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

SUNDERBANS WATERWAYS

RIVER: RAIMANGAL RIVER (STATE OF WEST BENGAL)

HEMNAGAR TO HASNABAD (53.381 KMS)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 04/08/2021

Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 4

AUGUST 2021

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Submission Date: 04/08/2021

Project: Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 1 National Waterways

Owner: IWAI, Ministry of Shipping

Consultant: Egis India Consulting Engineers

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EIPL wishes to express their gratitude to ***Sh. S.V.K Reddy (Chief Engineer) and CDR. Mahendra Kumar (Hydrographic Chief)*** *for their guidance and inspiration for this project. EIPL would also like to thank* ***Sh. Rajiv Singhal, S.H.S., IWAI*** *for their invaluable support and suggestions provided throughout the project duration. EIPL is pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation throughout the project duration.*

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IWAI	Inland Waterways Authority of India
IWT	Inland Water Transportation
MOS	Ministry of Shipping
NW	National Waterway
DPR	Detailed Project Report
WW	Waterway
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
UTM	Universal Transverse Mercator
WGS	World Geodetic System
MT	Metric Ton
GNSS	Global Navigation Satellite System
BM	Bench Mark
TBM	Temporary Bench Mark
WBSTC	West Bengal Surface Transport Corporation Ltd.
EMP	Environmental Management Plan
NoCs	No objection Certificates
WBDMD	West Bengal Disaster Management Department
NATMO	National Atlas & Thematic Mapping Organisation

SALIENT FEATURES OF RAIMANGAL 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	Hemnagar	Hasnabad			
	Latitude	22°11'40.55"N	22°33'57.25"N			
	Longitude	88°58'01.12"E	88°56'16.30"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**		
		53.381 km	53.381 km	0 km		
d)	Sounding Datum					
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Sagar values. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual.				
	Value w.r.t MSL (m)	0 – 10 km	10 – 20 km	20 – 30 km	30 – 40 km	40-53.381 km
		-2.36	-2.36	-2.36	-2.36	-2.36
e)	LAD Status (w.r.t. SD)					
		Sub - Stretch 1	**Sub - Stretch 2**	**Sub - Stretch 3**	**Sub - Stretch 4**	**Sub - Stretch 5**
	Stretch Km (From......To......)					
	Length with LAD < 1.2 m	0	0	0.4	0	3.2
	With LAD from 1.2-1.4 m	0	0	0	0.4	0
	With LAD from 1.5-1.7 m	0	0	0	0	0.4

Sr. No.	Particulars	Details				
	With LAD from 1.8-2.0 m	0	0	0	0	0.2
	With LAD > 2.0 m	10	10	9.6	9.6	9.581
	Total	10	10	10	10	13.381
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 – 30 km**	**30 – 40 km**	**40 – 53.381 km**	**Total (Km)**
	Dredging Required (M. Cum.)	0.00	0.00	0.080	0.062	0.839	0.980
	Bandalling	Nil	Nil	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil	Nil	Nil
	River Training (Km.)	Nil	Nil	Nil	Nil	Nil	Nil
	Bank Protection (Km.)	Nil	Nil	Nil	Nil	Nil	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	Road Bridge	1	Underconstruction at the time of Survey	
	HT/Tele-communication lines	HT	1	383 .0 m	17.562 m
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil

2.	***Traffic***	
a)	Present IWT Operations (type of services)	Passenger and RO-RO ferry services by State Govt. and private parties.
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	There are no big industries near the survey area, however a few brick kilns are found along the river banks.
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations	Hasnabad Railway station is about 0.55 km from the river bank. The mainland side of the Raimangal is connected with good road transport network and private vehicles are also available in the

Sr. No.	Particulars	Details				
	etc.)	nearby area.				
d)	Commodities	**In-bound**			**Out-bound**	
		Passenger			Passenger	
e)	Existing and Future Potential					
	Name of Commodity Passengers with 8% growth rate (nos. per day)	**Existing**	**5 years**	**10 years**	**15 years**	**20 years**
	For OD pair 1 Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat (Route length 15.0 km)	600	1,028	1,511	2,220	3,262
	For OD pair 2 Atapur ferry ghat – Khulna ferry ghat (Route length 3.0 km)	600	1,028	1,511	2,220	3,262
	For OD pair 3 Sandeshkhali Purba – Khulna ferry ghat (Route length 0.50 km)	500	857	1259	1850	2718
	For OD pair 4 Raypur – Binara ferry ghats (Route length 0.45 km)	450	771	1133	1665	2446
3.	***Terminals/Jetties***					
a)	Terminal/Jetty - 1	Hemnagar Ferry Terminal (Proposed to be developed as Tourist Jetty for Sunderbans reserve forest area)				
	Location	Right Bank				
	Type/Services	Tourism traffic for Sunderbans reserve forest area				
	Existing Infrastructure/Facilities	Cargo vessels plying along Indo – Bangladesh Protocol Route uses existing Hemnagar jetty for mooring. No terminal structure or basic amenities for passengers are available.				
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex				

Sr. No.	Particulars	Details
	Approach	River bank road
	Land Ownership	Government
	Area (sq.m.)	1200
b)	Terminal/Jetty - 2	Sardarpara 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
c)	Terminal/Jetty - 3	Atapur 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
d)	Terminal/Jetty - 4	Khulna 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

Sr. No.	Particulars	Details
e)	Terminal/Jetty - 5	Sandeshkhali Purba 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
f)	Terminal/Jetty - 6	Raypur 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
g)	Terminal/Jetty - 7	Binara 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	7 Nos. (18.0m L x 3.0m B x 1.58m D) from start date of operation, additional 8 vessels in 10^{th} year of operation and additional 17 vessels in 20^{th} year of operation.

<table>
<tr><th>Sr. No.</th><th>Particulars</th><th colspan="6">Details</th></tr>
<tr><td>c)</td><td>Loaded Draft</td><td colspan="6">0.80 m</td></tr>
<tr><td>d)</td><td>Capacity</td><td colspan="6">25 passengers</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>5.</td><td>Navigation Aids</td><td colspan="6"></td></tr>
<tr><td>a)</td><td>Type</td><td colspan="6">Marking buoys</td></tr>
<tr><td>b)</td><td>Nos.</td><td colspan="6">15</td></tr>
<tr><td>c)</td><td>Communication Facilities</td><td colspan="6">1.0 no. RIS system</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>C.</td><td>FINANCIAL</td><td colspan="6"></td></tr>
<tr><td>1.</td><td>Cost</td><td colspan="3">Capital Cost (INR Lakhs)</td><td colspan="3">O&M Cost (INR Lakhs)</td></tr>
<tr><td></td><td>Fairway Development</td><td colspan="3">1,960.95</td><td colspan="3">196.10</td></tr>
<tr><td></td><td>Terminal Structures</td><td colspan="3">701.86</td><td colspan="3">39.20</td></tr>
<tr><td></td><td>Vessels</td><td colspan="3">245.00</td><td colspan="3">109.05</td></tr>
<tr><td></td><td>Total Cost including Vessel</td><td colspan="3">3,317.00</td><td colspan="3">546.11</td></tr>
<tr><td></td><td>Total Cost without Vessel cost</td><td colspan="3">3,072.00</td><td colspan="3">437.06</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>2.</td><td>User Charges</td><td colspan="6">INR 5.00 per passenger per Km for proposed OD pairs.</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>3.</td><td>Financial Internal Rate of Return (%)</td><td colspan="2"><u>Option 1</u>
Total Capital Cost + Total O&M cost</td><td colspan="2"><u>Option 2</u>
Option 1 - Vessel Capital & O&M cost</td><td colspan="2"><u>Option 3</u>
Vessel Capital Cost + Vessel O&M Cost</td></tr>
<tr><td></td><td></td><td colspan="2">2.70%</td><td colspan="2">7.20%</td><td colspan="2">61.13%</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>4.</td><td>Economic Internal Rate of Return (%)</td><td colspan="2"><u>Option 1</u>
Total Capital Cost + Total O&M cost</td><td colspan="2"><u>Option 2</u>
Option 1 - Vessel Capital & O&M cost</td><td colspan="2"><u>Option 3</u>
Vessel Capital Cost + Vessel O&M Cost</td></tr>
<tr><td></td><td></td><td colspan="2">3.53%</td><td colspan="2">7.94%</td><td colspan="2">71.13%</td></tr>
</table>

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. Raimangal River is one of the 13 rivers clubbed in Cluster 3.

This detailed project report of 53.381 km stretch of Raimangal 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 53.381 km stretch of Raimangal National waterway proposed for DPR study lies from Hemnagar at Lat 22°11'40.55"N, Long 88°58'01.12"E to Hasnabad at Lat 22°33'57.25"N, Long 88°56'16.30"E. Whole stretch of Raimangal waterway is having tidal influence with a maximum tidal variation of 4.55 m to a minimum tidal variation of 3.725m.

River width in the waterway stretch varies from 0.17 km to 2.28 km. Average flow velocity in the waterway varies from 0.73 m/sec to 1.1 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 53.381 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation. The waterway is proposed to be developed as Class VII, and for this classification 9,80,477 cum of dreding is required to be done. The total capital and O&M cost of fairway development works out to INR 1,960.95 Lakh and INR 196.10 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 Raimangal waterway is connected with Indo Bangladesh waterway protocol route, Sahibkhali and Chhota Kalagachi National waterways.
b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Hemangar Jetty for mooring located at 0.0 Km Chainage.
c) There are no big industries near the survey area, however few brick kilns are found along the river banks.
d) 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 Raimangal river with major waterways, Passenger ferry services with floating Pontoon and Gangway facilities are proposed at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. Accordingly following OD links are proposed for development in Raimanagl waterway:

a) Link 1: Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat (OD pair length is 15 Km)
b) Link 2: Atapur ferry ghat – Khulna ferry ghat (OD pair length is 3 Km)
c) Link 3: Sandeshkhali Purba – Khulna ferry ghat (OD pair length is 0.5 Km)
d) Link 4: Raypur – Binara ferry ghats (OD pair length is 0.45 Km)

Arsadmiya ferry ghat along OD Link1 is located along Chhota Kalagachi waterway and considered for development in Chotta Kalagachi waterway DPR. Thus, the same is not detailed further in this DPR.

In addition to the above, Hemnagar ferry terminal is also proposed to be developed as a tourism jetty for tourist traffic of Sunderbans Reserve Forest Area. Hemnagar terminal may also provide support to the vessels operating along Indo Bangaldesh Protocal Route.

5.0 TERMINALS

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

1) Hemnagar ferry ghat;
2) Sardarpara ferry ghat;

3) Atapur ferry ghat
4) Khulna ferry ghat;
5) Sandeshkhali Purba ferry ghat;
6) Raypur ferry ghat, and
7) Binara ferry ghat.

It is proposed to develop passenger embarking and disembarking for passenger ferry services with floating Pontoon and Gangway facilities at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. In addition to this, Hemanagr ferry ghat is proposed to be developed as a tourist jetty with terminal complex and all basic ameneities for tourism traffic of Sunderbans Reserve Forest Area.

The total cost of terminals works out 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	701.86
2.0	O&M cost for Terminals	39.20

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
- Approach Platform
- Parking Facilities
- Terminal Building

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 vessel manufacturer, with carrying capacity of 25 passengers are proposed to be operated in Raimangal waterway for passenger ferry services. On the basis of DPR studies, for present traffic demand, four (4) numbers of vessels are proposed initially from the start date of operations for OD pair 1 and one (1) veesel in each OD pair 2, 3 and 4. Hence, in total seven (7) number of vessels are proposed at initial stage for Rainmangl waterway. Similarly, in 10th year of operation additional five (5) vessels are proposed for OD pair 1, two (2) vessels for OD pair 2 and one (1) vessel for OD pair 3. In 20th year of operation additional eleven (11) vessels are proposed for OD pair 1, three (3) number of vessels for OD pair 2, one (1) number of vessel for OD pair 3 and two (2) number of vessels for 4, for IWT operations as per required passenger traffic. Hence, with the above recommendations, the total number of vessels in the fleet shall be fifteen (15) from 10th year onwards and thirty-two (32) from 20th year after start date of of operation to cater the projected traffic demand. The procurement and O&M cost of passenger ferry vessels are as below:

Year of opertaion	Capital Cost (INR Lakh)	O&M cost (INR Lakh)
Inception (Cost due to procument of 7 vessels)	245.00	109.05 (from 1st year of operation onwards)
In 10th Year (additional cost due to procument of additional 8 vessels)	280.00	133.15 (from 11th year of operation onwards)
In 20th Year (additional cost due to procument of additional 17 vessels)	595.00	279.80 (from 21st year of operation onwards)

8.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like RIS system and marking buoys are proposed along the channel alignment. Capital and maintenance cost for the same works out to INR 306.03 Lakh and INR 175.89 Lakh respectively.

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Raimangal 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. 129.025 lakh.

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Rainmagal waterway, it is recommended that the development of Rainmagal 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 Institutional 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) Judgement based on Consultant's Experience

Raimangal 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 facilities required for passenger ferry services. Seven (7) ferry ghats are proposed for development along the river located at Hemnagar, Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara. It is proposed to develop the ferry ghats by providing floating pontoon and gangway facilities at all the above ferry ghats. In addition to this, Hemanagr ferry ghat is proposed to be developed as a tourist jetty with terminal complex and all basic amenities for tourism traffic. In this DPR, seven (7) number of passenger ferry vessels are proposed at the inception stage. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of IWT terminals and purchasing of vessels has been worked out as INR 3,317.00 Lakh with 7 vessels. In 10th year of operation capital cost of purchasing additional 8 vessels is INR 280.00 Lakh and in 20th year of operation capital cost of purchasing additional 17 vessels is INR 595.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Correspondingly O&M cost for Raimanagl waterway works out to INR 546.11 Lakh from inception stage and additional INR 133.15 Lakh from 11th year of operation due to additional 8 vessels.

12.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 24 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.

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	1.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	-12.75%	1.73%
2	1.50	Not Calculable	Not Calculable	Not Calculable	Not Calculable	10.41%	16.94%
3	2.00	Not Calculable	Not Calculable	-13.49%	-10.56%	19.59%	25.99%
4	2.50	Not Calculable	Not Calculable	-5.76%	-4.12%	26.92%	33.80%
5	3.00	-13.40%	-10.80%	-1.54%	-0.33%	33.72%	41.25%
6	3.50	-6.37%	-4.85%	1.40%	2.40%	40.41%	48.64%
7	4.00	-2.36%	-1.22%	3.68%	4.56%	47.18%	56.07%
8	4.50	0.48%	1.42%	5.58%	6.37%	54.08%	63.56%
9	5.00	2.70%	3.53%	7.20%	7.94%	61.13%	71.13%
10	5.50	4.55%	5.30%	8.64%	9.34%	68.33%	78.77%
11	6.00	6.14%	6.83%	9.94%	10.60%	75.64%	86.47%
12	6.50	7.54%	8.20%	11.13%	11.76%	83.06%	94.21%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Raimangal waterway is financially and economically viable for all the three options with a tarrif of INR 5.00 per passenger per Km onwards for proposed OD pairs.

Project life cycle cost analysis is also done for Raimangal waterway DPR and for 20 years of project life cycle with a tariff of INR 5.00 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 25,373 Lacs, the breakeven occurs during 17th year of operation.

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

With project life cycle cost of INR 18,683 Lacs, the breakeven occurs during 14th year of operation.

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

With project life cycle cost of INR 6,690 Lacs, the breakeven occurs during 0th year of operation.

14.0 CONCLUSION

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

a) Proposed Raimangal waterway is directly connected with Indo Bangladesh waterway protocol route, Sahibkhali and Chhota Kalagachi National waterways

b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Hemnagar Jetty located at start Chainage of Raimangal waterway for mooring.

c) By taking into advantage of tidal window, sufficient LAD is available in the complete 53.381 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation.

d) There are no big industries near the survey area, however few brick kilns are found along the river banks.

e) One RCC Road bridge is located at chaiange 50.00 Km near Hasnabad. Also Hasnabad and Par Hasnabad jetties are operated and maiantained by Government of West Bengal.

f) Passenger ferry services are operated by local parties from all other existing ferry ghats, 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 with a tariff of INR 5.00 per passenger per Km and above for the proposed OD pairs as below, in case the project is implemented in a single package.

1. OD pair 1) - Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat, (OD pair length is 15.0 km and daily passenger traffic is 600 pax)
2. OD pair 2) - Atapur ferry ghat – Khulna ferry ghat, (OD pair length is 3.0 km and daily passenger traffic is 600 pax)
3. OD pair 3) - Sandeshkhali Purba – Khulna ferry ghat, (OD pair length is 0.50 km and daily passenger traffic is 500 pax)
4. OD pair 4) - Raypur – Binara ferry ghats. (OD pair length is 0.45 km and daily passenger traffic is 450 pax)

However, in case the project is implemented in separate packages as shown below, the tariff can be reduced accordingly.

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

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. Raimangal River was clubbed under Cluster -3 for the two stage DPR studies.

This detailed project report of 53.381 km stretch of Raimangal 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

Raimangal 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 Raimangal River) was covered in the Sunderbans waterways (NW-97). Following section of the Raimangal 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
53.381 Km	22°11'40.55"N	Hemnagar	22°33'57.25"N	Hasnabad
	88°58'01.12"E		88°56'16.30"E	

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

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Raimangal 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
53.381 Km	22°11'40.55"N	Hemnagar	22°33'57.25"N	Hasnabad
	88°58'01.12"E		88°56'16.30"E	

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 53.381 km stretch of Raimangal waterway is located in North 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.

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

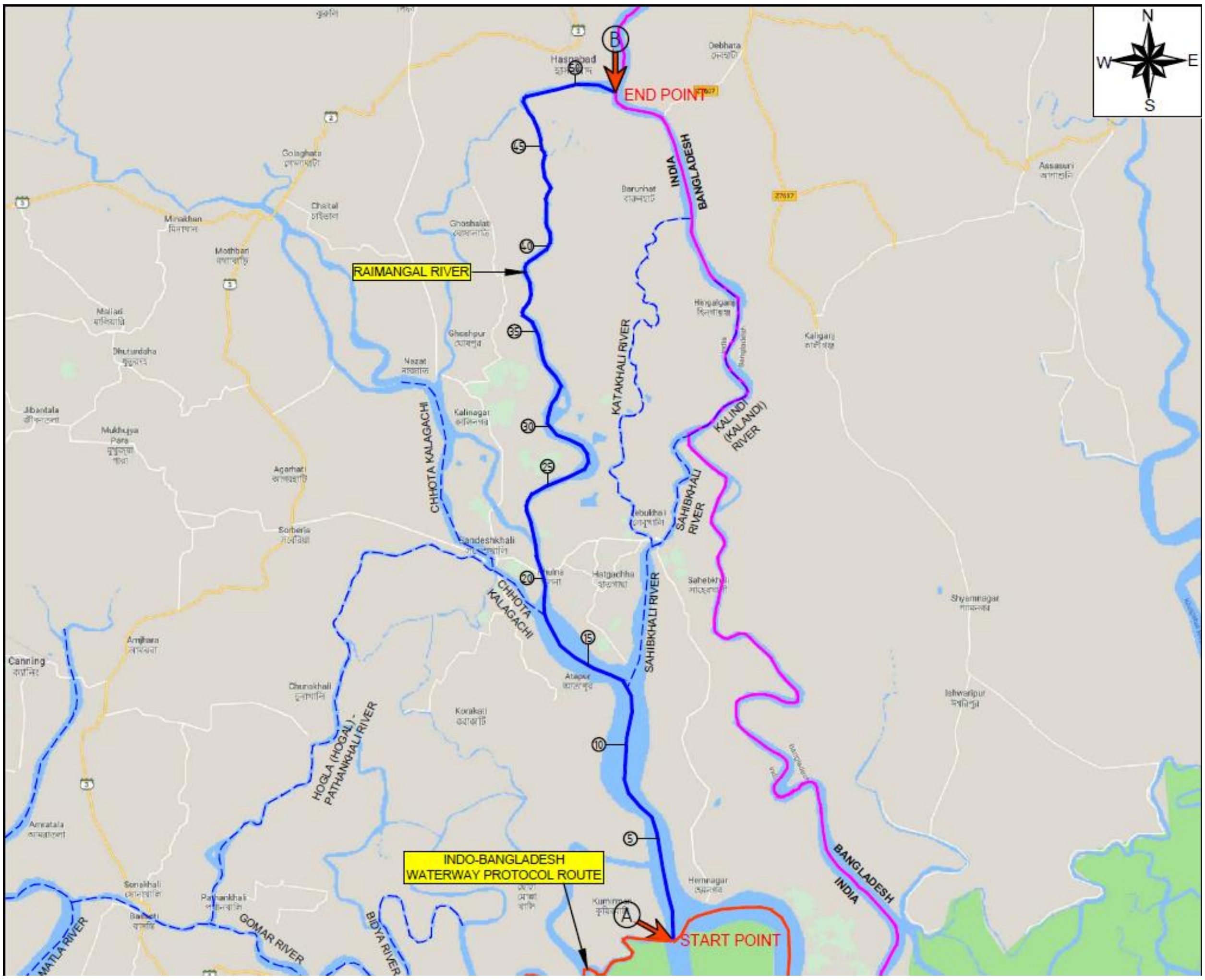


Figure 1: Raimangal National Waterway Project Location

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;

Stage-2: Field Survey & Investigations

- Benchmark Establishment
- Hydrographic survey & Topographic details
- Water level (Guage Measurement)
- Current & Discharge Measurement
- Water & Soil samples
- Traffic Surveys

Stage-2: Project Studies

- Analysis of Hydrographic survey data & existing infrastructure
- Traffic studies, Vessel analysis & dredging
- Proposed location for terminals/ports loading and unloading terminals
- Environmental Impact studies
- Fairway design, Navigational Aids and communication facilities
- River training, shore/bank protection measures
- Preliminary design of proposed facilities & infrastructure, alternatives
- BOQ and Cost Estimation
- Financial & Economic analysis

1.4 INDO–BANGLADESH WATERWAY PROTOCOL ROUTE

An Inland water transit and trade protocol exists between India and Bangladesh under which inland vessels of one country can transit through the specified routes of the other country. The existing protocol routes are (i) Kolkata-Pandu-Kolkata, (ii) Kolkata-Karimganj - Kolkata, (iii) Rajshahi-Dhulian-Rajshahi and (iv) Pandu-Karimganj-Pandu. For inter-country trade, four ports of call have been designated in each country namely; Haldia, Kolkata, Pandu and Karimganj in India and Narayanganj, Khulna, Mongla and Sirajganj in Bangladesh. Under the Protocol, 50:50 cargo sharing by Indian and Bangladeshi vessels is permitted both for transit and inter country trade.

IWAI is the Competent Authority on Indian side w.e.f. 8th September 2003 vide Ministry's Order No. WTC-15014/2/2001-IWT dated 29.08.03 and is responsible for maintenance of routes including conservancy and pilotage.

Proposed Raimangal Waterway connects with Indo Bangladesh Protocol route at Hemnagar (Chainage 0.0).

1.5 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) Commercial Viability

- 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:

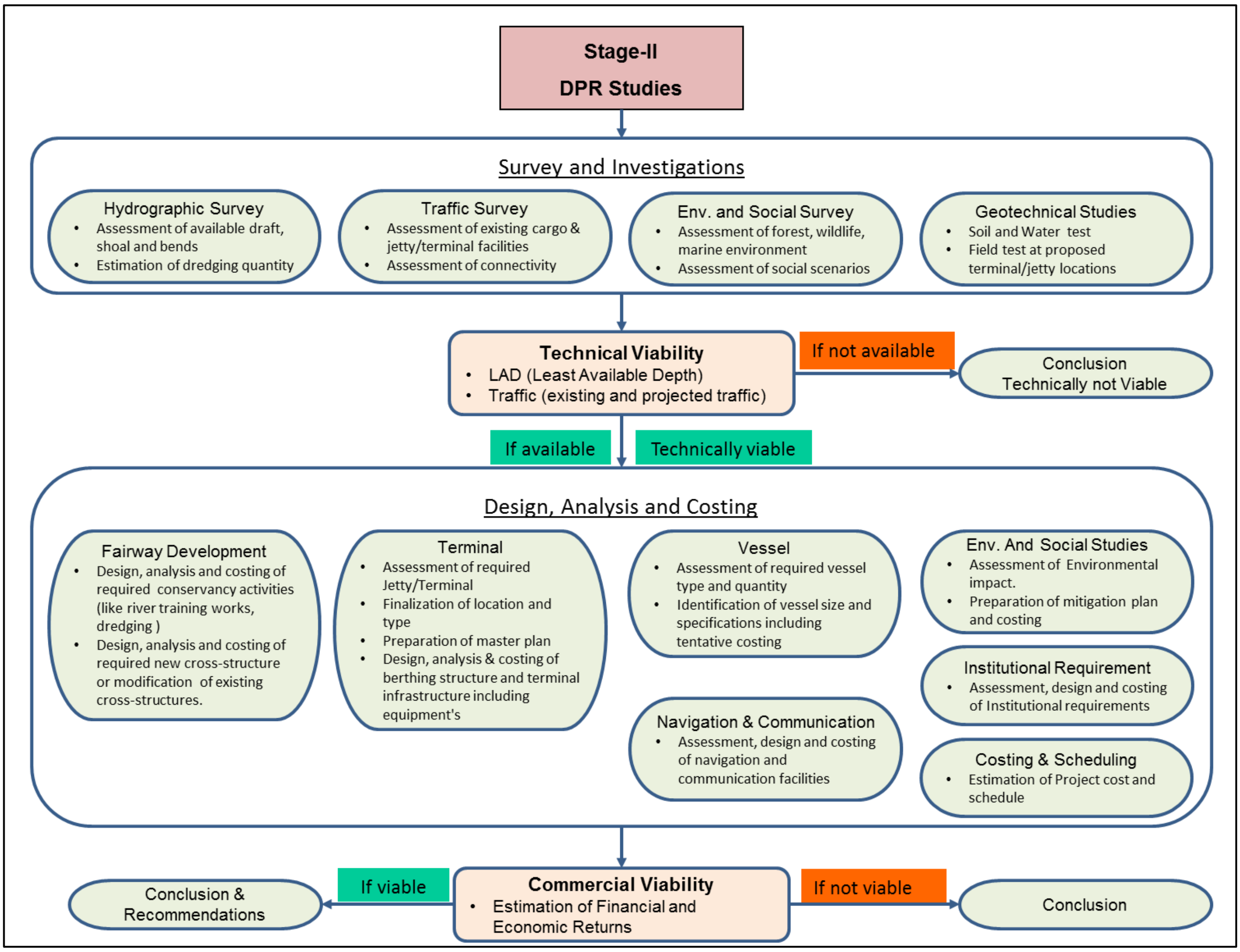


Figure 2: DPR Approach and Methodology Flow Chart

1.5.1 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.

1.5.2 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.

1.5.3 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.

1.5.4 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.

1.5.5 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

As detailed above, the National Waterway stretch of Raimangal river under DPR study is from Hemnagar at Lat 22°11'40.55"N, Long 88°58'01.12"E to Hasnabad at Lat 22°33'57.25"N, Long 88°56'16.30"E. The total length of this stretch is about 53.381 km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Raimangal 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 Raimangal River is a tidal estuarine river in and around the Sundarbans in North 24 Parganas district West Bengal, India. The river flows between Hasnabad and Hemnagar blocks and has a connection with the Chota kalagachi River at Tushkhali and Sahibkhali River at Ramapur. It falls in to the Bay of Bengal with a wide mouth after traversing about 70 kilometres. To assess the feasibility of water transportation over this stretch of river a bathymetric survey and topographic survey was carried out by Egis India Consulting Engineers Pvt Ltd.

The proposed 53.381 Km stretch of waterway is located in the North 24 Parganas district of West Bengal. Whole stretch of Raimangal waterway is having tidal influence with a maximum tidal variation of 4.55 m to a minimum tidal variation of 3.725m.

Average flow velocity in the waterway varies from 0.73 m/sec to 1.1 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, a 4 hour observation was carried out at SK-01 of Sahibkhali River and newly established BM, RM-01 to transfer the MSL value from SK-01. Also 4 hour observation were carried out at RM-02, RM-03, RM-04, RM-05 & RM-06 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.

Sounding datum was transferred from Mayapur and Gardenreach and Raimangal River was divided into 10 km stretches for ease of applying Tidal level corrections to the collected bathymetric data. The values of BM's RM-01, RM-02, RM-04 & RM-06 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 RM-03 & RM-05 were transferred from CK-01 and RM-04 respectively by base line processing method. Total six in number BM's pillars (naming RM-01, RM-02, RM-03, RM-04, and RM-05 & RM-06) were constructed and erected along the river from Hemnagar to Hasnabad.

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 MSL (m)	Height above SD (m)
RM-01	Hemnagar	1.081	22°12'23.74"	88°58'58.98"	704423.789	2457031.798	3.514	5.874
RM-02	Sardarpara	9.701	22°16'10.74"	88°57'12.66"	701288.453	2463974.916	2.719	5.079
RM-03	Khulna	20.1	22°21'02.70"	88°54'20.07"	696233.836	2472892.344	2.959	5.26
RM-04	Choto sehra ghat	30.4	22°24'58.06"	88°54'07.26"	695775.782	2480127.266	4.611	6.96
RM-05	Durgapur dharam bheria	40.78	22°29'53.09"	88°54'30.79"	696332.946	2489211.063	2.441	4.76
RM-06	Par Hasnabad	50.27	22°33'51.35"	88°54'47.96"	696729.953	2496546.076	3.847	6.16

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. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual. Details of Sounding Datum (SD) and reduction details are as follows:-

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 wrt SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
RM-01	Hemnagar	1.081	0.0 to 5.0	-2.36	-2.36	Tide Applied w.r.t SD	2.36
RM-02	Sardarpara	9.701	5.1 to 15.0	-2.36	-2.36		2.36
RM-03	Khulna	20.1	15.1 to 25.0	- 2.36	- 2.36		2.36
RM-04	Choto Sehra ghat	30.4	25.1to 35.0	-2.36	-2.36		2.36
RM-05	Durgapur dharam bheria	40.78	35.1 to 45.0	-2.36	-2.36		2.36
RM-06	Par Hasnabad	50.27	45.1 to 50.27	-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 KPT 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 below. 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	Hasnabad	High Tension Line	49.5	5.22	5.22

2.2.2 Bridges

One road bridge is located at Hasnabad (Chaiange 50.0 Km). The was underconstruction during the time of survey.

2.2.3 Electric Lines / Communication Lines

One (1) no. of high tension line is located along the waterway. The detail of this high tension line is provided **Table 5** in below.

Table 5: 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. MHWS (m)	Remarks (complete/ under- construction)
				Left Bank	Right Bank	Left Bank	Right Bank				
1	High Tension Lines	49.535.9	Hasnabad	22°33'57.29105 088°54'20.4506	22°33'57.27392 088°154'20.2169	2496718.669 695941.630	2496718.057 695934.962	4	383	17.562	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 6**.

Table 6: Details of Bends located along waterway

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	5.95	9.38	2,454
2.0	11.48	13.68	1,612
3.0	22.70	24.48	934
4.0	26.87	28.09	852
5.0	29.35	31.09	953
6.0	31.74	32.87	777
7.0	35.42	36.64	518
8.0	37.68	38.96	663
9.0	39.80	40.85	859
10.0	42.21	43.39	703
11.0	44.20	44.80	388
12.0	47.08	47.67	255

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 7.**

Table 7: 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	0.0	22°11'43.09"	088°58'18.15"	703270.50	2455766.15	10	1.30	1.01	0.98	1.10	15120	16632
2	9.5	22°16'12.36"	088°56'57.58"	700855.84	2464018.91	5.4	1.25	1.10	0.879	1.08	9008.18	9728.83
3	20	22°21'2.3449"N	088°54'15.9529"E	696115.92	2472879.72	8.5	1.06	0.93	0.74	0.91	4120.74	3749.87
4	30.5	22°25'0.5362"N	088°54'11.3281"	695890.89	2480204.74	10	0.97	0.80	0.77	0.85	2925.36	2486.56
5	40.5	22°29'46.1435"N	088°54'25.5046"	696184.58	24888995.16	9	0.93	0.82	0.71	0.82	2029.3	1664.03

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			
6	51.0	22°33'55.9735"N	088°55'4.7091"	697206.55	2496694.34	5	0.84	0.73	0.62	0.73	1016.89	742.33

2.5 WATERWAY DESCRIPTION

The total 53.381 km stretch of Raimangal Waterway under DPR study, can be broadly divided in to five (5) stretches. **Table 8** below provides the details of sub-stretches of Raimangal waterway.

Table 8: Sub-Stretches of Raimangal Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Kumirmari	Sadarpara	0 Km	10 km
2	Sadarpara	Khulna	10 Km	20 km
3	Khulna	Chhota Sehara	20 Km	30 km
4	Chhota Sehara	Durgapur Dharam Bheria	30 km	40 km
5	Durgapur Dharam Bheria	Hasnabad	40 km	53.4 km

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

2.5.1 Sub Stretch 1: From Kumirmari to Sadarpara (0km to 10km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 0 to 10 km chainage of the Raimangal River. It is the downstream portion of the Raimangal River. The area is sparsely populated, with fishing and farming being the main occupation of the people. There are a few guest house /hotels near Hemnagar and local road from Hemnagar to Dulduli is in the vicinity. This river stretch is considerably wide approx 1.5 Km in this stretch with some portion of the river bank protected. Fishermen extensively use the natural slope of the ground for landing the boats and there is a small jetty at Hemnagar from where boats ply.

Following are the observations made during survey of Sub-stretch 1: From Kumirmari to Sadarpara (0km to 10km)

- There are no overhead obstructions/crossovers.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 4.43 m in this Stretch.
- There is no hindrance or encroachment in this stretch.
- Since sufficient depth is available for all time navigation dredging is not considered a requirement at this stretch.

The details of current and discharge at different depths is placed at **Table 7.**

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Raimangal Waterway. The quantity of dredging required for all waterway classes for this stretch is provided in **Table 9**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

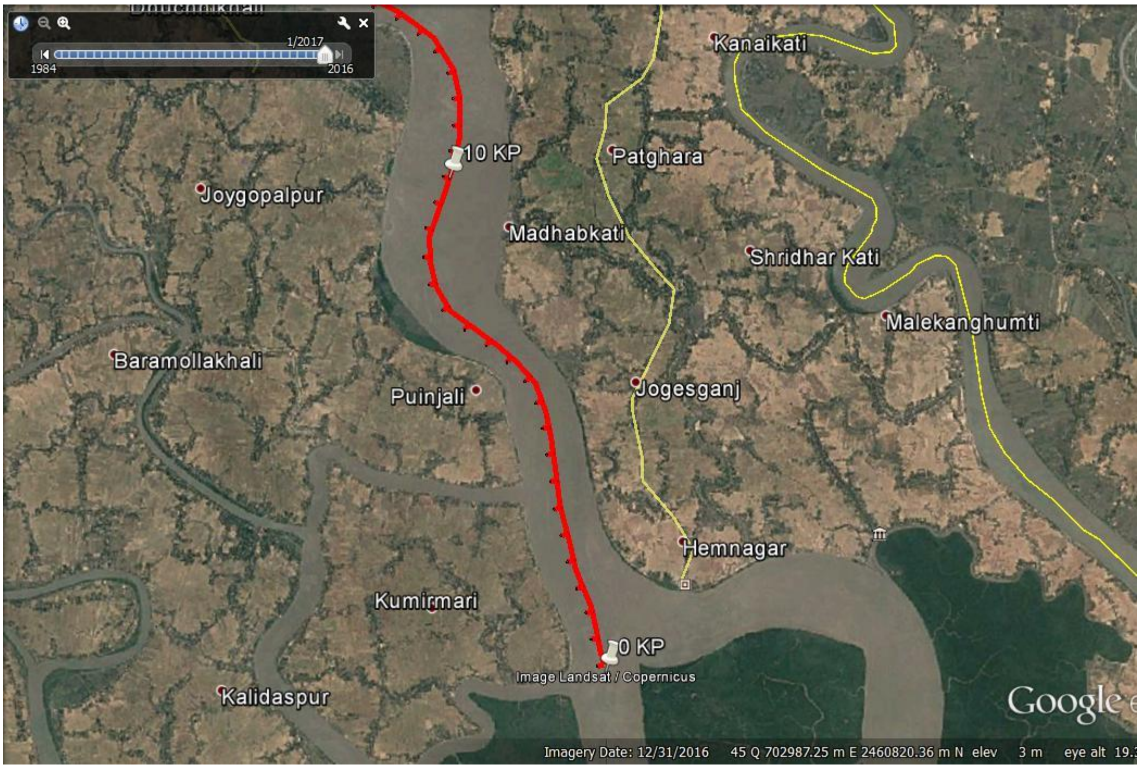


Figure 3: Google Image showing Sub-Stretch -1 From Kumirmari to Sadarpara

Table 9: 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				5.98	35.65	0	0.00
II	0	10					5.98	35.65	0	0.00
III	0	10					5.98	35.66	0	0.00
IV	0	10					5.98	35.65	0	0.00
V	0	10					5.98	35.77	0	0.00
VI	0	10					5.84	35.83	0	0.00
VII	0	10					5.51	36.06	0	0.00

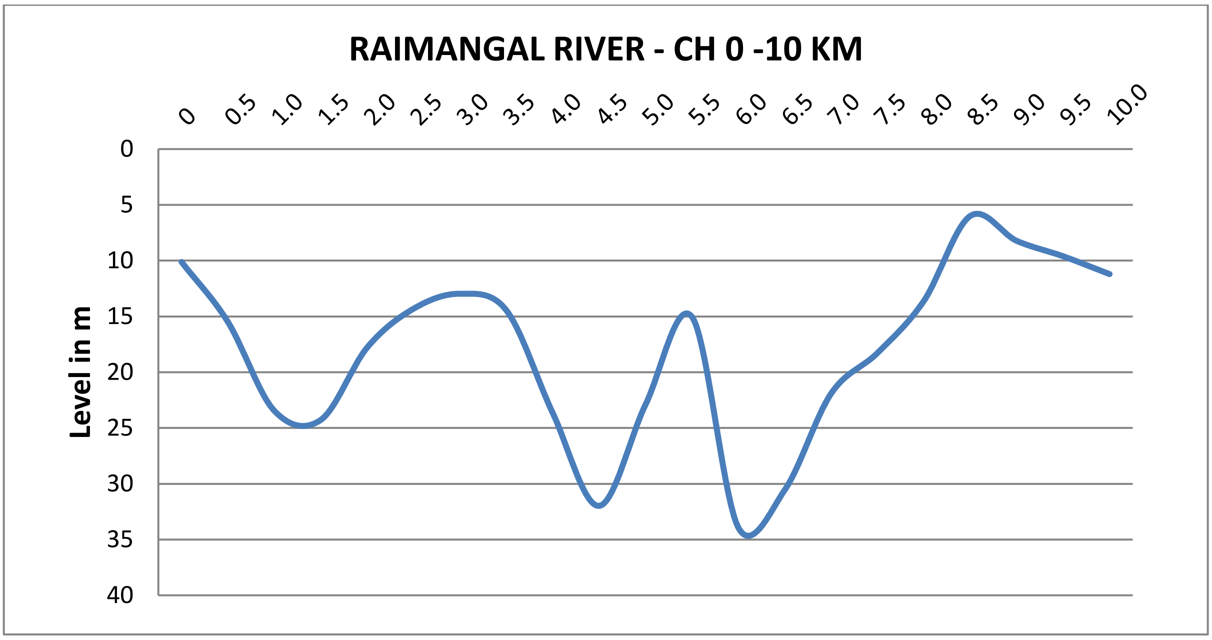


Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

Figure 5: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Sadarpara - Khulna (10km to 20km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 10 to 20 km chainage of the Raimangal River. The area is sparsely populated, with fishing and farming being the main occupation of the people & the fields in the area are dependent on the rainfall. This stretch width is about 1.5 Km with some portion of the river bank protected. There are small Ferry Ghats at sadarpara from where boats ply. The details of current and discharge at different depths is placed at **Table 7**.

Following are the observations made during survey of Sub-stretch 1: From Sadarpara - Khulna (10km to 20km)

There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.

- 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 4.55 m in this stretch as we move from downstream to upstream.
- Small boats ply on this stretch of Raimangal River from Sardarpara to Manipur and Khulna 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 waterway classes this stretch is provided in

Table 10**. Figure 7** shows the observed and reduced bed profile of sub-stretch 2.

Table 10: 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				4.09	34.04	0	0.00
II	10	20					3.73	34.04	0	0.00
III	10	20					3.49	34.06	0	0.00
IV	10	20					3.44	34.06	0	0.00
V	10	20					2.49	34.06	0	0.00
VI	10	20					2.19	34.08	0	0.00
VII	10	20					1.94	34.08	0	126.67

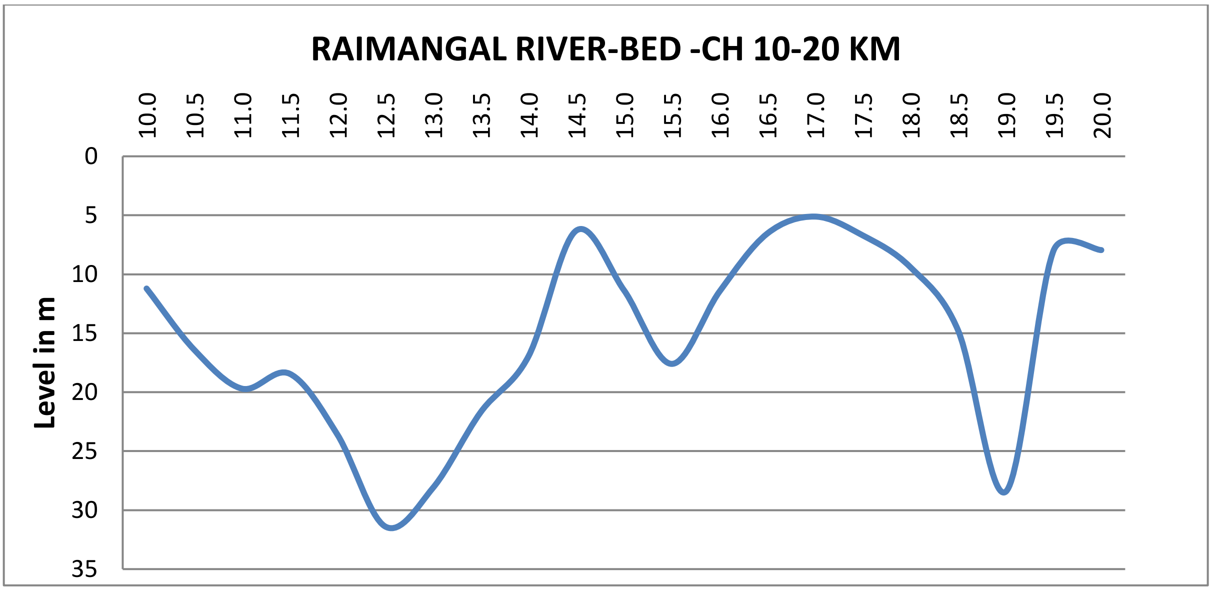


Figure 7: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

Figure 8: Photographs of Sub-stretch 2

2.5.3 Sub Stretch 3: From Khulna to Chhota Sehara (20 km to 30 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 20 to 30 km chainage of the Raimangal River. The area is very sparsely populated and has dense mangroves on either side of the river. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow about 400 mtrs. Large portion of the river bank is unprotected. The details of current and discharge at different depths is placed at **Table 7**.

- 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 2.02 m in this stretch.

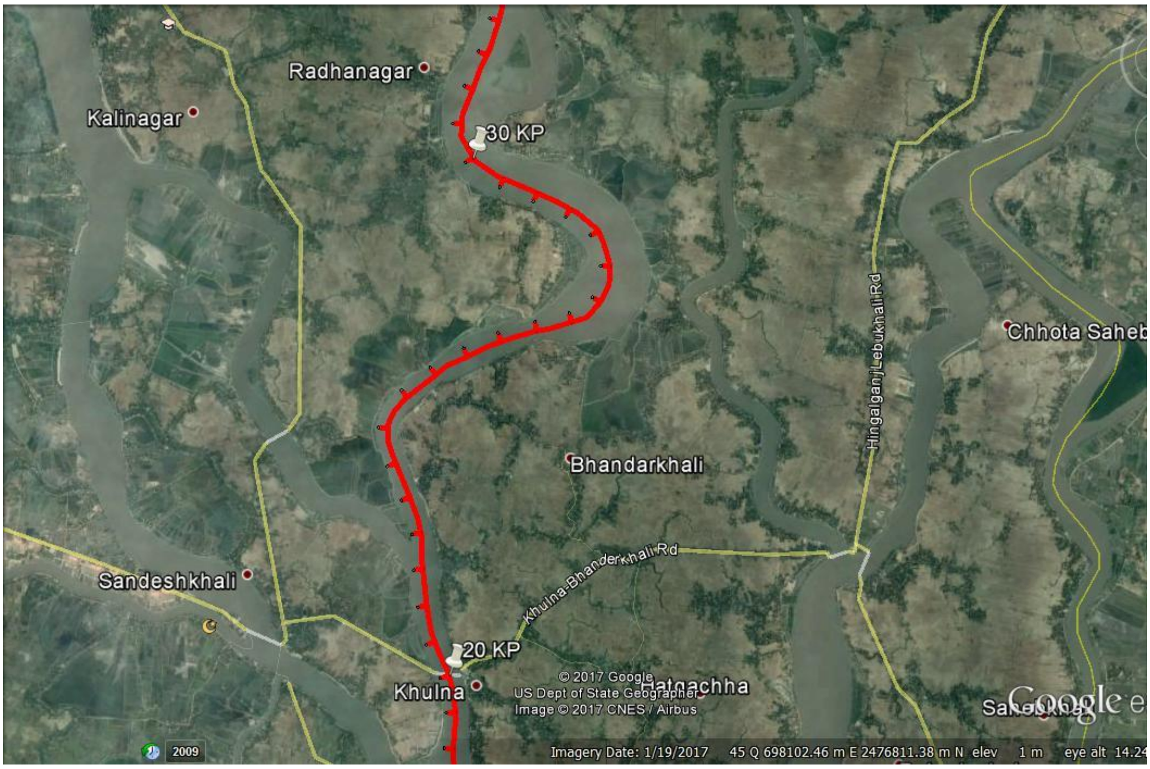


Figure 9: Google Image showing Sub-Stretch -3 of Waterway

Figure 9 above shows the alignment of sub-stretch 3 (Ch. 20.0 km to 30 km) of Waterway. The quantity of dredging required for all waterway classes for this stretch is provided in **Table 11**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 3.

Table 11: 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	30	Not Applicable Tidal Zone				0.37	29.90	0	5401.78
II	20	30					0.37	30.23	0	10207.28
III	20	30					0.33	30.23	0	18775.47
IV	20	30					0.33	30.23	0	25825.95
V	20	30					0.33	30.37	0	37013.96
VI	20	30					0.33	30.40	0	65196.36
VII	20	30					0.15	30.42	0	79658.10

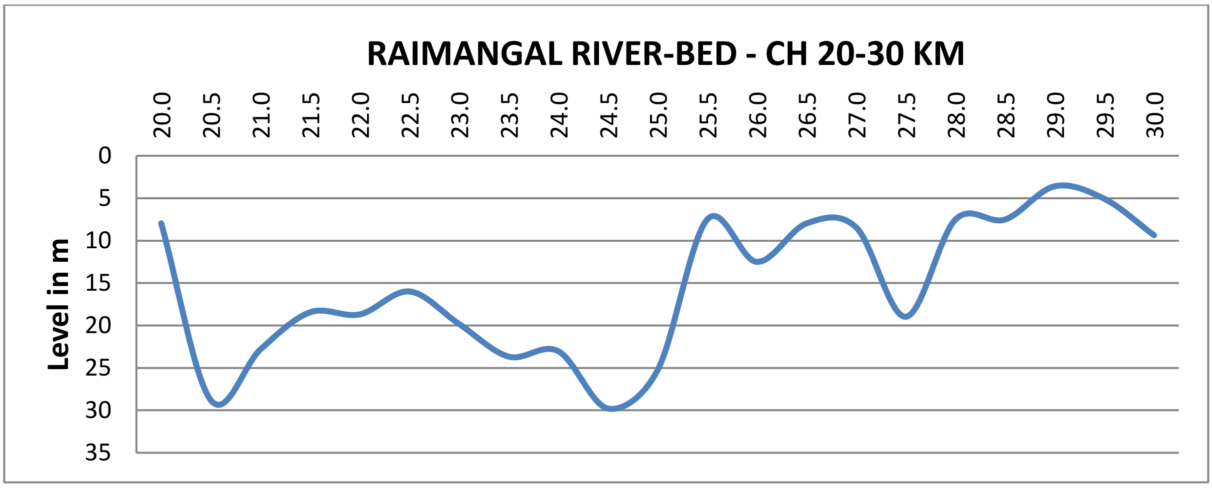


Figure 10: Bed Profile of Waterway Sub-stretch 3 (Chainage 20 km – 30 km)

Figure 11: Photograph along Sub-Stretch 3

2.5.4 Sub Stretch 4: From Chotta Sehara to Durgapur Dharam Bheria (30 km to 40 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 30 to 40 km chainage of the Raimangal River. The area is very sparsely populated. Both the banks are fairly populated as we move upstream towards Durgapur. Mangroves/bushes are present on both sides in the river. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch width is about 400 m. Some portion of the river bank is protected. The details of current and discharge at different depths is placed at **Table 7**.

