Detailed Project Report (DPR) for Development of Subansiri River, National Waterway-95

Stretch: Brahmaputra Confluence to Chauldhowa Ghat (106.45 km)

Volume – I (of III) Detail Project Report

Inland Water Authority of India

Detail Project Report (Final)

March 2019

The expert in WATER ENVIRONMENTS

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Prepared for	Inland Waterways Authority of India
Represented by	Hydrographic Chief & Director NER

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Project number	63801181
Submission date	27-03-2019
Revision	Final
Classification	Confidential

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This report has been prepared under the DHI Business Management System certified by BVC to comply with ISO 9001 (Quality Management), ISO 14001 (Environmental Management), OHSAS 18001 (Health and Safety Management)

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Acknowledgements

DHI (India) Water and Environment Pvt. Ltd. would like to take this opportunity to pen down our profound gratitude and appreciations to Ms. Nutan Guha Biswas, IAS, Chairperson, IWAI. We would also like to thank Shri. Praveer Pandey, Vice Chairman IA & AS, Shri Alok Ranjan (Member Finance), Shri Shrikant Mahiyaria, IRTS (Member Traffic) and Shri Sanjay Kumar Gangwar (Member Technical) for their valuable suggestions and advice at various stages of this project.

We, wish to express our gratitude to Cdr. P.K. Srivastava, former Hydrographic Chief, IWAI for his guidance and constant support during this project. DHI would also like to thank Shri. Rajiv Singhal, A.H.S., IWAI for his invaluable support and suggestions throughout the survey period.

DHI is pleased to place on record their sincere thanks to Shri. R.P. Khare, Senior Consultant, for constant scrutiny and consistent quality check to make this report foolproof.

We take this opportunity to thank all other staff and officers of IWAI and our well-wishers for their excellent support and cooperation.

The Detailed Project Report for Subansiri River (NW 95) is presented in three Volumes.

Volume # I: DPR (Present Report)

Volume # II: Detailed Engineering Drawings

Volume # III: Detailed Hydrography Survey Report and Survey Charts

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List of Abbreviations

ATF	:	Aviation Turbine Fuel
BM	:	Bench Mark
CEA	:	Central Electricity Authority
CH	:	Chainage
CP	:	Control Point
CPC	:	Calcined Petroleum Coke
CUM	:	Cubic Meter
CWC	:	Central Water Commission
DGPS	:	Differential Global Positioning System
DPR	:	Detailed Project Report
EGNOS	:	European Geo Stationary Navigation system
G&D	:	Gauge & Discharge
GPS	:	Global Positioning System
HFL	:	High Flood Level
HSD	:	High Speed Diesel
IHO	:	International Hydrographic Organization
IWAI	:	Inland Waterways Authority of India
IWT	:	Inland Water Transport
Km	:	Kilo Meter
LAD	:	Least Available Depth
M	:	Meter
MCM	:	Million Cubic Meter
MDR	:	Major District Roads
MoWR	:	Ministry of Water Resources
MS	:	Motor Spirit
NH	:	National Highway
NRL	:	Numaligarh Refinery Limited
NW	:	National Waterway
OEM	:	Original Equipment Manufacturer
PIA	:	Project Influence Area
RFP	:	Request for Proposal
RPC	:	Raw Petroleum Coke
RTK	:	Real Time Kinematic
SBAS	:	Satellite based Augmentation System
SH	:	State Highway
SKO	:	Superior Kerosene Oil
SONAR	:	SOund Navigation And Ranging
SWOT	:	Strength Weakness Opportunity and Threat
WAAS	:	Wide Area Augmentation System
WGS	:	World Geodetic System
WRIC	:	Western Regional Instrumentation Centre

Salient Features at a Glance

Sl. No	Particulars	Details					
A.	**GENERAL**						
	Name of the waterway	**Subansiri River (National Waterway 95)**					
1.	Location	North Lakhimpur					
a)	Name of the waterway	National Waterway 95: Subansiri River, Cluster 2					
b)	State(s)	Assam					
c)	Co-ordinates & Name of Place	Start		End			
	Place	Brahmaputra Confluence		Chauldowa Ghat			
	Latitude	26°52'24.93"N		27°27'2.96"N			
	Longitude	93°54'31.26"E		94°15'16.12"E			
B.	**TECHNICAL**						
1.	***Waterway***						
a)	National Waterway Number	95					
b)	Class	Class –II (proposed for cross shore movement)					
c)	Type (Tidal/Non-Tidal)	Non-Tidal					
	Length (Km.)	Total	Tidal	Non-Tidal			
		106.45	0	106.45			
d)	Average Tidal Variation, if applicable	NA					
e)	Chart Datum (wrt MSL)	6-year lowest water level (from CWC stations)					
	Badatighat	76.63 m					
	Chouldhowaghat	91.18 m					

f)	**LAD status (w.r.t. CD)**	Observed Depth					
		Sub Stretch (0-4.7 km)	**Sub-stretch- (4.7-17 km)**	**Sub-Stretch- (17-28 km)**	**Sub-Stretch- (28-37.6km)**	**Sub-Stretch- (37.6-47.9km)**	**Sub Stretch- (47.958.9km)**
	< 1.2 m (km)	0	1.000	1800	1.800	3.200	2.500

	1.2 m to 1.4 m (km)	0.200	0.800	2.000	0.800	2.000	1.200
	1.5 m to 1.7 m (km)	0.200	0.800	2.200	2.200	2.000	1.300
	1.8 m to 2.0 m (km)	0.200	1.400	2.000	1.400	1.500	1.500
	> 2.0 m (km)	4.100	8.300	3.000	3.400	1.600	4.500
	Total (km)	4.700	12.300	11.000	9.600	10.300	11.000
		Sub-Stretch-(58.9-69.6km)	**Sub-Stretch-(69.6-79.5 km)**	**Sub-Stretch-(79.5-89.3 km)**	**Sub-Stretch-(89.3-100.2 km)**	**Sub-Stretch-(100.2-106 km)**	**Total**
	< 1.2 m (km)	4.800	2.800	2.400	4.000	0.800	25.10
	1.2 m to 1.4 m (km)	1.600	2.400	1.400	2.300	1.000	15.70
	1.5 m to 1.7 m (km)	1.300	1.400	1.000	2.000	1.000	15.40
	1.8 m to 2.0 m (km)	1.000	1.200	0.800	1.200	1.200	13.40
	> 2.0 m (km)	2.000	2.100	4.200	1.840	1.800	36.84
	Total (km)	10.700	9.900	9.800	11.340	5.800	106.44
g)	Target Depth of Proposed Fairway (m)	1.5 (Class – II as per IWAI classification)					
h)	Conservancy Works Required	Dredging for Crossshore / Transverse movement alone Phase I: 53,132.6 cum (~0.05 MCM), Phase II: 1,46,798.10 cum (~0.15 MCM)					
i)	Existing Cross Structures						
	Name of Structure	Type	Nos.	Range of Horizontal Clearance	Range of Vertical Clearance w.r.t. HFL/MHWS		
	Dams/Barrages/Weirs/Aqueducts etc.	NA	NA	NA	NA		
	Bridges	RCC Road Bridge (NH 52)	1 (Chainage 105.4 km)	45 m	4.4 m		
		Girder Steel Bridge (Railway)	1 (Chainage 105.8 km)	60.5 m	3.6 m		

