zone and the channel side which is accounted for environmental and human factors including bank suction.

Values recommended by various authorities for the above equation vary within wide limits. Some of the recommended values are presented here:

BM = 1.3 B to 3.0 B
BM = BM1
C = 0.5 B to 1.0 B
C1 = 0.3 B to 1.5 B
Where, B = Beam of a design vessel.

Based on the experience and recommendations of experts on Inland Waterways, the factors considered for the present design are:

BM = 1.8 B
BM = BM1
C = 0.5 B
C1 = 0.5 B

The designed channel width = 1.8B+1.8B+0.5B+2x0.5B for two way navigation at draft level = 5.1B. The bottom width of the channel for two-way navigation for the design vessel can generally be considered as 5 x B.

Slopes

The selection of slope is in accordance with the soil characteristics of the bed and banks, width of the waterway etc. The adopted channel slope shall be 1:5

Width Allowance at Bends

In bends, the width of the fairway should be more than the width of the canal that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The drift angle is larger for vessels traveling in the downstream than the

upstream direction. The drift angle is inversely proportional to the bend radius 'R', that is, the larger the radius the smaller the value of drift angle. Unloaded ships normally subjected to more drift and consequently take up a greater width in bends than loaded ships and therefore the proposed allowance at the keel level of the unloaded ships is larger than the loaded ships.

Dredging of Navigational Channel

The dredging quantities for the above design channel shall be worked out based on the bathymetric surveys carried out. The system and different type of navigation marks shall be proposed in the DPR are given as follows:

- Lateral marks, to mark the left and right sides of the navigation route to be followed by navigator;
- Bifurcation marks, to mark the middle ground between the navigation channel, bifurcated channel and isolated dangers in the middle of the navigational channel;
- Shore marks;
- Bank wise marks, to indicate the channel at point where it approaches a bank;
- Crossing marks, to indicated crossing and alignment of the channel from one bank to another;
- Marks of prohibited areas, to indicate no permission of entry;
- Sound signal marks, to indicate use of horning or other sound signals;
- Marks for traffic control, to control up bound or down bound vessel in one way or sequence passage or to prohibit navigation;
- Marks on bridges, to indicate the passage through bridges;
- Depth indicator marks, to indicate shallow areas ahead in the navigation channel;
- Width indicator marks, to indicate the narrow stretches ahead in the navigational channel;
- River training marks, to indicate the ongoing river training works in the river to the navigators.

1.4.3 Identification of IWT Terminals

Site selection is the most important as it decides the investment for establishing the terminal facilities. Hence, proper consideration has to be given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site shall be carried out with the view of following considerations:

- Water availability near the terminal land throughout the year especially during lean season;
- Stable river channel with sufficient depth;

- Favourable hydraulic conditions for berthing and cargo handling;
- Availability of terminal land for infrastructure, cargo storage and handling;
- Traffic potential and cargo characteristics; and
- Navigational safety.

The proposed IWT Terminals shall be planned with the following infrastructure facilities for operation:

i) Steel Gangway resting on a floating pontoon. The detailed engineering & design of gangway arrangement shall be carried out during the construction stage. The preliminary layout drawing shall be proposed in the DPR;
ii) Administration Building and Bank protection arrangement;
iii) Covered Storage Shed/Transit Shed;
iv) Open storage area;
v) Security Shed;
vi) Forklift Trucks, Pay loaders & Dumper tracks; and
vii) Weigh Bridge, Watch and ward, Compound wall, Firefighting arrangement, Electrical & PH Facilities including DG.

The terminal shall be proposed with suitable mooring facilities, firefighting water line, water supply pipeline, power line for shore connection to barges, fenders etc. Preliminary planning and master plan shall be prepared in the DPR stage as per the relevant IS codes. It is envisaged and proposed that to the extent possible, all shore/river bank based buildings / godown are prefabricated, pre-engineered type conforming to the best standards in vogue in logistic / supply chain industry.

Other Alternatives to Improve for Navigation

Based on our earlier study for Ganga River between the reach from Allahabad to Ghazipur, there are many methods available to improve river navigation. Bandalling work – it has to follow closely falling stage of river, closing minor channels and diverting river flow in single channel to increase depth in the navigable channel in mainly due done by bandalling. In some reaches this method becomes successful but some river stretches remain shallow and need other training measures including dredging. Channelization of river and Construction of barrages at suitable locations, creating ponding conditions with required depth and navigational locks for ships and vessel movement shall be studied. The examination of various options/measures to improve the water depth shall be studied. The most suitable method for development shall be identified with consideration on the likely morphological, sediment transport, and dredging aspects of different options. This task is expected to be fed back

into from the financial and economic analysis providing refinement to the proposed development until a recommended solution is reached. The most appropriate type of river development including drudging option along the river shall be identified and likely impacts of these developments on river flow depths as well as sedimentation and morphology shall be investigated. This analysis will constitute an iterative process in which problems relating to LAD will be addressed to find more successful solutions where necessary. This will however, not be an open-ended process as the assessment of techno-economic feasibility updation only requires an indication of the likely costs of building and maintaining the structures which are shown to support achievement of LAD as intended.

1.4.4 Concept Design and Cost Estimates

Preliminary Design shall be performed for all the structures /developmental works proposed as per the above analysis and mathematical model studies carried out conforming to relevant IS Codes. Design drawings shall be prepared and submitted based on the preliminary design. Bill of quantities and cost estimates shall be prepared for all the proposed structures / developmental works. Based on the cargo potential and other considerations necessary for locating an IWT terminal, extent of land required for setting up of IWT terminals and other suitable locations shall be identified. Preliminary topographic survey shall be carried out and layout plan for all suggested locations shall be prepared clearly indicating all facilities e.g. jetty, approach to jetty, bank protection, covered and open storage, roads, office, sentry hut, boundary wall, bank protection, bunkering facility, water facility, turning circle for IWT vessels location of depth contours of 2m and 2.5m in the river near the terminal sites. Preliminary engineering design and drawings for setting up of terminals with related facilities including mechanical loading/ unloading at the proposed sites shall be prepared. Also inter modal cargo transfer facilities required at these terminals shall be indicated.

1.4.5 Financial and Economic Analysis

Financial and economic analysis through FIRR and EIRR of the project including SWOT analysis shall be carried out for the project. For the Financial Internal Rate of Return shall be computed as follows:

- Costs shall be calculated as total capital investment for the Project components, net rate of interest charges during construction and operations & maintenance costs for the Project;
- Income flows shall be calculated based on gross revenues of projected goods to be transported through private operators with permissible assumptions such as project life etc.;
- Economic Internal Rate of Return shall be computed taking into account the following factors;
- The assumed life of the project as per norms;

- Costs shall be calculated as Government contribution and other sources. A standard conversion factor shall be used to reduce financial costs to economic costs;
- Benefits shall be estimated as Government revenues, calculated as net profit share, royalties and tax;
- Social Benefits like fuel saving, reduction in environment pollution and carbon emission, accident reduction, decongestion of rail and roads, etc.

The financial viability and sustainability of this project depend upon the adaptation to the prevailing context in which they operate. In working out the Financial Viability and sustainability, the following factors shall be considered.

- budgeting and cost accounting systems,
- resource mobilization for capital investments,
- cost recovery and operational financing,
- cost reduction and control.

The Profitability projections and financial analysis for each of the project components shall be worked out in detail and presented in the report. The financial statements shall be prepared on the basis of the suitable assumptions. The cost benefit analysis for the proposed project shall be calculated. IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

2.0 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 HYDROGRAPHIC SURVEY

The National Waterway stretch of Katakhali river under DPR study is from Lebukhali at Lat 22°21'48.8533"N, Long 88° 57'23"E to Barunhat at Lat 22°30'29.56"N, Long 88°58'18.90"E. The total length of this stretch is about 22.465 km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Katakhali waterway comprises of:

- Undertake bathymetric and topographic survey of proposed waterway
- Establishing horizontal and vertical control stations.
- Construction of benchmark pillars and establishing its reduced level w.r.to Mean Sea Level.
- Transfer of sounding Datum.
- Setting up and deployment of water level gauges.
- Current velocity and discharge measurements.
- Collection and analysis of water and bottom samples.
- Collection of topographic features including existing cross structures.
- Preparation of inventory of industries in the project influence area (PIA).
- Analysis of survey data, including assessment of water availability for navigation.
- Preparation of survey charts and report.

2.1.1 Waterway in General and Hydro-Morphological Characteristics

The Katakhali River is a tidal estuarine river in and around the Sunderbans in North 24 Parganas district West Bengal, India. The river has a connection with the Kalindi River to the north and with Sahibkhali River in the south. The combined river flow falls in to the Bay of Bengal with a wide mouth after traversing about 80 kilometers. There are a couple of sharp curves in the river stream.

The proposed 22.465 km stretch of waterway is located in the North 24 Parganas district of West Bengal. Whole stretch of Katakhali waterway is having tidal influence with a maximum tidal variation of 3.37 m to a minimum tidal variation of 1.59 m.

Average flow velocity in the waterway varies from 0.563m/sec to 1.28 m/sec. Reduced depth at every 1 Km intervals for full stretch of the river is provided in **Chapter 3**.

2.1.2 Existing Hydrological / Topographical Reference levels

There was no GTS Station available near the survey area. As per IWAI guidelines, simultaneously 4 hour observation were carried out at newly established BM, KK-01 and RM-04 of Raimangal River. Also 4 hour observation were carried out at KK -2 & KK-03 BM's and data was logged in rinex format which was post processed in Auspos and Spectra software and value of BMs w.r.t. MSL were obtained.

The Bench mark values supplied by client and transferred values to near survey area by RTK System and auto levelling. Katakhali River was divided into 10 km stretches for ease of applying Tidal level corrections to the collected bathymetric data. The values of BM's KK-01 & KK-03 w.r.t Sounding datum were established by using few hour observation methods in accordance with Admiralty Manual of Hydrographic Surveying Vol 2 and SD value of KK-02 was transferred from KK-01 by base line processing method. Total three in number BM pillars (namedKK-01, KK-02&KK-03) were constructed and erected along the river from Lebukhali to Barunhat.

The final accepted WGS 84 coordinates and details of Benchmarks established during the conduct of survey are provided in **Table 2**.

Table 2: Description of Bench Marks

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above SD (m)	Height above MSL (m)
KK-01	Dulduli	0.0	22°21'42.47"	88°57'28.42"	701607.007	2474184.854	4.194	6.554
KK-02	Sandelerbil	9.8	22°25'50.23"	88°57'01.07"	700725.795	2481795.737	2.893	5.253
KK-03	Barunhat	21.9	22°30'25.27"	88°57'57.74"	702235.294	2490277.346	4.286	6.646

2.1.3 Sounding Datum and Reduction details

Sounding Datum was transferred at all the newly established BM's using Mayapur and Garden Reach values. Details of Sounding Datum (SD) and reduction details are provided in **Table 3** as below:

Table 3: Details of Sounding Datum

Sl No	Location of Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL(m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey(m)	Topo level data to be converted as depth for volume calculation w.r.t SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F= (E- WL datain MSL)	G = ((E- topo levels in MSL)
1	Dulduli	00.0	0.0 to 10.0	-2.36	-2.36	Tide Applied w.r.t SD	2.36
2	Sandelerbil	9.8	10.1 to 20.0	-2.36	-2.36		2.36
3	Barunhat	21.9	20.1 to 22.465	-2.36	-2.36		2.36

2.2 EXISTING CROSS STRUCTURES

2.2.1 MHWS

The value of MHWS and Mean Sea Level was taken from CHAINAGET Tide book for the Standard Port i.e Sagar Roads and same was applied at the site. The details of MHWS values for all cross structures are provided in **Table 4** below:-

Table 4: Details of MHWS values of Cross Structures

Sl. No.	Location	Cross-structure Details	Chainage (km)	Established MHWS w.r.t. MSL (m)	Computed MHWS at Cross-Structures w.r.t. MSL (m)
1	Barunhut (Hasnabad Hingalganj Road)	Road Bridge	22.1	5.22	5.22

2.2.2 Details of existing Bridges and Crossings over water way

There is one road bridge in the entire survey stretch of Katakhali River at Barunhat. The details are given in **Table 5**.

Table 5: Details of existing Bridges and Crossings

Sr. No.	Structure Name and for road / rail	Chainage (KM)	Type of Structure (RCC / Iron/ Wooden)	Location	Position (Lat/Long)		Position(UTM)		Length (m)	Width (m)	No of Pillars	Horizontal clearance (clear distance Between pillars) (m)	Vertical clearance w.r.t. MHWS (m)	Remarks (complete/ under- construction),in use or not, condition
					Left Bank	Right Bank	Left Bank	Right Bank						
1	Road Bridge	22.1	RCC	Barunhut (Hasnabad Hingalganj Road)	22°30'31.90"N, 88°58'0.07"E	22°30'22.17"N, 88°58'1.10"E	702299.34 E, 2490482.74 N	702332.44E, 2490183.11N	333.2	10.4	3	61.41	1.84	In use

Note: - From field observation Bridge clearance over MSL has been worked out. The value of MHWS and Mean Sea Level was taken from CHAINAGET Tide book and the difference has been taken as correction. Our field observations thereby arrived at clearance under the bridge over MHWS level in those locations.

2.2.3 Electric Lines / Communication Lines

There is one High tension line crossing the Katakhali River at Barunhat. The detail of this high tension line is provided in **Table 6** below.

Table 6: Detail of High Tension Lines

Sl No	Type of line	Chainage(km)	Location	Position (Lat/Long)		Position (UTM)		No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL/ MHWS (m)	Remarks (complete/ under- construction)
				Left Bank	Right Bank	Left Bank	Right Bank				
1	High Tension Lines	21.6	Barunhat	22°30'28.0542"N 88°57'45.0968"E	22°30'22.8931"N 88°57'46.6633"E	701872.672 E, 2490358.107 N	701919.525 E, 2490199.933 N	4	165	6.817	Complete

2.2.4 Pipe Lines / Cables

No cross-structures, pipe lines, underwater cables are located along the entire stretch of waterway.

2.2.5 Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

No dams, barrage, weir or any other cross structure are located along the entire stretch of waterway.

2.3 BENDS

Details of bends located along the entire stretch of waterway are provided in Table 7:

Table 7: List of Bends

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	1.06	1.96	482
2.0	2.32	2.97	457
3.0	3.36	3.96	443
4.0	4.64	5.15	201
5.0	5.52	6.15	421
6.0	7.74	8.24	231
7.0	8.95	9.55	368
8.0	10.27	10.94	547

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
9.0	11.09	11.58	449
10.0	11.71	12.28	372
11.0	13.12	13.75	603
12.0	14.01	14.52	254
13.0	14.65	15.20	260
14.0	15.87	16.32	235
15.0	16.54	17.00	207
16.0	17.12	17.50	229
17.0	17.63	17.94	268
18.0	19.45	19.76	210
19.0	19.85	20.13	129
20.0	20.48	20.90	184
21.0	20.98	21.25	146

2.4 VELOCITY AND DISCHARGE DETAILS

Current meter observation was carried out at each location at required depths using virtual ware Current meter. The observations were carried out at the deepest route of the channels. Discharge calculations are from the observed data. The current meter and discharge details are provided in **Table 8**.

Table 8: Current Meter and Discharge Details

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area(Sq m)	Discharge (Cu.m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
1	0.759	22°22'4.7732"N	88°57'4.8158"E	700922.71	2474861.88	4	1.49	1.21	1.14	1.280	242.67	310.617

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area(Sq m)	Discharge (Cu.m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
2	10	22°25'55.4593"N	88°56'54.812"E	700544.51	2481954.15	7	1.24	1.09	0.99	1.107	769.25	851.560
3	21.894	22°30'26.8694"N	88°57'57.2111"E	702213.04	2490326.21	3.5	0.85	0.43	0.41	0.563	49.87	28.077

2.5 WATERWAY DESCRIPTION

The total 22.465 km stretch of Katakhali Waterway under DPR study can be broadly divided in to three (3) stretches. **Table 9** below provides the details of sub-stretches of Katakhali waterway.

Table 9: Sub-Stretches of Katakhali Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Lebukhali	Rupmari	0 Km	10 km
2	Rupmari	Dharam Baria	10 Km	20 km
3	Dharam Baria	Barunhat	20 Km	22.465 km

Detail descriptions of each sub-stretch are provided in below sections.

2.5.1 Sub Stretch 1: From Lebukhali to Rupmari (0km to 10km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 0 to 10 km chainage of the Katakhali River. It is the downstream portion of the Katakhali River where it confluence with the Sahibkhali River. The area is sparsely populated, with fishing and farming being

the main occupation of the people. A few brick kiln are also seen in the area. Hingalganj - Lebukhali road is in the vicinity of the river bank. This stretch is about 200 meters wide with some portion of the river bank protected. Dredging would be required in this stretch for all time navigation. Fishermen extensively use the natural slope of the ground for landing the boats.

- Following are the observations made during survey of Sub-stretch 1: (Chainage 0 Km to 10 Km)
- There are no overhead obstructions/crossovers.
- There are no dams & barrage available in this stretch.
- The tidal range is 3.13 m in this stretch as we move from downstream to upstream.
- There is no hindrance or encroachment in this stretch.

The details of current and discharge at different depths is provided in **Table 8**.

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Katakhali Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 10**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

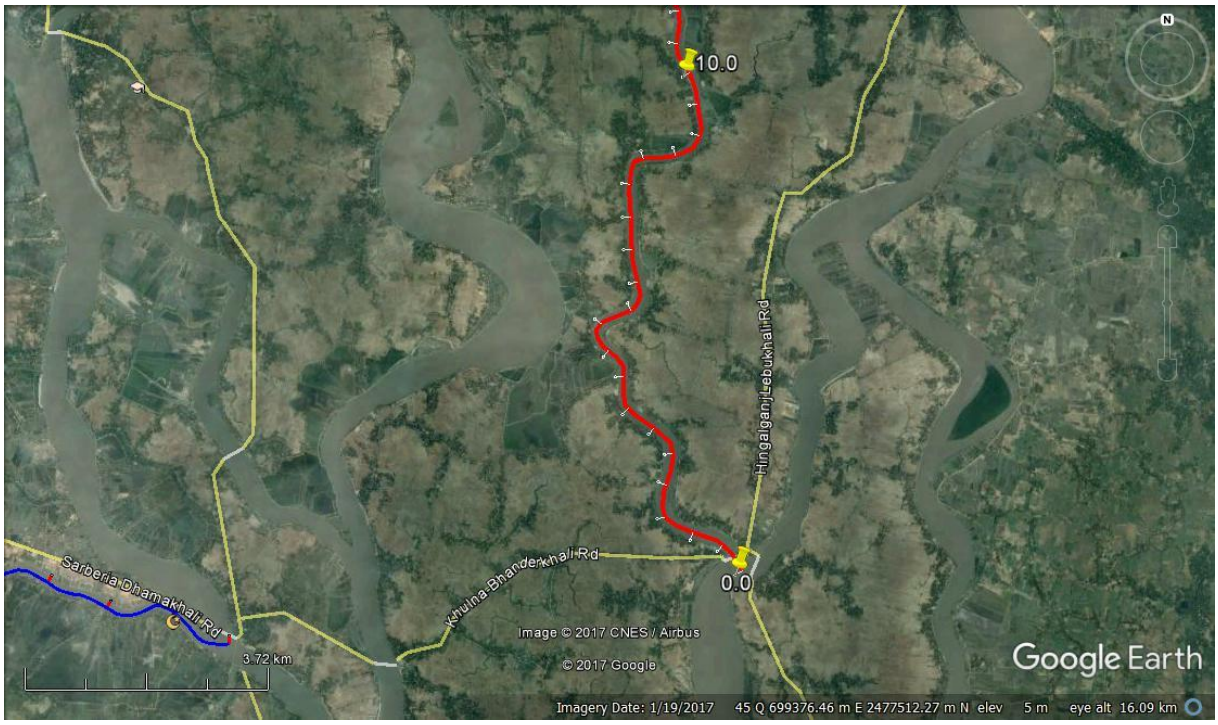


Figure 3: Google Image showing Sub-Stretch -1

Table 10: Dredging Quantity (cum) for Sub-Stretch 1

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	0	10	Not Applicable (Tidal Zone)				-1.7	35.18	1400	11965.76
II	0	10					-2.38	35.18	2600	26794.48
III	0	10					-4.00	35.18	3800	77806.58
IV	0	10					-4.09	35.18	4200	117353.7
V	0	10					-4.44	35.18	5000	219529.2
VI	0	10					-4.67	35.18	5800	479785.7
VII	0	10					-6.76	35.18	8400	850512

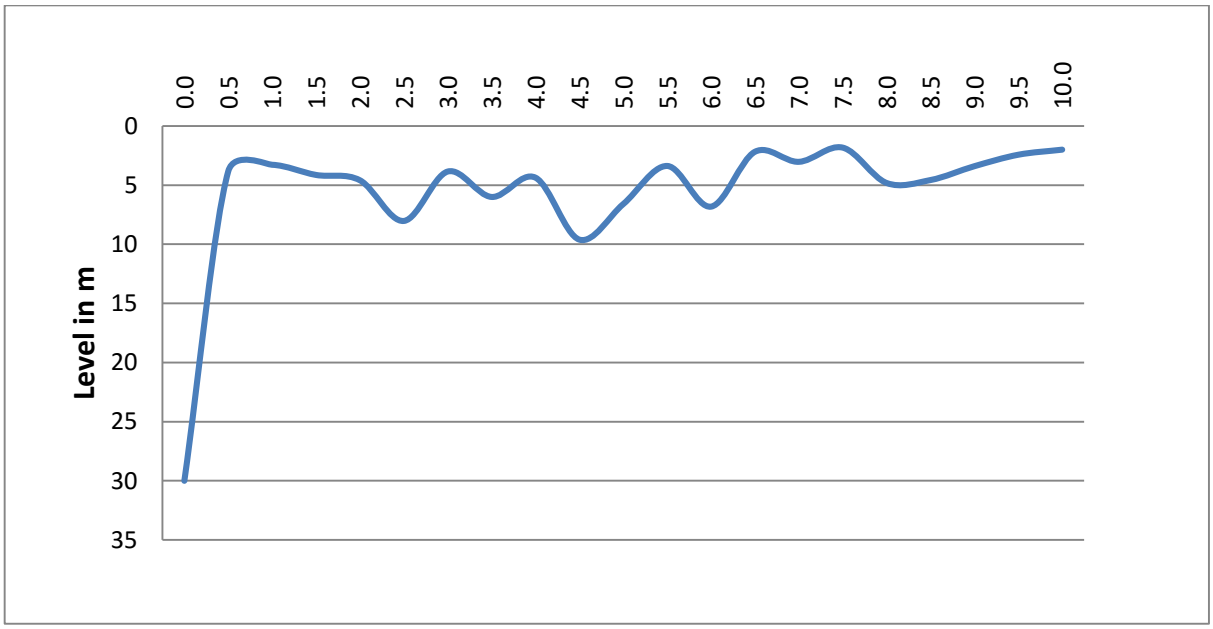


Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

Figure 5: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Dakshin Chandanpiri - Iswaripur (10km to 20km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 10 to 20 km chainage of the Katakhali River. There is dense mangrove forestation on both sides of the river in this stretch. The area is not densely populated, with fishing and farming being the main occupation of the people & the fields in the area are dependent on the rainfall. This stretch is not very wide and average width is about 400 mtrs with some portion of the river bank protected. The details of current and discharge at different depths is provided in **Table 8**.

Following are the observations made during survey of Sub-stretch 1: From Mritrunjaynagar to Budhakhali (Chainage 10 Km to 20 Km)

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 2.08 m in this stretch as we move from downstream to upstream.
- Small boats ply on this stretch of Katakhali River to Namkhana which is a big hub. However fishermen use the natural slope of the ground for landing the boats.

Figure 6: Google Image showing Sub-Stretch -2 of Waterway

The quantity of dredging required for all classes of waterways this stretch is provided in **Table 11**. **Figure 7** shows the observed and reduced bed profile of sub-stretch 2.

Table 11: Dredging Quantity (cum) for Sub-Stretch 2

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	10	20	Not Applicable (Tidal Zone)				-5.11	11.18	7000	155442.5
II	10	20					-5.76	11.18	8200	291075.3
III	10	20					-6.48	11.18	9200	523227.5
IV	10	20					-6.65	11.18	9400	636530.8
V	10	20					-6.73	11.18	9600	923857.8
VI	10	20					-6.75	11.18	9600	1446560
VII	10	20					-6.75	11.18	9800	2151548

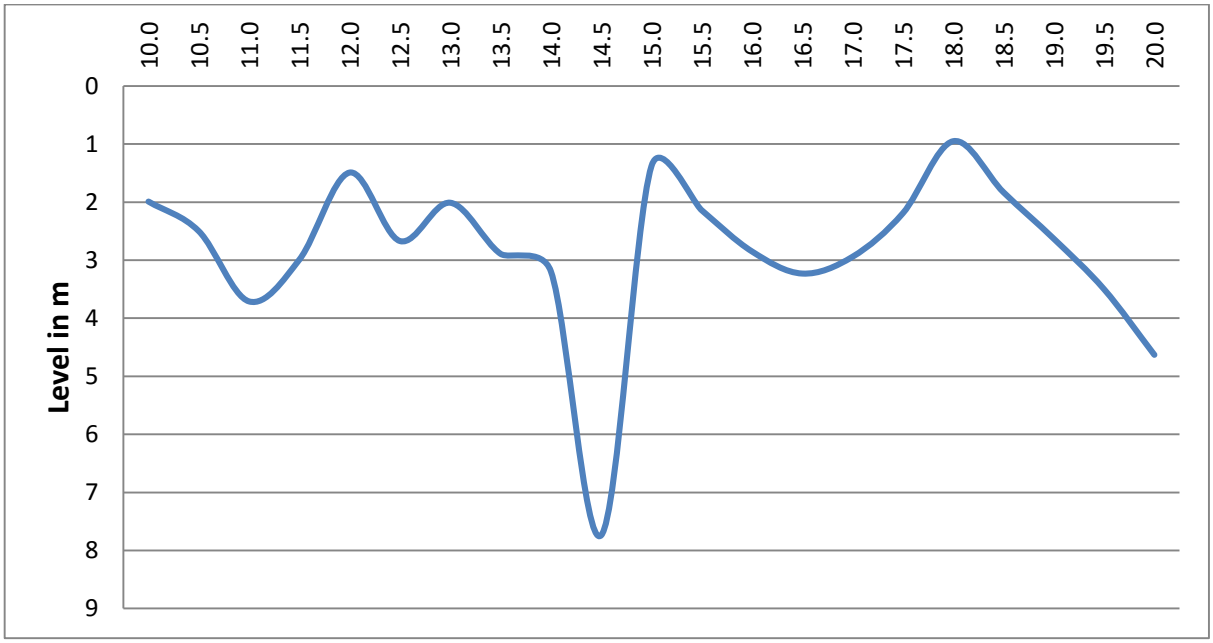


Figure 7: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

Figure 8: Photographs of Sub-stretch 2

2.5.3 Sub Stretch 3: From Dharam Baria to Barunhat (20km to 22.465 km)

Bathymetric and Topographic Survey was carried out for this stretch between 20 to 22.465 km chainage of the Katakhali River. The area is moderately populated as it is closer to the main town of Hasnabad which is the rail head of this area. Fishing and farming are the main occupation of the people & the fields in the area are dependent on the rainfall. A few brick kiln are also seen in the area. Hingalganj- Lebukhali road with a bridge is in the vicinity of the river bank. River banks are

partially protected. Soil erosion is found at some areas. This stretch is narrow and average width is about 80 meters. The details of current and discharge at different depths is provided in **Table 8**.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 3.37 m in this stretch as we move from downstream to upstream.

Figure 9: Google Image showing Sub-Stretch -3 of Waterway

Figure 9 above shows the alignment of sub-stretch 3 (Ch. 20.0 km to 22.465 km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 12**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 3.

Table 12: Dredging Quantity (cum) for Sub-Stretch 3

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	20	22.694	Not Applicable (Tidal Zone)				-2.73	6.26	2000	80031.05
II	20	22.694					-3.35	6.65	2200	142300.7

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	20	22.694					-4.03	7.01	2200	251705
IV	20	22.694					-4.19	7.07	2200	304388.7
V	20	22.694					-4.73	7.21	2200	415828.3
VI	20	22.694					-5.11	7.21	2200	608911.9
VII	20	22.694					-6.17	7.21	2200	864199.3

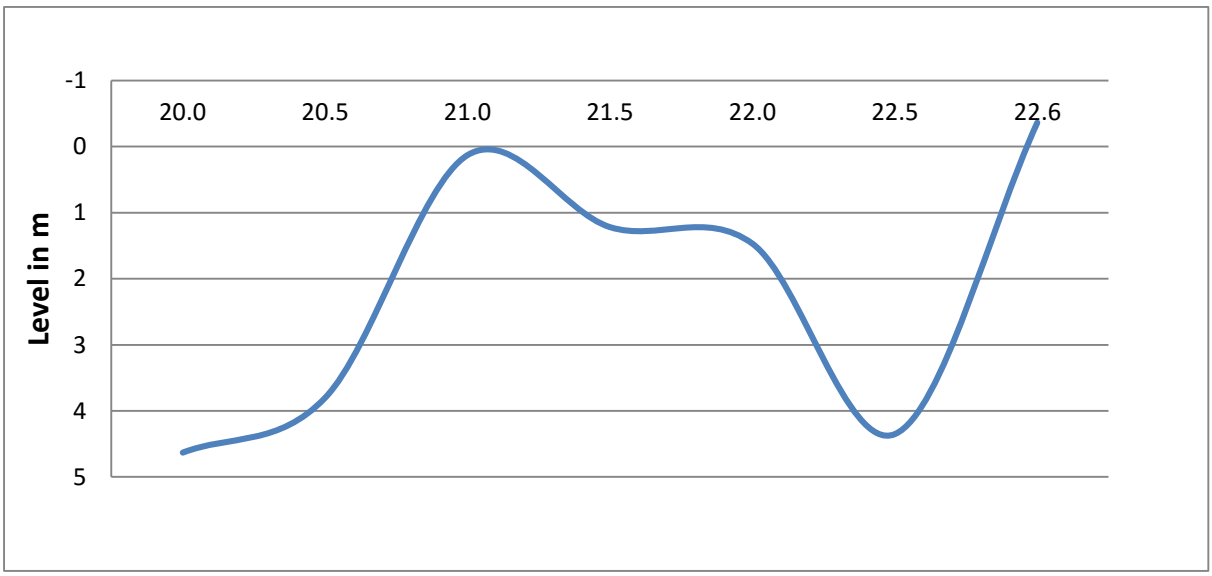


Figure 10: Bed Profile of Waterway Sub-stretch 3 (Chainage 20 km –22.465 km)

Figure 11: Photograph along Sub-Stretch 3

2.6 SOIL AND WATER SAMPLES ANALYSIS AND RESULTS

Waterway bed soil and water samples were collected using Vanveen Grab & Niskin type water sampler at respective locations. One sample were collected at each location in the river stretches. The location and depth of the collected samples are appended in **Table 13.**

Table 13: Soil & Water Sample Locations

Sample No	Chainage (KM)	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
1	0	22°22'4.7732"N	088°57'4.8158"E	700922.71	2474861.88	4
2	10	22°25'49.9031"N	088°56'58.8295"E	700661.62	2481954.15	7
3	21.894	22°30'26.8694"N	088°57'57.2111"E	702213.04	2490326.21	3.5

The collected soil & water samples were analyzed for the following properties:-

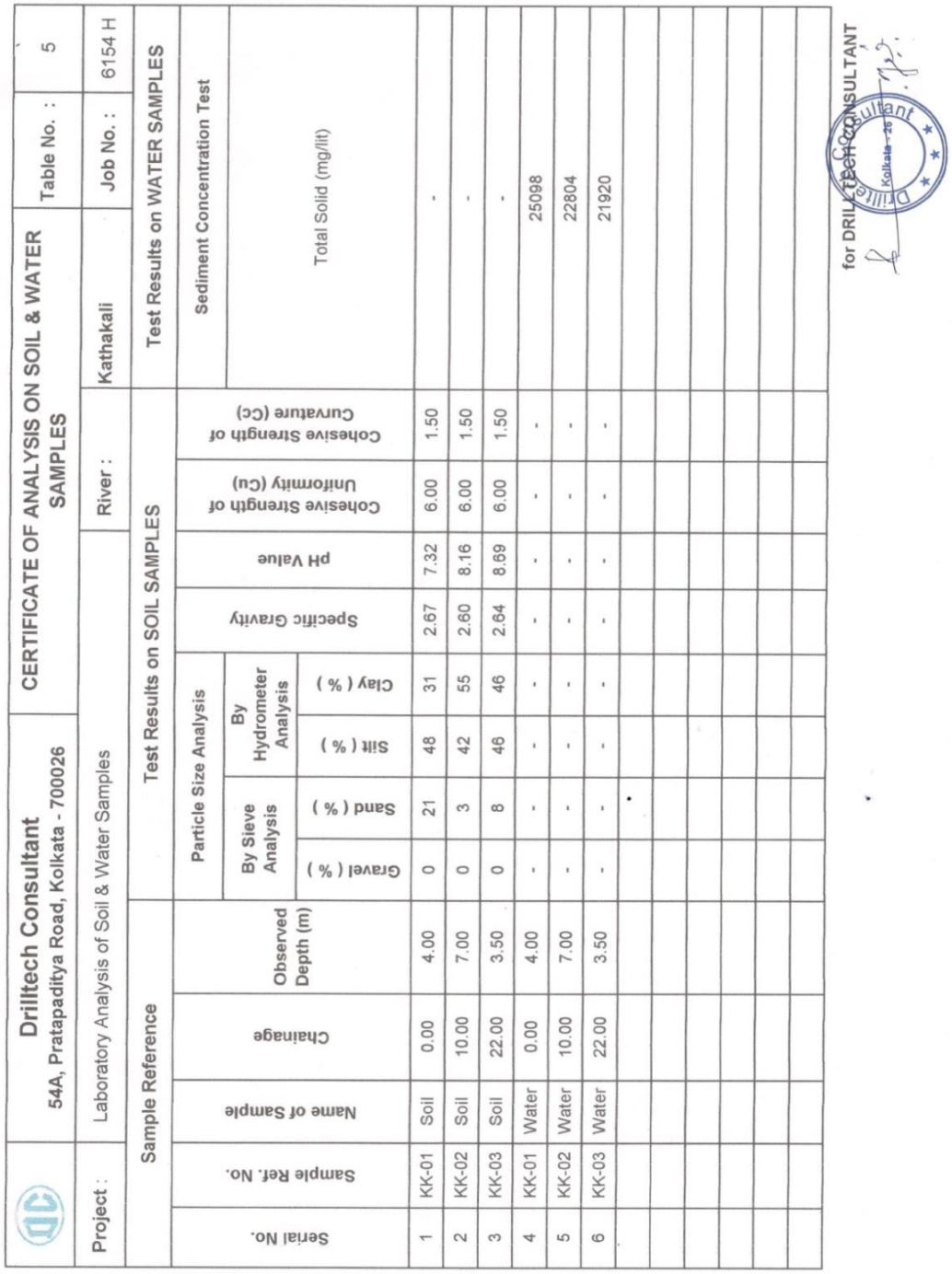
Soil Samples

- Grain size
- Specific gravity
- PH Value
- Cu, Cc
- Clay Silt percentage

Water samples

- Sediment Concentration

Test result of samples is provided in **Figure 12**.



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CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES

Table No. : 5

Job No. : 6154 H

Project : Laboratory Analysis of Soil & Water Samples

River : Kathakali

Serial No.	Sample Ref. No.	Name of Sample	Chainage	Observed Depth (m)	Test Results on SOIL SAMPLES									Test Results on WATER SAMPLES	
					Particle Size Analysis			Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)	Sediment Concentration Test	
					By Sieve Analysis		By Hydrometer Analysis						
					Gravel (%)	Sand (%)	Silt (%)	Clay (%)					Total Solid (mg/lit)
1	KK-01	Soil	0.00	4.00	0	21	48	31	2.67	7.32	6.00	1.50	-
2	KK-02	Soil	10.00	7.00	0	3	42	55	2.60	8.16	6.00	1.50	-
3	KK-03	Soil	22.00	3.50	0	8	46	46	2.64	8.69	6.00	1.50	-
4	KK-01	Water	0.00	4.00	-	-	-	-	-	-	-	-	25098
5	KK-02	Water	10.00	7.00	-	-	-	-	-	-	-	-	22804
6	KK-03	Water	22.00	3.50	-	-	-	-	-	-	-	-	21920

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Figure 12: Soil and Water Sample Test Results

3.0 FAIRWAY DEVELOPMENT

In most of the countries where inland navigation is developed, such as in Europe, China, Russia etc., the waterways have been classified in different classes depending on their physical characteristics and development potential in future. Generally, with larger waterway dimensions bigger IWT vessels can operate resulting in lower shipping cost per tonne of cargo as compared to the shipping cost of smaller vessels. One of the important factors contributing to lower shipping cost by operation of bigger vessels is the improvement in power to load ratio, i.e. capacity of cargo carrying per unit of engine power. Hence, every waterway should be developed to larger dimensions (depth and width of navigation channel) subject to the physical characteristics of the waterway. However, for developing a waterway to larger dimensions (in other wards waterway of higher class) additional investment would be required. Therefore, there would be an optimum waterway class for a particular waterway whereby total cost to the system (i.e., increase in cost due to development work vis-a-vis reduction in shipping cost) is minimum. This optimum solution is required for each waterway and for this purpose classification of waterways would facilitate planning for the optimum class of the waterway and its development.

3.1 PROPOSED CLASS / TYPE OF WATERWAY

IWAI gives a classification of waterways on the basis of width and depth of rivers/canals, radius of bends, vertical clearance, horizontal clearance between bridge piers and self-propelled vessel carrying capacity of vessels. On the basis of these criteria's, classification of waterways was done by IWAI as detailed in Paragraph **1.1.1** and **Table 1**.

From the detailed hydrographic survey, following observations are made on the proposed fairway:

a) No dams or barrage is located along the proposed fairway stretch.
b) Reduced depth of waterway varies from -6.76 m to 35.18 m w.r.t sounding datum for Class VII waterway.
c) Tidal variation varies from 1.59 to 3.37 m.
d) Width of river varies from 0.07 km to 0.24 km.

Figure 13 shows the proposed alignment of Katakhali waterway.