- There is no road bridge or HT wire present in this stretch. There are no hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 3.83 m in this stretch.

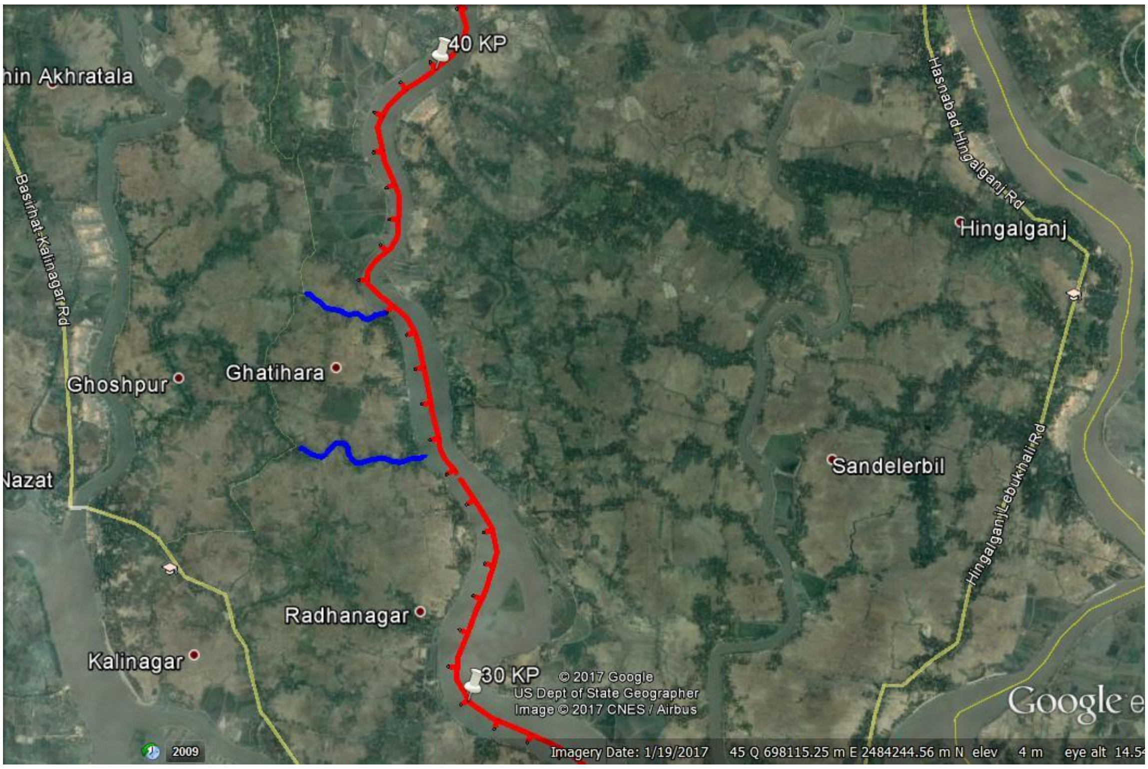


Figure 12: Google Image showing Sub-Stretch -4 of Waterway

Figure 12 above shows the alignment of sub-stretch 4 (Ch. 30.0 km to 40 km) of Waterway. The quantity of dredging required for all waterway classes for this stretch is provided in **Table 12**. **Figure 13** shows the observed and reduced bed profile of sub-stretch 4.

Table 12: Dredging Quantity (cum) for Sub-Stretch 4

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 Shoa (m)	Dredging Qty. (cu.m.)
I	30	40	Not Applicable Tidal Zone				1.54	28.78	0	0.00
II	30	40					1.46	28.78	0	0.00
III	30	40					1.44	28.78	0	468.23
IV	30	40					1.44	28.79	0	3884.00
V	30	40					1.22	28.79	0	7010.66
VI	30	40					1.15	28.79	0	42099.02
VII	30	40					0.56	28.79	0	61811.33

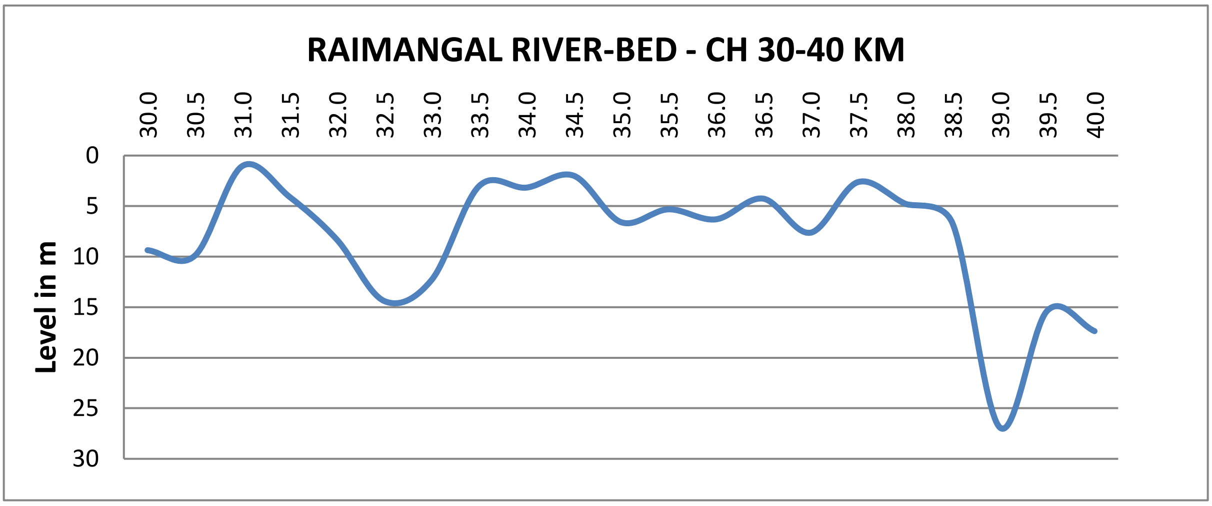


Figure 13: Bed Profile of Waterway Sub-stretch 4 (Chainage 30 km – 40 km)

2.5.5 Sub Stretch 5: Durgapur Dharam Bheria - Hasnabad (40 km to 53.4 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 40 to 53.4 km chainage of the Raimangal River. The area is very sparsely populated and has dense mangroves at some places on both the banks. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 300- 400 m. Some portion of the river bank is protected. There are Jetties available at Hasnabad and Par Hasnabad from where boat ply. The details of current and discharge at different depths is placed at **Table 7**.

- There is one HT wire connectivity near Hasnabad. There is no hindrance or encroachment in this stretch.
- One RCC Road bridge is located at Chainage 50.0 Km near Hasnabad.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.52 m in this stretch.
- Navigation is possible during high tide however dredging would be required for all time navigation at this stretch.

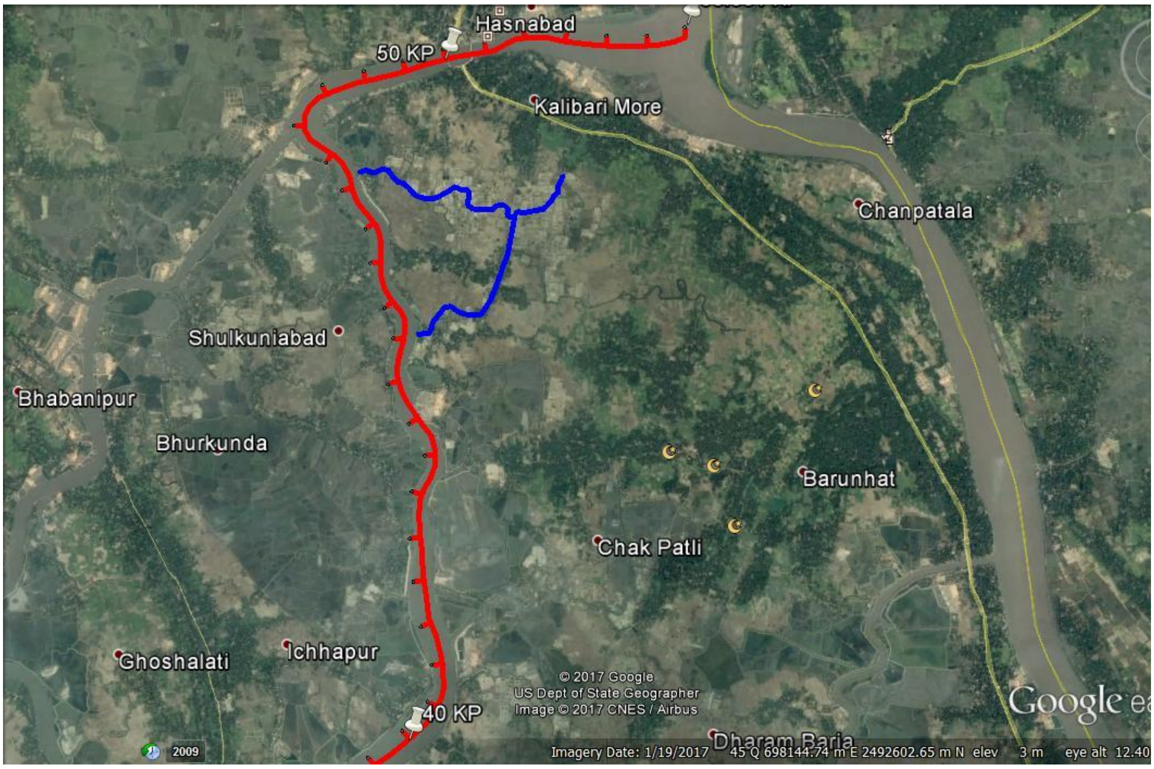


Figure 14: Google Image showing Sub-Stretch -5 of Waterway

Figure 14 above shows the alignment of sub-stretch 5 (Ch. 40.0 km to 53.4 km) of Waterway. The quantity of dredging required for all waterway class for this stretch is provided in **Table 13**. **Figure 15** shows the observed and reduced bed profile of sub-stretch 5.

Table 13: Dredging Quantity (cum) for Sub-Stretch 5

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	40	53.381	Not Applicable Tidal Zone				-2.02	22.09	1600	148513.41
II	40	53.381					-2.02	24.07	1600	208329.23
III	40	53.381					-2.19	24.07	1800	289627.10
IV	40	53.381					-2.23	24.07	1800	331408.66
V	40	53.381					-2.51	24.07	2000	503096.77
VI	40	53.381					-2.50	24.13	2400	682757.06
VII	40	53.381					-2.72	24.13	2600	838881.37

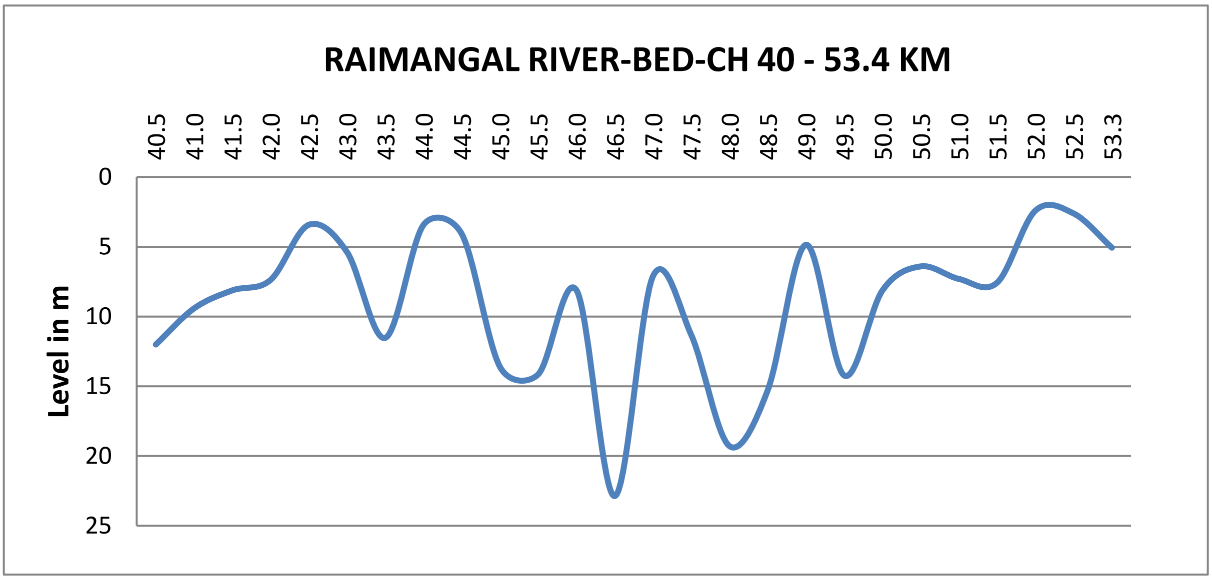


Figure 15: Bed Profile of Waterway Sub-stretch 4 (Chainage 40 km – 53.4 km)


Figure 16: Photograph along Sub-Stretch 4

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 14.**

Table 14: Soil & Water Sample Locations

Sample No.	Chainage (km)	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
1	0	22°11’43.09”	088°58’18.15”	703270.50	2455766.15	10
2	9.5	22°16’12.36”	088°56’57.58”	700855.84	2464018.91	5.4
3	20	22°21'2.3449"	088°54'15.9529"	696115.92	2472879.72	8.5
4	30.5	22°25’0.5362’	088°54’11.3281”	695890.89	2480204.74	10
5	40.5	22°29’46.1435”	088°54’25.5046”	696184.58	24888995.16	9
6	51	22°33’55.9735’	088°55’4.7091”	697206.55	2496694.34	5

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

<u>Soil Samples</u>

- Grain size
- Specific gravity
- PH Value

- Cu, Cc
- Clay Silt percentage

Water samples

- Sediment Concentration

Test result of samples is provided in **Figure 17**.

Drilltech Consultant
54A, Pratapaditya Road, Kolkata - 700026

CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES

Table No. : 3

Project : Laboratory Analysis of Soil & Water Samples | River : Raimangal | Job No. : 6154 H

Serial No.	Sample Ref. No.	Name of Sample	Chainage	Observed Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)	Total Solid (mg/lit)
Sample Reference					Test Results on SOIL SAMPLES (Particle Size Analysis: By Sieve Analysis)		(By Hydrometer Analysis)						Test Results on WATER SAMPLES (Sediment Concentration Test)
1	RM-03	Soil	20.00	8.50	0	8	49	43	2.63	7.98	6.00	1.50	-
2	RM-04	Soil	30.50	10.00	0	8	48	44	2.64	8.11	6.00	1.50	-
3	RM-05	Soil	40.50	9.00	0	4	49	47	2.61	8.44	6.00	1.50	-
4	RM-06	Soil	51.00	5.00	0	10	53	37	2.63	8.02	6.00	1.50	-
5	RM-02	Soil	9.50	5.40	0	6	44	50	2.62	8.72	6.00	1.50	-
6	RM-01	Soil	0.00	10.00	0	4	55	41	2.61	7.74	6.00	1.50	-
7	RM-01	Water	0.00	10.00	-	-	-	-	-	-	-	-	27638
8	RM-02	Water	9.50	5.40	-	-	-	-	-	-	-	-	27596
9	RM-03	Water	20.00	8.50	-	-	-	-	-	-	-	-	26112
10	RM-04	Water	30.50	10.00	-	-	-	-	-	-	-	-	24271
11	RM-05	Water	40.50	9.00	-	-	-	-	-	-	-	-	22984
12	RM--06	Water	51.00	5.00	-	-	-	-	-	-	-	-	22030

for DRILLTECH CONSULTANT

Figure 17: 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, barrage and any other cross-structure is located along the proposed fairway stretch.
b) Reduced depth of waterway varies from -2.2 m to 35.74 m w.r.t sounding datum.
c) Tidal variation varies from 3.725 to 4.55 m.
d) Width of river varies from 0.17 km to 2.28 km.

Figure 18 shows the proposed alignment of Raimangal waterway.

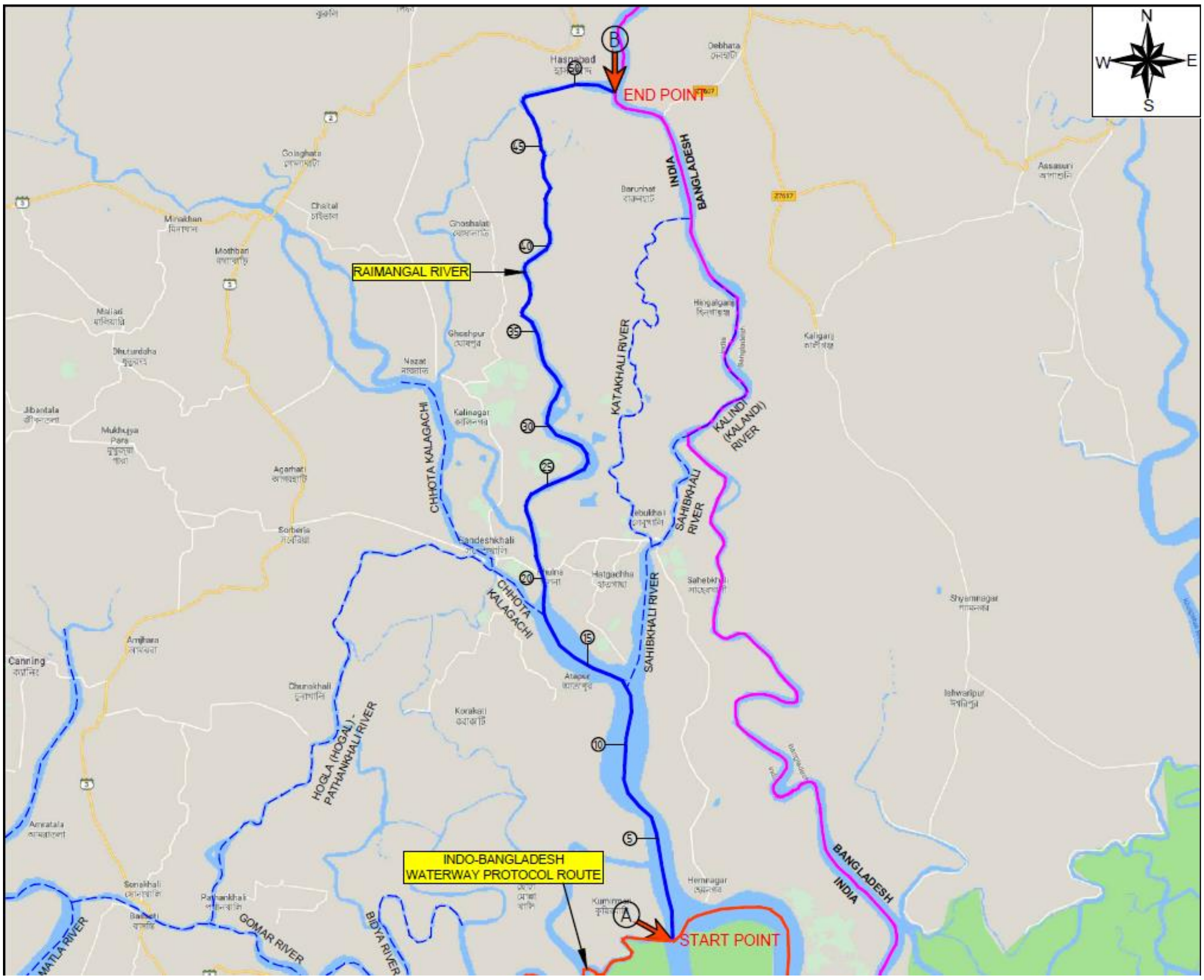


Figure 18: Proposed alignment of Raimangal Waterway

In addition to above features, Raimangal waterway is also connected with Indo-Bngladesgh Protocol Route at Chainage 0.0, which is already being maintained by IWAI

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 53.381 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 15** 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 Raimangal 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 19**. The dredging quantity obtained from Hypack software for 53.381 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:

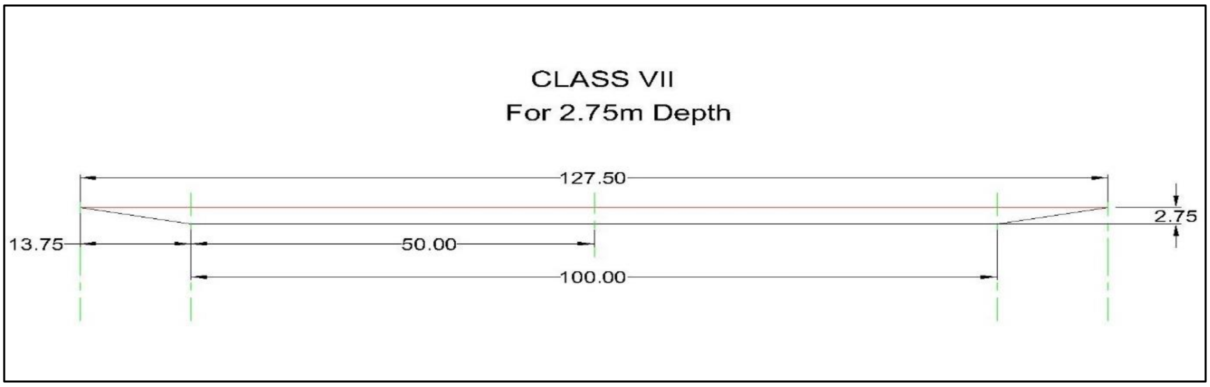


Figure 19: Fairway Dimension Class VII

Table 15: Dredging Quantity for Class VII Waterway

Chainage (KP)		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)				11.11	26.03	0	0.00	0.00
1	2					14.22	25.39	0	0.00	0.00
2	3					12.25	15.46	0	0.00	0.00
3	4					13.38	30.05	0	0.00	0.00
4	5					14.71	35.65	0	0.00	0.00
5	6					13.60	36.06	0	0.00	0.00
6	7					21.73	32.95	0	0.00	0.00
7	8					15.47	20.06	0	0.00	0.00
8	9					5.51	12.64	0	0.00	0.00
9	10					6.15	10.15	0	0.00	0.00
10	11					9.61	21.26	0	0.00	0.00
11	12					15.81	25.77	0	0.00	0.00
12	13					20.93	34.08	0	0.00	0.00
13	14					6.09	22.07	0	0.00	0.00
14	15					4.98	17.82	0	0.00	0.00
15	16					2.43	16.88	0	0.00	0.00
16	17					3.25	9.36	0	0.00	0.00
17	18					7.71	27.27	0	0.00	0.00
18	19					1.94	30.29	0	64	64
19	20					8.02	29.27	0	61	126
20	21					8.55	20.22	0	0.00	126
21	22					7.55	21.06	0	0.00	126
22	23					7.76	25.79	0	0.00	126
23	24					0.15	30.42	0	0.00	126
24	25					5.26	21.25	0	0.00	126
25	26					6.57	19.81	0	0.00	126
26	27					4.46	20.29	0	0.00	126
27	28					2.00	6.69	0	931	1057
28	29					0.33	10.13	0	23171	24229
29	30					0.74	9.17	0	55555	79784
30	31					4.51	15.84	0	0	79784

Chainage (KP)		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.
31	32					1.05	4.46	0	13536	93320
32	33					0.98	9.44	0	41301	134622
33	34					0.56	9.30	0	1593	136216
34	35					0.66	10.15	0	4057	140273
35	36					2.22	11.52	0	1322	141596
36	37					3.50	28.79	0	0	141596
37	38					3.40	21.18	0	0	141596
38	39					2.70	14.39	0	0	141596
39	40					2.38	8.28	0	0	141596
40	41					1.87	13.73	0	4266	145862
41	42					3.39	13.52	0	0	145862
42	43					4.17	23.30	0	0	145862
43	44					-0.46	20.88	200	807	146669
44	45					3.36	16.87	0	0	146669
45	46					-1.16	24.13	400	21260	167930
46	47					2.48	20.54	0	69	167999
47	48					-1.40	12.81	200	9762	177762
48	49					1.75	10.34	0	2701	180464
49	50					-0.89	6.30	200	42364	222828
50	51					1.52	9.01	0	4031	226860
51	52					-2.72	0.34	1000	439887	666748
52	53.381					-2.61	1.54	600	313729	980477
				Total				**Total**	**980477**	

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 9,80,477 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 20: 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

One HT line is located at Chainage 49.53 Km. Vertical and horizontal clearance available at existing HT line location w.r.t. MHWS is 17.562 m and 383 m respectively. One RCC Road Bridge is located at Chainage 50.0 Km near Hasnabad. The bridge was underconstruction at the time of survey.

No modification is proposed in the existing structures.

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 Raimangal 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 9,80,477 cum = INR 19,60,95,494/- (INR **1,960.95** 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 9,80,477 cum = INR 1,96,09,549 /- **(INR 196.10 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.

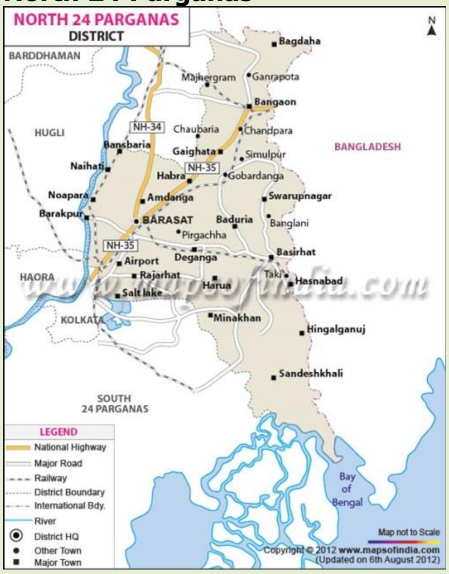
4.2 INFLUENCE AREA / HINTERLAND

Raimangal river flows through four (4) CD blocks of North 24 Parganas disctrict, namely, Hingalganj, Sandeshkhali – II, Sandeshkhali - I and Hasnabad. The Project Influence Area (PIA), considering existing and projected traffic for passenger ferry services, comprises of the following CD blocks and

[1] District Census Handbook, 2011

districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 16**.

Table 16: Project Influence Area/ Hinterland

<table>
<tr><th>District</th><th>Area (Km²)</th><th>C.D. Block</th><th>Area (Km²)</th><th>Total Hinterland area (Km²)</th></tr>
<tr><td rowspan="4">North 24 Parganas

</td><td rowspan="4">4094</td><td>Hingalganj</td><td>238.80</td><td rowspan="4">711.39</td></tr>
<tr><td>Sandeshkhali - II</td><td>197.22</td></tr>
<tr><td>Sandeshkhali - I</td><td>182.3</td></tr>
<tr><td>Hasnabad</td><td>153.07</td></tr>
</table>

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Raimangal waterway is provided in **Table 17** below:

Table 17: Population of Hinterland

<table>
<tr><th>State</th><th>District</th><th>Population (Nos.)</th><th>C.D. Block</th><th>Populatio n (Nos.)</th><th>Total Hinterland Population (Nos)</th></tr>
<tr><td rowspan="4">West Bengal</td><td rowspan="4">North 24 Parganas</td><td rowspan="4">1,00,09,781</td><td>Hingalganj</td><td>1,74,545</td><td rowspan="4">7,03,248</td></tr>
<tr><td>Sandeshkhali - II</td><td>1,60,976</td></tr>
<tr><td>Sandeshkhali - I</td><td>1,64,465</td></tr>
<tr><td>Hasnabad</td><td>2,03,262</td></tr>
</table>

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Raimangal waterway includes North 24 Parganas disctrict of West Bnagal. Gross State Domestic Product (GSDP) prices of West Bengal and growth rate in percentage are provided in **Table 18** and **Table 19** as below:

Table 18: 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 19: 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.

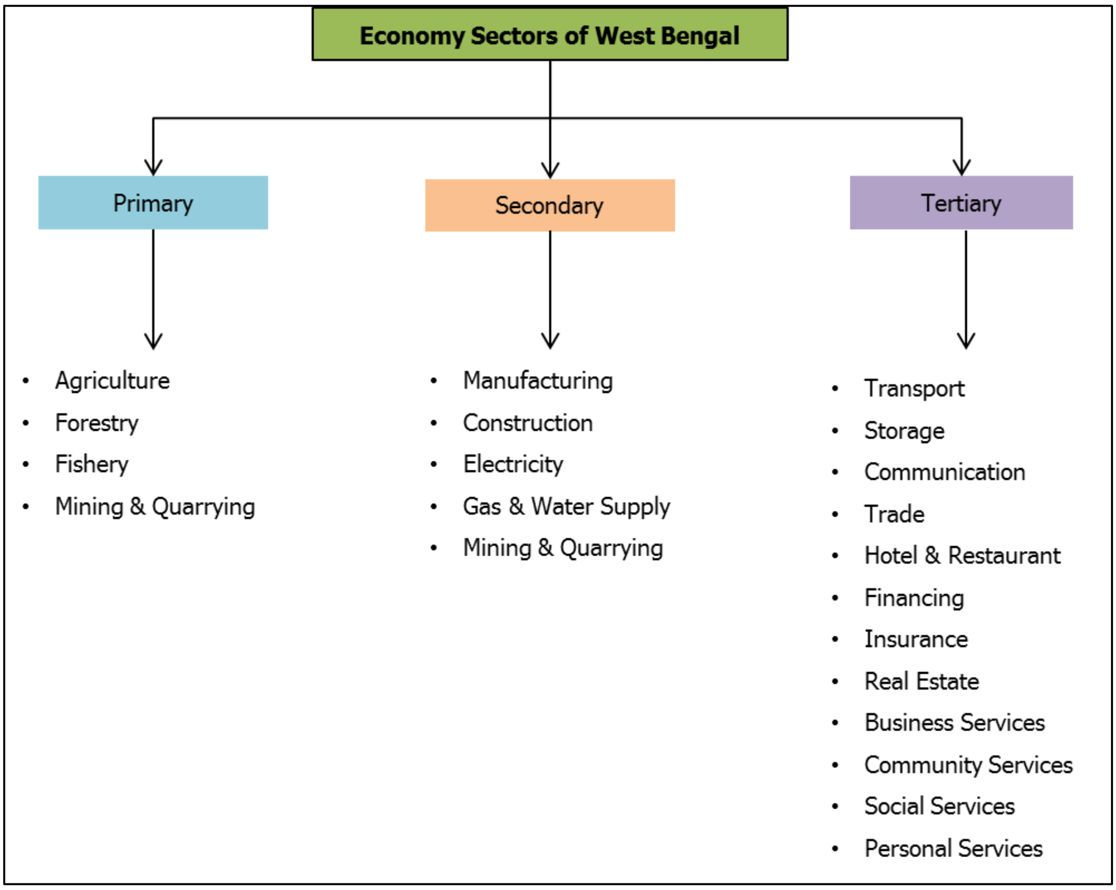


Figure 21: Sectors of West Bengal

Figure 22 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 23** 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.

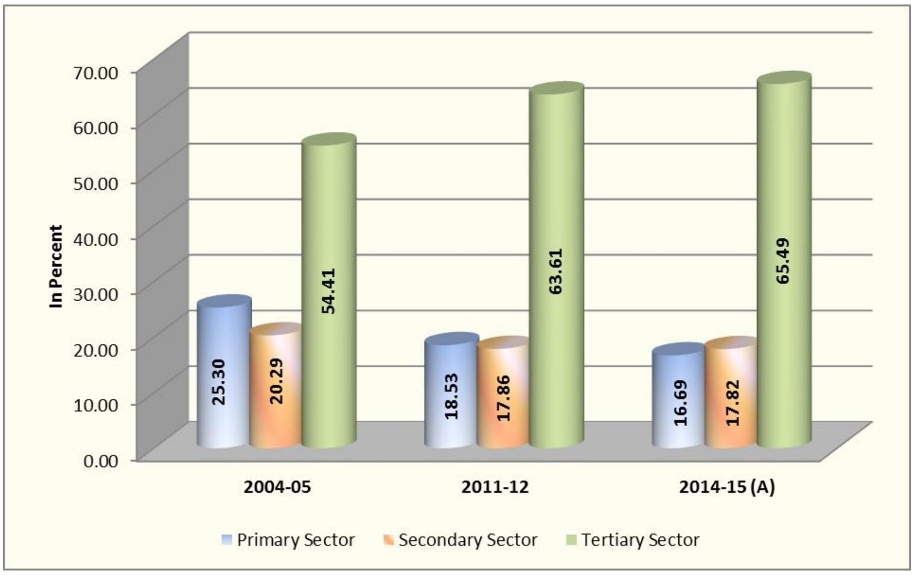


Figure 22: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

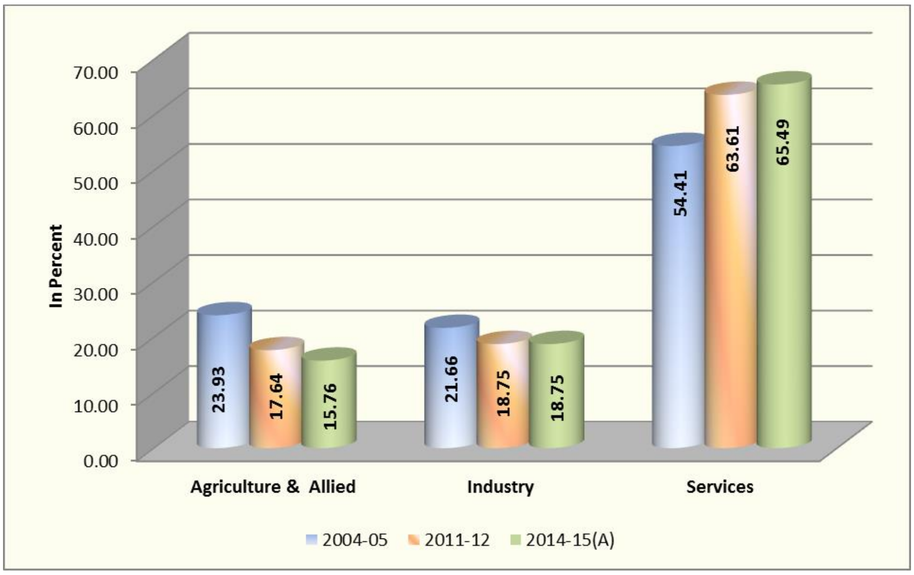


Figure 23: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

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 20** and the same is presented in **Figure 24** as below:

Table 20: 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

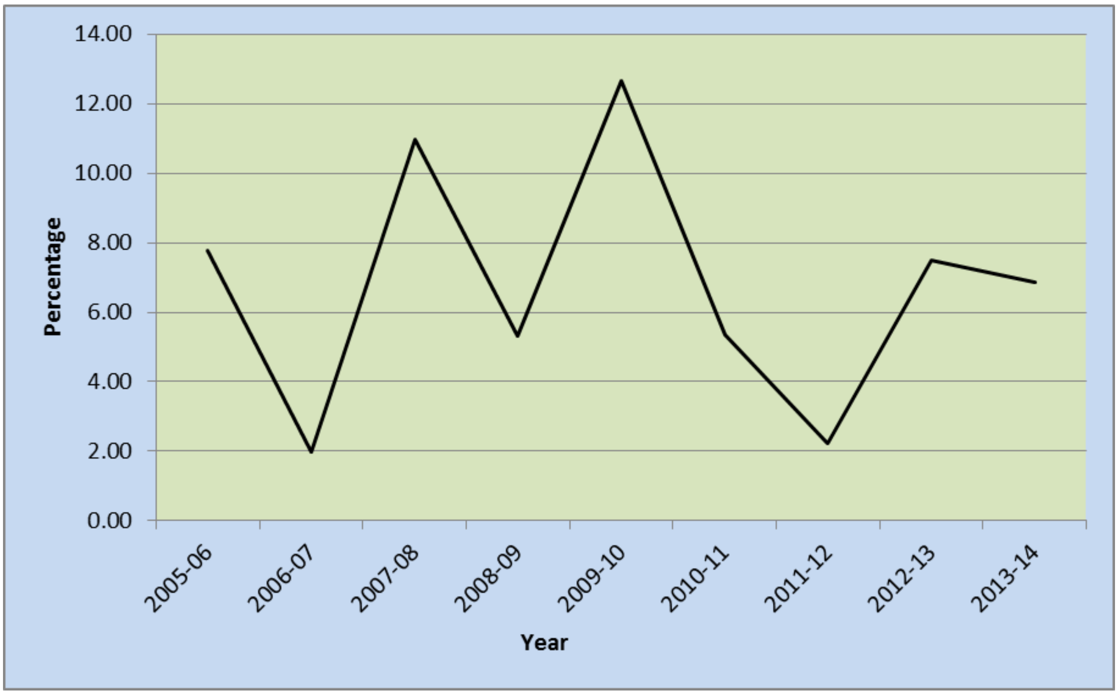


Figure 24: Annual Growth Rates of Gross District Domestic Product

Table 21: 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 21,** 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 25** as below:

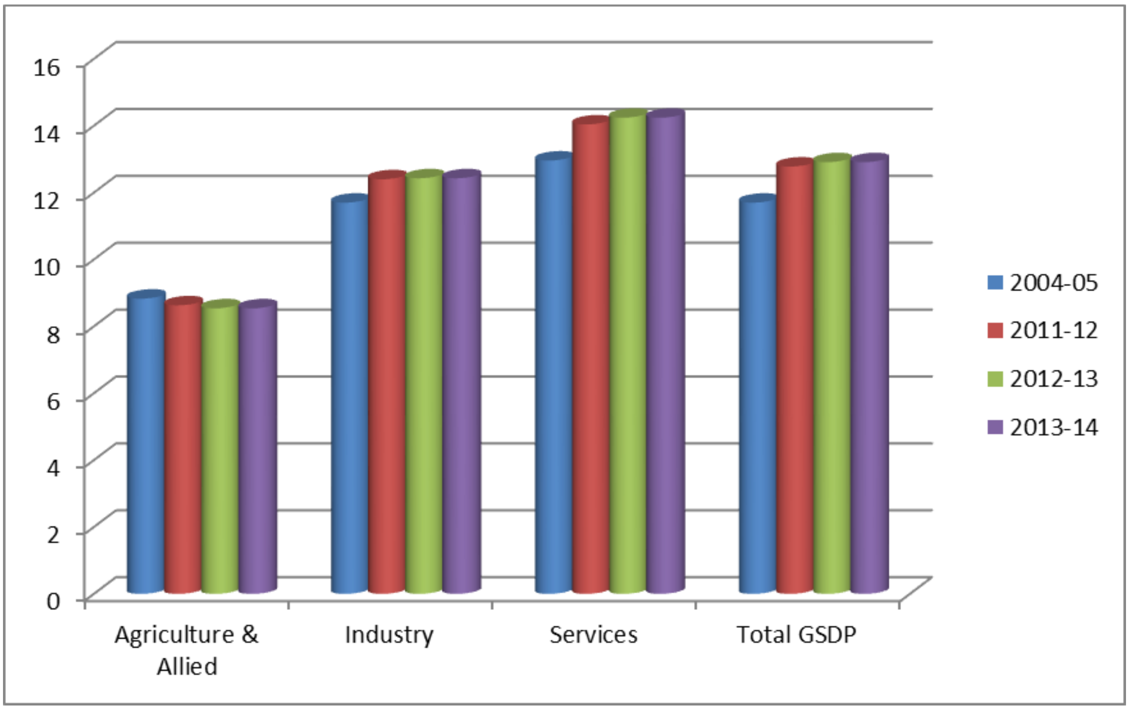


Figure 25: Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy

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 well connected with road and rail network. The nearest major rail head is at Hasnabad and SH 2 & 3 is in the vicinity. Ferry services runs from Hasnabad to Par Hasnabad, Kheya Ghat to Bhandarkhali, Khulna to Sandeshkhali, Rajni Ferry Ghat to Atapur Ferry Ghat & Hemnagar to Khulna. Mobile network is intermittently available in the area. There is one road bridge (at chainage 50.0 Km) and one High Tension wire in Raimangal River.

4.2.5 Connectivity with Other Wateways

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

Table 22: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Indo-Bangladesh Waterway Protocol Route	0.0 Km
2.0	Sahibkhali Waterway	12.70 Km
3.0	Chhota Kalagachi Waterway	18.12 Km

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Raimangal 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 and government bodies.

Also, the river connects to the Indo Bangladesh Waterway Protocol Route at Hemnagar.

Existing and proposed commodities planned for Raimangal 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 Raimangal waterway.

4.3.3 Passenger Traffic

Passenger ferry services are available at various locations along the 53.381 km stretch of Raimangal river. The details of passenger ferry services are provided in Table 23.

Table 23: Existing Passenger Ferry Services in Raimangal River

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
1	Hemnagar Jetty	Kumirmari, Kalidaspur	280
2	Hemnagar Jetty 1	Kumirmari	200

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
3	Sardar Para Ferry Ghat Jettty 1	Manipur	225
4	Sardar Para Ferry Ghat	Chimta	120
5	Jogesganj Jetty	Punjali	50
6	Kumirmari ferry	Choto sehara kheya ghat	150
7		Hasnabad	
8	Malpada	Bolakhali	300
9	Paraghata	Bailani	250
10	Sandeshkhali Purba	Khulna ferry ghat	500
11	Sardarpara ferry	Dhamakali/Arsadmiya	600
12	Atapur	Rajani ferry ghat	600
13	Hasnabad	Par Hasnabad	4500
14	Shulkuniabad	Chak khapukur	200
15	Binara	Raypur	450
16	Choto sehara	Kumirmari ferry	150
17	Bara sehara	Kumirmari ferry	100

From the above listed ferry services, Hasnabad to Par Hasnabad ferry service is operated by Government of West Bengal. All other ferry services are locally operated. **Figure 26** below shows the photographs of berthing locations at Hasnabad ferry ghat.

Figure 26: Photographs of Berthing Point at Hasnabad Ferry Ghat

In addition to above, the facilities that are available at Hemnagar Terminal include an IWAI regional office, customs office and mooring facility for ships carrying cargo in Bangladesh through Indo-Bangladesh Waterway Protocol Route.

4.4 ORIGINATING / TERMINATING COMMODITIES

Only passenger traffic with small cargo like agricultural products, fish, bricks, construction materials and two wheelers are located along the waterway.

4.5 TOURISM TRAFFIC

There are no major toruism traffic along the waterway. However, Hemnagar terminal, which is located at the confluence point of Raimangal waterway and Indo Bangladesh protocol route, is also located at the entrance of Sunderbans reseve forest area. Accordingly, the Hemnagar terminal is recommended to be developed to support the tourist traffic of Sunderbans reserve forest area.

4.6 IBP ROUTE TRAFFIC AND ITS POTENTIAL MOVEMENT IN RAIMANGAL WATERWAY

An Inland water transit and trade protocol exists between India and Bangladesh under which inland vessels of one country can transit through the specified routes of the other country. The existing protocol routes are (i) Kolkata-Pandu-Kolkata, (ii) Kolkata-Karimganj - Kolkata, (iii) Rajshahi-Dhulian-

Rajshahi and (iv) Pandu-Karimganj-Pandu. For inter-country trade, six ports of call have been declared in each country under the PIWT&T[2]. The Ports of call in India are Haldia (West Bengal), Kolkata (West Bengal), Dhubri (Assam), Pandu (Assam), Karimganj (Assam) and Silghat (Assam). The Ports of call in Bangladesh are Narayanganj, Khulna, Mongla, Sirajganj, Ashuganj and Pangaon as shown in **Figure 27** below. Under the Protocol, 50:50 cargo sharing by Indian and Bangladeshi vessels is permitted both for transit and inter country trade.

Figure 27: The Indo Bangladesh Protocol (IBP) routes under PIWT&T

IWAI is the Competent Authority on Indian side w.e.f. 8th September 2003 vide Ministry's Order No. WTC-15014/2/2001-IWT dated 29.08.03 and is responsible for maintenance of routes including

[2] Annual Report on Traffic on National Waterways: FY 2019-20, by IWAI

conservancy and pilotage. The stretch of IBP route along proposed 13 rivers of National waterway 97, Sunderbans waterways is shown in **Figure 28** below.

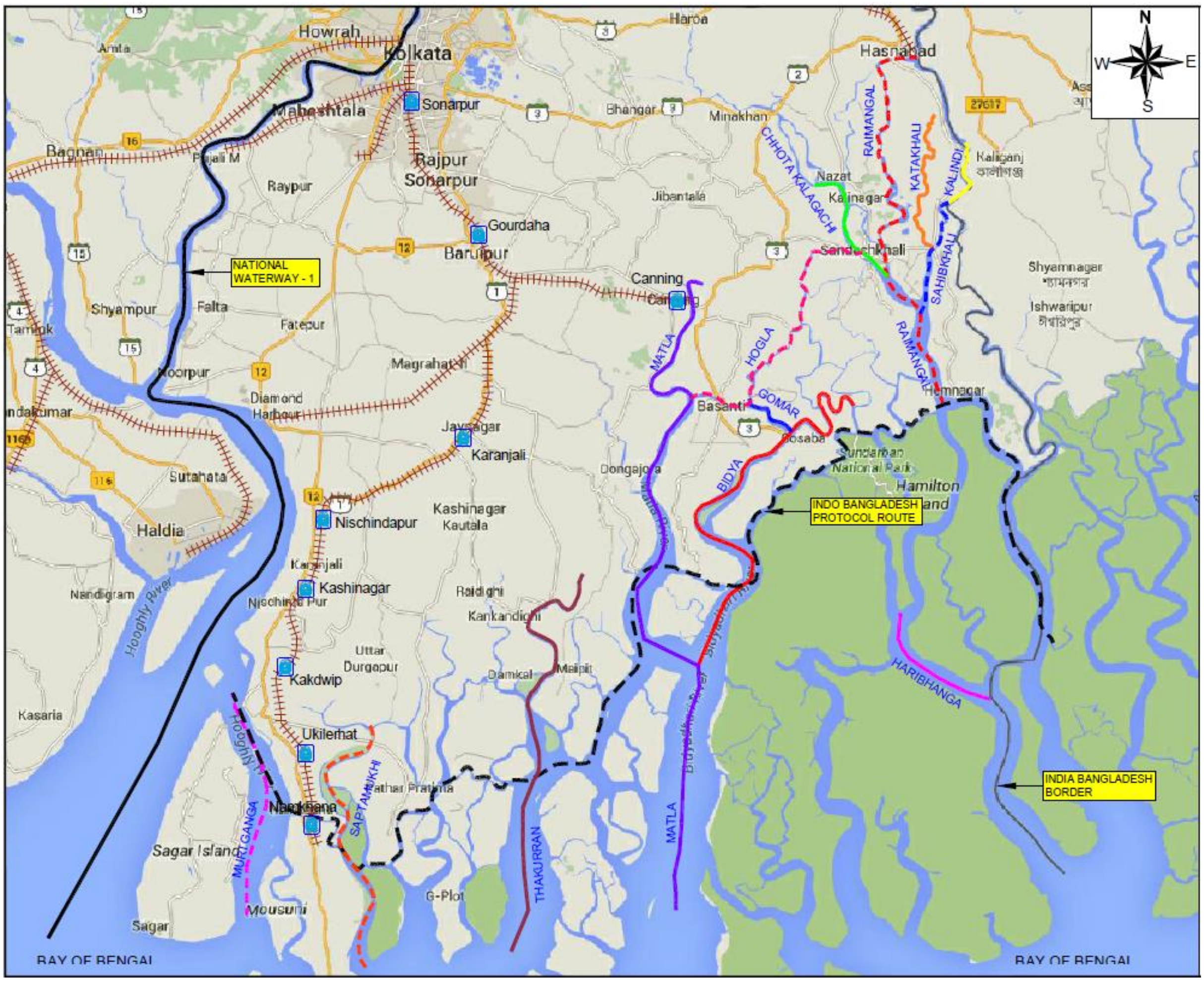


Figure 28: Location map of IBP route along NW97 (Sunderbans Waterways)

Traffic on the IBP route predominantly consists of fly ash movement from Kolkata/Haldia to destinations based in Bangladesh. Fly ash movement to Bangladesh is driven by the requirement of Cement plants. M/s Feedback Infra (P) Limited had conducted the Technical, Economic and Financial (TEF) feasibility studies for development of Sunderbans Inland Waterways in the IBP route[3]. The final report was submitted to IWAI on 30th March 2017. As per the report, the Indo-Bangladesh protocol route is the major contributor towards Indo-Bangladesh trade through waterways.