	HT/Tele-communication lines	HT	2	400 – 980 m	12.5 – 13.9
	Pipelines, underwater cables, etc.	NA	NA	NA	NA
2.	***Traffic***				
a)	Present IWT Operations (type of services)	**There are six main operational ghats at the right bank of the river namely Ghagar(Ch. 68.20 km), Aserkota (Ch. 56.30 Km.), Bali (Ch. 49.10 km), Khaboli/Khabolu (Ch. 41.00 km), Dhunaguri(Ch. 25.20 km), Badoti (Ch. 17.8). Their complementary ghats that are in the left bank are smaller in nature, operating with makeshift arrangement** **Majority of the Ghats have been transporting passengers and two wheelers, using wooden boats. Some of them could also transport four wheelers. Onshore almost no infrastructure is available.**			
	Terminal/Jetty - 1	**Khaboli/Khabolu Ghat (Large Terminal)**			
	Location (Bank/city/district)	Khaboli, K.B. Road, North Lakhimpur Revenue Circle, Lakhimpur District			
	Type/Services	Passenger & Ro-Ro (2 & 4 Wheelers) service. To the right bank ghat Luit Khabuli			
	Facilities	Wooden Motor Boats are used for across the river movement. No other facilities provided on existing Ghat			
	Approach	SH21 connects villages & Ghat. Bus, Tempo & Mini Tempo are available.			
	Terminal/Jetty - 2	**Dhunaguri Ghat (Large Terminal)**			
	Location (Bank/city/district)	Right bank, Bongalmara, Bihpuria Revenue Circle, Lakhimpur District.			
	Type/Services	Passenger & Ro-Ro (2 & 4 Wheelers) service			
	Facilities	Wooden Motar Boats are used for across the river movement. No other facilities provided on existing Ghat			
	Approach	Good Connectivity between Ghat & Villages, Tempo & Buses are available.			
	Terminal/Jetty - 3	**Ghagar Ghat (Small Terminal)**			
	Location (Bank/city/district)	Right bank, Ghagar, D.K. Road, North Lakhimpur Revenue Circle, Lakhimpur District.			
	Type/Services	Passenger & Ro-Ro (2 Wheelers) service			

	Facilities	Wooden Motar Boats are used for across the river movement. No other facilities provided on existing Ghat	
	Approach	Good Connectivity between Villages & Ghat, Tempos are available	
	Terminal/Jetty - 4	**Aserkota Ghat (Small Terminal)**	
	Location (Bank/city/district)	Aserkota Par (Khoga), North Lakhimpur Revenue Circle, Lakhimpur District.	
	Type/Services	Passenger & Ro-Ro (2 Wheelers) service	
	Facilities	Wooden Motar Boats are used for across the river movement. No other facilities provided on existing Ghat	
	Approach	Kachcha road connects Villages & Ghat, Only Tempos are available.	
	Terminal/Jetty - 5	**Bali Ghat (Small Terminal)**	
	Location (Bank/city/district)	Balighat, North Lakhimpur Revenue Circle, Lakhimpur District.	
	Type/Services	Passenger & Ro-Ro (2 Wheelers) service	
	Facilities	Wooden Motar Boats are used for across the river movement. No other facilities provided on existing Ghat	
	Approach	Good connectivity between villages & Ghat, Bus, Tempo, Jeep & Winger are available.	
	Terminal/Jetty - 6	**Badoti Ghat (Small Terminal)**	
	Location (Bank/city/district)	Badoti, Bihpuria Revenue Circle, Lakhimpur District.	
	Type/Services	Passenger & Ro-Ro (2 Wheelers) service	
	Facilities	Wooden Motar Boats are used for across the river movement. No other facilities provided on existing Ghat	
	Approach	People need to walk 2-3 kms from Ghat and then take vehicle to reach the destination. Poor Road connectivity to Ghat.	
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	No major industries	
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	NA	
d)	Commodities	In-bound	Out-bound

		N/A	N/A
e)	Future Potential	River holds potential for Passenger & Ro-Ro traffic – Across the River movement. The major growth drivers considered for projecting traffic growth in futurefor the proposed waterway in Subansiri River are population and consumption growth in the hinterland, growth in economy and trade of the region, increase in transportation demand for river crossing.	

	Proposed Terminals	Projected {Base Year (Fy'16)}						
		Fy'16	Fy'20	Fy'24	Fy'28	Fy'32	Fy'36	Fy'40
1	Ghagar Ghat/Terminal **numbers)** (Chainage 68.20 km)	**Average Daily Crossing Volume (units in**						
	Passengers	157	183	225	276	338	412	502
	2-wheeler	18	21	29	37	47	59	74
2	Dhunaguri Ghat/Terminal (Chainage 25.20 km)							
	Passenger	379	439	536	654	797	970	1181
	2-wheeler	53	62	78	97	120	147	181
	4-wheeler	32	38	48	60	75	93	115
3	Khaboli/Khabolu Ghat/Terminal (Chainage 41.00 km)							
	Passenger	224	261	320	390	476	580	706
	2-wheeler	56	66	82	102	126	155	191
	4-wheeler	29	35	44	56	70	87	108

3	**Proposed Terminals/Jetties**	

The identified terminal locations in Phase 1:

Sl. No.	Origination ghat	Destination ghat	Proposed traffic handling
1	Ghagar (Chainage 68.20 km)	Ghunasuti (Chainage 70.60 km)	Passenger + 4 wheeler
2	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Majuli District) (Chainage 27.00 km)	Passenger + 4 wheeler