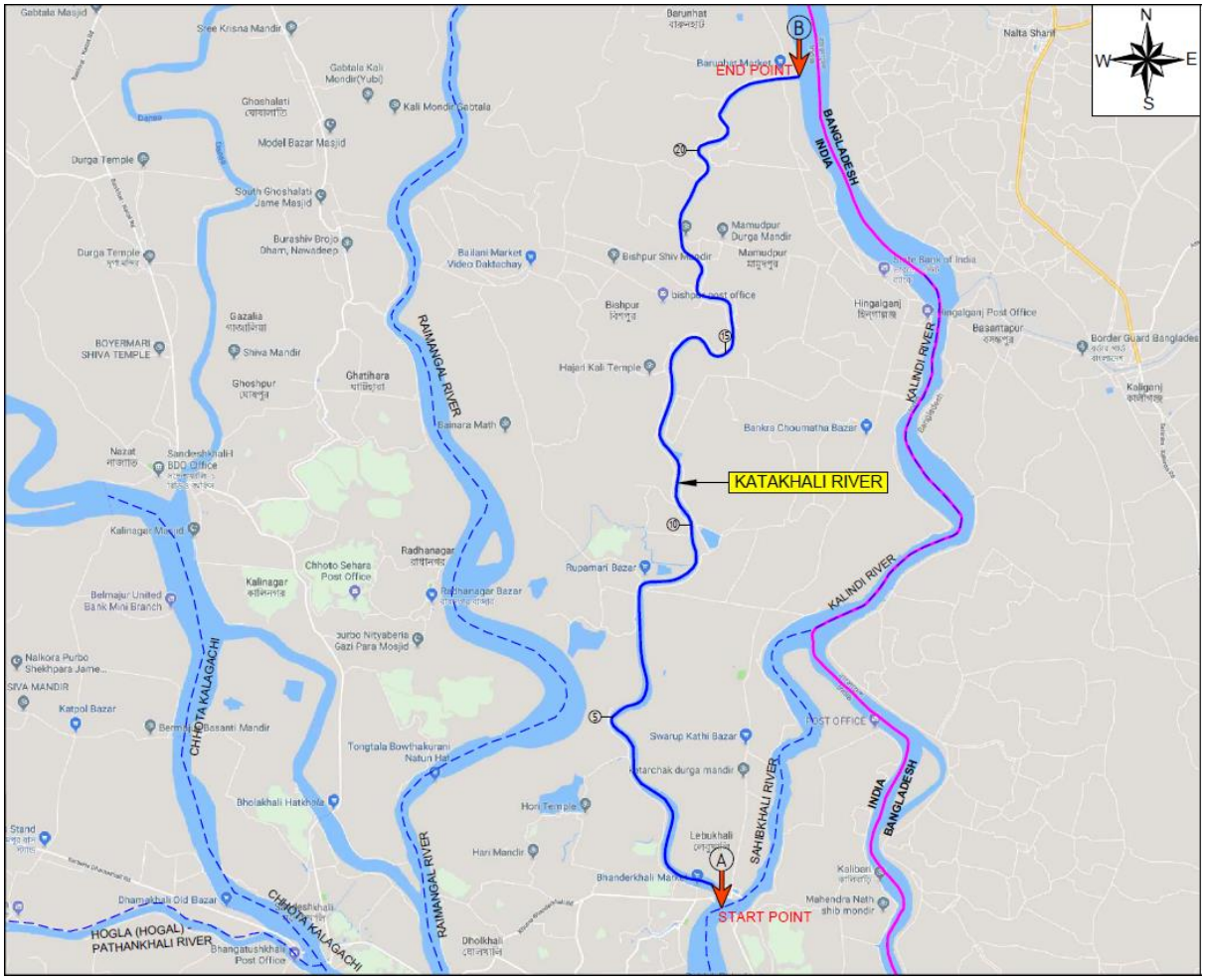


Figure 13: Proposed alignment of Katakhali Waterway

In addition to above features, Katakhali waterway is also connected with Sahibkhali and Kalindi waterway which is futher connected to other National Waterways and Indo-Bngladesh Protocol Route.

The classification of waterway and its type is based on the availability of LAD and Vessel proposed to be deployed for the required traffic. As per the hydro-graphic studies, as per Volume-III of this report, by taking into advantage of tidal window, sufficient LAD is available in the complete 22.465 km stretch of waterway, which suggest that waterway is viable for throughout the year navigation. It is principally decided by IWAI to develop Sunderbans waterways as per Class VII only.

3.2 DETAILS OF SHOALS

Due consideration was given for shoals identified during the survey. As shown in Table 14, shoals are located along the proposed waterway; hence dredging is required as detailed below.

3.3 PROPOSED CONSERVANCY ACTIVITIES

Dredging is proposed under conservancy works for the proposed fairway stretch.

3.3.1 Dredging

A defined waterway is required to make throughout the year navigation in the IWT stretch of Katakhali waterway. Design improvement measures and increase of channel depth by dredging is required in the first phase of the fairway development. Thereby, regular maintenance of fairway depth by dredging is required in the navigable route.

Fairway Dimensions

As per IWAI guidelines, fairway dimensions for river classified as Class-VII waterway should have required dimensions of 100m bottom width; 2.75m depth and side slop of 5:1 as shown in **Figure 14**. The dredging quantity obtained from Hypack software for 22.465 Km stretch of waterway for Class I to VII is provided in Volume 3A – Hydrographic Survey Report and Data. For waterway Class VII, the estimated dredging quantity is provided as below:

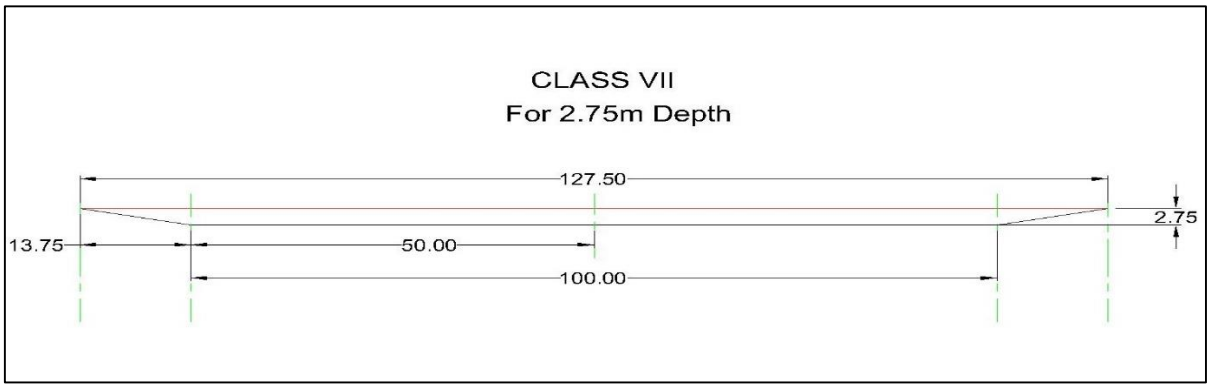


Figure 14: Fairway Dimension Class VII

Table 14: Dredging Quantity for Class VII Waterway

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
0	1	Not Applicable (Tidal Zone)				-2.22	35.18	800	78334	78334
1	2					-0.66	11.35	400	26919	105252
2	3					-4.36	9.47	1000	82519	187771
3	4					-4.59	10.67	600	45865	233636
4	5					-6.76	9.98	1000	100188	333825
5	6					-5.4	4.94	800	73421	407245
6	7					-3.6	5.94	800	55516	462762
7	8					-4.88	11.78	1000	112328	575089
8	9					-3.25	9.07	1000	91496	666585
9	10					-5.36	9.97	1000	183927	850512
10	11					-4.43	11.18	800	84479	934991
11	12					-4.32	8.36	1000	197056	1132047
12	13					-4.69	4.13	1000	196976	1329022
13	14					-4.01	6.71	1000	145877	1474899
14	15					-5.32	9.53	1000	230305	1705204
15	16					-6.75	5.9	1000	223968	1929173
16	17					-4.75	8.81	1000	242293	2171466
17	18					-6.65	7.48	1000	274994	2446460
18	19					-5.53	5.78	1000	279511	2725971
19	20					-5.98	6.65	1000	276089	3002060
20	21					-4.48	3.38	1000	317122	3319182
21	22.465					-6.17	7.21	1200	547077	3866259
								Total	**3866259**	

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 38,66,259.20 cum.

Total stretch for dredging along the proposed waterway is recommended on the basis of following points:

a) Connectivity of proposed Katakhali river with Sahibkhali waterway (at Chainage 0.0 Km) and therby with Indo Bangladesh Protocol Route through Rainmangal waterway.
b) Location of proposed terminals to be developed in this DPR (as detailed in subsequent chapters 4 ferry terminals are proposed to be developed at chaiange about 8.0 Km and 16.2 Km respectively).

Accordingly, on the basis of above criterias, Katakhali waterway is proposed to be developed from Chainage 0.0 Km to Chainage 17.0 Km. The total dredging quanity for developing this 17.0 Km stretch of waterway in Class VII, works out to 21,71,466 cum.

Disposal of Dredging Material

The dredged material is proposed to be dumped on low lying areas located on both sides of the river bank all along the waterway. The dredge material should be dumped providing gabion walls. The gabion walls should be adequately provided to prevent the dredged material to fall back in the waterway.

Figure 15: Photograph showing arrangement of Gabion Wall along River Bank

Selection of dredging equipment

The dredging is usually carried out with a cutter-suction dredger whereas maintenance dredging will be carried out with a trailing suction hopper dredger. There are various types of dredgers available in the market viz., suction dredger, bucket dredger, grab dredger, backhoe / dipper dredger, water injection dredger, pneumatic dredger etc. While most of these dredgers are ideally suited for sea conditions to dredge harbour and approach channels, the selection of a dredger for inland waterway is rather critical due to various mobility factors, seasonal variation of water levels (floods/dry season) and shallow depths.

The cutter suction dredgers having conventional centrifugal pumps or modern jet pumps will be more effective to dredge out the material. In a cutter-suction dredger or CSD, the suction tube has a cutter head at the suction inlet, to loosen the bed and transport it to the suction mouth. The cutter can also be used for hard consolidated type of bed. The dredged soil is usually sucked up by a wear resistant centrifugal pump and discharged through a pipe line or to barge.

Alternately the modern amphibious cutter suction dredger is also suitable for the waterway. The amphibious dredger can be road transportable, able to unload itself from the truck/lorry and can dredge rivers/canals having depths of 2.0 to 3.0 m. These dredgers can walk into the river and even in dry portions of the river during lean period. The dredgers can also be disassembled for transportation to other locations. These dredgers are indigenously available in India.

3.3.2 River Training

No river training works is required in the proposed navigable waterway stretch.

3.4 BANK PROTECTION / EMBANKMENT STRENGTHENING

The river bank in the proposed fairway stretch is fairly stable with mild slope. No bank protection works is envisaged in the proposed fairway stretch.

3.5 NAVIGATION MARKINGS / NAVIGATION AIDS

The seasonal change in river morphology plays an important role for maintaining the navigation channel. The navigation channel generally goes on shifting due to changes in river morphology depending on seasonal rainfall and runoff. On this kind of waterway, one of main concern is safety and ease of traffic. This can be achieved by providing proper navigation aids like marker buoys, lights.

The channel marking indicators is also very important for the safety and speed of navigation since the current velocity is much lower in the inner bends of a curved channel than the outer bend. If proper markings are provided, ships/vessel sailing upstream will take the inner bends with relatively less head current, thus making better speed. The ship sailing downstream in the outer bend will get the advantage of current. The main approach of the problem of making of shifting nature of navigable channel is to have the simple marks which could be shifted easily with less manpower and equipment.

As per the international convention, the aids to navigation are a device external to a craft, designed to assist in determination of position of the craft or a safe course or to warn of dangers. Whereas, navigational aids are the equipment on board a ship. Navigation markings/aids, proposed for safe navigation along the proposed fairway stretch are discussed in detail in Chapter 8.

3.6 MODIFICATION REQUIREMENT IN EXISTING BRIDGES / CABLES / DAMS / BARRAGES / LOCKS / WEIRS / ANICUTS / AQUEDUCTS

A road bridge and high tension wire are located at Barunhat on Hasnabad- Hingalganj Road at a Chainage of 22.1 Km and 21.6 Km respectively. No modification is required in the existing structures.

No Cable, Dam, Barrage, Lock, Weir, Anicut or Aqueduct is located in the waterway.

3.7 PROPOSED DAMS / BARRAGES / LOCKS / WEIRS TO IMPROVE DEPTH

No dam/ barrage/ locks/ weirs are proposed to improve depth.

3.8 LAND ACQUISITION

No additional land is required to be acquired for fairway development.

3.9 FAIRWAY COSTING

The cost estimate for fairway development of Katakhali waterway as per Class VII for IWT system including O&M of the system has been worked out. The cost estimates for development of the system are considered as Capital cost while for operation of the system is termed as maintenance or operating cost (O & M cost).

3.9.1 Basis of Cost

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal considered for various works;
b) Market surveys and enquires
c) Judgement based on Consultant's Experience

3.9.2 Capital Cost

The cost of initial dredging is as below:

Dredging cost @ INR 200/cum for 21,71,466 cum = INR 43,42,93,200/- (INR **4,342.93 Lakh**).

3.9.3 O&M Cost

Operation and Maintenance of fairway comprises of dredging cost only. Actual quantity of dredging required during operation stage can be worked out from model studies only. For DPR studies, it is assumed that 10% of dredging is required annually for smooth and safe navigation. Hence O&M cost works out as:

Dredging cost @ INR 200/cum for 10% of 21,71,466 cum = INR 4,34,29,320/- **(INR 434.29 Lakh**).

4.0 TRAFFIC STUDY

4.1 GENERAL

North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends in the tropical zone from latitude 22º11'6" north to 23º15'2" north and from longitude 88º20' east to 89º5' east. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district and (following the splitting of the Thane district of Maharashtra in 2014) the most populated district in the whole of India. It is also the tenth-largest district in the State by area.

The district of North Twenty Four Parganas has five Sub-divisions namely (i)Bongaon (ii)Barasat (iii)Barackpur (iv)Bidhannagar and (v)Basirhat. North 24 Parganas district highlights as per 2011 census[1]

- North 24 Parganas District comprises of 22 C.D. Blocks and 29 Statutory Towns.
- There are total 1527 Villages and 78 Census Towns in the District.
- North 24 Parganas is the most populated district of the State.
- The percentage of urban share of Population of North 24 ParganasDistrict has expanded from 54.3% (2001 Census) to 57.3% (2011 Census) of total Population of respective Census.
- North 24 Parganas District ranks 14th in decadal Population growth rate among the Districts with 12.0%.
- The density of Population (Population per square km) of the District is 2,445 per square km which makes its rank 3rd in the State.
- North 24 Parganas District stands 10th in terms of area (4094.00 sq km) in the State.
- There are 9 uninhabited Villages in the District.

4.2 INFLUENCE AREA / HINTERLAND

The Katakhali River is a tidal estuarine river in and around the Sunderbans in North 24 Parganas district West Bengal, India. The river has a connection with the Kalindi River to the north and with Sahibkhali River in the south.

[1] District Census Handbook, 2011

Katakhali river flows through one (1) CD block of North 24 Parganas disctrict, namely, Hingalganj. The Project Influence Area (PIA), considering existing and projected traffic for passenger ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 15**.

Table 15: Project Influence Area/ Hinterland

District	Area (Km^2)	C.D. Block	Area (Km^2)	Total Hinterland area (Km^2)
North 24 Parganas 	9,960	Hingalganj	238.8	238.8

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Katakhali waterway is provided in **Table 16** below:

Table 16: Population of Hinterland[2]

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
West Bengal	North 24 Parganas	81,61,961	Hingalganj	46,048	46,048

[2] District Census Handbook, 2011

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Katakhali waterway includes North 24 Parganas disctrict of West Bengal. Gross State Domestic Product (GSDP) prices of West Bengal and growth rate in percentage are provided in **Table 17** and **Table 18** as below:

Table 17: Historic GSDP of West Bengal

(at Constant Prices, INR Crores)

Year	Primary	Secondary	Teritary	GSDP
2004-2005 Series				
2004-05	52784.73	42345.24	113526.39	208656.36
2005-06	53904.43	43826.65	124058.38	221789.46
2006-07	55115.99	47764.33	136196.80	239077.12
2007-08	57961.17	51632.77	148038.24	257632.18
2008-09	56736.53	50607.84	162903.89	270248.26
2009-10	60482.83	55770.42	175701.71	291954.96
2010-11	59139.82	59303.48	190393.75	308837.05
2011-12	59933.06	57737.05	205746.87	323416.98
2012-13	62050.56	63944.59	221778.68	347773.83
2013-14	64042.77	67798.65	239953.62	371795.04
2014-15	66450.64	70992.85	260943.02	398386.51
2011-2012 Series				
2015-16	135884.08	141319.53	315478.40	612789.26
2016-17	141107.12	153276.84	247527.53	661714.69
2017-18	145213.53	170683.87	401788.08	737568.48

Source: Department of Statistics and Programm implementation, Government of West Bengal

Table 18: Annual Growth Rate of GSDP of West Bengal

(at Constant Prices, Per cent %)

Year	Primary	Secondary	Teritary	GSDP
2004-2005 Series				
2004-05	-	-	-	-
2005-06	2.22	3.30	9.28	6.29
2006-07	2.12	8.71	9.78	7.79
2007-08	6.21	6.85	8.69	7.76
2008-09	-2.35	-1.75	10.04	4.90

Year	Primary	Secondary	Teritary	GSDP
2009-10	6.94	9.68	7.86	8.03
2010-11	-2.10	5.82	8.36	5.78
2011-12	0.81	-1.99	8.06	4.72
2012-13	3.33	10.60	7.79	7.53
2013-14	3.01	6.07	8.20	6.91
2014-15	3.31	5.05	8.75	7.15
Average	**2.35**	**5.23**	**8.68**	**6.69**
2011-2012 Series				
2015-16	0.48	9.15	6.37	5.85
2016-17	3.84	8.46	10.16	7.98
2017-18	2.91	11.36	15.61	11.46
Average	**2.41**	**9.66**	**10.71**	**8.43**

Source: Department of Statistics and Programm implementation, Government of West Bengal

The below chart show the Primary, Secondary and Teritary sectors of West Bengal state. As depicted in the chart, Primary sector consists of Agriculture, Forestry, Fishery, Mining & Quarrying. Whereas Secondary sector includes different types of manufacturing industries, Construction, Elecrical, Gas & Water supply sectors. Services based industries comes under Tertiary sector.

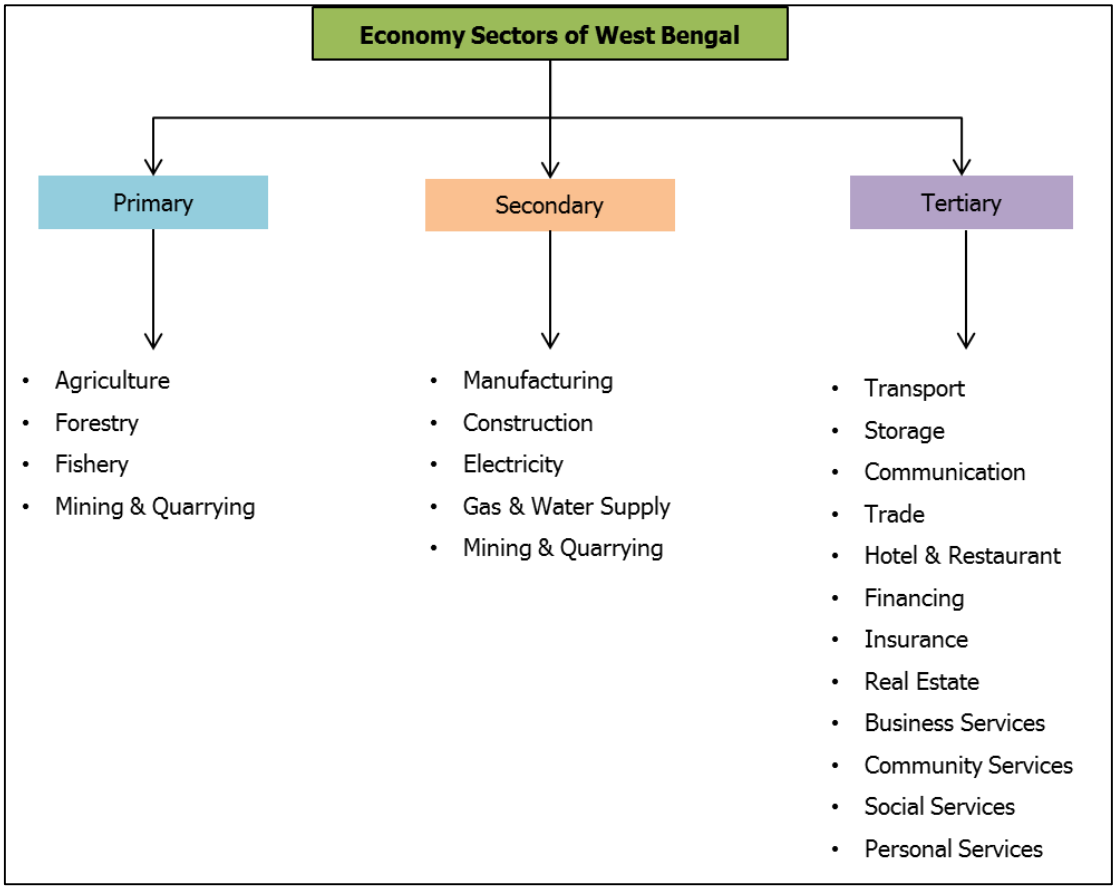


Figure 16: Sectors of West Bengal

Figure 17 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 18** below shows the sectoral composition of GSDP by broad sectors of agricultaural & allied, industry and services at constant price level of 2004-05. Input data sourced from Department of Statistics and Programm implementation, Government of West Bengal.

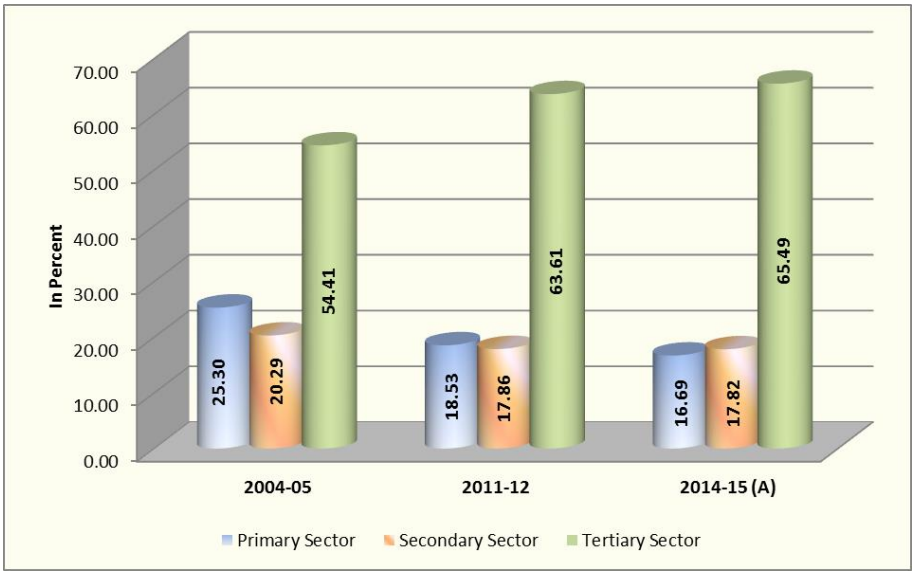


Figure 17: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

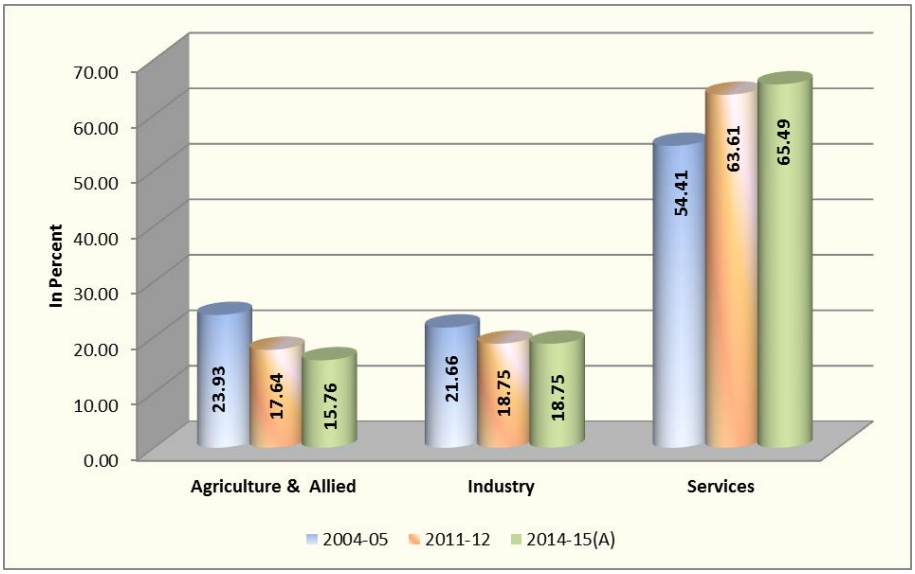


Figure 18: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

From the above charts, it is evaluated that the Services contributes more than 50% to GSDP and is shown considerable decadal growth rate. Contrary to this, the contribution of agricultural and industial sectors in GSDP is declining throughout the decade.

Economic profile of hinterland disctrict i.e. North 24 Parganas are provided in **Table 19** and the same is presented in **Figure 19** as below:

Table 19: Gross District Domestic Product and Annual Growth Rate of North 24 Parganas

(at 2004-05 Constant Prices,)

Year	Gross District Domestic Product *(INR Crores)*	Annual Growth Rate *(Percentage Change over Previous Year)*
2004-05	24416.69	-
2005-06	27157.76	11.23
2006-07	29049.04	6.96
2007-08	32131.75	10.61
2008-09	34747.1	8.14
2009-10	36706.81	5.64
2010-11	38989.62	6.22
2011-12	41335.35	6.02
2012-13	44949.67	8.74
2013-14	48035.5	6.87
Average	-	7.83

Source: Department of Statistics and Programm implementation, Government of West Bengal

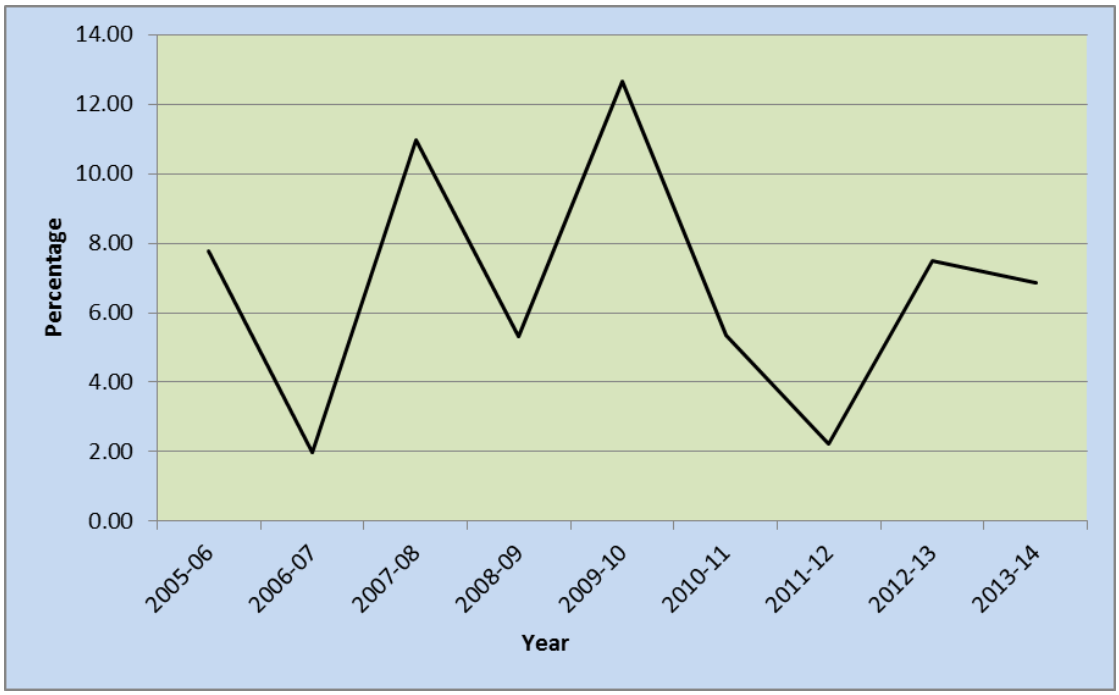


Figure 19: Annual Growth Rates of Gross District Domestic Product

Table 20: Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy in West Bengal

(at 2004-05 Constant Prices, Per cent %)

Sectors	2004-05	2011-12	2012-13	2013-14
Agriculture & Allied	8.83	8.63	8.54	8.54
Industry	11.7	12.4	12.43	12.43
Services	12.96	14.04	14.24	14.24
Total GSDP	11.7	12.78	12.91	12.91

From **Table 20,** it is concluded that, North 24 Parganas have major contribution in services sector and shows descent decadle growth. Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy in West Bengal is also presented in **Figure 20** as below:

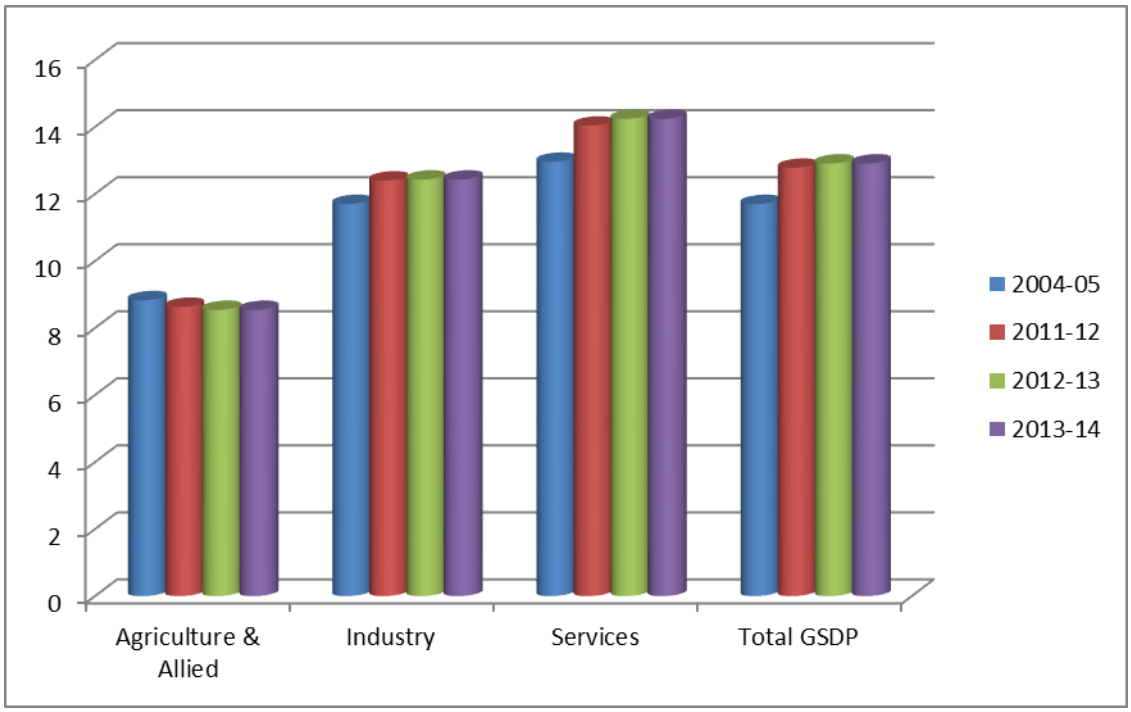


Figure 20: Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy

4.2.3 Existing and proposed Industries

Brick kilns are located all along the river stretch on both sides of banks. These brick kilns mostly uses fuel wood, saw dust, rice husks and agricultural residues along with coal for firing their kilns. All these are locally arranged and transported through roads/local boats by owners directly to their kilns. However, no major industry or any other commercial establishment is located and proposed in the hinterland area.

4.2.4 Hinterland Connectivity

The stretch is moderately connected with road and rail network. The right river bank of the Katakhali River has Hingalganj - Lebukhali road in the vicinity. SH 2 and the nearest rail head are at Hasnabad which is 8-12 Km away. Private vehicles are also available in the nearby area. The public transport buses are operated by West Bengal state and the area is well connected with nearby cities. The long trip buses up to Kolkata are also operated from Hasnabad. Mobile network is available in the area. There is one Road Bridge and one High Tension wire at Barunhat which cross overhead in this stretch.

4.2.5 Connectivity with Other Wateways

Katakhali waterway is also connected with other declared waterways of Sunderbans as shown below:

Table 21: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Sahibkhali Waterway	0.0 Km

In addition to this, Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways. Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Katakhali Waterway. During the survey, it was observed that, numerous ferry services are operational along the waterway to transport passengers and small cargo. The ferry sevices are operated by local private bodies.

Also, the river is connected with Sahibkhali and thereby with Raimangal river which connects to the Indo Bangladesh Waterway Protocol Route at Hemnagar.

Existing and proposed commodities planned for Katakhali waterway can be categorized as follows:

a) Agricultural Products
b) Construction Material
c) Passengers

4.3.1 Agricultural Products

Agriculture and allied sectors are the main-stay of the economy in districts comprising hinterland area. It provides both direct and indirect employment to the majority of the workforce. Agriculture is the main source of livelihood of the population supplemented by livestock rearing, fishery and horticulture. The district lack mineral resources and so also major and medium industries. Hence, the rural population of the district mainly depends on agriculture, fishery and other activities allied to agriculture for their livelihood.

The major crop in this area is Paddy which is dependent on seasonal rainfall and local water supply. Fishing and boat building is the main core business of locals and they earn their lively hood from this resource.

4.3.2 Construction Material

All construction materials are available and transported along the project hinterland by roads. Smaller quantities of construction material, like sand and cement bags, to be used for local construction activities along the river for areas not approachable by road, are transported through river. However, the same is transported on need basis by locals and can not be considered as permanent traffic. As per the traffic survey done in May 2017, majority of the materials are procured from Kolkata and destined for remote areas of South and North 24 Parganas as well as to Bangladesh. As the material is neither procured nor destined for the areas along or around proposed waterway, the quantity is not ascertained. Accordingly, there is no potential for movement of construction material in the Katakhali waterway.

4.3.3 Passenger Traffic

Passenger and Ro-Ro ferry services are available at various locations along the 22.465 km stretch of Katakhali river. The details of services collected during traffic survey done in May 2017 are provided in **Table 22**.

Table 22: Passenger Ferry Services in Katakhali River

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
1	Dulduli	Bhandarkhali	2000
		Lebukhali	

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
2	Lebukhali	Bhandarkhali	2000
		Dulduli	
3	Bhanadarkhali	Dulduli	2000
		Lebukhali	
4	Dumrali	Rupmari	600
5	Rupmari	Dumrali	600
6	Sandelerbil	Naminganj	200
7	Mamudpur	Bispur	600
8	Bispur	Mamudpur	600

From the above listed ferry services, Vessel Ferry services from Dulduli and Lebukhali are operated by Government of West Bengal. All other ferry services are locally operated. **Figure 21** below shows the photographs of ferry services at Lebukhali Landing ghat.

RO-RO Ferry Services

Passenger Ferry Services

Figure 21: Photographs of IWT services along Katakhali Waterway

4.4 ORIGINATING / TERMINATING COMMODITIES

Passenger, Ro-Ro traffic and small cargo like agricultural products, fish, bricks, and construction materials are located along the waterway.

4.5 TOURISM TRAFFIC

No tourism traffic is located along the waterway.

4.6 GROWTH TREND

As per district census statistics, the decadal population growth rate of North 24 Parganas is 12% and average Gross District GDP growth rate is 7.83. In the absence of any historical data, 8% of growth trend for passenger traffic is considered on the basis of discussion done with local boat operators during site visit.

Dulduli and Lebukhali jetties and ferry services are operated and maintained by Government of West Bengal. Bhandarkhali ferry jetty is proposed be developed for passenger ferry servies in submitted Sahibkhali DPR.

Accordingly, in this Katakhali DPR, daily passenger traffic of 600 passengers per day is considered for estimating the design traffic for proposed infrastructure development in this DPR. With the base traffic of about 600 passengers, the growth trend for passenger traffic in Katakhali waterway for 20 years is shown in **Figure 22**.

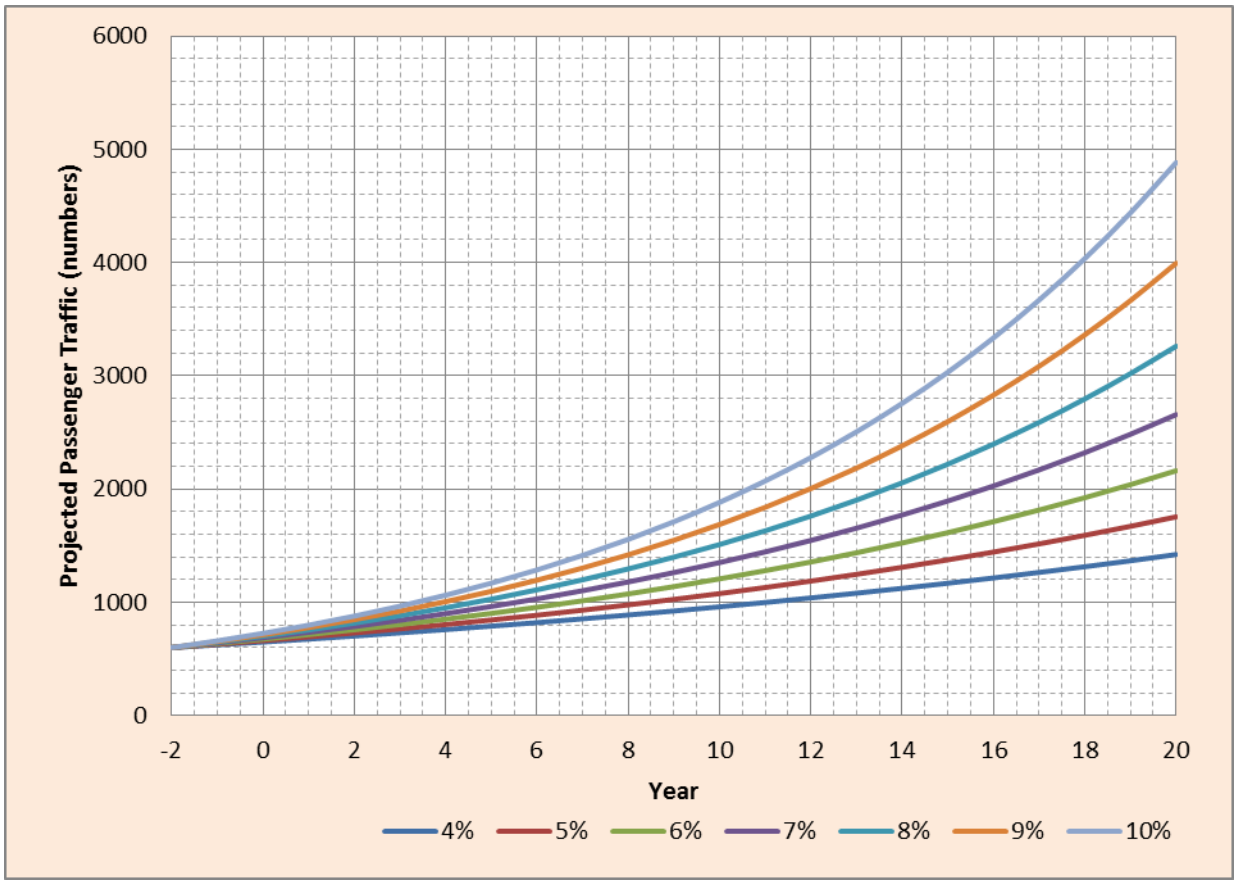


Figure 22: Projected Passenger Traffic of Katakhali River

With assumed growth rate of 8%, the passenger traffic considered for design is estimated as about 1,511 pax per day for 10th year and 3,262 pax per day for 20th year.

4.7 CONSLUSION

Following conclusions are made from the traffic studies done above:

a) Proposed Katakhali waterway is directly connected with Sahibkhali National waterway.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.

c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
e) 22.465 Km stretch of Katakhali River has passenger and Ro-Ro traffic.
f) Vessel ferry services at Lebukhali and Dulduli are operated and maintained by the State Governmnet.
g) Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking.

In view of existing passenger traffic per day and connectivity of Katakhali river with major waterways, 4 passenger ferry ghats, namely, Dumrali, Rupmari, Bishpur and Mamudpur ferry ghats are recommended to be developed for IWT services as detailed in following chapters of DPR.

5.0 TERMINALS

The terminal planning and design includes selection of suitable sites in the vicinity of traffic potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of waiting and parking areas and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities will be planned. The cost estimate including capital and operating costs is planned for each of the proposed system considering the design. These above aspects are briefly explained in the following subsequent sections.

5.1 GENERAL REVIEW

Katakhali River is having potential for Inland Water Transport due to its topography, location and connectivity with other declared national waterways.

As detailed in traffic study, the project area and connecting hinterland does not have any major commercial or industrial unit. However, the waterway is used for passenger & RO-RO ferry services and to transport small cargo along the stretch.

Vessel ferry services are operational in Katakhali Waterway by Government of Wast Bengal. Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking In view of the above, it is recommended to develop the waterway and ferry ghats to provide required inland water transport infrastructure facilities for safe and secure commuting for passengers.

5.2 IDENTIFICATION AND SITE LOCATION

Site selection is most important as it decides the investment for establishing the terminal facilities. Hence proper consideration has been given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site was carried out with the view of following considerations:

- Water availability near the terminal land throughout the year especially during lean season,
- Stable river channel with sufficient depth,
- Favourable hydraulic conditions for berthing,
- Availability of land for terminal infrastructure,
- Traffic potential, and
- Navigational safety.