[3] Final Technical, Economic & Financial Feasibility Report on Development of Sunderbans Inland Waterways, 2017, by IWAI

According to the TEF studies, majority of the cargo in the IBP route constitute of Fly ash, Slag, Clinkers and Gypsum. These products are raw materials to Cement industries and other manufacturing industries in Bangladesh. The cargo movement in IBP route is majorly from the Kolkata cluster to various river ports in Bangladesh.

Some of indicative long-standing linkages between industries in the region are as follows.

- Fly ash – from Kolaghat and Bandal coal-fired power plants (West Bengal Power Development Corporation Limited)
- Gypsum – from chemical industries cluster in Haldia
- Clinker – from cement industries (Ambuja, ACC Cement, etc.)
- Granulated slag – from steel plants in Kolkata cluster

The protocol route was also used for transportation of commodities including fuel (diesel and petrol), food grains (rice and pulses), iron rods, etc. to Tripura and other north-eastern states. The commodities are majorly transshipped through Ashuganj port (on Kolkata-Karimganj route) and moved through road to the north-eastern states.

Based on the commodity flows and industrial assessment, the traffic along the protocol route were broadly classified into three categories in the TEF studies, as shown below:

a) Trade traffic – includes commodity movement between Kolkata (via Petrapole Land Port, Kolkata Sea and waterways) and Bangladesh.
b) Transit traffic – includes commodity movement between the hinterland and North-Eastern states such as Assam, Tripura, Manipur, Mizoram, Meghalaya and Arunachal Pradesh.
c) Traffic within Sunderbans – Includes the passenger and commodity movement between major population nodes of Sunderbans.

It was concluded from the feasibility studies that, major component of traffic in sunderban waterways along IBP route comprises trade and transit traffic only. Traffic within sunderbans comprises of passenger movement only because of tourism and work. This movement is by ferry across rivers, on short stretches along rivers and tourism based passenger traffic. On the bais of estimated traffic, IBP route was proposed for development in the TEF feasibility report along with terminal infrastructure facilities at 3 locations i.e. Kolkata, Haldia and Hemnagar. The Hemnagar Terminal is proposed as a Customs check-point and no loading or unloading of material/cargo is envisaged at the terminal.

The results concluded from this TEF studies are also supported by the IBP route traffic presented in the Annual Report on Traffic on National Waterways of FY 2019-20, published by IWAI.

As per the Annual Report on Traffic on National Waterways of FY 2019-20, published by IWAI, approx. 3.5 million tonne of traffic moved on the IBP route in FY-20 and displayed a growth of approx. 7% over FY-19 as shown in **Figure 29**. Vessels plying on IBP route for fly ash movement are shown in **Figure 30**.

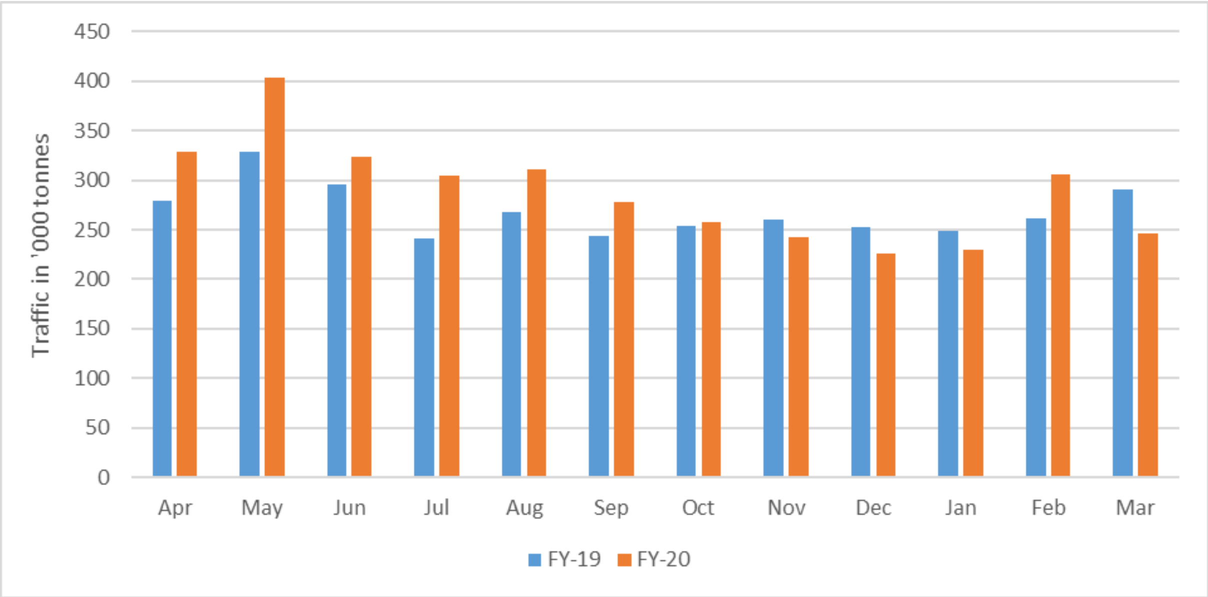


Figure 29: IBP route: Month-wise traffic (FY-19 & FY-20)

Figure 30: Vessels plying on the IBP route

Figure 31 below shows the commodity profile of the traffic handled on the IBP route in FY-20. It can be observed that almost 97% of the traffic on the IBP route is fly ash. The jetties at the origin locations handling fly ash are IWAI Haldia Jetty (30%), Budge Budge, Kolkata (24%), T.T Shed (18%) and G.R Jetty 2 (14%). Among the jetties at the destination locations, Narayanganj receives 84% of this fly ash followed by Khulna which receives the remaining 16%.

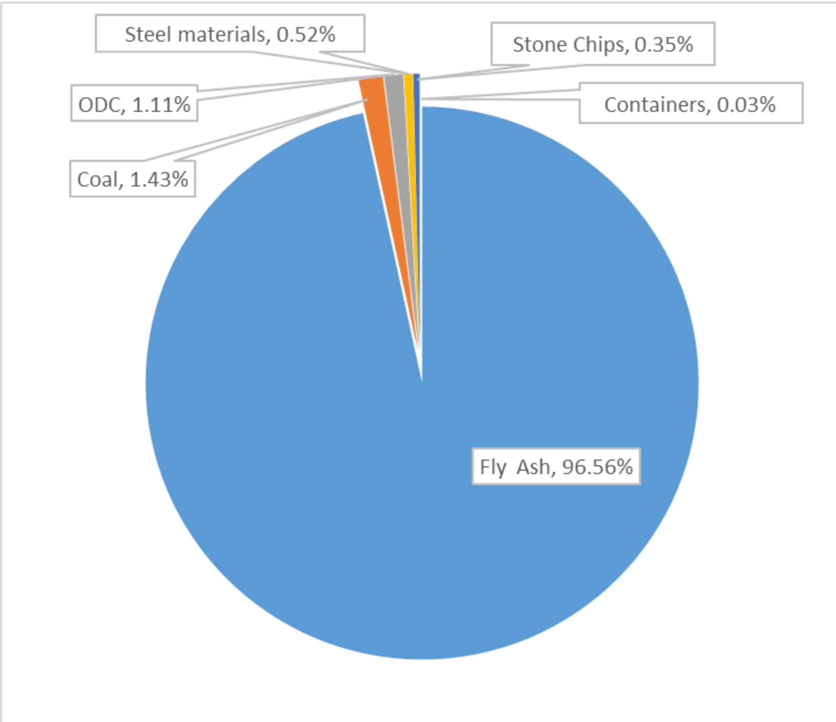


Figure 31: IBP route: Commodity profile of traffic (FY-20)

Commodities other than fly ash constitute approx. 3% of traffic on the IBP route, of which coal is the highest (1.4%) followed by Over Dimensional Cargo (ODC) (1.11%). Steel materials, Stone chips and Containers constitute less than 1% of the traffic.

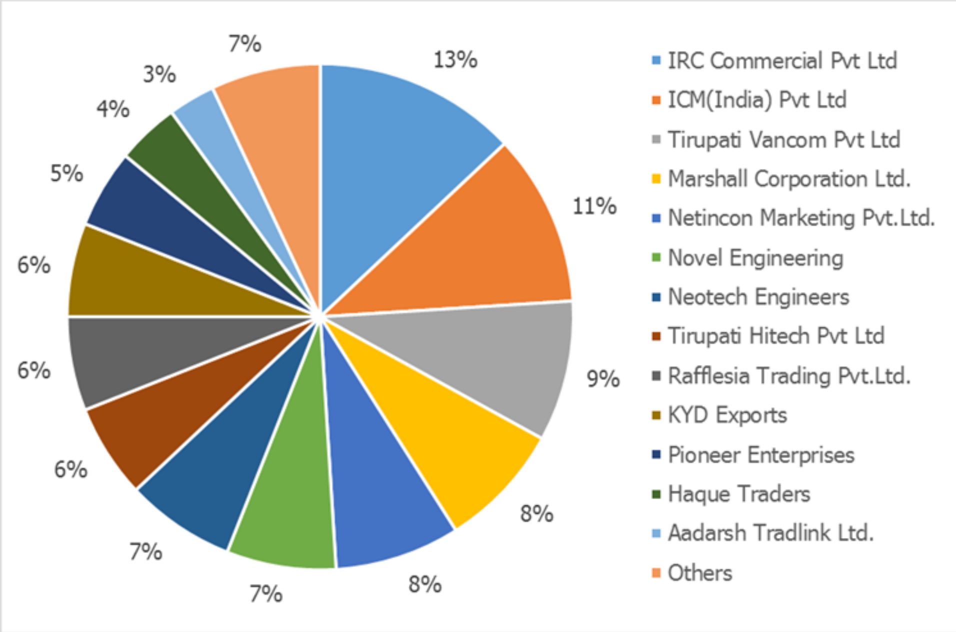
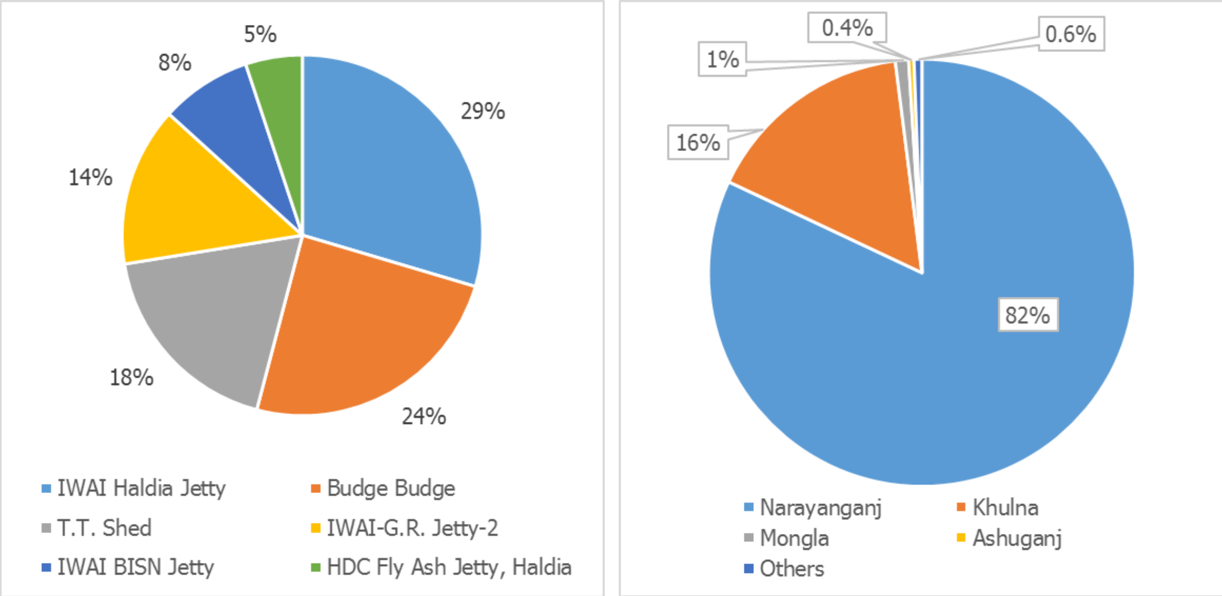


Figure 32: IBP route: Shipper-wise traffic (FY-20)

Figure 32 above shows the key shippers who used the IBP route for movement in FY-20. It can be observed that there are multiple shippers who move their cargo using the IBP route. Most of these shippers are exporters of fly ash. There are close to 39 shippers on the IBP route of which the top 13 constitute 93% of the traffic. The balance 25 shippers also include large scale companies like Bharat Heavy Electricals Limited (ODC, Steam Turbine & Steel), Jindal Steel & Power (Steel materials) and Tata Steel (Hot rolled steel coils).



Jetty-wise share of traffic at origin (FY-20) | Jetty-wise share of traffic at destination (FY-20)

Figure 33: IBP route: Jetty-wise share of traffic at origin & destination (FY-20)

Figure 33 above shows the jetty wise share of cargo handled both at the origin and the destination on the IBP Route in FY-20.

It can be observed that among the origin jetties/ports (India Ports of call), 85% of the traffic on the IBP route is handled at 4 jetties namely IWAI Haldia Jetty, Budge Budge-Kolkata, T.T Shed-Kolkata and G.R Jetty 2-Kolkata. Of these 4, the top 2 jetties, IWAI's Haldia Jetty and Budge Budge Jetty only handled fly ash and steam coal. T. T Shed primarily handled fly ash along with a small quantity of ODC and steam coal, whereas IWAI's G.R. Jetty 2 handled a variety of commodities. Of the remaining jetties, HDC fly ash Jetty and IWAI's BISN Jetty constituted 13% of the traffic. HDC fly ash jetty and IWAI BISN Jetty handled fly ash. The other jetties such as KPD, Kolkata, NS Dock, Kolkata and HDC, Kolkata jetties handled 2 % of the traffic mainly consisting of project cargo and steel materials.

In terms of the destination jetties/ports (Bangladesh Ports of call), Narayanganj and Khulna handled more than 98% of the traffic. Both these jetties predominantly unload fly ash along with small quantities of project cargo, steel material and stone chips.

A total of 12 jetties on NW-1 loaded traffic for the IBP route in FY-20, of which 6 jetties loaded 98% of the traffic.

Proposed Raimangal Waterway connects with Indo Bangladesh Protocol route at Hemnagar (Chainage 0.0) as shown in **Figure 34**.

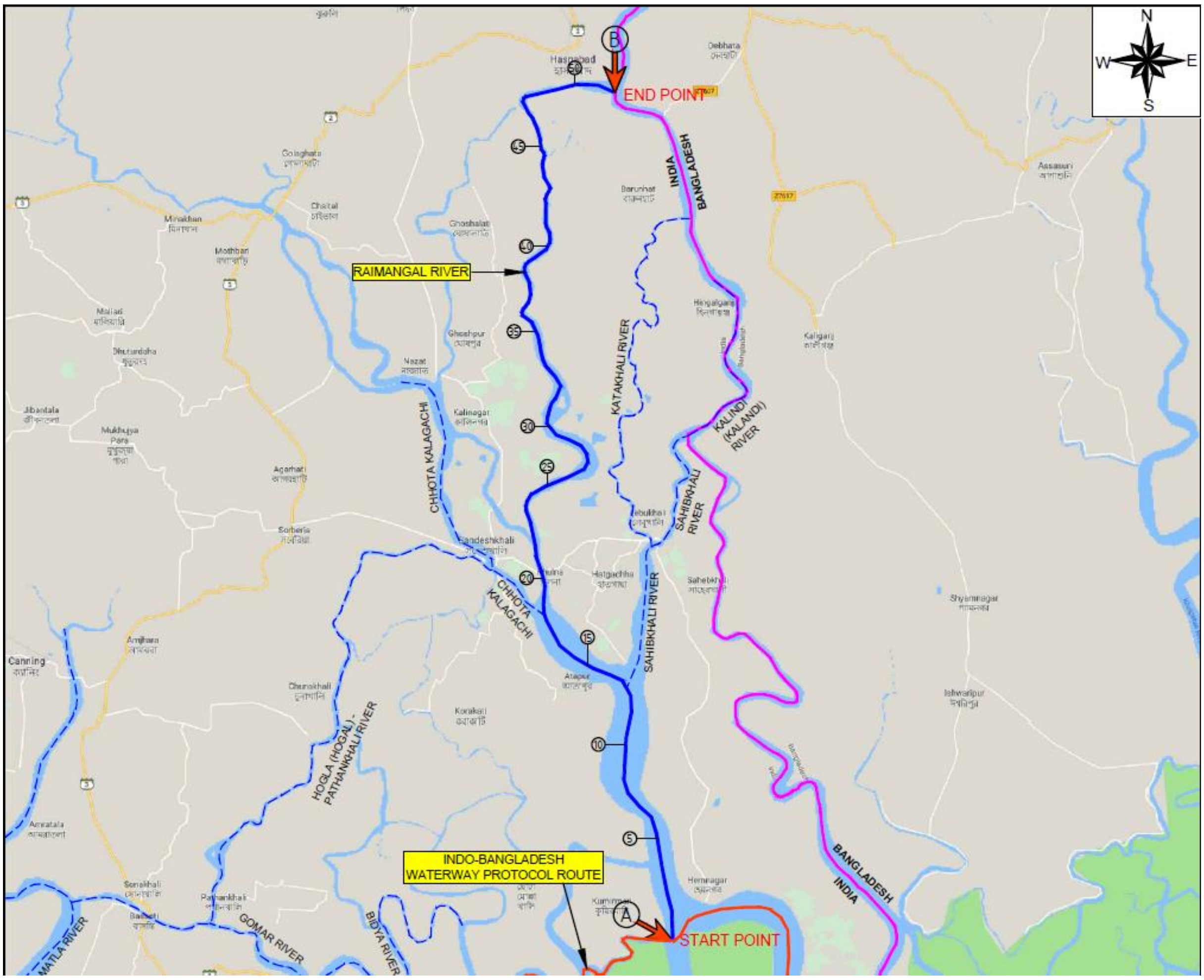


Figure 34: Raimangal Waterway route along IBP route

As per the traffic studies done in this DPR, TEF report for development of Sunderbans waterways in the IBP route and IBP traffic data provided in annual Report on Traffic on National Waterways (FY 2019-20) preparaed by IWAI, potential of cargo movement is not envisaged from/to Raimangal waterway to/from IBP route.

4.7 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. In discussions with local boat operators during traffic survey done in April 2017, following information were acquired:

a) Ferries are operated by locals.
b) Local ferries are only means of transport to cross the river.
c) Two wheelers are also carried by passengers on ferry boats.
d) Large number of people uses ferry boats to cross rivers for work, school and other livelihood stuff.
e) With no plan of construction of any bridge or cross-structure across the river by Government in near future, the dependency on local ferries will increase with growth in local population.

As Hasnabad jetty having maximum passenger traffic of 4500 pax per day, is operated and maintained by Govt. of West Bengal. Daily passenger traffic of Sardarpara ferry jetty 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 Raimangal waterway for 20 years is shown in **Figure 35**.

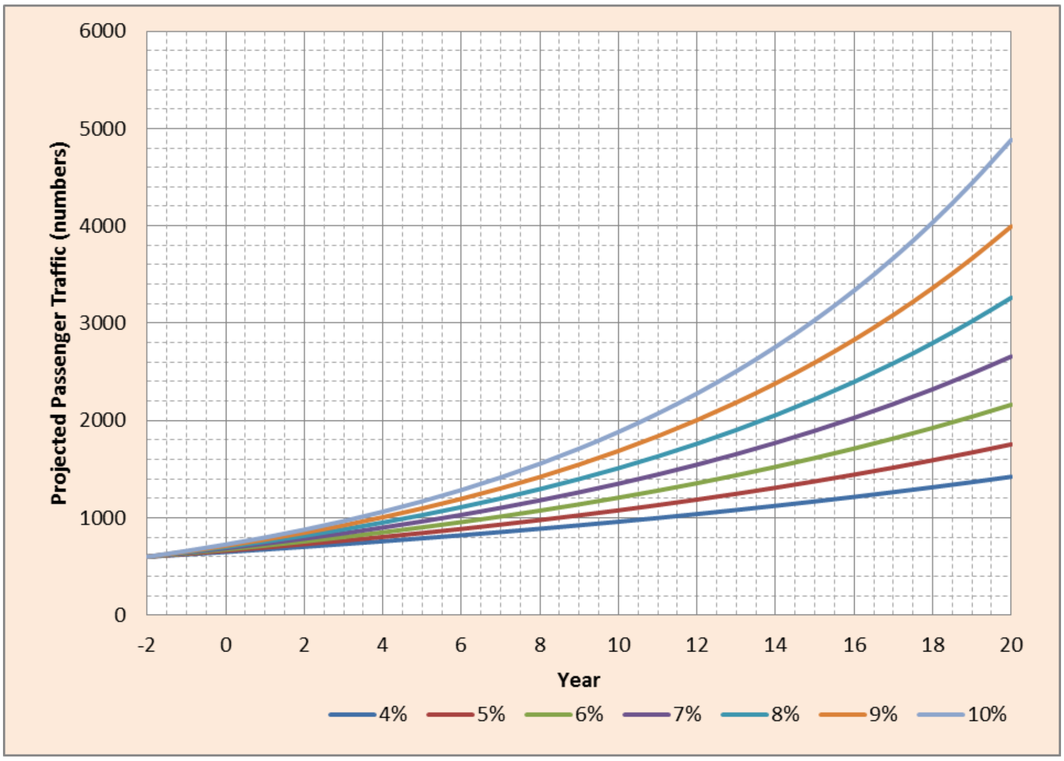


Figure 35: Projected Passenger Traffic of Raimangal River

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

4.8 INFRASTRUCTURE PROPOSED BY GOVERNMENT OF WEST BENGAL

In view of growth in traffic for river crossing at Hasnabad and considering the safety of commuters, Government of West Bengal proposed to construct a road bridge at Hasnabad. The bridge is under construction by PWD at the time of survey, West Bengal, refer **Figure 36**.

Figure 36: Photographs of Road Bridge under construction at Hasnabad

4.9 CONSLUSION

Following conclusions are made from the traffic studies done above:

a) Proposed Raimangal waterway is connected with Indo Bangladesh waterway protocol route, Sahibkhali and Chhota Kalagachi National waterways.
b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Hemangar Jetty for mooring located at 0.0 Km Chainage.
c) There are no big industries near the survey area, however few brick kilns are found along the river banks.

d) Hemnagar Terminal has facilities that include an IWAI regional office, customs office and mooring facility for ships carrying cargo in Bangladesh through Indo-Bangladesh Waterway Protocol Route.
e) 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 Raimangal river with major waterways, Passenger ferry services with floating Pontoon and Gangway facilities are proposed at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. Accordingly following OD links are proposed for development in Raimanagl waterway:

a) Link 1: Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat (OD pair length is 15 Km)
b) Link 2: Atapur ferry ghat – Khulna ferry ghat (OD pair length is 3 Km)
c) Link 3: Sandeshkhali Purba – Khulna ferry ghat (OD pair length is 0.5 Km)
d) Link 4: Raypur – Binara ferry ghats (OD pair length is 0.45 Km)

Arsadmiya ferry ghat along OD Link1 is located along Chhota Kalagachi waterway and considered for development in Chotta Kalagachi waterway DPR. Thus, the same is not detailed further in this DPR.

In addition to the above, Hemnagar ferry terminal is also proposed to be developed as a tourism jetty for tourist traffic of Sunderbans Reserve Forest Area. The details of infrastructure and vessel design in accordance with above proposed developments are provided in subsequent DPR chapters.

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

Raimangal river is having potential for Inland Water Transport due to its topography, location and connectivity with other declared national waterways including Indo Bangladesh protocol (IBP) Route.

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

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.

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 Raimangal River as provided in **Table 24.**

Table 24: List of Existing Jetties

Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Hemnagar	22°12'20.52"N 88°59'0.10"E	0.0 Km	2.5m	Dulduli-Hemnagar road	Hemnagar
Sardarpara ferry	22°16'12.26"N 88°57'10.66"E	9.5km	2.2m	Dulduli-Hemnagar road	Sardarpara, Madhabkati, Patghara,
Atapur	22°19'31.36"N 88°54'3.07"E	17.5km	2.1m	Khulna-Banderkhali road	Atapur, Tushkhali, Dhuchnikhali
Khulna	22°21'1.30"N 88°54'18.50"E	20km	1.5m	Khulna-Banderkhali road	Khulna, Dholkhali, Hatgachha
Sandeshkhali Purba	22°21'2.13"N 88°54'5.17"E	20km	1.5m	Khulna-Banderkhali road	Sandeshkhali
Bolakhali	22°23'16.53"N 88°54'1.16"E	24.4km	1.8m	Basirhat-Kalinagar road	Bolakhali, Bara sehra, Nityabaria
Malpada (Bowthakurani)	22°23'6.34"N 88°54'3.46"E	24.4km	2.1m	Khulna-Banderkhali road	Malpada, Bouthakurani, Tongatala, Bhandarkhali
Kumirmari	22°24'51.45"N 88°54'38.66"E	29.6 km	1.1m	Basirhat-Kalinagar road	Kumirmari, Ripmari, Bainara
Bara sehra	22°24'41.10"N 88°54'17.75"E	29.9km	1.2m	Basirhat-Kalinagar road	Chhota sehra, Radhanagr, Bara sehra, Nityabaria
Choto sehara	22°24'58.02"N 88°54'10.56"E	30.4km	1.5m	Basirhat-Kalinagar road	Chhota sehra, Radhanagr, Bara sehra, Nityabaria

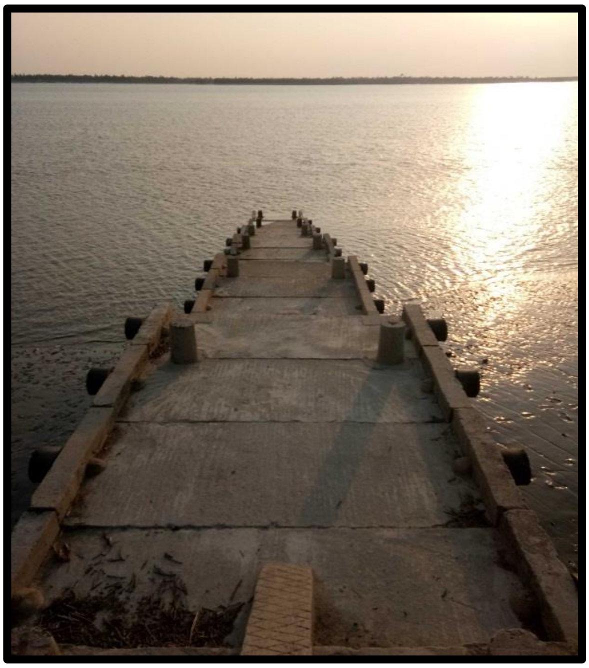
Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Binara	22°26'32.55"N 88°54'27.90"E	33.4km	1.0m	Basirhat-Kalinagar road	Bainara, Dhanikhali, Paschim khejurbaria, purba khejurbaria, Rupmari
Raypur	22°26'25.79"N 88°54'14.15"E	33.4km	1.0m	Basirhat-Kalinagar road	Raipur,Radhanagar, Ghaihara
Bailani	22°28'52.01"N 88°53'49.90"E	38.4km	1.1m	Bailani-Hasnabad road	Durgapur bailani, Dharam Baria, kakaria, Pubergheri, Dhanikhali
Paraghata	22°28'53.35"N 88°53'33.88"E	38.5km	1.0m	Bailani-Hasnabad road	Paraghata, Bademari, Ichapur, Ghatihara
Chak khanpukur	22°32'33.75"N 88°54'9.87"E	46 km	1.1m	Chakpatil-Hasnabad road	Chak khanpukur, Purba chak
Shulkuniabad	22°32'33.07"N 88°53'59.70"E	46km	1.2m	Hasnabad-Hingalganj road	Shulkuniabad
Hasnabad	22°33'58.36"N 88°54'46.03"E	50.3km	1.2m	Hasnabad-Hingalganj road	Hasnabad, Angara, Amalani, Mohanpur
Par Hasnabad	22°33'52.86"N 88°54'47.69"E	50.3km	1.2m	Hasnabad-Hingalganj road	Par-Hasnabad, Kalibari more, Chak Tengramari

Location map of all the above ferry ghats are provided in Volume 2 of the DPR. Photographs of ferry ghats are provided in **Figure 37** below .

From the above listed ferry ghats Hasnabad and Par Hasnabad jetties are operated and maintained by Government. Hemnagar jetty are maintained by BSF and IWAI for mooring of vessels plying along Indo-Bangladesh Protocol Route. 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 ferry ghats/terminals:

1) Hemnagar ferry ghat;
2) Sardarpara ferry ghat;
3) Atapur ferry ghat
4) Khulna ferry ghat;
5) Sandeshkhali Purba ferry ghat;
6) Raypur ferry ghat, and
7) Binara ferry ghat.

It is proposed to develop passenger embarking and disembarking for passenger ferry services with floating Pontoon and Gangway facilities at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. In addition to this, Hemanagr ferry ghat is proposed to be developed as a tourist jetty with terminal complex and all basic ameneities for tourism traffic of Sunderbans Reserve Forest Area.

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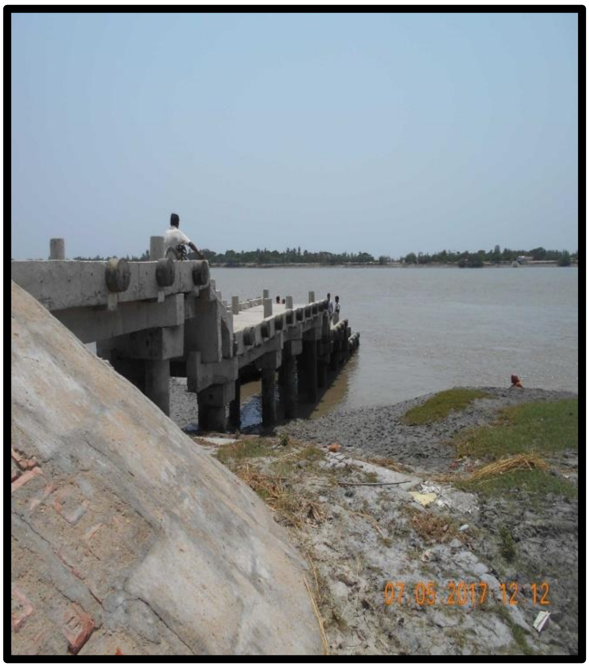
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Figure 37: Photographs of Jetties located along Raimangal Waterway

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:

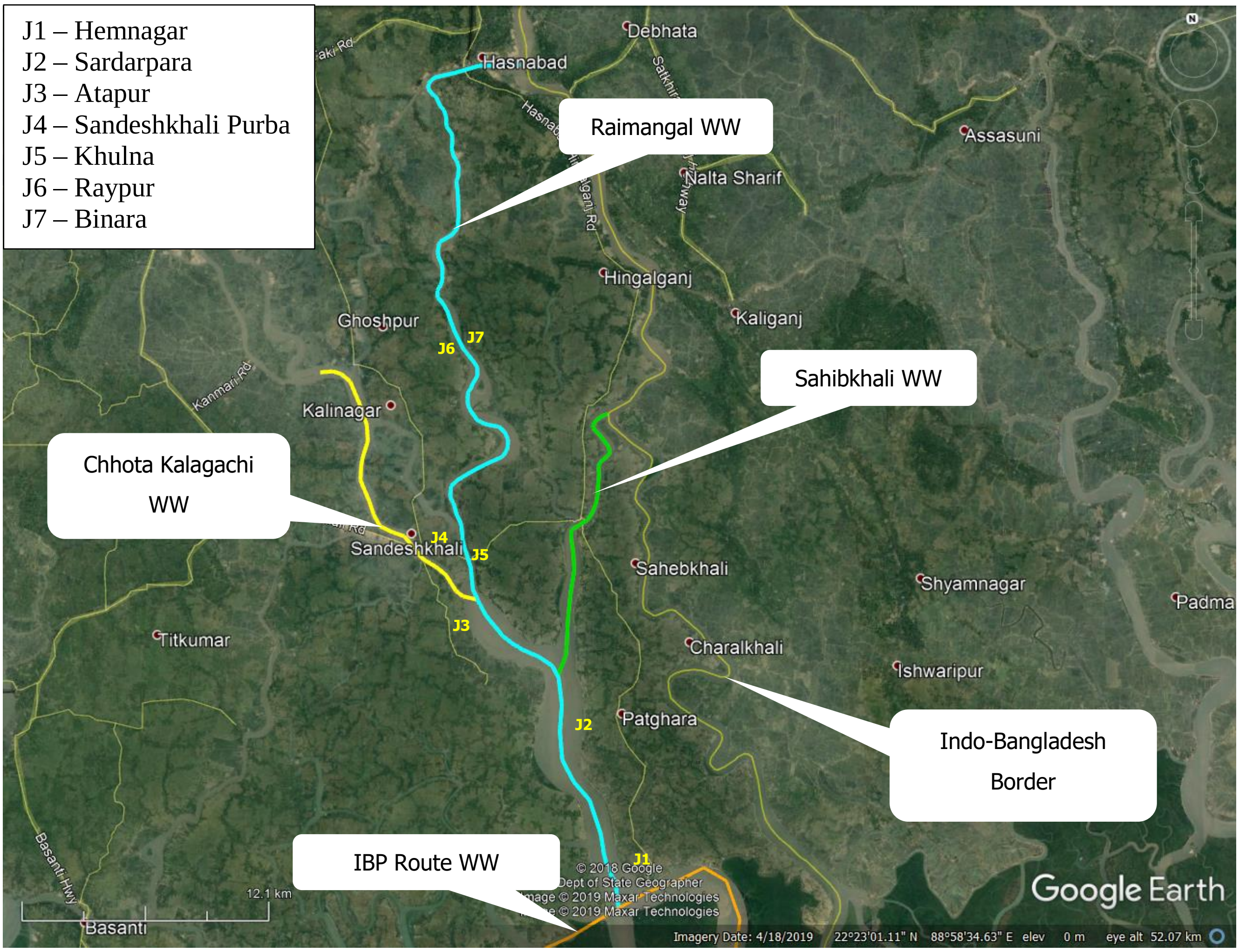


Figure 38: Location map of terminals proposed for development

5.3.2 IWT Facilities

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

1) Pontoon
2) Gangway
3) Terminal complex

A. <u>LAYOUT</u>

The passenger terminal at proposed locations is designed to facilitate the efficient operation of passenger ferries. 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.

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.

Navigation at night is not foreseen/ recommended on the proposed pontoon facilities for passenger ferry services considering the availability of traffic. However, in case the pontoon are used for small cargo vessels, adequate night navigation equipments and facities required to be provided.

E. SERVICES

There will be a small operation, maintenance and storage room within the ticketing complex area. This room will contain equipment necessary for operation and maintenance of the Gangway and Pontoon.

The electricity supply to the pontoon will be sufficient for power requirements of the operating equipment as well as flood lighting and lighting and a standby generator will be installed in the terminal complex providing sufficient power for basic lighting and operation of the terminal infrastructure. A wireless telephone connection will be there in ferries for direct communication with the shore.

Facilities for reception of wastes from the ferries will be installed adjacent to the berth. A fuel supply will also be installed close to the berth to enable fuelling of ferries from storage tanks on shore.

F. TERMINAL COMPLEX

The various facilities to be developed on the shore is provided as below:

i) Ticketing room/window
ii) Embarking and disembarking ares,
iii) Electrical Panel & Generator Room,
iv) Workshop, emergency medical centre,
v) Staff room/secutity cabin

These are support requirements for buildings with a high functional priority and they are listed below.

i) Roads and parking facilities;
ii) Water supply system;
iii) Storm water disposal system;
iv) Sewage disposal system;
v) Electricity, including emergency power system;
vi) Fuel storage and supply system (for ferries);
vii) Telecommunication system including wireless network and PA system;
viii) Fire protection arrangements

Certain basic services such as power, water supply, etc. which are sourced from the public supply outside the terminal may need upgrading to satisfy the additional demand imposed by the IWT facilities.

5.4 LAND DETAILS

The tentative quantity of land required (excluding area required for future development) for construction of terminal complex area and other passenger amenieties is about 1200 m^2 for each ferry ghat. However, no additional land is required to be acquired for terminal construction as the ferry ghats are already operational at the proposed locations. Only upgradation works are required to be done for terminal development.

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 INFRASTRUCTURE INCLUDING EQUIPMENT

IWT Terminals proposed to be constructed with the following infrastructure facilities for operation.

a) Floating Pontoon
b) Gangway,
c) Approach platform,
d) Operation cum Administration Building,
e) Passenger car Parking area.

As per the scope of work mentioned in ToR preliminary engineering design is done in the DPR. The detailed engineering & design of terminals shall be carried out during the construction stage. The preliminary layout shown in **Volume-II** drawing is proposed for the DPR purposes only.

Major facilities provided at proposed terminals for safe and efficient terminal operation are discussed in detail as below:

5.6.1 Terminal Building

The following terminal buildings are proposed for the IWT terminal:

1. <u>Terminal Operation cum Administration Building</u>

It will be single building housing the following:

- Administration wing of the terminal including documentation
- Terminal operations wing

It is assessed that the terminal operation cum administration building shall be of size 20m X 27m (including exit corridor) and will have a total floor area of 540 sqm.

2. Security Office

This will be a single storied building/office for security personnel at the entrance of terminal premises of size 4.5m X 5m.

3. Electrical Sub-station

The electrical panel cum control room of suitable size 5m X 4m shall be located inside admin building preferably at the ground floor.

4. Overhead water tank

The overhead water tank above terminal building to cater need of the daily water demand required for terminal staff and passengers. The minimum capacity of the overhead tank shall be 60 m^3 or the two days requirement whichever is higher.

5.6.2 Boundary Wall / Fencing

It is proposed to provide boundary wall of 2.4 m height using brick masonry with barbed wire fencing. The boundary wall shall be provided along the periphery of the terminal area.

5.6.3 Sewerage System

Sewerage system for the IWT has been proposed considering the requirement of the proposed terminal vis-à-vis the development control regulation. An independent system has been proposed for the terminal considering the new CRZ regulation.

SYSTEM PROPOSAL

With the above, proposed sewerage system for the terminal area has been prepared. Features of the system are as below:

- A fab based package STP of 12 KLD or 12 cum/day are proposed for the sewage generated from the terminal building, etc. However capacity of 12 KLD is draft only and may vary during detailed engineering as per the requirements of the system.
- Sewage from the independent building unit to STP will be conveyed through underground conduit;
- Conveyance of flow will be through gravity only;

- Inspection chamber of each building unit will collect the sewage of that unit. Thereafter the same will be conveyed to the nearest sewage collection pit/ manhole connected to the main sewer line of STP. Manhole will be proposed when the length of individual sewer line is more than 30m;
- The treated effluent from STP will be collected in a treated effluent tank. The same will then be utilized for gardening and in case of any surplus that will be discharged to the drainage network along the access road outside the western side of terminal boundary;
- The sludge coming out from the treatment plant will be taken to centrifuge and converted into sludge cake, which may be used as manure.

5.6.4 Firefighting System

For terminal building, Electrical room and other building Dry type fire extinguishers will be provided. Beside above, a continuous back up support will be provided by fire tenders round the clock are envisaged for the firefighting system.

The complete firefighting system shall be designed as per standard guidelines & codes. The system provided shall cater to the terminal area. However, for future developments, separate dedicated firefighting system may be required based in the future requirements.

<u>Portable Fire Extinguishers (PFE)</u>

Portable Fire extinguishers (PFE) are small hand held appliances that are used to put out fires in the very early stage of their inception. There are different types of extinguishers in use and their classification is based on the types of fires on which they are effective. Hence an understanding of the types of fire is very essential in selecting the appropriate type of extinguisher for use in a particular location.

<u>Quantity</u>

As per TAC (Tariff Advisory Committee) at least two extinguishers are to be provided in every area/ room. The appliances are to be so distributed over the entire floor such that a person has to travel not more than 15 metres to reach the nearest appliance.

As per TAC Guidelines - For any property, basic protection shall be appliances suitable for class A fires, since class A fires are of universal character.

Where class B fires are anticipated, a suitable number of appliances as determined above shall be replaced with appliances suitable for B class fires.

As a thumb rule the requirements specified above would mean approximately 2 extinguishers for every 600 m^2 of floor area or part thereof which would however be slightly less in case of light hazard occupancies having larger than 600 m^2 floor area in a single fire compartment.

In rooms containing only electrical equipment such as electrical transformers, switch gears, motors or other electrical apparatus, not less than 2 KG Dry Powder or carbon Dioxide type extinguishers are to be provided within 15 metres of the apparatus.

In rooms containing motors and/or other electric equipment along with other machineries or facilities one 5 Kg. DCP or Carbon Dioxide extinguisher is to be installed within 15 metres of the equipment in addition to the requirements that were earlier specified.

<u>Location</u>

Generally Portable Fire Extinguishers (PFE) are to be placed (wall mounted) as near as possible to exits or staircase landings by also taking into consideration (wherever possible) the normal routes of escape of persons. Placed PFE in such positions will enable these to be seen by persons following the natural impulse to get out of danger.

Standards further prescribe that PFE's be so located that the top of the extinguisher is located at a height of 1.5 metres from the finished floor level or that the bottom of the extinguisher is located at a height of 1 metre from the finished floor level.

Based upon the above the Selection of Fire Extinguishers shall be as follows

A. For Terminal Operation cum Administrative Building

a. Ground Floor:

Type of Fire Extinguishers Selected : 2 X 5kg, CO_2 (Type ABC) inside office Area
(ii) 1 X 5kg, DCP (Dry Chemical powder) Type C inside Electrical panel /Control room

B. Car/Vehicle Parking Area

Type of Fire Extinguishers Selected : 2 X 5kg, DCP (Dry Chemical powder) Type C

5.7 BERTHING STRUCTURE (FLOATING PONTOON)

The berthing structure for Ferry terminal proposed for waterway should have:

- Berthing facility for ferries,
- Facilities boarding/de-boarding of passengers,
- Land based facilities for passenger's movement, ticketing, waiting, etc.
- Scope for future development.

In order to work out the pontoon requirements to meet the projected requirement, it is necessary to define the following governing parameters:

- Ferry Size
- Passenger traffic
- Number of operational days per year
- Number of ferry trips per day
- Effective working hours per day
- Time required for peripheral/other activities

All the proposed facility shall connect terminal area to pontoon platform as shown in Layout drawing.

5.8 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

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
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 Raimangal 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 Raimangal waterway. The cost estimate for proposed ferry terminals 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).

5.8.1 Capital Cost

It is proposed to provide floating Pontoon and Gangway facilities for passenger traffic at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. Hemnagar terminal is proposed to be developed as tourism jetty with passenger terminal, pontoon, ganagway and all basic amenities require for tourism services. Accordingly, capital cost for proposed ferry terminal is provided in **Table 25** respectively.

Table 25: Capital Cost for Ferry Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR Lakh)	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
3	Passenger Approach Area/ Bus Car Drop Off Area	m^2	132	40,000	52.80

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR Lakh)	Cost (INR Lakh)
4	Control Room Equipment's including navigation control equipment's	No.	1	50,000	0.50
5	Telecomm. Room Equipment's	lot	...	LSM	1.00
6	Ticket vending Machine & installation cost	No.	1	4,00,000	4.00
7	Automatic Fare collection gates (set of 2 nos. at Entry gates +Set of 1 no. at Exit Gate)	Per set	3	3,00,000	9.00
8	Passengers Arrival Area facility	-	...	LSM	5.00
9	Visitors parking Area (15m X 10 m)	m^2	150	18,000	27.00
10	Passengers Waiting Chairs @ 50 per terminal	No.	50	2,500	1.25
11	Substation	No.	1	10,00,000	10.00
12	Fire Fighting System (dry type)	lot	...	LSM	2.50
13	Electrical, Water& Utility	lot	...	LSM	12.50
14	Security Office (4.5m X 5m)	m^2	22.5	18,000	4.05
15	Sewage Treatment System	No.	1	25,00,000	25.00
16	Approach Platform (3m X 7 m)	m^2	21	75000	15.75
Total					**237.85**
17	Cost of Detail Engineering and construction supervision			6%	14.27
Total					**252.12**
18	Contingency			3%	7.56
	Capital cost of each ferry terminal with Pontoon and Gangway				**259.68**
19	Number of proposed Terminal/Jetties				1
	Capital cost of proposed ferry terminals with Pontoon and Gangway at Hemnagar				**259.68**

20	Pontoon Platform with all required accessories at all Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats	No.	6	50,00,000	300.00
21	Gangway at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats	No.	6	17,50,000	105.00
22	Cost of Detail Engineering and construction supervision			6%	24.30
	Total				**429.30**
23	Contingency			3%	12.88
	Capital cost of proposed Pontoon and Gangway facilities at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats				**442.18**

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR Lakh)	Cost (INR Lakh)
	Total Capital Cost of proposed ferry terminals in the Raimangal waterways				**701.86**

Hence, total capital cost for facilities proposed to be developed at all ferry ghats works out as **INR 701.86/- Lakh**.

5.8.2 O&M Cost

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

a) Manning

The efficient IWT operation requires a substantial number of staff. These include: -

- Maintenance Engineering Staff comprising the maintenance engineer, his deputy, mechanical, electrical and civil engineers, foremen, fitters, welders, electricians, plumbers, joiners, painters, riggers and their mates and labourers;
- Security Staff comprising the Security Chief and security officers

The total number of staff required to operate the terminal (excluding critical staff) is estimated as provided in **Table 26.**

Table 26: Manpower Requirement for IWT Terminal Operation

Sl. No	Manpower	No./ Shift	No. of Shift required	Location of Posting	Total no. of Personnel required for proposed Jetties/Terminals
1	Control Room Operator	2	1	1 Jetties/ Terminals	2
2	Plumper & Electrician	1	2		2
3	Security Guards	2	2		4
4	Misc. for Field Works	1	2		2
	Total				**10**

It is recommended that the manning proposed in operating building at Bhandarkhali Jetty for Sahibkhali waterway DPR, also provide operational support to proposed jetty/terminals of Raimangal waterway. Accordingly, as manning cost of manpower posted in Operating building proposed at Bhandarkhali jetty is already considered in Sahibkhali waterway DPR, the manning cost of Terminal Manager, operating staff/Executive and Accountant posted in Operating building are not considered in this DPR of Raimangal waterway.

Table 27: Manpower Cost per annum

Sl. No.	Manpower	Category/ Level	Reference	Min Gross Salary (INR/ month)	Annual Gross Salary (INR)	Cost (INR) in Lakh
1	Control Room Operator	Skilled	West Bengal Minimum rates of wages w.e.f July 2020	10347	1,24,164	2.48
2	Plumper & Electrician	Skilled		10347	1,24,164	2.48
3	Security Guards	Unskilled		8550	1,02,600	4.10
4	Misc. for Field Works	Unskilled		8550	1,02,600	2.05
	Total					**11.12**

From the above table, the total annual manpower cost required for running the all the proposed jetties/terminal facilities in Raimangal waterway works out to INR **11.12/- Lakh** annually.

b) Utilities and Services

The annual cost of providing water, electricity and other services is considered as about 1.0% of the capital cost. Thus, the annual cost for providing Utilities and Services for proposed teminals works out as **INR 7.02/- Lakh annually.**

c) Maintenance

To ensure that the terminals 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.

In the first four years, the maintenance staff might consist only of fitters, electricians and plumbers together with their mates all under the control of a general trades foreman. Their duties would be to deal with breakdowns in the mechanical and electrical equipment as well as the water supply system. In the fourth year, it would be advisable to provide a fully equipped workshop where equipment can be repaired and serviced. The workshops would provide storage space for spare parts and would provide a base for all maintenance staff.

The annual cost of maintaining terminal structures including all civil, mechanical and electrical components is considered to be about 3% of the capital cost. Thus, the annual maintenance cost for proposed terminals works out as **INR 21.06/- Lakh**.

The total O&M cost of proposed passenger ferry service facilities are provided in **Table 28** below:

Table 28: Annual O&M cost of terminals

Sl. No	Item	O&M Cost (INR) Lakh
1.	Manpower	11.12
2.	Utilities and Services	7.02
3.	Maintenance	21.06
Total annual O&M cost		**39.20**

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 jetty, terminal structures and access infrastructure is done and provided as below for ferry terminals.

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
- IS 875 (Part 3): Code of Practice for Design Loads for Building and Structures-Wind Load
- 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 passenger terminal. The following are the main facilities required for operation of the terminal:

- Approach Platform
- Gangway
- Pontoon Platform
- Terminal Building & parking facilities

A. STRUCTURAL SYSTEM

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

The approach platform is a piled structure, 7 m long and 3 m wide. The pile spacing of 0.75 m dia pile is 2.5m in longitudinal direction and mono-pile configuration is adopted. Beams of 0.9m wide and 1.2m deep connect the piles. The deck slab is 0.35 m thick.