1.	**Main terminal - Ghagar Ghat (Right Bank); Auxiliary terminal - Ghunasuti (Left Bank)** People residing in Ghunasuti village are the frequent commuters, who travel via Ghagar Ghat ferry to reach to the other side of the river. Ghunasuti village is in Lakhimpur district. Naharlagun, Itanagar, Jorhat, Sibsagar are nearby cities around Ghunasuti. North Lakhimpur railway station is near the Ghunasuti village (about 1 km) but the major railway station Dibrugarh is 93 km away from Ghunasuti. Lilabari airport is the nearest airport located 7km away from Ghunasuti. No permeant berthing structure is suggested for any of the terminals. Main terminal in the right bank is proposed to have a main terminal building with office area, resting area, toilets and security. A borehole and an overhead tank are also suggested for the uninterrupted supply of potable water. Auxiliary terminal at the left bank will have a smaller terminal building with resting area security and toilets.
2.	**Origin -Dhunaguri (Bongalmara) Destination - Selek Ghat** Local people use this ghat to go to the other side of the river. Mostly teachers from Lulak, Bihpuria & Bongalmara cross the river to go to schools, located on other side of the river in Selek, Majuli district. Bongalmara & Bihpuria are well developed places compared to other nearby places, so people from other side come here for Medical, education, commercial purpose. Cash crops cultivated in Majuli district are brought here in upper region of Subansiri river for selling in the Market by crossing the river. Livestock trading is done in both sides of the river. People living in lower region of Subansiri River; like Majuli, are mostly dependent on Ghats for crossing the river for their daily needs. No permeant berthing structure is suggested for any of the terminals. Main terminal in the right bank is proposed to have a main terminal building with office area, resting area, toilets and security. A borehole and an overhead tank are also suggested for the uninterrupted supply of potable water. Auxiliary terminal at the left bank will have a smaller terminal building with resting area security and toilets.
	The identified terminal locations in Phase 2: Sl. No. | Origination ghat | Destination ghat | Proposed traffic handling **1** | Khaboli/Khabolu (Chainage 41.00 km) | Luit Khabolu Panchayat (Chainage 42.00 km) | Passenger + 4 wheeler
3.	**Origin - Khabolu Ghat Destination - Luit Khabolu Panchayat** Khabolu Ghat is located in North Lakhimpur Circle near Loliti Morang village just opposite to Hastinapur Village. Ferry service from this ghat connects State Highway 21 on both sides of the river. This ghat is also one of the busiest ghats, after Ghagar Ghat. Traffic of this ghat consists of people mostly who come for tourism. World's largest river island, i.e. Majuli is located on the other side of the river which is 20 km away. People from North Lakhimpur come to this ghat by roadways, take ferry service to cross the river and further take road to the Island. Mostly people staying near Majuli come to North Lakhimpur to purchase their daily requirement and goods for their shops. No permeant berthing structure is suggested for any of the terminals. Main terminal in the right bank is proposed to have a main terminal building with office area, resting area, toilets and security. A borehole and an overhead tank are also suggested for the uninterrupted

	supply of potable water. Auxiliary terminal at the left bank will have a smaller terminal building with resting area security and toilets.	
4.	***Design Vessel***	
a)	Type	Modular ferry
b)	LOA	30
c)	Beam	7-8
d)	Draft	1.2
e)	Number of vessels proposed	3
5.	***Navigation Aids***	Buoys to demarcate the channel boundaries
a)	Type	
b)	Nos.	Phase I: 4 Phase II: 2
b)	Communication Facilities	VHF Radio
C.	**FINANCIAL**	
1.	*Project Cost*	
a)	**Capital Cost (Phase I and II)**	**₹ 8.03 Crores**

Sl. No.	Description	Phase I (lakhs)	Phase II (lakhs)	Total (in Rs.) (lakhs)
I Fairway development				
1	Dredging	₹ 106.26	₹ 293.60	₹ 399.86
2	River training/ Bank protection / embankment strengthening works	₹0	₹ 0	₹ 0
3	Navigation markings / Navigational aids	₹ 2.40	₹ 0.60	₹ 3.00
II Terminals				
I	Terminal Building	₹ 45.26	₹ 22.63	₹ 67.89

II	Waiting Building	₹ 11.97	₹ 5.98	₹ 17.95
III	Navigation and Communication	₹ 5.00	₹ 2.50	₹ 7.50
IV	Auxiliary items	₹ 20.00	₹ 5.00	₹ 25.00
V	Landscaping	₹ 3.00	₹ 1.50	₹ 4.50
VI	Utility shifting	₹ 3.00	₹ 1.50	₹ 4.50
VII	Modular Ferry Vessel	₹ 200.00	₹ 100.00	₹ 300.00
	Total (lakhs)	**₹ 396.89**	**₹ 433.33**	**₹ 830.2**
	Total (Crores)	**₹ 3.969**	**₹ 4.333**	**₹ 8.302**

b) O & M Cost

Sl. No.	Description	Percentage of Capex	Phase I Annual cost (lakhs)	Phase II Annual cost (lakhs)
I	Fairway maintenance			
1	Dredging	5	₹ 19.84	₹ 21.66
2	Navigation markings / Navigation aids	2	₹ 7.93	₹ 8.66
II	Terminal maintenance			
1	Terminal infrastructure	1	₹ 1.98	₹ 4.33
2	Navigation and Communication	5	₹ 19.884	₹ 21.66
3	Modular Ferry Vessel	10	₹ 39.68	₹43.33
4	Administrative Cost		₹ 58.76	
	Total (lakhs)		**₹ 148.06**	**₹ 99.66**
	Total (Crores)		**₹ 1.481**	**₹ 0.996**

6.	*Financial Internal Rate of Return (%)*	*8.68%*

7.	*Economic Internal Rate of Return (%)*	*Case 1 -EIRR with only direct benefits of saving in trip time by passengers and vehicles and increase in farm income = 4.09%* *Case 2-EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output = 20.09 %* *Case 3- EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output and long-term benefits due to increase in land value = 52.49 %*
7.	*Any other Important Feature*	*NIL*

Executive Summary

Introduction

Inland Waterways Authority of India (IWAI) has engaged DHI (India) Water and Environment Pvt Ltd. to prepare a Detailed Project Report (DPR) for development of Subansiri River (NW 95) for inland navigation. Subansiri River is one of the largest tributaries of the Brahmaputra River and flows through the states of Arunachal Pradesh and Assam. It joins Brahmaputra near Majuli Island. Current study is from Brahmaputra confluence to Chauldowa Ghat (106.45 km). The entire stretch of the river is non-tidal. This report is the volume 1 of 3 volume DPR. Volume 2 is Detailed Engineering Drawings and Volume 3 is Detailed Hydrography Survey Report and Survey Charts.