5.3 EXISTING AND PROPOSED FACILITIES

There are number of existing ferry ghats located along the Katakhali River as provided in **Table 23**:

Table 23: List of Existing Jetties

Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Lebukhali	22°21'55.74"N 88°57'21.64"E	0 km	2.2 m	Hingalganj-lebukhali road	Lebukhali, Ketarchak,
Dulduli	22°21'41.69"N 88°57'24.21"E	0 km	2.1 m	Hingalganj-lebukhali road	Dulduli, Putiamathbari
Bhanadarkhali	22°21'53.52"N 88°57'12.98"E	0.3 km	1.3 m	Khulna-Bhandarkhali road	Bhandarkhali, Hatgachha, Mondelpara
Dumrali	22°25'9.59"N 88°56'28.77"E	7.9 km	1.2 m	Hingalganj-lebukhali road	Dumrali, Ambaria, Kothabbari
Rupmari	22°25'14.59"N 88°56'26.24"E	7.9 km	1.4 m	Hingalganj-lebukhali road	Rupmari, Purba-khejurbaria
Sandelerbil	22°27'22.82"N 88°56'42.78"E	12.9 km	1.1 m	Hingalganj-lebukhali road	Sandelerbil, Bankra, Hingalganj
Mamudpur	22°28'14.08"N 88°57'4.59"E	16.2 km	1.2 m	Mamudpur-Narkoltala road	Mamudpur
Bishpur	22°28'11.94"N 88°57'2.00"E	16.2km	1.5m	Bishpur-bailaniraod	Bishpur, Paschim-khejurbaria

Location map of all the above ferry ghats are provided in Volume 2 of the DPR. Photographs of ferry ghats are provided in **Figure 23**.

From the above listed ferry ghats Dulduli and Lebukhali jetties are operated and maintained by Government. Bhanadarkhali ferry ghat is proposed to be developed for passenger ferry services in the submitted DPR of Sahibkhali waterway. All other listed ferry ghats are locally maintained and operated. On the basis of faiway and traffic studies done in this DPR, it is recommended to develop following four (4) ferry ghats for passenger ferry services:

1) Dumrali,
2) Rupmari,
3) Mamudpur, and
4) Bishpur.

It is proposed to inland water transport facilities like Gangway and Pontoon at the above ferry ghat locations for passenger embarking and disembarking.

Figure 23: Photographs of Jettiy located along Katakhali Waterway

5.3.1 Location Map of Proposed Ferry Ghats

Location of the above proposed three ferry ghats is presented in the Google earth image below:

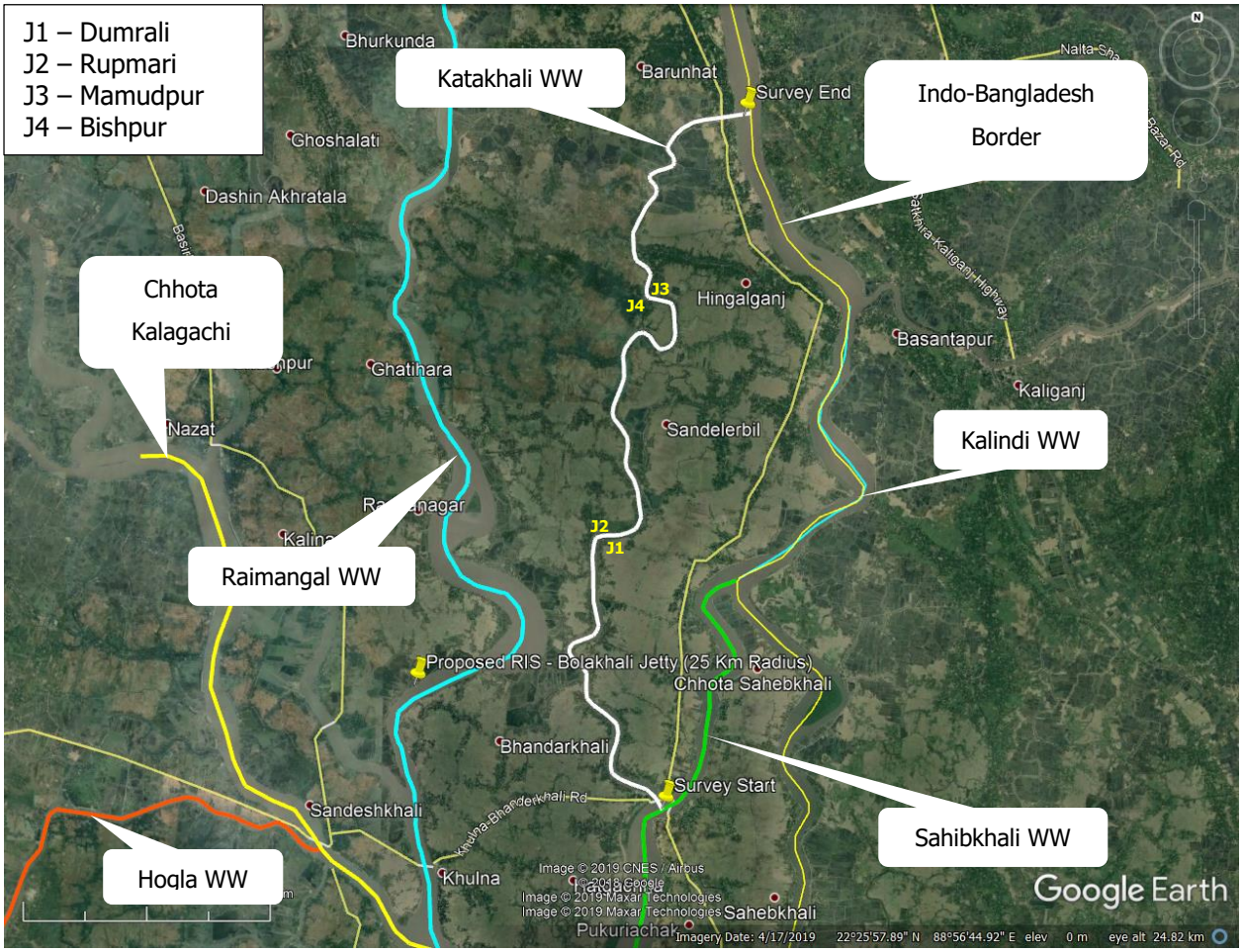


Figure 24: Location map of terminals proposed for development

5.3.2 IWT Facilities

It is proposed to provide following facilities at the proposed ferry ghat loactions:

1) Pontoon
2) Gangway

A. <u>LAYOUT</u>

A single floating pontoon platform is provided for berthing of ferries at each site capable of handling all types of proposed ferry vessels. A gangway is also provided linking the berthing pontoon to the shore, allowing pedestrian transfer between the shore terminal and the ferries.

The ferry platform are intended for use by vessels operating on regular ferry services to other terminals along the waterway and further afield, but the designs do not preclude use by other vessels.

B. Gangway

16 m long x 2.2m wide Gangway is proposed to provide necessary link between the pontoon platform and the shore platform.

C. PONTOON

A pontoon also known as a floating bridge/platform uses floats or shallow-draft boats to support a continuous deck for pedestrian and vehicle travel. The buoyancy of the supports limits the maximum load they can carry. The level of the pontoon will vary as per the tide variations. Floating pontoon shall provide the support to the other end of the approach bridge and also provide berthing to the passenger ferries. The pontoon is to be stationed at proposed terminal locations along river. The pontoon will be moored at site via sets of catenary and anchors. The pontoon shall be suitably chained anchored to the river bed for the horizontal & vertical stability.

The pontoons shall be as per Indian Register of Shipping rules / regulations for dumb barge / pontoon applicable to inland waters. The pontoon shall be designed and built in accordance with the requirements of the rules and regulations of:

- IRS (Indian Register of Shipping) or any Classification Society who is member of International Association of Classification Society (IACS)
- The Inland Vessel Act 1917 and as amended in 2007.

The Pontoon shall comply with IMO's stability requirements. The Pontoons shall not have any trim by fore in any of the operating conditions at terminal. The pontoon shall be shaped with rounded corners and swims ends. The hull shall be divided into watertight subdivisions for the stability.

The steel to be used for the construction of the pontoon shall comply with IS 2062 Grade B or equivalent. The welding works shall be of excellent quality and using high quality electrodes and shall be done by certified welders. Necessary hull preservation and painting shall be done for the prevention of corrosion. Draft marks shall be suitably placed on pontoon of 3 mm in welded steel plate and painted with at least two coats. They shall be located at intervals of 200 mm vertical (P&S) and at forward aft and amidships. The accuracy of these marking will be checked & verified.

Pontoon of 10m x 20m size is considered DPR design and costing. It is envisaged that pontoon will used for berthing of ferry vessels, to support one end of gangway and to provide passage for passengers from terminal building to ferry through gangway.

No waiting/halting of passengers is recommended on pontoon. The pontoon shall be designed to encounter current of maximum 2m/sec during flood. Suitable mooring arrangements along with anchors shall to be provided along the sides. The winches, anchor chain, mooring ropes, shackles etc. shall be as per the class requirement.

The Steel fenders shall be of min. 300 mm dia (6 mm thick) shall be placed on either sides for 95 percent of the length of pontoon. Tyre fenders of sufficient size shall also to be provided on both sides in such a manner that the spacing between them does not exceed 1250 mm. Lugs of not less than 16 mm to tie up these tyres shall be welded to the sides. Pipe Bollards of about 20-25 ton capacity are proposed for safe mooring operations.

D. SAFETY

The Pontoon and Gangway are provided with appropriate safety equipment including lifesaving equipment, ladders and safety rails. The passenger's walkway will be marked in lanes as appropriate and signs will be installed to direct. A detailed set of procedures will be prepared for the safe operation of the link between the ferry and the shore. A fendering system on pontoon will be incorporated to cater for both normal berthing impacts and abnormal accidental ferry impact.

5.4 LAND DETAILS

No additional land is required to be acquired for construction or installation of Pontoon and Gangway, as the ferry ghats are already operational at the proposed locations.

5.5 GEOTECHNICAL INVESTIGATIONS

For preliminary engineering design, the data about soil characteristics is collected from the local sources based on the basis of structure constructed near by. On the basis of visual inspection as observed during site visit the top layer of the area (around 2.5 m depth) is covered with fine river sand. During project execution, detail geotechnical investigation may be done for detail engineering.

5.5.1 Regional Geology

The district of North 24 Parganas of West Bengal, India, lies in the southern part of the Bengal Basin. The basin is actually a peri-cratonic basin and comprises of Ganga-Brahmaputra delta in the southern part. It had broken from the Gondowana land along the margin of the Indian plate and then moved northerly in the early Cretaceous (125Myr ago) period. The collision of the Indian plate and European plate began in the early Eocene (40–41 Myrs ago) period and resulted in the formation of the Himalayas. Due to this, the two sediments from the Ganga and the Brahmaputra Basin got merged subsequently. Relatively recent folding and uplifting (Quaternary epoch) of the Brahmaputra sediments close to the intraplate boundary have redirected the course of the Brahmaputra to its present configuration.

The Ganga-Brahmaputra delta thickens towards the south and has three stratigraphic sequences–the proto - Ganges delta, the transitional delta and the modern delta (created 11Myrs ago) with a successive sequence of sand, sandy mud, silt and mud which were deposited under a major eustatic sea level about 11 Myrs ago. The modern delta has been formed primarily from alluvial sediments transported by the rivers originating from the Chotanagpur Uplands in the west e.g. the Mayurakshi, the Ajoy, the Damodar etc. and subsequently by the rivers flowing from the Himalayan foredeep basin from the north e.g. the Ganges, the Padma, the Bhagirathi, the Brahmaputra etc. when a gap named as the Garo -Rajmahal gap, was created due to tectonic movements. Arsenic contaminated groundwater occurs in the modern deltaic sediments.

In the present study area, the main water bearing formations are Quaternary formations which chiefly comprises of Recent and Pleistocene alluvial deposits and aquifer materials comprising of sand of varying grades and gravels. Thus ground water occurs within water table and in semi confined to confined conditions.

5.5.2 Physical Condition and Drainage

The drainage capabilities of the canals, rivers etc. located in the district have been reduced due to unplanned manmade activities and some ecological changes like silting of the rivers etc. So, the flood/heavy water logging has been common occurrence every year in the most parts of the aforesaid sub-divisions. Similarly, Cyclone and High tide has been commonly found in the riverine belts of Basirhat sub-division.

5.6 TERMINAL COSTING

As part of collective development of NW-97, an optimised approach for infrastructure development is proposed herewith. Accordingly, operating buildings and corresponding mannings proposed in NW-97 are provided as below:

Sl. No.	Name of waterway supported by proposed operating building and corresponding Manning	Name of Jetty/Terminal where Operating Building and corresponding Manning is proposed	Name of waterway in which cost of operating building and corresponding Manning is considered
1.	Muri Ganga waterway	Dhaki Jetty	Thakurran waterway
2.	Saptamukhi waterway		
3.	Thakurran waterway		
4.	Matla waterway	Basanti Jetty	Hogla waterway
5.	Bidya waterway		
6.	Gomar waterway		
7.	Hogla waterway		
8.	Chhota Kalagachi waterway	**Bhandarkhali Jetty**	**Sahibkhali waterway**
9.	Raimangal waterway		
10.	Sahibkhali waterway		
11.	**Katakhali waterway**		
12.	Kalindi waterway		

Hence, for Katakhali waterway, the Operating Building and corresponding mannings proposed at Bhandarkhali Jetty along Sahibkhali waterway is recommended to support the operational activities of all the ferry terminals proposed in Katakhali waterway. The cost estimate for proposed ferry service facilities including O&M of the system has been worked out. The cost estimates for development of the system are considered as Capital cost while for operation of the system is termed as maintenance or operating cost (O & M cost).

5.6.1 Capital Cost

For Katakhali waterway only pontoon and gangway facilities are proposed to be developed at Dumrali, Rupmari, Mamudpur, and Bishpur ferry ghats. Facilities at Haripur and Hajira ferry ghats are proposed for crossing the river only and as such is recommended that all basic anemities of terminal structure

like parking, ticketing etc. shall be locally handled. Accordingly, no additional facilities are envisaged to be provided at above four ferry ghats. Capital cost for proposed ferry terminal is provided in **Table 24** respectively.

Table 24: Capital Cost for Ferry Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
1	Pontoon Platform with all required accessories	No.	1	50,00,000	50.00
2	Gangway (Including Maintenance)	No.	1	17,50,000	17.50
				Total	**67.50**
3	Cost of Detail Engineering and construction supervision			6%	4.05
				Total	**71.55**
4	Contingency			3%	2.15
	Capital cost of each Pontoon and Gangway system				**73.70**
5	Number of Jetties proposed to be developed				4
	Total Capital cost of proposed Pontoon and Gangway system for all ferry ghats				**294.79**

Capital Cost of operating building proposed at Bhanderkhali jetty is considered in Sahibkhali waterway DPR. Hence, total capital cost of proposed ferry terminals in Kathakali waterway works out as **INR 294.79/- Lakh**.

5.6.2 O&M Cost

Operation and Maintenance cost to be incurred for running terminal facilities for ferry terminals are provided as below.

a) Maintenance

To ensure that the Pontoon and Gangway facilities are kept in an efficient and safe condition, it will be necessary to ensure that money is set aside for annual maintenance. In the first four years of operation, maintenance costs are comparatively low but would then build up as structures and equipment begin to be affected by wear and tear.

The annual cost of maintaining Pontoon and Gangway including all civil, mechanical and electrical works is considered to be about 3% of the capital cost. Thus, the annual maintenance cost for proposed facilities works out as **INR 8.84/- Lakh**.

6.0 PRELIMINARY ENGINEERING DESIGNS

The main objective of preliminary engineering is to ascertain quantitatively the feasibility of engineering works. Preliminary engineering is carried out to arrive at the preliminary sizing of all major facilities required at the terminal and waterway for safe navigation. The preliminary sizing, design and engineering of the facilities are presented in following sections.

6.1 RIVER TRAINING

As stated in the earlier sections, no river training works including barrages, weirs or locks is required for the waterway.

6.2 BANK PROTECTION

As stated in the earlier sections, no bank protection works is required for the waterway.

6.3 NAVIGATION AIDS

The total navigation operation, ranging from arrival to departure, can be subdivided in to the following operations,

- Navigation through the waterway
- Arrival at berthing location
- Preparation for berthing, including possible turning of the vessel and pre-berthing procedures
- Berthing including mooring, etc. to the berth structure
- Loading and unloading operation while at berth
- Departure

Navigation aids for the waterway and terminals are required to ensure safe and efficient navigation of vessels navigating through the waterway and berthing/un-berthing at terminals.

These aids are proposed to be installed on land or in water for guidance to all vessels for safe and regulated navigation in channels, basin, berths and docks. The various types of aids to navigation proposed for IWT operation on proposed waterway is provided in detail in Chapter 8.

6.4 FERRY TERMINAL AND JETTIES

Preliminary engineering design required for DPR level costing and analysis for Pontoon and Gangway are done and provided as below. Following codes and standards are used for preliminary design of structures.

Civil Works:

- IS 4651 (Part 1-5): Codes of Practice for Planning and Design of Ports and Harbors
- IS 456 - 2000: Code of Practice for Plain and Reinforced Concrete
- IS 800 – 1984: Code of Practice for General Construction of Steel
- IS 2911: Code of Practice for Design and Construction of Pile Foundations
- IS 1893 – 2002 (Part 1): Criteria for Earthquake resistant design of Structures
- IS 9527 (Part 3): Code of Practice for Design and Construction of Port and Harbor Structures
- IRC-6: Standard Specifications and code of Practice for Road Bridges, Section 2 Loads and Stresses

Geotechnical

- IS 2991 (Part 1 – Sec 2) 2010: Code of Practice for Design and Construction of Pile Foundations – Bored Cast in-situ Piles
- IS 14593 - 1998: Design and Construction of Bored Cast in-situ Piles founded on Rocks-Guidelines

Where applicable the following International Standards are referred

- BS 6349 Maritime Structures
- BS 8110 & 5400 Reinforced Concrete Structures
- BS 449 & API-RP 2A-WSD Offshore Platforms-Working Stress Design
- BS 5950 Structural Steel Work
- BS 8004 & 8000 Foundations
- MJ Tomlinson: Pile Design and Construction Practice, Fourth edition
- Joseph E Bowles: Foundation Analysis and Design, Fifth edition.

6.4.1 Ferry Terminal

The objective of this chapter is to present design of river & landside facilities required for development of Pontoon and Gangway. The following are the main facilities required for operation of the terminal:

- Gangway
- Pontoon Platform

A. STRUCTURAL SYSTEM

The overall Layout showing location of facilities is shown in drawings provided in Volume 2 of the DPR.

The gangway is aluminium/steel platform hinged on the approach platform and pontoon platform on the other end.

B. CONSTRUCTION METHOD

The construction method proposed for approach platform is as described below:

PILING

1) Drive steel liner up to refusal.
2) Bore inside the liner up to the founding level.
3) Lower Reinforcement cage and concrete the pile up to bottom of Pile muff.
4) Place sacrificial precast pile muff over the piles and concrete the annular space between the pile and pile muff.

ERECTION & CONCRETE WORK

1) After the in-situ concrete attains strength, place the precast pile cap U beams over the Pile muffs. Note that the Precast U beams are designed as part of permanent structure.
2) Concrete inside the U beam upto the soffit level of bottom slab.
3) After the in-situ concrete attains strength place precast planks and precast Fender wall panel over the U beams.
4) Cast the in-situ portion of the bottom slab.
5) On completion of concrete works fixtures like fenders, bollards, pipes and cable support system shall be installed

6) All equipment, pipes, cables, light poles shall be installed at the end.

6.5 Construction Schedule

The time schedule for construction activities of the project is considered as one (1) year. The proposed project schedule is provided in **Figure 25.**

Sl. No.	Activities	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Approval of DPR and Project Financial Closure				
2	Environmental, Forest and CRZ clearances				
3	Fairway development				
a)	Procurement of Hardware and other equipment's				
b)	Capital Dredging				
4	Procurement and installation of Aids to Navigation				
5	Construction/ Installation of Pontoon and Gangway				
6	Upgrading existing road to terminals				

Figure 25: Construction Schedule

7.0 VESSEL DESIGN

The major principal parameters governing Inland Waterway Fleet designs are:

- Terminal facilities and obstructions enroute,
- Waterway characteristic like river course, depth of water, radius of bends, current/velocities of water etc.,
- Navigational aspects and improvements to navigation,
- Cargo characteristic like type of cargo, quantum of cargo and distance of transportation,
- The vessel dimension like length, beam, moulded depth, minimum and maximum draft,
- Haulage distance
- Physical constrains like clearance under bridges, navigation locks size etc., and
- Capital, operation and maintenance cost.

7.1 GENERAL REVIEW

India has a long history of river based water transport. India has about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc. Currently, inland water transport is restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the deltaic regions of the Godavari-Krishna rivers. Besides the organised operations by mechanised vessels, country boats of various capacities also operate in various rivers and canals. Data of cargo and passenger movement in unorganised sector (i.e. by country boats, etc.) has not been compiled (for which efforts are on) but it is a fact that substantial quantum of cargo and passengers are transported in the unorganised sector as well. Considering the inherent advantages of this mode in terms of fuel efficiency, environment friendliness and cost effectiveness, the Govt. of India is trying to develop this mode to make it an effect supplementary mode of transportation vis-a-vis rail and road modes.

7.2 CURRENT SCENARIO

Ferry and small cargo vessels are already operational in Katakhali river. The photographs of existing vessels plying along the waterway are provided in **Figure 26**.

Figure 26: Vessels plying on Katakhali Waterway

7.3 PASSENGER TRAFFIC AT PROPOSED LOCATIONS

As detailed in chapter 4, the passenger traffic at proposed loactions as obtained from traffic survey done in May 2017 are provided as below:

Table 25: Passenger Traffic at Proposed Locations

Sl. No	Proposed Ferry Ghat	Average daily passenger traffic
1.	Dumrali	600
2.	Rupmari	600
3.	Mamudpur	600
4.	Bispur	600

The tentative hourly variation of passenger traffic at proposed loactions for 12-hour waterway operations from 6:00 AM to 6:00 PM, on the basis of collected data are presented as below:

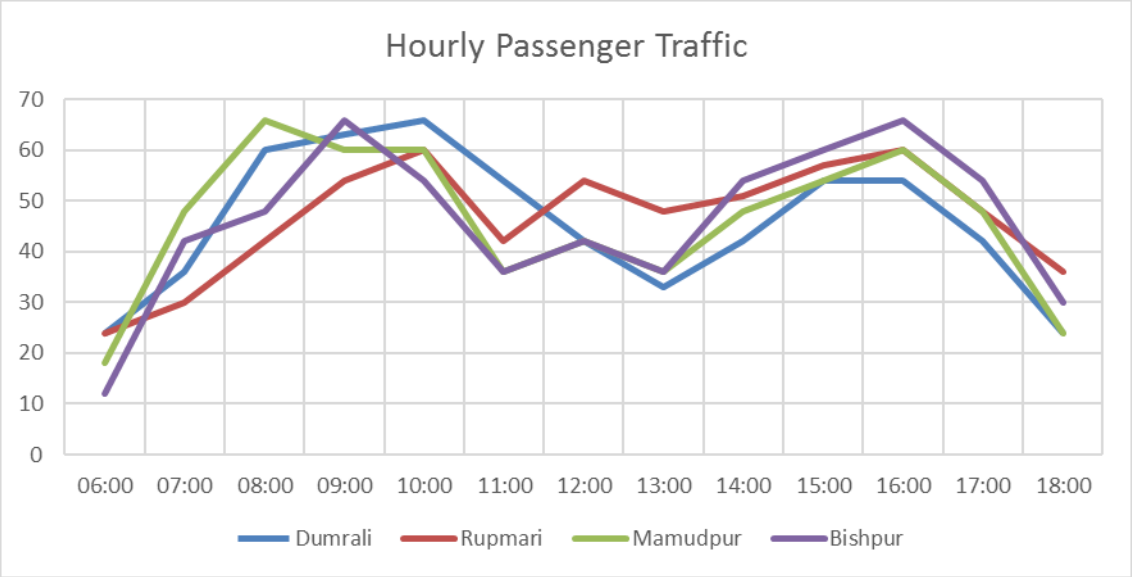


Figure 27: Hourly Passenger Traffic

7.4 DESIGN BASIS

The type and size of vessels proposed to be operated in the waterway is designed on the basis of following factors:

a) Cargo Characteristics
b) Cargo Factors
c) Waterway and Other Features
d) Operational Factors

7.4.1 Cargo Characteristics

Cargo considered for DPR design of the proposed waterway consists of passengers including small cargo like bikes, cycles and agricultural goods. The total volume of cargo originating and terminating from different terminal is shown in Traffic Studies chapter.

7.4.2 Waterway and Other Features

Field investigations done in the total stretch of the river bring out the following characteristic of the waterway which shall influence selection of the vessel for transportation.

- Shoals located along the waterway.

- Complete stretch of waterway is tidal.

Hence, the waterway condition during low tide would dictate the selected vessel to have shallow draft to ensure un-interrupted navigation.

7.4.3 Operational Factors

The following factors are generally considered as operational factors in the process of study on vessels for IWT.

- Speed of vessel under varying hydraulic condition,
- Relation between speed, propulsive power and energy consumption,
- Rate of embarkment and dis-embarkment of passengers.
- Number of unworkable days per year, and
- Susceptibility of vessel to damage and crew efficiency.

7.5 PROPOSED VESSEL SIZE AND SPECIFICATIONS

Passenger ferry services are proposed along the waterway at locations detailed above. As per the bathymetric survey, draft available in proposed stretch of waterway is in the range of -6.76 m to 35.18 m w.r.t sounding datum for Class VII.

The ferry boats shall be of a design combining reliability, fuel efficiency, low environmental impact (low wash), safety and comfort. The vessels should be based on environmental and climatic change friendly designs to improve energy efficiency and reduce the environmental footprint. Possible features could include, but not limited to, using alternate clean fuels, use of solar modules for ancillary energy needs (lights) on ferries.

The ferry boats shall be equipped with an Intelligent Transport and Navigation System. The ferry boats shall be compliant with the rules and contents of a member of the International Association of Classification Societies (IACS) and the Inland Vessels Rules of State as well as Central Authorities.

The major parameters, considered for proposing sutiable and optimized passenger ferry vessel for the waterway are hull material, hull form, propulsions system, steering system Shipboard Systems, Environmental Friendliness, etc. The brief charateristics of vessels categories applicable for Inland waterways are presented in below table:

Table 26: Characterisctics of Vessel Categories

Vessel Type	Category	Pax Capacity	Vehicle Capacity	Max Speed (knots (nautical miles/hour)	Horsepower	Hull Type
Passengery Ferry	1	12-30		16-25	115-375	Mono
Passengery Ferry	2	31-50		8-24	180-700	Pontoon
Passengery Ferry	3	31-50		12-30	180-850	Mono or Cat
Passengery Ferry	4	51-100		8-20	230-900	Mono or Cat
Passengery Ferry	5	51-100		21-38	525-2100	Mono or Cat
Passengery Ferry	6	101-150		10-20	225-1800	Mono
Passengery Ferry	7	101-150		21-35	900-4000	Cat
Passengery Ferry	8	151-300		8-37	400-7200	Mono
Passengery Ferry & RORO	9	25-100	2-15	5-15	100-1000	Mono
Passengery Ferry & RORO	10	100-500	2-10	9-15	500-3000	Mono
Passengery Ferry & RORO	11	100-500	10-50	9-15	285-4500	Mono
Passengery Ferry & RORO	12	250-500	50-100	39-42	19300-22600	Mono

The above types of vessels generally have one of three hull types – monohull, catamaran, or pontoon. Monohulls are a traditional hull design that are often used for slower speed services. Monohulls can be designed for high speeds, but generally more engine power is required to reach the same top speed with a monohull than with a catamaran hull. RORO ferries are almost always monohulls. Catamarans are often used for higher speed services. They require less power, and thus less fuel to travel at the same speed as a monohull, and provide a more stable ride for passenger comfort. Pontoons are more affordable than other hull types, but generally only carry 30-50 passengers and cannot travel at high speeds.

Transport department of Government of West Bengal is operating regular ferry services in the state, to provide, clean, safe and faster mode of transport system. The list of various ferry service operators and number of water crafts for the ferry trips operating by Government of West Bengal (excluding private operators) in the Hooghly River are provided in **Figure 28**.

List of various Ferry Service Operators and number of water crafts for the ferry trips :

1. WBSTC Ltd. *(A Govt. of West Bengal undertaking).*
2. HNJPSS (Hooghly Nadi Jalapath Paribahan Samabay Samity Limited).
3. Ghatal Steam Navigation Company (private operator).
4. Indo Swiss Waterways Company (private operator).

Name of operator	Number of steel vessel with capacity of passengers
WBSTC Ltd.	16 steel vessels of capacity for 400 passengers 2 steel vessels of capacity for 250 passengers 2 Steel vessels of capacity for 150 passengers
HNJPSS	14 steel vessels of capacity for 400 passengers 6 steel vessels of capacity for 250 passengers 4 steel vessels of capacity for 150 passengers 10 wooden vessels of capacity for 100 passengers
Ghatal Steam Navigation Company	1 steel body vessel of capacity for 150 passengers 1 wooden vessel of capacity for 100 passengers
Indo Swiss Waterways Company	2 steel vessels of capacity for 150 passengers

Note – It has been decided that the jetties at Bandhaghat in Howrah and Ahiritala in Kolkata will be renovated by Kolkata Port Trust. Ghatal Steam Navigation Company & Indo Swiss Waterways Company are operating the ferry service at these ferry ghats on contact basis from the Kolkata Port Trust. Kolkata Port Trust has been informed

Figure 28: Ferry Services in the river Hooghly between Kolkata and Howrah[3]

7.6 TURNAROUND TIME

Turnaround time for ships is defined as the length of time between arriving at a point and being ready to depart from that point. It is used in this sense for the loading, unloading, re-fuelling, and re-arming of vessels. Turnaround time varies with type of vessel, efficiency of jetties and available cargo handling facilities on the jetties. Turnaround time for passenger ferry vessel is discussed in detail in following paragraphs.

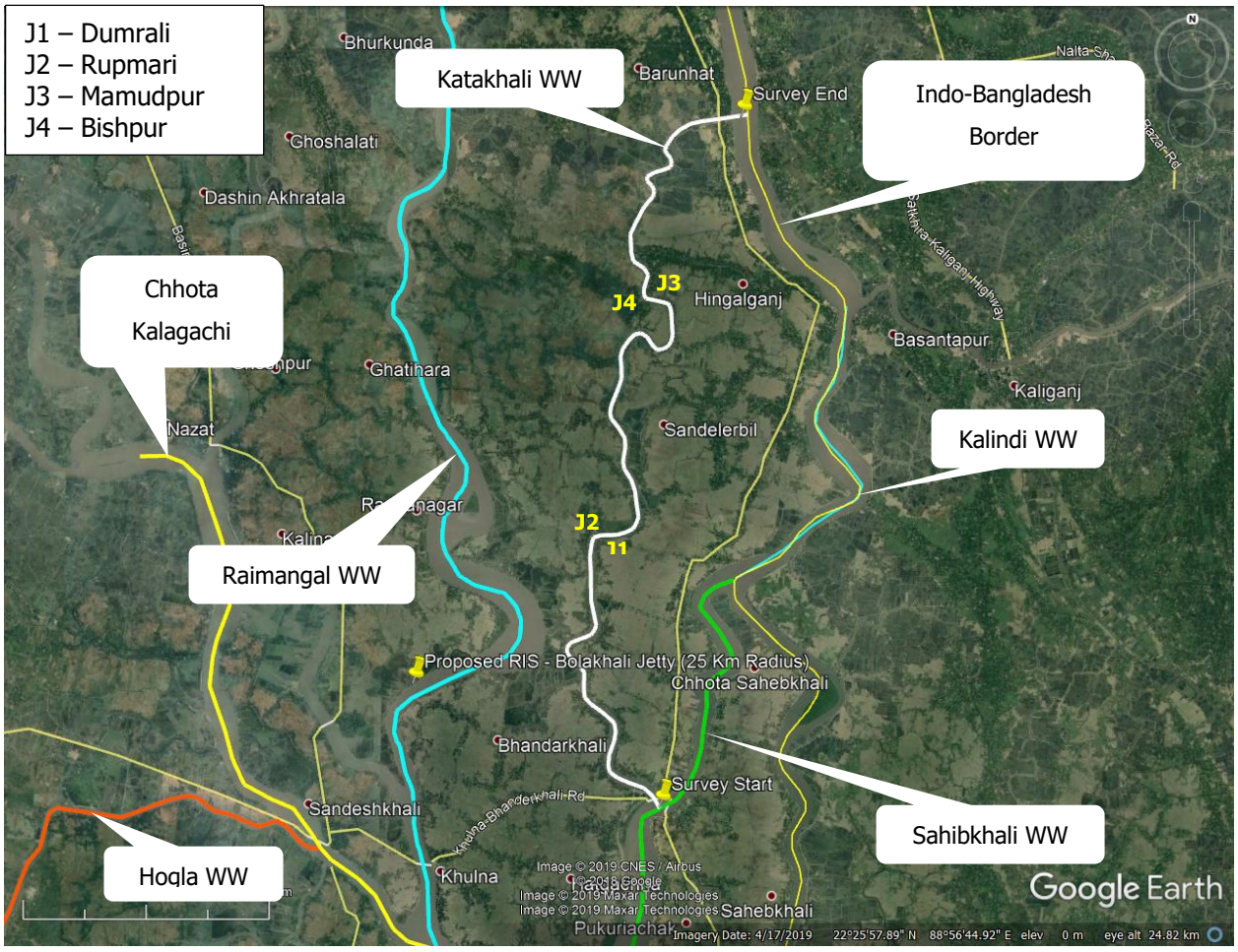
Katakhali waterway is connected directly with Sahibkhali waterway and indirectly with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways. Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway. However, for calculating turnaround time, it is considered that the vessels will operate along following proposed O-D routes:

[3] http://transport.wb.gov.in/transport-services/ferry-services/passenger-ferry-services/

a) Link 1: Dumrali – Rupmari (Route length = 0.2 Km)

b) Link 2: Manudpur – Bispur (Route length = 0.2 Km)

The above proposed O-D link pairs are proposed for river crossing at chainage of 7.9 Km and 16.2 Km respectively.



7.7 NUMBER OF VESSEL REQUIRED

Number of vessel required to ply on route is estimated and provided in **Table 27** as below.

Table 27: Estimate of No. of vessel required for Passenger Ferry Service per OD pair

Sl. No.	Description	Unit	Value
A	Average Speed of vessel considered	Knot	5
B	Length of the waterway considered for vessel operation	Km	0.2

Sl. No.	Description	Unit	Value
C	Time required by vessel to travel in proposed waterway stretch	minutes	5.00
D	Embarking and Dis-embarking time considered for 2 terminals	minutes	10
E	Trip duration (sl. no. C + sl. no. D)	hours	0.25
F	Operating hours per day (as per information collected on site)	hours	12
G	No. of trips allowed during 12 hours operational time per day per vessel (sl. no. F / sl. no. E)	trips	48.00
H	Considering Passenger ferry vessels with capacity of	pax/vessel	25
I	Present passenger's traffic	pax/day	600
J	Required no. of trips per day for current passenger traffic (sl. no. I/ sl. no. H)	trips	24.00
K	Number of Ferry vessel required for current passenger traffic demand (sl. no. J/ sl. no. G)	numbers	0.50
L	Design passenger traffic in 20th year	pax/day	3262
M	Required no. of trips per day for design passenger traffic (sl. no. L/ sl. no. H)	trips	130.48
N	Number of Ferry vessel required for design passenger traffic (sl. no. M/ sl. no. G)	numbers	2.72
O	Proposed number of ferry vessels for present passenger traffic	numbers	2.00
P	Proposed number of ferry vessels for design passenger traffic of 20th year	numbers	6.00

Accordingly, for Katakhali waterway, it is proposed to provide ferry vessel of 25 passenger capacity. The vessels shall be provided in phase wise manner as per traffic demand. For DPR purpose, it is considered that for present traffic demand for both the above proposed OD pairs, two (2) numbers of vessels are proposed initially from the start date of operation. In 10th year of operation additional two (2) vessels and againg in 20th year of operation additional two (2) vessels are proposed for IWT operations as per required passenger traffic, making total fleet of six (6) vessels to cater the projected traffic demand in 20th year of operation.

The required numbers of smaller capacity ferry vessels are proposed to cater the daily hourly traffic fluctuation at the proposed terminals. The tentative technical details for the proposed vessels of 25 passenger capacity for Katakhali waterway are as below:

a. Type – Fibre boat
b. Length – 18.0 m
c. Breadth – 3.0 m

d. Depth – 1.58 m
e. Draft – 0.8 m
f. Engine capacity – as per design with conventional propulsion
g. Crusing Speed – 5 knot

For proposed passenger ferry services in the waterway, passenger ferry vessels built in house by WBTIDC or other local vessel manufacturer are proposed. DPR consultant has only considered conventional vessels at this stage to keep the start-up risk to a minimum.

7.8 VESSEL COSTING

The cost of operating a ferry is made up from a number of component parts. In keeping with generally accepted principals and methods for the financial analysis of transportation business entities, total expenses (cash outflows) are classified into three mutually exclusive categories of capital costs, direct operating costs and indirect operating costs. Vessel debt repayment includes principal and interest payments on the portion of the vessel purchase price not funded by the equity investment of the owners. Direct operating costs are defined here as vessel direct operating costs, which include crew costs (in this case deck and engine crew only, excluding passenger service crew), fuel and lubricant costs, and vessel maintenance. Indirect operating costs are defined here as including insurance, marketing, advertising, and general administration.

7.8.1 Capital Cost

The cost to purchase the vessels, whether they are new or second hand, represents a significant commitment for the ferry operating company. For passenger ferry services, vessels need to be procured. For the purpose of estimating a capital cost for vessels proposed to be operated in the waterway, the price data were compiled from a variety of sources including newspaper archives, marine industry magazines, other ferry cost studies, and discussions with ferry operators. Vessel purchase prices vary greatly, and many vessels are built to meet particular specifications, which are not always made clear when prices are reported. **Figure 29** shows the range of purchase prices found for new vessels in each vessel category.