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

A terminal building is provided with all facilities like ticketing room, waiting area, operations control centre, pantry and toilets

B. CONSTRUCTION METHOD

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

<u>PILING</u>

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.

<u>ERECTION & CONCRETE WORK</u>

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.

C. DESIGN CRITERIA

LOADING DATA

The principal loads considered for design of various components are listed as below:

1) Dead Load
2) Live Load
3) Seismic Loads

Since it is a completely landside piled structure with no berthing and mooring operation, loads due to the same is not considered. Further, no effects due to wave and current are considered as they are insignificant because of their location. The values of intensities of the above loads considered in design are detailed in the following sections

1) Dead Load:

The following unit weights are used in design

Reinforced Cement Concrete	2.5 T/m^3
Structural Steel	7.85 T/ m^3
Density of sea Water (Tidal section)	1.025 T/ m^3

2) Live Load:

Live load on the jetty and approach structure is as per relevant Indian standards and the same is given below.

Load	Intensity
UDL – Jetty	25 kN/m^2
UDL – Terminal Building	5 kN/m^2
Load due to Gangway on approach platform	90 kN

3) Seismic Load:

The site falls in Zone 3 as per seismic map of India presented in IS 1893 (Part I) – 2002. Design horizontal seismic coefficient is evaluated as per provisions mentioned in code for the following parameters

Zone Factor	0.16
Importance Factor	1.5
Response	3

LOAD COMBINATIONS

The structure will be analysed as per load combinations presented in IS 4651 (Part IV) – 2014 for ultimate limit state and serviceability limit state.

SL.No	Loading	Partial Load factor					
		Serviceability Limit State			Ultimate Limit State		
		Short Term	Long Term	Normal	Extreme/ Survival	Temporary	Reverse
1	Dead Load (DL)	1.0	1.0	1.5	1.2	1.2	0.9
2	Live Load –Dynamic (DyL)	1.1	0.5	1.5	1.2	1.2	0.9
3	Live Load –Static (LL)	1.0	0.5	1.5	1.2	1.2	0.9
4	Seismic Load (SL)	1.0	-	-	1.2	-	1.5

SERVICEABILITY CRITERIA

1) Deflection Limit

Deflection of Pile at Pile cut-off level shall be L/350 under operating condition and L/250 under extreme condition, where L is the length of the pile from pile fixity to cut-off level.

2) Crack width Limit

Crack width in structural elements shall be maintained as per IS 4651 (Part IV) – 2014. The same has been reproduced here for ready reference.

Sl. No:	Exposure Zone	Maximum Crack width	
		Sustained	Transient
1	Atmospheric Zone (Above Splash Zone)	0.2 mm	0.3 mm
2	Splash Zone (Between CD & MHWS)	0.1 mm	0.2 mm
3	Continuous sea water immersion Zone (Below Splash Zone	0.2 mm	0.3 mm
4	Below Seabed Level	0.3 mm	0.3 mm

MATERIAL PROPERTIES

All reinforced cement concrete works shall be carried out with M40 grade concrete and reinforcement steel shall be of Fe500 grade. Clear cover to reinforcement shall be as per IS 4651 (Part IV) – 2014 which is as shown below.

Sl. No:	Exposure Zone	Clear Cover
1	Atmospheric Zone (Above Splash Zone)	50 mm
2	Splash Zone (Between CD & MHWS)	75 mm
3	Continuous sea water immersion Zone (Below Splash Zone upto sea	75 mm
4	Below Seabed Level	75 mm

DESIGN LIFE

The jetty and associated structure shall be designed for the following design life

Sl. No:	Structural Element	Design life
1	RCC Pile and deck superstructure	50 Years

DESIGN METHODOLOGY

The structure shall be idealized in STAAD Pro with all mentioned loads and design criteria to analyse and design the structural elements. Fixity method shall be adopted in modelling of piles. All design is based on IS 456-2000 and IS 2911 (Part 1/Section 2) – 2010.

D. METHOD OF ANALYSIS

The following software have been used in design

- STAAD Pro V8i

STRUCTURAL STAAD MODEL

3-dimensional STAAD model has been idealized for each of the structure envisaged. Piles and beams have been modelled as beam elements while deck slab is idealized as plate elements. Length of the pile has been assessed based on sea bed level as presented in available data. The following figures give an in-sight of the modelling undertaken for analysis.

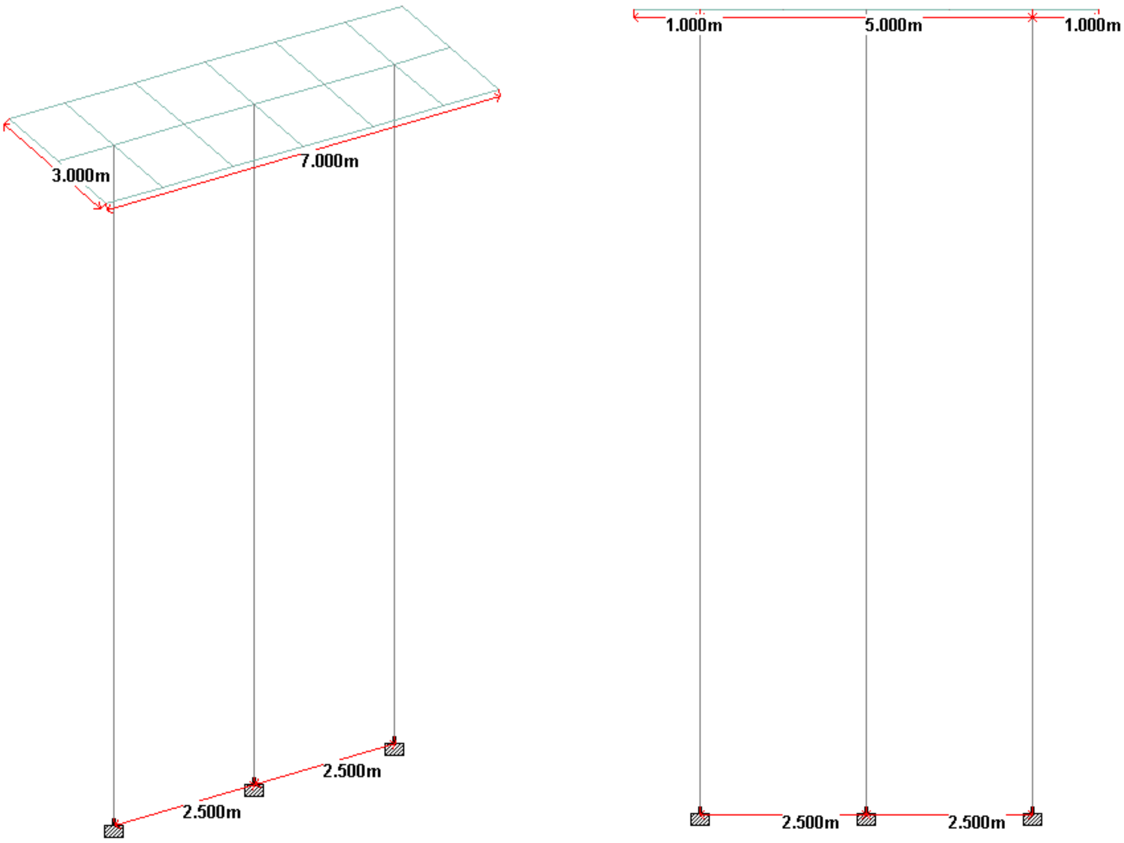
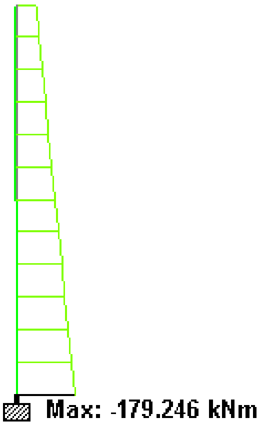


Figure 39: 2D View of STAAD Model – Approach Platform

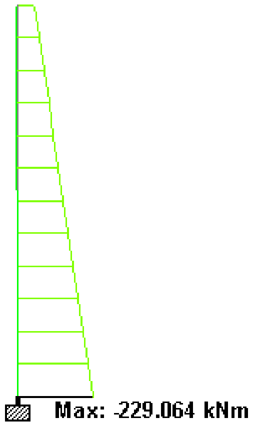
P-Δ analysis is carried out on the idealized model to include secondary effects. All possible loads and load combinations as per IS4651 (Part 4): 2014 is considered and applied in a logical way to analyse the structure to determine the design forces.

Limit State Design Method is used for design of structural components. All possible limit states are checked which includes serviceability and collapse limit states.

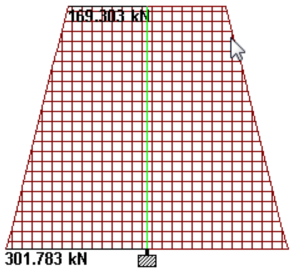
ANALYSIS RESULTS



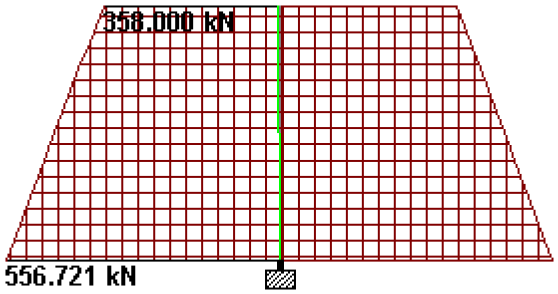
Max. Bending Moment My (SLS)



Max. Bending Moment My (ULS)



Min. Axial force Fx (SLS)



Max. Axial force Fx (ULS)

Design of piles

Design of longitudinal and helical reinforcement of pile is done as per IS:456-2000 & SP 16. Pile are checked for all possible severe combination of resultant forces and design for governing forces.

Development length (Refer IS: 456-2000, Cl. 26.2.1)

Development length, L_d $= \Phi\ \sigma_s / 4\ \tau_{bd}$

Bond stress, τ_{bd} = 1.9 MPa

60% increase in bond stress for deformed bars (Refer IS: 456-2000, Cl. 26.2.1.1)

Hence, Design Bond Stress = 3.04 MPa

Stress in bar, $\sigma s = 0.87 f_y$ = 435 MPa

L_d = 35.8 Φ

Say = 36 Φ

6.5 Construction Schedule

The time schedule for construction activities of the project is considered as two (2) years. The proposed project schedule is provided in **Figure 40.**

Sl. No.	Activities	1st Year	2nd Year
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/Upgrdation of terminal building, landside facilities		
6	Upgrading existing road to terminals		

Figure 40: 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. Among operators, the government owned CIWTC (Central Inland Water Transport Corporation) is the largest owner of vessels and barges. Private operators have a substantial fleet, but have not been investing in new vessels in the last decade. In fact, there has been scrapping vessels of late, and all operators may require some help in reviving them and investing in new vessels.

7.2 CURRENT SCENARIO

Ferry and small cargo vessels are already operational in Raimangal river. The photographs of existing vessels plying along the waterway are provided in **Figure 41.** Ferry boats having approximate dimensions of about 14.0 m long, 2.25 m breadth and 1.0 m depth are used for movement of passenger and small cargos. The existing vessels lack the basic safety gears and communication equipments. Hence, vessels with required safety and communication equiments are proposed along the waterway.

Figure 41: Vessels plying on Raimangal Waterway

7.3 PASSENGER TRAFFIC AT PROPOSED LOCATIONS

In view of existing passenger traffic per day and connectivity of Raimangal river with major waterways, Passenger ferry services with floating Pontoon and Gangway facilities are proposed at Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara ferry ghats. Accordingly following OD links are proposed for development in Raimanagl waterway:

a) Link 1: Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat (OD pair length is 15 Km)
b) Link 2: Atapur ferry ghat – Khulna ferry ghat (OD pair length is 3 Km)
c) Link 3: Sandeshkhali Purba – Khulna ferry ghat (OD pair length is 0.5 Km)
d) Link 4: Raypur – Binara ferry ghats (OD pair length is 0.45 Km)

Arsadmiya ferry ghat along OD Link1 is located along Chhota Kalagachi waterway and considered for development in Chotta Kalagachi waterway DPR. Thus, the same is not detailed further in this DPR.

In addition to the above, Hemnagar ferry terminal is also proposed to be developed as a tourism jetty for tourist traffic of Sunderbans Reserve Forest Area. 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 29: Passenger Traffic at Proposed Locations

Sl. No	Proposed Ferry Ghat	Average daily passenger traffic
1.	Sardarpara ferry ghat	600
2.	Atapur ferry ghat	600
3.	Khulna ferry ghat	500
4.	Sandeshkhali Purba	500
5.	Raypur	450
6.	Binara	450

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

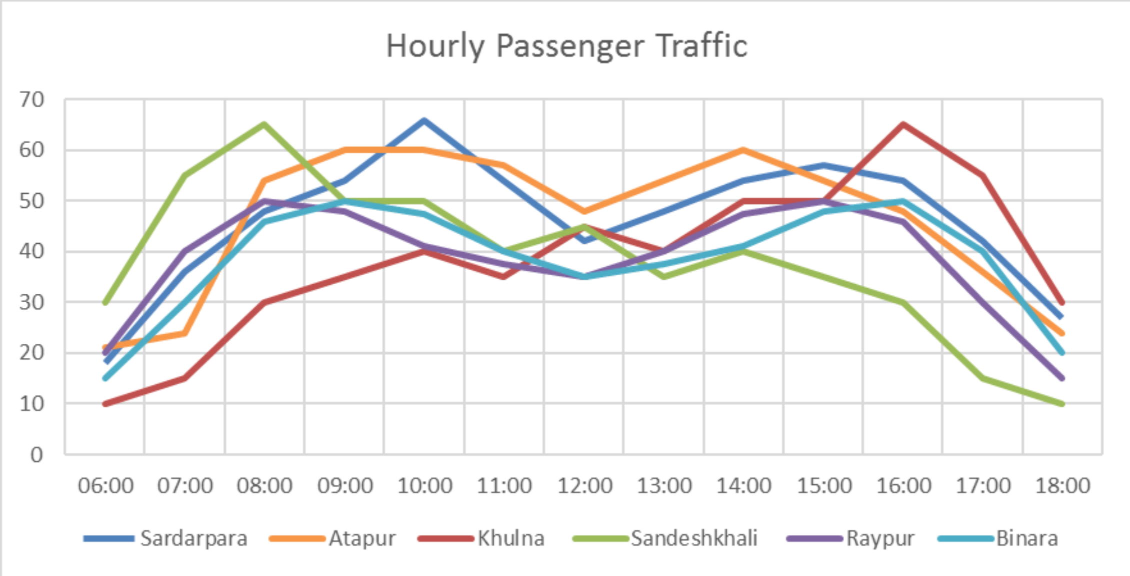


Figure 42: Hourly Passenger Traffic

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 -2.72 m to 36.06 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 Raimangal 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 30: 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 43**.

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 43: Ferry Services in the river Hooghly between Kolkata and Howrah[4]

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.

As detailed in above sections, following OD links are proposed for development in Raimanagl waterway:

a) Link 1: Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat (OD pair length is 15 Km)

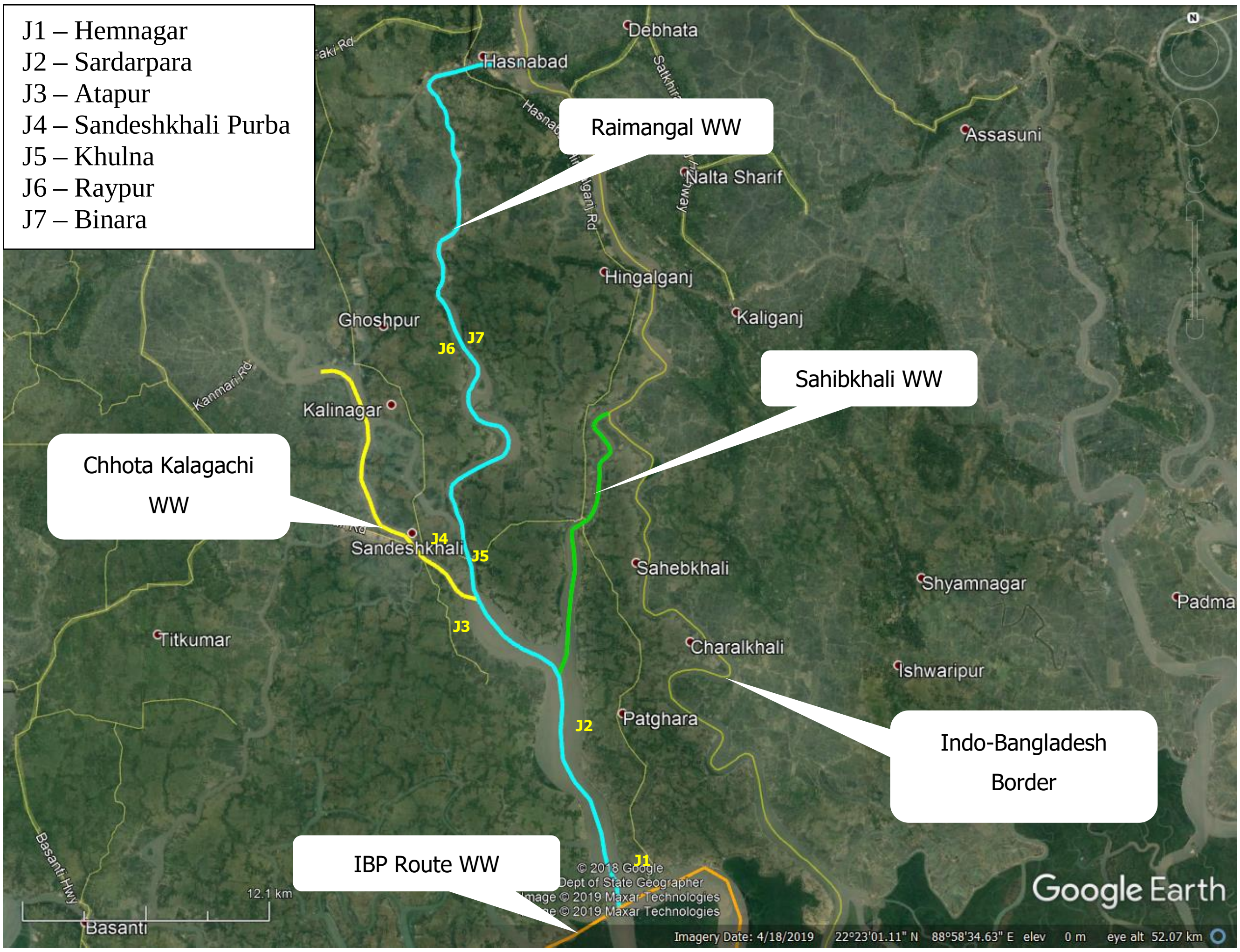
[4] http://transport.wb.gov.in/transport-services/ferry-services/passenger-ferry-services/

b) Link 2: Atapur ferry ghat – Khulna ferry ghat (OD pair length is 3 Km)

c) Link 3: Sandeshkhali Purba – Khulna ferry ghat (OD pair length is 0.5 Km)

d) Link 4: Raypur – Binara ferry ghats (OD pair length is 0.45 Km)

Accordingly, for estimation of number and capacity of vessel, above OD pairs are considered with respective OD pair length and corresponding passenger traffic respectively.



7.7 NUMBER OF VESSEL REQUIRED

Number of vessel required to ply on route is estimated and provided in **Table 31** as below.

Table 31: Estimate of No. of vessel required for Passenger Ferry Service

Sl. No.	Description	Unit	Values for OD 1	Values for OD 2	Values for OD 3	Values for OD 4
A	Vessel cruising speed considered	Knot	5	5	5	5
B	Length of the waterway considered for vessel traffic	Km	15.00	3.00	0.50	0.45
C	Time required by vessel to travel in proposed waterway stretch	minutes	97.17	19.44	5.00	5.00
D	Embarking and Dis-embarking time considered	minutes	10	10	10	10
E	Trip duration (sl. no. C + sl. no. D)	hours	1.79	0.49	0.25	0.25
F	Operating hours per day (as per information collected on site)	hours	12	12	12	12
G	No. of trips allowed during 12 hours operational time per day per vessel (sl. no. F / sl. no. E)	trips	6.72	24.46	48.00	48.00
H	Considering passenger ferry vessels with capacity as	pax/vessel	25	25	25	25
I	Present passenger's traffic	pax/day	600	600	500	450
J	Required no. of trips per day for current passenger traffic (sl. no. I/ sl. no. H)	trips	24.00	24.00	20.00	18.00
K	Number of Ferry vessel required for current passenger traffic demand (sl. no. J/ sl. no. G)	numbers	3.57	0.98	0.42	0.38
L	Design passenger traffic in 20th year	pax/day	3262	3262	2718	2446
M	Required no. of trips per day for design passenger traffic (sl. no. L/ sl. no. H)	trips	130.48	130.48	108.73	97.86
N	Number of Ferry vessel required for design passenger traffic (sl. no. M/ sl. no. G)	numbers	19.43	5.33	2.27	2.04
O	Proposed number of ferry vessels for present passenger traffic	numbers	4	1	1	1
P	Proposed number of ferry vessels for design passenger traffic of 10th year	numbers	9	3	2	1
N	Proposed number of ferry vessels for design passenger traffic of 20th year	numbers	20	6	3	3

Accordingly, for Raimangal waterway, it is proposed to provide ferry vessels of 25 passenger capacity. The vessels shall be provided in phased wise manner as per traffic demand. On the basis of DPR studies, for present traffic demand, four (4) numbers of vessels are proposed initially from the start date of operations for OD pair 1 and one (1) veesel in each OD pair 2, 3 and 4. Hence, in total seven (7) number of vessels are proposed at initial stage for Rainmangl waterway. Similarly, in 10th year of operation additional five (5) vessels are proposed for OD pair 1, two (2) vessels for OD pair 2 and one (1) vessel for OD pair 3. In 20th year of operation additional eleven (11) vessels are proposed for OD pair 1, three (3) number of vessels for OD pair 2, one (1) number of vessel for OD pair 3 and two (2) number of vessels for 4, for IWT operations as per required passenger traffic. Hence, with the above recommendations, the total number of vessels in the fleet shall be fifteen (15) from 10th year onwards and thirty-two (32) from 20th year after start date of of operation to cater the projected traffic demand.

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 Hogla 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 44** shows the range of purchase prices found for new vessels in each vessel category.

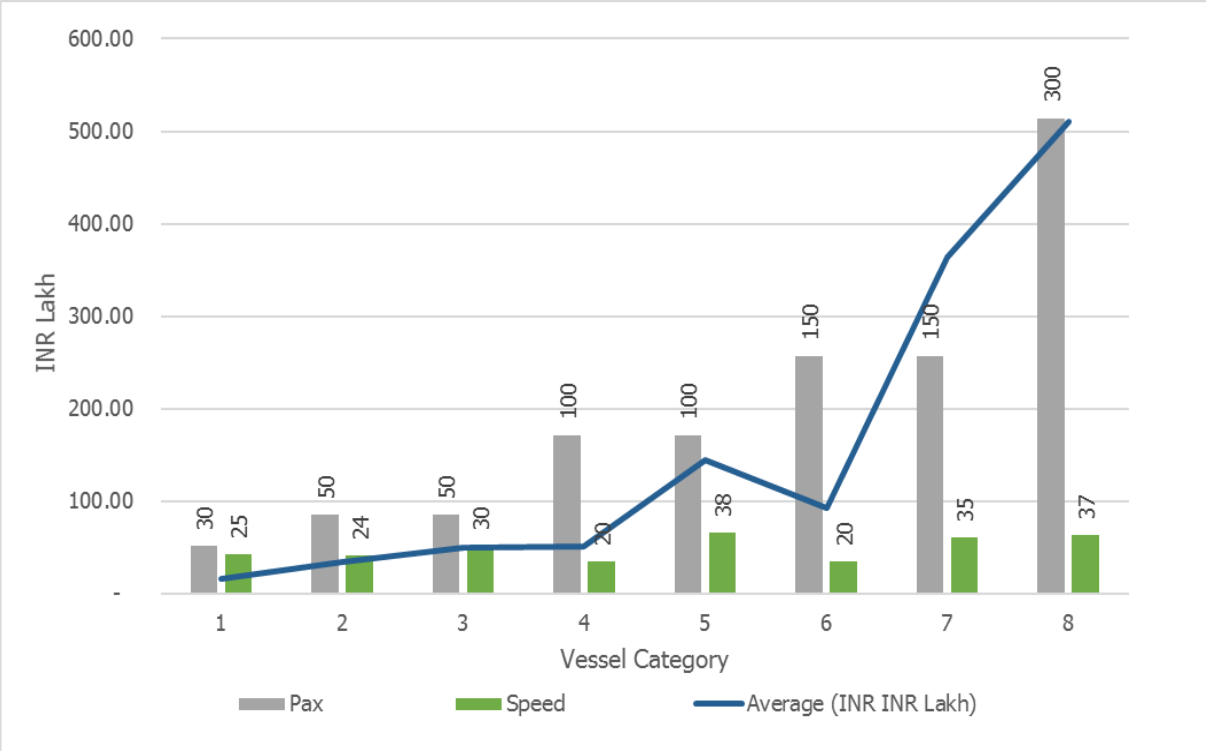


Figure 44: Graph showing variation in Vessel cost w.r.t passenger capacity and speed

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

Table 32: 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	7 (from start date of operation)	245.00
2.			8 (in 10th year of operation)	280.00
3.			17 (in 20th year of operation)	595.00

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 33: 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/-
3.	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
Approximate rate of fuel per litre = 75 INR per litre

Fuel cost per round trip for each vessel for OD pair 1 = INR 1,457.88
Fuel cost per round trip for each vessel for OD pair 2 = INR 291.58
Fuel cost per round trip for each vessel for OD pair 3 = INR 75.00
Fuel cost per round trip for each vessel for OD pair 4 = INR 75.00
Fuel cost per annum for each vessel for OD pair 1 = INR 14.69 Lakh per Annum
Fuel cost per annum for each vessel for OD pair 2 = INR 10.70 Lakh per Annum
Fuel cost per annum for each vessel for OD pair 3 = INR 5.40 Lakh per Annum
Fuel cost per annum for each vessel for OD pair 4 = INR 5.40 Lakh per Annum

Table 34: Annual O&M cost of Vessels

Sl. No	Item	Annual O&M Cost for OD pair 1 (INR Lakh)	Annual O&M Cost for OD pair 2 (INR Lakh)	Annual O&M Cost for OD pair 3 (INR Lakh)	Annual O&M Cost for OD pair 4 (INR Lakh)
1.	For each vessel in INR Lacs per annum	18.80	10.70	5.40	5.40
2.	For proposed 7 vessels from inception stage	75.21	14.81	9.51	9.51
3.	Additional cost for proposed 8 vessels from 11th year onwards	94.01	29.62	9.51	0.00
4.	Additional cost for proposed 17 vessels from 20th year onwards	206.83	44.43	9.51	19.03

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 45** below. As shown in figure below, all 13 waterways prpopsed under NW-97 fall under the radial cnverage of proposed DGPS at Canning. Radial distance of canning from farthest point in Raimangal waterway is about 38 Km. The capital and O&M cost of proposed DGPS system at Canning is considered in DPR of Matla waterway.

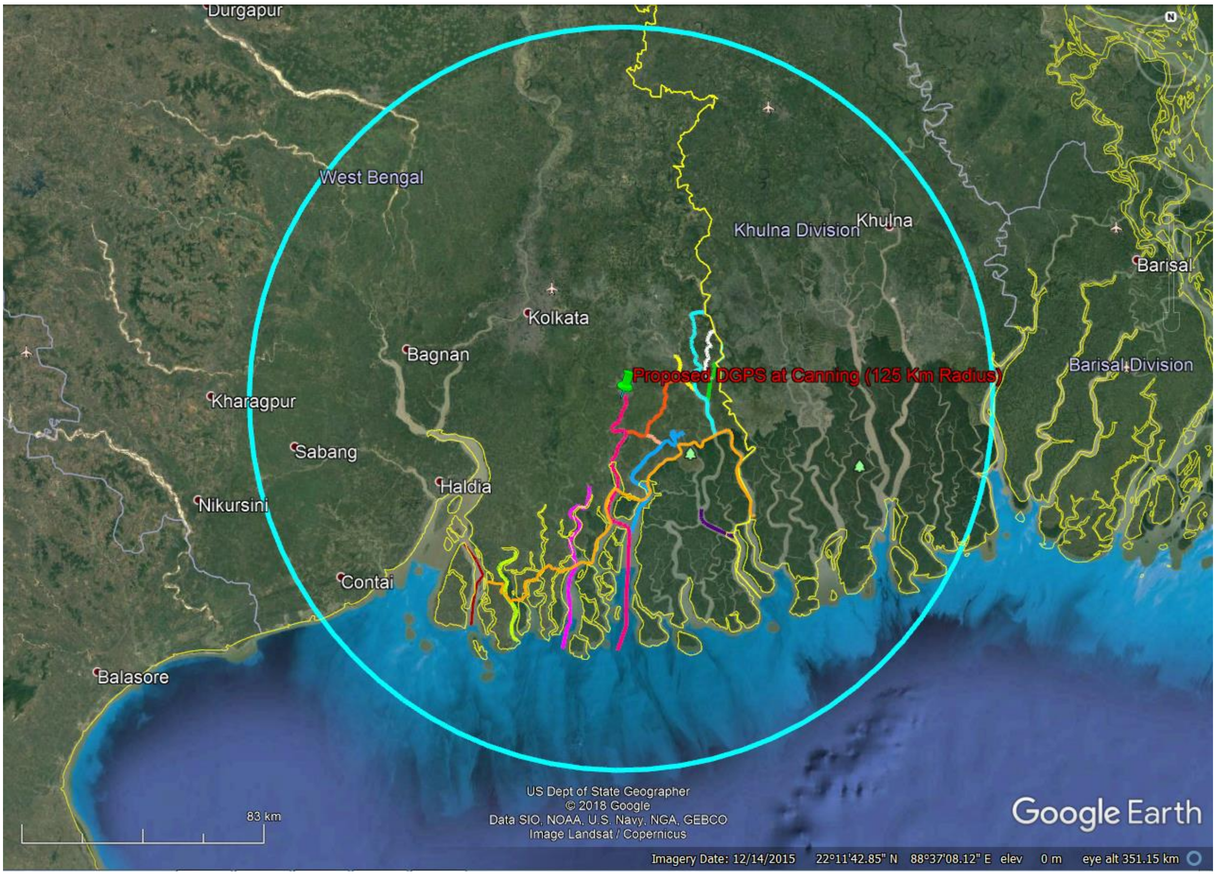


Figure 45: Google Earth image showing location map of proposed DGPS and effective coverage

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 35: 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 to be set up at Bolakhali Jetty (22°23'17.49"N, 88°53'59.43"E) along Raimangal waterway will cover the complete stretch of proposed Raimangal waterway as shown as shown in **Figure 46**.

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

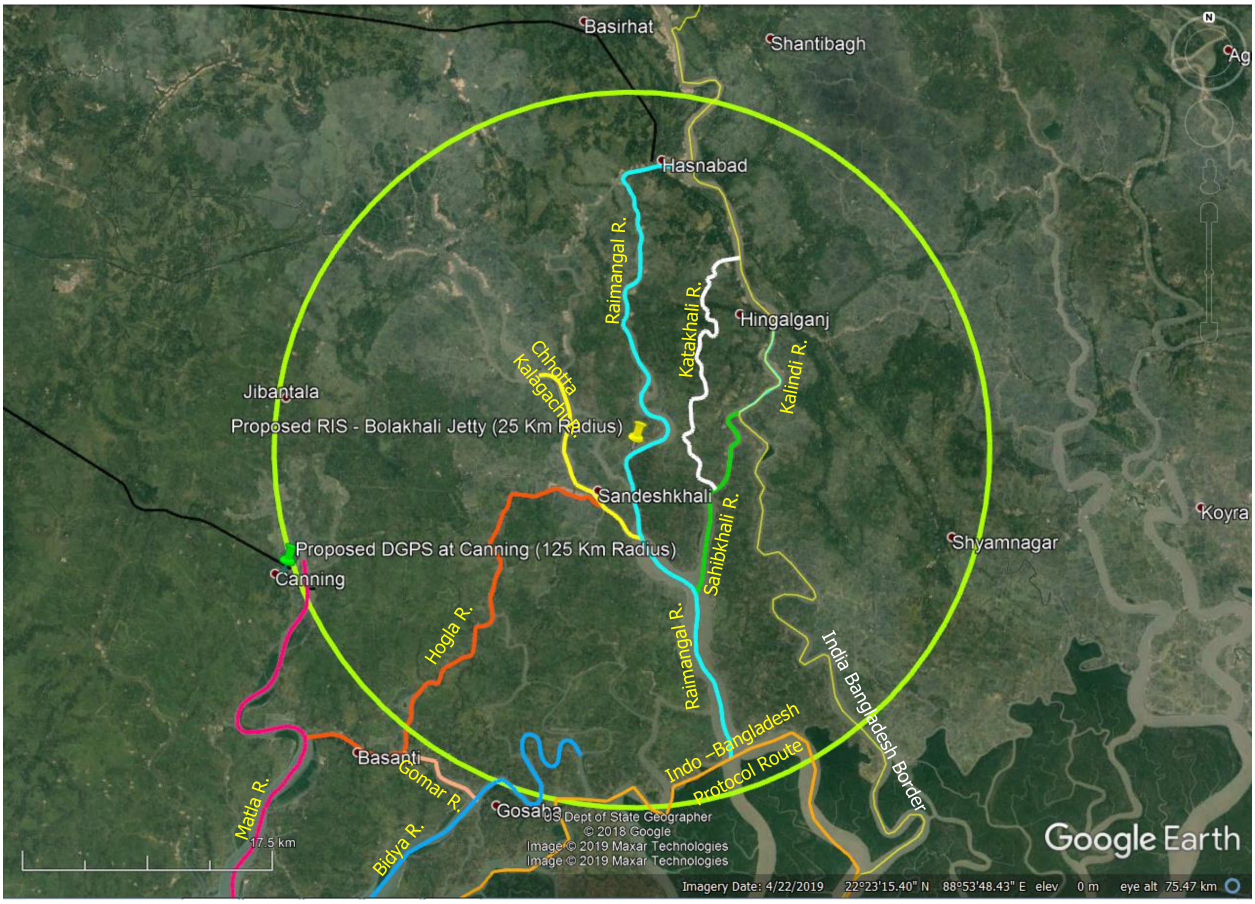


Figure 46: Google Earth image showing location map of proposed RIS and effective coverage

8.2 NIGHT NAVIGATION FACILITIES

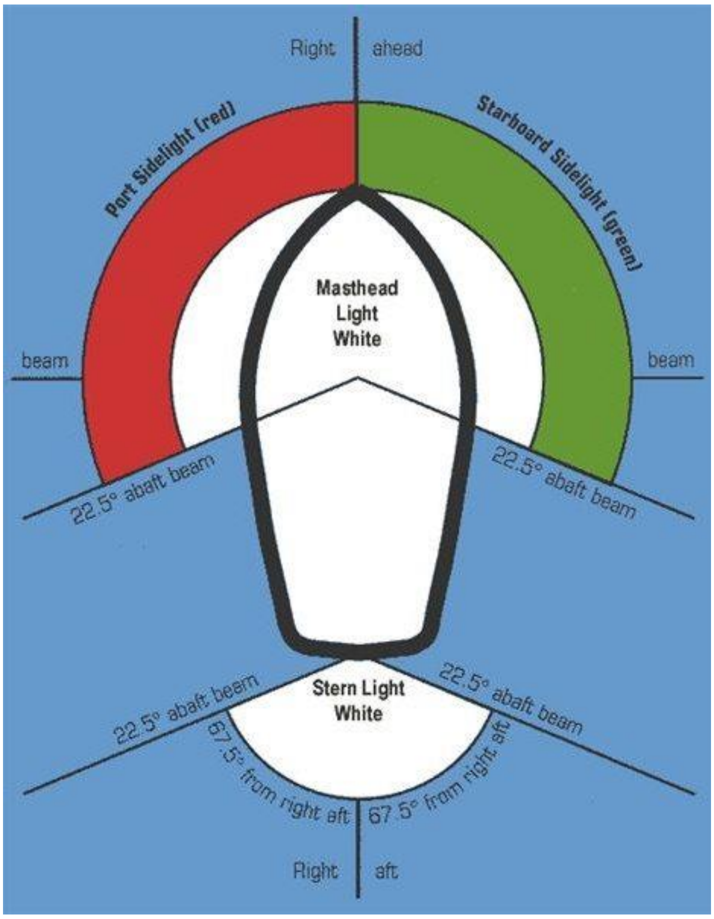
On sectors of the river where there is day and night navigation, forks, junctions and the axis of the fairway, along with obstacles to navigation lying within the fairway, shall be marked by light buoys or bank marks and lights. Floating signs shall be installed at such a depth and at such a distance 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:

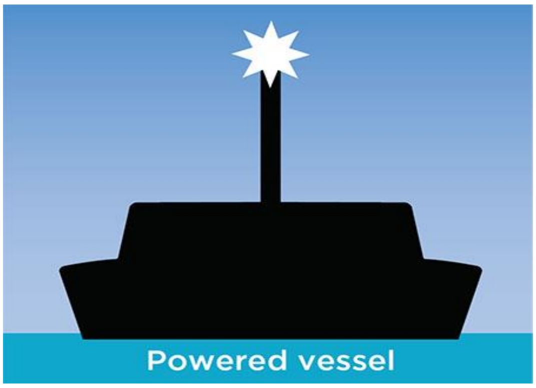
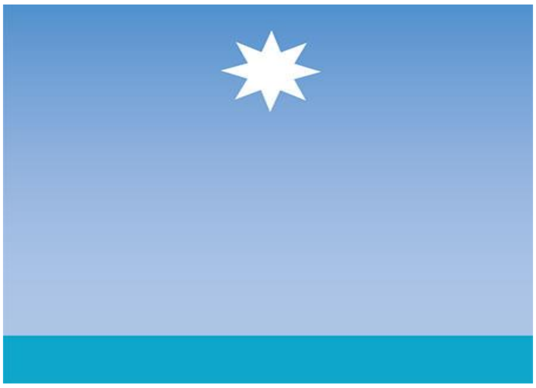


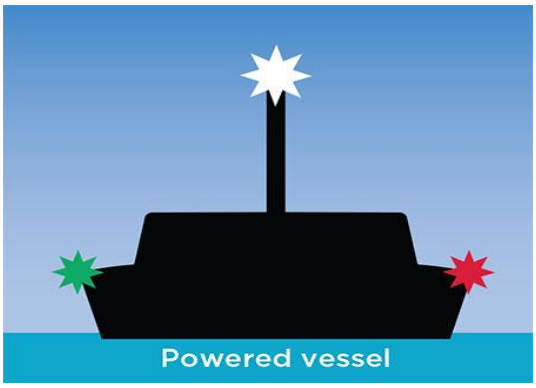
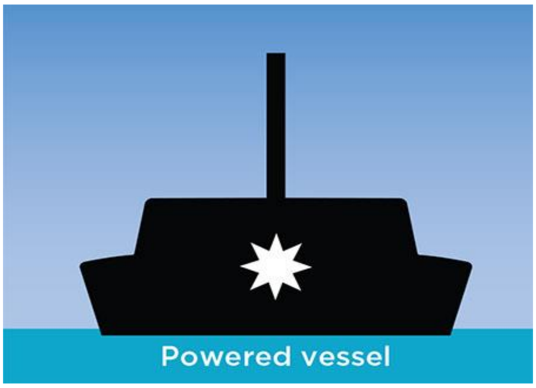
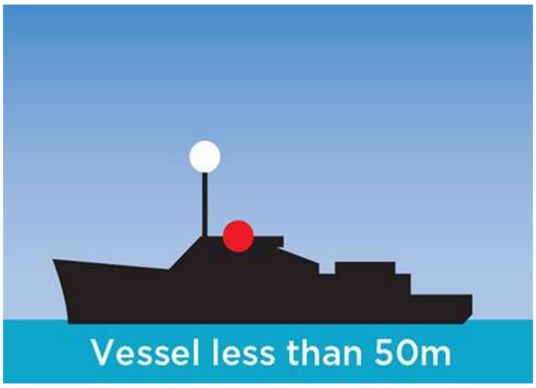
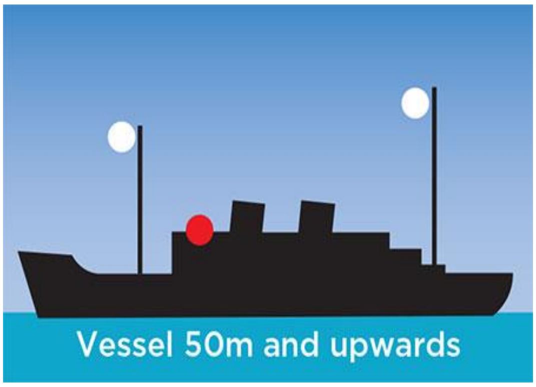
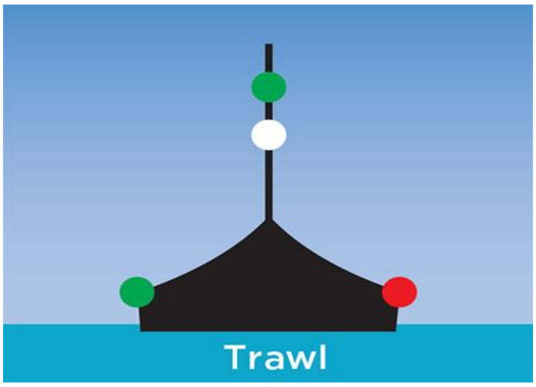
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- 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 53.381 Km of Raimangal 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 47** as below.

SYSTEM	SERVICE													
	Fairway information	Traffic information		Traffic management			Calamity abatement support	Information for transport logistics				Information for law enforcement	Statistics	Waterway charges and harbour dues
		Tactical	Strategic	Vessel traffic services	Navigational support	Lock and bridge management		Voyage planning	Transport management	Inter-modal port and terminal management	Fleet and cargo management			
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 47: Relation between Services and RI Systems

8.5 NIGHT NAVIGATION

Obviously, night navigation is a very importantm measures to raise the turnaround rate of vessels. Night navigation will almost double the efficiency in case that a ship only navigates by day. However, night navigation requires the following conditions:

- The requirement of the development of waterborne transportation, specially cargo and tourism traffic
- The natural conditions of waterway suitable for night navigation, for example, the gradient, current speed, current direction, current state and enough water depth, width and radius of curvature.
- A reliable aids system equipped with dependable lights, buoys or other buoyant apparatus.
- Having enough capability, (including man power, techniques work and boat, etc) to guarantee the timely recovery when light failure or discrepancy of buoys occurs.

As, majorly, NW-97 (Sunderbans waterways) are proposed to be developed for passenger services only for daily traffic commuting along the waterways, night navigation may not be required along most of the rivers forming part of NW-97.

However, the NW-97 waterways connecting Indo Bangladesh Protocol route (i.e. Muri Ganga, Saptamukhi, Thakurran, Matla, Bidya and Raimangal waterways) and those connected with Sunderban Reserve Forest area (i.e. Matla and Raimangal waterways) are proposed to be provided with adequate day/night navigation bouys along the waterways.

8.6 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) CAMC for minimum three years has been considered after one year warranty from the date of commissioning.
iv) As Raimangal 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 is provided in respective Matla DPR. The capital cost of proposed RIS and day/night marine lanterns/bouys provided in Raimangal Waterway are worked out as below.

8.6.1 Capital Cost

Table 36: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	**RIS System**			
1	AIS Base Station	1	30,00,000.00	30.00
2	RADAR	1	100,00,000.00	100.00
3	Meteo Sensor	1	7,00,000.00	7.00
4	ATG	1	9,00,000.00	9.00
5	VHF	1	5,00,000.00	5.00
6	DG Set 10 KVA	1	7,00,000.00	7.00
7	UPS	1	5,00,000.00	5.00
8	RIS Software	1	35,00,000.00	35.00
9	Installation Testing & Commissioning	1	20,00,000.00	20.00
10	Porta cabin	2	12,00,000.00	24.00
11	Trestle Tower	1	10,00,000.00	10.00
	Total cost of one RIS system			252.00
12	Construction Supervision, Design and Engineering charges		6%	15.12
	Capital cost per RIS system			**267.12**
B	Marine Lantern/Buoys of 1.25 m dia	15	2,00,000	**30.00**
	Capital Cost in Lakh			**297.12**
13	Contingencies Charges		3%	8.91
D	**Total Navigation & Communication Cost in Lakh**			**306.03**

8.6.2 O&M Cost

The operation and maintenance cost works out to as below:

Table 37: O&M Cost for Aids to Navigation and Communication

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lakh)
1	Engineer 1 * Site 1 * Months 12 per year	12	35,000.00	4.20

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lakh)
	Operator 3 * Site 1 * Months 12 per year	36	20,000.00	7.20
	Security 3 * Site 1 * Months 12 per year	36	15,000.00	5.40
2	Second Year			17.98
3	Third Year			19.23
4	Fourth Year			20.58
			Total	**74.59**
	CAMC for 4 Years			
1	1st Year	1		30.60
2	2nd Year	1		33.66
3	3rd Year	1		37.03
			Total	**101.30**
	Overall O&M Cost in INR Lakh			**175.89**

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 Raimangal River from Km 0.000 to Km 53.381 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 Raimangal River is a tidal estuarine river in and around the Sundarbans in North 24 Parganas district West Bengal, India. The river flows between Hasnabad and Hemnagar blocks and has a connection with the Chota Kalagachi River at Tushkhali and Sahibkhali River at Ramapur. It falls in to the Bay of Bengal with a wide mouth after traversing about 70 kilometres.

Raimangal River has several tributaries/creeks on its banks. The details of the creeks are given in **Table 38.**

Table 38: List of Creeks

Sl No	Creek	Chainage	Length(Km)
1	Raypur creek	33.848	2.1
2	Ghatihara Creek	35.981	1.28
3	Chak Khanpukur Creek	45.083	3.11
4	Purbba Chak Creek	47.143	2.4

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.

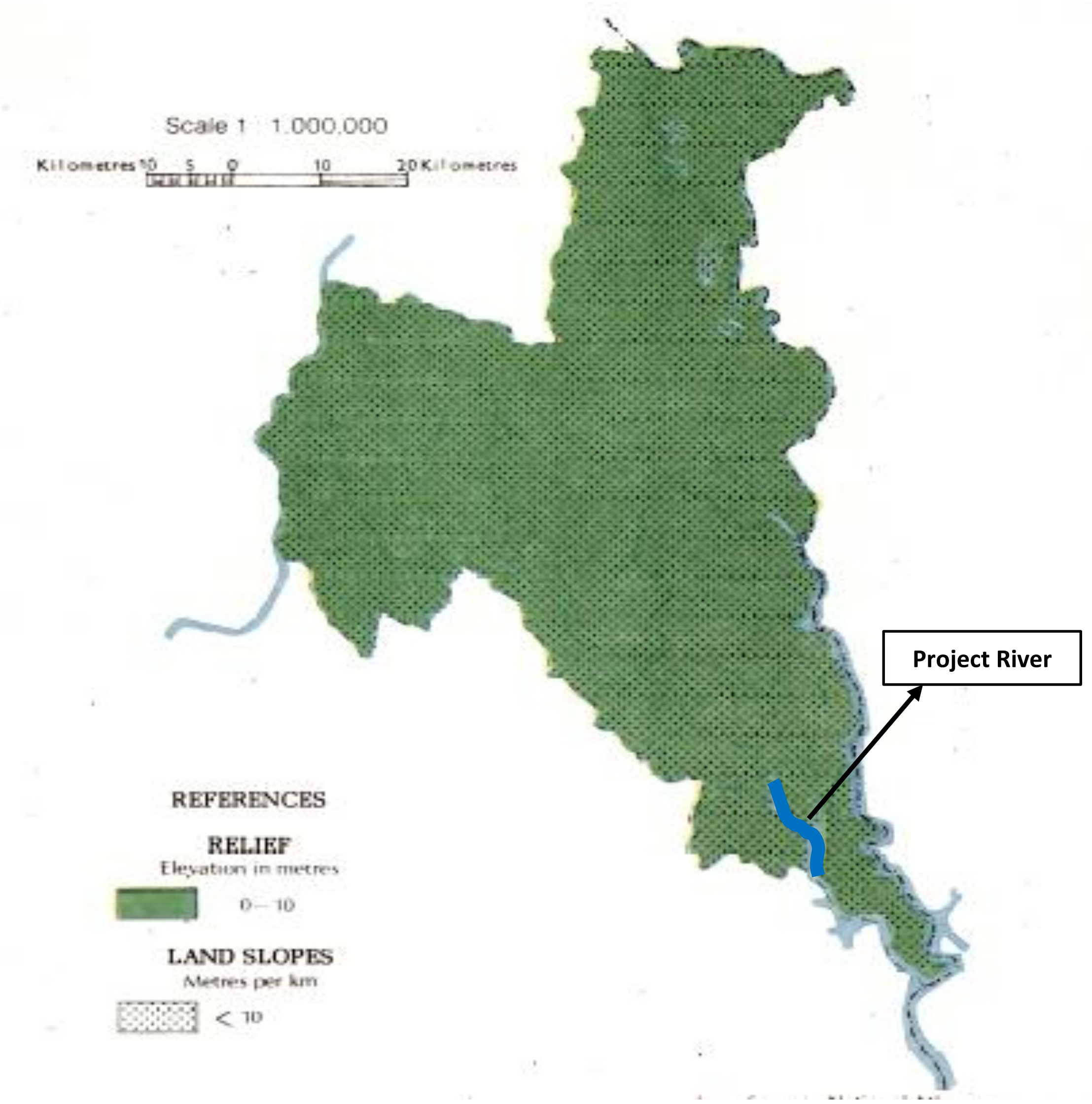
The district, North 24-parganas, has been divided geographically into three parts,

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 study stretch passes through North 24 Parganas District in the state of West Bengal. 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 48**.