Detailed hydrographic Survey

Detailed hydrographic survey was conducted from 17 November 2016 to 28 December 2016. There are no dams, barrages, weirs, anicut, locks or aqueduct present along the proposed stretch of Subansiri River. An RCC road bridge (Chainage 105.4 km) and Girder Steel Bridge (Railway) (Chainage 105.8 km) with minimum vertical clearance w.r.t. HFL is 3.6 m and the minimum horizontal clearance is about 45 m. However, these bridges at Chauldhowa Ghat are at the upstream location of the proposed NW. There are two high tension lines along the proposed stretch (ch 40.4 km and ch105.5 km). The minimum vertical clearance of HTL is 12.5 m and horizontal clearance is 400m Hence there are no major hindrances except for the presence of gravel with comparatively steep gradient between Chainage 104 and 106 km as per the hydrographic survey. No protected or sensitive area could be located along the entire stretch. The flood period is from April to August and the lean period is September to March.

Analysis of the satellite image and observation during the hydrogaphic survey revealed that the river is highly braided in nature. The river often get divided into various channels and sand bars and islnads are formed at various places. Shoals and dredging quantity for various classes of waterway (classification given by IWAI) calculated from the detailed hydrographic survey is provided below.

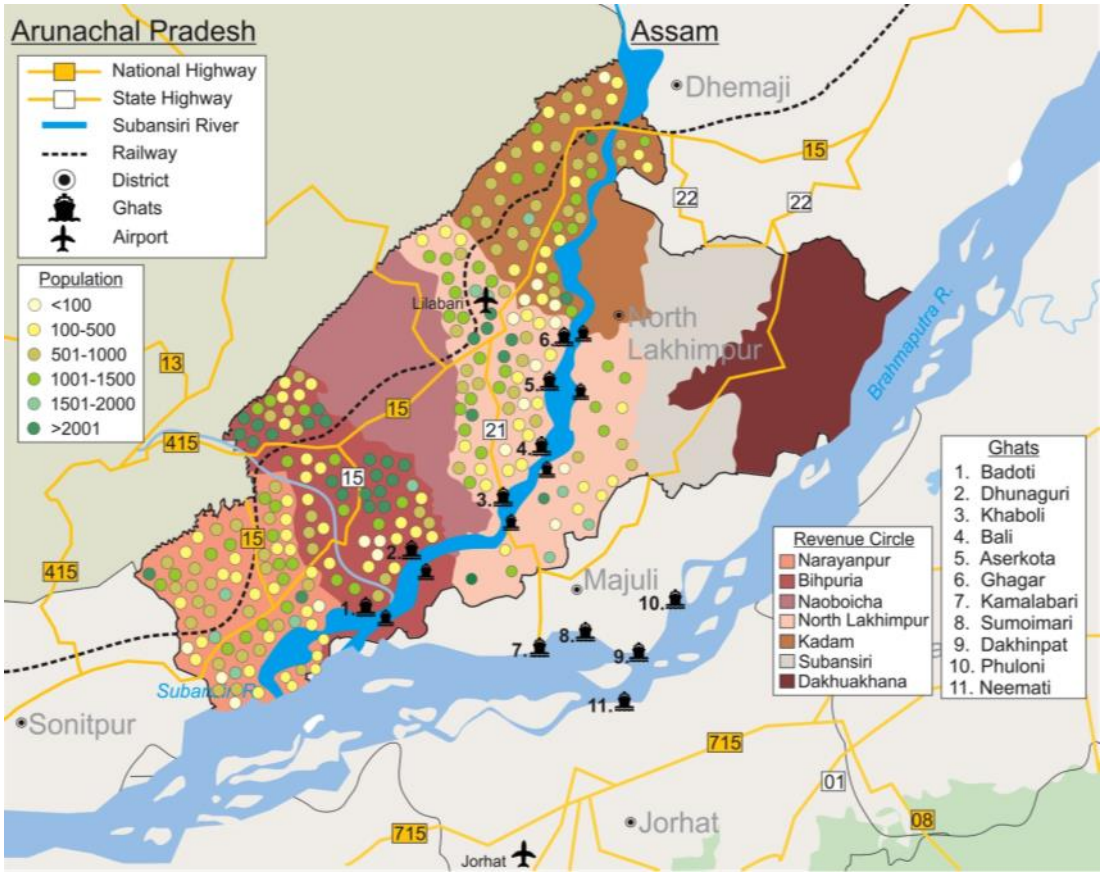
Class	Chainage (km)		Observed (during 17 Nov 2016 to 28 Dec 2016)				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)
I	0	106	0.3	13.3	38600	0.5	-0.3	12.3	39200	4.5
II					45400	1.2			47200	7.0
III					52600	1.9			56800	9.3
IV					69800	4.2			74300	15.3

Detailed report on the hydrographic survey conducted is submitted as Volume III of this report. The same is discussed briefly in Chapter 2 Waterway/ Detailed hydrographic survey of this report.

Traffic study

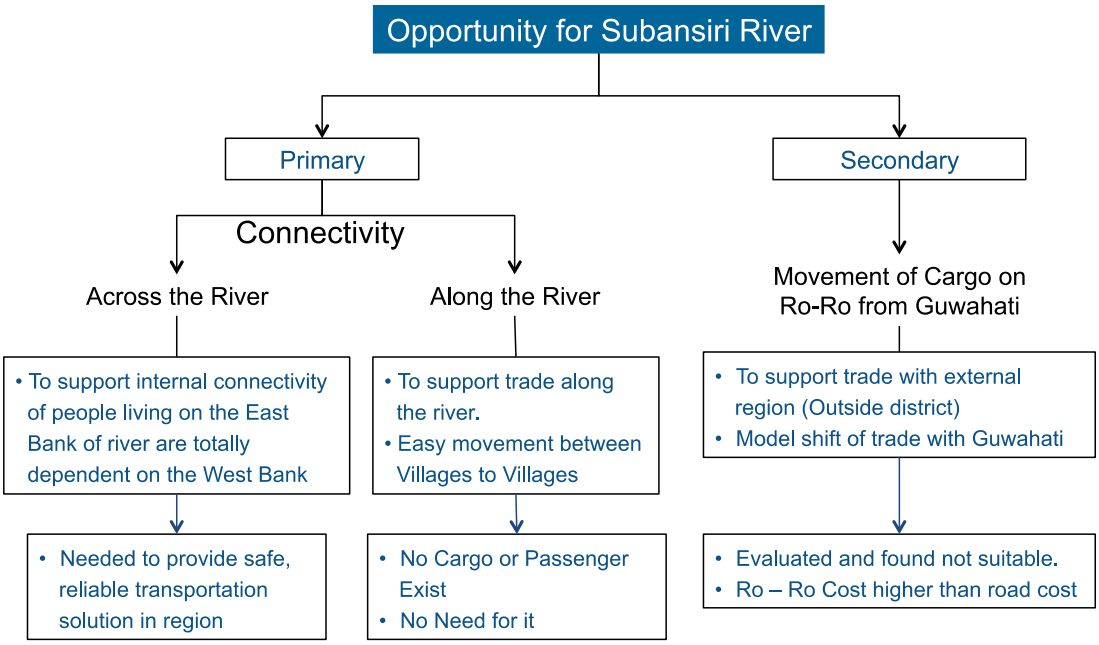
A detailed traffic survey was conducted to identify and assess the traffic potential of the proposed waterway. There are 6 main operational ghats along the river, operating with makeshift arrangement. Majority of the Ghats have been transporting passengers and two wheelers, using wooden boats. Some of them could also transport four wheelers. Apart from these main ghats various other ghats operates during lean season. The demand for cargo and passenger transportation infrastructure in the river would be linked to the growth in passenger, goods and vehicle movement. The catchment area of Subansiri does not have any major/minor industries. Hence, there is no requirement to move industrial cargo in the river. The need for development of waterway would be to provide an alternative mode of transportation to local population and help make their day-to-day commute convenient.