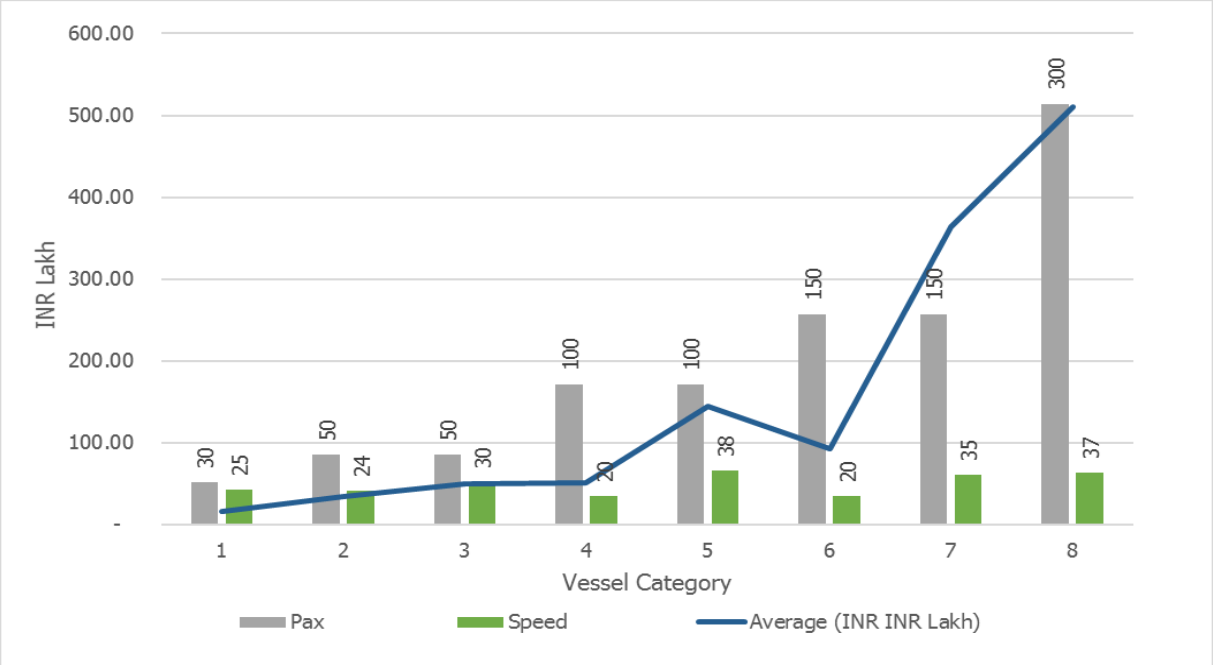


Figure 29: Graph showing variation in Vessel cost w.r.t passenger capacity and speed

Accordingly, for passenger ferry vessel of 25 pax capacity, the capital cost considered is provided in table below:

Table 28: Capital Cost of Vessels

Sl. No.	Description	Rate per Vessel (INR Lakh)	No. of Vessels	Total Cost for vessels (INR Lakh)
1.	Passenger Ferry Vessel	35.00	2 (from start date of operation)	70.00
			2 (in 10th year of operation)	70.0
3.			2 (in 20th year of operation)	70.00

7.8.2 O&M Cost

The O&M cost of vessels are estimated as below:

a) Officers and Crew Costs

One team has been allocated for each vessel to enable continuous operation of vessels for 12 hours depending upon traffic flow. Each crew team comprise of members for running/operating of vessel and on-board safety and security in accordance with the Inland Vessel (IV) Act, 1917. Total nos. of crew members proposed is provided as below:

Table 29: Manning Cost

Sl. no.	Type of Crew	Level/ Classification	Reference	Min Gross Salary (INR/ month)	Annual Gross Salary (INR)	Number	Annual Cost (INR Lakh)
1.	One master with Master Class 3 / Serang certificate	L-2	7th pay commission pay matrix	19900	2,38,800	1	2.39/-
2.	General Purpose Ratings for attending duties of deck hands & engine hands	Unskilled	West Bengal Minimum rates of wages w.e.f July 2020	8550	1,02,600	1	1.03/-
Total						**2**	**3.41/-**

Hence, for each vessel 2 crew members are required with annual cost of INR 3.41/- Lakh.

b) Consumables and Repair/Maintenance Cost

Maintenance cost of about 2% per annum of capital cost is considered under this head. Hence, annual consumables and repair/maintenance cost works out to INR 0.70 Lakh for each vessel.

c) Fuel Cost

Fuel expenses for running passenger ferry vessels in the proposed fairway is estimated as below:

Number of days of operation in a year	= 300 days
Number of trips in a day per vessel	= 48.0 trips
Mobility time per trip	= 5.0 minutes
Approximate rate of fuel per litre	= 75 INR per litre
Fuel cost per trip per vessel	= INR 75.00
Fuel cost per annum for each vessel	= INR 5.40 Lakh per Annum

Table 30: Annual O&M cost of Vessels

Sl. No	Item	Annual O&M Cost for each vessel (INR Lakh)	Annual O&M Cost for 2 vessels (INR Lakh)
1.	Officer and Crew Costs	3.41	6.83
2.	Consumables and Repair/Maintenance Cost	0.70	1.40
3.	Fuel Cost	5.40	10.80
	Total	**9.51**	**19.03**

Hence, total O&M cost for running two (2) vessels is INR 19.03 Lakh per year.

8.0 NAVIGATION AND COMMUNICATION SYSTEM

In SOLAS-V/13 ("Safety of navigation" IMO, 1974), IMO established that each State shall provide the aids to navigation appropriate to the level of traffic and the degree of risk. International Association of Lighthouse Authorities (IALA) defines aids to navigation as systems external to the ship capable of helping determine its position and course, warning about dangers and obstacles and indicating the best route to follow.

As defined by IMO, the absolute horizontal accuracy of aids to navigation regarding vessel position on inland waterways should be 10 metres, with a probability of 95%. The accuracy of nautical charts is also very important. The national authority responsible for their publication must work in coordination with the body responsible for aids to navigation. In the particular case of restricted waters, the nautical chart scale is 1:10 000, requiring an accuracy of 10 m (IALA-AISM, 2014).

Aids to navigation include visual aids (lighthouses, beacons, buoys and leading lines), electronic navigation (AIS, DGPS, VTMS etc.), a pilotage service and traffic organisation boats.

The objectives of e-navigation are: to facilitate the safe navigation of vessels with regard to hydrographical, meteorological and navigation information, facilitate maritime traffic management, facilitate communication and provide opportunities to improve the efficiency of transport and logistics. E-navigation is a concept that incorporates systems and services.

8.1 GENERAL REQUIREMENTS

The information system for navigation and communication aims to improve the navigational capability and safety in the inland waterways, key points of River Information System are:

- The information system will help to track the real time position of ships plying on the inland waterways
- The system will also provide real time weather reports and help in building communication among the vessels
- Under the project, radars and sensors will be installed in boats and river ports
- The information will be sent via Very High Frequency (VHF) wireless communication between the operators and the user

For safe navigation of the ships throught the waterway, state of the art navigation and communication system are to be provided in the waterway stretch. These services should be supported by currently available technical systems like:

- Mobile radio communication systems for inland navigation (VHF radio)
- Ship and shore based radar
- Mobile data communication systems
- Global navigation satellite system (GNSS)
- Internet
- Electronic chart and display and information system for inland navigation (Inland ECDIS)
- Automatic identification system for inland navigation (Inland AIS)
- Ship reporting systems.

8.1.1 VHF / HF

One of the main characteristics of the River Information Service is efficient and reliable flow of information. It can be effectively achieved in real time through VHF communication, which is of key importance in maritime navigation and has been implemented to meet the requirements of inland waterway shipping services.

VHF communication is in use in inland navigation to ensure safe flow of information among vessels and services coordinating SAR operations within the RIS operation range.

The RIS operating centre is proposed to be located in one of the terminal building. Within a usable floor area of 200 sq. m, a room shall be arranged for the maintenance of constant radio watch by three system operators who can control the system modules. The foreground item of the equipment's will be a display consisting of six LCD screens.

It will display a view of the AIS and views from CCTV cameras, which, combined, support real time view of the situation on the waterway. The RIS Centre shall also provide electronic charts for the purposes of the Inland ECDIS, transmits Notices to Skippers (NtS), receives ERI messages and ensures system users reliable VHF radio communication. Signals received by VHF radio stations are transmitted directly to the RIS Operating Centre via a relay network.

8.1.2 DGPS

The Differential Global Positioning System (DGPS) is an enhancement to GPS that improves accuracy to under 3 metres, by means of a ground-based network of reference stations. It is proposed that all vessels should be equipped with latest DGPS equipment's to track the time positional accuracy of vessels.

One DGPS station is proposed at Canning with an effective radial coverage of about 125 km, as part of development of Sunderbans waterways and to cater all the 13 national wateways proposed under Sunderbans waterways (NW 97) as shown in **Figure 30** below. As shown in figure below, all 13 waterways prpopsed under NW-97 fall under the radial coverage of proposed DGPS at Canning. Radial distance of canning from farthest point in Katakhali waterway is about 40.0 Km. The capital and O&M cost of proposed DGPS system at Canning is considered in DPR of Matla waterway.

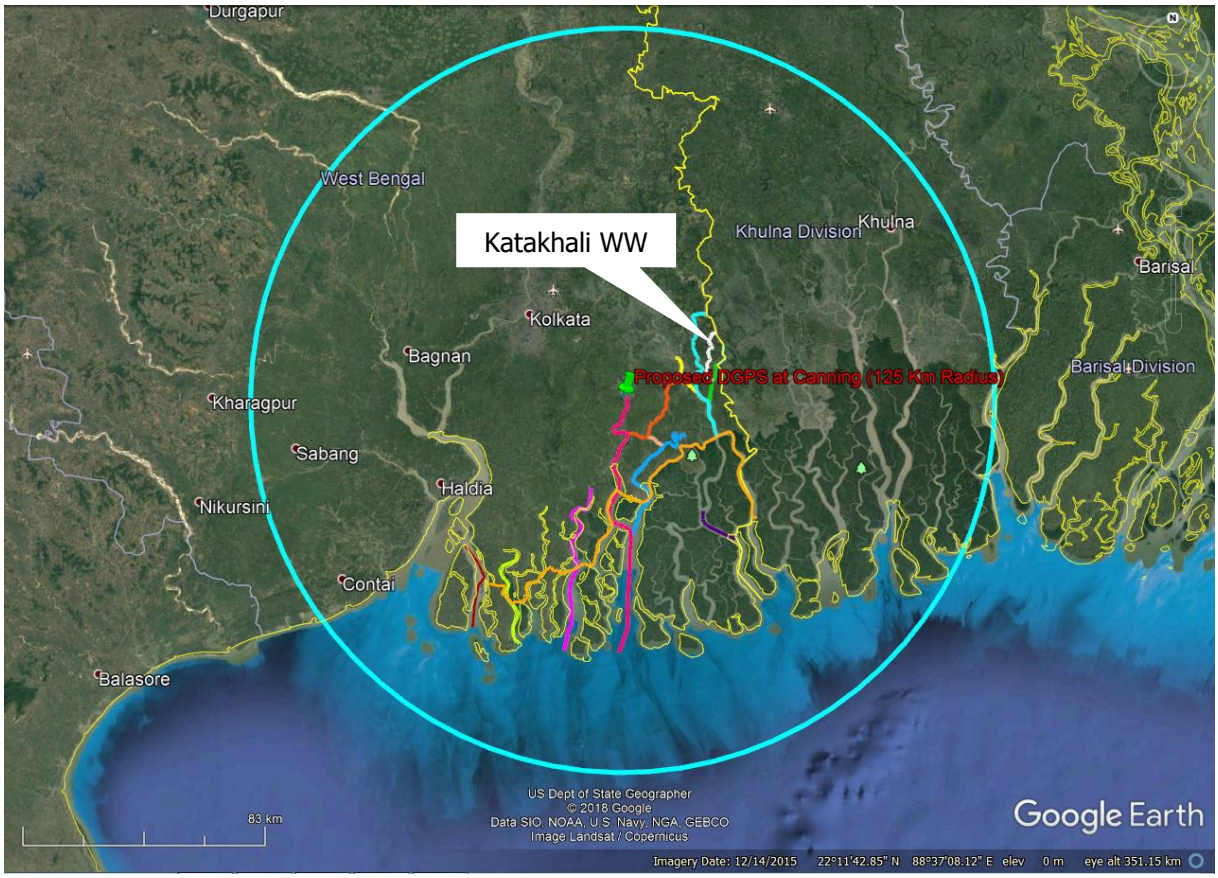


Figure 30: Google Earth image showing location map of proposed DGPS and effective coverage

8.1.3 RIS / AIS / Radar / VTMS

An objective is the description of intention. The objective may also be called the goal or aim. RIS have three main objectives:

1) Transport should be *safe*:

- Minimise injuries
- Minimise fatalities
- Minimise voyage incidents

2) Transport should be *efficient*:

- Maximise throughput or effective capacity of waterways
- Maximise the carrying capacity of vessels (length, width, draught and height)
- Reduce travel time
- Reduce workload of RIS users
- Reduce transport costs
- Reduce fuel consumption
- Provide efficient and economical link between transport modes
- Provide efficient harbours and terminals

3) Transport should be *environmentally friendly*:

- Reduce environmental hazard
- Reduce polluting emissions and spills due to accidents, illegal actions or normal operations

These objectives should be met under the constraints that all RIS are supplied in a manner that is reliable, cost efficient and legally sound.

As part of collective development of NW-97, Sunderbans waterways, following RIS stations are proposed with radial coverage of 25 Km. The proposed RIS stations will serve following waterways as shown in table below and accordingly the cost is considered in the waterway as provided below:

Table 31: Details of RIS stations proposed in NW-97, Sunderbans waterways

RIS Station No.	Proposed location of RIS station			Waterway covered by proposed RIS	Reach length in Km	Chainage from Km	Chainage to Km	Waterway incoporating cost of proposed RIS
	Co-ordinates	Location Name	Waterway Name					
1	21°43'31.48"N, 88°18'33.06"E	Bhagabatpur	Saptamukhi WW	Muri Ganga	28.418	0.00	28.418	Saptamukhi
				Saptamukhi	37.163	0.00	37.163	
				Thakurran	36.4	0.00	36.4	
2	21°59'19.55"N, 88°31'3.58"E	Dhaki Jetty	Thakurran WW	Thakurran	40.865	23.0	63.865	Thakurran
				Matla	45.0	30.0	75.0	
				Bidya	28.50	0.00	28.50	
3	22°10'5.76"N, 88°47'14.07"E	Godkhali Jetty	Gomar WW	Matla	43.731	55.0	98.731	Gomar WW
				Bidya	49.623	6.20	55.823	
				Gomar	6.711	0.00	6.711	
				Hogla	37.202	0.00	37.202	
				Raimangal	21.50	0.00	21.50	
				Chhota Kalagachi	8.324	0.00	8.324	
4	**22°23'17.49"N, 88°53'59.43"E**	**Bolakhali Jetty**	**Raimangal WW**	Hogla	27.702	10.0	37.202	**Raimangal WW**
				Raimangal	53.381	0.00	53.381	
				Chhota Kalagachi	15.324	0.00	15.324	
				Sahibkhali	14.392	0.00	14.392	
				Katakhali	**22.465**	**0.00**	**22.465**	
				Kalindi	8.513	0.00	8.513	

Hence, the proposed RIS stations at Bolakhali Jetty (22°23'17.49"N, 88°53'59.43"E) along Raimangal waterway will cover the complete stretch of proposed Katakhali waterway as shown in **Figure 31**.

The capital and O&M cost of proposed RIS at Bolakhali Jetty is considered in DPR of Raimangal waterway.

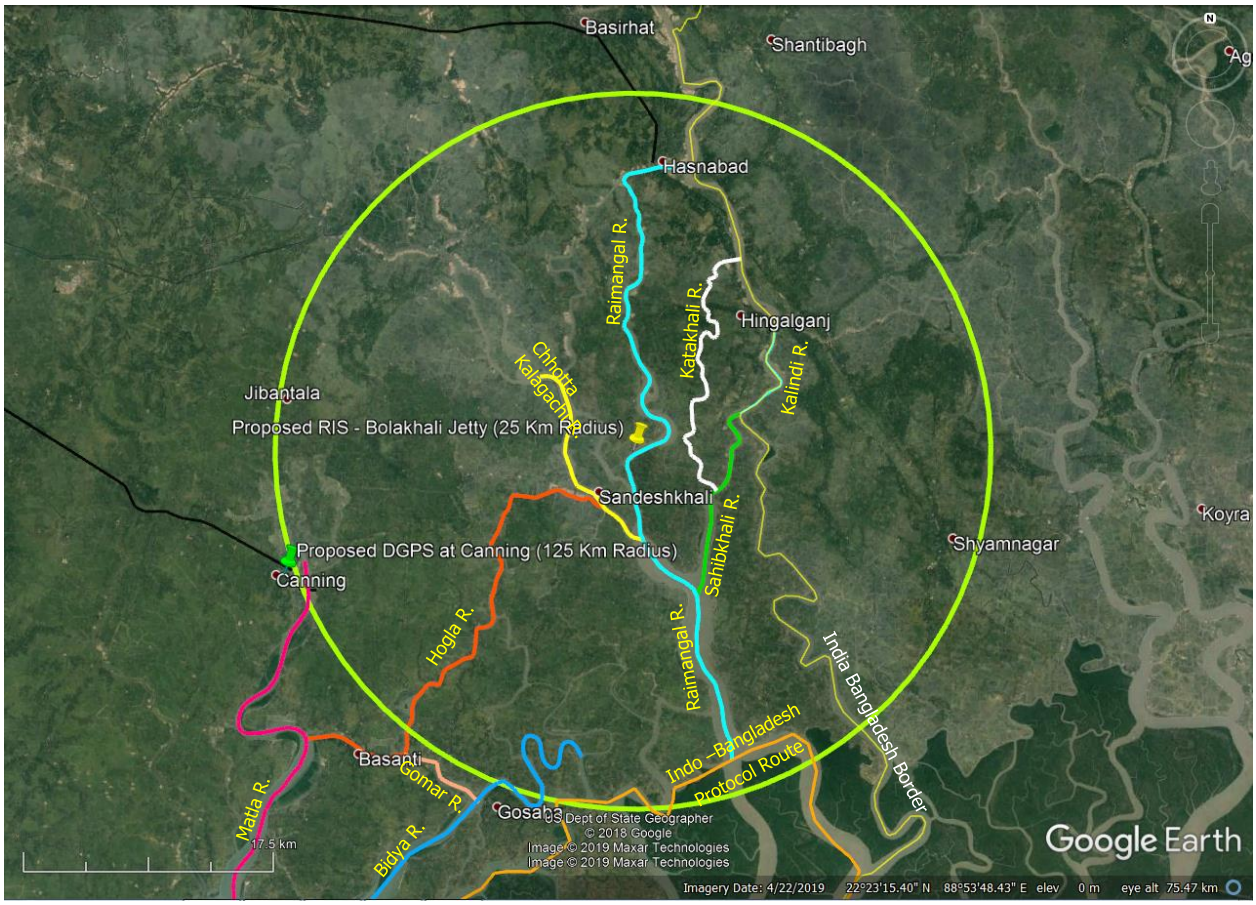


Figure 31: Google Earth image showing location map of proposed RIS and effective coverage

8.2 NIGHT NAVIGATION FACILITIES

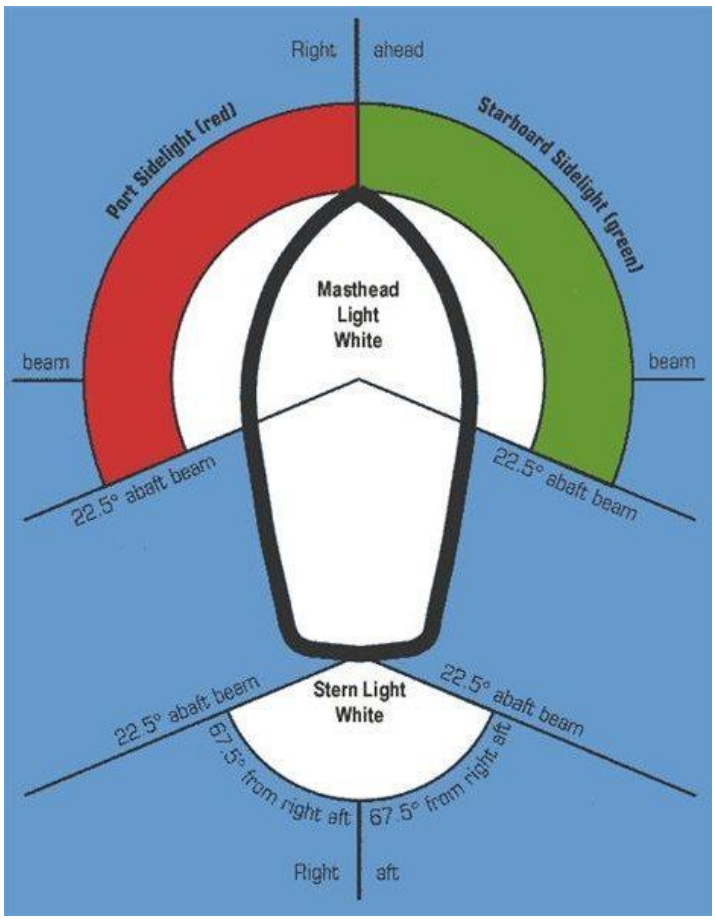
On sectors of the river where there is day and night navigation, forks, junctions and the axis of the fairway, along with obstacles to navigation lying within the fairway, shall be marked by light buoys or bank marks and lights. Floating signs shall be installed at such a depth and at such a distance from the obstacle that the safety and ease of movement of vessels shall be guaranteed at night and in poor visibility. The marking shall be in operation continuously (by day and by night) all along the navigable section of the river.

The visibility of signs regulating navigation on the waterway shall be ensured at night by lighting them with fixed directional white lights, operating uninterruptedly and so positioned that the light does not incommode the boatmasters. If electric lighting cannot be used, the sign boards shall be covered with reflective material of a corresponding colour on which the symbol shall be clearly visible to vessels. At night, for proposed waterway terminals, it shall be sufficient to illuminate the day markings described above. If lights are considered necessary, the entrance shall be marked:

- To port of a vessel entering: by a red light, preferably rhythmic;
- To starboard of a vessel entering: by a green light, preferably rhythmic.

In the case of a narrow or specially shaped entrance, one of these lights may be sufficient to help a boatmaster to enter the harbour. Such a single light shall be rhythmic.

On the vessels there is a pattern in which these lights are set in conjunction with the International Association of Lighthouse Authorities (IALA) Buoyage Systems. The pattern is explained below:

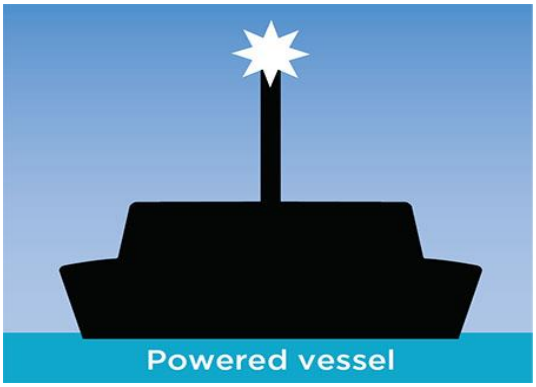


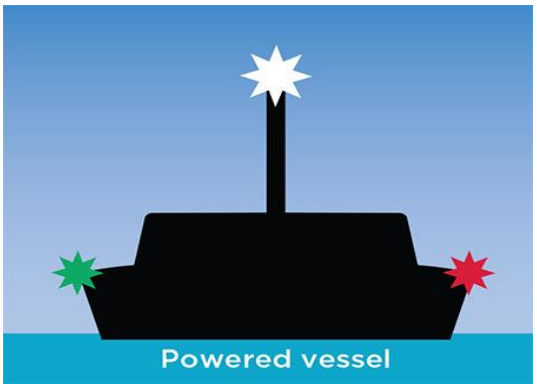
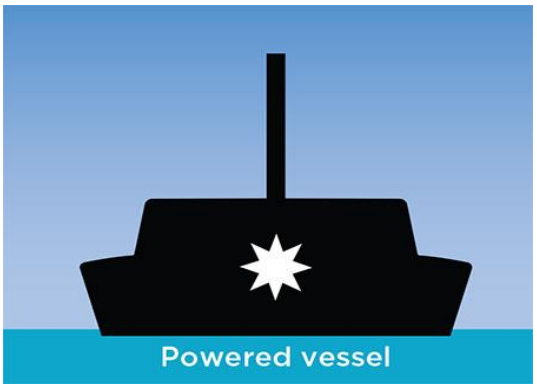
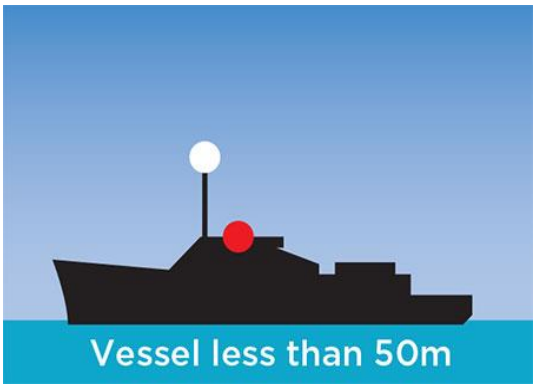
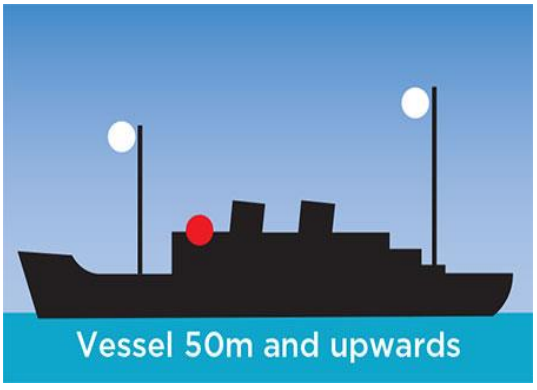
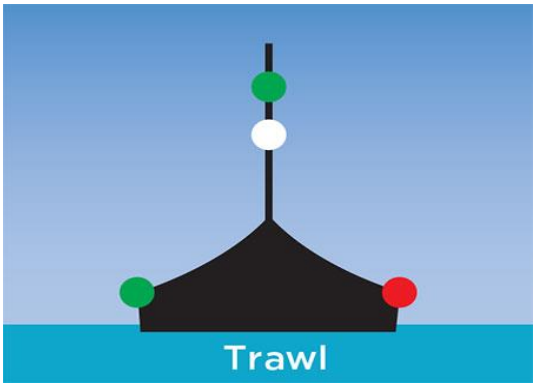
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- Both the sidelights show an unbroken light over an arc of the horizon of 112.5 degrees such that from right ahead it can be viewed to 22.5 degrees shaft on either side.
- A white light is also placed at the back of the boat (known as the stern side). This shows an unbroken light over an arc of horizon of 135 degrees and fixed to show the light 67.5 degrees from right aft on each side
- The mast of the boat also has to have night lights. The colour of this light is white. Two mastheads lights are in place, with the second one shaft of and higher than the first, when the length of the vessel is greater than 50 metres. Shows an unbroken light over an arc of the horizon of 225 degrees and so fixed to show the light from right ahead to 22.5 degrees abaft on either side.

To stay safe on the water at night or at times of restricted visibility, the vessel operator also need to be able to recognise lights on other vessels. These lights help prevent collisions. A vessel's navigation lights tell the master/serang:

- whether it's at anchor or underway
- the direction it's travelling
- the vessel type and size.

Some examples of navigation lights used during night navigation are as below:

	
All round white light on any vessel up to 50m long at anchor	All round white light or torch light on any vessel up to 7m long going in any direction – moving towards, moving away, crossing left or right – or it may be at anchor

	
Green light to your port (left) and red light to starboard (right) on Sailing boat coming.	Powerboats and sailing boats using their engine up to 50m long coming also display a masthead light.
	
Powerboat or sailing boat using its engine up to 50m long travelling away.	A powerboat or sailing boat using its engine also displays a masthead light. Powerboat or sailing boat using its engine up to 50m long crossing path
	
Ships or other large vessels over 50m long display 2 masthead lights. Ship over 50m long crossing path	Displays special lights when its activity – such as trawling – restricts its manoeuvrability.

8.3 EXISTING SYSTEM

Full length of 22.465 Km of Katakhali River is proposed for development as national waterway. Presently, passenger ferry services are operational along the river. The ferry services are operated by locals and no safety, aids to navigation and communication system exists currently along the waterway.

8.4 ADDITIONAL REQUIREMENT

State-of-art navigation and communication system is required in the proposed waterway. The details of River information systems and its applicability and relations to different services in navigation are provided in **Figure 32** as below.

SYSTEM	SERVICE													
		Traffic information		Traffic management				Information for transport logistics						
	Fairway information	Tactical	Strategic	Vessel traffic services	Navigational support	Lock and bridge management	Calamity abatement support	Voyage planning	Transport management	Inter-modal port and terminal management	Fleet and cargo management	Information for law enforcement	Statistics	Waterway charges and harbour dues
Visual aids to navigation	x													
Radar reflecting aids to navigation	x			x										
Light signals	x			x		x								
Mobile phone (voice and data)	x				x	x	x	x	x	x	x	x		x
GNSS for vessel positioning		x	x				x	x	x	x				
VHF radio	x	x	x	x	x	x	x	x		x		x		
Internet	x				x		x	x	x	x	x			x
Vessel based radar	x	x					x							
Shore based radar		x		x		x	x							
Shore based CCTV cameras		x		x		x								
Electronic navigational chart	x	x		x		x	x	x						
Vessel tracking and tracing system		x	x	x		x	x	x	x	x	x	x		x
Ship reporting system			x				x	x	x	x	x	x	x	x

Figure 32: Relation between Services and RI Systems

8.5 COSTING

The following criteria have been adopted for estimating the quantity and cost of navigational aids, proposed for waterway.

i) Quantity of the equipment/s has been decided depending on the distance of the river to be covered.
ii) To operate the system, proper certified operators are to be deployed at site along with the security guards.
iii) As Katakhali waterway is constituent of NW-97 comprising 13 rivers, required quantity of DGPS and RIS condering their effective coverage to avoid duplicity of Instrument proposed and cost over runs is considered.

Capital cost of purchase & installation and O&M cost of DGPS and RIS are provided in respective Matla and Raimangal DPR's. In addition to DGPS and RIS, Marine lanterns/bouys are provided in Katakhali Waterway and the corresponding cost works out as below.

8.5.1 Capital Cost

Table 32: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	Marine Lantern/Buoys of 1.25 m dia	15	2,00,000	30.00
			Total Cost in Lakh	**30.00**
B	3% Contingencies charges			0.90
C	**Total Navigation & Communication Cost in Lakh**			**30.90**

8.5.2 O&M Cost

The O&M cost is considered as 10% of the capital cost for Marine Lanter/Bouys. Accordingly, O&M cost for providing Aids to Navigation and Communication facilities at Katakhali waterway works out to **INR 3.09 Lakh**.

9.0 ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 OBJECTIVE OF ENVIRONMENTAL AND SOCIAL STUDIES

Inland Waterway Authority of India (IWAI), Ministry of Shipping, Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, and recommending the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India.

The section of Katakhali River from Km 0.000 to Km 22.465 falling in North 24 Parganas District of West Bengal State is also considered for Sunderban waterways and declared as National Waterway No. 97 (NW-97).

The Katakhali River is a tidal estuarine river in and around the Sunderbans in North 24 Parganas district West Bengal, India. The river has a connection with the Kalindi River to the north and with Sahibkhali River in the south. The combined river flow falls in to the Bay of Bengal with a wide mouth after traversing about 80 kilometers. There are a couple of sharp curves in the river stream.

Katakhali River has several tributaries/creeks on its banks. The details of creeks are given in **Table 33**.

Table 33: List of Creeks

Sl No	Creek Name	Chainage	Length(Km)
1	Bhandarkhali	2.339	3.40
2	Tongtala	3.986	2.12
3	Creek	4.354	0.31
4	Banstala	4.899	0.85
5	Kothabbari	5.522	2.10
6	Kothabbari	6.096	1.65
7	Ambaria	6.950	1.20
8	Creek	7.192	1.86
9	Rupmari	8.858	0.53
10	Rupmari	8.907	1.65
11	Bankra Dobar	9.231	2.90
12	Sandelerbil	11.282	3.71
13	Purbba Khejurbaria	11.517	0.56

Sl No	Creek Name	Chainage	Length(Km)
14	Paschim Khejurbaria	12.257	1.95
15	Bispur	13.443	2.18
16	Bispur	13.654	0.48
17	Creek	14.412	1.54
18	Hingalganji	15.132	2.30
19	Mamudpur	15.670	1.69
20	Creek	17.666	3.70
21	Creek	17.918	2.62
22	Creek	18.743	1.82
23	Creek	19.064	1.65
24	Creek	19.074	0.79
25	Dharam Baria	19.250	3.12
26	Creek	19.335	1.80
27	Creek	20.719	0.57
28	Barunhat	21.130	1.44

The major objective of this study is to establish present environmental condition along the project corridor through available data /information supported by field studies to evaluate the impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize / reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable. The study basically includes:

- Establishment of the present environmental and social scenario
- Study of the specific activities related to the project
- Evaluation of the probable environmental and social impacts
- Recommendations of necessary environmental control measures.
- Preparation of Environmental Management Plan
- To identify the requirement of various regulatory clearances, NoCs

9.2 ENVIRONMENTAL SETTING IN THE PROJECT AREA

9.2.1 Physiographic

The study stretch passes through North 24 Parganas District of West Bengal State. North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends from latitude 22º11'6" North to 23º15'2" North and from longitude 88º20' East to 89º5' East. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district. It is also the tenth-largest district in the State by area.

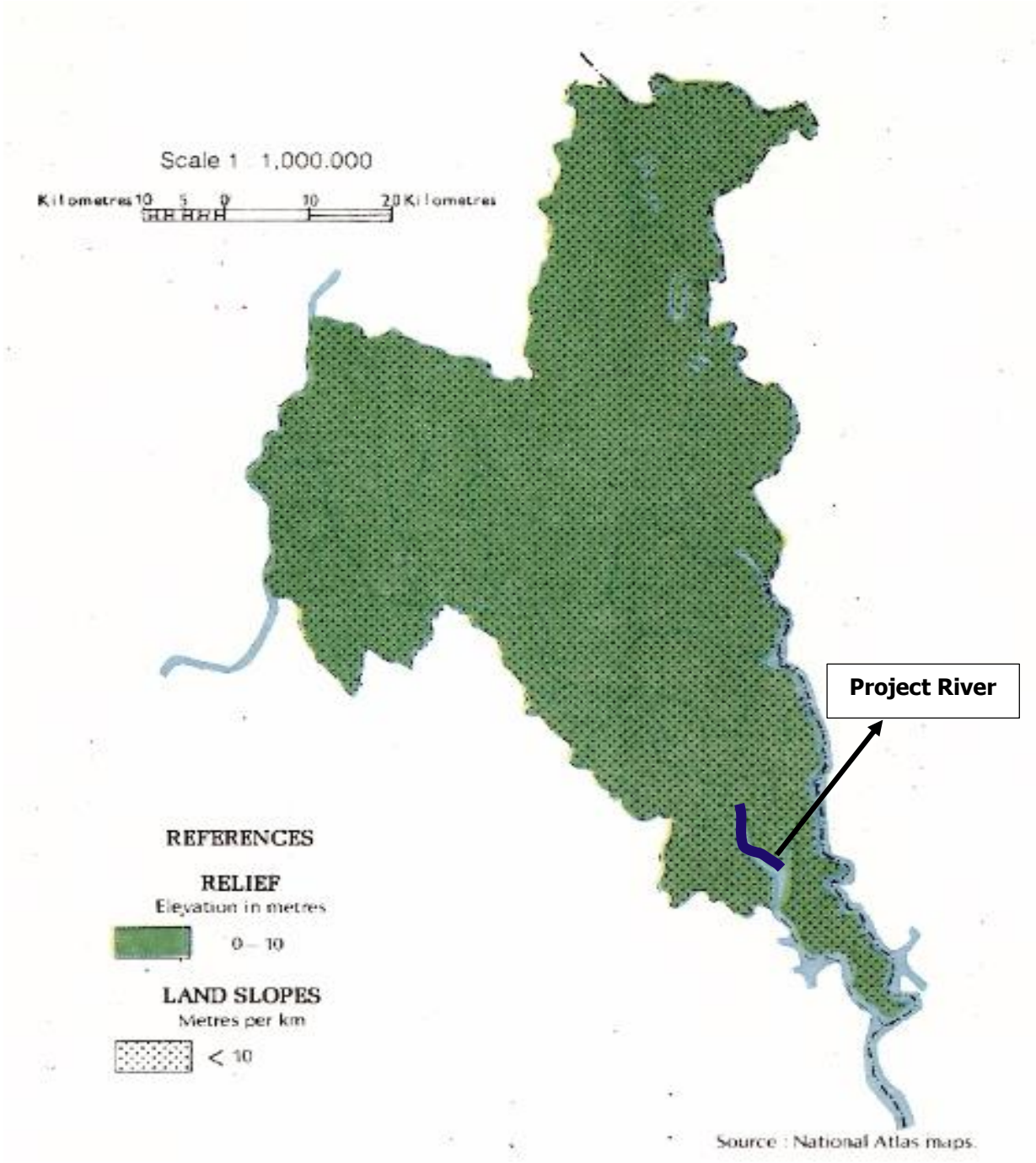
The district, North 24-parganas, has been divided geographically into three parts,

a) Vast reverine belt in the Southern part of Basirhat Sub-Division. (Sundarban area),
b) The industrial and urbanized zone of Bidhannagar and Barrackpore Sub-division
c) Vast cultivating plain land in the Bongaon Sub-division and adjoining part of Barrackpore, Barasat & Northern part of Basirhat Sub-Divisions.

The physiography of the region is that of a typical alluvial plain with gentle ups and downs. The terrain is essentially composed of Soft River borne sediments deposited under fluviatile environment. The general slope is from north west to south east. As the area is situated very near to the out fall, the dominant slope of the land is towards south with average elevation varying from 3.5 m to 2.5 m above MSL. The region is criss-crossed by a network of small streams and rivulets with out falls either at river Hooghly or Haldi. Since these rivers are connected to the sea, the channels suffer daily fluctuations in water level due to tidal influence. Hence, estuarine conditions prevail here with problems of salinity and coastal hazards especially along the banks and river fronts.

The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. The main rivers of the district of North 24-Parganas are Ichhamati, Kalindi, Raimangal, Dansa, Borokalagachi, Benti, Haribhanga, Gourchrar, Bidyadhari, Hooghly, etc. Ichhamati is the longest among these rivers. It enters the district through Bagdah block in the north of the district from Nadia and flows south through Bangaon, Swarupnagar, Baduria, Bashirhat-I, Hasnabad and Hingalganj. This river flows into river Kalindi and Kalindi in turn flows into Raimangal. It indicates the borderline between India and Bangladesh during its course of flow from Bashirhat to Hingalganj. River Hooghly lies between Hooghly and North 24-Parganas district. Besides, Sunderban deltas make many rivers flow in this region due to high tidal water entering from Bay of Bengal

Relief and Slope Map of North 24 Parganas District is furnished in **Figure 33**.



Source : NATMO

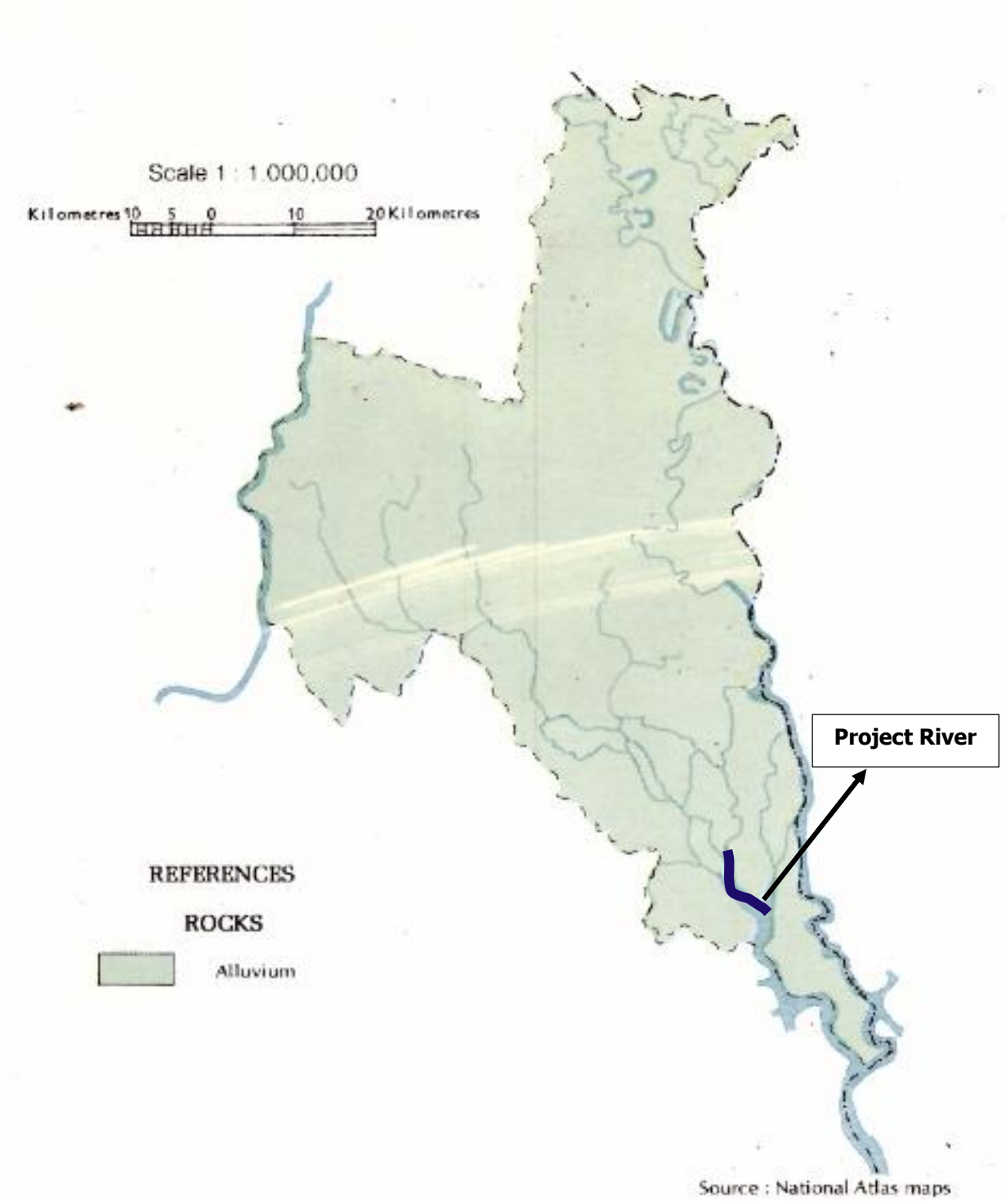
Figure 33: Relief and Slope Map of North 24 Parganas District

9.2.2 Geology and Seismicity

Geology:

The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. There are many other rivers, which include the Ichhamati, Jamuna, and Bidyadhari. The entire landmass of Sundarbans is of very recent in origin and is the result of extensive fluvial-marine deposits of the river Ganges and Bay of Bengal. This stretch of coastal landmass exhibits varied geomorphologic features like sandstones, beach ridge, intertidal sandy flats, tidal shoals etc. These structures are evolved out of dynamic and varied interactions of marine agencies like waves, tides and littoral currents combined with fluvial components. The silt, clay and sand particles have been deposited layer by layer by the river Ganges and its tributaries in the sea board. These rapid delta formations have resulted in uneven thickness and width of the horizons in the estuarine mouths by facing the Bay of Bengal. Lithological logs of the boreholes of Sundarbans include thick clay blanket (15.24 m to 76.20 m) at the topand is underlain by the presence of very coarse sediment containing medium to small gravels of rock fragments and quartz of Quaternary age.