Source : NATMO

Figure 48: 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.

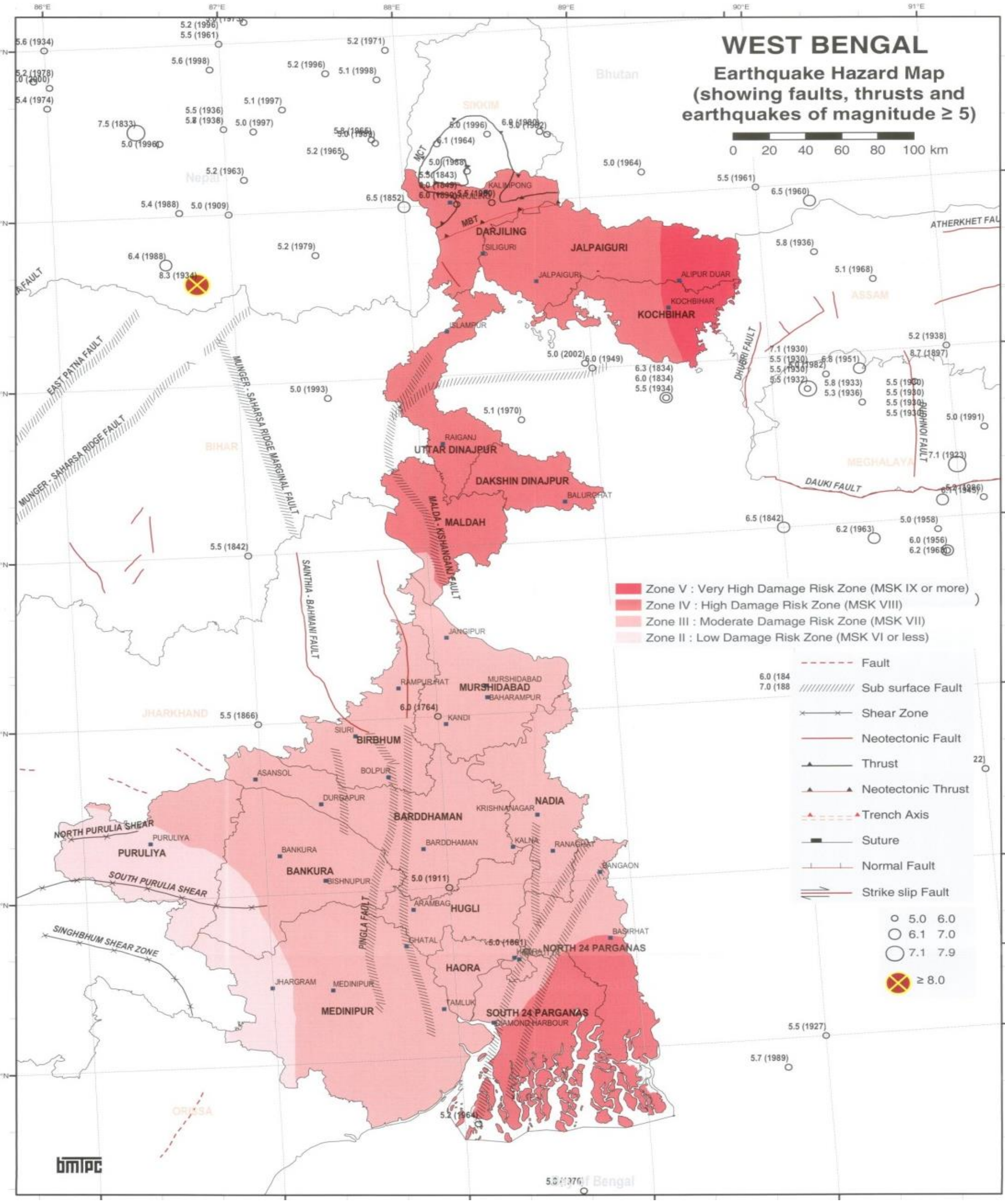
The Rock and Mineral Map of North 24 Parganas District is presented in **Figure 49**.

Source : NATMO

Figure 49: 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 50**.



Source: West Bengal Disaster Management Department

Figure 50: Earthquake Zoning map of West Bengal

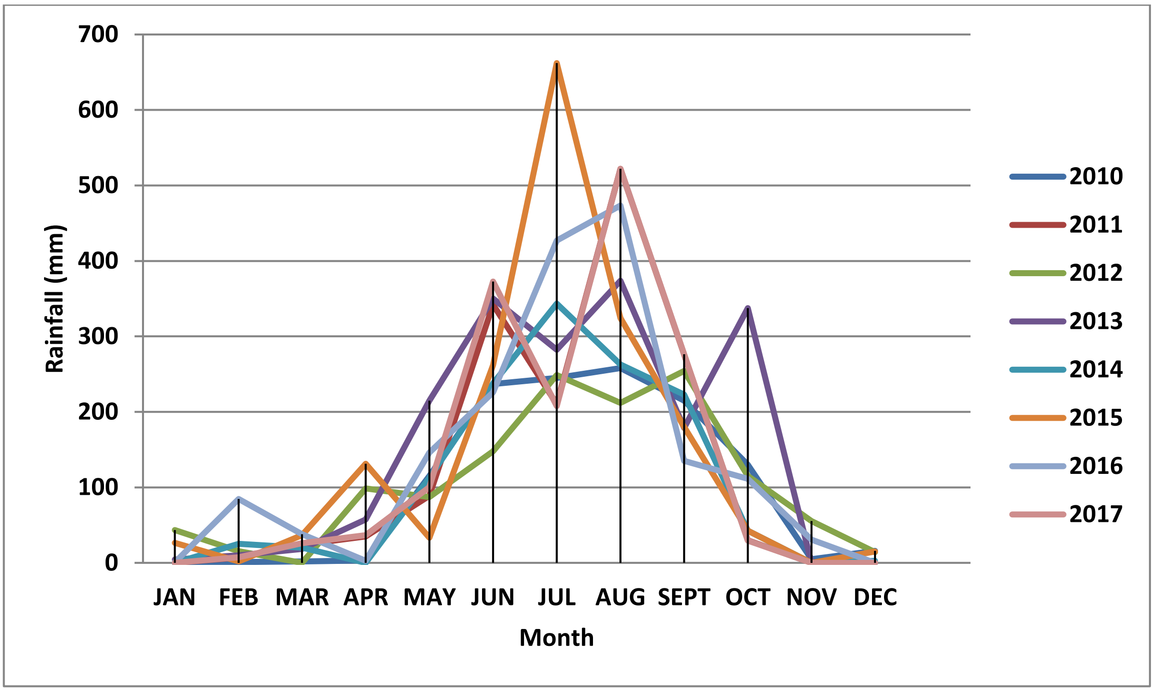
9.2.3 Climate

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 39: 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 51: Rainfall Pattern of North 24 Parganas 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 40: Daily (Mean) Maximum and Minimum temperature by month in the Project Area (1981-2007)

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
January	25.6	12.9
February	29.0	16.6
March	33.3	21.3
April	35.5	24.7
May	35.6	25.9
June	34.3	26.5
July	32.9	26.3

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
August	32.7	26.4
September	32.8	25.9
October	32.2	23.8
November	29.9	19.0
December	26.8	14.0

Source: India Meteorological Department

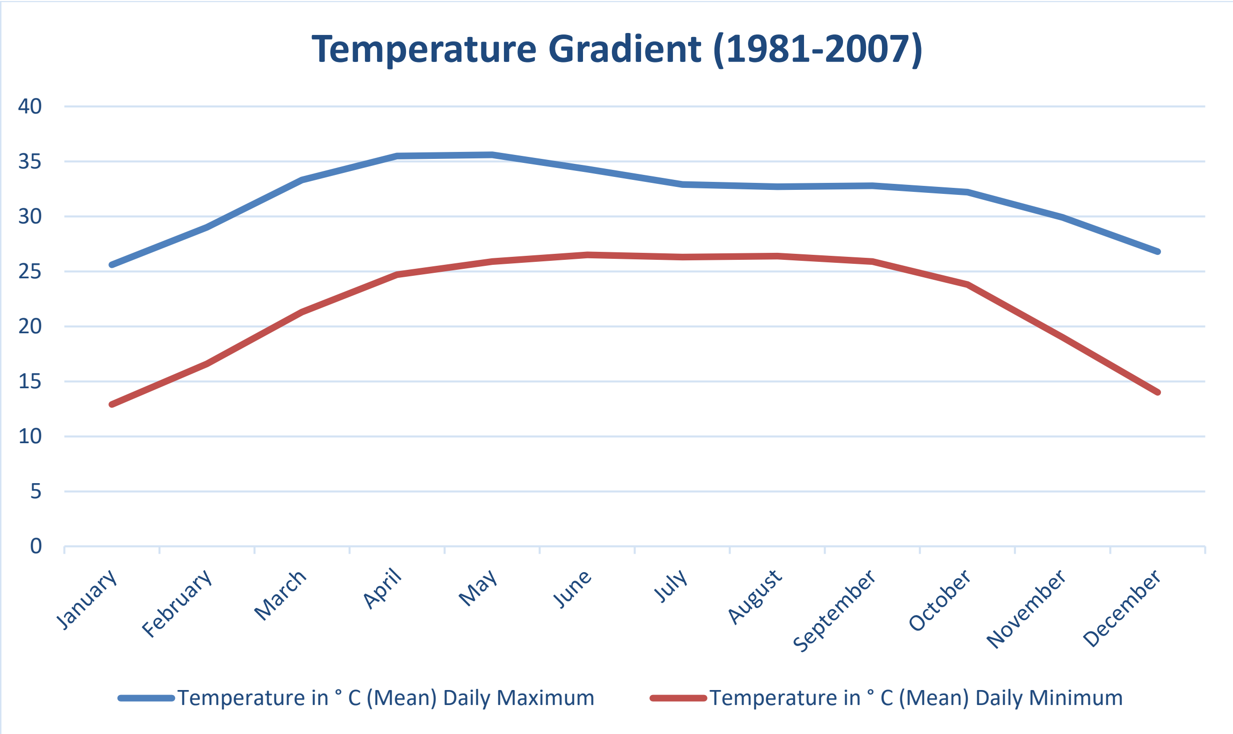
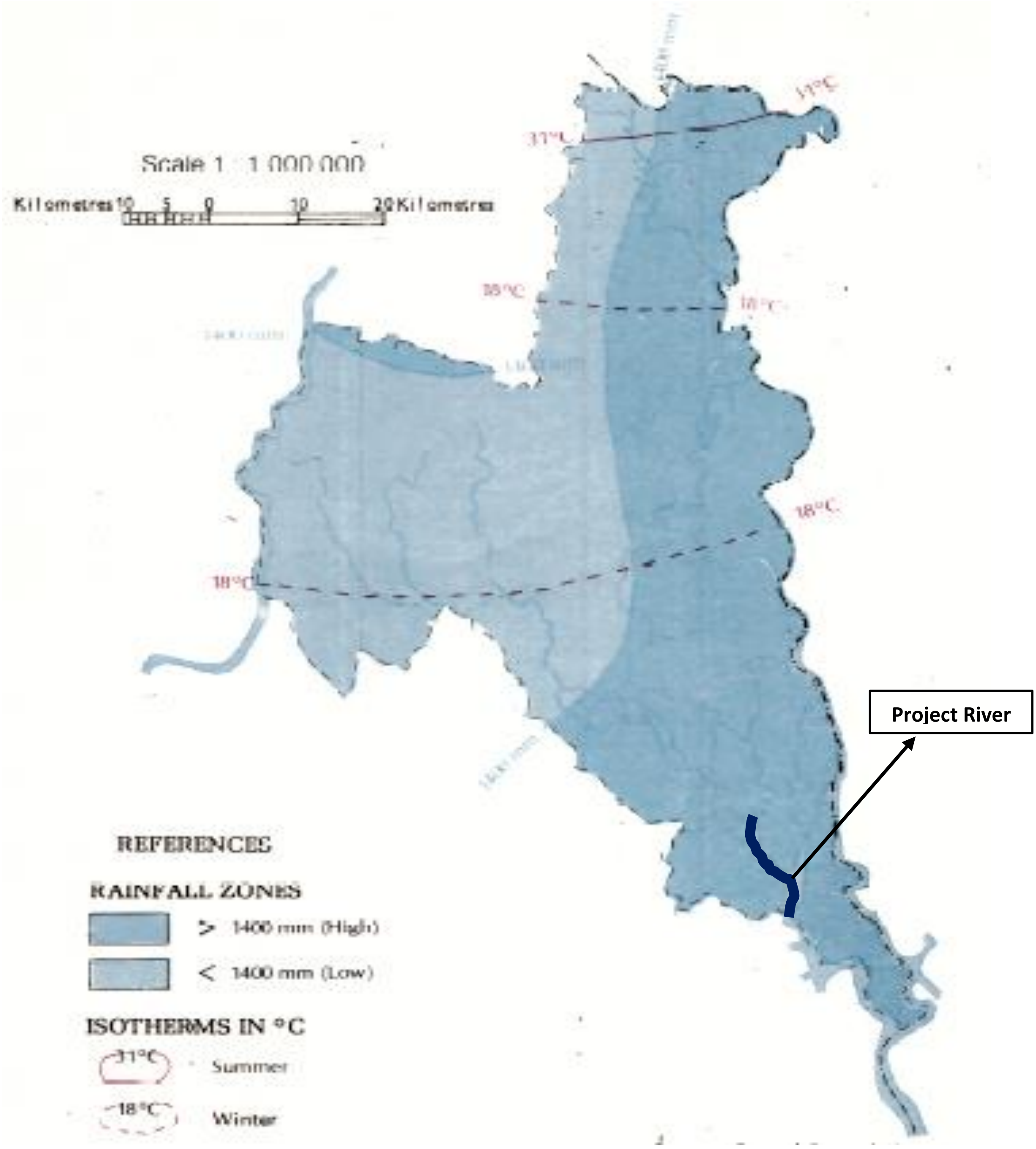


Figure 52: Graphical representation of Temperature Gradient for the year 1981-2007



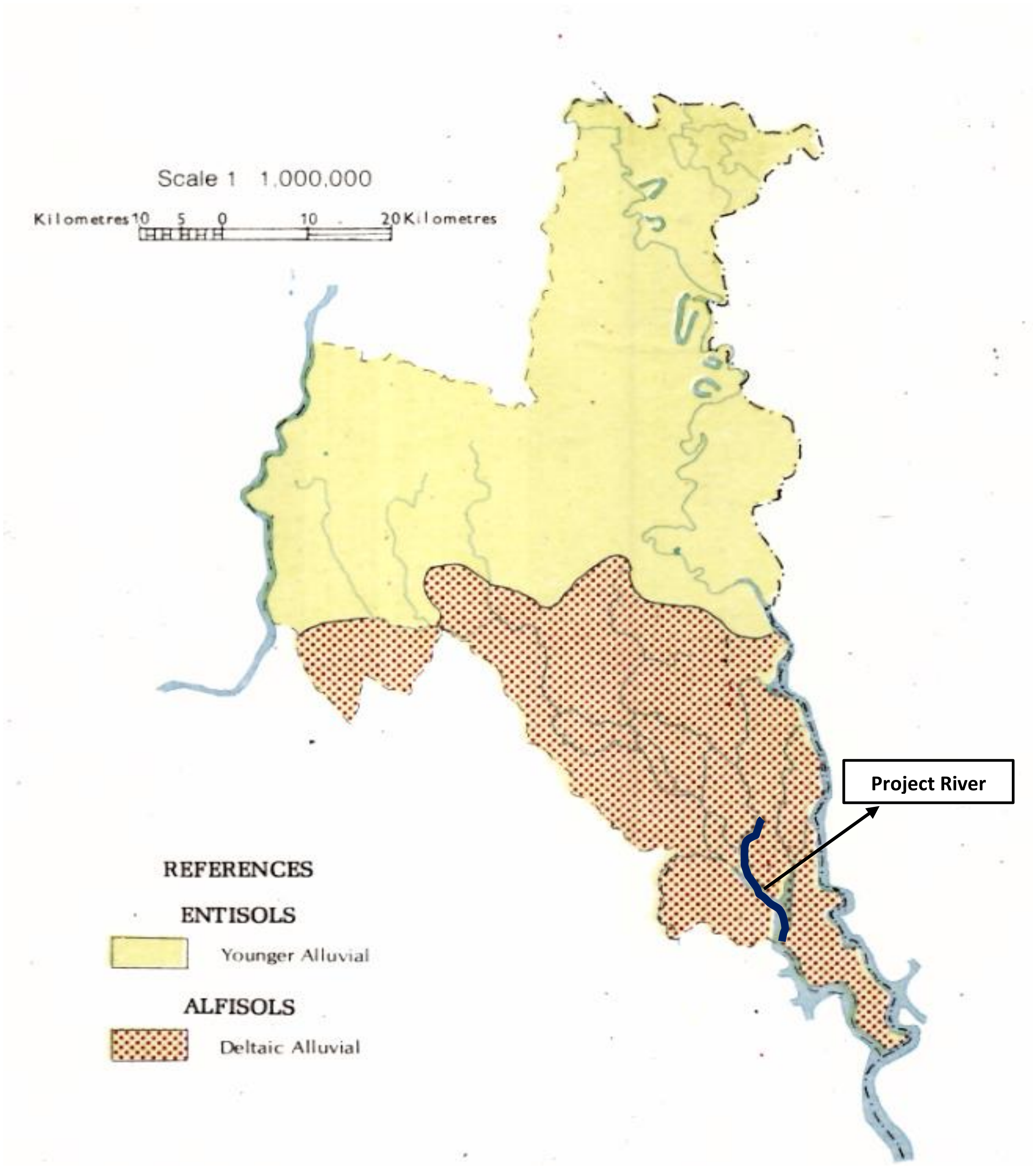
Source : NATMO

Figure 53: 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 54: Soil Map of North 24 Parganas District

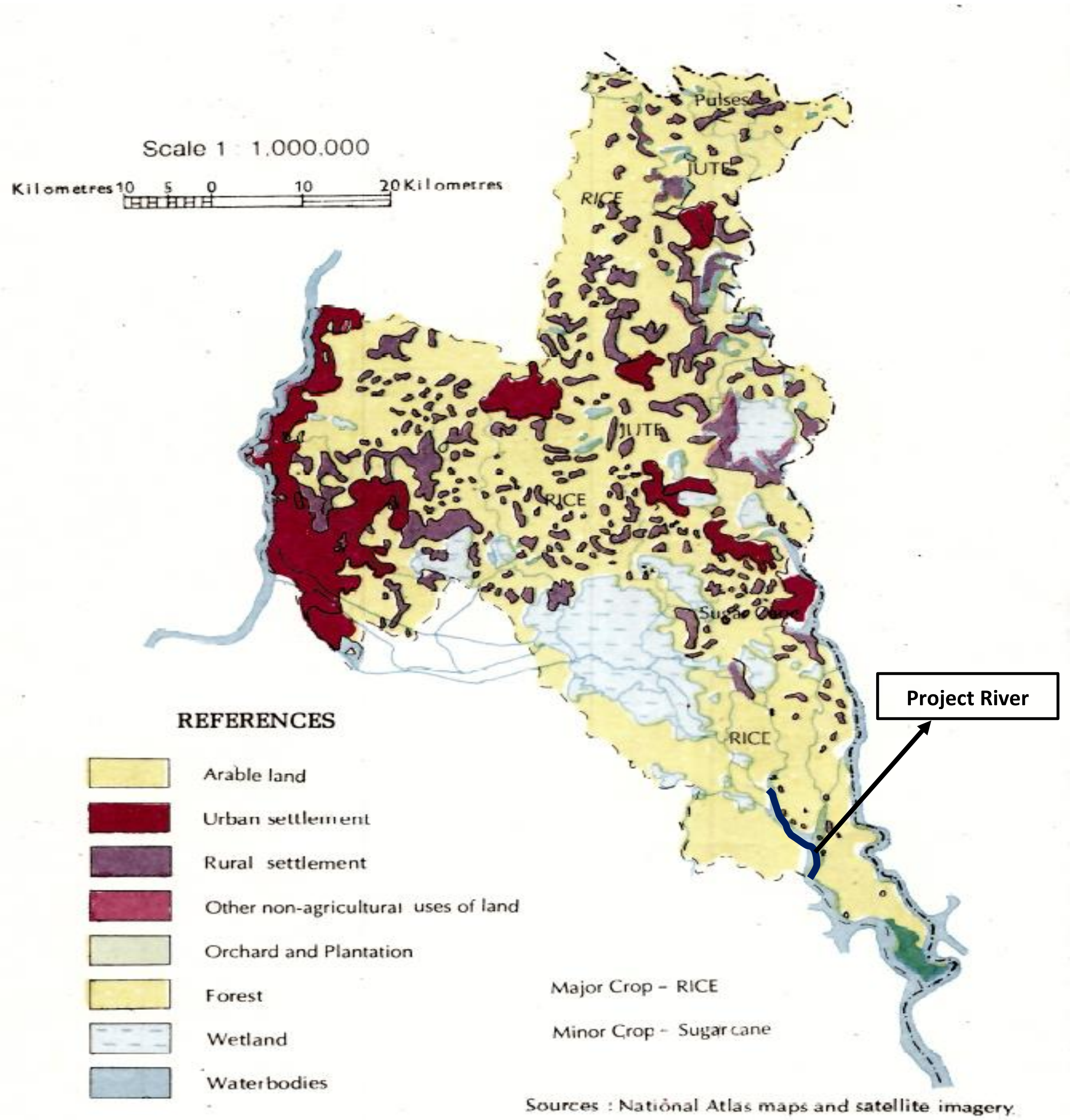
9.2.5 Land Use Pattern

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 41**.

Table 41: 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, 2012-13



Source: NATMO

Figure 55 : 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 Raimangal 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 Raimangal 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

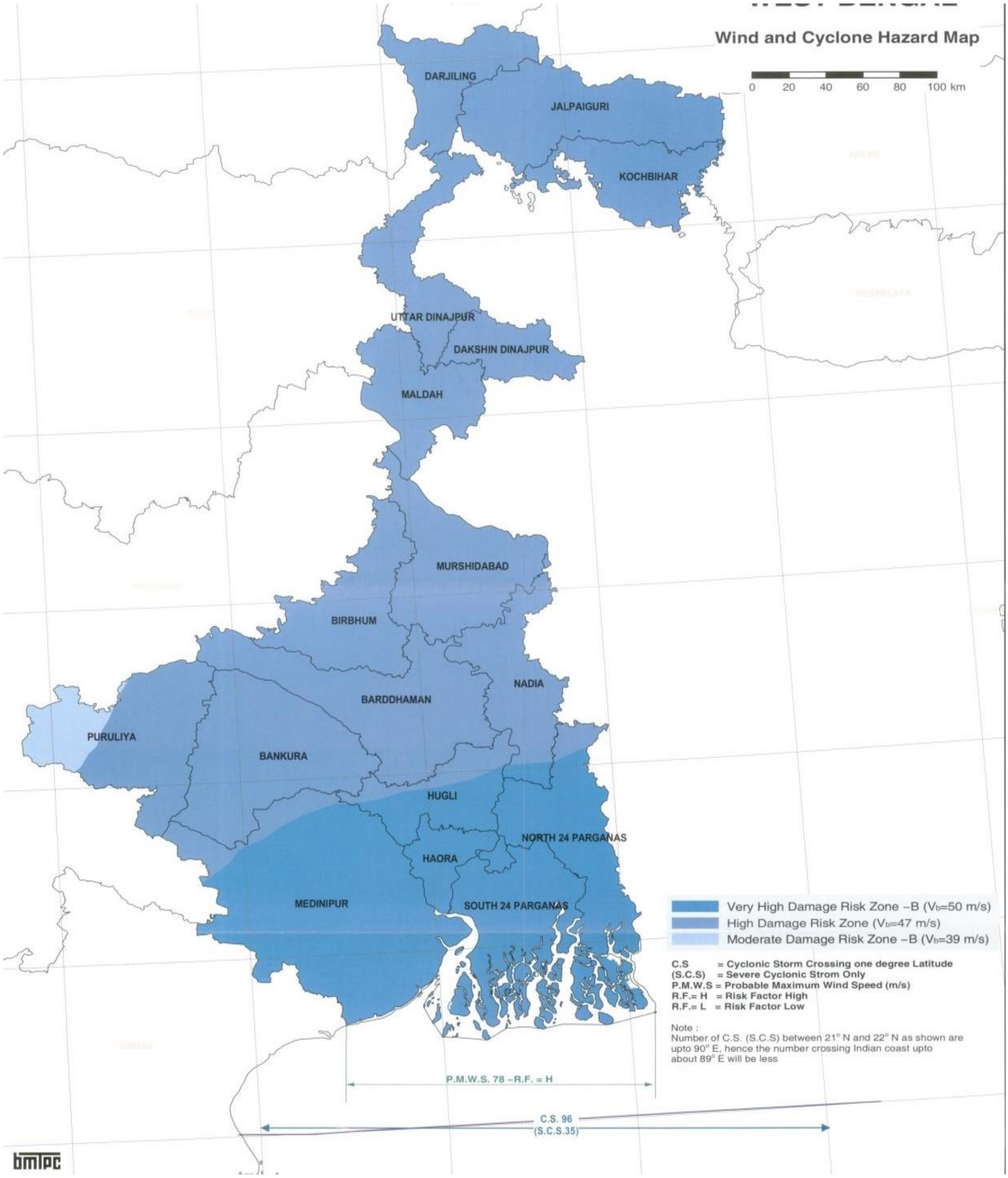
Figure 56: Flood Prone Zones of West Bengal

- **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 57: 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 Bansjhari Mallikpur at Lat 22°39'6.71"N, Long 88°55'33.35"E and ends at Kalanchi at Lat 22°53'53.79"N, Long 88°53'53.94"E. The start point is nearest to Dampier-Hodges Line and located at a distance of 4.5 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 30 km north-west of Raimangal 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 are 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 are recorded. This is similar with gangetic West Bengal. Notable common mammals are *Canis aureus* (Fox), *Presbytis entellu s*(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 (S*mooth 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 42. 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 42: 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**

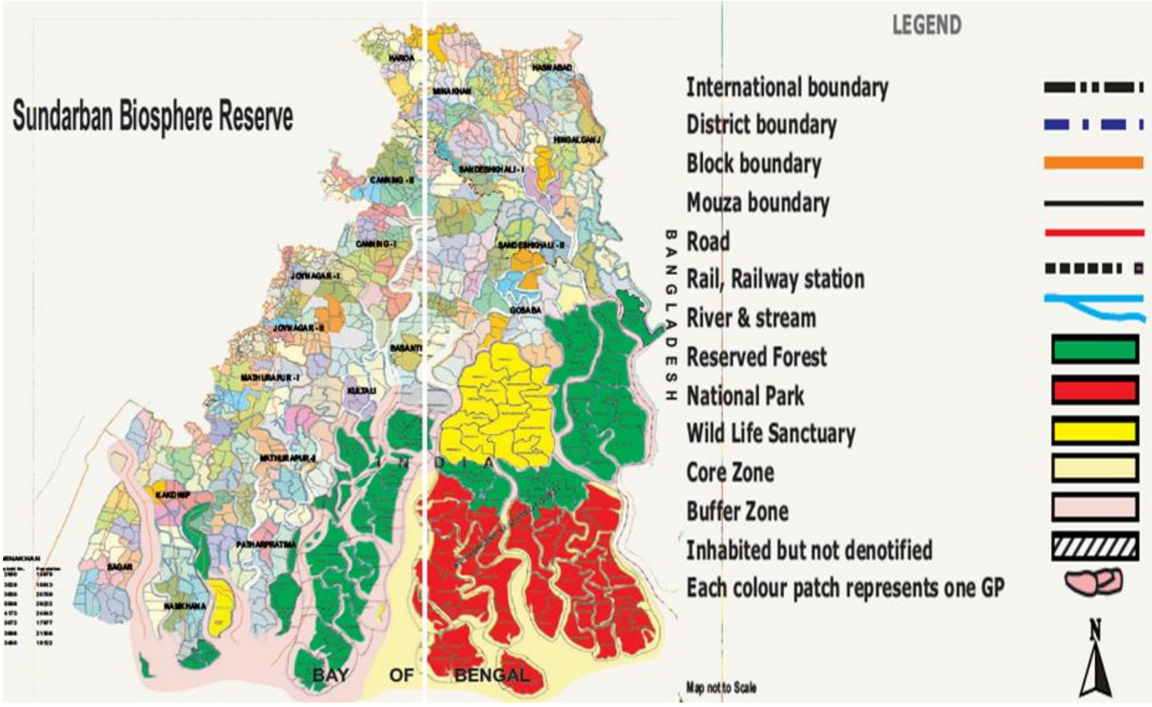
Source : Forest Survey of India, 2015

As confirmed by concerned forest department, there is no forest patches along the proposed waterway stretch.

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.

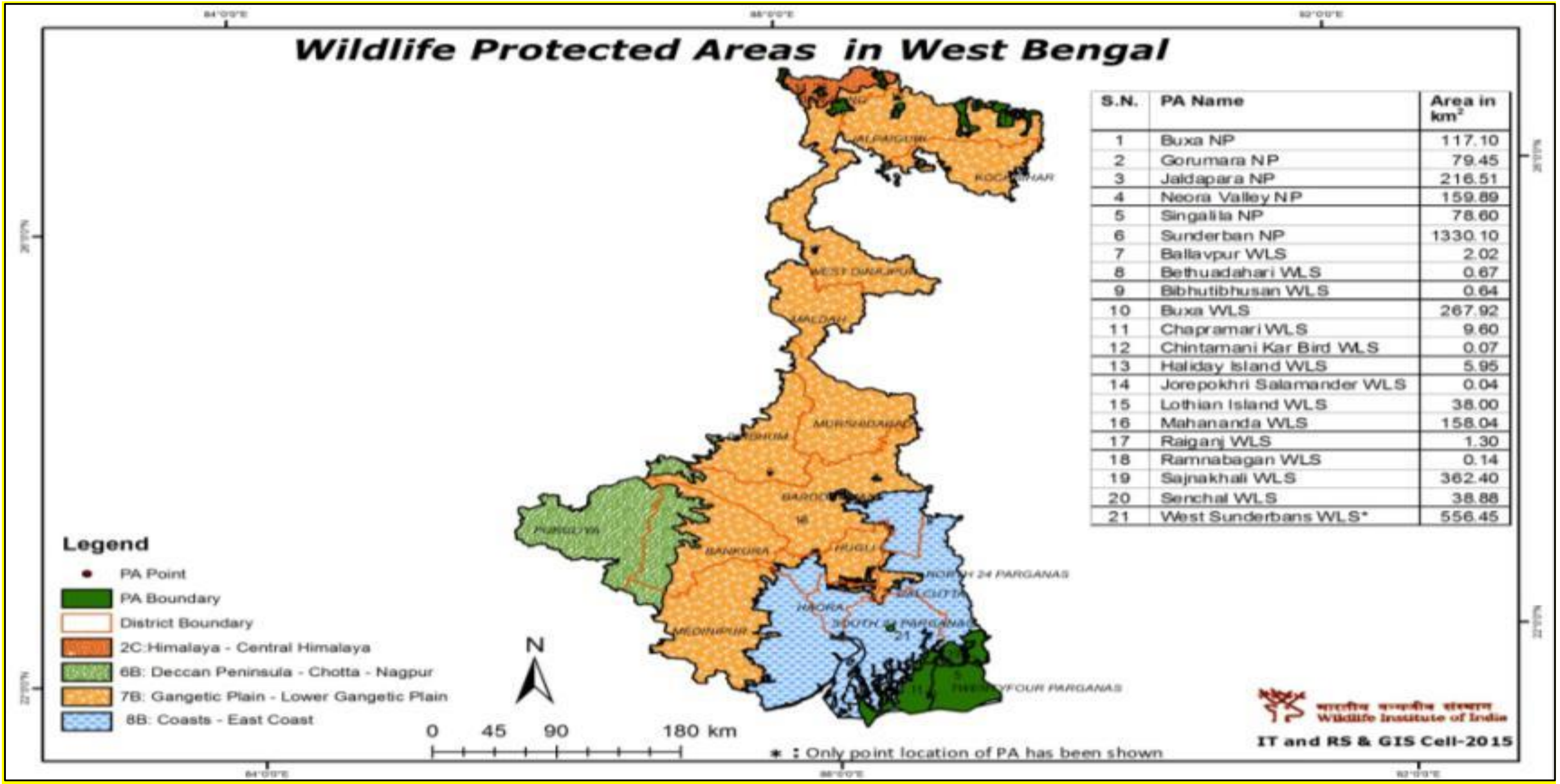
The Sunderban Biosphere Reserve is located within the project district. The Map of Sunderban Biosphere Reserve is furnished in **Figure 58**.



Source : WWF-India

Figure 58: 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 59**.



S.N.	PA Name	Area in km^2
1	Buxa NP	117.10
2	Gorumara NP	79.45
3	Jaldapara NP	216.51
4	Neora Valley NP	159.89
5	Singalila NP	78.60
6	Sunderban NP	1330.10
7	Ballavpur WLS	2.02
8	Bethuadahari WLS	0.67
9	Bibhutibhusan WLS	0.64
10	Buxa WLS	267.92
11	Chapramari WLS	9.60
12	Chintamani Kar Bird WLS	0.07
13	Haliday Island WLS	5.95
14	Jorepokhri Salamander WLS	0.04
15	Lothian Island WLS	38.00
16	Mahananda WLS	158.04
17	Raiganj WLS	1.30
18	Ramnabagan WLS	0.14
19	Sajnakhali WLS	362.40
20	Senchal WLS	38.88
21	West Sunderbans WLS*	556.45

Source : Wildlife Institute of India

Figure 59: 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 43**.

Table 43: **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 Raimangal River has been listed in the **Table 44** along with population details as per Census of India Data, 2011.

Table 44: **Major settlements/village along the project stretch of River**

Sl. No.	Village/ Town name	Population (nos.)
1	Hemnagar	3960
2	Kumirmari	17451
3	Puinjali	5455
4	Chimta	6332
5	Madhabkati	4304
6	Manipur	8152
7	Atapur	5287
8	Sitalia	6092
9	Khulna	5958
10	Bholakhali	2993
11	Bouthakurani	2840

Sl. No.	Village/ Town name	Population (nos.)
12	Bir para	3050
13	Tongtala	1759
14	Banstala	3449
15	Bainara	1940
16	Raypur	2630
17	Kakaria	742
18	Ghatihara	3614
19	Bedemari	2117
20	Ichhapur	2697
21	Chak Patli	7128
22	Shulkuniabad	5414
23	Chak Khanpukur	1886
24	Mohanpuranad	1104
25	Chak Tengramari	2315
26	Hasnabad	3412
27	Angnara	1789
28	Rajnagar	1005

Source : Census of India, 2011

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 948260, total Buffalo population accounts for 38071, total live-stock population is 2055617, total poultry 7936844 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 9,80,477 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:

  Seven (7) ferry ghats are proposed for development along the river located at Hemnagar, Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara. These ghats are locally maintained and opearated. It is proposed to develop the ferry ghats by providing floating potoon and gangway facilities at all the above ferry ghats. In addition to this, terminal complex area is also proposed at Hemnagar ferry ghat. About 1200 m^2 of area will required for passenger ferry terminal complex area. No additional land is required to be acquired for terminal construction as the ferry ghats are already operational at the proposed locations. 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. <u>IMPACTS ON AMBIENT NOISE AND VIBRATION</u>

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. <u>IMPACTS ON ECOLOGY AND BIODIVERSITY</u>

The proposed development is situated along the Chota Kalagachi 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. <u>IMPACTS ON RIVER WATER</u>

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. <u>IMPACTS ON AIR</u>

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 45** 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 45: 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		10 Km from Wildlife Sanctuary boundary. • 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	**Supervision**
		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.		
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 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		drains, etc, will be carried out.		
(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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		activities.		
(iv)	Contamination of land from fuel and lubricants	• Impervious platform and oil and grease 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.	Contractor	Supervision 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		be covered • Mixing equipment will be well sealed and equipped as per PCB norms.		
(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 Plan. • Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of dust	Contractor	Supervision Consultants, IWAI
(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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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.		
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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		MoEFCC/CPCB/WBPCB noise standards. • All vehicles and equipment used in construction will be fitted with exhaust 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	Contractor	Supervision Consultants,

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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		IWAI
5.	Safety			
(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,	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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.		
(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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 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

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
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 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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		
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	• All waste water and solid waste or maintenance waste should be disposed at	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Vessel/barges	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.		

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 46.**

Table 46: Key Environmental Laws and Regulations

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Environmental (Protection) Act	1986	To protect and improve the overall environment.	MOEFCC. GoI; CPCB, West Bengal State Pollution Control Board	√	..	This act is applicable to all environmental 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

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
						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	1988 1989	To check vehicular air and noise pollution.	Transport Department and West Bengal	√	..	For construction vehicles (Construction Stage)

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Vehicle Rules			State Pollution Control Board			– 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 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	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	--	√	This act will not be applicable
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	√		

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

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 47.**

Table 47: 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
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	Engagement of Labour	Construction stage (Prior to initiation of	Contractor

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
	Office		any work)	
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 48**.

Table 48: 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 49**)	10.79
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
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		**57.79**

Table 49: 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	No.	3 (Twice a week for	10000	7.2

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
			& Night time) to be done at each location.		twelve week): 72 Nos.		
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.	2	8000	0.16
4.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	No.	3	4000	0.12
5.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	No.	2	7500	0.15
6.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton,	One time study	No.	2	150000	3.0

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
		Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.					
	Sub-Total						**10.79**

b) Estimated cost at construction Stage:

Table 50: 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 51**	24.36
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			**45.36**

Table 51: 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: 3 Locations X 6 times X 2 Years = 36**	No.	36	10,000	3.6
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (3 locations in the interval of once in two month for 2 years)	No.	36	4,000	1.44

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
	Break up: 3 Locations X 6 times X 2 Years = 36				
3.	Monitoring of River water Quality (2 locations in the interval of once in two months for 2 years during HFL and LFL) **Break up: 2 Locations X 6 times X 2 Years X 2 (HFL&LFL) = 48**	No.	48	8000	3.84
4.	Monitoring of ground water (2 locations in the interval of of once in two months for 2 year) **Break up: 2 Locations X 6 times X 2 Year = 24**	No.	24	8000	1.92
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: 2 Locations X 2 times X 2 Year = 8**	No.	8	7,500	0.60
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					**24.36**

c) Estimated cost during operation Stage

Table 52: 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 53**	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 53: 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 54**.

Table 54: Estimated Environmental and Social Cost for the Project

Sl. No.	Project Stages	Cost (Lakh INR.)
1.	Pre-Construction Stage	57.79
2.	Construction Stage	45.36
3.	Operational Stage	25.875
Total Estimated Budget (*Except Statutory Fee*)		**129.025**

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Rainmagal waterway, it is recommended that the development of Rainmagal 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 Institutional 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) Judgement based on Consultant's Experience

11.2 DEVELOPMENT COST

Raimangal 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 55**.

Table 55: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	Capital cost for Fairway Development		1,960.95
2.0	Capital cost for ferry service facilities	**Table 25**	701.86
3.0	Capital Cost for Passenger ferry Vessels	Table 32	245.00
4.0	Capital Cost for Aids to Navigation and Communication	**Table 36**	306.03
5.0	Cost allotted for EMP	**Table 54**	103.15
	Total Capital Cost		**3,317.00**
	After 10 years of IWT operations on the basis of actual traffic growth		
7.0	Capital Cost for additional eight (8) Passenger ferry Vessels		**280.00**
	After 20 years of IWT operations on the basis of actual traffic growth		
8.0	Capital Cost for additional seventeen (17) Passenger ferry Vessels		**595.00**

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 56** as below:

Table 56: 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		196.10
2.0	O&M cost for ferry service facilities	**Table 28**	39.20
3.0	O&M Cost for Passenger ferry Vessels	**Table 34**	109.05
4.0	O&M Cost for Aids to Navigation and Communication	**Table 37**	175.89
5.0	EMP Cost during operation stage	**Table 54**	25.88
	Total O&M Cost		**546.11**
	After 10 years of IWT operations on the basis of actual traffic growth		
7.0	Additional O&M Cost for additional eight (8) Passenger ferry vessels		**133.15**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 2 years, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 57** and also shown in **Figure 60** below.

Table 57: Phasing of Expenditure

Months >	M1 – M6	M7 – M12	M13 – M18	M19 – M24
Total Cash Flow INR Lakh	497.55	995.10	995.10	829.25
% of Cash Flow	15%	30%	30%	25%

At inception 7 vessels is recommended for IWT development. Additional vessels shall be purchased in 10th & 20th year of operaton on the basis of traffic demand. Hence the same is not considerd to work out phasing of expenditure in 2 years of construction period.

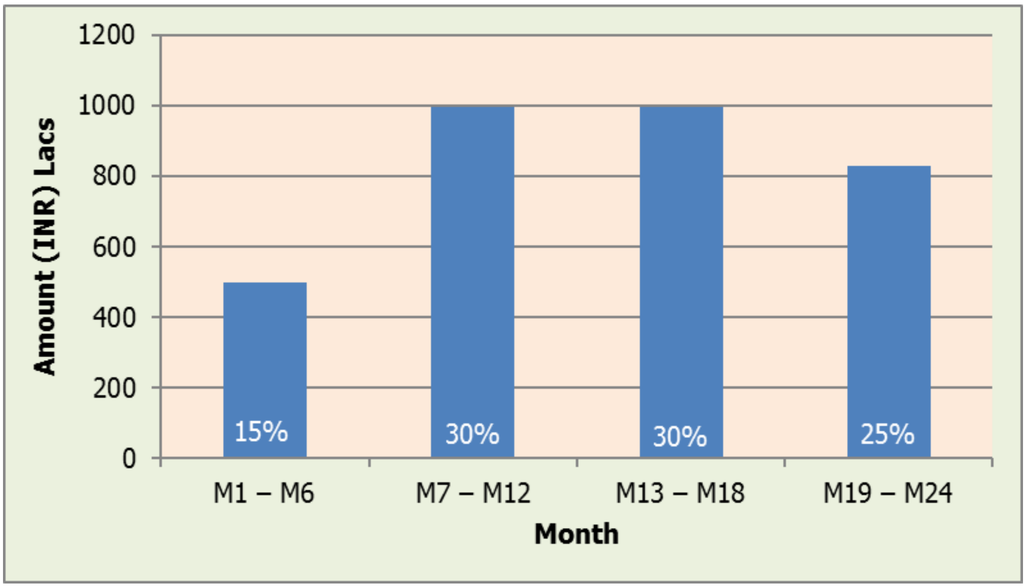


Figure 60: Phasing of Expenditure.

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of Raimangal 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 two (2) years. The proposed project schedule is provided in **Figure 61** as below.

Sl. No.	Activities	1st Year	2nd Year
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/Upgrdation of terminal building, landside facilities		
6	Upgrading existing road to terminals		

Figure 61: 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 Raimanagal 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 Raimangal 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 Raimangal 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) - Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat,
    2. OD pair 2) - Atapur ferry ghat – Khulna ferry ghat,
    3. OD pair 3) - Sandeshkhali Purba – Khulna ferry ghat, and
    4. OD pair 4) - Raypur – Binara ferry ghats.
d) Route length –
    1. OD pair 1) – 15.0 Km,
    2. OD pair 2) – 3.0 Km,
    3. OD pair 3) – 0.5 Km, and
    4. OD pair 4) – 0.45 Km.
e) For revenue estimation, present daily passenger traffic in the proposed OD pair are considered as below:
    1. OD pair 1) - 600 passengers,
    2. OD pair 2) - 600 passengers,
    3. OD pair 3) - 500 passengers, and
    4. OD pair 4) - 450 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 58** to **Table 60.**

Table 58: 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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-2	1493		1493	0	-1493	0	-1493	0	-1493	0	-1493	0	-1493
-1	1824		1824	0	-1824	0	-1824	0	-1824	0	-1824	0	-1824
0		546	546	39	-507	118	-428	197	-349	276	-270	354	-192
1		573	573	46	-527	138	-436	230	-344	321	-252	413	-160
2		602	602	54	-549	161	-441	268	-334	375	-227	482	-120
3		632	632	62	-570	187	-445	312	-320	437	-195	562	-70
4		664	664	73	-591	219	-445	364	-299	510	-154	656	-8
5		697	697	85	-612	255	-442	425	-272	595	-102	765	68
6		732	732	99	-633	297	-434	496	-236	694	-38	892	161
7		768	768	116	-653	347	-421	578	-190	810	41	1041	272
8		807	807	135	-672	405	-402	674	-132	944	137	1214	407
9		847	847	157	-690	472	-375	787	-60	1101	254	1416	569
10	280	890	1170	184	-986	551	-619	918	-252	1285	115	1652	482
11		1067	1067	214	-853	642	-425	1070	3	1498	431	1927	859

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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
12		1121	1121	250	-871	749	-371	1248	128	1748	627	2247	1127
13		1177	1177	291	-885	874	-303	1456	280	2039	862	2621	1445
14		1235	1235	340	-896	1019	-216	1698	463	2378	1142	3057	1822
15		1297	1297	396	-901	1189	-109	1981	684	2774	1476	3566	2269
16		1362	1362	462	-900	1386	24	2311	949	3235	1873	4159	2797
17		1430	1430	539	-891	1617	187	2695	1265	3773	2343	4851	3421
18		1502	1502	629	-873	1886	385	3144	1642	4401	2900	5659	4157
19		1577	1577	733	-843	2200	623	3667	2090	5134	3557	6600	5024
20	595	1656	2251	855	-1395	2566	316	4277	2026	5988	3737	7699	5448
FIRR (%)					**#NUM!**		**-13.40%**		**2.70%**		**8.81%**		**12.98%**

Table 59: 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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-2	1382		1382		-1382		-1382		-1382		-1382		-1382
-1	1690		1690		-1690		-1690		-1690		-1690		-1690
0		437	437	39	-398	118	-319	197	-240	276	-161	354	-83
1		459	459	46	-413	138	-321	230	-229	321	-137	413	-46
2		482	482	54	-428	161	-321	268	-214	375	-107	482	0
3		506	506	62	-443	187	-318	312	-194	437	-69	562	56
4		531	531	73	-458	219	-313	364	-167	510	-21	656	125
5		558	558	85	-473	255	-303	425	-133	595	37	765	207
6		586	586	99	-487	297	-288	496	-90	694	108	892	307
7		615	615	116	-499	347	-268	578	-37	810	195	1041	426
8		646	646	135	-511	405	-241	674	29	944	299	1214	568
9		678	678	157	-521	472	-206	787	109	1101	423	1416	738
10		712	712	184	-528	551	-161	918	206	1285	573	1652	940
11		748	748	214	-533	642	-105	1070	323	1498	751	1927	1179

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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
12		785	785	250	-535	749	-36	1248	464	1748	963	2247	1462
13		824	824	291	-533	874	50	1456	632	2039	1214	2621	1797
14		865	865	340	-526	1019	154	1698	833	2378	1512	3057	2192
15		909	909	396	-512	1189	280	1981	1072	2774	1865	3566	2657
16		954	954	462	-492	1386	432	2311	1357	3235	2281	4159	3205
17		1002	1002	539	-463	1617	615	2695	1693	3773	2772	4851	3850
18		1052	1052	629	-423	1886	834	3144	2092	4401	3349	5659	4607
19		1104	1104	733	-371	2200	1096	3667	2562	5134	4029	6600	5496
20		1160	1160	855	-304	2566	1407	4277	3117	5988	4828	7699	6539
FIRR (%)					**#NUM!**		**-1.54%**		**7.20%**		**12.23%**		**16.01%**

Table 60: 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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-2	0		0.00		0		0		0		0		0
-1	245		245.00		-245		-245		-245		-245		-245
0		109	109.05	39	-70	118	9	197	88	276	167	354	245
1		115	114.50	46	-69	138	23	230	115	321	207	413	299
2		120	120.23	54	-67	161	40	268	148	375	255	482	362
3		126	126.24	62	-64	187	61	312	186	437	311	562	436
4		133	132.55	73	-60	219	86	364	232	510	378	656	523
5		139	139.18	85	-54	255	116	425	286	595	456	765	626
6		146	146.14	99	-47	297	151	496	350	694	548	892	746
7		153	153.44	116	-38	347	194	578	425	810	656	1041	887
8		161	161.12	135	-26	405	244	674	513	944	783	1214	1053
9		169	169.17	157	-12	472	303	787	618	1101	932	1416	1247
10	280	178	457.63	184	-274	551	93	918	460	1285	827	1652	1194
11		320	319.66	214	-106	642	323	1070	751	1498	1179	1927	1607

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 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
12		336	335.65	250	-86	749	413	1248	913	1748	1412	2247	1911
13		352	352.43	291	-61	874	521	1456	1104	2039	1686	2621	2269
14		370	370.05	340	-30	1019	649	1698	1328	2378	2008	3057	2687
15		389	388.55	396	8	1189	800	1981	1593	2774	2385	3566	3177
16		408	407.98	462	54	1386	978	2311	1903	3235	2827	4159	3751
17		428	428.38	539	111	1617	1189	2695	2267	3773	3345	4851	4423
18		450	449.80	629	179	1886	1436	3144	2694	4401	3951	5659	5209
19		472	472.29	733	261	2200	1728	3667	3195	5134	4661	6600	6128
20	595	496	1090.90	855	-236	2566	1475	4277	3186	5988	4897	7699	6608
FIRR (%)					**-12.75%**		**33.72%**		**61.13%**		**90.57%**		**121.20%**

From the above analysis with various options it is concluded that the passenger ferry services in the waterway is financially viable in all cases for fare of INR 5.0 per passenger per Km and above for thr proposed OD pairs. However, it would be better 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

13.3 ECONOMIC ANALYSIS / EIRR

The economic analysis for proposed IWT in Raimangal waterway is done on all the above scenarios discussed in financial analysis section.