Below map shows the revenue circles of Lakhimpur district. Railways & Roadways connectivity has been marked on the map along with most populated villages & cities. Considered Ghats along the river are also shown on the map. Highly populated places are located near the National Highways & Railway line and are far from Subansiri River.



Opportunity for Subansiri River from the primary & secondary catchment area is shown in the below figure. This figure depicts traffic generating sources for river movement. In primary catchment area, opportunity from both across the river and along the river

movement have been evaluated. Across the river movement frequently happens, which is likely to increase in future. There is no along the river movement of passengers and cargo. Hence, movement of goods and passenger is only possible in the primary catchment area.



Based on the present traffic observed, considering financial year 2016 data as base data three traffic scenarios are projected viz; Optimistic (7% growth rate), Base Growth (5%) and Pessimistic (3%).

Terminal wise IWT traffic analysis

Three modes of transportations were evaluated and the recommendations are:

- Cargo or Ro-Ro movement across river – Ro-Ro movement is needed
- Cargo or Ro-Ro movement along river – There is no need for this movement
- Ro-Ro movement from Guwahati – Commercially not viable for regular service. However, this could be used for transporting Over Dimension Cargo (ODC) on a case to case basis

Based on this analysis, from the six major operating terminals, three were identified to have heavy traffic. It was identified that developing a new terminal would not be advised, as there already exist landing points, which lacks even basic facilities. It is recommended that IWAI may develop these exisitng landing points. Upgrading existing terminals could be cost effective and convenient. These identified locations have good road connectivity with other parts of the district in Lakhimpur.

The detailed report based on traffic study is presented in Chapter 4 Traffic study

Terminals

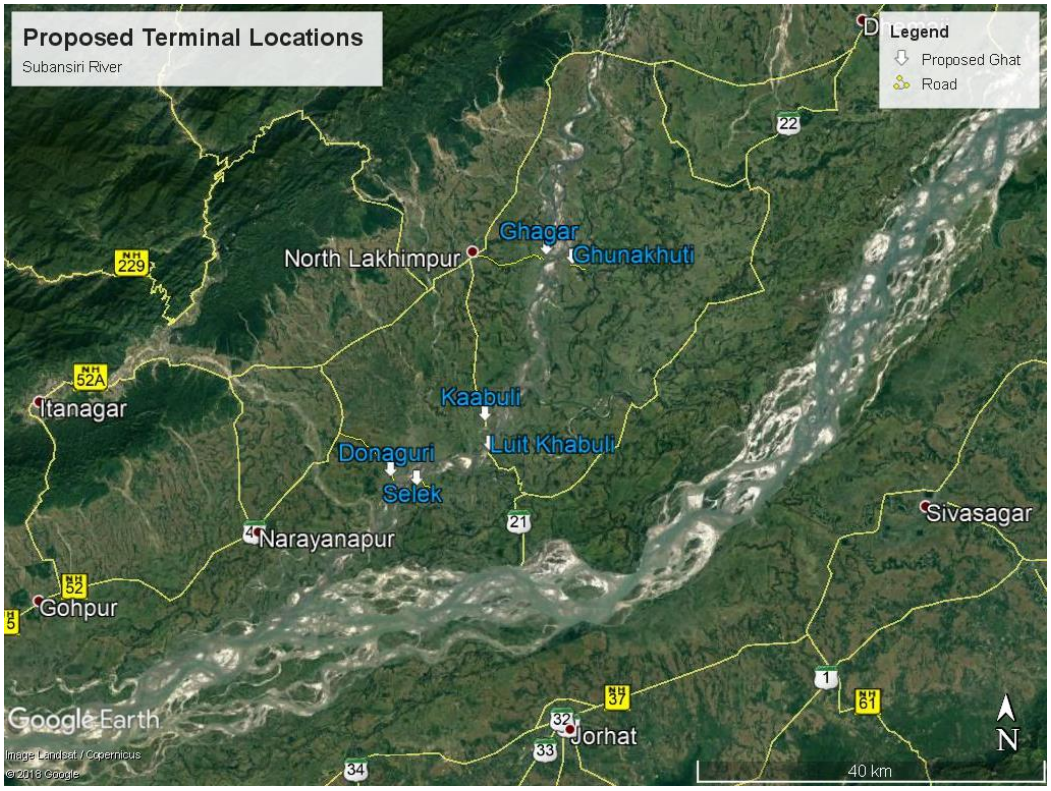
Terminals are centers of receipt, export, storage distribution of cargo and embarkation of passengers. Terminals in Subansiri River should be strategically placed in such a way that

enough traffic passes through the terminals and should help in developing the hinterland associated with the terminals. Facilities associated with the terminal should meet the traffic demand nevertheless, as the resources are scare, the investment made should be economically viable.

Apart from the low projected traffic / cargo movement, the banks of the river is not morphologically stable. Hence huge engineering intervension is not preferable. Keeping these in mind a masterplan was made to vitalise the cross-shore transport by identifying optimum terminal locations and cost-effective terminal design.

Proposed terminal locations

The locations of the terminals were identified by looking into availability of berthing area, width required for the design vessel, traffic study, connectivity with the major cities and the land details. Based on these, six locations, with main terminal at the right bank and auxiliary ghats on the left bank were identified for handling passenger and four wheeler traffic in RO-RO mode and are presented below



Sl. No.	Main ghat	Auxiliary ghat	Proposed traffic handling
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4 wheeler
2	Khaboli/Khabolu (Chainage 41.00 km)	Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4 wheeler
3	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Majuli District) (Chainage 27.00 km)	Passenger + 4 wheeler

Master planning

Two sets of amenities (one for right bank terminals and another for the left bank terminals) are designed for the proposed terminals. Based on this a master plan for developing the terminal locations is made. Out of many options considered, two options were found vilable for the project.