The Rock and Mineral Map of North 24 Parganas District is presented in **Figure 34**.

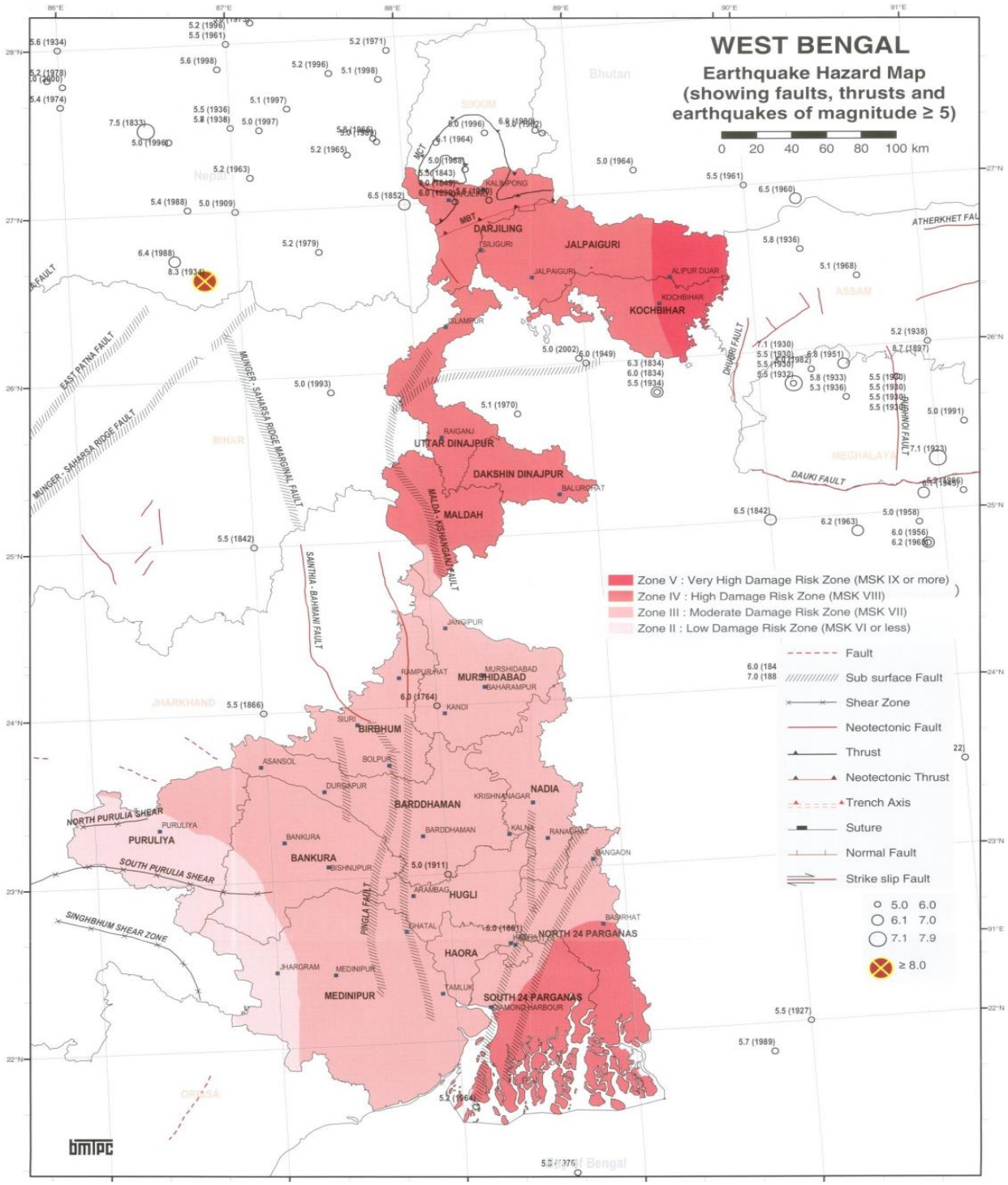


Source : NATMO

Figure 34: Rock and Mineral Map of North 24 Parganas District

Seismicity:

As defined by the Indian Standard (IS) 2002 seismic zoning classification system, the seismicity is measured on a scale from II to V where zone II is most stable and Zone V is considered to be least stable. According to West Bengal Disaster Management Department (WBDMD) western sections of the northern districts of Jalpaiguri and Kooch Bihar lie in Zone V. The remaining parts of these two districts, along with the districts of Darjeeling, Uttar Dinajpur, Dakshin Dinajpur, Maldah, 24 North Parganas and 24 South Parganas lie in Zone IV. The rest of the state along with the city of Kolkata lies in Zone III. The project stretch lies in Earthquake high damage risk zone-IV. The Eartquake zoning map of West Bengal state is shown in **Figure 35**.



Source : West Bengal Disaster Management Department

Figure 35: Earthquake Zoning map of West Bengal

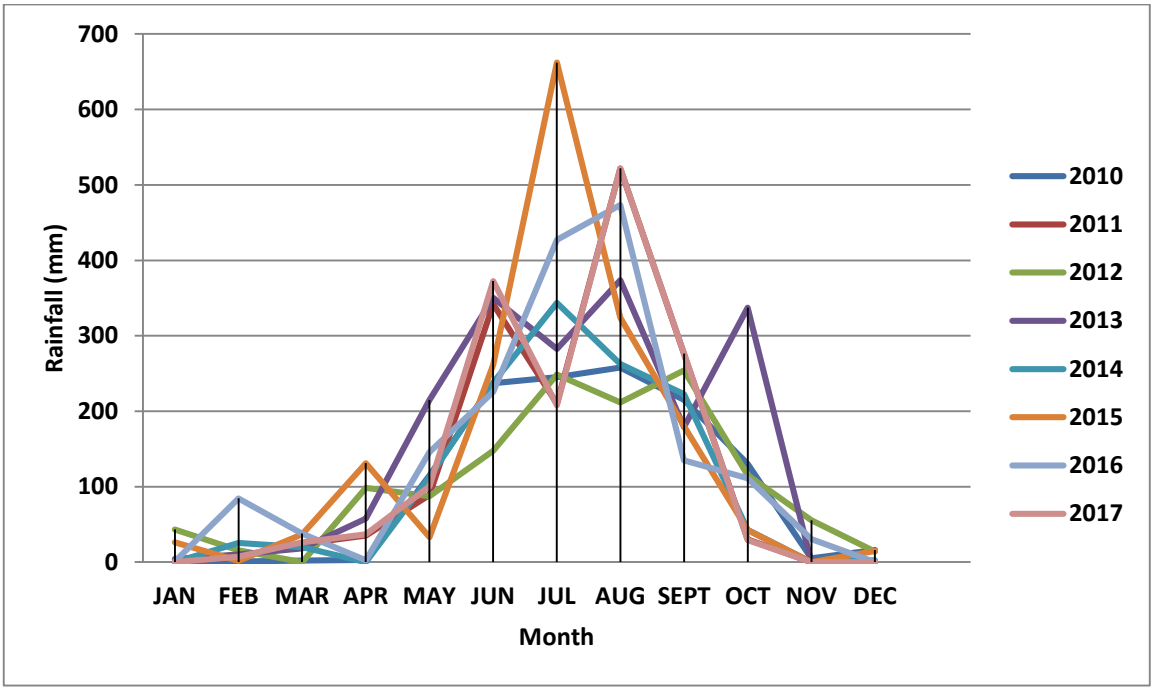
9.2.3 Climate

The district North 24 Parganas is characterized by humid, subtropical climate. It receives adequate rainfall from South-West Monsoon, which sets in the later half of June and continues upto middle of October. Premonsoon torrential downpour received during March-May. The average annual rainfall is 1579mm. The temperature ranges between 41 °C in May (Max) to 10°C in January (Min) and Relative Humidity ranges between 50% in March & 90% in July. The pattern of Rainfall in North 24 Paraganas District is furnished in below table and figure.

Table 34: Rainfall pattern of North 24 Parganas District

Year	Month wise Rainfall Pattern (mm)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2010	0	1	2	3	115	237	245	258	215	130	5	16
2011	0	7	24	35	89	342	210	522	276	30	0	0
2012	43.3	15.6	0	98.5	87.2	147.6	248.7	211.8	254.2	115.2	55.5	14
2013	4.3	10.1	18.2	57.6	214.9	350.3	282.5	373.7	178.8	337.4	0	0
2014	0	25.3	19.9	0	112.6	237.9	343.4	262.6	222.8	42.7	0	2.5
2015	26.3	1.8	36.7	131.2	33.2	261.9	662.1	324.1	180.2	42.5	0	15
2016	0.7	84.4	37.8	2.5	146	225.8	427.1	473.4	135	111.3	30.7	0
2017	0	7.27	26.10	36.78	100.35	372.47	207.66	521.81	276.36	29.28	0	0

Source: India Meteorological Department



Source: India Meteorological Department

Figure 36: Rainfall Pattern of North 24 Pargana District

The observatory of Indian Meteorology Department is located in Dumdum (Kolkata). Based on observations between 1971-2000 the temperature profile of the project area is furnished in below table. April is the warmest month of the year. The maximum temperature in April averages 35.5 °C. The lowest average temperatures in the year occur in January, when it is around 12.9 °C (minimum).

Table 35: Daily (Mean) Maximum and Minimum temperature by month in the Project Area (1981-2007)

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
January	25.8	12.9
February	28.7	16.2
March	33.3	21.0
April	35.5	24.5
May	35.4	25.6
June	34.0	26.3
July	32.6	26.0

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
August	32.3	26.1
September	32.5	25.7
October	32.2	23.8
November	29.9	19.1
December	26.7	13.8

Source: India Meteorological Department

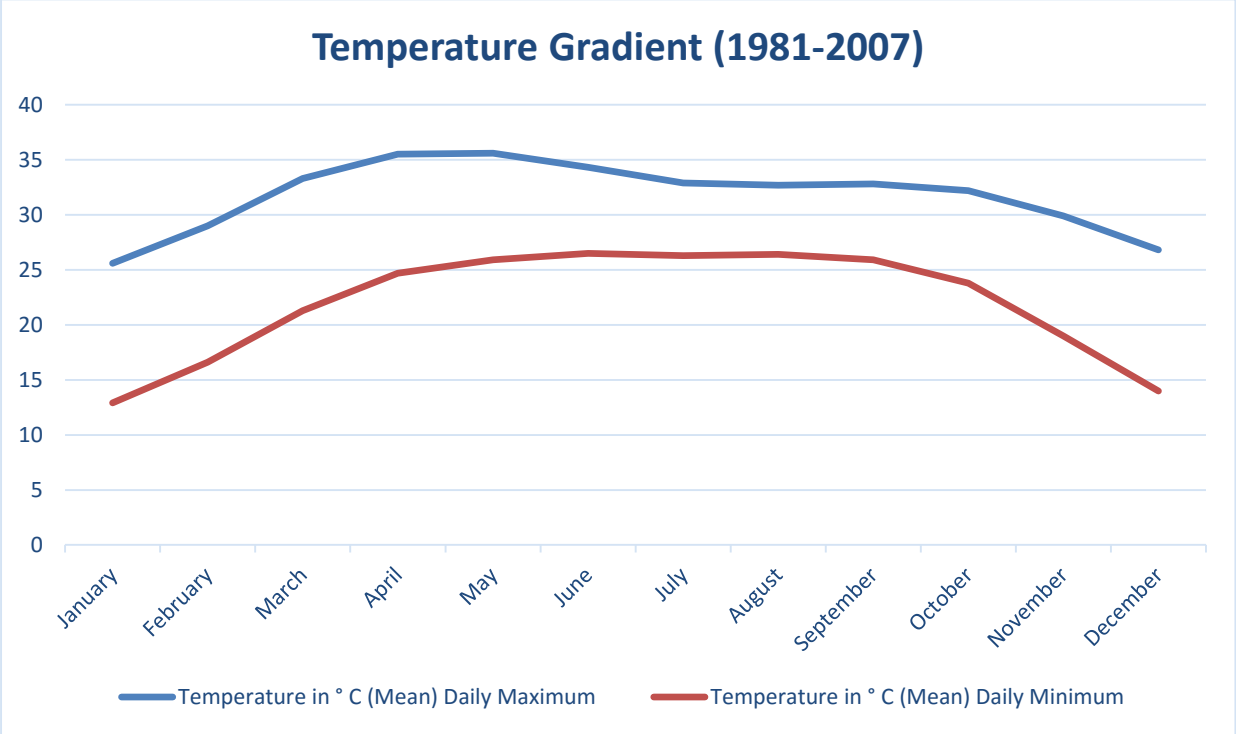
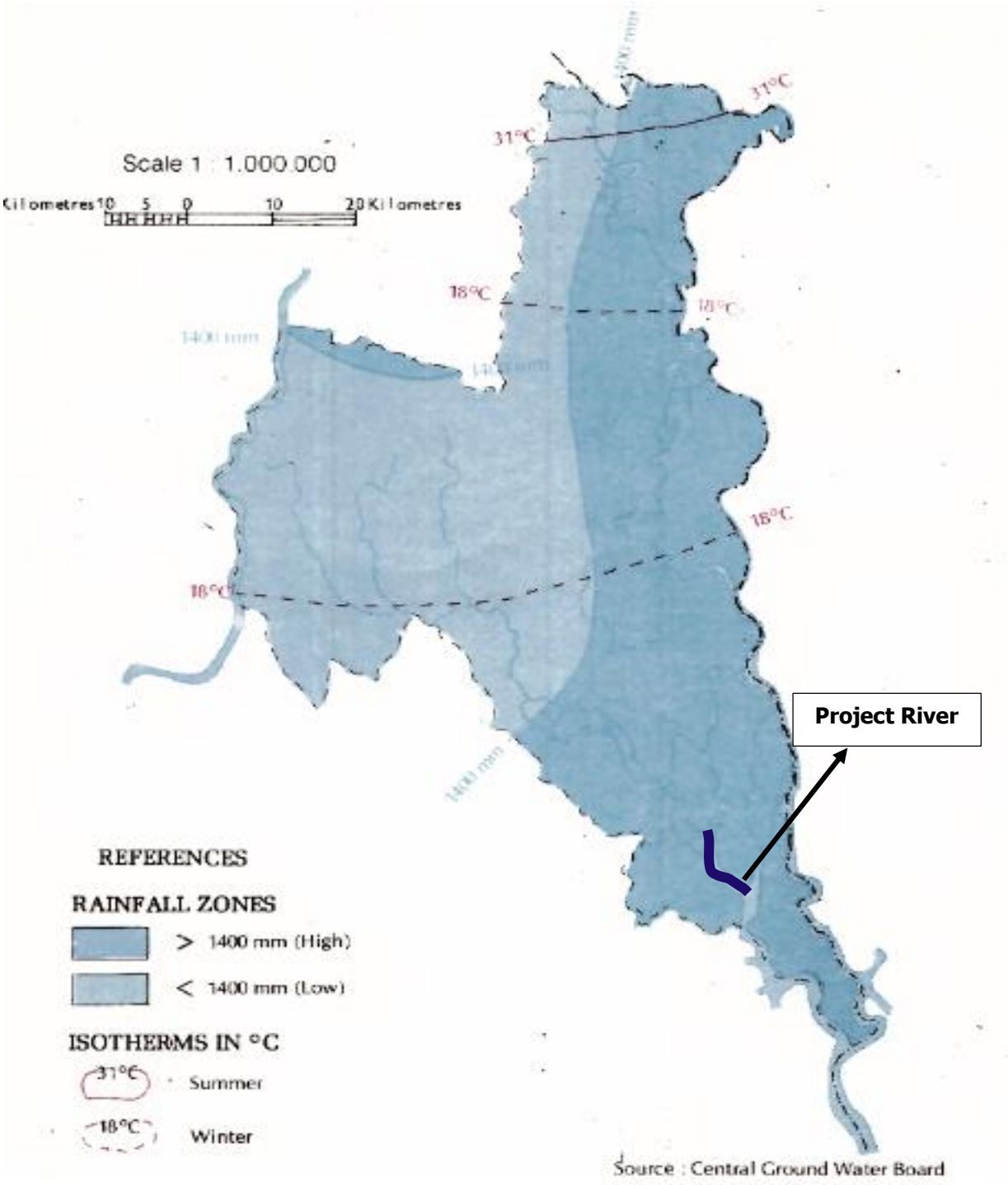


Figure 37: Graphical representation of Temperature Gradient for the year 1981-2007



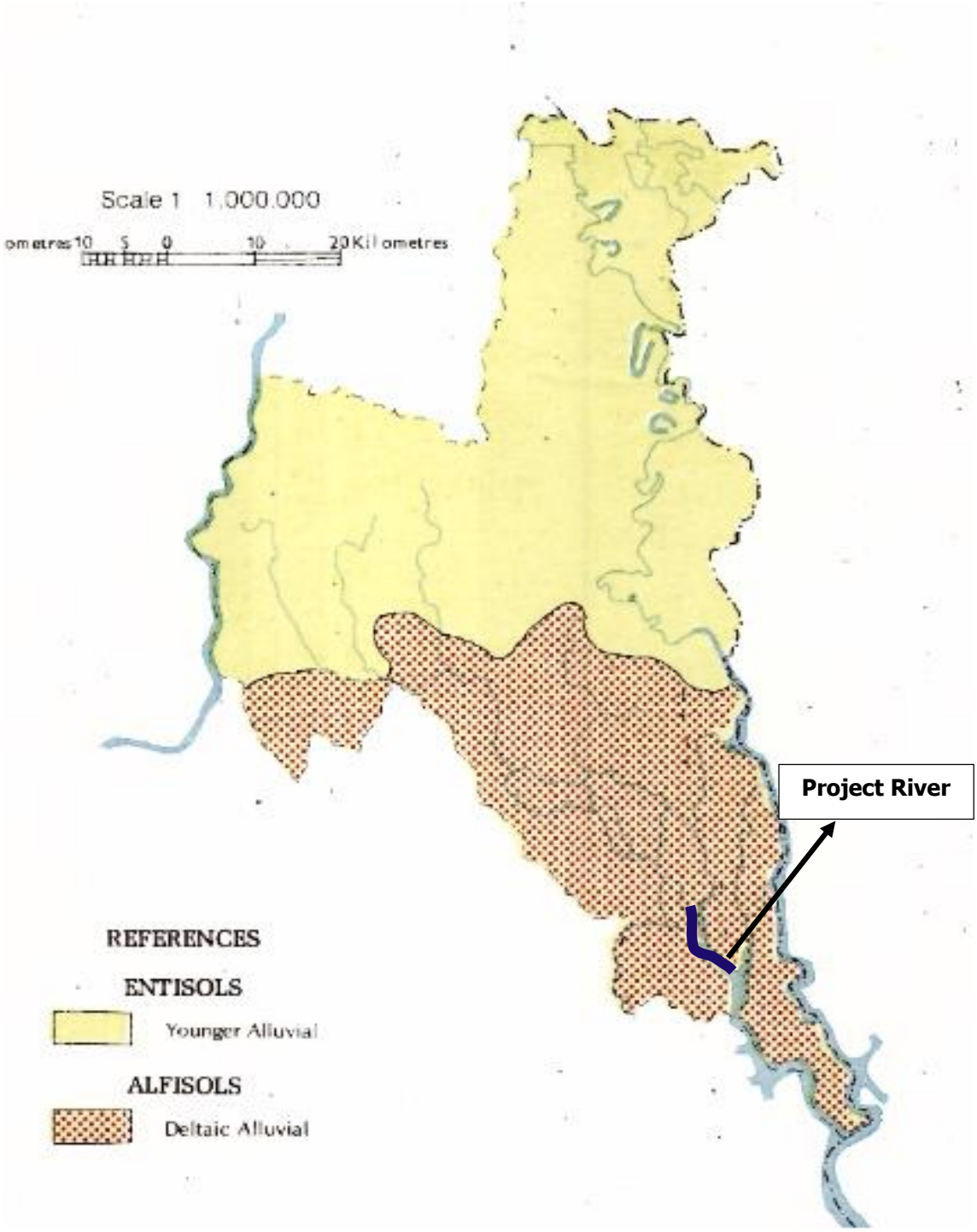
Source : NATMO

Figure 38: Climatic condition of North 24 Parganas District

9.2.4 Soil

North 24 Parganas district is underlain by Quaternary sediments consisting of clay, silt and various grades of sand gravel and pebble. No hard rock geological formation is found here. Lithological log indicates the presence of a clay bed at the top of the geological succession with thickness varying from 10- 40 m. Alternate clay and sand bed exists further in the downward direction. A group of granular aquifer is found between 250-650 m below ground level. These layers are being tapped as groundwater sources. The unconsolidated alluvial sediments of Quaternary age have over laid the older deposits of Tertiary age as noticed in this pile of alluvium. The top most sediment, belonging to recent alluvium which contains mostly of clay. The type of soil varies widely from Sandy, alluvial to clay loam. As the district falls within the Gangetic delta, the soil of the district is very favourable for cultivation. Shallow black and brown soils are also found. The presence of good number of rivers, creeks, khals etc. also favours the cropping pattern of the district. The soil of northern part of the district is sandy, in the central middle part it is sandy with clay loam and in southern side it is clay loam. The physiography of the district is mostly plain. Most of the soils derived from alluvial deposits are azonal with little or no profile development. Clay loam is the predominating type. Clays with or without muck soils occur in swamps and alluvial lakes. These soils have been formed from deposits brought by tidal currents. The active delta still growing southwards is a system of innumerable tidal rivers, canals and creeks, saline soils, swamps and marshes. A part of this active delta contains forests. Known as Sunderbans, this part of the active delta region is under reserve forests. Quite a large part of Sunderbans has been brought under cultivation. Even then the area of Sunderbans spread over 24 Parganas (north and south) is 0.42 million hectares (1629 sq. km.). Sunderbans is a mangrove forest. All the mangroves protect the shore from erosion and aid in accumulation of deposit of peat and mud.

The soil map of the district is given in below Figure.



Source : NATMO

Figure 39: Soil Map of North 24 Parganas District

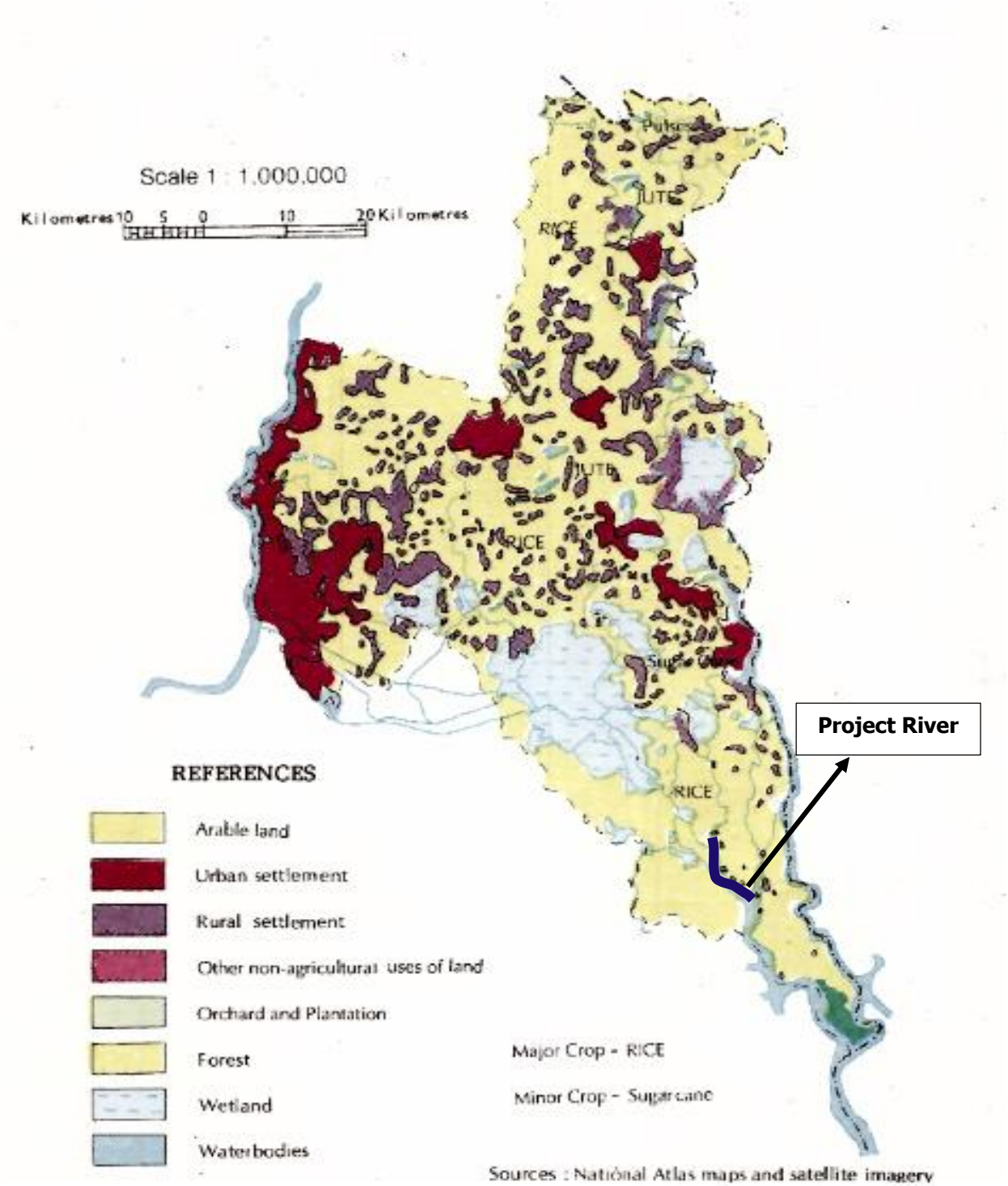
9.2.5 Land Use Pattern

The land use along the project waterway is predominantly agricultural land. There are a number of brick klins located along the waterway. Land use pattern of the project influenced district is presented in **Table 36**.

Table 36: Land Utilization Pattern of the Project district (Area in '000 ha.)

Year	Reporting Area	Area under Non-agricultural use	Barren & un-agriculturable land	Permanent pastures & other grazing lands	Land under misc. tree groves not included in Net area sown	Culturable waste land	Fallow other than current fallow	Current fallow	Net area sown
2006-07	386.52	119.70	0	0	4.44	0	0	2.4	259.98
2007-08	386.52	121.92	0	0	3.39	0.17	0	1.82	259.23
2008-09	386.52	122.37	0	0	4.85	0	0	1.89	257.41
2009-10	386.52	123.23	0.06	0	4.48	0	0	39.12	219.63
2010-11	386.52	124.78	0	0	4.81	0	0	33.91	223.02
2011-12	386.52	124.36	0.04	0	4.45	0.25	0.63	26.73	230.06
2012-13	386.52	125.30	0.03	0	4.00	0.21	0.59	25.12	231.27

Source: - District Statistical Hand Book, North 24 Parganas, 2010-11



Source: NATMO

Figure 40 : Land Use Map of North 24 Parganas District

9.2.6 Ambient Air Quality

During the reconnaissance survey, it was the found that the Air quality along the study area of Katakhali River was free from dust. However, it was also confirmed from the local people that there is no problem caused due to Air pollution. Also there is no major industrial development along the waterway stretch except some good number brick klins.

9.2.7 Ambient Noise Level

During the reconnaissance survey, it was the found Noise is not big issues in the surrounding areas of Katakhali River. There are not any noises generating sources in the nearby areas.

9.2.8 Susceptibility to Natural Hazards

West Bengal is vulnerable to multiple disasters. Due to its sub-tropical littoral location, the state is prone to tropical cyclones, storm surges and tsunamis. In past, this district was hit by natural hazards in many occasions. The hazards include Cyclone, Storm Surge, Flood, Earthquake etc. of medium to large intensities. Susceptibility to various kinds of Natural Hazards are elaborated in the following sections-

- **Susceptibility to floods**

19.16% of the population lives in flood-prone areas. Most flood-prone Blocks are Hingalganj, Hasnabad, Sandeshkhali- I/II, Minakhan, Horoa, Baduria, Swarupnagar, Bagdah, Bongaon, Gaighata, Deganga, Habra-I/II. There are 18 rivers running through the district and as it is situated at the downstream of these rivers. Embankments of all the rivers are made of Soil and the river beds are getting high day by day due to Siltation. All inhabitants are situated in the area comparatively at the lower level than the water level of river, so they face a water logging in almost every year due to heavy rainfall. In the year 2015 rainfall has occurred in 2491.50 mm. Due to heavy rainfall and breach of embankment maximum area of this district was water logged. As a result huge nos. of houses are damaged, agricultural crop, fishery, and other infrastructure like roads, tube wells & schools etc. are also damaged.

Source: West Bengal Disaster Management Department

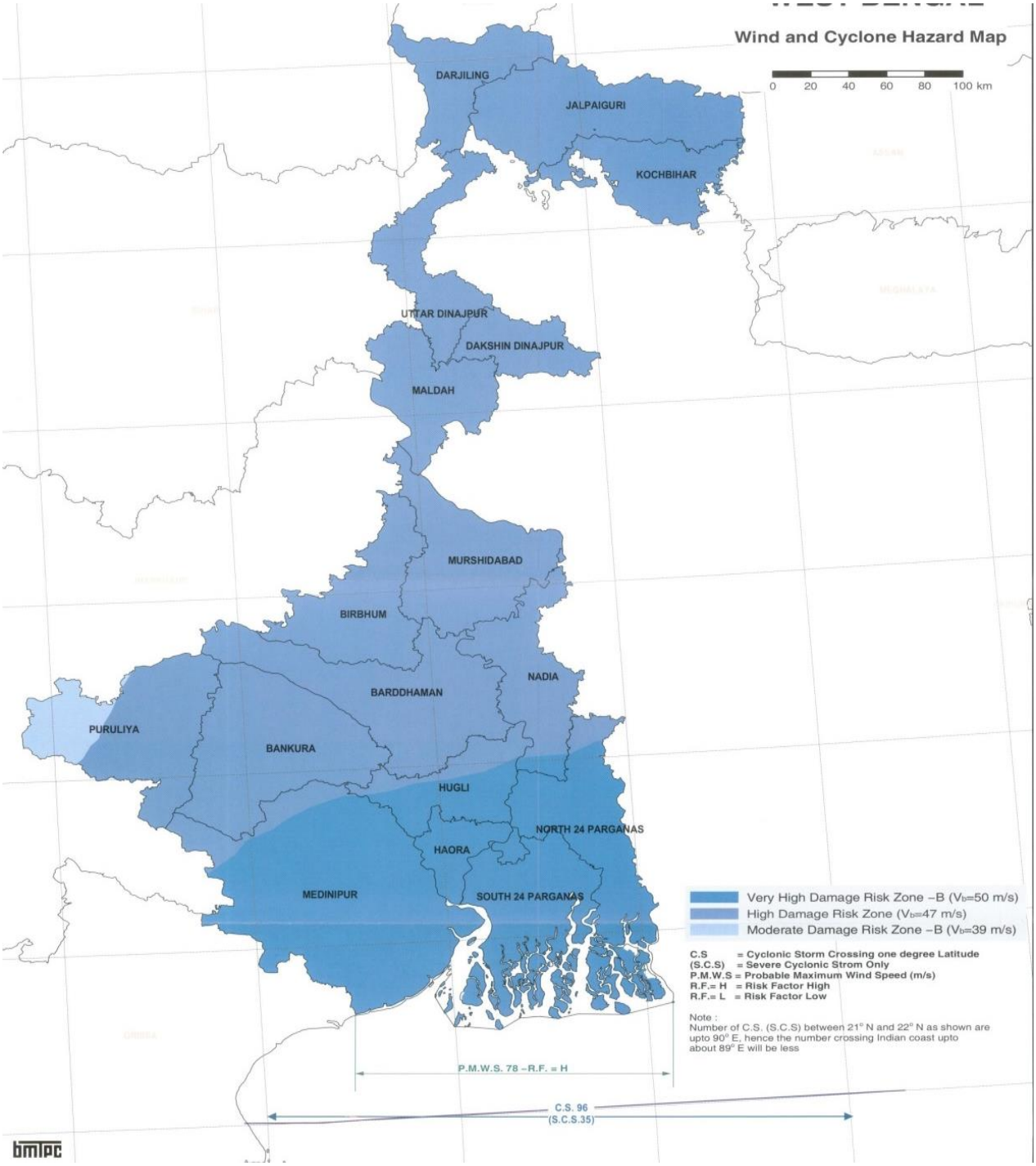
Figure 41: Flood Prone Zones of West Bengal

- **Susceptibility to Earth Quake**

73 % of the total area comes under High Damage Risk Zone (Zone IV) and 27 % of the total area comes under Moderate Damage Risk Zone (Zone III). Part of Bangaon, Barasat and Barrackpore Sub divisions come under Zone IV. Entire Basirhat Subdivision containing the entire Sunderban area under this district is highly vulnerable to Earth Quake and Tsunami.

- **Susceptibility to Wind and Cyclones**

Cyclone and High tide has been commonly found in the reverine belts of Basirhat sub-division. Strangely, several focal areas of Gaighata Block of Bongaon sub-division had been found to be hit by tornado several times in the past. The East Coast of India is one of the six most cyclone-prone areas in the world. One of the Cyclone AILA which hit coastal West Bengal on 25 May, 2009 is described as one of the worst storms to hit the state in many years. Over 5.1 million people have been affected in 16 districts of West Bengal. Over 500,000 houses were damaged either fully or partially. The storm was especially devastating for farmers who were preparing to harvest rice and other crops. According to media sources, the Sundarbans national reserve forest was worst-hit, as many as three million people lived in the forests. All the coastal districts are vulnerable to cyclones.



Source : West Bengal Disaster Management Department

Figure 42: Wind and Cyclone Map of West Bengal

- **Susceptibility to Drought**

Draught is Occasional in North 24 Parganas. The district recently experienced draught in 2010 owing to less rainfall (857 mm) in Monsoon Season against normal rainfall (1579 mm). Probability of Draught is increasing with increasing water Scarcity.

- **Susceptibility to Tornadoes**

Tornado hits at Gaighata Block in the year 1983, 2001 under Bongaon Sub-Div. Tornado hits at Asoknagar – Kalyangar Municipality, Habra-I Block Deganga Block in the year 2015 (29.7.15).

9.2.9 Estuary and Coastal Zone

Estuaries form a transition zone between riverine and maritime environments. They are subject to both to marine influences—such as tides, waves, and the influx of saline water—and to riverine influences—such as flows of fresh water and sediment. The inflows of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

The section of waterway starts from Lebukhali at Lat 22°21'48.8533"N, Long 088° 57'23"E and ends to Barunhat at Lat 22°30'29.56"N, Long 088°58'18.90"E. Katakhali River is located at a distance of 26.5 km north from the Dampier-Hodges Line. It is an imaginary line, passing through 24 Parganas South and North districts, which roughly indicates the northern-most limits of estuarine zone affected by tidal fluctuations. However, tidal influence is observed in the stretch of waterway. According to Dept. of Environment, GoWB, proper delineation of CRZ area is yet to be finalized.

9.2.10 Archaeological and Heritage Locations

Chandraketugarh is an archaeological site located beside the Bidyadhari river, about 35 km north-west of Katakhali River. The history of Chandraketugarh dates back to almost the 3rd century BC, during the pre-Mauryan era. Artefacts suggest that the site was continuously inhabited and flourished through the Shunga-Kushana period.

Sunderban Biosphere Reserve, a World Heritage Site declared by UNESCO in 1987 and International Biosphere Reserve declared by UNESCO in 2001 is located in the district.

9.2.11 Flora

The floral environment in the study area is quite similar with Gangetice West Bengal. Identified flora in the area are *Mangifera indica* (Mango), *Syzygium cumini* (Jaam), *Phoenix sylvestris* (Date Plam), *Musa sapientum* (Banana), *Carica papaya* (papya), *Psidium guajava* (Guava), *Artocarpus heterophyllus* (Jackfruit), common shrubs and herbs like *Abutilon indicum* (*Potari*), *Achyranthes aspera* (*Latjira*), *Adhatoda vasica* (Basak), *Ageratum conyzoides* (Uchunti), *Amaranthus viridis* (Kata Note), *Amorphophallus paeoniifolius* (Oal/Gandira), *Andrographis paniculata* (Kalmegh), *Bambusa bambos* (Bamboo), *Blumea lacera* (Kukurmuta), *Bryophyllum pinnatum* (Patharkuchi), *Calotropis gigantean* (Akanda), *Catharanthus roseus* (Nayantara), *Centella asiatica* (Thankuni), *Cestrum diurnum* (Day jasmine), *Clerodendrum infortunatum* (Ghentu), *Clitoria ternatea* (Aparajita), *Coccinia grandis* (Telakucha), *Commelina benghalensis* (Bengal Day flower/Kanchira), *Cynodon dactylon* (Doobghas),*Datura metel* (Dhutura), *Dentella repens* (Creeping Dentella), *Dryopteris filixmas* (Fern), *Euphorbia neriifolia* (Mansa), *Grangea maderaspatana* (Namuti), *Grewia hirsuta* (Kukurbicha), *Hibiscus rosa sinensis* (Joba), *Leucas aspera* (Swet Dron/ Ghal),*Mimosa pudica* (Lajjabati),*Musa paradisiaca* (Kachkola), *Nerium oleander* (Raktakarabi),*Ocimum basilicum* (Bantulsi), *Ocimum sanctum* (Tulshi), *Parthenium hysterophorus* (Parthenium), *Solanum surattense* (Kanta Begun), *Tragia involucrata* (Bichuti), *Vitex negundo* (Nishinda).

Climbers trees are *Abrus precatorius* (Gunch), *Asparagus racemosus* (Shatamuli), *Bougainvillea spectabilis* (Baganbilas), *Gymnema sylvestre* (Gurmar/ Chhotadudhilata), *Ichnocarpus frutescens* (Kalidudhi), *Luffa aegyptiaca* (Purulgach), *Paederiascandens* (Gandal*)*, *Tinospora cordifolia* (Nimgilo/ Gulancha).

9.2.12 Fauna

In the study area common mammals, birds, reptiles and amphibians area recorded. This is similar with gangetic West Bengal. Notable common mammals are *Canis aureus* (Fox), *Presbytis entellus*(Common Langur), *Rattus rattus* (House rat), *Mus musculus* (House Mouse), *Bandicota bengalensis* (Indian mole rat), *Suncus murinus* (Indian Shrew), *Felis domesticus* (Domestic Cat), *Rousettus Leschenaulti* (Fruit bat), *Pipistrellus coromandra* (Chamchika), *Canis lupus familiaris* (Indian Street Dog), *Herpestes edwardsii* (Indian grey Mongoose), *Funambulus palmarum* (Three stripped squirrel), *Funambulus pennantii* (Five-striped palmsquirrel) etc.