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 tariff of INR 5.0 per person per km for all the three (3) options is provided in **Table 61.**

Table 61: 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)
-2		-1493	-1493	-1382	-1382	0	0
-1		-1824	-1824	-1690	-1690	-245	-245
0	35	-349	-314	-240	-205	88	123
1	35	-344	-308	-229	-194	115	151
2	36	-334	-299	-214	-178	148	183
3	36	-320	-284	-194	-157	186	222
4	36	-299	-263	-167	-130	232	268
5	37	-272	-235	-133	-96	286	323
6	37	-236	-199	-90	-53	350	387
7	38	-190	-153	-37	1	425	462
8	38	-132	-94	29	67	513	551
9	38	-60	-22	109	147	618	656
10	39	-252	-213	206	244	460	499
11	66	3	70	323	389	751	817
12	67	128	195	464	531	913	980
13	68	280	347	632	700	1104	1171
14	68	463	531	833	902	1328	1397
15	69	684	753	1072	1142	1593	1662
16	70	949	1018	1357	1426	1903	1973
17	70	1265	1336	1693	1764	2267	2337
18	71	1642	1713	2092	2163	2694	2765
19	72	2090	2162	2562	2634	3195	3266
20	73	2026	2099	3117	3190	3186	3259
EIRR (%)			**3.53%**		**7.94%**		**71.13%**

From the the above table, it is concluded that Raimangal waterway is economically viable for all the three options.

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 62.**

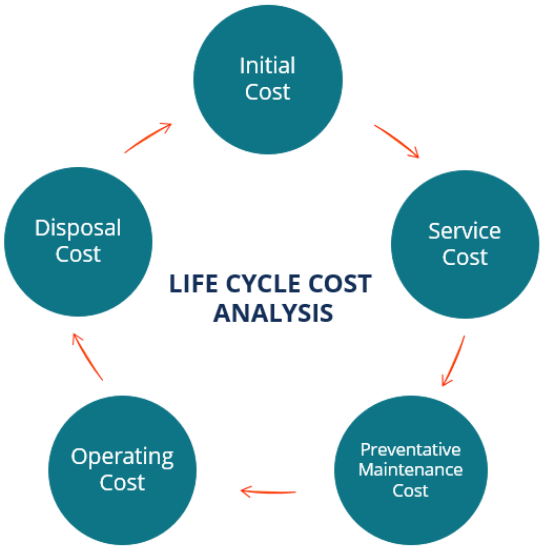
Table 62: Sensitivity Analysis w.r.t to varying IWT fare

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	1.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	-12.75%	1.73%
2	1.50	Not Calculable	Not Calculable	Not Calculable	Not Calculable	10.41%	16.94%
3	2.00	Not Calculable	Not Calculable	-13.49%	-10.56%	19.59%	25.99%
4	2.50	Not Calculable	Not Calculable	-5.76%	-4.12%	26.92%	33.80%
5	3.00	-13.40%	-10.80%	-1.54%	-0.33%	33.72%	41.25%
6	3.50	-6.37%	-4.85%	1.40%	2.40%	40.41%	48.64%
7	4.00	-2.36%	-1.22%	3.68%	4.56%	47.18%	56.07%
8	4.50	0.48%	1.42%	5.58%	6.37%	54.08%	63.56%
9	5.00	2.70%	3.53%	7.20%	7.94%	61.13%	71.13%
10	5.50	4.55%	5.30%	8.64%	9.34%	68.33%	78.77%
11	6.00	6.14%	6.83%	9.94%	10.60%	75.64%	86.47%
12	6.50	7.54%	8.20%	11.13%	11.76%	83.06%	94.21%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Raimangal waterway is financially and economically viable for all the three options with a tarrif of INR 5.0 per passenger per Km and above for the proposed OD pairs.

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 Raimangal 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 5.50 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 63**.

Table 63: 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)
-2	1,493	-	1,382	-	-	-
-1	1,824	-	1,690	-	245	-
0	546	232	437	232	109	232
1	573	265	459	265	115	265
2	602	304	482	304	120	304
3	632	348	506	348	126	348
4	664	401	531	401	133	401
5	697	462	558	462	139	462
6	732	533	586	533	146	533
7	768	616	615	616	153	616
8	807	712	646	712	161	712
9	847	825	678	825	169	825
10	1,170	956	712	956	458	956
11	1,067	1,137	748	1,137	320	1,137
12	1,121	1,315	785	1,315	336	1,315
13	1,177	1,524	824	1,524	352	1,524
14	1,235	1,767	865	1,767	370	1,767
15	1,297	2,050	909	2,050	389	2,050
16	1,362	2,380	954	2,380	408	2,380
17	1,430	2,766	1,002	2,766	428	2,766
18	1,502	3,215	1,052	3,215	450	3,215
19	1,577	3,739	1,104	3,739	472	3,739
20	2,251	4,350	1,160	4,350	1,091	4,350
Total	**25,373**	**29,896**	**18,683**	**29,896**	**6,690**	**29,896**

On the basis of above LCCA, Financial chart and breakeven for all the 3 options are presented in **Figure 62** to **Figure 64**. For 20 years of project life cycle with a tariff of INR 5.0 per passenger per Km, following is concluded:

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

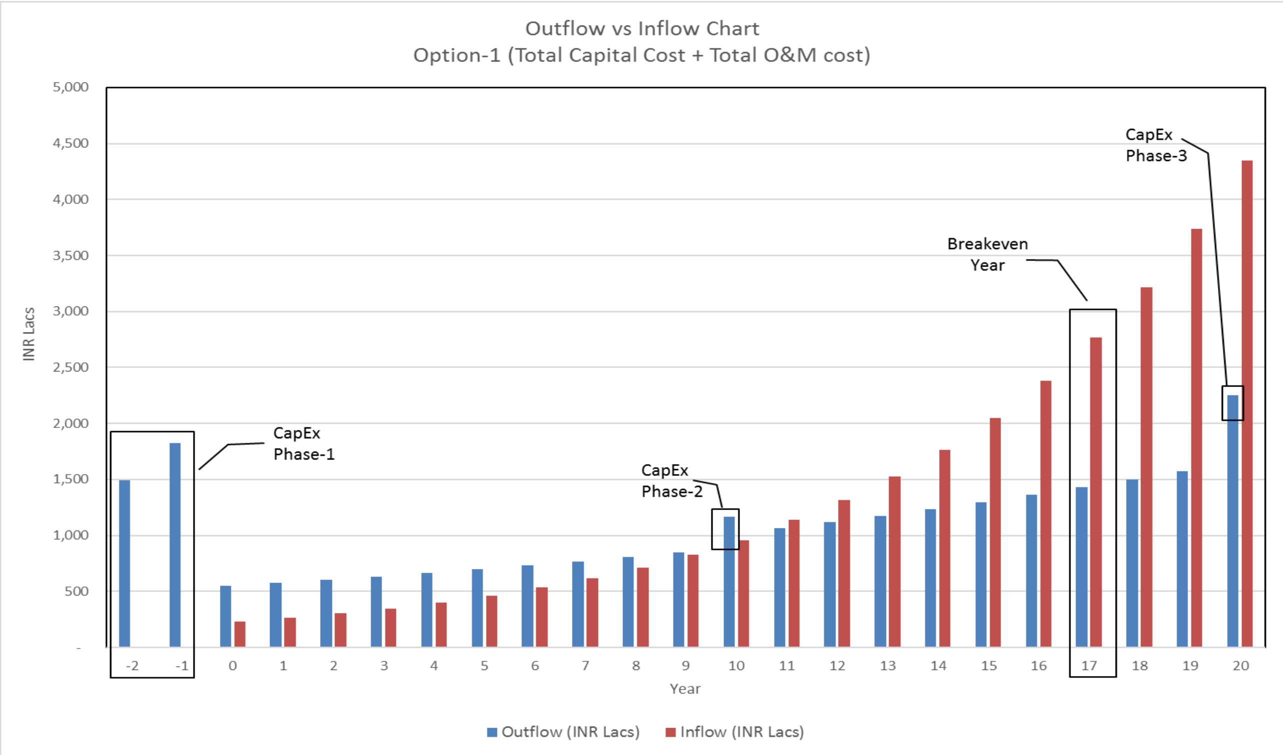
With project life cycle cost of INR 25,373 Lacs, the breakeven occurs during 17^{th} year of operation.

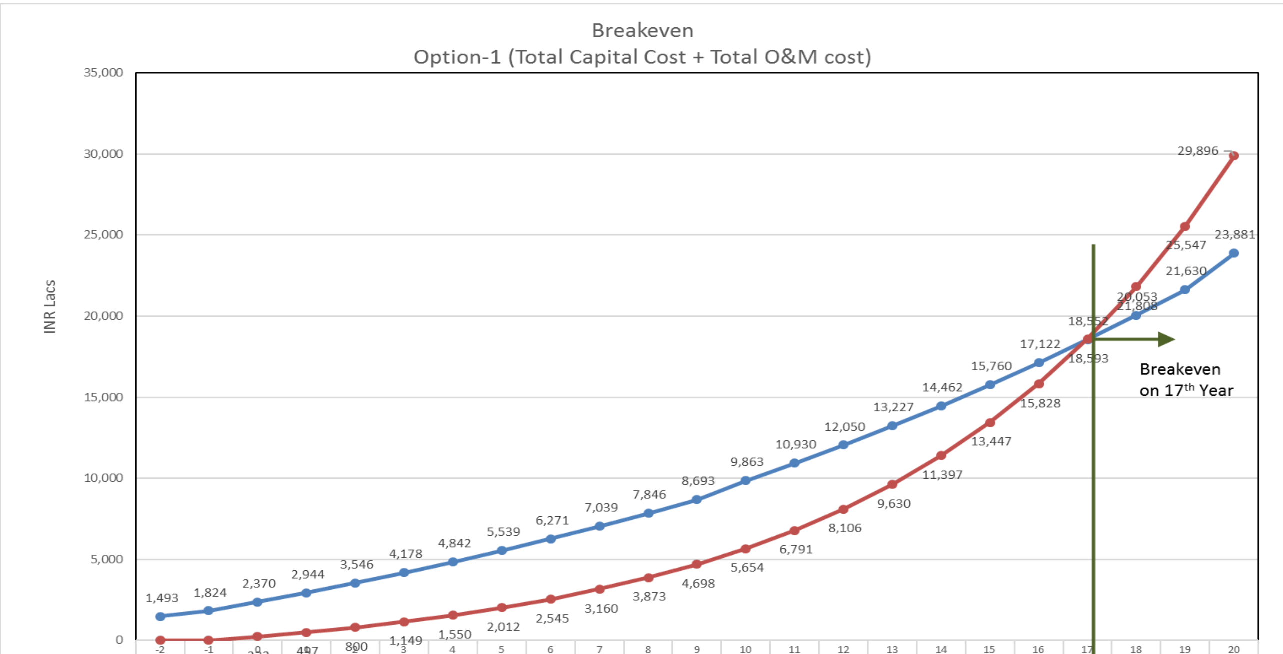
Option 2: Option 1 - Vessel Capital & O&M cost

With project life cycle cost of INR 18,683 Lacs, the breakeven occurs during 14^{th} year of operation.

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

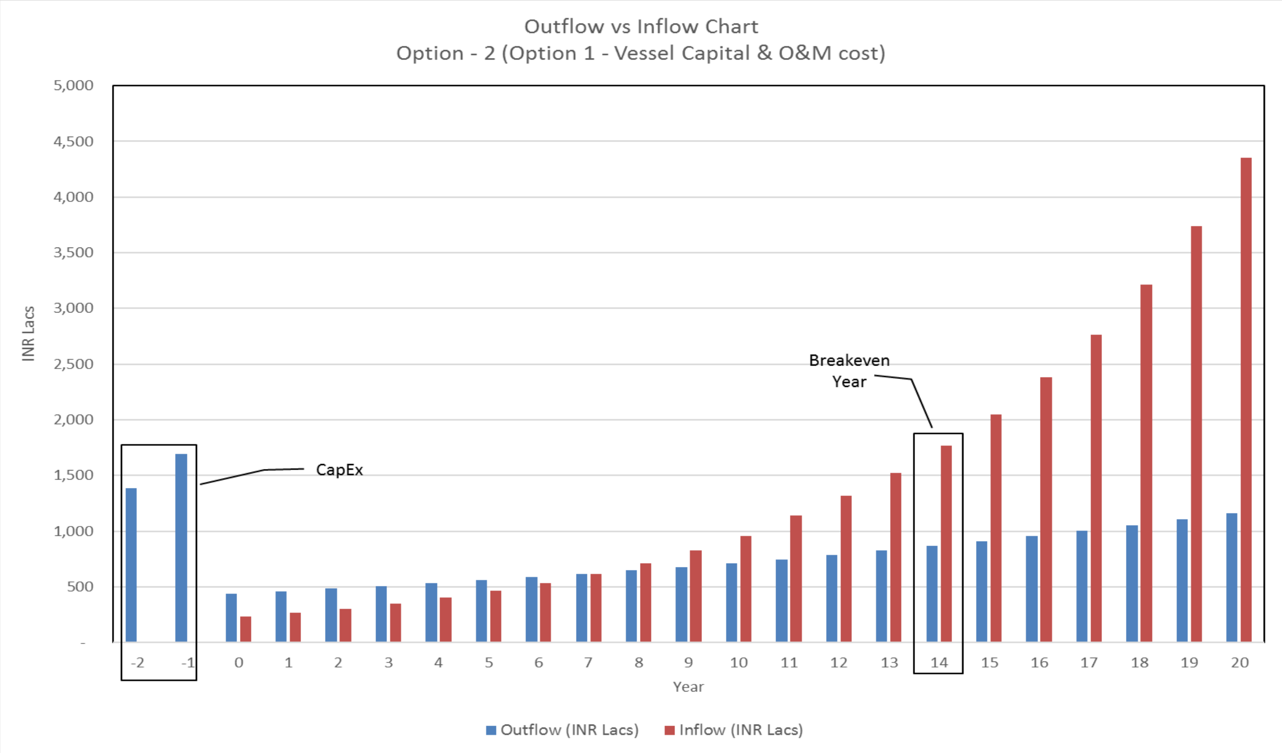
With project life cycle cost of INR 6,690 Lacs, the breakeven occurs during 0^{th} year of operation.

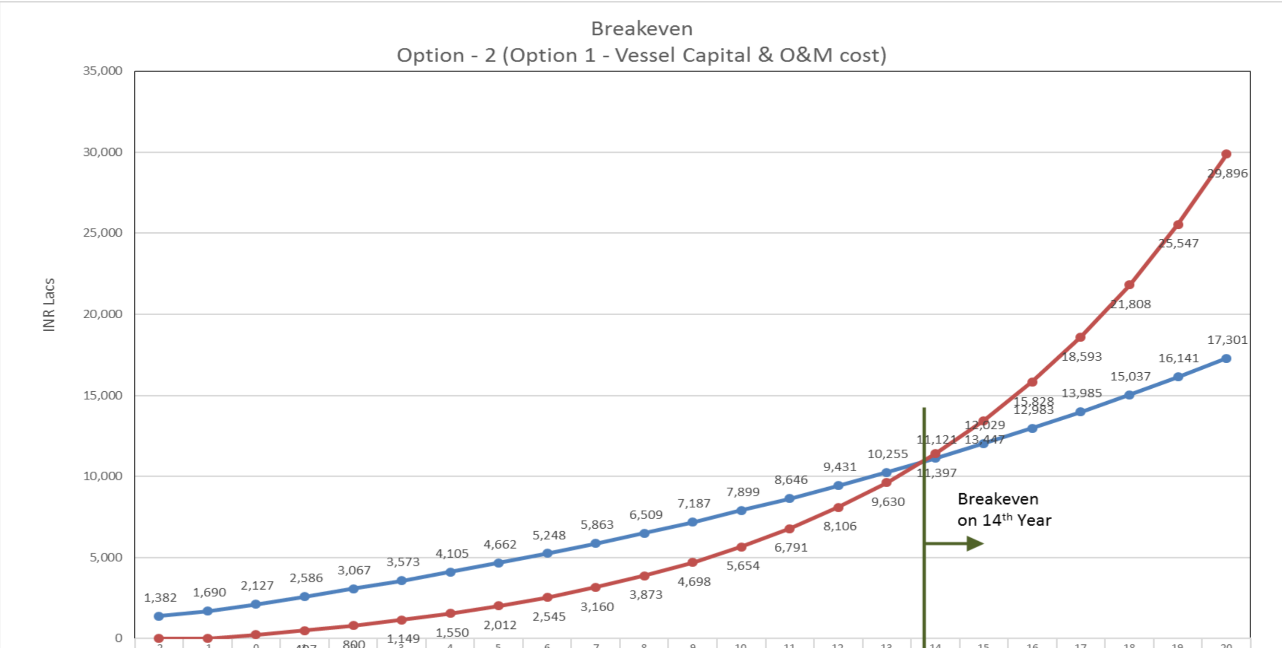




Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	1,493	1,824	2,370	2,944	3,546	4,178	4,842	5,539	6,271	7,039	7,846	8,693	9,863	10,930	12,050	13,227	14,462	15,760	17,122	18,552	20,053	21,630	23,881
Cum Inflow (INR Lacs)	-	-	232	497	800	1,149	1,550	2,012	2,545	3,160	3,873	4,698	5,654	6,791	8,106	9,630	11,397	13,447	15,828	18,593	21,808	25,547	29,896

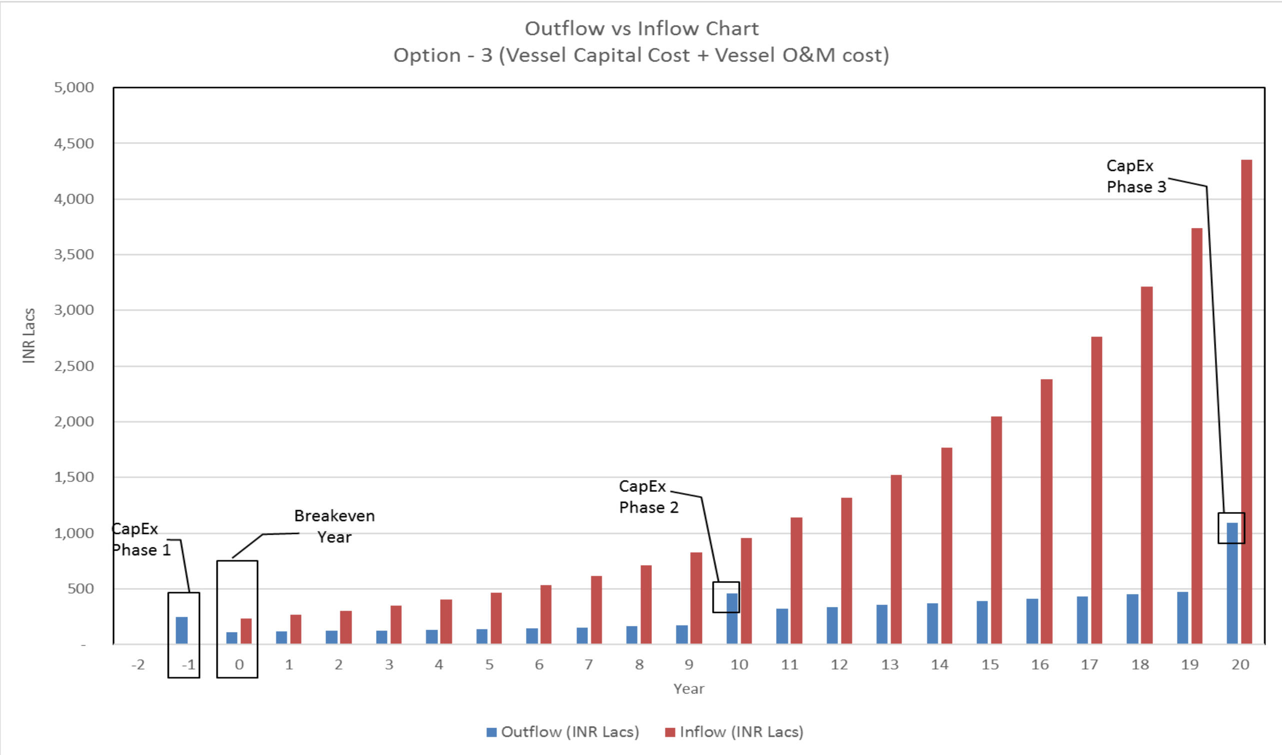
Figure 62: Financial (Outflow vs Inflow) Chart and Breakeven – Option 1

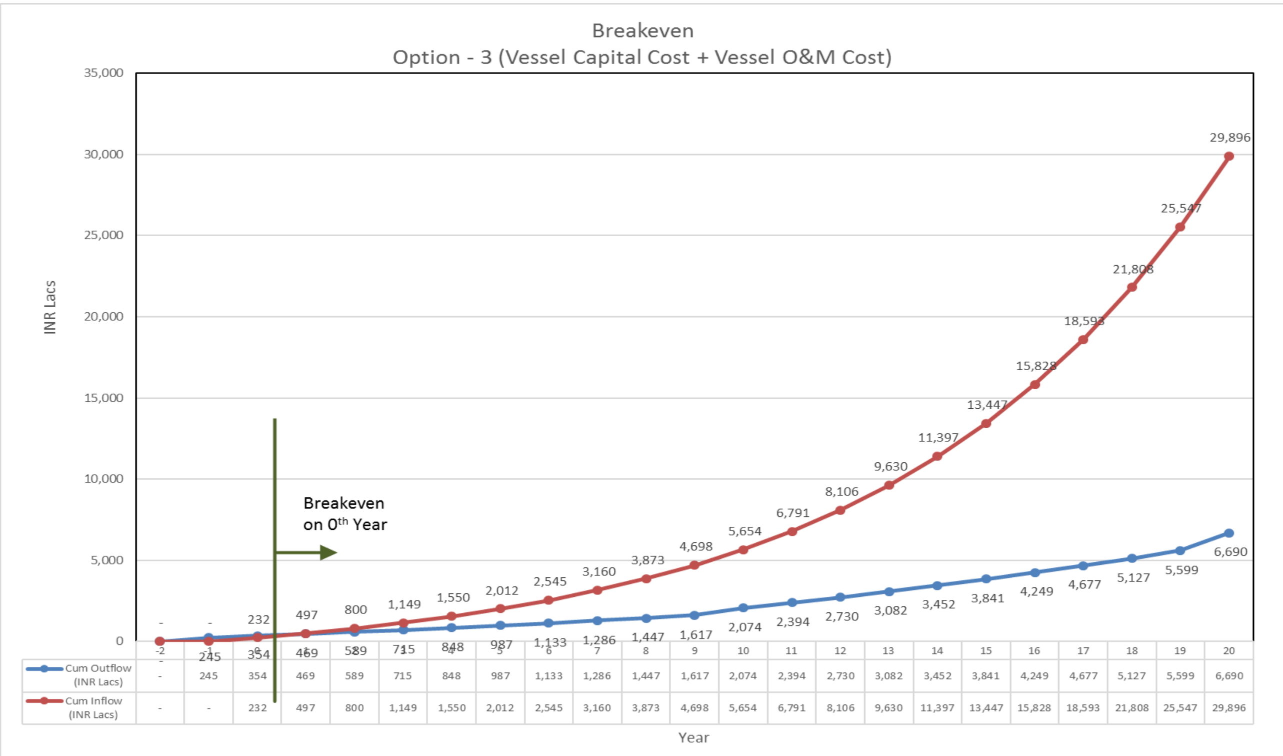




Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	1,382	1,690	2,127	2,586	3,067	3,573	4,105	4,662	5,248	5,863	6,509	7,187	7,899	8,646	9,431	10,255	11,121	12,029	12,983	13,985	15,037	16,141	17,301
Cum Inflow (INR Lacs)	-	-	232	497	800	1,149	1,550	2,012	2,545	3,160	3,873	4,698	5,654	6,791	8,106	9,630	11,397	13,447	15,828	18,593	21,808	25,547	29,896

Figure 63: Financial (Outflow vs Inflow) Chart and Breakeven – Option 2





	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	-	245	354	469	589	715	848	987	1,133	1,286	1,447	1,617	2,074	2,394	2,730	3,082	3,452	3,841	4,249	4,677	5,127	5,599	6,690
Cum Inflow (INR Lacs)	-	-	232	497	800	1,149	1,550	2,012	2,545	3,160	3,873	4,698	5,654	6,791	8,106	9,630	11,397	13,447	15,828	18,593	21,808	25,547	29,896

Figure 64: 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 Raimangal waterway is directly connected with Indo Bangladesh waterway protocol route, Sahibkhali and Chhota Kalagachi National waterways
b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Hemnagar Jetty located at start Chainage of Raimangal waterway for mooring.
c) By taking into advantage of tidal window, sufficient LAD is available in the complete 53.381 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation.
d) There are no big industries near the survey area, however few brick kilns are found along the river banks.
e) One RCC Road bridge is located at chaiange 50.00 Km near Hasnabad. Also Hasnabad and Par Hasnabad jetties are operated and maiantained by Government of West Bengal.
f) Passenger ferry services are operated by local parties from all other existing ferry ghats, 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 facilities required for passenger ferry services. Seven (7) ferry ghats are proposed for development along the river located at Hemnagar, Sardarpara, Atapur, Khulna, Sandeshkhali Purba, Raypur and Binara. It is proposed to develop the ferry ghats by providing floating pontoon and gangway facilities at all the above ferry ghats. In addition to this, Hemanagr ferry ghat is proposed to be developed as a tourist jetty with terminal complex and all basic amenities for tourism traffic. In this DPR, seven (7) number of passenger ferry vessels are proposed at the inception stage. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of IWT terminals and purchasing of vessels has been worked out as INR 3,317.00 Lakh with 7 vessels. In 10^{th} year of operation capital cost of purchasing additional 8 vessels is INR 280.00 Lakh and in 20th year of operation capital cost of purchasing additional 17 vessels is INR 595.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Correspondingly O&M cost for Raimanagl waterway works out to INR 546.11 Lakh from inception stage and additional INR 133.15 Lakh from 11th year of operation due to additional 8 vessels.

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 with a tariff of INR 5.00 per passenger per Km and above for the proposed OD pairs as below, in case the project is implemented in a single package.

5. OD pair 1) - Sardarpara ferry ghat – Dhamakhali/Arsadmiya ferry ghat, (OD pair length is 15.0 km and daily passenger traffic is 600 pax)
6. OD pair 2) - Atapur ferry ghat – Khulna ferry ghat, (OD pair length is 3.0 km and daily passenger traffic is 600 pax)
7. OD pair 3) - Sandeshkhali Purba – Khulna ferry ghat, (OD pair length is 0.50 km and daily passenger traffic is 500 pax)
8. OD pair 4) - Raypur – Binara ferry ghats. (OD pair length is 0.45 km and daily passenger traffic is 450 pax)

However, in case the project is implemented in separate packages as shown below, the tariff can be reduced accordingly.

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

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

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		√	
c) Tiger or Elephant Reserve		√	
d) Biosphere Reserve	√		The entire river stretch is located within Sundarban Biosphere Reserve
e) Reserved / Protected Forest		√	
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, flooding, cyclone or extreme or adverse climatic conditions)	√		Prone to Flood, Cyclones and heavy winds

Screening Question	Yes	No	Details / Remarks
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 Bhavan, 1, Parliament Street,
New Delhi - 110 001

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ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Oparate' 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 Pallerla
Director

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ANNEXURE 4: PHOTOGRAPHS

RIVER BANK AT CHAINAGE 0, RIGHT BANK

RIVER BANK AT CHAINAGE 0, RIGHT BANK

RIVER BANK AT CHAINAGE 0, RIGHT BANK

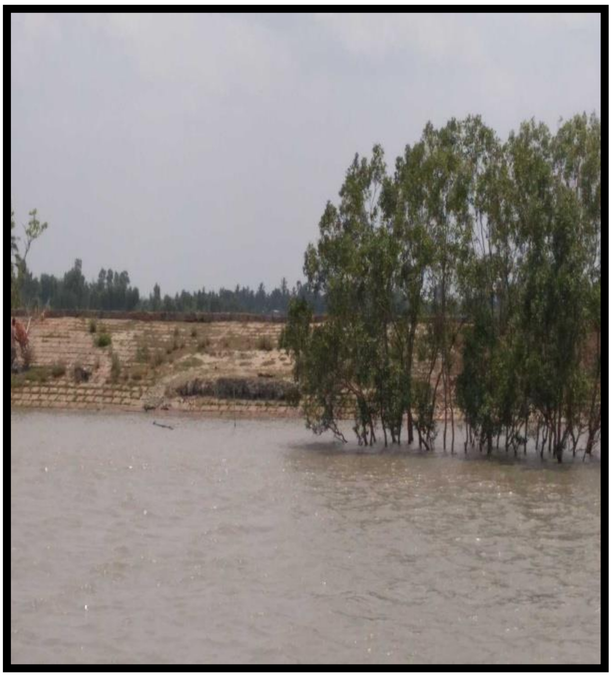
RIVER BANK AT CHAINAGE 0, RIGHT BANK

VESSAL ACHORED CHAINAGE 0, NEAR HEMNAGAR

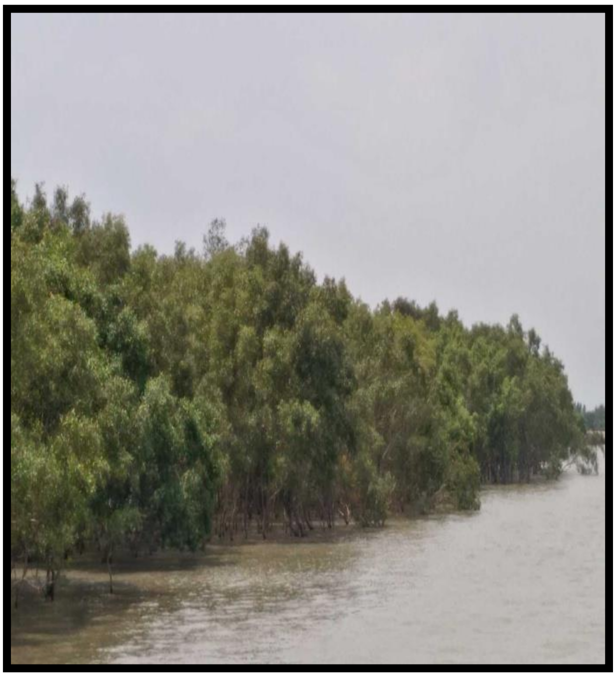
VESSAL ACHORED CHAINAGE 0, NEAR HEMNAGAR

MANGROVE AT CHAINAGE 0, LEFT BANK

RIVER BANK AT CHAINAGE 0, LEFT BANK

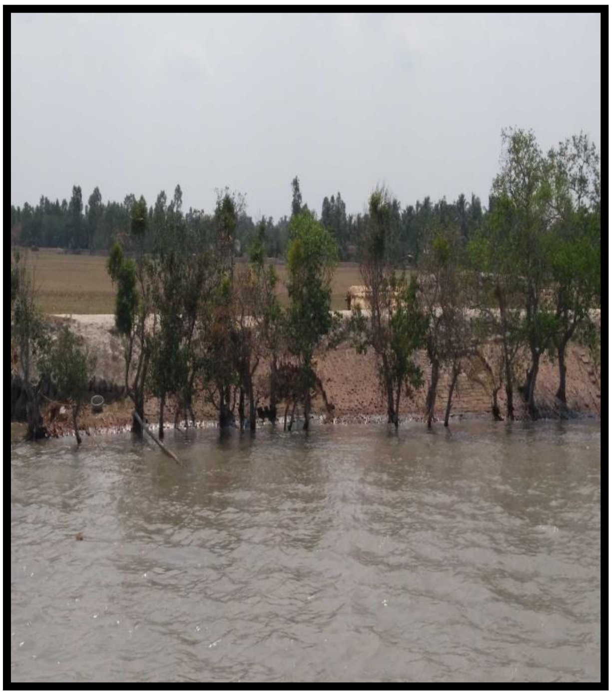


RIVER BANK AT CHAINAGE 1, LEFT BANK



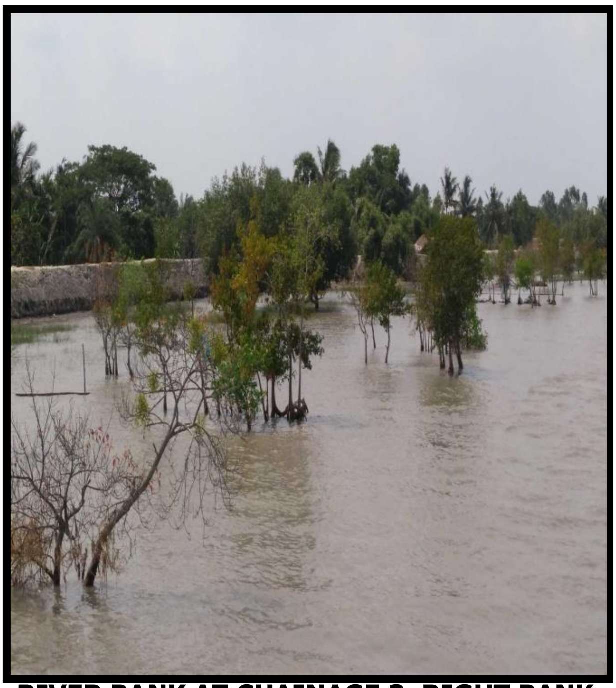
MANGROVE AT CHAINAGE 1, LEFT BANK

RIVER BANK AT CHAINAGE 2, LEFT BANK



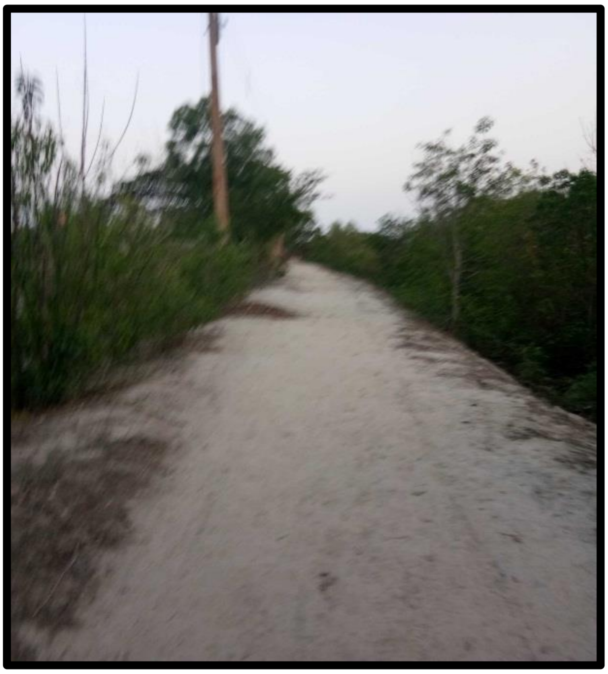
RIVER AT CHAINAGE 2, RIGHT BANK

MANGROVE AT CHAINAGE 3, LEFT BANK



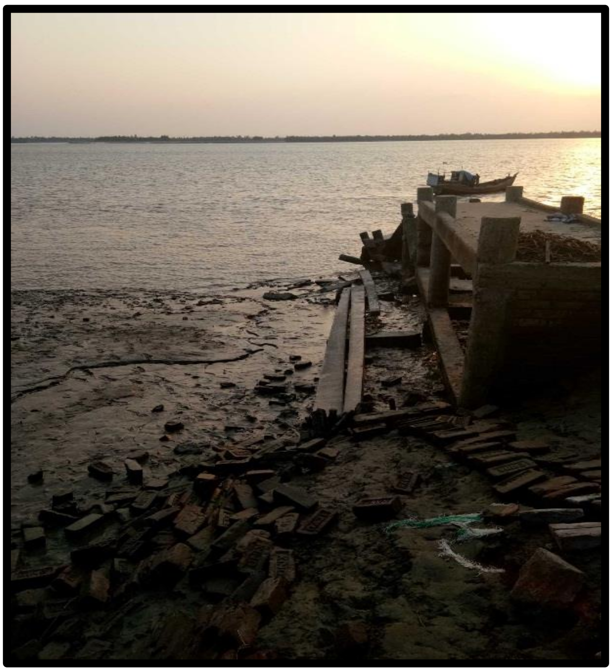
RIVER BANK AT CHAINAGE 3, RIGHT BANK

RIVER BANK AT CHAINAGE 3.5, LEFT BANK



TREE COVER AREA AT CHAINAGE 3.5, RIGHT BANK

JETTY AT CHAINAGE 4, RIGHT BANK



JETTY AT CHAINAGE 4, RIGHT BANK

TREE COVER AREA AT CHAINAGE 4, RIGHT BANK

RIVER BANK CHAINAGE 4, LEFT BANK

RIVER BANK AT CHAINAGE 4, LEFT BANK

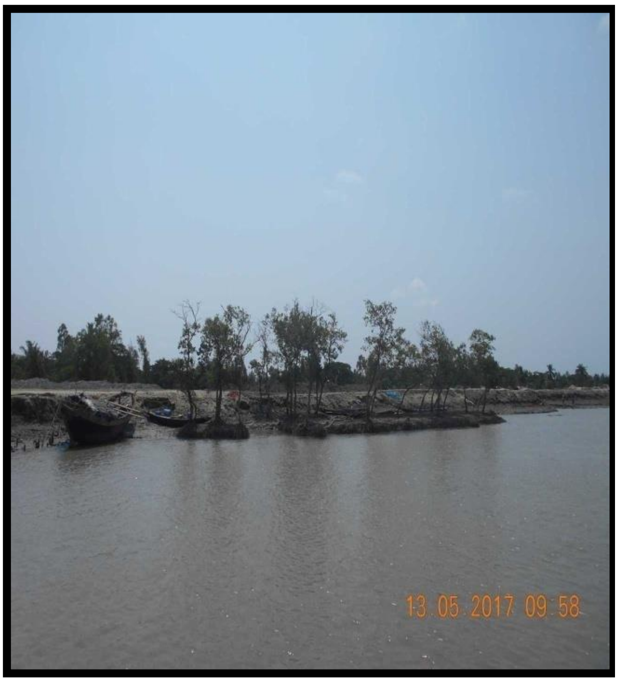
TREE COVER AREA AT CHAINAGE 4.3, RIGHT BANK

MANGROVE AT CHAINAGE 4.5, RIGHT BANK

TREE COVER AREA AT CHAINAGE 4.8, RIGHT BANK

TREE COVER AREA AT CHAINAGE 5, RIGHT BANK

RIVER BANK AT CHAINAGE 5, LEFT BANK



RIVER BANK AT CHAINAGE 5, LEFT BANK

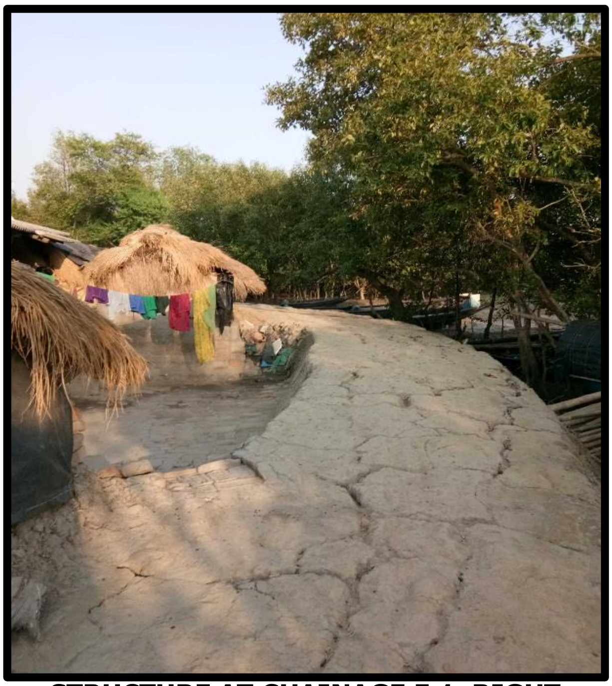
RIVER BANK AT CHAINAGE 5, LEFT BANK

CHAINAGE 5, LEFT BANK

RIVER BANK AT CHAINAGE 5, LEFT BANK

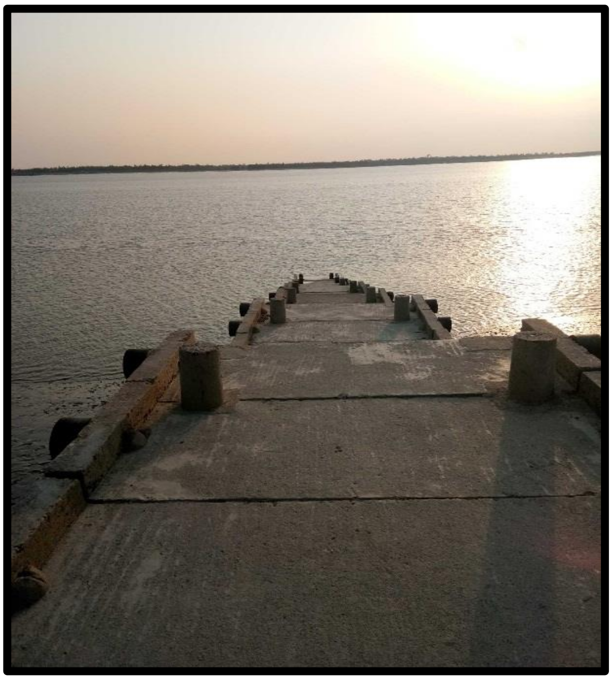
MANGROVE AT CHAINAGE 5, LEFT BANK

MANGROVES AT CHAINAGE 5, RIGHT BANK

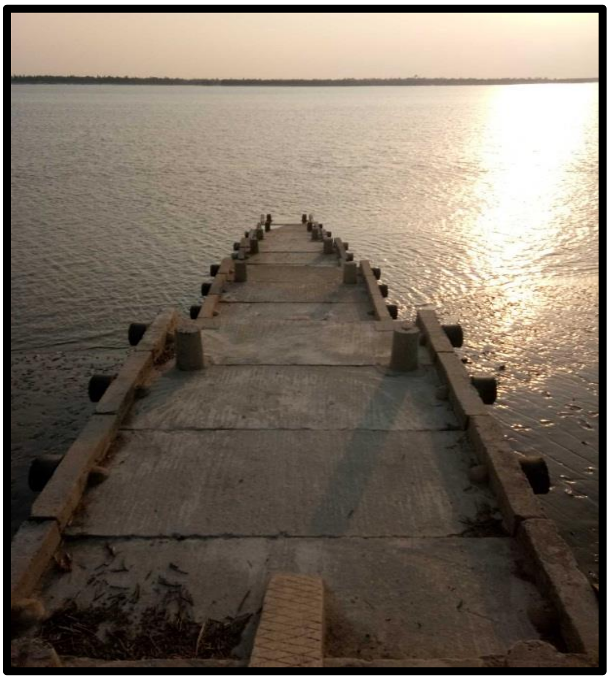


STRUCTURE AT CHAINAGE 5.1, RIGHT BANK

TREE COVER AREA AT CHAINAGE 5.1, RIGHT BANK



JETTY AT CHAINAGE 5.2, RIGHT BANK

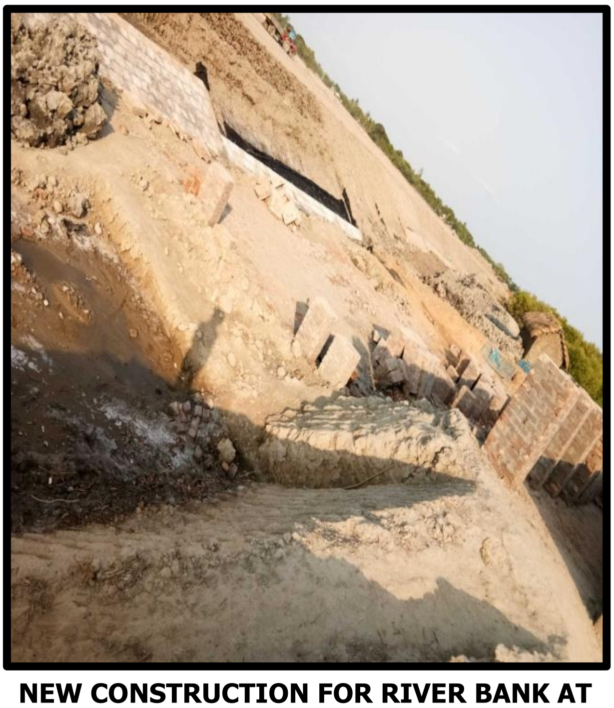


JETTY AT CHAINAGE 5.2, RIGHT BANK

RIVER BANK AT CHAINAGE 5.2, RIGHT BANK

MANGROVE AT CHAINAGE 5.2, RIGHT BANK

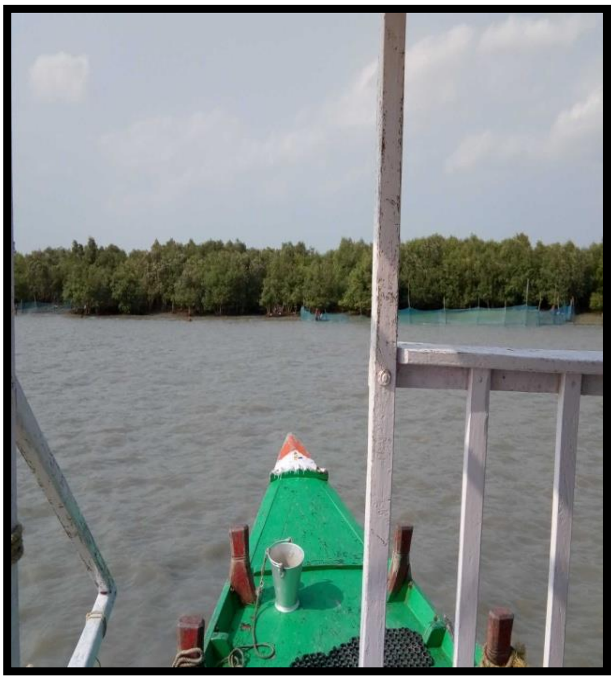
MANGROVE AT CHAINAGE 5.2, RIGHT BANK



NEW CONSTRUCTION FOR RIVER BANK AT CHAINAGE 5.3, RIGHT BANK

NEW CONSTRUCTION FOR RIVER BANK AT CHAINAGE 5.3, RIGHT BANK

MANGROVE AT CHAINAGE 5.5, LEFT BANK



MANGROVE AT CHAINAGE 5.5, RIGHT BANK

RIVER BANK AT CHAINAGE 5.5, RIGHT BANK

RIVER BANK CHAINAGE 5.7, RIGHT BANK

MANGROVES AT CHAINAGE 6, LEFT BANK

FIELD AREA AT CHAINAGE 6, LEFT BANK

FIELD AREA AT CHAINAGE 6, LEFT BANK

FIELD AREA AT CHAINAGE 6, LEFT BANK

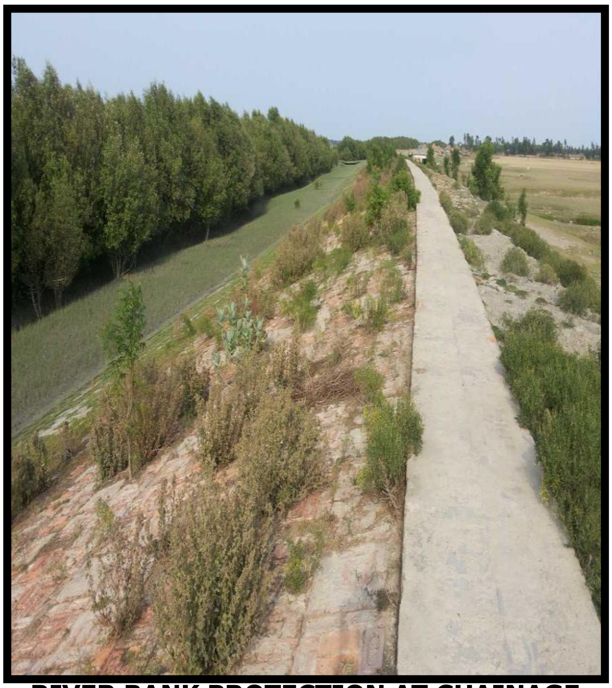
NEW CONSTRUCTION FOR RIVER BANK AT CHAINAGE 6, RIGHT BANK

NEW CONSTRUCTION FOR RIVER BANK AT CHAINAGE 6, RIGHT BANK

RIVER BANK AT CHAINAGE 6, RIGHT BANK

MANGROVES AT CHAINAGE 6.3, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 6.5, LEFT BANK