Option 1: Floating pontoon quay and access trestle

A floating structure and access system which can be easily shifted to different locations is considered as first option. The floating pontoon is to be anchored to the river bottom, such that the transverse movement of the pontoon is resisted at the same time the anchorage shouldn't have any permanent arrangements. Capital cost estimate without considering dredging of this option is ₹ 470.85 lakhs

Option 2: Employing modular ferry barges

This type of ferries are provided with foldable access ramps of length ranging from 3 to 5m and can serve at any location even without a quay. Advantage of this option is that no special berthing structure is needed for the operation of this vessel. Capital cost estimate without considering dredging of this option is ₹ 413.85 lakhs.

Both the options are economic and will tackle the issue with the bank migration. However, after considering the ease of operation and the comparatively lesser cost, Option 2: Employing modular ferry barges is recommended. Photo of the suggested option is given below.

Details of the terminal and master planning is discussed in Chapter 5 Terminals of the report.

Amenities

All the terminals will have mooring facility for safe mooring of the vessel. As discussed in the terminal section, no permeant berthing structure is suggested for any of the terminals.

The terminals in the right bank of the river is considered as Main terminals and those on the left bank is identified as auxiliary terminal. The main terminal locations will have a main terminal building with office area, resting area, with rest rooms and security. A borehole and an overhead tank are also suggested for the uninterrupted supply of potable water. Auxiliary terminal will have a smaller terminal building with resting area security and toilets. Details of the amenities and the detailed engineering drawings are presented in Chapter 6 Preliminary Engineering Designs.

Buoys are proposed to mark the channel. To help navigation, one set of VHF radio is also suggested for each location.

Vessel Design

The type of vessel suggested to be employed is modular ferry. Optimum dimensions of the vessel need to be identified. The vessel dimensions are arrived primarily based on the horizontal and vertical dimensions of the water way under consideration. The design also considers the safety aspects while manoeuvring in the shallow waters and the availability of local resources. PIANC guidelines were followed for finalising the dimensions of the proposed vessel. The proposed vessel dimension is as follows

Type	**Modular ferry having access ramp for beaching**
Length overall (LOA)	30 m
Beam	7-8m
Draft	1.2m

Details and design basis of the proposed vessel is discussed in Chapter 7 Vessel Design

Phasing and implementation schedule

The project is proposed to be completed in two phases. No fairway development is proposed along the river as no along river transport could be predicted by traffic analysis. Locations identified to be modified during each phase and the proposed development is briefly presented in the following table.

Locations identified for terminals development during Phase I

Sl. No.	Main Ghat	Auxiliary Ghat	Proposed traffic handling	Proposed developments
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4-wheeler	Dredging and developing cross-shore channel to the level of Class II.
2	Khaboli/Khabolu (Chainage 41.00 km	Luit Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4-wheeler	

Locations identified for terminals development during Phase II

Sl. No.	Main Ghat	Auxiliary Ghat	Proposed traffic handling	Proposed developments
1	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Chainage 27.00 km)	Passenger + 4-wheeler	Dredging and developing cross-shore channel to the level of Class II.

All the locations identified for terminal locations are government land. Hence, no settlement will be impacted due to construction of terminals.

IWAI will own the project with no involvement of private sector participant. Private sector participation is restricted to dredging contract during construction period. The option of integrating tourism circuits along the project corridor can also be a source of possible ancillary revenue which can be explored in the subsequent phases.

Implementation schedule of phase I

Sl no	Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Part A: Civil works																		
1	Tendering and awarding of work	■	■	■	■	■													
2	Construction of foundation and substructure for Main/ auxiliary terminal building						■	■											
3	Fabrication of roof truss							■	■										
4	Construction of super structure of buildings and installation of roof								■	■	■								
5	Plumbing, electrification											■	■						
6	Landscaping													■					
7	Dredging											■	■	■	■	■	■		
8	Installation of channel markings																	■	
9	Commissioning																		■
	Part B: Ferry Vessel																		
1	Tendering and awarding of work	■	■	■	■														
2	Tendering, procuring, commissioning, placement and mobilisation of Modular ferry to the site					■	■	■	■	■	■	■	■	■	■	■	■	■	■

Implementation schedule of phase II

Sl no	Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Part A: Civil works																		
1	Tendering and awarding of work																		
2	Construction of foundation and substructure for Main/ auxiliary terminal building																		
3	Fabrication of roof truss																		
4	Construction of super structure of buildings and installation of roof																		
5	Plumbing, electrification																		
6	Landscaping																		
7	Dredging																		
8	Installation of channel markings																		
9	Commissioning																		
	Part B: Ferry Vessel																		
1	Tendering and awarding of work																		
2	Tendering, procuring, commissioning, placement and mobilisation of Modular ferry to the site																		

Project costing

The capital cost of the proposed project envisaged to be implemented in two phases is estimated to be ₹ 8.30 crores. Summary of Capital Expenditure is provided below.

CAPEX				
Sl. No.	**Description**	**Phase I (lakhs)**	**Phase II (lakhs)**	**Total (in lakh Rs)**
I Fairway development				
1	Dredging	₹ 106.26	₹ 293.59	₹ 399.86
2	River training/ Bank protection / embankment strengthening works	₹0	₹ 0	₹ 0
3	Navigation markings / Navigational aids	₹ 2.40	₹ 0.60	₹ 3.00
II Terminals				
I	Terminal Building	₹ 45.26	₹ 22.63	₹ 67.89
II	Waiting Building	₹ 11.97	₹ 5.98	₹ 17.95
III	Navigation and Communication	₹ 5.00	₹ 2.50	₹ 7.50
	VHF Radio			
IV	Auxiliary items	₹ 20.00	₹ 5.00	₹ 25.00
V	Landscaping	₹ 3.00	₹ 1.50	₹ 4.50
VI	Utility shifting	₹ 3.00	₹ 1.50	₹ 4.50
VII	Modular Ferry Vessel	₹ 200.00	₹ 100.00	₹ 300.00
Total (lakhs)		**₹ 396.89**	**₹ 433.3**	**₹ 830.2**
Total (Crores)		**₹ 3.97**	**₹ 4.33**	**₹ 8.30**

Year-by-year breakup of O&M costs is given below.