Common birds are *Corvus splendens* (House Crow), *Eudynamys scolopacea* (Koel), *Columba livia* (Pegion), *Passer domesticus indicus* (Sparrow),*Psittacula krameri* (Parrot), *Acridotheres tristis* (Myna),

Athene brama (Spotted owl), *Alcedo atthis* (Common Kingfisher), *Bubulcus ibis* (Cattle Egret), *Ardeola grayii* (Pond Heron), *Streptopelia orientalis* (Oriental turtle dove), *Spilopelia chinensis* (Spotted Dove), *Arachnothera longirostra* (Little spiderhunter), *Ardea purpurea* (Purple heron), *Egretta garzetta* (Little egret), *Coracias benghalensis* (Indian roller), *Orthotomus sutorius* (Common tailorbird), *Halcyon smyrnensis* (White-throated kingfisher), *Haliastur indus* (Brahminy kite), *Nycticorax nycticorax* (Night Heron), *Lanius cristatus* (Brown shrike).

Numbers of reptiles are recorded, those are *Hemidactylus flaviviridis* (House gecko), *Typhlops acutus* (Blind snake), *Xenochrophis piscator* (Checkered keelback), *Enhydris enhydris* (Rainbow water snake), *Naja naj* (Cobra),Common retiles like *Ptyas mucosa* (indian rat snake), *Vipera russelii* (Russells vipers), *Dendrelaphis tristis* (Bronz Back Trees snake), *Bungarus caeruleus* (Indian Krait), *Amphiesma stolatum* (Streeped Kill back)etc.

In the study area common amphibians noted are Rana tigrina (*Indian bull frog*), Bufo melanostictus (Common Indian toad), *Hyla sp.* (Tree Frog), *Euphlyctis hexadactylus* (Indian green frog) etc.

Part of Sundarban Biosphere Reserve and Sundarban National Park area is annexed to the District of North 24-Parganas which are in the South-East portion of the district. It covers 6 (six) Blocks viz Sandeshkhali-I, Sandeshkhali-II, Hingalganj, Haroa, Minakhan and Hasnabad. Sunderban area harbours many endangered/rare/vulnerable species like *Panthera tigris* (Royal Bengal Tiger), *Prionailurus viverrinus (Fishing Cat), Neomeris phocaenoides (Finless Porpoise), Platanista gangetica (Gangetic Dolphin), Orcaella brevirostris* (*Irawady Dolphin), Lutrogale perspicillata (Smooth coated otter).*

There is no forest land along the bank of the waterway, however some sporadic growth of mangrove and mangrove associated vegetaion like Ceriops sp (Goran), Heritiera fomes (Sundari), Avicennia sp (Baen), Porteresia coarctata (Dhani Grass), Barringtonia sp (Hijal) are present.

9.2.13 National Parks, Forests, Wildlife Sanctuaries and Reserves

According to Forest Survey of India Report, 2015 the total forest cover of North 24 parganas district is 724 Km^2 which is about 17.68 % of the district's total geographical area (4094 Km^2).

Out of 724 Km^2, 13 Km^2 falls under very dense forest area category; whereas Moderately Dense Forest and Open Forest area covers 185 Km^2 and 526 Km^2 areas respectively. The comparative statement showing forest cover of North 24 Parganas District and West Bengal state is presented in

Table 37. It is observed from the table that district's Forest Cover percentage in respect to total geographical area is little less than state's overall coverage.

Table 37: Forest Cover of North 24 Parganas District and West Bengal State

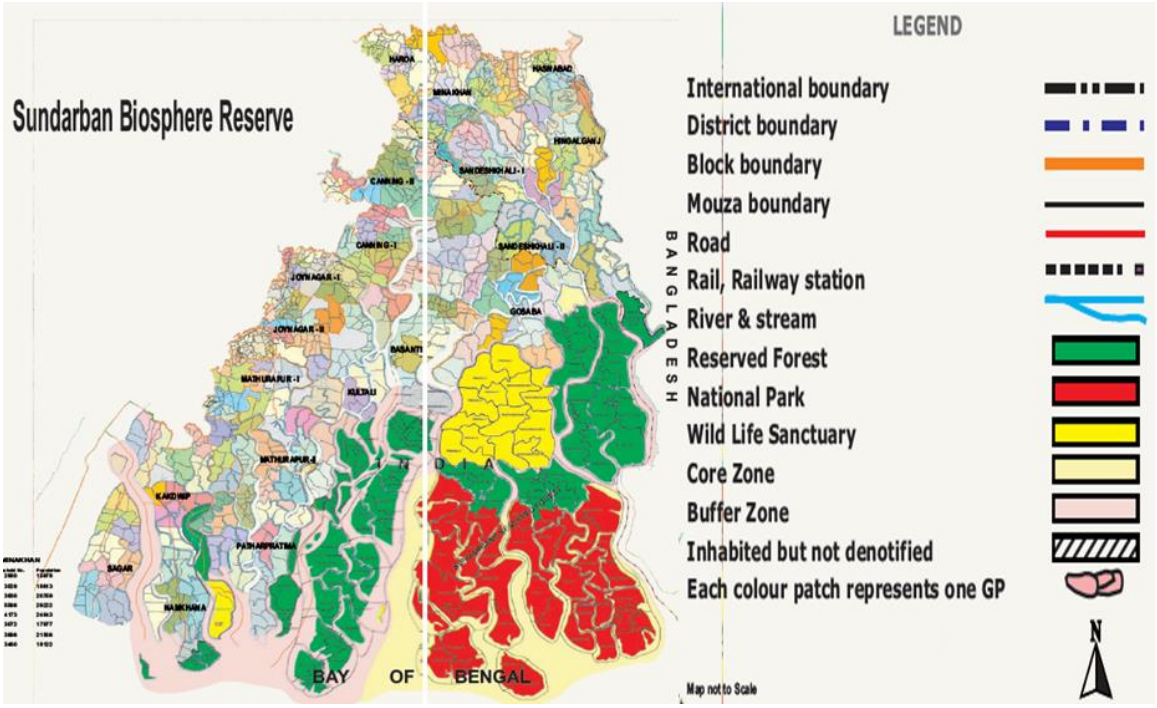
District / State	Forest Cover in Sq. Km					
	Geographical Area (GA)	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	Percentage of GA
North 24 Parganas	4094	13	185	526	724	17.68
West Bengal	**88752**	**2948**	**4172**	**9708**	**16828**	**18.96**

Source : Forest Survey of India, 2015

National Parks, Wildlife sanctuaries, Biosphere Reserve play a vital role in protecting the wildlife of a particular area and providing them their natural habitat.

Part of Sundarban Biosphere Reserve and Sundarban National Park area is annexed to the District of North 24-Parganas which are in the South-East portion of the district. Which covers 6 (six) Blocks viz Sandeshkhali-I, Sandeshkhali-II, Hingalganj, Haroa, Minakhan and Hasnabad. These blocks are surrounded by tidal rivers such as the Ichhamati, Bidyadhari, Kulti, Dansa, Raymangal etc. besides being crisscrossed by numerous creeks and channels. Sundarban have been declared a National Park, a Biosphere Reserve by Indian Government and World Heritage Site and "An International Biosphere Reserve" by UNESCO during the 1980s and special measures were taken to reduce further deforestation and human induced destruction of forest.

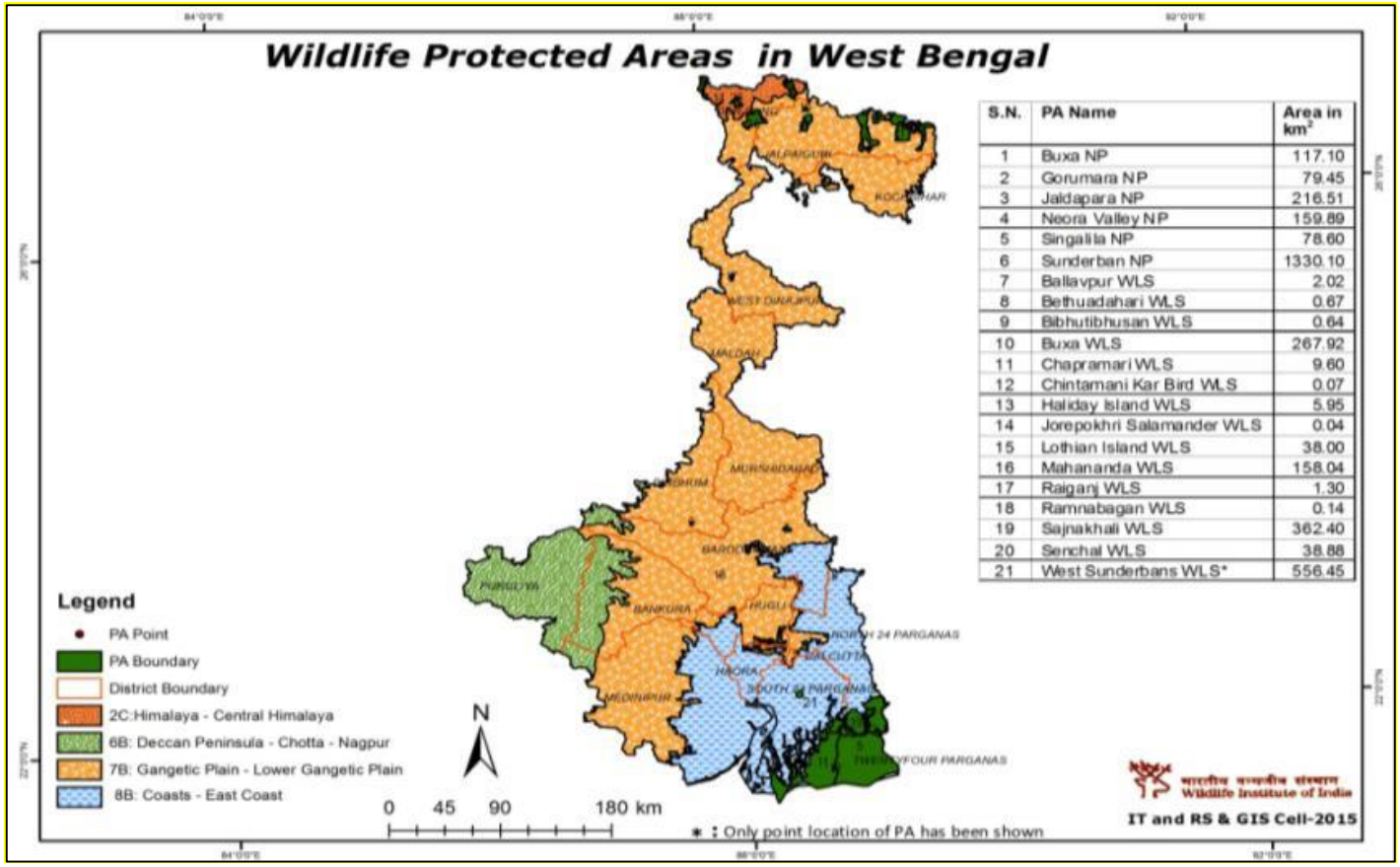
The Sunderban Biosphere Reserve is located within the project district. The Map of Sunderban Biosphere Reserve is furnished in **Figure 43**.



Source : WWF-India

Figure 43: Map of Sundarban Biosphere Reserve

Besides Sundarban, the other notified Protected Area (under Willdlife Act, 1972) in the district is situated in Bongaon sub-division and is known as Bibhutibhusan Wildlife Sanctuary (formerly Parmadan Forest). The details of various protected areas in West Bengal covered under purview of Wildlife Act, 1972 is given in **Figure 44**.



Source : Wildlife Institute of India

Figure 44: Wildlife Protected Area of West Bengal

9.2.14 Socio-Economic Profile

Social Profile

The distribution of population in rural and urban area in the district as per 2011 census shows that majority of the population i.e. 57.3% live in urbn areas. The percentage of rural population on the other hand is gradually decreasing from 57.1% in 1951 cencus to 42.7% in 2011 census. The total population of the district is 1,00,09,781 (Male- 5,119,389; Female – 4,890,392). The literary rate and sex ratio being 84.06% and 955 respectively, the percentage of SC and ST was 21.67 and 2.64 in the district. The district comprises of 27 municipalities along with 78 Census Towns and 1,527 villages. The demographic profile of the project district is presented in **Table 38**.

Table 38: **Demographic Profile of North 24 Parganas District**

Total Population	Male Population	Female Population	Literary Rate (%)	Sex Ratio	SC (%)	ST (%)
1,00,09,781	5,119,389	4,890,392	84.06	955	21.67	2.64

Source : Census of India, 2011

Major settlements/village located along the section of Katakhali River has been listed in the **Table 39** along with population details as per Census of India Data, 2011.

Table 39: **Major settlements/village along the project stretch of River**

Sl. No.	Village/ Town name	Population (nos.)
1	Tushkhali	960
2	Bhangatushkhali	855
3	Sandeshkhali	1130
4	Arsadmiya	1240
5	Kalatpada	850
6	Bermajur	1200
7	Gazikhali	1160
8	Nazat	1320
9	Atapur	790
10	Kadkhali	1020

Source : Hydrogrpahic Survey Report

Economic Profile

Agriculture: Abundance of fertile lands supported by handful rainfall had made the district an agricultural paradise. Total area used for production of Total Food Grains in the district is 239.1 thousand hectares during 2010-11. Oil seeds are grown in 45.6 thousand hectares of land and fibers are grown in 50.6 thousand hectares of land.

Irrigation: As already stated, economy of the district depends on agriculture andtherefore irrigation plays a major role. Water is drained into the field through various canals. The presence of abundant rivers, creeks etc. help the cultivators a lot.

Animal Husbandry: The district has plenty of live stocks. As per District Statistical Hand Book, North Twenty Four Parganas, 2010-11 data of Aminal Husbandary had shown up to 2007. There were total cattle population accounts for 9,48,260, total Buffalo population accounts for 38,071, total live-stock population is 20,55,617, total poultry 79,36,844 in the District.

Fishery: Because of abundant rivers, creeks, khals (manmade water channels) and bils, a fishery of the district has flourished. Many people earn their livelihood by catching fishes. Fishes are not only distributed among various parts of the state but also are exported to the other parts of the country.

Industry: Industrial development in the district of North Twenty Four Parganas is noteworthy. It is one of the top most districts in the state in terms of industrialization. Industries like cotton handloom, leather tanning, manufacturing of cutlery, brass and bell-metal industries, pottery, embroidery and lace works (chikan) etc. flourished in the district during the last century. Later large scale industries like jute manufacturing, engineering, rubber, textile, paper, chemical, etc. have been established. Cotton handloom textile industries and jute manufacturing industries plays an important role in the district's economy. Due to its geographical advantages, the riverside of Hooghly was developed as a centre of jute manufacturing mills by the British Government. The major jute mills of India are situated here. Cotton handloom textile industry centers are located mainly at Baduria, Barasat, Taki and Basirhat though there are other centers also. Huge qualities of handloom products are being exported from the district. There are several power loom centres found in the district. There are many large scale industries in the district also. The most notable of them is the Andrew Yule Company Ltd. which was established in 1863 with Japanese collaboration. Other important large scale industries are Chloride Industries Ltd. At Shyamnagar, India Foils Ltd. at Kamarhati, India Paper Pulp at Naihati, Titagarh Paper Mills Ltd., The Locomotive Carriages and Wagon Workshop at Kanchrapara, Kalyani Spinning Mills Ltd., West Bengal Ceramic Development Corporation, Sree Saraswati Press Ltd. etc.

The Information Technology hub of Kolkata is situated in this district, which is the centre of some of the reputed IT/ITES Indian and multinational companies. Around 1.2 Lakh people are employed in Sector V and Sector III at Salt Lake City. The area is administered by Naba Diganta Industrial Township Authority (NDITA).

Trade and Commerce: Due to improved industrialization as well as growth ofagricultural products along with fisheries, the district has a good trade and commerce setup. International trade towards Bangladesh is made through the international boarder of Bongaon. The most important export items are engineering, chemical, jute, cereals, vegetables, poultry, bamboo etc. On the other hand coal, petroleum products, sugar etc.are imported in the district.

Transport: Transport and communication in the district is quite developed. Without adequate transport facilities, industries and agriculture could not be as developed as it is in this district. Summary of the length of roads maintained by different Government bodies (as per 2011 census); P.W.D road is 1391.00 km, Zilla Parishad road is 670 km, Gram Panchayat & Panchayat Samity road is 6711.48 km & road under Prime Minister's Gramin Sarak Yojana is 91.20 km. A good number of vehicles are registered with the Regional Transport Authority. There are numerous non-registered vehicles as hand pulled rickshaw, batteryoperated e-rickshaw etc. which is also used for human as well as material transport.

The district has good railway connectivity also. It falls under the Sealdah Division of the Eastern Railways. Four important section viz. (1) Sealdah-Dankuni, (2) Sealdah- Ranaghat, (3) Sealdah-Bongaon, and (4) Sealdah-Barasat-Hasnabad connects different parts of the district. The only international airport of entire Eastern India is located at Dum Dum named The Netaji Subhash Chandra Bose International Airport.

9.3 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND THEIR MITIGATION MEASURES

Environmental assessment helps in identifying the likely impacts due to project activities for all stages of the project viz, construction and operation stage on the physical, biological and social environment.

The three major activities involved in the project development which may have impacts on environment at different stages are construction and operation of civil interventions, capital and maintenance dredging and operation of vessels. These activities may impact different environmental components at different stages of project life cycle. The details are follows:

9.3.1 Impacts during Construction Phase

A. IMPACTS DUE TO EXCESS SOIL/ DREDGING MATERIAL/ WASTE

The excess soil and muck generated from various construction activities, waste from construction vehicles, fuel lubricants, machinery & maintenance equipment needs to be properly disposed, so as to avoid adverse impacts. The impacts however, shall be marginal. The solid waste generated due to various construction activities should be disposed off at designated disposal ground.

Capital and Maintenance dredging is proposed for Class VII waterways. Dredging may change the water quality, river bed topography and benthos if not prevented. These activities must not occur in sites protected for drinking water supply and fish spawning.

The total quantity of muck generated due to dredging will be 38,66,259.20 cum. It is proposed that the muck will be used for dumping in low lying area located on both sides of the river bank all along the waterway.

B. IMPACTS ON LAND

The impact associated with the land environment during design and construction phases are as follows:

- Loss of land / land acquisition:

  Three (3) ferry ghats are proposed for development along the river located at Dumrali, Rupmari, Bishpur and Mamudpur. These ghats are locally maintained and opearated. It is proposed to develop the area and provide inland water transport facilities like Gangway and Pontoon at these ferry ghats for passenger embarking and disembarking. Only upgradation works are required to be done for terminal development.

- Change in topography
- Change in land use
- Deterioration of soil quality due to spillage of fuel, disposal of muck and any other construction material.

Mitigation Measures:

- ✓ Excavation and filling tasks should be carried out simultaneously so as to minimize the soil erosion. Unusable debris material should be suitably disposed off at designated site with prior approval from concerned authority
- ✓ Compaction of soil should be undertaken by controlled sprinkling the water to minimize the surface runoff and erosion.
- ✓ Agricultural land should be avoided for setting up construction camps, plant site or any other construction purpose
- ✓ Water sprinkling to be carried out for dust suppress
- ✓ Dredging soil should be proper utilized as proposed for flood protection measures around the terminal area.

C. IMPACTS ON SOIL

The site clearance process includes excavation and vegetation clearance for development activities, which ultimately induces vegetation loss as well as loss of top soil. Since, the vegetation clearance shall be confined to the minimum area; the area affected would be very less. The activities associated with the site preparation and excavation plus movement of vehicles and equipments can disturb the surrounding lands

Contamination of Soil: Contamination of soil is primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to Hogla River in case of dumping being done near River locations. However, by following mitigation measures such as maintenance of vehicles and machines and fuel refilling is carried out in a confined area can avoid contamination of soil to a great extend. The provision for oil interception chamber is suggested in EMP for treating the waste water generated from vehicle washing, refilling and maintenance areas. Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over. These measures are expected to minimise the impact on soil contamination.

Compaction of Soil: Compaction of soil may anticipate due to the movement of construction vehicles and heavy machines. Thus regulation of movement of heavy equipments and vehicles shall be essential to prevent this.

Mitigation Measures:

- ✓ Rehabilitate all sites during construction including construction camps, stockpile area, temporary access and hauling routes, as soon as possible after the disturbance has ceased.
- ✓ Contractor to exercise strict care in the disposal of construction waste, with proof of disposal at an approved site provided after offloading each waste load and this logged/registered.
- ✓ Contain contaminated water and dispose off site at an approved disposal site in consultation with State Pollution Control Board.
- ✓ Dispose of waste from the oil interceptors only through suitable waste-handling contractor and request for safe disposal certificates.
- ✓ The movement of construction vehicles and equipments will be restricted to only designated route.
- ✓ Mix cement, concrete and chemicals on a concrete plinth and contain spillages or overflows into the soil.
- ✓ Vehicle maintenance are not allowed on site.
- ✓ If oil spills occur, disposing contaminated soil at a disposal site in consultation with State Pollution Control Board.
- ✓ Stockpiling of subsoil and overburden in all construction and lay down areas.

D. IMPACTS ON AIR

The air quality parameter is the most common environmental feature, which is being affected by any infrastructure improvement projects at different stages i.e. during constructional as well as operational phase. The major indicators of Ambient Air Quality relevant to the project are the concentration of Particulate matters of size less than 10µ (PM_{10}), Particulate matters of size less than 2.5µ ($PM_{2.5}$), Sulphur dioxide (SO_2), Nitrogen oxides (NOx), Carbon monoxide (CO) in the atmosphere.

Sensitive receptors and nearby habitation area may be affected temporarily by increased of traffic due to movement of construction vehicles and transportation of material. Fugitive dust can also impact on air quality due to various construction activities. Exhaust fumes from construction machinery, and potential smoke from cooking fires, burning of waste and cleared vegetation also affect the air quality. The improper sanitation at worker camps and waste disposal usually lead to odour problem. The problems related to the deterioration of air quality, however, will temporal in nature till the construction period only.

Vegetations existing at terminal development site will be removed. Bare & loose soil after vegetation uprooting/removal will be exposed to wind and will add on to the concentration of ambient dust levels. Air quality will also be affected in case tree cutting is undertaken at site as the tree act as air purifiers

Mitigation Measures:

- ✓ All the Construction vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection) Rules, 1986.
- ✓ All the DG sets will conform to the emission standards as stipulated under Environment (Protection) Rules, 1986.
- ✓ Undertaking monitoring of air pollution levels as per monitoring plan in potential problem areas.
- ✓ Avoid dust generating construction activities during strong winds.
- ✓ Cover soil loads in transit.
- ✓ Cover stockpiles of soil or apply suitable dust palliative such as water or commercial dust suppressants.
- ✓ Regularly service vehicles off-site in order to limit gaseous emissions.
- ✓ No open fires permitted on site
- ✓ Place portable toilets on-site and maintain on a daily basis.
- ✓ Water will be sprayed in construction area and other excavation areas for suppressing fugitive dust.
- ✓ Transportation material should be Water sprinkled and covered with tarpaulin.
- ✓ Dust emission from stock piles of excavated material will be controlled either by covering the stockpiled materials or water spraying over it.
- ✓ Special attention will be given when working near educational institutions and health centers and settlement areas.
- ✓ As soon as construction is over all the surplus earth will be utilized properly and all loose earth will be removed from the site.
- ✓ Compensatory plantation of trees having adequate canopy should be implemented.

E. IMPACTS ON AMBIENT NOISE AND VIBRATION

The proposed construction activities are expected to increase the noise levels mainly due to plying of construction vehicles, pumping machines, use of portable generators, mechanical machinery etc. These activities will occur round the clock and the noise pollution thus created may affect human

habitations, particularly during the night time. Increase of noise level at night may cause discomforts to population in the vicinity of the site in case construction activity is extended into the night hours.

Sensitive receptors and nearby habitation may be affected temporarily by increased traffic due to movement of heavy construction vehicle and equipments, which may generate high levels of noise.

Vibrations resulting from bulk earthworks, micro-tunneling and compaction may create significant disturbances to nearby area.

Mitigation Measures:

- ✓ All noise generating equipment's and construction camps will be installed sufficiently away from settlement and sensitive areas.
- ✓ Restrict construction activities to reasonable working hours where near sensitive receptors.
- ✓ Keep adjacent landowners informed of unusually noisy activities planned.
- ✓ The main stationary noise producing sources such as generator sets shall be provided with noise shields around them. The noise shields can either be a brick masonry structure or any other physical barrier which is effective in adequate attenuation of noise levels.
- ✓ The plants and equipment used for construction will strictly conform to CPCB noise standards and ensures that machinery in a good state of maintenance
- ✓ Vehicles and equipments used will be fitted with silencer and maintained accordingly.
- ✓ Noise to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.
- ✓ An awareness programme may be organized for drivers and equipment operators to make them aware of the consequences of noise and to act properly at site.

F. IMPACTS ON ECOLOGY AND BIODIVERSITY

The proposed development is situated along the Katakhali River. No such significant ecologically diverse area occurs within the proposed project location. Hence no major impact on ecology is anticipated. However capital and maintenance dredging is proposed for Class VII waterways, which may have likely impact on population of phytoplankton, zooplankton, benthic communities and fishes, but temporary in nature.

Mitigation Measures:

- ✓ Ensure any landscaping to be undertaken will be done with locally indigenous species and low maintenance requirements.
- ✓ Capital and maintenance dredging should avoidable during breeding season of aquatic fauna.
- ✓ The generated muck due capital and maintenance dredging should not be disposed off in the waterway.

G. IMPACTS ON RIVER WATER

The impact on water arises due to the following:

- Discharge of sewage and wastewaters from construction sites and camps to surface waters
- Re-suspension of sediments contaminated with heavy metals during the construction of the terminal.
- Risk of accidental spillages of oils, fuels, and other materials

Mitigation Measures:

- ✓ The site surface has been engineered and shaped in such a way that rapid and efficient evacuation of runoff is achieved.
- ✓ Provide containment areas for potential pollutants at construction camps, refueling, depots, asphalt plants and concrete batching plants.
- ✓ Implement waste management practices.
- ✓ Control and manage transport, storage, handling and disposal of hazardous substances.

H. IMPACTS DUE TO LABOUR CAMP

Construction workers are neglected group in the country. Unless the workers are provided proper amenities to live at the construction site the environmental issues of project cannot be properly met. Location of the Construction camp also has certain impacts on surrounding environment if not properly managed.

At labour and construction camps lot of wastes are generated. These wastes are refuge from the plants, and equipments, waste water and other domestic waste. These wastes are solid as well as liquid waste mainly refuse water and kitchen waste. The disposal of such waste material to the surrounding land can potentially damage the land and would generate health risk to not only

surrounding area but within the premises itself. Improper drainages system within the premises also creates insanitation condition thereby enhancing health risk.

Maximum labour to be employed in the project shall come from nearby areas. Some labour is expected to be migrated from other areas and is likely to put some stress on account of the following:

- Generation of sewage from labour colony.
- Generation of solid waste from labour colony.

Mitigation Measures:

- ✓ The Construction/labour camps will be established only on approved area.
- ✓ The worker's/labour camp will be located away from water bodies, schools and residential areas. The camp will be constructed with proper accommodation facilities.
- ✓ The workers camp will be provided with drinking water supply system so that local water sources are not disturbed.
- ✓ The camp should be provided with fuel for cooking like kerosene and /or LPG to avoid any cutting of trees for fuel wood.
- ✓ All camps will be provided with proper sanitation facilities, separate toilets and bathrooms for female and male workers, septic tanks with soak pits of sufficient size, dust bins etc.
- ✓ Waste water from domestic uses and solid wastes will be disposed of without violating environmental norms. The measures will be site specific.
- ✓ The labour camps will be provided with crèche, first aid facilities, etc as required under Factory Act.
- ✓ After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

I. <u>SOCIAL IMPACTS</u>

- Impacts on Socio-economic environment

No impact will be envisaged on socio-economic environment

- Impacts on the Regional Economy

There would be benefits to the local and regional economy through the direct demand for construction goods and services associated with construction activities.

- Health and Safety

One of the potential impacts of the proposed project will be on the air quality due to the dust generated during construction. The amount of dust generated will depend upon the level of digging and the prevailing weather conditions. Based on past experience, the air pollution due to entrainment of fugitive emission is marginal in nature and is observed up to a distance of 100 to 200 m from the point of entrainment. Thus, it is expected to lead to marginal impact on ambient air quality. No major health related issues due to air pollution during construction phase of the proposed project are anticipated.

Construction related activities may lead to injuries. Open fires in construction camp can result in accidents. Safety of workers and general public may be compromised due to difficult site conditions. Poor waste management practices and unhygienic conditions at temporary ablution facilities can breed diseases. Standing water due to inadequate storm water drainage systems, inadequate waste management practices, pose a health hazard to providing breeding grounds for disease vectors such as mosquitoes, flies and snails. The use of hazardous chemicals in the micro-tunneling and restoration of roads can pose potential environmental, health and safety risks. Road safety may be affected during construction, especially when traffic is detoured.

Mitigation Measures:

- ✓ Implement good housekeeping practices at the construction camp.
- ✓ Strictly implement health and safety measures and audit on a regular basis.
- ✓ Secure enclosed construction site.
- ✓ Use reputable contractors.
- ✓ Provide warning signs of hazardous working areas.
- ✓ The plants and equipments will be installed sufficiently away from the settlement.
- ✓ All the construction equipments and vehicles will conform to the emission standards stipulated by the CPCB.
- ✓ Clearly demarcate excavations and provide barriers (not just danger tape) to protect pedestrians from open trenches.
- ✓ Thoroughly train workers assigned to dangerous equipment.
- ✓ Workers have the right to refuse work in unsafe conditions.
- ✓ Undertake waste management practices (Planned disposal of sludge from pumping stations within surrounding areas of PS) particularly for Pumping Station
- ✓ Control speed and movement of construction vehicles

- ✓ Exclude public from the site
- ✓ Ensure all workers are provided with and use Personal Protective Equipment.
- ✓ Ensure the visibility of workers through their use of high visibility vests when working in or walking through heavy equipment operating areas
- ✓ Ensure that qualified first-aid can be provided at all times. Ensure equipped first-aid stations are easily accessible throughout the site;
- ✓ Provide medical insurance coverage for workers.
- ✓ Provide clean eating areas where workers are not exposed to hazardous or noxious substances;
- ✓ Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;
- ✓ Ensure moving equipment is outfitted with audible back-up alarms;
- ✓ Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate.
- ✓ Safe working techniques will be followed up and all the workers will be trained
- ✓ Proper caution signage, barricading, delineators etc. will be installed at Construction zone and temporary diversions
- ✓ Proper traffic management will be ensured at the Construction zone as per IRC.
- ✓ An Emergency Response system in case of any incidence will be developed and implemented
- ✓ Periodical health check facility will be provided at camp sites.

- Aesthetics

The presence of heavy duty vehicles and equipment, temporary structures at construction camps, stockpiles, may result in impacts on aesthetics and landscape character.

Mitigation Measures:

- ✓ Properly fence off storage areas.
- ✓ Collection of all domestic solid waste central point of disposal and feed into the city waste collection system.
- ✓ Contractor to exercise strict care in disposing construction waste.
- ✓ Identifying suitable waste disposal site with enough capacity to hold additional waste to be generated by the construction activities.

- ✓ Retaining mature trees on and around the site where possible.
- ✓ Removing unwanted material and litter on a frequent basis.
- ✓ Reinstate pathways and other local infrastructure immediately to at least their pre-project condition upon completion of construction.

- Employment Generation

The project will provide employment opportunities for local people during construction. Expectations regarding new employment will be high especially among the unemployed individuals in the area. Labor gathering at the site for work can be a safety and security issue, and must be avoided. The training of unskilled or previously unemployed persons will add to the skills base of the area.

Mitigation Measures:

- ✓ Employing local labour
- ✓ Training of labour to benefit individuals beyond completion of the project.
- ✓ Ensure recruitment of labors will take place offsite.
- ✓ Ensure at least 50% of all labor is from surrounding communities in the contractual documentation.

9.3.2 Impacts during Operation Phase

A. IMPACTS ON AIR

Sensitive receptors and nearby habitation area may be affected temporarily by increased traffic and other related impacts.

Exhaust gases from moving vessel are source of air pollution. However, vessels emit least air emissions compared to the road and railway modes. The impact on air quality due to vessel movement is anticipated insignificant considering the emission levels and projected vessel traffic.

Mitigation Measures:

- ✓ Ensure compliance with the Air Act.
- ✓ Ensure compliance with emission standards
- ✓ Regularly service vehicles off-site in order to limit gaseous emissions
- ✓ Material generating dust should be transported under covered condition

- ✓ Uses of cleaner fuel
- ✓ Material should be stored under cover sheds
- ✓ Water sprinkling should be carried out during all loading and unloading activities and storage period.

B. IMPACTS DUE NOISE AND VIBRATION

Noise generated during operation phase are improper handling and irregular maintenance of operating machines, which may lead to increased noise pollution during operation phases, which would affect the daily life of the surrounding neighborhoods. However, impacts on this account are expected to be marginal.

Mitigation Measures:

- ✓ Restrict maintenance activities to reasonable working hours where near sensitive receptors.
- ✓ Keep adjacent landowners informed of unusually noisy activities planned.
- ✓ Fit and maintain silencers to all machinery on site.
- ✓ Monitor noise levels in potential problem areas
- ✓ Personal Protective Equipment (PPE) should be provided to the worker working.
- ✓ Use of DG set with acoustic enclosure.

C. IMPACTS DUE TO OIL SPILLAGE FROM BARGES AND VESSELS

There may be possibility of oil spillage from barges/vessels during oil transportation. This affects the water quality and aquatic ecology of the river.

Mitigation Measures:

- ✓ All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only.
- ✓ The wastewater from vessels can be sent to STP for treatment and the treated water can be used for landscaping and dust suppression at terminal sites
- ✓ Vessels also may have some facilities for treatment of the waste generated
- ✓ Provision of oil water interceptors

- ✓ Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Washing should be undertaken only at the maintenance facility only.

D. IMPACTS ON WATER

Maintenance dredging & on-shore dumping of dredged material is the sources which may impact the water quality of river.

Mitigation Measures:

- ✓ Dredging material should be disposed to the designated area.

E. IMPACTS ON FLORA AND FAUNA

The proposed development is unlikely to have any significant impact on biodiversity. However, maintenance dredging may impact the growth of aquatic life. Impacts may also arise during the movement of vessel/barges.

F. IMPACTS ON HEALTH AND SAFETY

- Danger of operations and maintenance-related injuries.
- Safety of workers and general public must be ensured.
- Poor waste management practices and unhygienic conditions at the improved facilities can breed diseases.
- Standing water due to inadequate storm water drainage systems, inadequate waste management practices, pose a health hazard to providing breeding grounds for disease vectors such as mosquitoes, flies and snails.
- Fire and electrocution hazards in the pumping stations.

Mitigation Measures:

- ✓ Implement good housekeeping practices at terminal and jetty area.
- ✓ Strictly implement health and safety measures and audit on a regular basis.
- ✓ Provision of warning signs of hazardous working areas.
- ✓ Training of workers assigned to dangerous equipment.

- ✓ Undertaking waste management practices- specifically periodic removal of sludge from pumping stations.
- ✓ Ensuring all workers are provided with Personal Protective Equipment.
- ✓ Provision of medical insurance coverage for workers

G. IMPACTS ON REGIONAL ECONOMY

The project is expected to bring the economic benefits of the region directly through expansion of regional trade, increase new business opportunity, development of new industries. It will also decrease the travel time for crossing one bank to another through ferry facilities.

9.4 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The main aim of the Environmental Management Plan (EMP) is to ensure that the various adverse impacts are mitigated and the positive impacts are enhanced. The EMP identifies the potential issues of various activities that are anticipated in the design and development, construction, and operation phases of the proposed project. The EMP ensures to suggest appropriate mitigation measures against the issues/ concerns identified during the environmental study.

9.4.1 Implementation of EMP

A copy of the EMP must be kept on site during the construction period at all times. The EMP will be made binding on all contractors operating on the site and will be included within the Contractual Clauses. Non-compliance with, or any deviation from, the conditions set out in this document constitutes a failure in compliance.

The contractor shall be responsible to implement the EMP primarily in assistance with the Supervision Consultant team. The Environmental Specialist from the Supervision Consultant shall monitor the compliance of the EMP.

9.4.2 Environmental Management Action Plan

This section describes the Environmental Management Action Plan for the proposed project during different stages of project. The Environmental mitigation measures have been incorporated at all the stages of the project right from Designing phase to Construction and Operational Phase. The Management Plan has been formulated for implementation of environmental mitigation measures to be carried out and to ensure that the provisions of the EMP are strictly followed and implemented by

strengthening implementation arrangements to prevent and minimize the adverse environmental impacts during Construction phase of the project. EMP has also addressed certain environmental measures to be taken to prevent further deterioration of environment components for various stages of the project.

Appropriate measures have also been identified for action during various stages of the project, viz, Design and Pre-Construction, Construction and Operational phases. The measures identified for all three phases, are tabulated in **Table 40** which describes the nature of the potential environmental impact, the measures, which have or will be taken, the timeframe in which they are taken, the implementing agency and responsible organization.