RIVER BANK PROTECTION AT CHAINAGE 6.5, LEFT BANK

NEW CONSTRUCTION FOR RIVER BANK AT CHAINAGE 6.5, RIGHT BANK

MANGROVE AT CHAINAGE 7, LEFTBANK

RIVER BANK AT CHAINAGE 7.5, RIGHT BANK

RIVER BANK AT CHAINAGE 7.5, RIGHT BANK

STRUCTURE AT CHAINAGE 8, RIGHT BANK

MANGROVE AT CHAINAGE 8.5, LEFT BANK

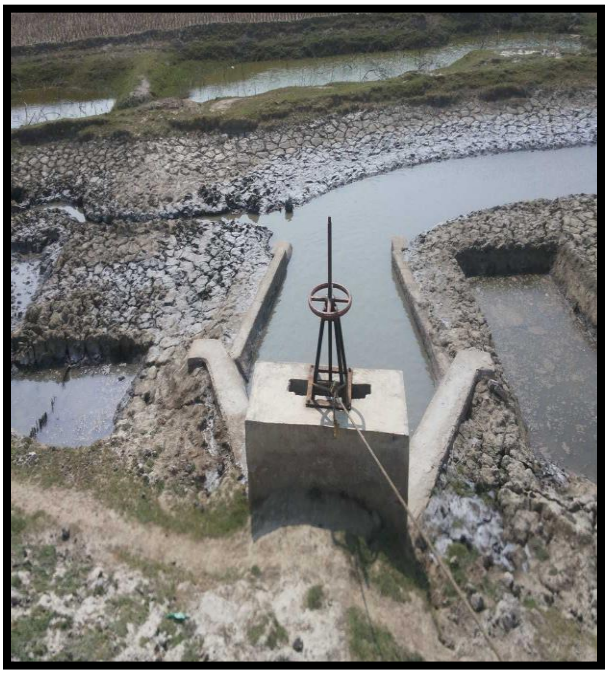
TEMPORARY PROTECTION AT CHAINAGE 9, LEFT BANK

POND AT CHAINAGE 9, LEFT BANK

WATER LOCK AT CHAINAGE 9.2, LEFT BANK

SCHOOL AT CHAINAGE 9.5, LEFT BANK

RIVER BANK AT CHAINAGE 9.5, RIGHT BANK



WATER LOCK AT CHAINAGE 9.7, LEFT BANK

WATER LOCK AT CHAINAGE 10.2, LEFT BANK

MANGROVES AT CHAINAGE 10.3, LEFT BANK

GROUND LEVEL AT CHAINAGE 10.5, LEFT BANK

POND AT CHAINAGE 11, LEFT BANK

SCHOOL AT CHAINAGE 11.3, LEFT BANK

SCHOOL AT CHAINAGE 11.3, LEFT BANK

JETTY GHAT AT CHAINAGE 11.5, LEFT BANK

JETTY GHAT AT CHAINAGE 11.5, LEFT BANK

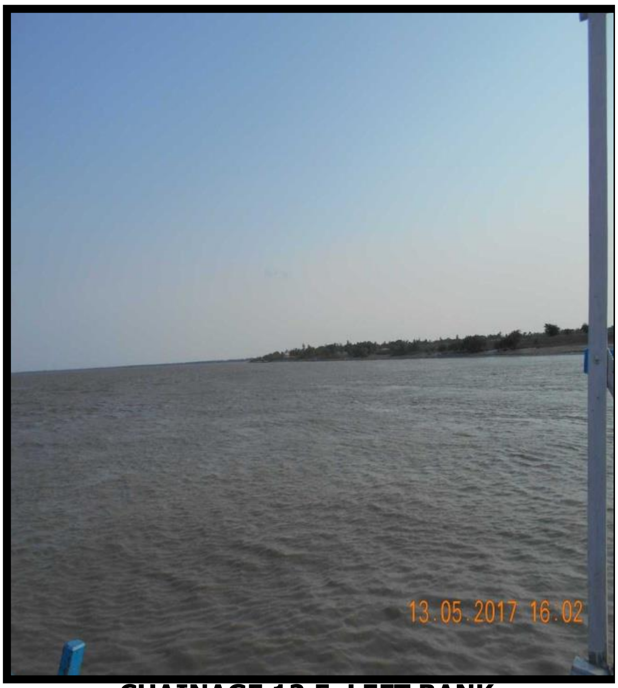
CHAINAGE 12, RIGHT BANK

CHAINAGE 12, LEFT BANK

CHAINAGE 12, RIGHT BANK

RIVER BANK AT CHAINAGE 12.5, RIGHT BANK

RIVER BANK AT CHAINAGE 12.5, LEFT BANK



CHAINAGE 12.5, LEFT BANK

RIVER BANK AT CHAINAGE 12.5, RIGHT BANK

RIVER BANK AT CHAINAGE 12.5, RIGHT BANK

CHAINAGE 13, LEFT BANK

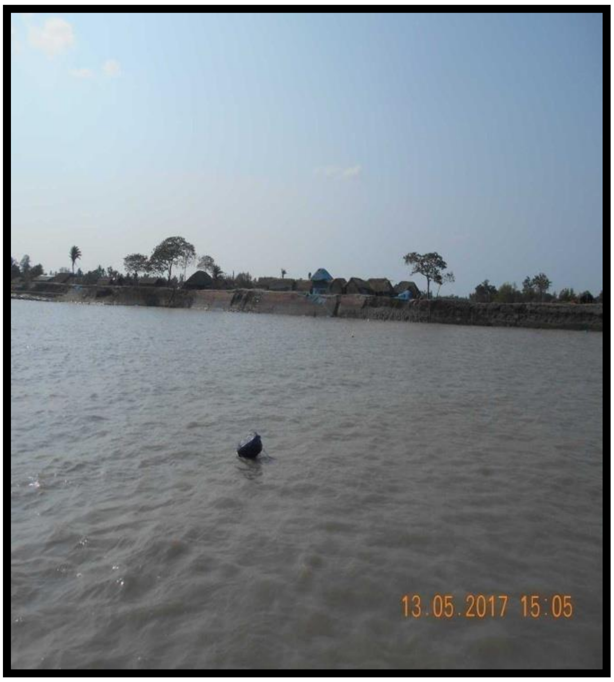
RIVER BANK AT CHAINAGE 13, LEFT BANK

CHAINAGE 13, LEFT BANK

CHAINAGE 13, LEFT BANK

FISHING POND CHAINAGE 13, LEFT BANK

FISHING POND CHAINAGE 13, LEFT BANK



RIVER BANK AT CHAINAGE 13.5, LEFT BANK

RIVER BANK AT CHAINAGE 13.5, LEFT BANK

FISHING POND CHAINAGE 13.5, LEFT BANK

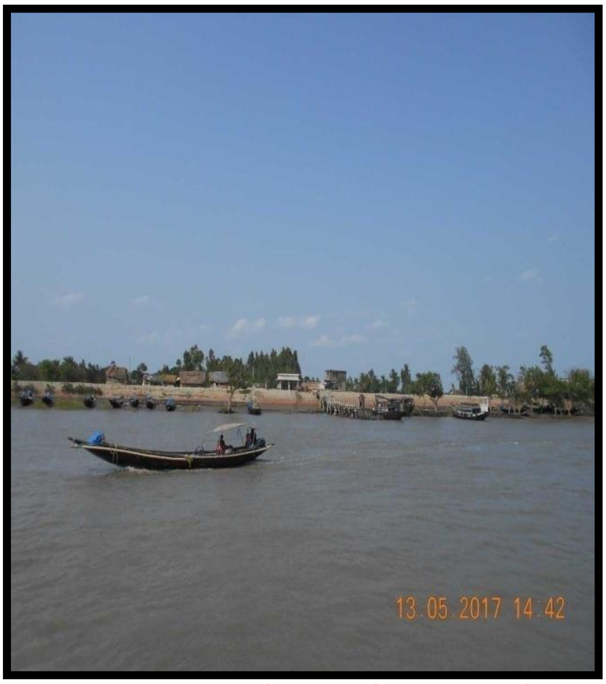
FISHING POND 13.8, LEFT BANK

RIVER BANK AT CHAINAGE 14, RIGHT BANK

RIVER BANK AT CHAINAGE 14, RIGHT BANK

RIVER BANK AT CHAINAGE 14, LEFT BANK

FISHING POND CHAINAGE 14, LEFT BANK

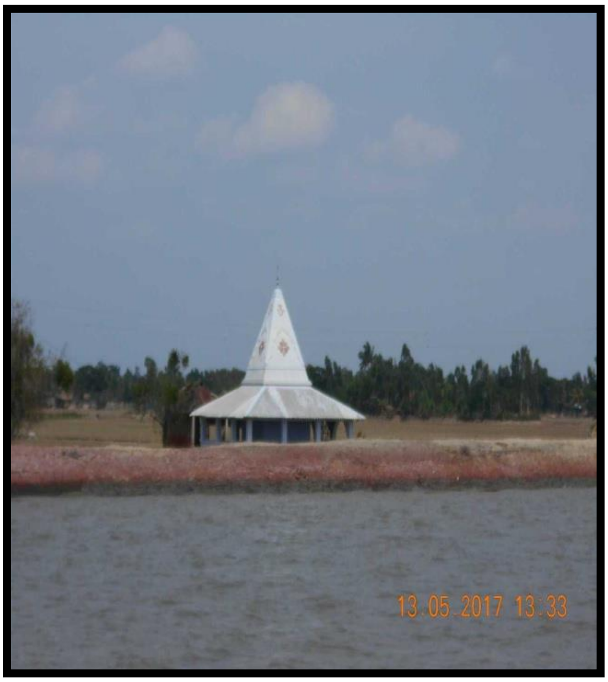


RIVER BANK AT CHAINAGE 14.5, RIGHT BANK

RIVER BANK AT CHAINAGE 15, RIGHT BANK

RIVER BANK AT CHAINAGE 15, RIGHT BANK

RIVER BANK AT CHAINAGE 15, RIGHT BANK



TEMPLE AT CHAINAGE 15.5, RIGHT BANK

RIVER BANK AT CHAINAGE 15.5, RIGHT BANK

RIVER BANK CHAINAGE 15.5, LEFT BANK

RIVER BANK AT CHAINAGE 15.5, LEFT BANK

CHAINAGE 16, LEFT BANK

RIVER BANK AT CHAINAGE 16, RIGHT BANK

RIVER BANK AT CHAINAGE 16, RIGHT BANK

MANGROVE AT CHAINAGE 16.5, LEFT BANK

RIVER BANK AT CHAINAGE 17, RIGHT BANK

CHAINAGE 17, LEFT BANK

RIVER BANK AT CHAINAGE 17, LEFT BANK

RIVER BANK AT CHAINAGE 17, LEFT BANK

RIVER BANK AT CHAINAGE 17, LEFT BANK

RIVER BANK AT CHAINAGE 19.5, RIGHT BANK

RIVER BANK AT CHAINAGE 19.5, LEFT BANK

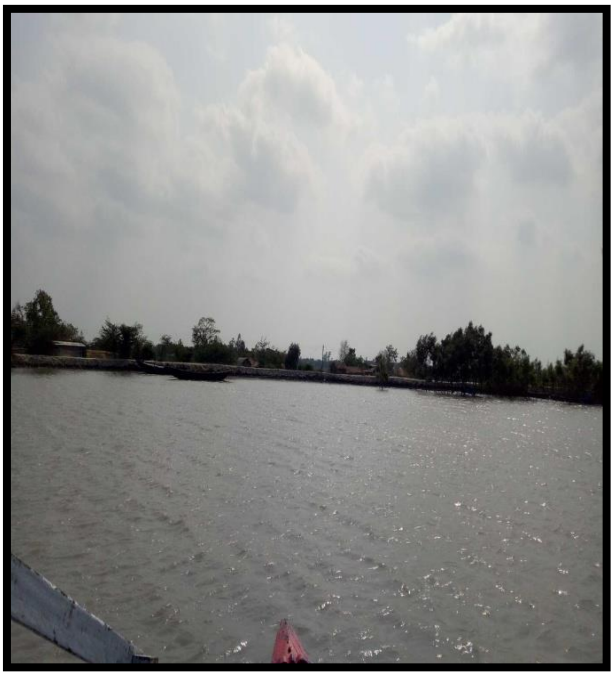
RIVER BANK AT CHAINAGE 19.5, RIGHT BANK

RIVER BANK AT CHAINAGE 20, LEFT BANK

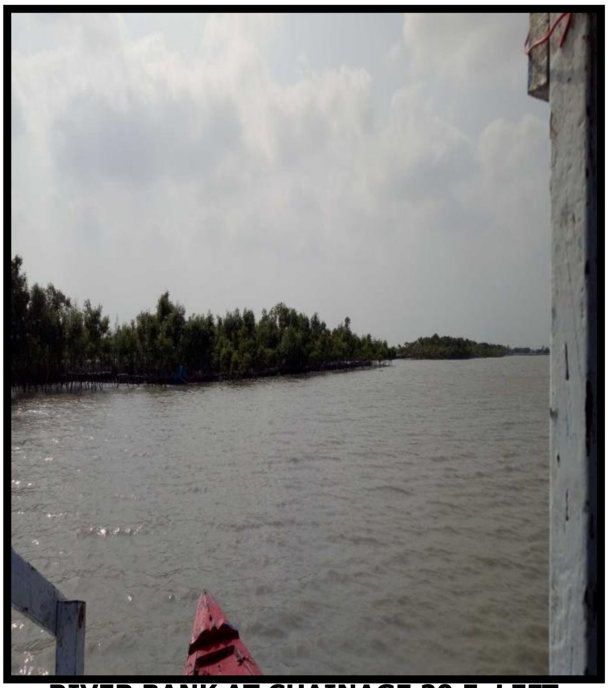
RIVER BANK AT CHAINAGE 20, LEFT BANK

ROAD AT CHAINAGE 20.2, RIGHT BANK

ROAD AT CHAINAGE 20.2, RIGHT BANK



RIVER BANK AT CHAINAGE 20.5, LEFT BANK



RIVER BANK AT CHAINAGE 20.5, LEFT BANK

RIVER BANK AT CHAINAGE 20.5, RIGHT BANK

FISHING NET AT CHAINAGE 20.5, RIGHT BANK

FISHING NET AT CHAINAGE 20.5, LEFT BANK

FISHING NET AT CHAINAGE 20.5, LEFT BANK

JETTY AT CHAINAGE 20.8, RIGHT BANK

JETTY AT CHAINAGE 20.8, RIGHT BANK

JETTY AT CHAINAGE 20.8, RIGHT BANK

JETTY AT CHAINAGE 20.8, RIGHT BANK

RIVER BANK AT CHAINAGE 21, LEFT BANK

RIVER BANK AT CHAINAGE 21.5, RIGHT BANK

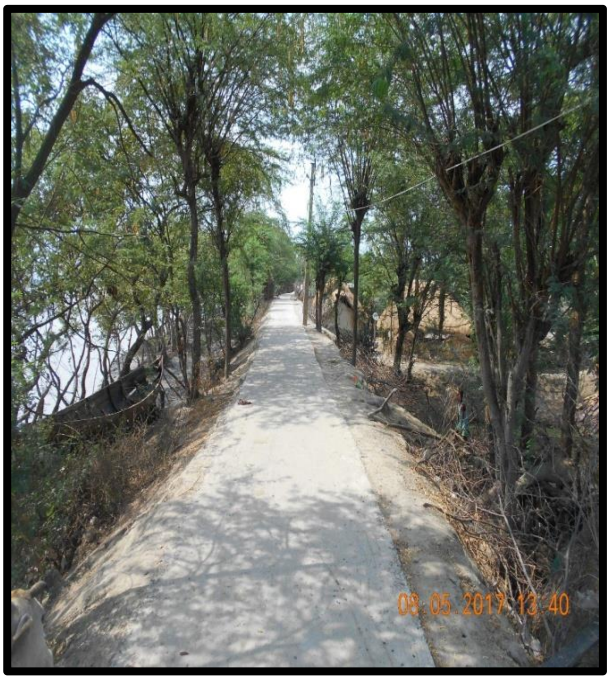
RIVER BANK AT CHAINAGE 21.5, RIGHT BANK

RIVER BANK AT CHAINAGE 21.5, LEFT BANK

RIVER BANK AT CHAINAGE 21.5, LEFT BANK

RIVER BANK AT CHAINAGE 21.5, RIGHT BANK

RIVER BANK AT CHAINAGE 21.5, RIGHT BANK



ROAD AT CHAINAGE 21.5, RIGHT BANK

RIVER BANK AT CHAINAGE 22, RIGHT BANK

RIVER BANK AT CHAINAGE 22, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 22, LEFT BANK

RIVER BANK AT CHAINAGE 22, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 22.2, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 22.2, RIGHT BANK

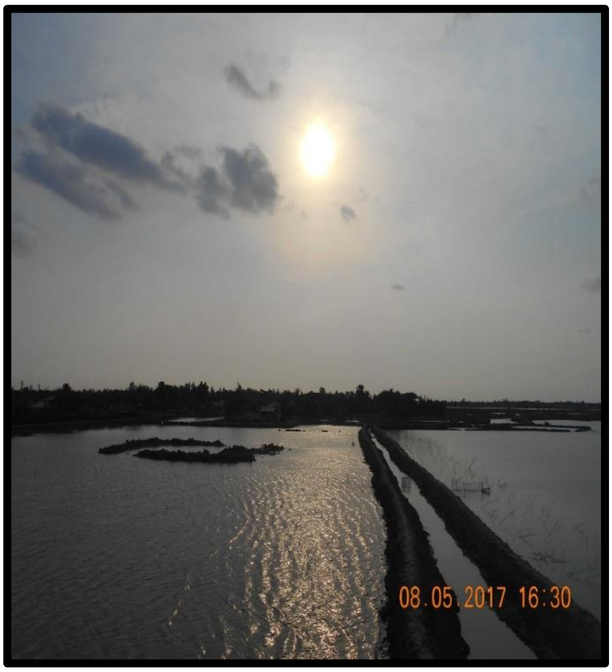
FISHING NET AT CHAINAGE 22.5, LEFT BANK

RIVER BANK AT CHAINAGE 22.5, RIGHT BANK

RIVER BANK AT CHAINAGE 22.5, RIGHT BANK

FISHING NET AT CHAINAGE 22.5, RIGHT BANK

FISHING POND AT CHAINAGE 22.6, LEFT BANK

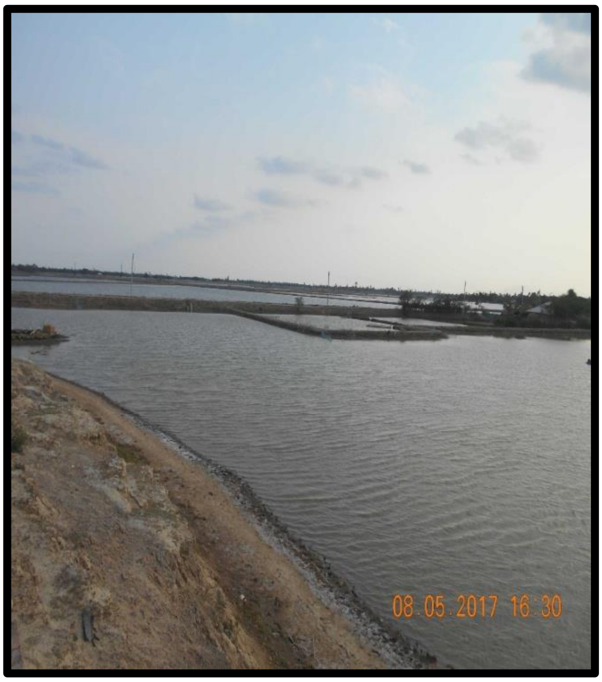


FISHING POND AT CHAINAGE 22.6, LEFT BANK

WATER LOCK AT CHAINAGE 22.7, RIGHT BANK

WATER LOCK AT CHAINAGE 22.7, RIGHT BANK

SCHOOL AT CHAINAGE 22.8, RIGHT BANK



FISHING POND AT CHAINAGE 22.8, LEFT BANK

FISHING POND AT CHAINAGE 23, LEFT BANK

FISHING POND AT CHAINAGE 23.2, LEFT BANK

POND AT CHAINAGE 23.2, RIGHT BANK

FISHING POND AT CHAINAGE 23.3,LEFT BANK

POND AT CHAINAGE 23.4, RIGHT BANK

POND AT CHAINAGE 23.5, RIGHT BANK

RIVER BANK AT CHAINAGE 23.5, RIGHT BANK

RIVER BANK AT CHAINAGE 23.5, LEFT BANK

RIVER BANK AT CHAINAGE 23.5, LEFT BANK

RIVER BANK AT CHAINAGE 23.5, LEFT BANK

FISHING POND AT CHAINAGE 23.6, LEFT BANK

FISHING POND AT CHAINAGE 23.8, LEFT BANK

FISHING POND AT CHAINAGE 23.8, LEFT BANK

FISHING POND AT CHAINAGE 24, LEFT BANK

FISHING POND AT CHAINAGE 24, LEFT BANK

MALAPADA FERRY GHAT AT CHAINAGE 24, RIGHT BANK

MALAPADA FERRY GHAT AT CHAINAGE 24, RIGHT BANK

	
BOLAKALI JETTY AT CHAINAGE 24	**RIVER BANK AT CHAINAGE 24**
	
RIVER BANK AT CHAINAGE 24.5, LEFT BANK	**RIVER BANK AT CHAINAGE 24.5, LEFT BANK**

JETTY CHAINAGE 24.5, LEFT BANK

RIVER BANK AT CHAINAGE 24.5, RIGHT BANK

RIVER BANK AT CHAINAGE 24.5, RIGHT BANK

RIVER BANK AT CHAINAGE 24.5, LEFT BANK

RIVER BANK AT CHAINAGE 24.5, LEFT BANK

RIVER BANK AT CHAINAGE 25, RIGHT BANK

RIVER BANK AT CHAINAGE 25, RIGHT BANK

RIGHT RIVER BANK AT CHAINAGE 25

LEFT RIVER BANK AT CHAINAGE 25

LEFT RIVER BANK AT CHAINAGE 25

RIVER BANK AT CHAINAGE 25, RIGHT BANK

RIGHT RIVER BANK AT CHAINAGE 25.5

RIVER BANK AT CHAINAGE 25.5, LEFT BANK

RIVER BANK AT CHAINAGE 25.5, LEFT BANK

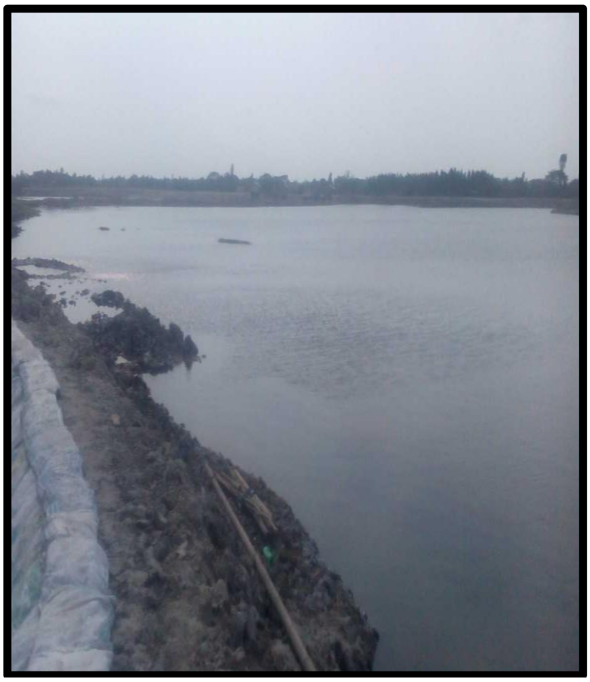
RIGHT RIVER BANK AT CHAINAGE 25.5

RIGHT RIVER BANK AT CHAINAGE 26

RIGHT RIVER BANK AT CHAINAGE 26.5

LEFT RIVER BANK AT CHAINAGE 26.5

RIGHT RIVER BANK AT CHAINAGE 26.5



RIVER BANK AT CHAINAGE 26.5

POND AT CHAINAGE 26.8, RIGHT BANK

POND AT CHAINAGE 27, RIGHT BANK

RIGHT RIVER BANK AT CHAINAGE 27

LEFT RIVER BANK AT CHAINAGE 27

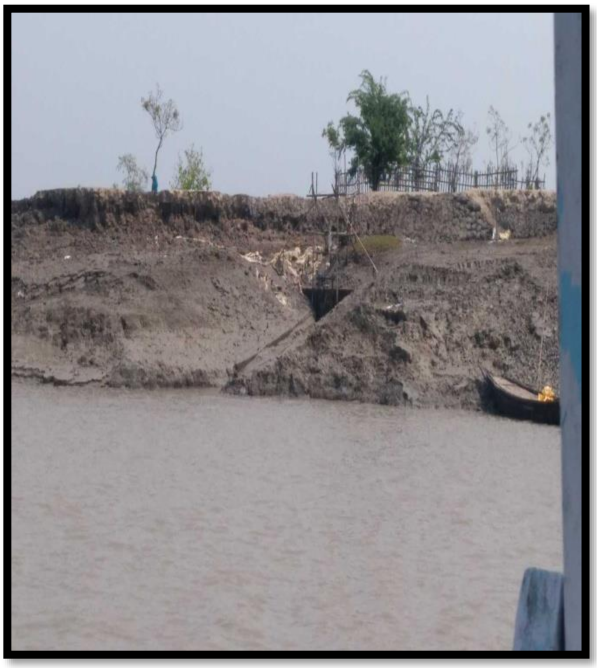
RIGHT RIVER BANK AT CHAINAGE 27.5

LEFT RIVER BANK AT CHAINAGE 27.5

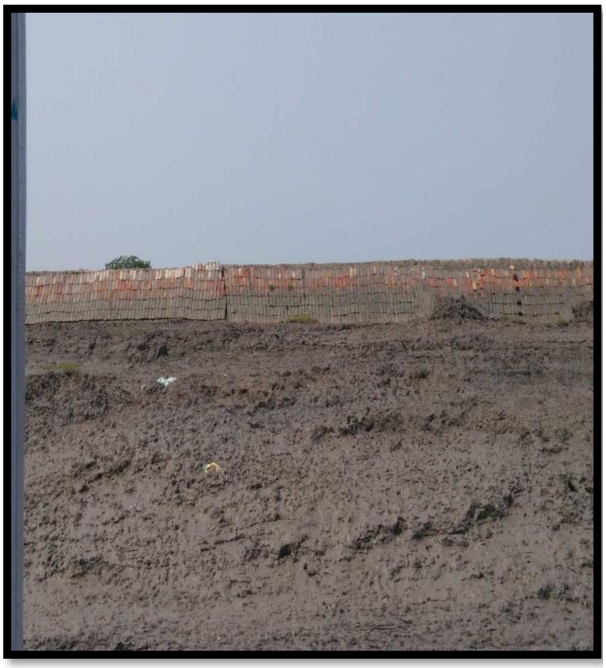
POND AT CHAINAGE 28

RIGHT RIVER BANK AT CHAINAGE 28

RIGHT RIVER BANK AT CHAINAGE 28.5

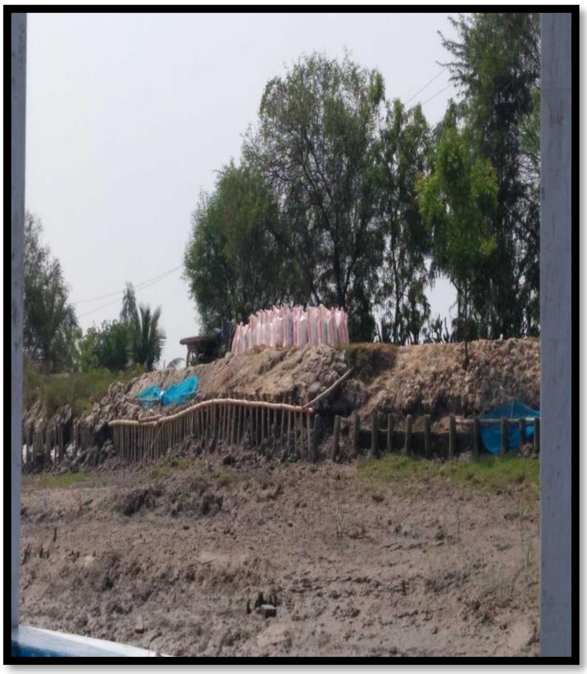


LEFT RIVER BANK AT CHAINAGE 28.5



RIGHT RIVER BANK PROTECTION AT CHAINAGE 28.5

LEFT RIVER BANK AT CHAINAGE 29



LEFT RIVER BANK AT CHAINAGE 29

RIGHT RIVER BANK AT CHAINAGE 29

LEFT RIVER BANK AT CHAINAGE 29

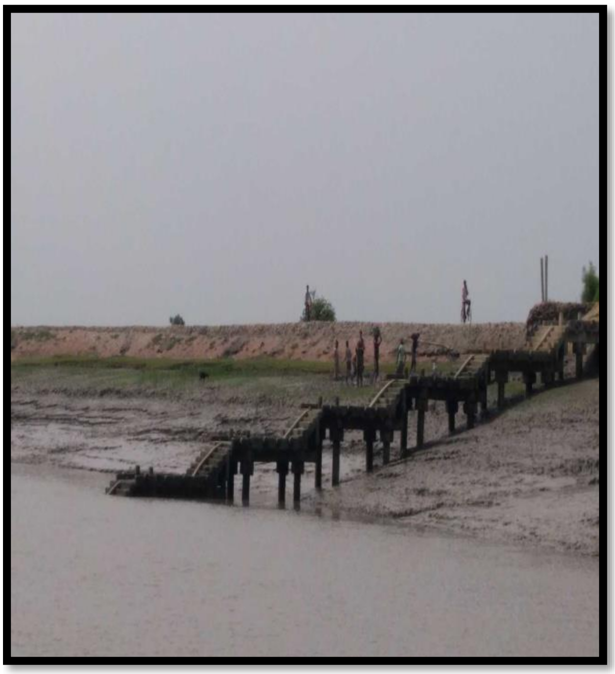
POND AT CHAINAGE 29

DAMAGED JETTY AT CHAINAGE 29.5, RIGHT BANK

JETTY AT CHAINAGE 29.5, LEFT BANK

RIVER BANK AT CHAINAGE 29.5, LEFT BANK

RIGHT RIVER BANK AT CHAINAGE 30



JETTY AT CHAINAGE 30, LEFT BANK

RIGHT RIVER BANK AT CHAINAGE 30

WOODEN JETTY AT CHAINAGE 30.5, LEFT BANK

LEFT RIVER BANK AT CHAINAGE 30.5

POND AT CHAINAGE 30.5, LEFT BANK

POND AT CHAINAGE 30.5, LEFT BANK

CREEK AT CHAINAGE 30.7, LEFT BANK

CREEK AT CHAINAGE 30.7, LEFT BANK

POND AT CHAINAGE 30.7, LEFT BANK

ROAD AT CHAINAGE 30.9, LEFT BANK

LEFT RIVER BANK AT CHAINAGE 31

RIGHT RIVER BANK AT CHAINAGE 31

RIGHT RIVER BANK AT CHAINAGE 31

RIVER BANK AT CHAINAGE 31 LEFT BANK

FISHING POND AT CHAINAGE 31.8, RIGHT BANK

RIVER BANK AT CHAINAGE 32, RIGHT BANK

FISHING POND AT CHAINAGE 32, RIGHT BANK

FISHING POND AT CHAINAGE 32, RIGHT BANK

LEFT RIVER BANK AT CHAINAGE 32.5

RIGHT RIVER BANK AT CHAINAGE 32.5

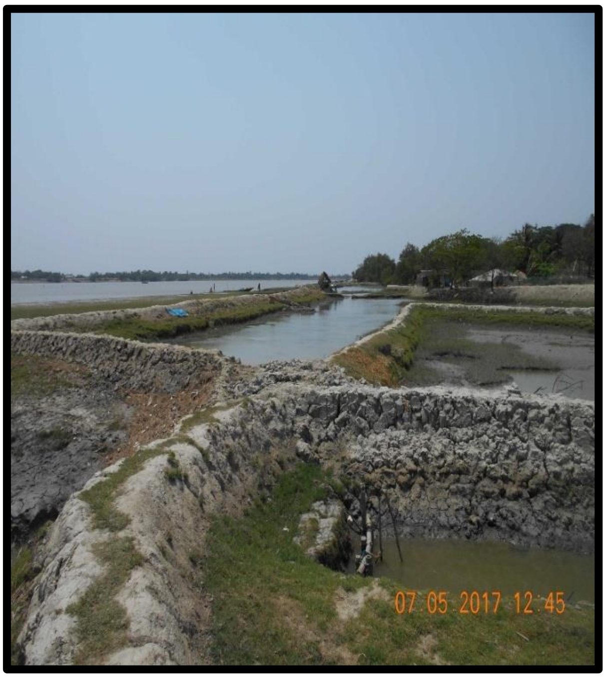
FISHING POND AT CHAINAGE 32.7, RIGHT BANK

LEFT RIVER BANK AT CHAINAGE 33

LEFT RIVER BANK AT CHAINAGE 33

RIGHT RIVER BANK AT CHAINAGE 33

LEFT RIVER BANK AT CHAINAGE 33



FISHING POND AT CHAINAGE 33, RIGHT BANK

FISHING POND AT CHAINAGE 33, RIGHT BANK

RIVER BANK AT CHAINAGE 33, RIGHT BANK

ROAD AT CHAINAGE 33, LEFT BANK

FISHING NET AT CHAINAGE 33.5, LEFT BANK

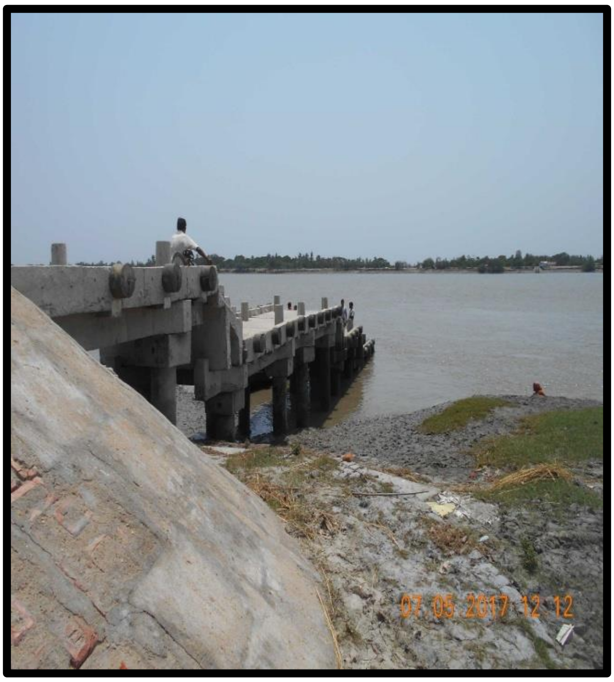
JETTY AT CHAINAGE 33.5, RIGHT BANK

JETTY AT CHAINAGE 33.5, LEFT BANK

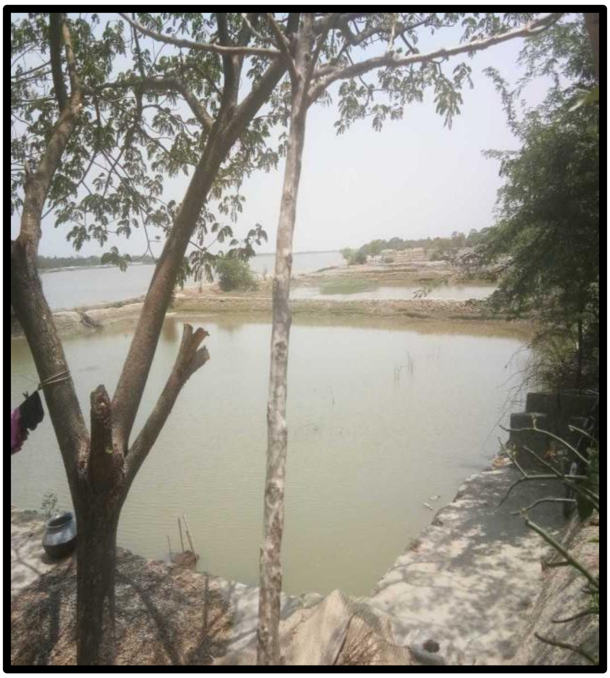
POND AT CHAINAGE 33.5, RIGHT BANK

BINDADA JETTY AT CHAINAGE 33.5, RIGHT BANK

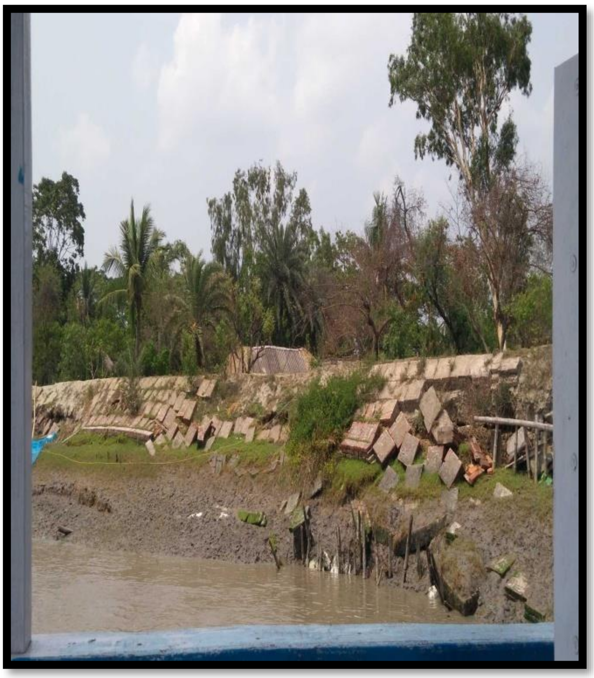
BINDADA JETTY AT CHAINAGE 33.5, RIGHT BANK