	Mar-19	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25	Mar-26
OPEX (in Crores)								
Dredging	-	₹ 0.194	₹ 0.155	₹ 0.116	₹ 0.114	₹ 0.097	₹ 0.094	₹ 0.077
Navigation aids	-	₹ 0.074	₹ 0.062	₹ 0.046	₹ 0.046	₹ 0.039	₹ 0.037	₹ 0.031
Civil works		₹ 0.019	₹ 0.015	₹ 0.012	₹ 0.0114	₹ 0.0096	₹ 0.0093	₹ 0.0077
Administrative Cost		₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876
Total Opex		**₹ 0.878**	**₹ 0.8199**	**₹ 0.7618**	**₹ 0.7589**	**₹ 0.7328**	**₹ 0.728**	**₹ 0.704**

Economic and financial analysis

The financial feasibility of the project has been determined in the form of Net Present Value (NPV) of pre-tax cash flows projected up to 2049.

Two scenarios have been considered for financial analysis

- Scenario 1: Current tariff structure (as per IWAI guidelines published in 2011)
- Scenario 2: Proposed tariff structure (as per proposed revised tariffs)

The tariff structure for passenger and vehicles for each terminal has been separately captured. Accordingly the projections are made with 80% capacity utilisation and a sensitivity to capture the variations in capacity utilisation has been built in the financial model. The project has been structured in two (2) phases with a minimal interval of 6 months. The revenue from the operational activities of phase 1 is considered to be commencing from 11 months onwards and that of phase II has been captured from 17th month onwards.

The total operation expense over a period of 30 years is estimated to be ~ Rs.78 Cr. The project is structured in a way that, the authority is operating the ferry service directly. Based on the financial projections it is observed that, the cashflow has turned out to be positive over a period of 14 years.

Based on the financial analysis, FIRR stands 8.68% which is quite acceptable.

Economic feasibility analysis is carried out by assessing the economic cost and benefits and the socio-economic impacts in ‘without’ and ‘with’ project.

EIRR is found out after analyzing positive and negative costs to the society over next 23 years (up to 2040) due to the project using discount cash flow techniques.

Case 1 -EIRR with only direct benefits of saving in trip time by passengers and vehicles and increase in farm income = 4.09%

Case 2-EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output = 20.09 %

Case 3- EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output and long-term benefits due to increase in land value = 52.49 %

Details of this chapter is discussed chapter 13 Economic and financial analysis of this volume.

1 Chapter 1: Introduction

1.1 Project Background

Inland Waterway Transport (IWT) is generally acknowledged as a clean, safe, and most energy efficient mode of transport when compared to land-based systems, which are often confronted with congestion and capacity problems. IWT is a competitive alternative and addition to road and rail transport, offering a sustainable and environment-friendly mode of transport in terms of energy consumption, noise and gas emissions. IWT is also often the most economical inland transport mode due to low infrastructure and external costs – a characteristic of crucial importance. However, IWT is often still under-used and suffers from infrastructure, institutional, legal and technical barriers. In order to keep in pace with the latest advancements in the navigation and cargo handling systems and to flawlessly operate a state-of-the-art transportation system, timely maintenance and upgradation to the latest technologies and practices are necessary.

Government of India intends to develop 111 Inland Rivers on an immediate and long term basis to bring back its lost glory, and hence planned to conduct a Feasibility Study and recommending thereafter the possibility of preparing the DPR to achieve navigation and to develop water transport facilities in Cluster regions.

As part of this, Inland Waterway Authority of India (IWAI) awarded DHI (India) Water and Environment Pvt Ltd. the contract to prepare Detailed Project Report (DPR) for Subansiri River (NW 95) for developing it into a navigable waterway.

The Detailed Project Report for Subansiri River (NW 95) is presented in 3 Volumes:

Volume # 1: DPR (Present Report)

Volume # 2: Detailed Engineering Drawings

Volume # 3: Detailed Hydrography Survey Report and Survey Charts

1.2 Project Location / Details of Study Area

Subansiri River, better known as the "Gold River" is the largest tributary of the Brahmaputra River. Subansiri flows through the states of Arunachal Pradesh and Assam located in the NorthEast part of India (Figure 1.1). It joins the mighty Brahmaputra at the mystic confluence of Majuli Island, which is the largest inhabited river island in the world. Subansiri River flows through the difficult terrain with vertical rock faces. This is one of the fast-flowing and adrenal-pumping rivers set in a scenic breath-taking environment. The Subansiri is 442 km long, with a drainage basin of 32,640 km^2. It contributes 7.92% of the Brahmaputra's total flow. Subansiri in Assam flowed by touching northern boundary of Jorhat district, Lakhimpur district and northeastern boundary of Dhemaji district. The river maintains a stable course in the upstream before entering Assam, and then it becomes unstable. The riverbed mainly consists of gravel, silt and sand in the survey area. Subansiri is the lifeline of the people of Lakhimpur and Dhemaji districts. Subansiri provides diverse habitat in its downstream for living biota such as stream, riparian zones wetlands etc. The wetlands are ecologically and economically important for the local people. Fishing in Subansiri is very famous among the people.

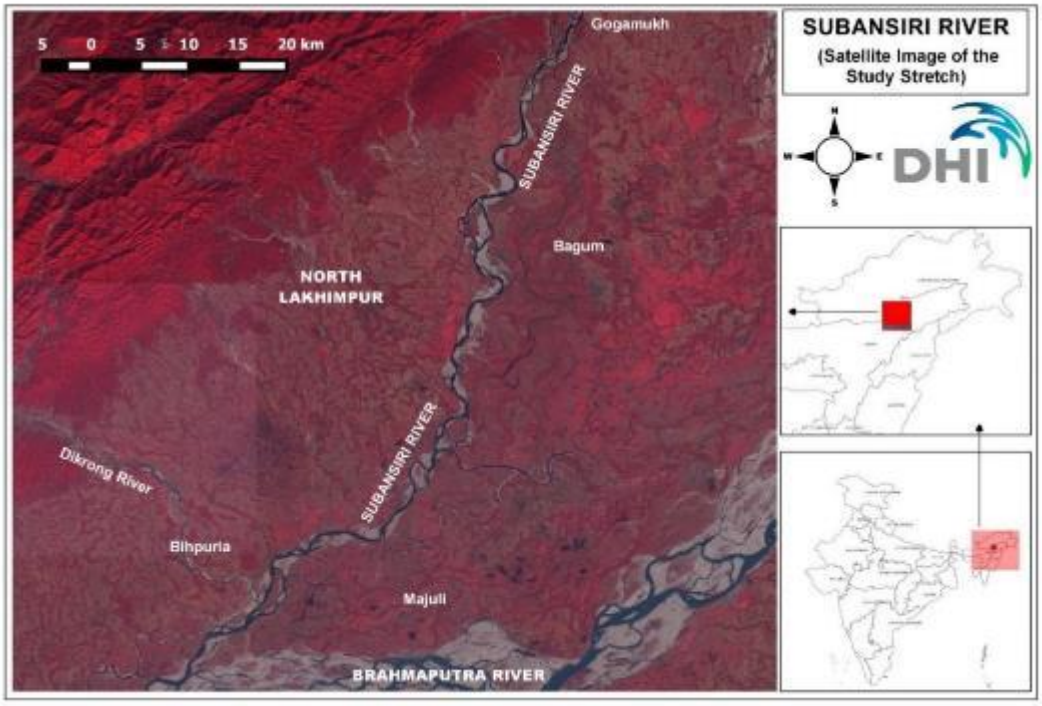


Figure 1.1 Location map of Subansiri River

1.2.1 Tributaries of Subansiri River

There are no major tributaries along the study stretch of the Subansiri River. However, at the upstream part there are two major tributaries, which are given below.