Table 40: Environmental Management Plan (EMP)

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
A. DESIGN AND DEVELOPMENT/ PRE-CONSTRUCTION PHASE				
1.	Arrangements for temporary land for Establishing Camps/Plants/ Temporary diversions	• The Contractor as per prevalent rules will carry out negotiations with the landowners for obtaining their consent for temporary use of lands for workers camp, construction sites/hot mix plants/traffic detours etc. • The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. • The Contractor will ensure that the site is properly restored to the satisfaction of the land owner prior to handling over to the owner and shall submit satisfactory certificate from the Land Owner.	Contractor	Supervision Consultants, IWAI
2.	Establishment of Construction Camp	• The locations of construction camp to be identified by the Contractor. Construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. Location for stockyards for construction materials will be identified at least 1000 m from water sources / and 10 Km from Wildlife Sanctuary boundary.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. • The Camp site will be provided with all the necessary facilities as per norms.		
3.	Establishment of Stone crushers, hot-mix plants, WMM Plant, Concrete Batching plants etc.	• Stone crushers, Hot mix plants, WMM Plants and Concrete Batching plants will be sited sufficiently away from settlements, agricultural operations and any commercial establishments. Such plants will be located at least 500 m away from the boundary of the nearest village/settlement preferably in the predominant downwind side. • The Contractor shall submit a detailed layout plan for all such sites and approval of the Environmental Expert of Supervision Consultants shall be necessary prior to their establishment. • All plants will be fitted with adequate dust suppression and emission control equipments and facilities. • Specifications of crushers and hot mix plants will comply with the requirements of the relevant current emission control legislations and Consent/NOC for all such plants shall be obtained from the State Pollution Control Board. • The Contractor shall not operate the plants till the required legal clearance, permits are obtained and submitted.	Contractor	Supervision Consultants, IWAI
4.	Material Sources	• Finalization of material sourcing and all logistic arrangements are well as compliance to environmental requirements, as applicable, will be the sole responsibility of the Contractor	Contractor	Supervision Consultants, IWAI
B. CONSTRUCTION PHASE				
1.	Impact on Soil			
(i)	Soil Erosion	• Maintaining the excavation by Shoring	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		trench sides by placing sheeting, timber shores, trench jacks, bracing, sheet piling materials to resist pressures surrounding the excavation • Exposed surface will be resurfaced and stabilized by making the sloping sides of trench to the angle of repose at which the soil will remain safely at rest • Proper stock piling of excavated soil and must be bordered by berms • Soil erosion checking measures as the formation of sediment basins, slope drains, etc, will be carried out.		Consultants, IWAI
(ii)	Loss of Topsoil	• The topsoil from all areas of cutting and all areas to be permanently covered will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m. • The stored topsoil will be spread back to maintain the soil physico-chemical and biological activity. The preserved top soil will be used for restoration of sites, in landscaping and avenue plantation • To prevent excessive disturbance of natural vegetation, the top soil excavated should be stored and utilized for re-vegetation after completion of work. • Topsoil and subsoil must be placed on opposite sides of the trench and must be kept separate throughout construction and rehabilitation.	Contractor	Supervision Consultants, IWAI
(iii)	Compaction of soil	• Construction vehicles, machinery and equipment will move, or be stationed in the designated area, to avoid compaction of soil. • If operating from temporarily hired land, it will be ensured that the topsoil for agriculture remains preserved & not destroyed by storage, material handling or any other construction related activities.	Contractor	Supervision Consultants, IWAI
(iv)	Contamination of	• Impervious platform and oil and grease	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	land from fuel and lubricants	trap for collection of spillage from construction equipment vehicle maintenance platform will be appropriately provided at construction camp, servicing area and liquid fuel and lubes at storage areas.		Consultants, IWAI
(v)	Contamination of land from construction wastes and spoils	• All spoils will be disposed off as desired and the site will be fully cleaned before handing over. The non-usable bitumen spoils will be disposed off in a deep trench providing clay lining at the bottom and filled with soil at the top (for at least 0.5m)	Contractor	Supervision Consultants, IWAI
2.	Impact on Air			
(i)	Emission from construction vehicles and machinery	• All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. • The asphalt plants, crushers and the batching plants will be sited at least 500 m in the downwind direction from the nearest human settlement (Boundary of town/village). • Vehicles transporting earth materials will be covered • Mixing equipment will be well sealed and equipped as per PCB norms.	Contractor	Supervision Consultants, IWAI
(ii)	Emission from Construction Vehicles, Equipment and Machineries	• Contractor will ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm that pollution emission levels comply with the relevant requirements of SPCB. • The Contractor will submit PUC certificates for all vehicles/ equipment/machinery used for the project. Monitoring results will also be submitted to 'PIU' through the 'Engineer'. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carrier out as per Environmental Monitoring	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		Plan. • Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of dust		
(iii)	Dust Pollution	• The Contractor will take every precaution to control dust nuisance at all the construction zones and allied sites where works are under progress. • Every equipments and machinery will be fitted with dust suppression devices such as water sprinklers, dust bags, cyclone etc. as appropriate. • The Contractor will provide necessary certificates to confirm that all crushers used in construction conform to relevant dust emission control legislation. • At all the construction zones and unpaved lead roads, earthen temporary diversions and plant premises periodical water sprinkling will be carried out to suppress dust. • Transportation of loose earth, sand will be done in covered vehicles. • All equipments and machineries will be maintained properly. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carried out as per Environmental Monitoring Plan. • Workers at mixing sites will wear masks to reduce the chances of exposure to fugitive dusts.	Contractor	Supervision Consultants, IWAI
3.	Impact on Noise Pollution			
(i)	Noise from vehicles and construction equipments	The Contractor will confirm the following: • All plants and equipments used in construction shall strictly conform to the MoEFCC/CPCB/WBPCB noise standards. • All vehicles and equipment used in construction will be fitted with exhaust	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		silencers. • Servicing of all construction vehicles and machinery will be done for exhaust silences and will be checked and if found defective will be replaced. • All the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am. • No noisy construction activities will be permitted around educational institutions/health centers (silence zones) up to a distance of 100 m from the sensitive receptors. • Monitoring shall be carried out at the construction sites as per the monitoring schedule and results will be submitted to Supervision Consultants (SC) and IWAI. • Environmental Expert of SC will be required to inspect regularly to ensure the compliance of EMP.		
4.	Impact on Flora and Fauna	• If required, Vegetation will be removed from the construction zone before commencement of construction • Construction vehicles, machinery and equipment will move or be stationed in the designated area only to prevent compaction of vegetation • Construction workers will be directed not to disrupt or damage the fauna. • Capital and maintenance dredging should avoidable during breeding season of aquatic fauna. • The generated muck due capital and maintenance dredging should not be disposed off in the waterway • Construction vehicles will run along specified access to avoid accidents to cattle	Contractor	Supervision Consultants, IWAI
5.	Safety			

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
(i)	Accidents due to construction activities	• To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • Traffic rules and regulations will be strictly adhered to. • Safety of workers undertaking various operations during construction will be ensured by providing helmets, masks, safety goggles, etc • The electrical equipment will be checked regularly • At every camp site, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), para medical staff and an attending doctor will be provided. • Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Adequate signage, barriers and persons with flags during construction to control the traffic will be provided.	Contractor	Supervision Consultants, IWAI
(ii)	Occupation Health and Safety	• The Contractor will provide adequate good quality Personal Protective Equipments (PPE) to all the workers working at construction zones and Plant sites and will ensure that these PPEs are used by workers at all time during works. • Adequate drainage, sanitation and waste disposal will be provided at workplaces. • Proper drainage will be maintained around sites to avoid water logging leading to various diseases • Adequate sanitation and waste disposal facilities will be provided at construction camps by means of septic tanks, soakage pits etc. • A health care system will be maintained at construction camp for routine check up of workers and avoidance of spread of	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		any communicable disease • Readily available First Aid kit bearing all necessary first aid items will be proved at all the work sites and should be regularly maintained.		
6.	Wastes	• Ensure that no litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the premises must be collected in rubbish bins and disposed of weekly at registered refuse facility sites. • Toilet facility must be provided at construction site and should be maintained properly. Toilets must be emptied regularly at treatment plants and every effort must be made to prevent the contamination of surface or sub-surface water • Muck generated due to dredging should be disposed as per the proposal of disposing around the proposed terminal area for flood protection	Contractor	Supervision Consultants, IWAI
7.	Camp Site management	• Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. • The location, layout and basic facility provision of each labour camp will be submitted to the Engineer and IWAI prior to their construction. • The construction will commence only upon the written approval of the Engineer. • The contractor will maintain necessary living accommodation and ancillary facilities in • Functional and hygienic manner and as approved by the Engineer. • Periodical medical check up will be	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		ensured for all the workers • The Contractor will provide potable water facilities within the precincts of every workplace in an accessible place. • The sewage system for the camp will be designed, built and operated in such a fashion that it should not pollute the ground water or nearby surface water. • Separate toilets/bathrooms, will be arranged for men and women • Adequate water supply is to be provided in all toilets and urinals • The Contractor will provide segregated garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of SC.		
8.	Monitoring of Air, Water & Noise Quality Pollution Monitoring	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/contamination in the selected locations as suggested in environmental monitoring plan will be the responsibility of Contractor	Contractor	Supervision Consultants, IWAI
C. OPERATION PHASE				
1.	Monitoring of Operation Performance	• The IWAI will monitor the operational performance of the various mitigation/enhancement measures carried out as a part of the project.	Contractor	IWAI
2.	Air	• Ensure compliance with the Air Act. • Ensure compliance with emission standards • Regularly service vehicles off-site in order to limit gaseous emissions • Material generating dust should be transported under covered condition • Uses of cleaner fuel • Material should be stored under cover	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		sheds • Water sprinkling should be carried out during all loading and unloading activities and storage period		
3.	Noise	• Restrict maintenance activities to reasonable working hours where near sensitive receptors. • Keep adjacent landowners informed of unusually noisy activities planned. • Fit and maintain silencers to all machinery on site. • Monitor noise levels in potential problem areas • Pernonal Protective Equipment (PPE) should be provided to the worker working. • Use of DG set with acoustic enclosure	IWAI	IWAI
4.	Oil Spillage from Vessel/barges	• All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only. • Vessels also may have some facilities for treatment of the waste generated • Provision of oil water interceptors • Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Washing should be undertaken only at the maintenance facility only.	IWAI	IWAI

9.5 APPLICABLE LEGAL AND REGULATORY FRAMEWORK

The increase of environmental concern also necessitated appropriate tools/actions to protect environment. During Stockholm Conference, first exclusive Environmental Protection Act was enacted in India in 1986. Prior to this umbrella act, Water (Pollution Prevention and Control) Act was enacted in India in 1974 & Air Pollution act, 1981. In accordance with EPA act (1986) Central and State Boards for Prevention and Control of Water Pollution were set up. Later these boards were renamed into

Central Pollution Control Board and respective State Pollution Control Boards. Department of Environment was set up in 1980. Subsequently in 1985, it was upgraded to a full-fledged Ministry of Environment and Forests and Climate Change (MoEFCC) under Government of India to serve as the focal point in the administrative structure for the planning, promotion and coordination of environmental and forestry programmes. The name of MoEF has been revised in the year 2014 to Ministry of Environment, Forests and Climate Change (MOEFCC). This ministry has overall authority for the administration and implementation of government policies, laws and regulations related to the environment, including conservation, environmental assessment, sustainable development, forest conservation and pollution control. MOEFCC identifies the need to enact new laws and amend existing environmental legislation when required, in order to continue to conserve and protect the environment. At the state level, the MOEFCC authority is implemented by the Department of the Environment and the Department of Forests.

In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. As a result, a number of laws related to environmental conservation were passed to strengthen existing legislation. Environment (Protection) Act, 1986 is the landmark legislation as it provides for the protection of environment and aims at plugging the loopholes in the other related acts and this Act is called as umbrella Act. Under this Umbrella Act all the environmental acts and rules have been formed.

The laws and regulation applicable under the progamme:

- Policy and Regulatory Framework of Government of India
- Environmental Policy of respective State Government
- Legislation applicable to construction activities

9.5.1 Key Environmental Laws and Regulations

The relevant Acts and Rules are given in the **Table 41.**

Table 41: Key Environmental Laws and Regulations

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Environmental	1986	To protect and improve the overall	MOEFCC. GoI; CPCB, West	√	..	This act is applicable to all environmental

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
(Protection) Act		environment.	Bengal State Pollution Control Board			notifications, rules and schedules are issued under this act.
Environment Impact Assessment Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	MOEFCC	--	√	Environment Impact Assessment Notification has been issued for requirement of EIA and activities requiring clearance from Central Government in the Ministry of Environment and Forests (MoEFCC). The proposed project does not require environmental clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017 (A copy enclosed as **Annexure 3**)
Municipal Solid Waste (Management and Handling) Rules	2000	To manage collection transportation, segregation, treatment and disposal of municipal solid waste	MOEFCC, GoI, West Bengal State Pollution Control Board	√	..	Applicable for the project for the management of Solid waste
Indian Forest Act The Forest (Conservation) Act The Forest (Conservation) Rules	1927 1980 1981	To check deforestation by restricting conversion of forested areas into non forested areas.	Forest Department, Govt. of West Bengal, MOEFCC, Regional Office and MOEFCC.	..	√	No diversion of Forest land required for this project
Wildlife (Protection) Act	1972	To protect wildlife through certain of	Chief Conservator.	√	..	Applicable,as the project require

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		National Parks and Sanctuaries.	Wildlife, Wildlife Wing, Forest Department, Gov. of West Bengal and National Board For Wildlife, GoI.			Wildlife clearance
Water (Prevention and Control of Pollution) Act	1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Air (Prevention and Control of Pollution) Act	1981	To control air pollution by controlling emission of air pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Noise Pollution (Regulation and Control) Rules The Noise Pollution (Regulation and Control) Amendment Rules	2000 2006	To regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise	CPCB; WBSPCB & Transport Department; Govt. of West Bengal	√	..	This act will be applicable during construction phase of the project.
Central Motor Vehicle Act Central Motor Vehicle Rules	1988 1989	To check vehicular air and noise pollution.	Transport Department and West Bengal State Pollution Control Board	√	..	For construction vehicles (Construction Stage) – Pollution Under Control Certificate
Ancient Monuments and Archaeological Sites and Remains Act	1958	These Acts are applicable in case any development activity is undertaken in close vicinity of any archaeological site or any are	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage	--	√	This act will not be applicable

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		discovered during the construction stage. The Act requires prior authorization of the Archaeological Survey of India (ASI) for development within 300 m of a Protected Property	(INTACH).			
Wetland Conservation and Management Rules	2010	The rule specifies the activities which are harmful and prohibited in the wetlands such as industrialization, construction, dumping of untreated waste and effluents and reclamation.	Central Wetland Regulatory Authority; MOEFCC	√	…	Not applicable
CRZ Notification	2019	To ensure livelihood security to the fisher communities and other local communities, living in the coastal areas, to conserve and protect coastal stretches, its unique environment and its marine area and to promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due	West Bengal State Coastal Zone Management Authority and MoEF&CC	√	..	CRZ Notification issued for to regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		to global warming.				

9.6 NEED FOR ENVIRONMENTAL CLEARANCE

The proposed project will not require Environmental Clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017. The letter is enclosed as **Annexure 3**.

9.7 OTHER MAJOR CLEARANCES / APPROVALS / PERMITS APPLICABLE TO THE PROJECT

The CRZ Clearances will be applicable as per the CRZ Notification 2019. The other clearances and permits required for project at different stages is given in **Table 42.**

Table 42: Other Statutory Clearances required for the Project

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
1	NOC and consents under Air & Water Act	For development of Waterway	Pre-construction Stage	IWAI
2	NOC (Consent to Establish and Consent to Operate) under Air and Water Act from SPCB	For siting, erection and operation of stone crusher, Hot Mix Plant, batching plant, WMM Plant etc.	Construction Stage	Contractor
3	Explosive License from Chief Controller of Explosives,	For storing fuel oil, lubricants, diesel etc.	Construction stage (Prior to storing fuel, lubricants and Diesel, etc.)	Contractor
4	Quarry Lease Deed and Quarry License from State Department of Mines and Geology	Quarry operation	Construction stage (Prior to initiation of Quarrying)	Contractor
5	Environmental Clearance for stone quarry from District Level environmental Impact Assessment Authority,	Opening of new Quarry and Borrow area for earth material	Construction stage (Prior to initiation of Quarrying)	Contractor

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
6	Permission for extraction of ground water for use in road construction activities from State Ground Water board.	Extraction of ground water	Construction stage (Prior to initiation of installation of Bore wells and abstraction of water from such source)	Contractor
7	Permission for use of water for construction purpose from irrigation department	Use of surface water for construction	Construction stage (Prior to initiation of abstraction of water from such source)	Contractor
8	Labour license from Labour Commissioner Office	Engagement of Labour	Construction stage (Prior to initiation of any work)	Contractor
10	Authorization of Hazaradous Waste Storage	Storage of Hazardous Waste	Construction stage (Prior to storge of Hazardous waste)	Contractor

9.8 COST IMPLICATIONS

The estimated environment cost is as follows:

a) Estimated cost as Pre-construction stage:

The estimated cost for EIA-EMP & SIA studies have been summarized in **Table 43**.

Table 43: Summary of Estimated Cost of EMP and SIA studies

Sl. No.	Particulars	Unit	Amount (Lakh INR)
1.	Man Power Cost (13 nos of Experts: 1 no. EC and 12 noc FAE)	Lump sum	30.00
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	One season cost (**Table 44**)	5.755
3.	Public consultation meeting (PCM)	Lump Sum	2.00
4.	Surveys/ Reports / Document Printing	Lump Sum	5.00
5.	Travelling Cost for Site Visits	Lump Sum	3.00

Sl. No.	Particulars	Unit	Amount (Lakh INR)
6.	Lodging & Boarding Cost	Lump Sum	5.00
7.	Cost for collection of metrological data and other information like Maps etc.	Lump Sum	2.00
	Total		**52.755**

Table 44: Estimated cost for Baseline data generation

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
1.	Ambient Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO_2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	No.	1 (Twice a week for twelve week): 24 Nos.	10000	2.4
2.	Surface Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Grab Sampling	No.	2	8000	0.16
3.	Ground Water Quality Monitoring		Grab Sampling	No.	1	8000	0.08
4.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	No.	1	4000	0.04
5.	Soil	Bulk Density,	Composite	No.	1	7500	0.075

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
		Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	sample shall be prepared based on at least 3 replicates from each location.				
6.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study	No.	2	150000	3.0
	Sub-Total						**5.755**

b) Estimated cost at construction Stage:

Table 45: Estimated Cost during Construction Stage

Sl. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
1.	Environmental Monitoring Cost at Construction Stage for two year	**Table** 46	17.82
2.	Greenbelt Development nearby terminal Premises by Contractor	Lump sum	7.00
3.	Solid Waste Management	Lump sum	5.00
4.	Sanitary facilities at labour camps	Lump sum	5.00
5.	Disaster Management Plan	Lump sum	2.00
6.	Environmental Training	Lump sum	2.00
Total			**38.82**

Table 46: Environmental Monitoring Cost during Construction Phase

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
1.	Ambient Air Quality monitoring of PM_{10}, $PM_{2.5}$, CO, SO_2 & NO_2 (3 locations in the interval of once in two month for 2 years) **Break up: 1 Location X 6 times X 2 Years = 12**	No.	12	10,000	1.2
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (3 locations in the interval of once in two month for 2 years) **Break up: 1 Location X 6 times X 2 Years = 12**	No.	12	4,000	0.48
3.	Monitoring of River water Quality (1 location in the interval of once in two months for 2 years during HFL and LFL) **Break up: 1 Location X 6 times X 2 Years X 2 (HFL&LFL) = 24**	No.	24	8000	1.92
4.	Monitoring of ground water (1 location in the interval of of once in two months for 2 year) **Break up: 1 Location X 6 times X 2 Year = 12**	No.	12	8000	0.96
5.	Soil Quality monitoring (1 location along the Bank of River and 1 location at Construction site for once in six month for 2 year) **Break up: 1 Locations X 2 times X 2 Year = 4**	No.	4	7,500	0.30
6.	Monitoring of drinking water quality at construction camp (1 location in the interval of once in two months for 2 year) **Break up: 1 Locations X 6 times X2 Years = 12**	No.	12	8,000	0.96
7.	Study of Acquatic and terrestrial fauna (2 locations in the interval of once in six month for two year) **Break up: 2 Locations X 2 times X 2 Years = 8**	No	8	150000	12.0
Sub-Total					**17.82**

c) Estimated cost during operation Stage

Table 47: Estimated Cost during Opertaion Stage

S. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
1.	Environmental Monitoring Cost at Operational Stage for one year	**Table 48**	4.875
2.	Maintenance & Supervision of Greenbelt Developed	Lump sum	6.00
3.	Solid Waste Management	Lump sum	5.00
4.	Sanitary facilities nearby terminals	Lump sum	5.00
5.	Miscellaneous	Lump sum	5.00
Total			**25.875**

Table 48: Environmental Monitoring cost during operation stage

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
1.	Ambient Air Quality monitoring of PM_{10}, $PM_{2.5}$, CO, SO_2 &NO_2 (1 location once in a year for 1 year) **Break up: 1 Location X 1 time X 1 Year =1**	No.	1	12000	0.12
2.	Monitoring of River Water Quality (2 locations interval of 3 months for 1 year during HFL and LFL) **Break up: 2 Locations X 4 times X 1 Years X 2 (HFL&LFL) = 16**	No.	16	10000	1.6
3.	Monitoring of drinking water (1 location in a interval of 3 month for 1 year) **Break up: 1 Locations X 4 times X 1 Year = 4**	No.	4	10000	0.40
4.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (1 location once in a year for 1 year) **Break up: 1 Locations X 1 time X 1 Years = 1**	No.	1	5,500	0.055
5.	Soil Quality monitoring (1 locations along the Bank of River once in a year for 1 year) **Break up: 1 Locations X 1 time X 1 Years = 1**	No.	1	9,500	0.95
6.	Study of Acquatic and terrestrial fauna (1 location once in a year for 1 year) **Break up: 1 Location X 1 time X 1 Years = 1**	No.	1	175000	1.75
Sub-Total					**4.875**

The total estimated Environmental cost for the project is given in **Table 49**.

Table 49: Estimated Environmental and Social Cost for the Project

Sl. No.	Project Stages	Cost (Lakh INR.)
1.	Pre-Construction Stage	52.755
2.	Construction Stage	38.82
3.	Operational Stage	25.875
Total Estimated Budget (*Except Statutory Fee*)		**117.45**

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Katakhali waterway, it is recommended that the development of Katakhali waterway shall be handled by Project Management Unit (PMU) proposed for development of Sahibkhali waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata. Accordingly, the cost of development of Instituional requirement is considered in Sahibkhali waterway DPR.

The Institutional facilities proposed in all 13 rivers of NW-97 and the names of waterways supported by them are provided as below:

Sl. No.	Name of waterway supported by proposed Institutional facility	Name of Jetty/Terminal where Institutional facility is proposed to be set up	Name of waterway in which cost of Institutional facility is considered
1.	Muri Ganga waterway	Dhaki Jetty	Thakurran waterway
2.	Saptamukhi waterway		
3.	Thakurran waterway		
4.	Matla waterway	Basanti Jetty	Hogla waterway
5.	Bidya waterway		
6.	Gomar waterway		
7.	Hogla waterway		
8.	Chhota Kalagachi waterway	**Bhandarkhali Jetty**	**Sahibkhali waterway**
9.	Raimangal waterway		
10.	Sahibkhali waterway		
11.	**Katakhali waterway**		
12.	Kalindi waterway		

11.0 PROJECT COSTING

The project cost estimates for development of the Inland Water Transport system as well as for maintenance of the system have been worked out. The cost estimates for development of the system are termed as capital cost while for operation of the system is termed as maintenance or operating cost.

11.1 BASIS OF COSTING

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal.
b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultants experience on various projects sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires
f) Approved DPR's by IWAI of other National waterways

11.2 DEVELOPMENT COST

Katakhali waterway is proposed to be developed as Class VII waterway. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) Cost of jetties and terminal buildings
c) Vessel Cost
d) EMP cost.

11.3 CAPITAL EXPENDITURE

The expenses expected to be incurred in construction and development of the waterway, terminal structures including jetties and procurement of vessels are considered as capital expenditure. The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies is provided in **Table 50**.

Table 50: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	Capital cost for Fairway Development		4,342.93
2.0	Capital cost for four (4) Terminals	**Table 24**	294.79
3.0	Capital Cost for two (2) Passenger ferry Vessels	**Table 28**	70.00
4.0	Capital Cost for Aids to Navigation and Communication	**Table 32**	30.90
5.0	Cost allotted for EMP	**Table 49**	91.58
	Total Capital Cost		**4,830.19**
	In 10th year of IWT operations on the basis of actual traffic growth		
6.0	Capital Cost for additional two (2) Passenger ferry Vessels		**70.00**
	In 20th year of IWT operations on the basis of actual traffic growth		
7.0	Capital Cost for additional two (2) Passenger ferry Vessels		**70.00**

11.4 OPERATIONAL AND MAINTENANCE EXPENDITURE

The detail O&M cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 51** as below:

Table 51: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	O&M cost for Fairway Development		434.29
2.0	O&M cost for Terminals		8.84
3.0	O&M Cost for two (2) Vessels	**Table 30**	19.03
4.0	O&M Cost for Aids to Navigation and Communication		3.09
5.0	EMP Cost during operation stage	**Table 49**	25.88
	Total O&M Cost		**491.13**
	In 10th year of IWT operations on the basis of actual traffic growth		
6.0	Capital Cost for additional two (2) Passenger ferry Vessels		**19.03**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 1 year, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 52** and also shown in **Figure 45** below.

Table 52: Phasing of Expenditure

Months >	M1 – M3	M4 – M6	M7 – M9	M10 – M12
Total Cash Flow INR Lakh	724.53	1449.06	1449.06	1207.55
% of Cash Flow	15%	30%	30%	25%

During construction stage 2 vessels are recommended for IWT development. Additional vessels shall be purchased in 10th and 20th year of operaton on the basis of traffic demand. Hence the same is not considerd to work out phasing of expenditure in 1 year of construction period.

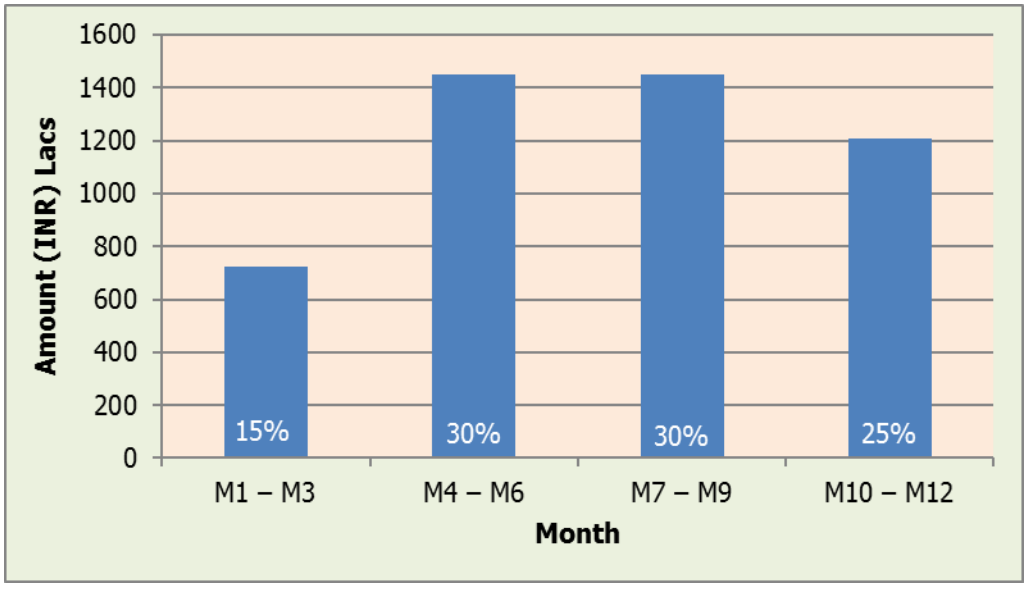


Figure 45: Phasing of Expenditure

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of Katakhali waterway and its associated facilities are presented in this chapter. The probable time schedule for various activities from onset to completion of the project and commencement of operation are also discussed in this chapter.

12.1 TIME FRAME

The time schedule for construction activities of the project is considered as one (1) year. The proposed project schedule is provided in **Figure 46** as below.

Sl. No.	Activities	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Approval of DPR and Project Financial Closure				
2	Environmental, Forest and CRZ clearances				
3	Fairway development				
a)	Procurement of Hardware and other equipment's				
b)	Capital Dredging				
4	Procurement and installation of Aids to Navigation				
5	Construction/ Installation of Pontoon and Gangway				
6	Upgrading existing road to terminals				

Figure 46: Construction Schedule

12.2 PHASING

For timely completion of the project, identification of major project components and sequential planning of various modules is very important for any project. The major components of Katakhali waterway include both the construction of offshore and onshore facilities, apart from installation of mechanical and electrical equipment's.

The offshore facilities include development of pontoon, gangway, approach platform and dredging whereas the development of onshore facilities includes site development, construction of terminal building and providing utilities like water supply system, sewerage system, storm water drainage system and firefighting facility.

The schedule has been prepared with the presumption that IWAI will be developing the project in single phase through EPC contract.

12.3 SUGGESTED IMPLEMENTATION MECHANISM

The various activities to be carried out prior to commencement of construction, includes selection of site, preparation of detail engineering drawings & Report, survey and investigation, Social and Environmental Impact Assessment, preparation of tender document, Bid process management, selection of EPC contractor and award of work to the selected contractor. It is assessed that the lead time required to carry out the bid process management and selection of EPC contractor would be 3 months.

The schedule for the project also depends on the schedule of various Statutory Clearances required from different Statutory Agencies for the development of the project and therefore, all the requirement clearances need to be in place before the start of the construction activities.

The following are the major activities involved for effective completion of Katakhali waterway project, which involves engineering, procurement, construction and commencement of operational activities.

Pre Construction activities:

- Detailed Engineering;
- Environmental clearance (if any);
- Financial closure and Statutory approvals from all concerned authorities as per Para 9.5;
- Land acquisition and site development;

Construction activities:

- Construction of onshore facilities for ferry terminal;
- Construction of offshore facilities for ferry terminal;
- Procurement of vessels;
- Up gradation/construction of access roads;

- Supply, installation and commission of electrical and mechanical equipment's.

Post Construction activities:

- Defect Liability period.

13.0 ECONOMIC AND FINANCIAL ANALYSIS

Financial feasibility is a key determinant in a business oriented investment decision. In case of the projects of public/national interest like development of Inland Water Terminals, the viability of the project depends on the economic feasibility which act as the deciding factor. In this chapter, the financial and economic viability for development of Katakhali Waterway is worked out.

13.1 REVENUE

An attempt has been made to estimate the possible revenue available from this service. Although this has been calculated in a thorough and logical manner the study is based on many assumptions and it should therefore be taken as a guide to the magnitude of possible revenue. Downtime of 2 months is considered, which could be occurred due to weather, operational or other factors. Hence, it is assumed that the full service is operating for 300 days annually

The techno-economic model has been run with the following considerations as stated below:

a) Passenger Ferry services - passenger ferry vessels of 25 pax capacity operating 6:00 AM to 6:00 PM.
b) Number of days of operation – 300 days.
c) OD pair links -
    1. OD pair 1) - Dumrali – Rupmari, and
    2. OD pair 2) - Manudpur – Bispur
d) One-way trip length –
    1. OD pair 1) – 0.2 Km, and
    2. OD pair 2) – 0.2 Km
e) For revenue estimation, present daily passenger traffic in the proposed OD pair are considered as below:
    1. OD pair 1) - 600 passengers, and
    2. OD pair 2) - 600 passengers

The revenue for passenger ferry services for both the OD pairs has been worked out by considering the variable tariff from INR 1.00 per person per Km onwards as per following formula:

$$\text{Revenue (INR)} = T \times L \times (1+R)^{Y} \times P \times D$$

where;

T = Proposed tariff in INR/Km/pax

L = OD Pair length in Km

R = Incremental rate of tariff in %, assuming at 8% per year on the basis of CPI Index of last 2 years

Y = Year of service from start date of operation

P = Peak Passenger traffic per day in a year

D = Days of operation per year, considering as 300 days per year

13.2 FINANCIAL ANALYSIS/ FIRR

The introduction of the IWT will yield tangible and non-tangible saving due to equivalent reduction in road traffic and certain socio-economic benefits. These include saving in road construction and maintenance, vehicle operation costs, travel time and other socio-economic benefits of travel time, better accessibility, better comfort and quantity of life, increase in mobility etc.

The direct and indirect benefits of the project are following:

- Reduced road stress.
- Better accessibility to facilities in the influence area.
- Economic stimulation in the micro region of the infrastructure.
- Increased business opportunities.
- Overall increased mobility.
- Facilitating better planning and up-gradation of influence area.
- Saving in vehicle operating costs of buses and other vehicles that are using the existing transport network after the IWT is introducing due to decongestion effect on road stress.
- Saving in time of passenger of existing modes, because of reduced congestion on road.
- Saving on account of reduction of vehicular pollution.

The financial analysis of the project is done on the basis of estimated cost proposed to be incurred for construction/development of fairway, terminal and procurement of vessels including other miscellaneous expenses, O& M cost proposed to be incurred during proposed project life cycle of 20 years and revenue that could be generated.

The implementation of this project has been conceptualized as Government funded project and in view of small capital cost, no loan has been considered. However, the FIRR for proposed waterway is done with following options:

Option 1: Total Capital Cost + Total O&M cost

Option 2: Option 1 - Vessel Capital & O&M cost

Option 3: Vessel Capital Cost + Vessel O&M Cost.

The Financial analysis for all the above options are worked out and provided in **Table 53** to **Table 55.**

Table 53: FIRR (Option 1: Total Capital Cost + Total O&M cost)

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
-1	4830		4830	0	-4830	0	-4830	0	-4830	0	-4830	0	-4830
0		491	491	1	-490	13	-479	84	-407	126	-365	168	-323
1		516	516	1	-515	15	-501	98	-418	147	-369	196	-320
2		541	541	1	-540	17	-524	114	-427	171	-370	229	-313
3		569	569	1	-567	20	-549	133	-435	200	-369	267	-302
4		597	597	2	-595	23	-574	155	-442	233	-364	311	-286
5		627	627	2	-625	27	-600	181	-446	272	-355	363	-264
6		658	658	2	-656	32	-626	211	-447	317	-341	423	-235
7		691	691	2	-689	37	-654	247	-444	370	-321	493	-198
8		726	726	3	-723	43	-682	288	-438	432	-294	575	-150
9		762	762	3	-759	50	-712	336	-426	503	-259	671	-91
10	70	800	870	4	-866	59	-811	391	-479	587	-283	783	-87
11		859	859	5	-854	68	-791	457	-402	685	-174	913	54
12		902	902	5	-897	80	-822	533	-369	799	-103	1065	163

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
13		947	947	6	-941	93	-854	621	-326	932	-15	1242	295
14		994	994	7	-987	109	-886	725	-270	1087	92	1449	455
15		1044	1044	8	-1036	127	-917	845	-199	1268	223	1690	646
16		1096	1096	10	-1087	148	-949	986	-111	1479	382	1971	875
17		1151	1151	11	-1140	172	-979	1150	-1	1725	573	2299	1148
18		1209	1209	13	-1195	201	-1008	1341	132	2012	803	2682	1473
19		1269	1269	16	-1254	235	-1035	1564	295	2346	1077	3128	1859
20	70	1333	1403	18	-1384	274	-1129	1824	422	2737	1334	3649	2246
FIRR					**#NUM!**		**#NUM!**		**#NUM!**		**-4.07%**		**1.30%**

Table 54: FIRR (Option 2: Option 1 - Vessel Capital & O&M cost)

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
-1	4760		4760		-4760		-4760		-4760		-4760		-4760
0		472	472	1	-471	13	-460	84	-388	126	-346	168	-304
1		496	496	1	-495	15	-481	98	-398	147	-349	196	-300
2		520	520	1	-519	17	-503	114	-406	171	-349	229	-292
3		547	547	1	-545	20	-527	133	-413	200	-347	267	-280
4		574	574	2	-572	23	-551	155	-418	233	-341	311	-263
5		603	603	2	-601	27	-575	181	-421	272	-331	363	-240
6		633	633	2	-631	32	-601	211	-421	317	-315	423	-210
7		664	664	2	-662	37	-627	247	-418	370	-294	493	-171
8		698	698	3	-695	43	-654	288	-410	432	-266	575	-122
9		732	732	3	-729	50	-682	336	-397	503	-229	671	-61
10		769	769	4	-765	59	-710	391	-378	587	-182	783	14
11		807	807	5	-803	68	-739	457	-351	685	-123	913	106
12		848	848	5	-843	80	-768	533	-315	799	-49	1065	217

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
13		890	890	6	-884	93	-797	621	-269	932	42	1242	352
14		935	935	7	-927	109	-826	725	-210	1087	152	1449	514
15		981	981	8	-973	127	-855	845	-136	1268	286	1690	709
16		1031	1031	10	-1021	148	-883	986	-45	1479	448	1971	941
17		1082	1082	11	-1071	172	-910	1150	68	1725	642	2299	1217
18		1136	1136	13	-1123	201	-935	1341	205	2012	875	2682	1546
19		1193	1193	16	-1177	235	-958	1564	371	2346	1153	3128	1935
20		1253	1253	18	-1234	274	-979	1824	572	2737	1484	3649	2396
FIRR					**#NUM!**		**#NUM!**		**-14.56%**		**-2.91%**		**2.07%**

Table 55: FIRR (Option 3: Vessel Capital Cost + Vessel O&M Cost)

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
-1	70		70.00		-70		-70		-70		-70		-70
0		19	19.03	1	-18	13	-6	84	65	126	107	168	149
1		20	19.98	1	-19	15	-5	98	78	147	127	196	176
2		21	20.98	1	-20	17	-4	114	93	171	150	229	208
3		22	22.03	1	-21	20	-2	133	111	200	178	267	245
4		23	23.13	2	-22	23	0	155	132	233	210	311	288
5		24	24.29	2	-22	27	3	181	157	272	248	363	338
6		26	25.50	2	-23	32	6	211	186	317	292	423	397
7		27	26.78	2	-24	37	10	247	220	370	343	493	467
8		28	28.12	3	-25	43	15	288	260	432	403	575	547
9		30	29.52	3	-26	50	21	336	306	503	474	671	642
10	70	31	101.00	4	-97	59	-42	391	290	587	486	783	682
11		52	51.58	5	-47	68	17	457	405	685	633	913	862
12		54	54.16	5	-49	80	26	533	478	799	745	1065	1011

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 15.0 /pax/Km		Tafiff INR 100.00 /pax/Km		Tafiff INR 150.00 /pax/Km		Tafiff INR 200.00 /pax/Km	
13		57	56.86	6	-51	93	36	621	564	932	875	1242	1185
14		60	59.71	7	-52	109	49	725	665	1087	1027	1449	1389
15		63	62.69	8	-54	127	64	845	782	1268	1205	1690	1627
16		66	65.83	10	-56	148	82	986	920	1479	1413	1971	1906
17		69	69.12	11	-58	172	103	1150	1081	1725	1655	2299	2230
18		73	72.58	13	-59	201	129	1341	1268	2012	1939	2682	2609
19		76	76.20	16	-61	235	158	1564	1488	2346	2270	3128	3052
20	70	80	150.01	18	-132	274	124	1824	1674	2737	2587	3649	3499
FIRR					**#NUM!**		**14.14%**		**112.34%**		**171.31%**		**230.80%**

From the above analysis with various options it is concluded that the passenger ferry services in the waterway is financially viable with option 3 only, with a fare of INR 15.0 per passenger per Km and above for proposed OD pairs. Accordingly, for proposed OD-Pairs of 0.2 Km trip length each, with option 3, the tariff on the basis of financial analysis is estimated as INR 3.0 per passenger one way per trip.

Hence, it is recommended that the implementation of the whole project may be taken up as two packages:

Package – 1 : Construction, Operation & Maintenance of fairway and jetties
Package – 2 : Procurement, operation & maintenance of Ferry Vessel.

Also, as part of community development to provide safe and reliable water transport facilities for locals and as part of cumulative development of Sunderbans waterways, the proposed project may be recommended for development by higher authorities.

13.3 ECONOMIC ANALYSIS / EIRR

In addition to above, economic benefit foreseen due to factors like reduction in pollution and accidents, carbon savings is considered for economic analysis. For the analysis following assumptions were made:

a) Road haulage cost: INR 2.0/Ton-Km
b) Road accident cost saving: INR 0.2/Ton-Km
c) Carbon savings: INR 0.1/Ton-Km transferred from road
d) Annual incremental economic benefit: 1%

Passenger ferry services are already operational from above proposed jetty locations, however a proposal for safe and efficient ferry services along with necessary infrastructure services are made in this DPR. Hence economic benefit due to road and rail haulage cost saving, road accident cost savings and carbon savings is not considered for economic evaluation for passenger ferry services. Also, as the ferry operations are currently active along the proposed fairway route, saving in fuel cost due to IWT operation is not foreseen. Benefit due to job creation is only considered for economic analysis of passenger ferry services. The economic benefit analysis with obtained minimum tariff with positive FIRR i.e. INR 15.0 per person per km (INR 3.0 per passenger one way per trip) for proposed OD pair, for option-3 is provided in **Table 56.**

Table 56: EIRR from IWT

Year	Economic Benefit (INR Lakh)	Option-1		Option-2		Option-3	
		Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)
-1		-4830	-4830	-4760	-4760	-70	-70
0	6.83	-479	-472	-460	-453	-6	0
1	6.90	-501	-494	-481	-474	-5	2
2	6.97	-524	-517	-503	-496	-4	3
3	7.03	-549	-542	-527	-519	-2	5
4	7.11	-574	-567	-551	-543	0	7
5	7.18	-600	-592	-575	-568	3	10
6	7.25	-626	-619	-601	-594	6	13
7	7.32	-654	-647	-627	-620	10	18
8	7.39	-682	-675	-654	-647	15	22
9	7.47	-712	-704	-682	-675	21	28
10	7.54	-811	-804	-710	-703	-42	-35
11	14.45	-791	-776	-739	-725	17	31
12	14.59	-822	-808	-768	-753	26	40
13	14.74	-854	-839	-797	-782	36	51
14	14.88	-886	-871	-826	-811	49	64
15	15.03	-917	-902	-855	-840	64	79
16	15.18	-949	-933	-883	-868	82	97
17	15.33	-979	-963	-910	-894	103	119
18	15.49	-1008	-992	-935	-920	129	144
19	15.64	-1035	-1019	-958	-943	158	174
20	15.80	-1129	-1113	-979	-963	124	139
EIRR (%)			**#NUM!**		**#NUM!**		**19.25%**

From the the above table, it is concluded that Katakhali waterway is economically viable for option-3.