BINDADA JETTY AT CHAINAGE 33.5, RIGHT BANK



POND AT CHAINAGE 33.8,LEFT BANK



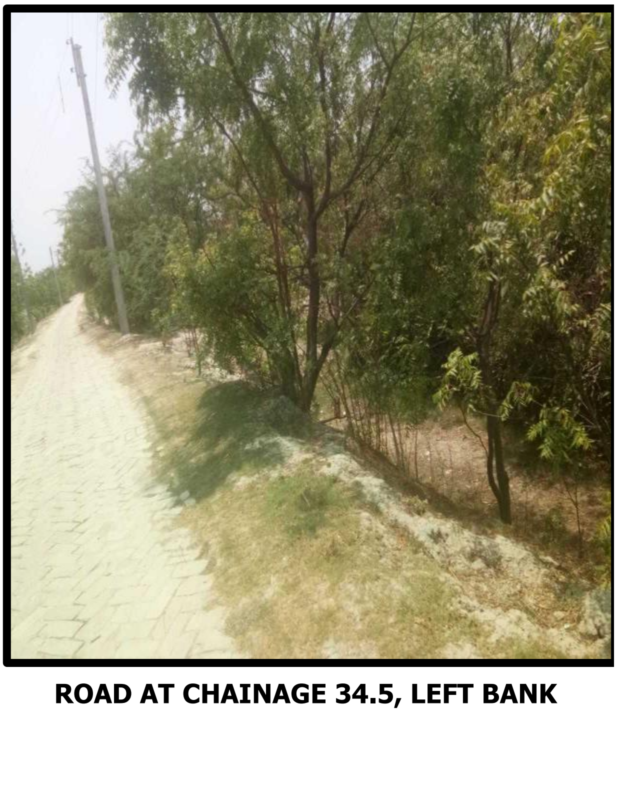
DAMAGED RIVER BANK PROTECTION AT CHAINAGE 34, RIGHT BANK

RIGHT RIVER BANK AT CHAINAGE 34

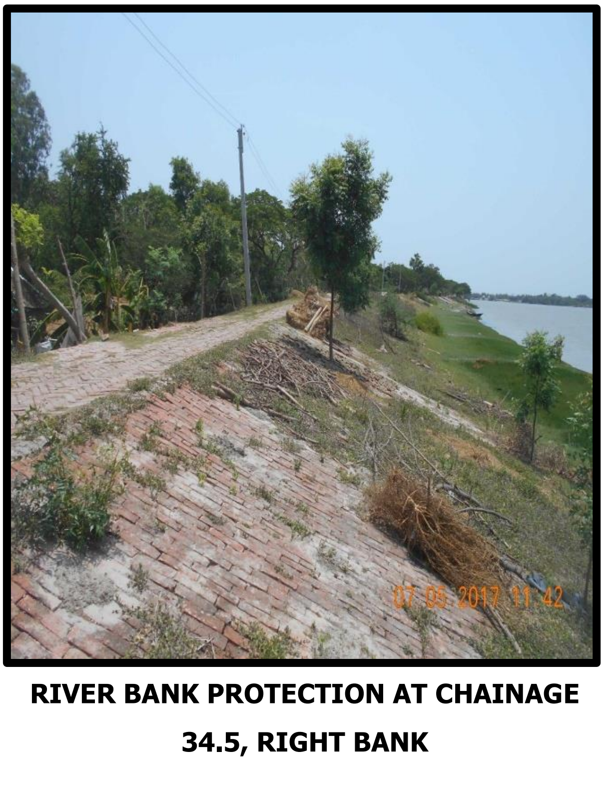
TREE AT CHAINAGE 34, LEFT BANK

RIVER BANK AT CHAINAGE 34, LEFT BANK

RIVER BANK AT CHAINAGE 34.3, LEFT BANK



ROAD AT CHAINAGE 34.5, LEFT BANK

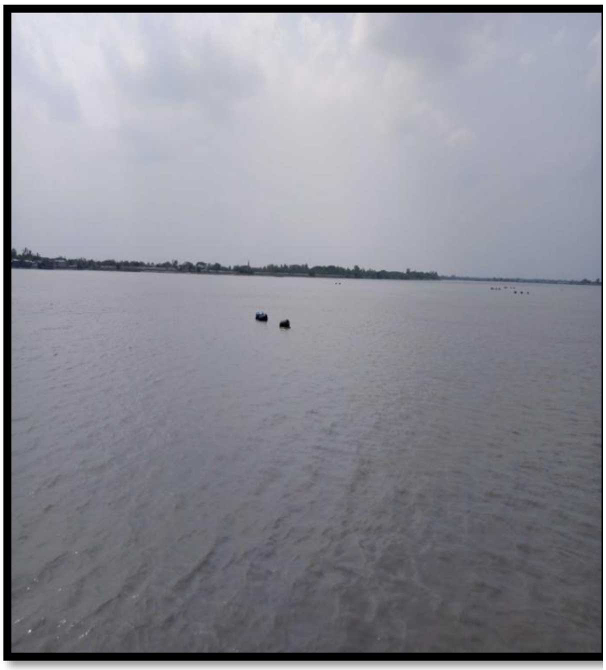


RIVER BANK PROTECTION AT CHAINAGE 34.5, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 34.5, RIGHT BANK

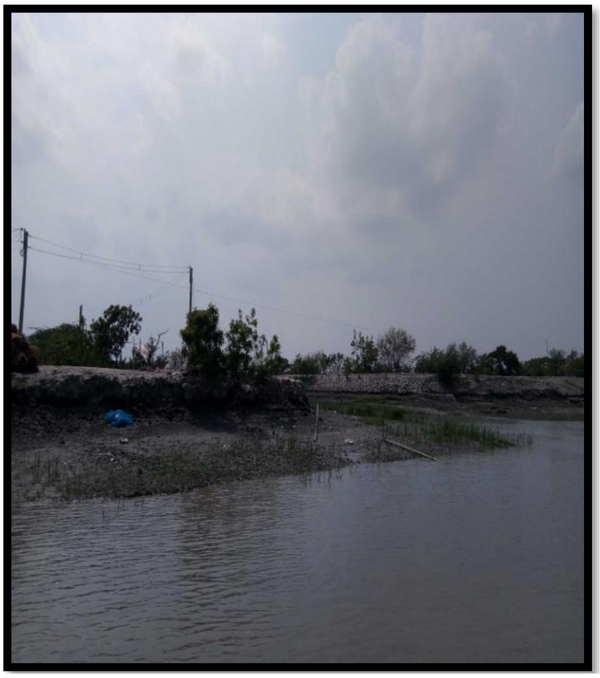
LEFT RIVER BANK AT CHAINAGE 34.5

RIGHT RIVER BANK AT CHAINAGE 34.5



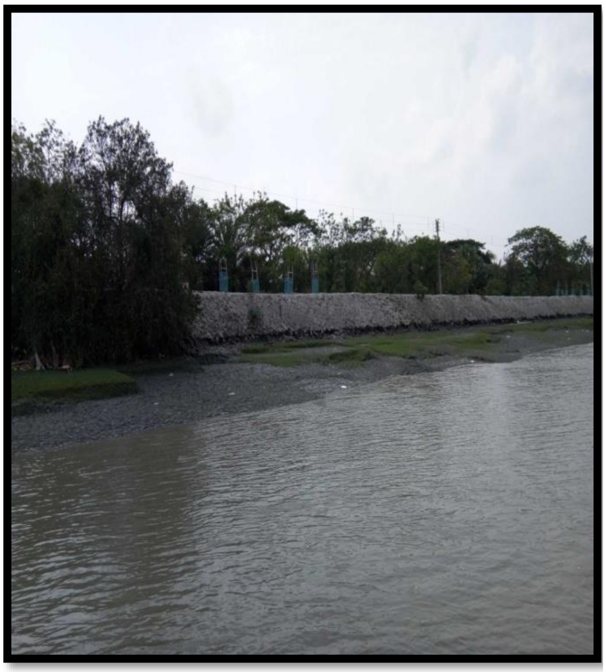
LEFT RIVER BANK AT CHAINAGE 34.5

WATER LOCK AT CHAINAGE 34.7, LEFT BANK



LEFT RIVER BANK AT CHAINAGE 35

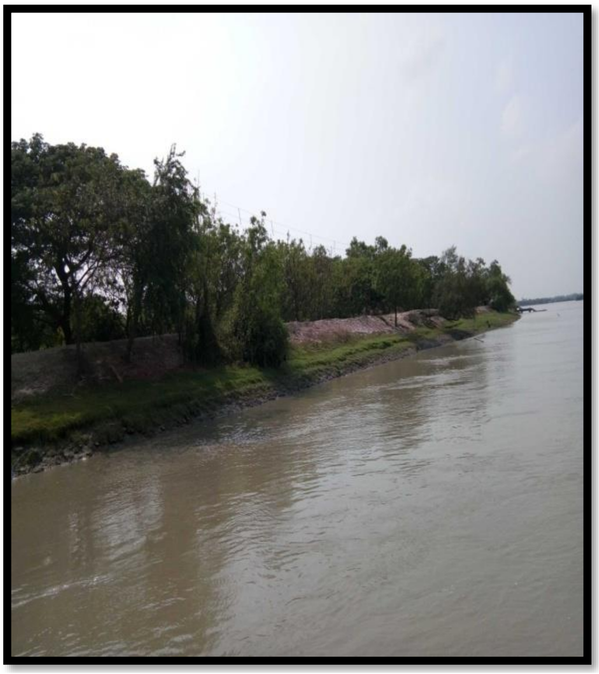
LEFT RIVER BANK AT CHAINAGE 35



LEFT RIVER BANK AT CHAINAGE 35

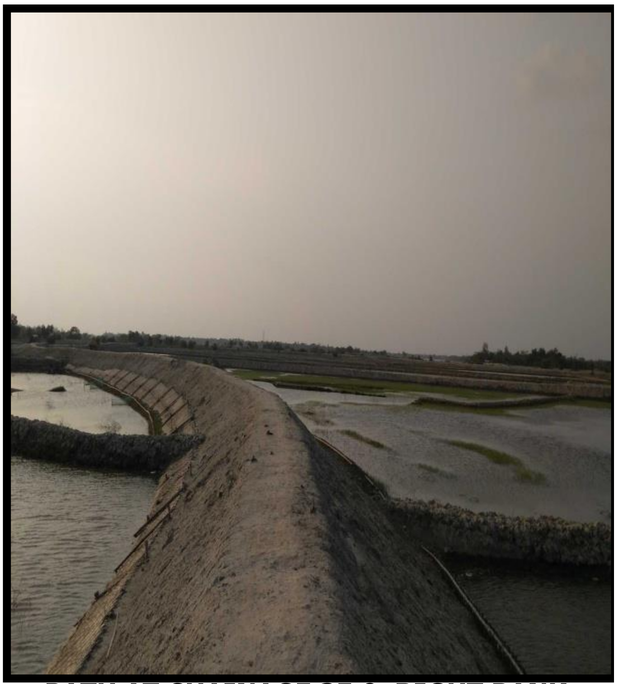
RIVER BANK AT CHAINAGE 35, LEFT BANK

RIGHT RIVER BANK AT CHAINAGE 35.5



LEFT RIVER BANK AT CHAINAGE 35.5

RIVER BANK AT CHAINAGE 35.5, LEFT BANK



PATH AT CHAINAGE 35.9, RIGHT BANK

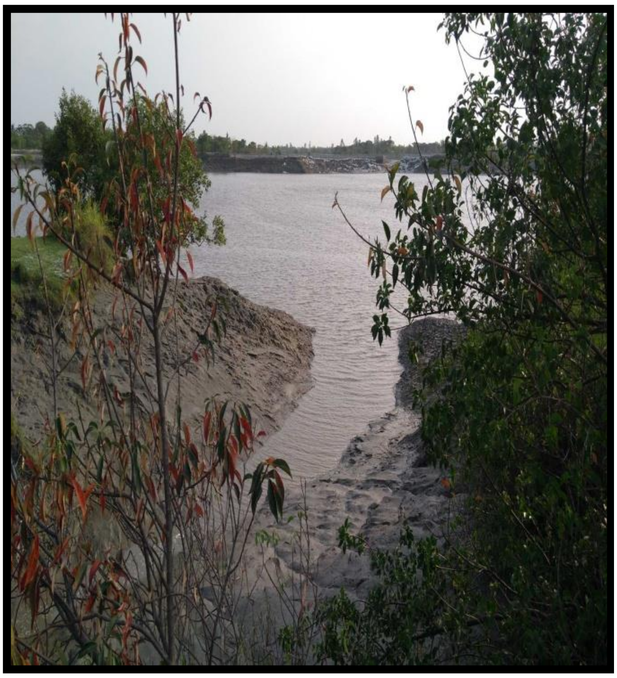
RIVER BANK AT CHAINAGE 36, LEFT BANK

RIVER BANK AT CHAINAGE 36, RIGHT BANK

LEFT RIVER BANK AT CHAINAGE 36

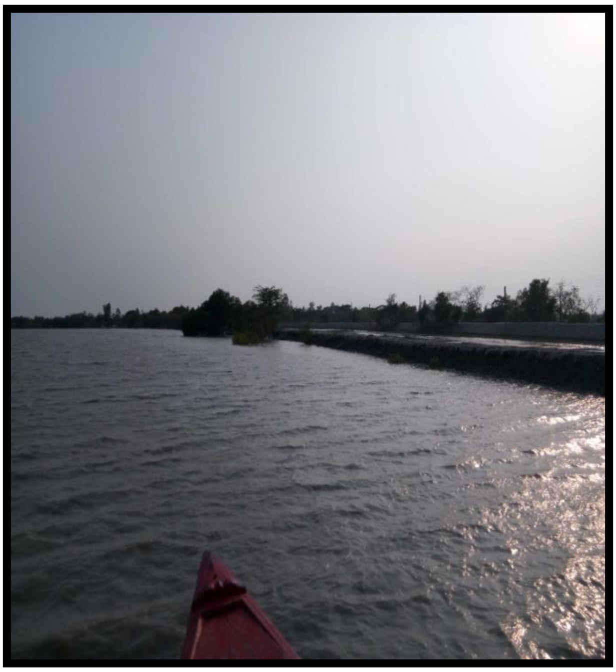
LEFT RIVER BANK ISLAND AT CHAINAGE 36

LEFT RIVER BANK ISLAND AT CHAINAGE 36



CREEK AT CHAINAGE 36.3, RIGHT BANK

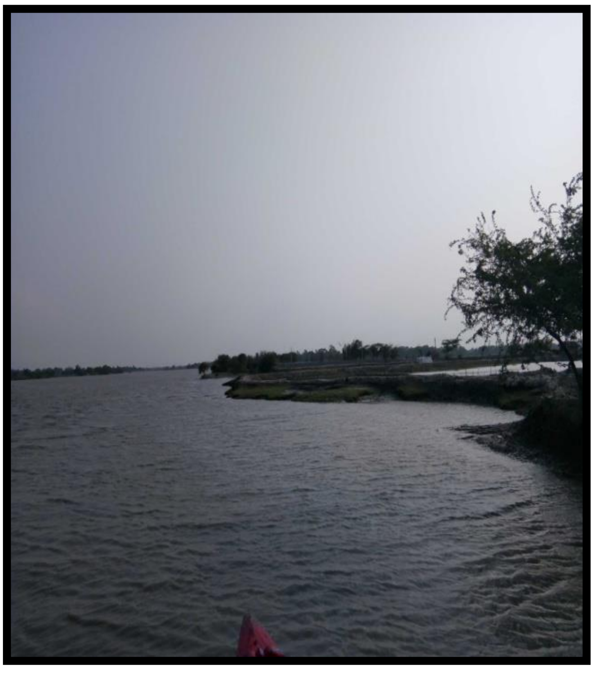
RIVER BANK AT CHAINAGE 36.5, LEFT BANK



RIVER BANK AT CHAINAGE 36.5, RIGHT BANK

POND AT CHAINAGE 36.5, RIGHT BANK

RIVER BANK AT CHAINAGE 37, LEFT BANK



RIVER BANK AT CHAINAGE 37, RIGHT BANK

RIVER BANK AT CHAINAGE 37.5, LEFT BANK

RIVER BANK AT CHAINAGE 37.5, LEFT BANK

RIVER BANK AT CHAINAGE 37.5, RIGHT BANK

JETTY AT CHAINAGE 38, LEFT BANK

BAILANY JETTY AT CHAINAGE 38.4, RIGHT BANK

BAILANY JETTY BOARD AT CHAINAGE 38.4, RIGHT BANK

RIVER BANK AT CHAINAGE 38.5, LEFT BANK

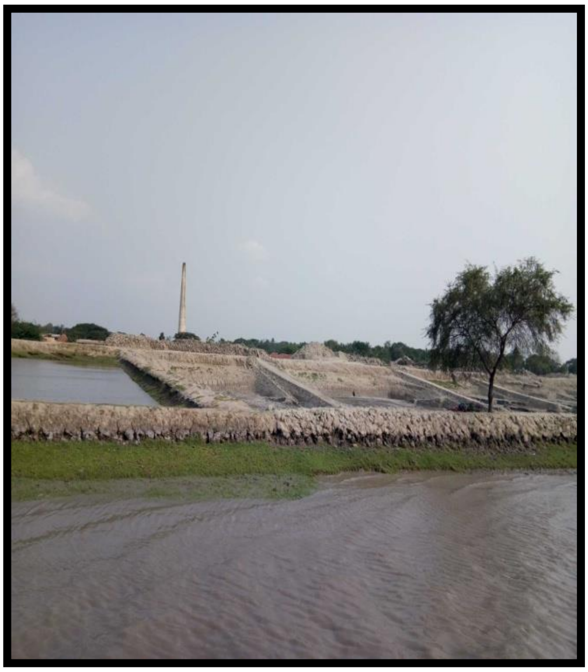
RIVER BANK AT CHAINAGE 38.5, RIGHT BANK

LAND AT CHAINAGE 38.7, RIGHT BANK

RIVER BANK AT CHAINAGE 39, LEFT BANK

RIVER BANK AT CHAINAGE 39, RIGHT BANK

RIVER BANK AT CHAINAGE 39, RIGHT BANK



RIVER BANK AT CHAINAGE 39.5, LEFT BANK

FISHING NET AT CHAINAGE 39.5, RIGHT BANK

CREEK AT CHAINAGE 39.8, RIGHT BANK

CREEK AT CHAINAGE 39.8, RIGHT BANK

RIVER BANK AT CHAINAGE 40, LEFT BANK

RIVER BANK AT CHAINAGE 40, LEFT BANK

FISHING NET AT CHAINAGE 40, RIGHT BANK

LAND AT CHAINAGE 40, RIGHT BANK

POND AT CHAINAGE 40, RIGHT BANK

RIVER BANK AT CHAINAGE 40.5, LEFT BANK

RIVER BANK AT CHAINAGE 40.5, RIGHT BANK

RIVER BANK AT CHAINAGE 40.5, RIGHT BANK

RIVER BANK CONSTRUCTION AT CHAINAGE 40.8, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 40.8, RIGHT BANK

POND AT CHAINAGE 40.8, LEFT BANK

POND AT CHAINAGE 40.9, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 41, RIGHT BANK

RIVER BANK AT CHAINAGE 41, RIGHT BANK

POND AT CHAINAGE 41, RIGHT BANK

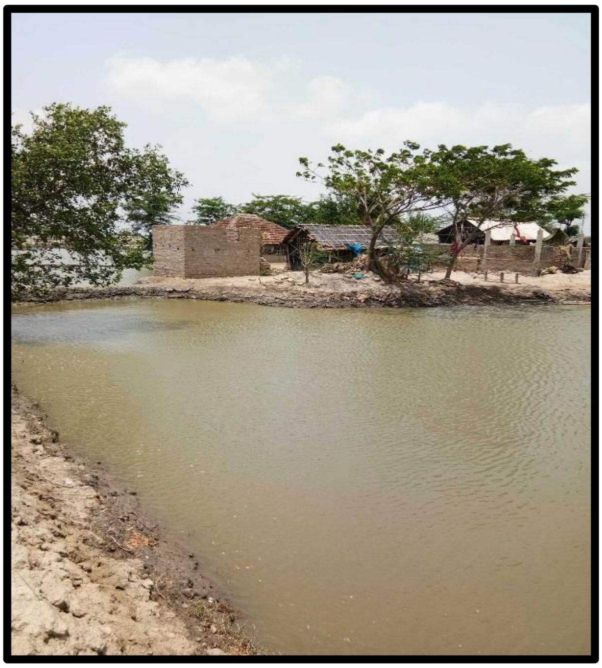
RIVER BANK PROTECTION AT CHAINAGE 41, RIGHT BANK

LAND AT CHAINAGE 41, RIGHT BANK

POND AT CHAINAGE 41, LEFT BANK

POND AT CHAINAGE 41.1, LEFT BANK

POND AT CHAINAGE 41.2, LEFT BANK



POND AT CHAINAGE 41.3, LEFT BANK

POND AT CHAINAGE 41.4, LEFT BANK

CREEK AT CHAINAGE 41.4, RIGHT BANK

CREEK AT CHAINAGE 41.4, RIGHT BANK

POND AT CHAINAGE 41.5, LEFT BANK

FISHING POND AT CHAINAGE 41.5, RIGHT BANK

RIVER BANK AT CHAINAGE 41.5, LEFT BANK

RIVER BANK AT CHAINAGE 41.5, LEFT BANK

RIVER BANK AT CHAINAGE 41.5, RIGHT BANK

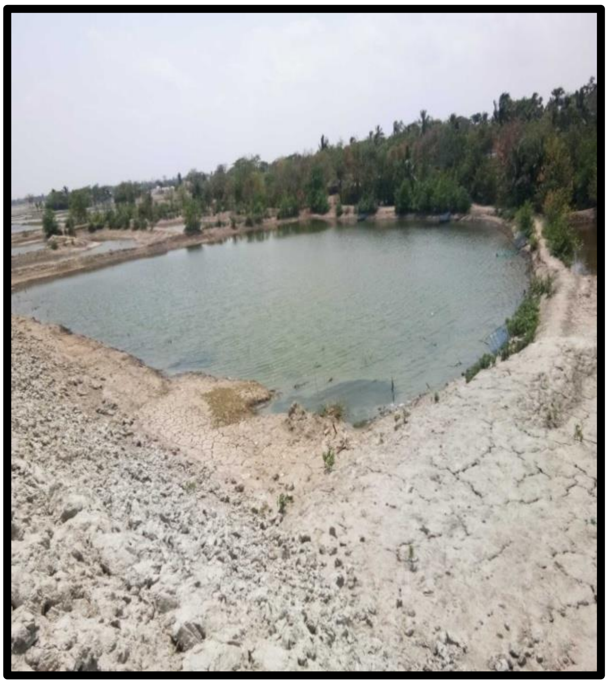
POND AT CHAINAGE 41.6, LEFT BANK

POND AT CHAINAGE 41.7, LEFT BANK

POND AT CHAINAGE 41.7, LEFT BANK

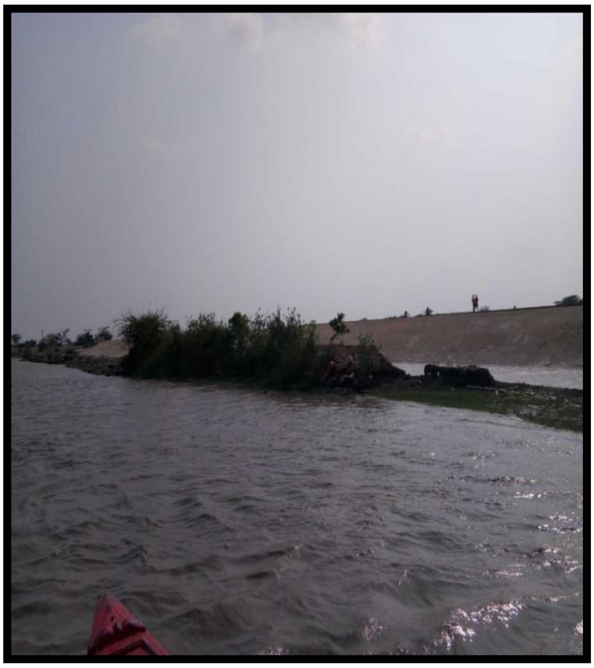
FISHING POND AT CHAINAGE 41.8, RIGHT BANK

POND AT CHAINAGE 41.8, LEFT BANK



POND AT CHAINAGE 41.9, LEFT BANK

RIVER BANK AT CHAINAGE 42, LEFT BANK



RIVER BANK AT CHAINAGE 42, RIGHT BANK

FISHING POND AT CHAINAGE 42, RIGHT BANK

POND AT CHAINAGE 42, LEFT BANK

POND AT CHAINAGE 42, LEFT BANK

FISHING POND AT CHAINAGE 42.1, RIGHT BANK

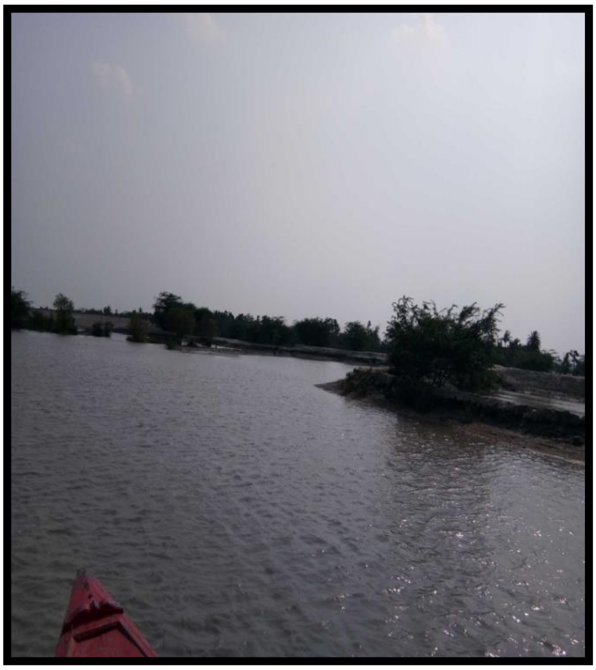
POND AT CHAINAGE 42.1, LEFT BANK

FISHING POND AT CHAINAGE 42.3, RIGHT BANK

POND AT CHAINAGE 42.3, LEFT BANK

POND AT CHAINAGE 42.4, LEFT BANK

FISHING POND AT CHAINAGE 42.5, RIGHT BANK



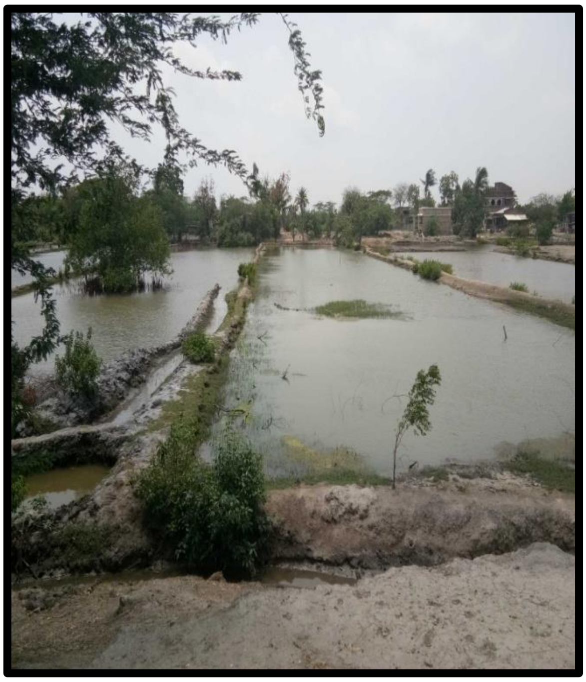
RIVER BANK AT CHAINAGE 42.5, RIGHT BANK

POND AT CHAINAGE 42.5, LEFT BANK

CHAINAGE 42.6, LEFT BANK

FISHING POND AT CHAINAGE 42.7, RIGHT BANK

FISHING POND AT CHAINAGE 42.7, RIGHT BANK



POND AT CHAINAGE 42.7, LEFT BANK

POND AT CHAINAGE 42.8, LEFT BANK

POND AT CHAINAGE 42.9, LEFT BANK

FISHING POND AT CHAINAGE 43, RIGHT BANK

RIVER BANK AT CHAINAGE 43, LEFT BANK

RIVER BANK AT CHAINAGE 43, LEFT BANK

RIVER BANK AT CHAINAGE 43, RIGHT BANK

RIVER BANK AT CHAINAGE 43, LEFT BANK

POND AT CHAINAGE 43, LEFT BANK

POND AT CHAINAGE 43, LEFT BANK

CHAINAGE 43.1, LEFT BANK

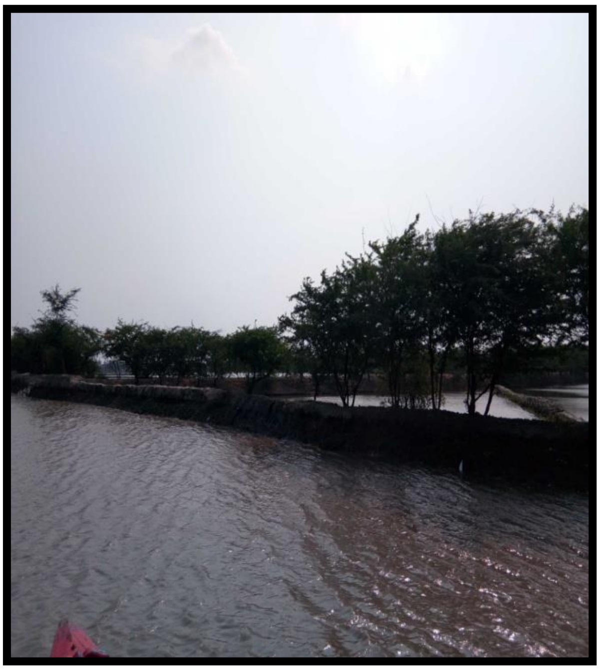
POND AT CHAINAGE 43.2, LEFT BANK

TREE COVER AREA AT CHAINAGE 43.3, LEFT BANK

CREEK AT CHAINAGE 43.3, RIGHT BANK

CREEK AT CHAINAGE 43.3, RIGHT BANK

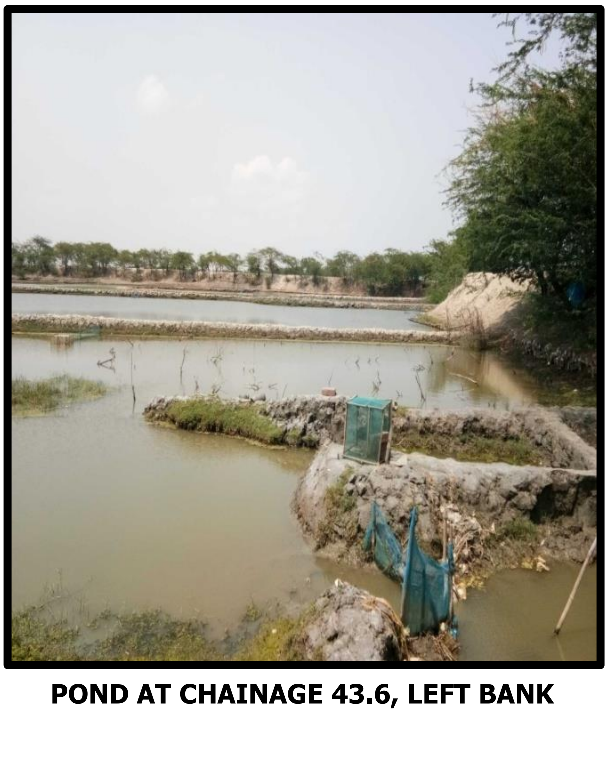
RIVER BANK AT CHAINAGE 43.5, LEFT BANK



RIVER BANK AT CHAINAGE 43.5, RIGHT BANK

FISHING POND AT CHAINAGE 43.5, RIGHT BANK

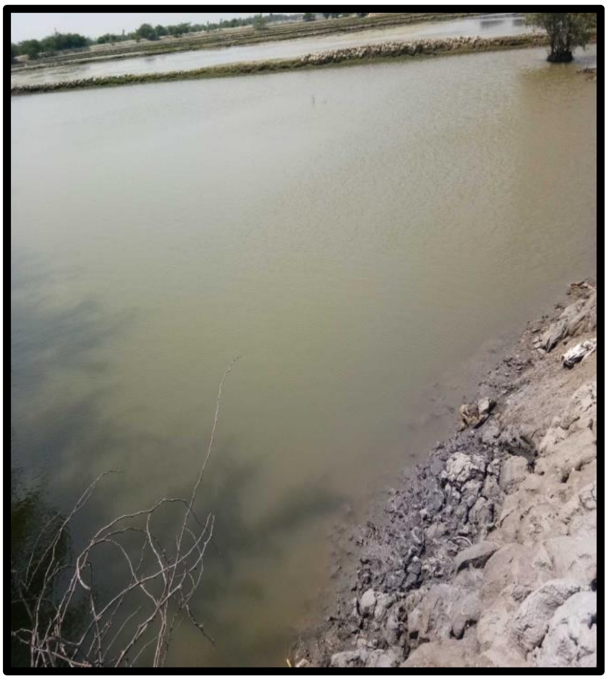
POND AT CHAINAGE 43.5, LEFT BANK



POND AT CHAINAGE 43.6, LEFT BANK

POND AT CHAINAGE 43.7, LEFT BANK

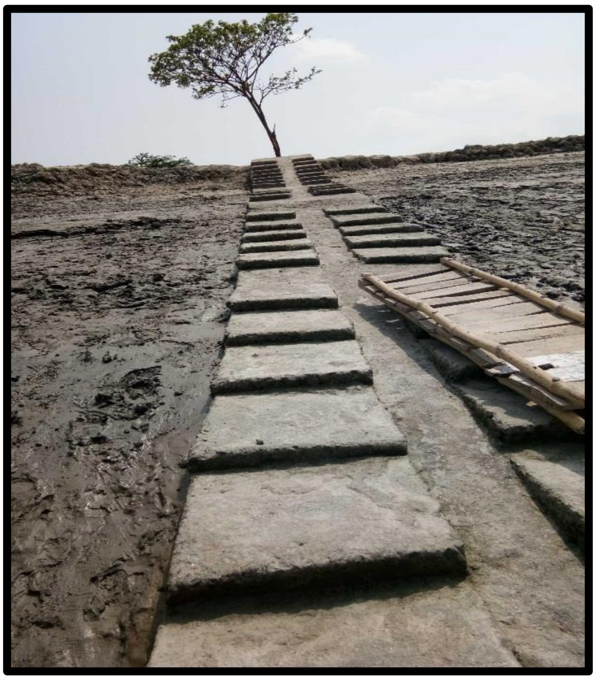
LAND AT CHAINAGE 43.8, RIGHT BANK



POND AT CHAINAGE 43.8, LEFT BANK

RIVER BANK AT CHAINAGE 43.8, LEFT BANK

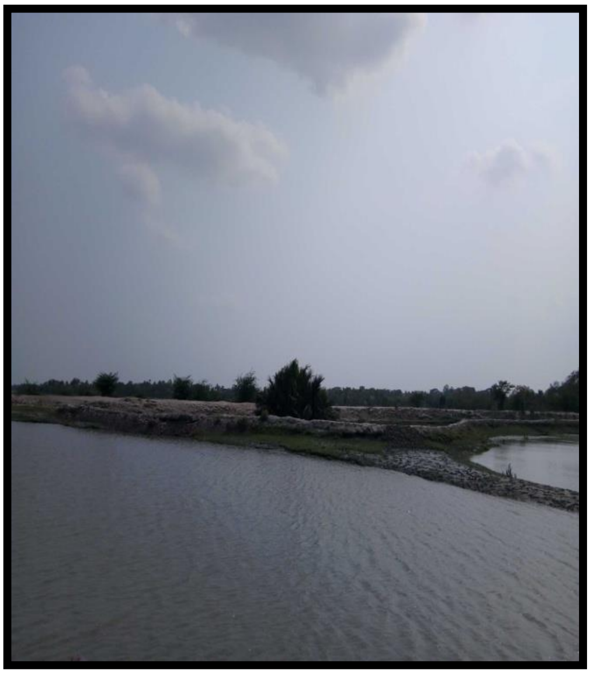
ROAD AT CHAINAGE 43.9, LEFT BANK



JETTY AT CHAINAGE 43.9, LEFT BANK

JETTY HOUSE AT CHAINAGE 43.9, LEFT BANK

RIVER BANK AT CHAINAGE 44, LEFT BANK



RIVER BANK AT CHAINAGE 44, RIGHT BANK

PANCHI GHAT JETTY AT CHAINAGE 44, RIGHT BANK

PANCHI GHAT JETTY AT CHAINAGE 44, RIGHT BANK

BRICKKLIN AT CHAINAGE 44, RIGHT BANK

BRICKKLIN AT CHAINAGE 44, RIGHT BANK

RIVER BANK AT CHAINAGE 44, LEFT BANK

RIVER BANK AT CHAINAGE 44.1, LEFT BANK

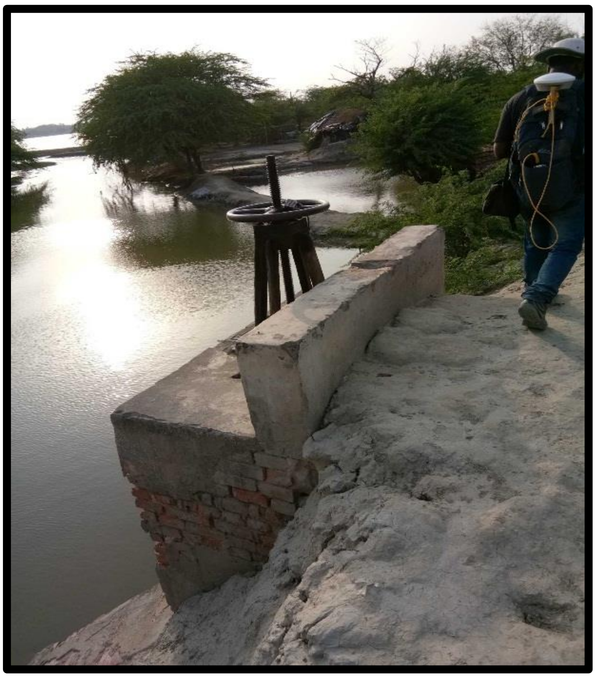
RIVER BANK AT CHAINAGE 44.2, LEFT BANK

GROUND LEVEL AT CHAINAGE 44.2, LEFT BANK

LAND AT CHAINAGE 44.2, LEFT BANK

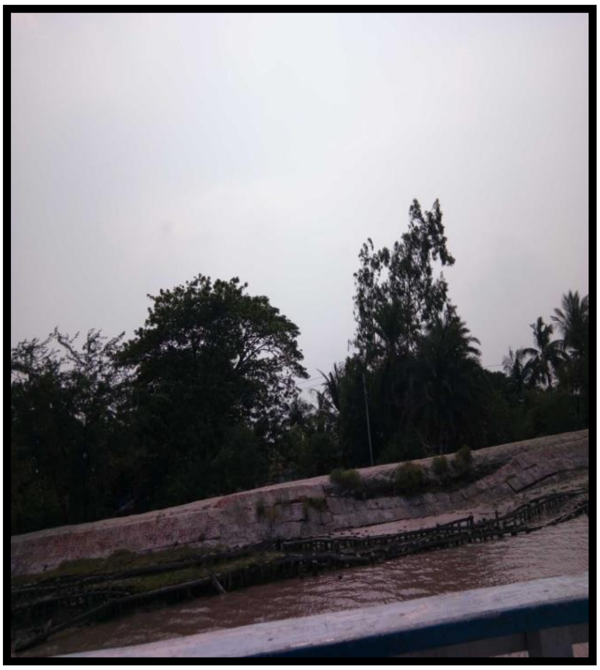
BRICKKLIN AT CHAINAGE 44.2, RIGHT BANK

RIVER BANK AT CHAINAGE 44.3, LEFT BANK



WATER LOCK AT CHAINAGE 44.3, LEFT BANK

RIVER BANK AT CHAINAGE 44.5, LEFT BANK



RIVER BANK AT CHAINAGE 44.5, RIGHT BANK

DAMAGED JETTY AT CHAINAGE 44.8, LEFT BANK

BRICK KLIN AT CHAINAGE 44.8, RIGHT BANK

LAND AT CHAINAGE 44.8, LEFT BANK

LAND AT CHAINAGE 44.9, LEFT BANK

POND AT CHAINAGE 44.9, LEFT BANK

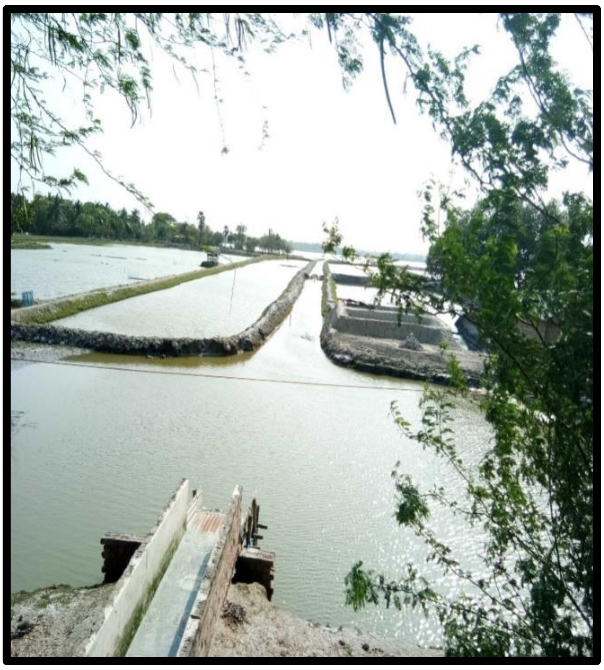
RIVER BANK AT CHAINAGE 45, LEFT BANK

RIVER BANK AT CHAINAGE 45, LEFT BANK

RIVER BANK AT CHAINAGE 45, RIGHT BANK

CREEK AT CHAINAGE 45, RIGHT BANK

CREEK AT CHAINAGE 45, RIGHT BANK



POND AT CHAINAGE 45, LEFT BANK

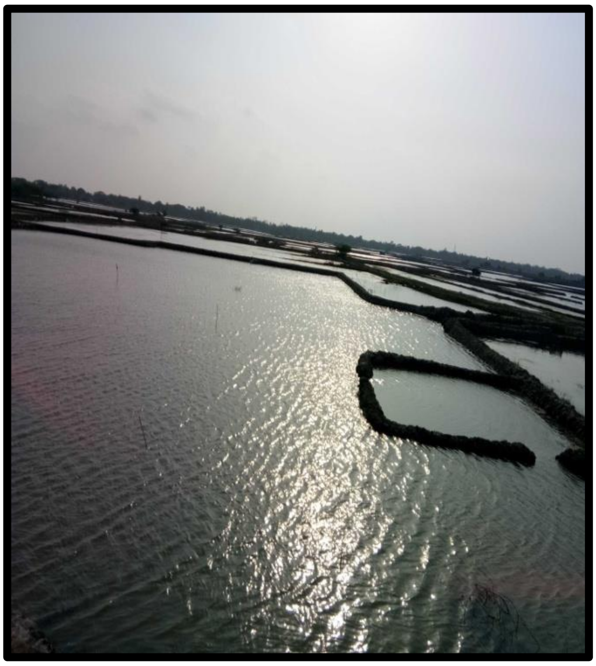
JETTY AT CHAINAGE 45, LEFT BANK

STRUCTURE AT CHAINAGE 45, LEFT BANK

CEMETERY AT CHAINAGE 45, LEFT BANK

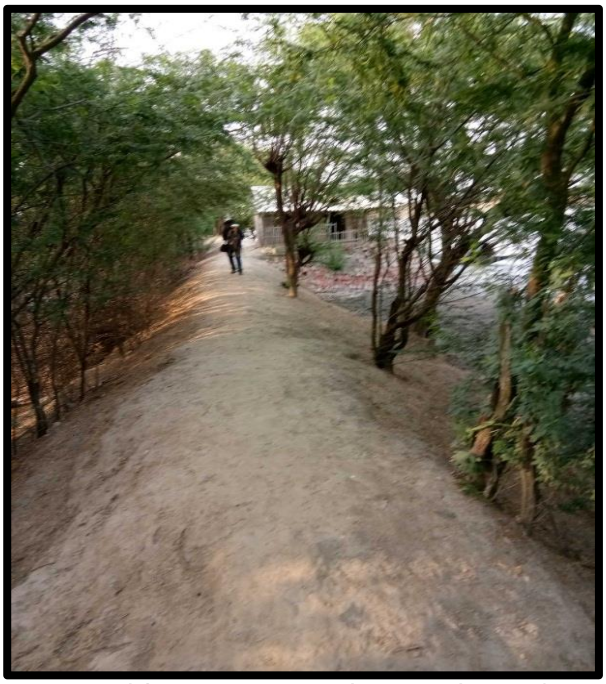
STRUCTURE AT CHAINAGE 45.1, LEFT BANK

ROAD AT CHAINAGE 45.2, LEFT BANK



POND AT CHAINAGE 45.2, LEFT BANK

POND AT CHAINAGE 45.2, LEFT BANK



TREE COVER AREA AT CHAINAGE 45.2, LEFT BANK

ROAD AT CHAINAGE 45.3, LEFT BANK

RIVER BANK AT CHAINAGE 45.5, LEFT BANK

RIVER BANK AT CHAINAGE 45.5, RIGHT BANK

ROAD AT CHAINAGE 45.6, LEFT BANK

CHAK KHAPUKUR JETTY AT CHAINAGE 46, RIGHT BANK

JETTY GHATAT CHAINAGE 46, LEFT BANK

RIVER BANK AT CHAINAGE 46.5, LEFT BANK

RIVER BANK AT CHAINAGE 46.5, LEFT BANK

RIVER BANK AT CHAINAGE 46.5, RIGHT BANK

RIVER BANK AT CHAINAGE 46.5, RIGHT BANK

POND AT CHAINAGE 47, LEFT BANK

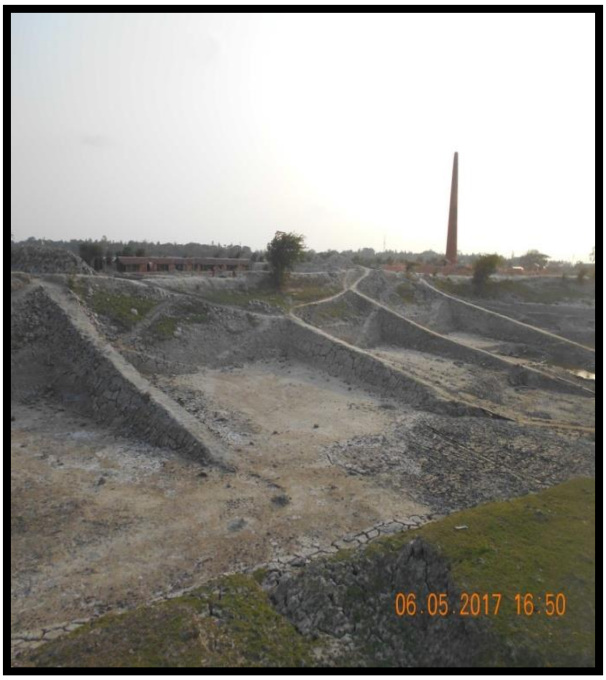

RIGHT RIVER BANK PROTECTION AT CHAINAGE 47


RIGHT RIVER BANK WATER LOCK AT CHAINAGE 47.1


CHAINAGE 47.5, LEFT BANK


RIVER BANK AT CHAINAGE 47.5, LEFT BANK

RIVER BANK AT CHAINAGE 47.5, RIGHT BANK



BRICK KLIN AT CHAINAGE 47.7, LEFT BANK

RIGHT RIVER BANK FISHING POND AT CHAINAGE 48

RIVER BANK AT CHAINAGE 48, LEFT BANK

RIVER BANK AT CHAINAGE 48, LEFT BANK

FISHING POND AT CHAINAGE 48, LEFT BANK

RIGHT RIVER BANK FISHING POND AT CHAINAGE 48.2

RIGHT RIVER BANK FISHING POND AT CHAINAGE 48.4

RIVER BANK AT CHAINAGE 48.5, RIGHT BANK

RIVER BANK AT CHAINAGE 48.5, RIGHT BANK

RIGHT RIVER BANK FISHING POND AT CHAINAGE 48.8

RIVER BANK AT CHAINAGE 49, LEFT BANK

HIGH TENSION LINE AT CHAINAGE 49, RIGHT BANK

RIVER BANK AT CHAINAGE 49, LEFT BANK

RIGHT RIVER BANK GROUND LEVEL AT CHAINAGE 49.3

RIGHT RIVER BANK PROTECTION AT CHAINAGE 49.3

RIVER BANK AT CHAINAGE 49.5, LEFT BANK

RIVER BANK AT CHAINAGE 49.5, LEFT BANK

RIVER BANK AT CHAINAGE 49.5, RIGHT BANK

RIGHT RIVER BANK CREEK AT CHAINAGE 49.5

RIGHT RIVER BANK HIGH TENSION LINE AT CHAINAGE 49.5

RIGHT RIVER BANK HIGH TENSION LINE AT CHAINAGE 49.5

RIGHT RIVER BANK HIGH TENTION AT CHAINAGE 49.6

RIGHT RIVER BANK HIGH TENTIONAT CHAINAGE 49.6

BRIDGE IN CONSTRUCTION AT CHAINAGE 50, RIGHT BANK

BRIDGE IN CONSTRUCTION AT CHAINAGE 50, RIGHT BANK

BRIDGE IN CONSTRUCTION AT CHAINAGE 50, RIGHT BANK

BRIDGE IN CONSTRUCTION AT CHAINAGE 50, LEFT BANK

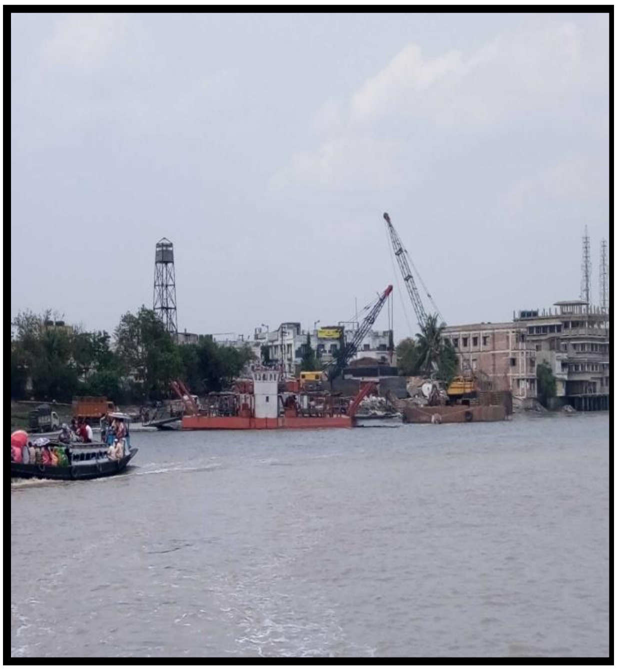
HASNABAD FERRY GHAT AT CHAINAGE 50, LEFT BANK

HASNABAD FERRY GHAT AT CHAINAGE 50, RIGHT BANK

HASNABAD FERRY GHAT NO.2 AT CHAINAGE 50, LEFT BANK

RIVER BANK AT CHAINAGE 50.5, RIGHT BANK

HASNABAD VESSEL JETTY AT CHAINAGE 51, LEFT BANK



HASNABAD VESSEL JETTY AT CHAINAGE 51, RIGHT BANK

RIVER BANK AT CHAINAGE 51, RIGHT BANK

RIVER BANK AT CHAINAGE 51, RIGHT BANK

RIVER BANK AT CHAINAGE 51, LEFT BANK

RIGHT RIVER BANK HASNABAD FERRY GHATCHAINAGE 51.3

RIGHT RIVER BANK BRIDGE CONSTRUCTION AT CHAINAGE 50

RIGHT RIVER BANK BRIDGE CONSTRUCTION CHAINAGE 50

RIVER BANK AT CHAINAGE 51.5, LEFT BANK

RIGHT RIVER BANK BRICKLIN AT CHAINAGE 51.5

RIGHT RIVER BANK BRICKLIN AT CHAINAGE 51.7

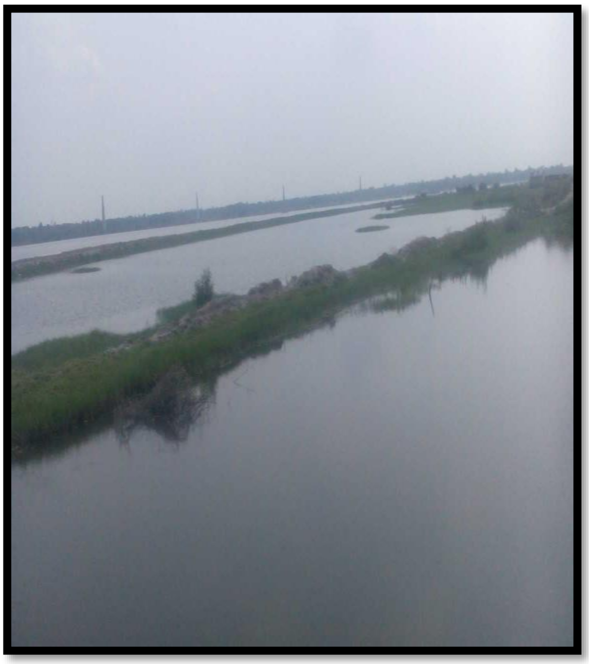
RIGHT RIVER BANK BRICKLIN AT CHAINAGE 51.8

RIGHT RIVER BANK BRICKLIN AT CHAINAGE 51.8

RIVER BANK AT CHAINAGE 52, LEFT BANK

RIVER BANK AT CHAINAGE 52, LEFT BANK

RIVER BANK AT CHAINAGE 52, LEFT BANK



RIGHT RIVER BANK POND AT CHAINAGE 52

RIGHT RIVER BANK POND AT CHAINAGE 52

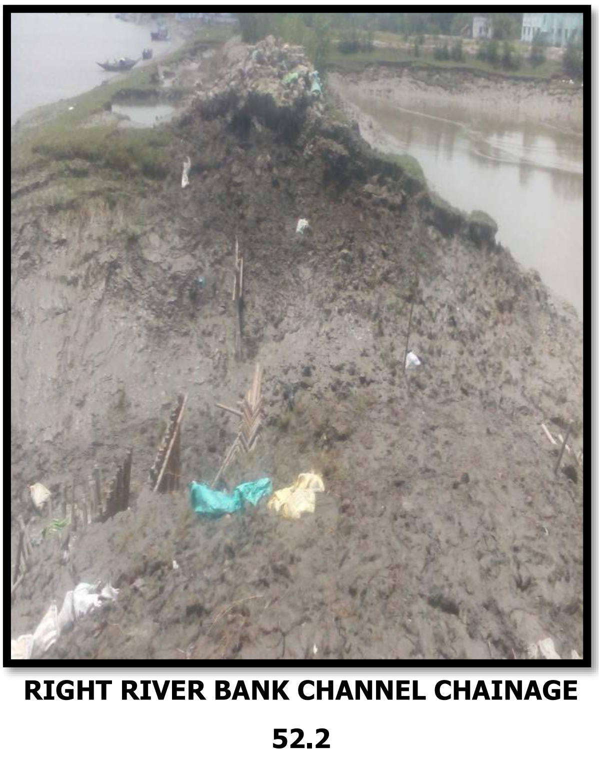
RIGHT RIVER BANK FISHING POND AT CHAINAGE 52

RIGHT RIVER BANK WATER TREATMENT PLANT CHAINAGE 52

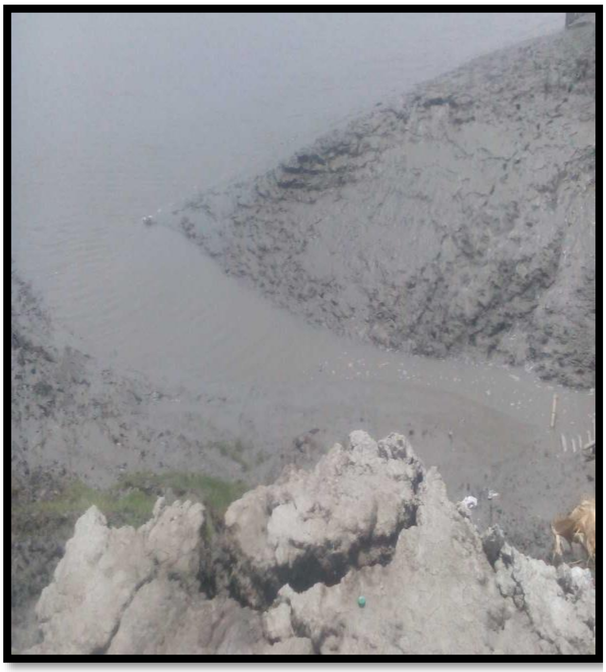
RIGHT RIVER BANK POND AT CHAINAGE 52.2

RIGHT RIVER BANK POND AT CHAINAGE 52.2

RIGHT RIVER BANK POND AT CHAINAGE 52.2



RIGHT RIVER BANK CHANNEL CHAINAGE 52.2



RIGHT RIVER BANK CREEK AT CHAINAGE 52.5

RIVER BANK AT CHAINAGE 52.5, RIGHT BANK

RIVER BANK AT CHAINAGE 52.5, RIGHT BANK

RIVER BANK AT CHAINAGE 52.5, LEFT BANK

VOLUME – II

DRAWINGS