13.4 SENSITIVITY ANALYSIS

Sensitivity analysis shows the uncertainty in the output values for different sources of uncertainty in its inputs. The financial and economic evaluation of proposed IWT operations in waterway depends on factors like, fuel cost, demand ratio of IWT, serviceability and operational days in a year. These fluctuations will have a dramatic effect on the profitability of IWT.

Sensitivity analysis of IWT on proposed waterway is carried out for varying fare for passenger ferry services and considering the basic operational and serviceability conditions as same. For varying fare for passenger ferry services, the change in FIRR and EIRR is shown in **Table 57.**

Table 57: Sensitivity Analysis w.r.t to varying IWT fare

Sr. No.	Fare (INR) per passenger per KM	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
		FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)
1	5.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable
2	10.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	2.99%	9.52%
3	15.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	14.14%	19.25%
4	20.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	21.40%	26.41%
5	25.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	27.52%	32.73%
6	100.00	Not Calculable	Not Calculable	-14.56%	-13.94%	112.34%	120.62%
7	150.00	-4.07%	-3.83%	-2.91%	-2.68%	171.31%	180.12%
8	200.00	1.30%	1.46%	2.07%	2.23%	230.80%	239.86%
9	250.00	4.78%	4.90%	5.40%	5.53%	290.49%	299.70%
10	300.00	7.42%	7.53%	7.97%	8.08%	350.29%	359.59%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Katakhali waterway is financially and economically viable for option 3 with a tarrif of INR 10.00 per passenger per Km and above for proposed OD pairs. Accordingly, for proposed OD-Pairs of 0.2 Km trip length each, with option 3, the tariff on the basis of economic analysis is estimated as INR 2.0 per passenger one way per trip. In view of above Internal Rate of Returns for proposed tarrif of INR 10.00 per passenger per Km is provided as below:

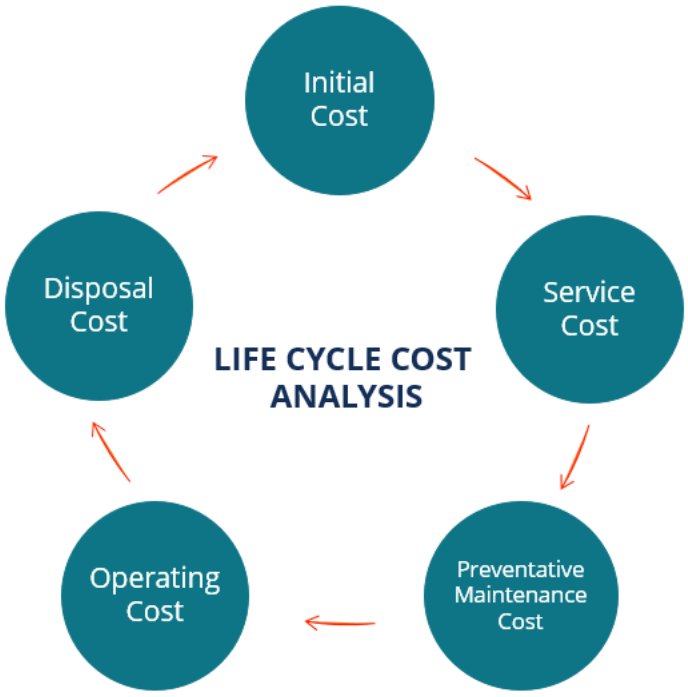
Table 58: IRR with proposed tarrif of INR 10.0 per passenger per Km

Year	Economic Benefit (INR Lakh)	Option-1		Option-2		Option-3	
		Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)
-1		-4830	-4830	-4760	-4760	-70	-70
0	6.83	-483	-476	-464	-457	-11	-4
1	6.90	-506	-499	-486	-479	-10	-3
2	6.97	-530	-523	-509	-502	-10	-3
3	7.03	-555	-548	-533	-526	-9	-2
4	7.11	-581	-574	-558	-551	-8	0
5	7.18	-609	-602	-584	-577	-6	1
6	7.25	-637	-630	-612	-604	-4	3
7	7.32	-666	-659	-640	-632	-2	5
8	7.39	-697	-689	-669	-661	1	8
9	7.47	-728	-721	-699	-691	4	12
10	7.54	-831	-823	-730	-722	-62	-54
11	14.45	-813	-799	-762	-747	-6	9
12	14.59	-849	-834	-795	-780	-1	14
13	14.74	-885	-870	-828	-813	5	20
14	14.88	-922	-907	-862	-847	13	28
15	15.03	-960	-945	-897	-882	22	37
16	15.18	-998	-983	-932	-917	33	48
17	15.33	-1036	-1021	-967	-952	46	61
18	15.49	-1075	-1059	-1002	-987	62	77
19	15.64	-1113	-1097	-1037	-1021	80	96
20	15.80	-1220	-1204	-1070	-1054	32	48

Year	Economic Benefit (INR Lakh)	Option-1		Option-2		Option-3	
		Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)
		FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)
		#NUM!	#NUM!	#NUM!	#NUM!	2.99%	9.52%

13.5 LIFE CYCLE COST ANALYSIS

Life cycle cost analysis (LCCA) is an approach used to assess the total cost of owning a facility or running a project. LCCA considers all the costs associated with obtaining, owning, and disposing of an investment.



Life cycle cost analysis is especially useful where a project comes with multiple alternatives and all of them meet performance necessities, but they differ with regards to the initial, as well as the operating, cost. In this case, the alternatives are compared to find one that can maximize savings.

Life cycle cost analysis used to assess infrastructural projects make use of:

- capital expenditure, which is the initial cost involved when constructing or delivering an infrastructural asset.
- operating expense, which consists of a number of costs, including utility, manpower, insurance, equipment, health, and routine and planned repairs.
- Replacement costs, incurred every cycle based on the predefined age of replacement for different assets and the manufacturer's preference, and
- disposal cost.

LCCA of Katakhali Inland waterway project is done for 20 years of project life cycle, considering the Capital and O&M expnses to be incurred in project phases. Revenue generated with proposed tariff of INR 15.00 per passenger per Km has been considered in the analysis.

Comparative analysis of life cycle cost for the three options as stated in financial and economical analysis is done and presented in below **Table 59**.

Table 59: Project Life Cycle Cost

Year	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)
-1	4,830	-	4,760	-	70	-
0	491	15	472	15	19	15
1	516	17	496	17	20	17
2	541	18	520	18	21	18
3	569	20	547	20	22	20
4	597	23	574	23	23	23
5	627	25	603	25	24	25
6	658	28	633	28	26	28
7	691	32	664	32	27	32
8	726	36	698	36	28	36
9	762	41	732	41	30	41
10	870	47	769	47	101	47
11	859	60	807	60	52	60
12	902	68	848	68	54	68
13	947	77	890	77	57	77
14	994	87	935	87	60	87

Year	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)
15	1,044	100	981	100	63	100
16	1,096	114	1,031	114	66	114
17	1,151	130	1,082	130	69	130
18	1,209	150	1,136	150	73	150
19	1,269	172	1,193	172	76	172
20	1,403	198	1,253	198	150	198
Total	**22,752**	**1,459**	**21,623**	**1,459**	**1,129**	**1,459**

On the basis of above LCCA, Financial chart and breakeven for all the 3 options are presented in **Figure 47** to **Figure 49**. For 20 years of project life cycle with a tariff of INR 10.00 per passenger per Km, following is concluded:

Option 1: Total Capital Cost + Total O&M cost

With project life cycle cost of INR 22,752 Lacs, the breakeven will not occur in 20 years' period.

Option 2: Option 1 - Vessel Capital & O&M cost

With project life cycle cost of INR 21,623 Lacs, the breakeven will not occur in 20 years' period.

Option 3: Vessel Capital Cost + Vessel O&M Cost

With project life cycle cost of INR 1,129 Lacs, the breakeven occurs during 15th year of operation.

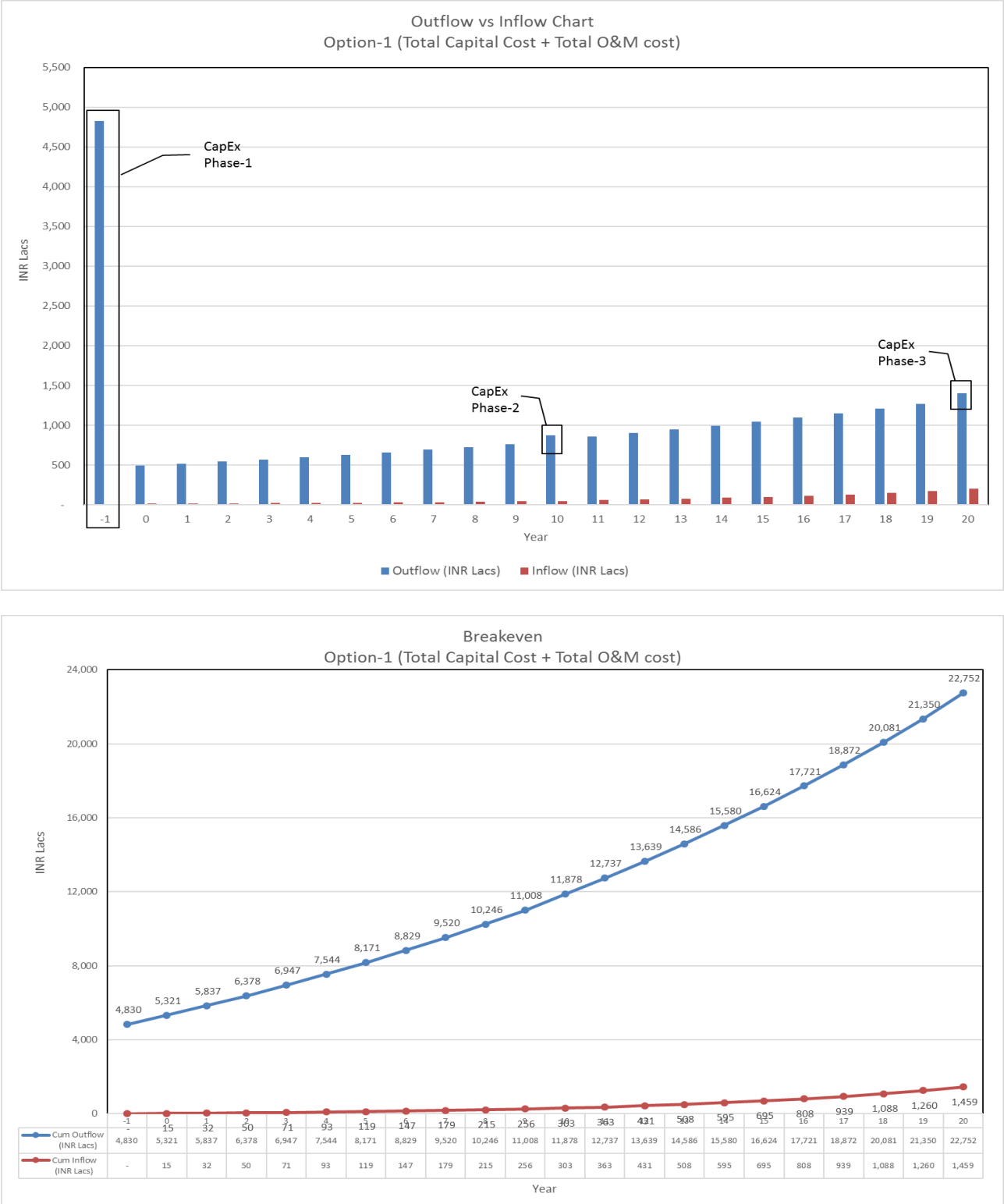
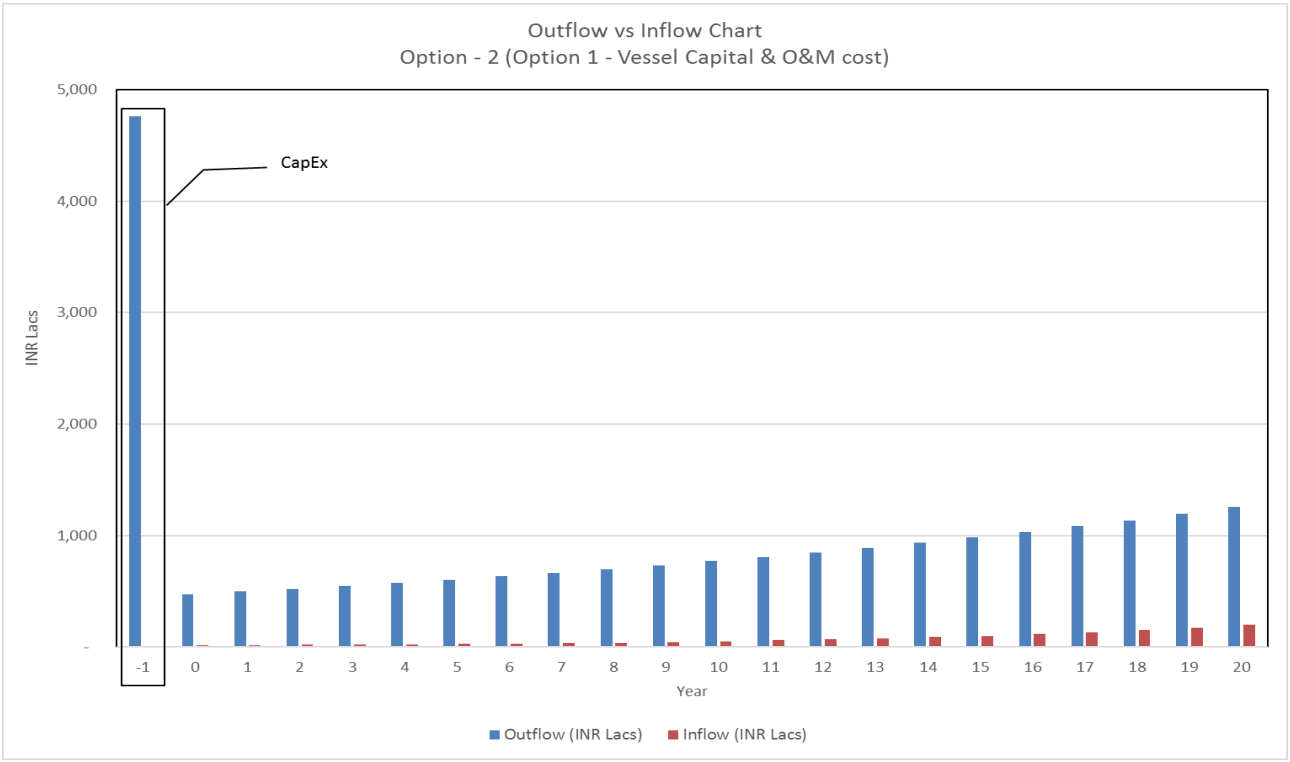


Figure 47: Financial (Outflow vs Inflow) Chart and Breakeven – Option 1



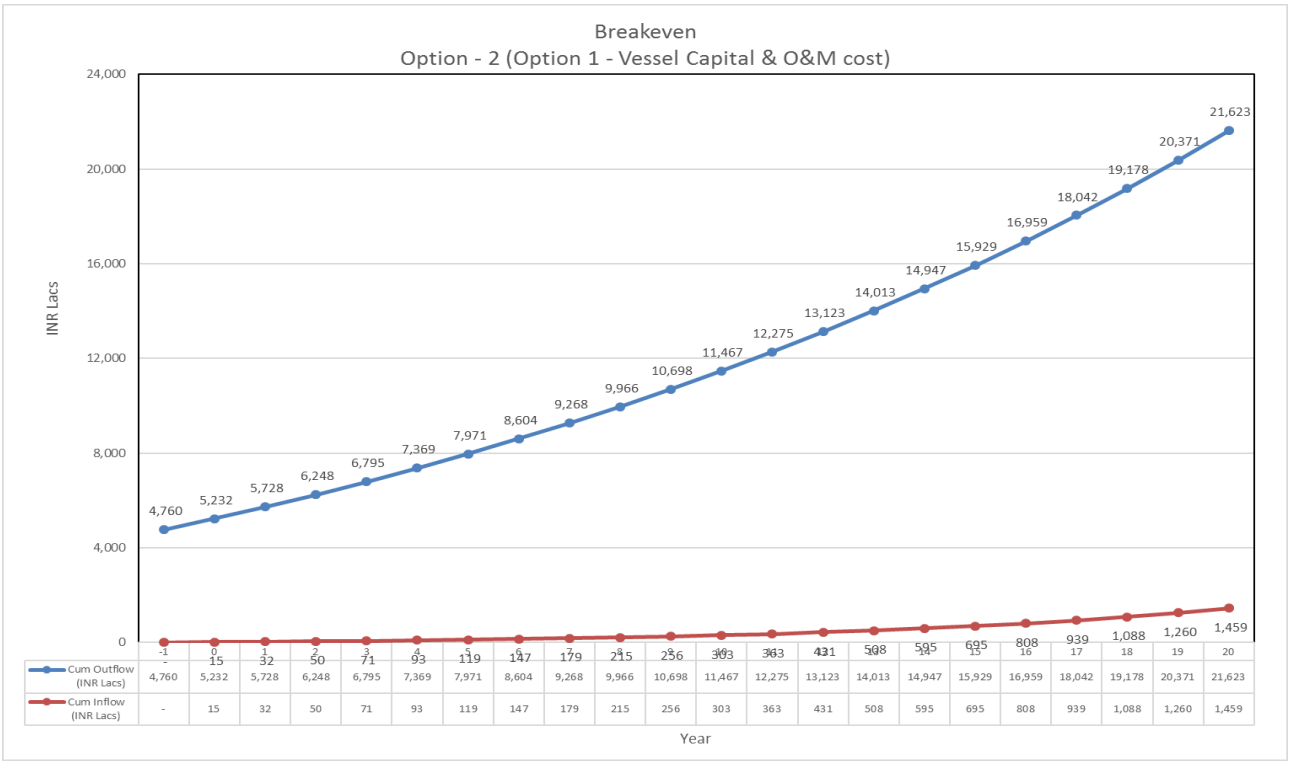
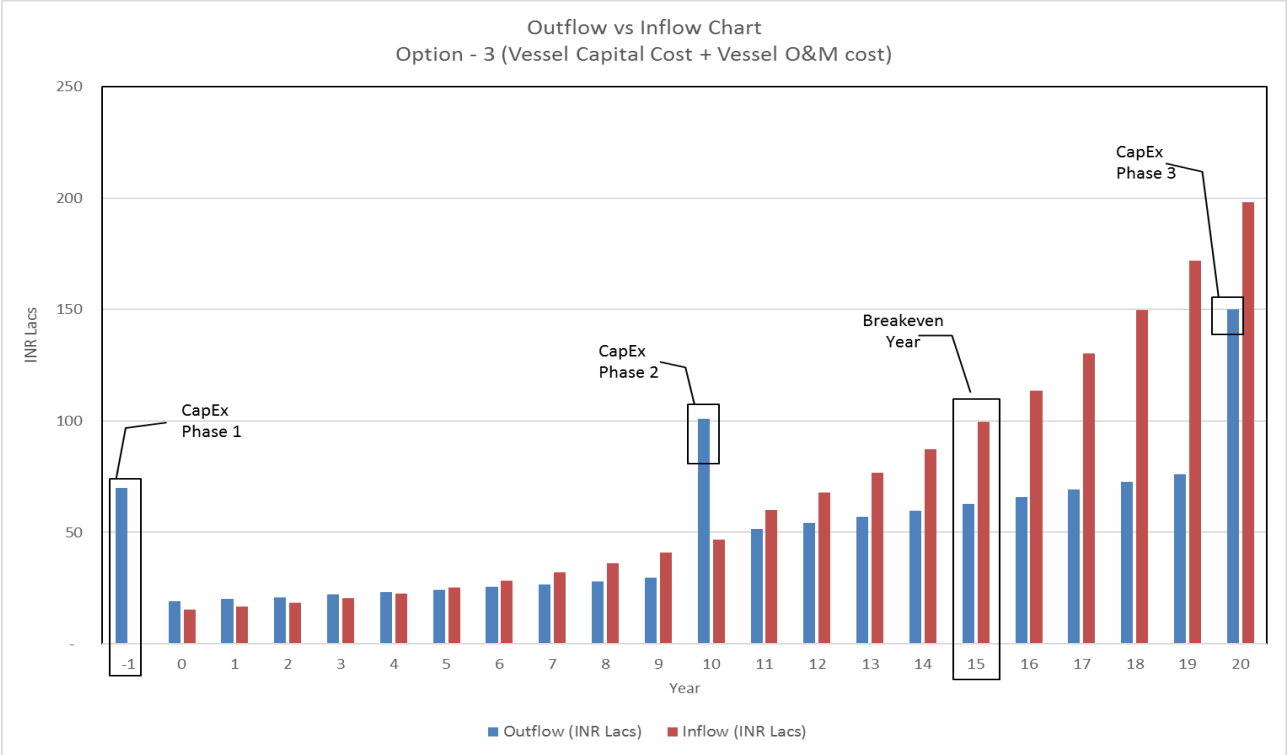


Figure 48: Financial (Outflow vs Inflow) Chart and Breakeven – Option 2



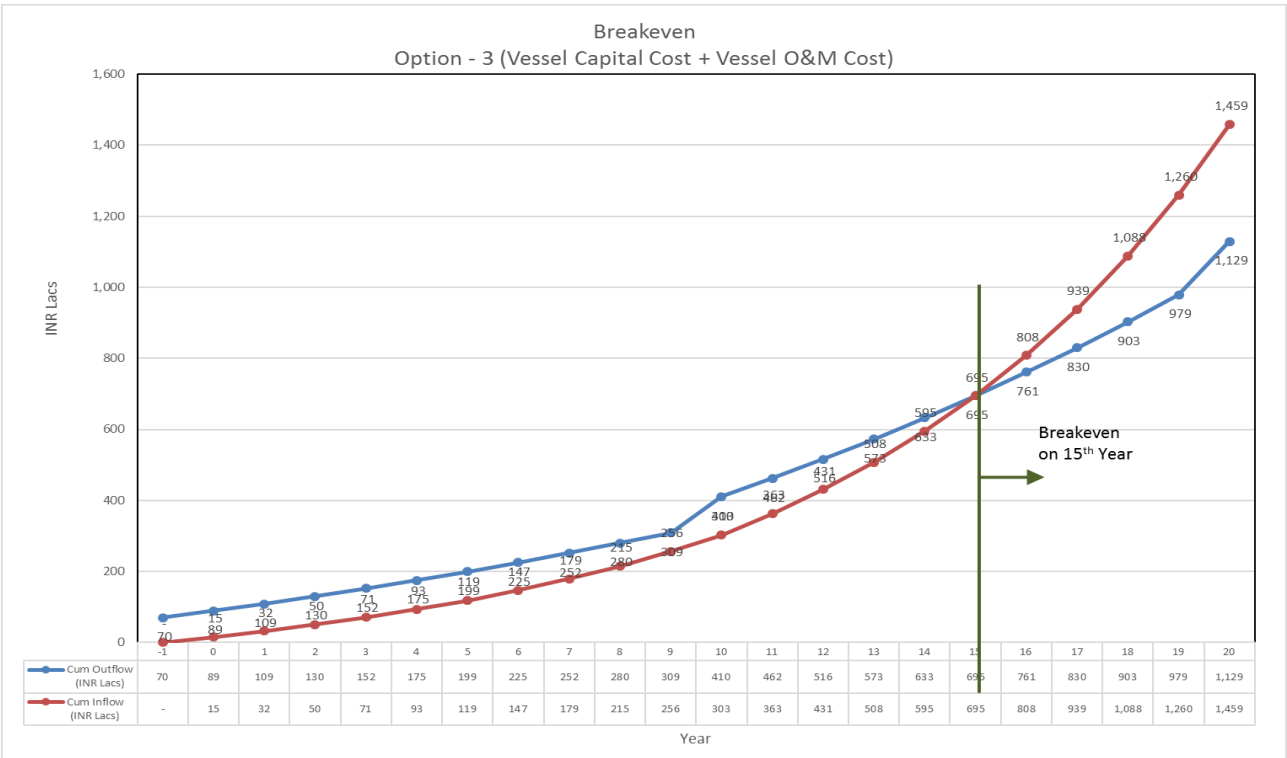


Figure 49: Financial (Outflow vs Inflow) Chart and Breakeven – Option 3

13.6 RISK FACTORS AND MITIGATION

Environmental and social risk involved in construction and operational stage of the project including their mitigation measures are discussed and provided in detail in Chapter 9.0 above. Other minor risks foreseen at this stage of the project for successful implementation and execution of the project are provided as below:

a) Dependency on inter-modality –

Integrated road transport connectivity is required for passenger ferry services.

13.7 NECESSITY OF GOVT. SUPPORT (VGF/PPP)

The guide lines were notified by the ministry of finance, department of economic affairs for financial support to infrastructure project that are to be undertaken through Public Private Partnerships (PPP).

Proposal is to be made under this scheme shall be considered for providing Viability Gap Funding (GAF), one time or deferred with the objective of making a PPP project commercially viable.

The proposal shall relate to a public private partnership (PPP) project which is based on a contract or concession agreement between a Government or statutory entity (Inland Waterways Authority of India) on the one side and a private sector company on the other side, for delivering an infrastructure service on payment of user charges.

This scheme will apply only if the contract/concession is awarded in favour of a private company in which 51% or more of the subscribed and paid up equity is owned and controlled by a private entity.

A private sector company shall be eligible for VGF only if it is selected on the basis of open competitive bidding and is responsible for financing, construction, maintenance and operation of the project during concession period.

The project should provide a service against payment of a predetermined tariff or user charge.

The proposal for seeking clearance of the Empowered Institution shall be sent (in six copies, both in hard and soft form) to the PPP cell of the Department of Economic Affairs in the prescribed format. The proposal should include copies of all project agreements (such as concession agreement, state support agreement etc.) and the project report.

Once cleared by Empowered Institution, the project is eligible for financial support financial bids shall be invited by the concerned ministry, state Government or statutory entity, as the case may be, for the award of the project within four months of the approval of the Empowered Institution. This period may be extended by the Department of Economic Affairs.

The private sector company shall be selected through a transparent and open competitive bidding process. The criterion for bidding shall be the amount of VGF required by a private sector company where all other parameters are comparable

14.0 CONCLUSION

The viability of Island Water Transport project for introduction of navigation on any waterway can be judged by both technically and commercially. The technical viability of the project can be assessed based on availability of discharges to maintain navigable depth in a design channel suitable to ply design vessel and the availability of traffic (either existing or forecasted). The commercial viability of the project can be gauged based on its growth over the project period and return on investment made besides several others socio-economic benefits such as employment generation, poverty alleviation in rural areas and so on. The recommendation for implementation of the project is based on the trade-off between costs to be incurred and benefits derived.

On the basis of studies done in this DPR following conclusions are made:

a) Proposed Katakhali waterway is directly connected with Sahibkhali National waterway.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
e) Vessel ferry services at Lebukhali and Dulduli are operated and maintained by the State Governmnet.
f) Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking

The waterway is proposed to be developed for Class VII, with with pontoon and gangway facilities at 4 ferry ghats and 2 passenger ferry vessels at the inception stage. The ferry ghats proposed to be developed for Passenger ferry services for river crossing, in this DPR are Dumrali, Rupmari, Bishpur and Mamudpur ferry ghats. The capital cost for development of the system components of the project viz., development of the designed waterway, facilities for passenger ferry services and purchasing of vessels has been worked out as INR 4,830.19 Lakh with 2 vessels. In 10^{th} year of operation capital cost of purchasing additional 2 vessels is INR 70.0 Lakh and in 20^{th} year of operation capital cost of purchasing additional 2 vessels is INR 70.0 Lakh. The additional vessels shall be purchased on the basis of growing passenger traffic. Correspondingly O&M cost for Katakhali waterway works out to

INR 491.13 Lakh from inception stage and from 11th year onwards the O&M cost is estimated as INR 19.03 Lakh.

The cost benefit analysis, calculations done for financial internal rate of return (FIRR) and Economic internal rate of return (EIRR) concludes that the project is financially and economically viable for option 3 with a tarrif of INR 10.00 per passenger per Km and above for proposed OD pairs. Accordingly, for proposed OD-Pairs of 0.2 Km trip length each, with option 3, the tariff on the basis of economic analysis is estimated as INR 2.0 per passenger one way per trip. Hence, it is recommended that the implementation of the whole project may be taken up as two packages:

Package – 1 : Construction, Operation & Maintenance of fairway and jetties
Package – 2 : Procurement, operation & maintenance of Ferry Vessel.

Also, as part of community development to provide safe and reliable water transport facilities for locals and as part of cumulative development of Sunderbans waterways, the proposed project may be recommended for development by higher authorities.

ANNEXURES

ANNEXURE 1: TOR OF THE AGREEMENT

ANNEXURE 2: ENVIRONMENTAL AND SOCIAL SCREENING TEMPLATE

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site.			
a) National Park		√	
b) Wildlife/ Bird Sanctuary	√		Lothian Island Wildlife Sanctuary. It is about 4.0 Km from the study stretch
c) Tiger or Elephant Reserve		√	
d) Biosphere Reserve	√		The entire river stretch is located within Sundarban Biosphere Reserve
e) Reserved / Protected Forest	√		Some Forest patches are available along the study stretch of the river
f) Wetland	√		
g) Important Bird Areas		√	
h) Mangroves Areas	√		Within the stretch mangrove species are present
i) Estuary with Mangroves	√		
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	√		
k) World Heritage Sites	√		Sundarbans World Heritage site
l) Archeological monuments/ sites (under ASI's Central / State list)		√	
2. Is the project located in whole or part in /near any Critically Polluted Areas identified by CPCB?		√	
3. Is, there any defense installations near the project site?		√	
4. Whether there is any Government Order/ Policy relevant / relating to the site?		√	
5. Is the project involved clearance of existing land, vegetation and buildings?	√		
6. Is the project involved dredging?	√		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion,	√		Prone to Flood, Cyclones and heavy winds

Screening Question	Yes	No	Details / Remarks
flooding, cyclone or extreme or adverse climatic conditions)			
8. Is the project located in whole or part within the Coastal Regulation Zone?	√		
9. Is the project involved any demolition of existing structure?		√	
10. Is the project activity requires acquisition of private land?		√	
11. Is the proposed project activity result in loss of direct livelihood / employment?		√	
12. Is the proposed project activity affect schedule tribe/ caste communities?		√	

S. N.	Result of Screening Exercise	(Yes / No)
1	Environment Impact Assessment is Required	Yes
2	CRZ Clearance is Required	Yes
3	Environmental Clearance is Required	No
4	Forest Clearance is required	No
5	Wildlife Clearance is required	Yes
6	NOC from SPCB is required	Yes
7	Social Impact Assessment is Required	No
8	Abbreviated RAP is required	No
9	Full RAP is required	No
10	Any other clearance is required	Yes

ANNEXURE 3: MOEF&CC LETTER

Moef&CC Letter

No. F.No.14-9/2016-IA-III
Government of India
Ministry of Environment, Forest and Climate Change
(Impact Assessment Division)

Indira Paryavaran Bhawan
Jor Bagh Road, Aliganj
New Delhi-110003

Dated: 21st December, 2017.

OFFICE MEMORANDUM

Subject: Non-requirement of environment clearance for maintenance dredging in rivers for the purpose of navigation - regarding.

This has reference to your Office Memorandum IWT-11011/89/2016-IWT-(Vol.II) dated 7th December 2017 on the above mentioned subject.

2. The minutes of the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping and Water Resources, River Development & Ganga Rejuvenation held on 24.10.2017 concluded that as per the extant legal position, no prior EC is required for maintenance dredging for navigational channel for Inland Waterways.

3. In view of the above the Ministry of Shipping may like to go ahead with the decision taken during the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping held on 24.10.2017 subject to the implementation of the environmental safety measures as enclosed as annexure.

4. This issues with the approval of the competent authority.

Sharath Kumar Pallerla
Director

To

The Secretary,
Ministry of Shipping,
Parivahan Bhawan, 1, Parliament Street,
New Delhi - 110 001

Page 1 of 3

ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Operate' shall be obtained from State Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.
ii. The project authority shall ensure that no rivers or tributaries are blocked due to any activities at the project site and free flow of water is maintained.
iii. Shoreline shall not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary.
iv. Dredging shall not be carried out during the fish/turtle breeding seasons.
v. All vessels used in the river will be fitted with noise control and animal exclusion devices so that aquatic life is not unduly disturbed.
vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.
vii. Construction waste including debris shall be disposed safely in the designated areas and in no case shall be disposed in the aquatic environment.
viii. Vessels shall not discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil.
ix. The project authority shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.
x. All vessels will also have to comply with 'zero discharge' standards to prevent solid or liquid waste from flowing into the river and affecting its biodiversity.
xi. The dredging shall be carried by integrated and systematic planning by selective grid method by allowing migratory movement of Benthic fauna.
xii. All required Noise and vibration control measures are to be adopted in Dredgers. Cutter section Dredgers should be avoided as much as possible which produces more noise and vibration. No Drilling and Blasting is to be carried out.
xiii. Pre geo-tectonic studies has to be completed and the strata to be dredged is predetermined with complete data pertaining to hardness, compressive and tensile strengths.
xiv. Dredger type and other strata loosening methods shall be preconceived.
xv. Staggered dredging shall be carried based on turbidity monitoring to minimise the impact of turbidity.
xvi. Threshold level of turbidity, which has a minimal effect on fauna, has to be predetermined and Dredging planned accordingly.
xvii. Further silt screens needs to be used for minimising the spread of Turbidity.

Page 2 of 3

xviii. Disposal places of Dredged sediments needs to be predetermined, along the shore by assessment of suitability, which will not affect the shoreline (erosion) and also causing impacts during monsoon and flooding.

xix. As much as possible, it shall not be disposed off in the river itself, and the site should be such that the dispersion is quicker by undertaking modelling studies.

xx. Ballast water control and management measures shall be implemented.

xxi. Waste and waste water reception facilities in Jetty shall be implemented.

xxii. The Risk and Disaster management plan has been prepared in consonance with the manual of terminals and harbours issued by the Ministry of Environment and Forests dated 5th May 2010.

xxiii. Standard Operating Procedures (SOP) and Emergency Response Plan (ERP) for onsite and offsite emergencies shall be prepared and implemented based on Hazard Identification and Risk Assessment to handle, process, store and transport of hazardous substances.

xxiv. Oil spill contingency plan shall be prepared and part of DMP to tackle emergencies. The equipment and recovery of oil from a spill shall be assessed. Guidelines given in MARPOL and Shipping Acts for oil spill management shall be followed.

xxv. No diversion of the natural course of the river shall be made without prior permission from the Ministry of Water resources.

xxvi. All the erosion control measures shall be taken at water front facilities.

xxvii. Necessary Air Pollution Control measures shall be taken during loading unloading, handling, transport of the material at the berthing and water front facilities.

xxviii. The Vessels shall comply the emission norms prescribed from time to time.

xxix. All safety measures are to be implemented in coordination with the respective state government departments such as State Forest Department, Public Works Department, State Pollution Control Board etc.

Sharath Kumar Palleria
Director

Page 3 of 3

ANNEXURE 4: PHOTOGRAPHS

Vessel Ghat on Left Bank at CHAINAGE 0.0

Fishing Activities at CHAINAGE 0.5

Fishing Activities on Left Bank at CHAINAGE 1.0

Unprotected Right Bank at CHAINAGE 1.0

Fishing Activities on Left Bank at CHAINAGE 1.0

Unprotected Right Bank at CHAINAGE 1.5

Unprotected Right Bank at CHAINAGE 2.0

Fishing Activities on Left Bank at CHAINAGE 2.0

Unprotected Right Bank at CHAINAGE 2.5

Unprotected Left Bank at CHAINAGE 2.5

Unprotected Left Bank at CHAINAGE 3.0

Unprotected Right Bank at CHAINAGE 3.5

Unprotected Left Bank at CHAINAGE 3.5

Unprotected Left Bank at CHAINAGE 4.0

Lock Gate at 4.0 CHAINAGE

Broken Ferry Jetty at 4.0 CHAINAGE on Right Bank

Unprotected Left Bank at CHAINAGE 4.5

Unprotected Right Bank at CHAINAGE 4.5

Unprotected Left Bank at CHAINAGE 4.7

Unprotected Right Bank at CHAINAGE 5.0

Unprotected Right Bank at CHAINAGE 5.5

Unprotected Left Bank at CHAINAGE 5.5

Unprotected Right Bank at CHAINAGE 6.0

Unprotected Left Bank at CHAINAGE 6.5

Right bank at CHAINAGE 6.5

Unprotected Right Bank at CHAINAGE 6.5

Fishing pond on right bank at CHAINAGE 6.5

Water Lock on right bank at CHAINAGE 6.8

Unprotected Left Bank at CHAINAGE 7.0

Unprotected Right Bank at CHAINAGE 7.0

Unprotected Right Bank at CHAINAGE 7.5

Right bank at 7.5 CHAINAGE

Unprotected Left Bank at CHAINAGE 7.5

Unprotected Right Bank at CHAINAGE 8.0

Shops on left bank at CHAINAGE 8

Shops on left bank at CHAINAGE 8

Unprotected Left Bank at CHAINAGE 8.0

Fishing Activities on unprotected Left Bank at CHAINAGE 8.5

Walkway on right bank at CHAINAGE 8.5

Unprotected Right Bank at CHAINAGE 8.5

Unprotected Right Bank at CHAINAGE 9.0

Unprotected Left Bank at CHAINAGE 9.0

Right bank at CHAINAGE 9.0

Creek on right bank at CHAINAGE 9.3

Unprotected Left Bank at CHAINAGE 9.5

Fishing pond on right bank at CHAINAGE 9.5

Unprotected Right Bank at CHAINAGE 9.5

Walkway in between tree cover on left bank at CHAINAGE 10

Unprotected Right Bank at CHAINAGE 10

Unprotected Left Bank at CHAINAGE 10

Unprotected Left Bank at CHAINAGE 10.5

Unprotected Right Bank at CHAINAGE 10.5

Unprotected Right Bank at CHAINAGE 11.0

Unprotected Left Bank at CHAINAGE 11.0

Unprotected Right Bank at CHAINAGE 11.5

Unprotected Left Bank at CHAINAGE 11.5

Unprotected Right Bank at CHAINAGE 12.0

Unprotected Left Bank at CHAINAGE 12.0

Unprotected Left Bank at CHAINAGE 12.5

Small Jetty on left bank at CHAINAGE 12.9

Unprotected Right Bank at CHAINAGE 13.0

Unprotected Left Bank at CHAINAGE 13.0

Concrete structural remains on unprotected Left Bank at CHAINAGE 13.5

Unprotected Right Bank at CHAINAGE 13.5

Unprotected Right Bank at CHAINAGE 14.5

Unprotected Left Bank at CHAINAGE 15.0

Unprotected Right Bank at CHAINAGE 15.0

Unprotected Right Bank at CHAINAGE 16.0

Bispur Ferry jetty at CHAINAGE 16.0

Shops on right bank ferry jetty at CHAINAGE 16.5

Ferry Jetty on Right Bank at CHAINAGE 16.5

Unprotected Right Bank at CHAINAGE 17.0

Fishing activity on unprotected Left Bank at CHAINAGE 17.0

School near right bank at CHAINAGE 17.5

Water lock on right bank at CHAINAGE 17.8

Fishing nets at CHAINAGE 18.0

Water lock on right bank at CHAINAGE 18.7

Pond on left bank at CHAINAGE 19.0

Unprotected Right Bank at CHAINAGE 19.0

Water lock on left bank at CHAINAGE 19.2

Unprotected Left Bank at CHAINAGE 20.0

Unprotected Right Bank at CHAINAGE 20.0

Right river bank at CHAINAGE 20.0

Pond on left bank at CHAINAGE 20.4

Fishing activity on unprotected Left Bank at CHAINAGE 20.5

Pond on left bank at CHAINAGE 20.7

Pond on right bank at CHAINAGE 20.7

Pond on right bank at CHAINAGE 21.1

Water Lock at CHAINAGE 21.1

Left Bank at CHAINAGE

Pond on left bank at CHAINAGE 21.4

Pond on right bank at CHAINAGE 21.4

Unprotected Left Bank at CHAINAGE 21.5

Pond on right bank at CHAINAGE 21.5

Pond on right bank at CHAINAGE 21.6

Bridge at CHAINAGE 22.1

Unprotected Left Bank at CHAINAGE 22.5