Kamla River

The upper part of the catchment is covered with snow clad mountains & glaciers, barren & rocky waste land. Most part of the catchment of Kamla River is covered with semi-dense mixed subtropical, semi evergreen forest. Confluence point with Subansiri: near Rachrath village.

Kurung River

The upper part of the catchment is covered with snow clad mountains & glaciers, barren rocky, waste land. Most part of the Catchment is covered with semi-dense, mixed subtropical & semi evergreen forest. Confluence point with Subansiri: Near Rai and Bao village.

1.2.2 State/District through which the River passes

The Subansiri River stretch flows through Assam state. Almost all the area of the river under consideration is in North Lakhimpur district. However, in the downstream end (i.e. near Brahmaputra confluence), a small portion is in Golaghat district. Jorhat and Dhemaji districts also touches the river at south and northeast part respectively of the study area.

1.3 Brief Scope of Work and Compliance statement

Detailed TOR is attached as Annexure A.

Sl No	Scope	Compliance
a	Assessment of the morphological, hydrological, hydrographical conditions, andoperation and maintenance requirements of the proposed waterways to identify works in sufficient details that are required in respect of: • River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation. • Navigational aids and communication facilities. • Improvements with reference to horizontal and vertical clearances required on the existing or proposed cross structures such as bridges, power cables, locks etc.	✓
b	Geo-technical investigation will be carried out by the consultant as per standard guidelines of Geological Survey of India, Government of India.	✗
c	To conduct necessary investigations for the preliminary design, to ensure a coordinated development to cover waterways engineering works and structures, waterway crossing, navigational structures, riverine ports and terminals, land and rail access.	✓
d	Prepare preliminary engineering designs, drawings and estimates for the optimum structure of river training and bank protection measures and navigational aids to develop and maintain a navigable channel for the waterway system in an EPC mode.	✓
e	For preliminary engineering designs, the data about soil characteristics shall be collected from the local sources based on the structures constructed nearby. In case of critical structures, consultant can suggest the detailed soil investigation including borehole tests etc.	✓
f	River training/bank protection works particularly for those stretches where either the channel is narrow and needs to be widened by dredging or where it is anticipated that the bank can erode due to continuous movement of barges.	✓
g	Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.	✓
h	Prepare a realistic construction schedule for the whole project indicating the priority of different components of the project. The phasing of expenditure is also to be worked out. Also suggest phased programs of construction including riverine terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities.	✓
i	Prepare cost estimate for various possible alternatives for the entire proposed infrastructure, handling, and other allied facilities. While comparing the different alternatives, the cost and economy factors shall also be evaluated. The most suitable alternative recommended shall have detailed costing for all the components of the project. The Consultant is to propose the River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation. Alternate possible methods for water	✓

	augmentation are also to be suggested in detail. FIRR, EIRR, NPV and SWOT analysis are also to be carried out by the Consultant.	
j	Assess the environmental impacts due to these development works and suggest suitable environmental management plan (EMP) to mitigate the adverse impacts, if any, including its cost. Flood Plain specialist will be responsible to assess the Environmental Impact and preparation of EMP. Consultant has to identify the Authorities who will give the clearances for EIA/EMP. Consultant will not be required to take clearances from these identified Authorities.	✓
k	Suggest horizontal and vertical clearances to be provided on cross structure such as bridges, power cables, locks etc. for commercial viable navigation in present as well as in future. For this, IWAI guidelines Section-IV, may also be referred to.	✓

2 Chapter 2: Waterway / Detailed Hydrographic Survey

2.1 Hydrographic Survey

2.1.1 Waterway in General and Hydro-morphological Characteristics

The survey stretch is 106.452 km starting from the Brahmaputra Confluence to Chauldhowa Ghat. The entire stretch of the river is non-tidal. Major inferences derived from the detailed hydrographic survey are summarised in the following sections.

There are no dams, barrages, weirs, anicut, locks or aqueduct present along the proposed stretch of this Subansiri River. There are four cross structures along the survey stretch of this River. The two bridges present in the waterway are at the upstream end of the proposed waterway and hence do not pose any hindrance to navigation. The minimum vertical clearance is 3.6 m w.r.t. HFL and the minimum horizontal clearance is about 45 m. There are two high tension lines (ch 40.4 km and ch105.5 km) along the proposed stretch. The minimum vertical clearance is 12.5 m and horizontal clearance is 400m. There are no major hindrances except for the presence of gravel with comparatively steep gradient between Chainage 104 and 106 km. Any protected or sensitive area could not be located along the entire stretch. Good water availability throughout the year is expected in this river. The flood period is from April to August and the lean period is September to March.

During lean season, about 15 major and minor ferry services are in operation along the survey stretch by Inland Waterways Transport, Govt. of Assam and private firms. The right bank of the river is moderately connected by roads than the left bank. The settlements are mostly along the right bank of the river; whereas the left bank is sparsely populated. It was observed that there is a good scope for developing tourism along the proposed stretch of Subansiri. The riverbed of Subansiri is mainly sandy in nature. Isolated small-scale sand/Gravel mining by the local people was noticed during the survey. Both the banks of the river have farming practice. Encroachment was observed in many parts of the riverbanks. The water flow is not obstructed anywhere in the entire stretch. The average water velocity during the survey period was found to be about 0.80 m/s. During the survey period, the depth of the river was between 0.3 to 13.3m.

Analysis of the satellite image and observation during the hydrogaphic survey, it was noticed that the river is highly braided in nature. The river often get divided into various channels and sand bars and islnads are formed at various places. Braided rivers are formed usually where water flow is slow and sediment load carried by the river is high. This can cause changes in the direction of the river and create new channels. The average slopes at various subsections of the river as observed during the detailed hydrographic survey is presented in table 2.1

Table 2.1 Average bed slope observed during detailed hydrographic survey

Chainage at BMs (km)		Water Level w.r.t MSL (m)		Distance Between BM's (km)	Height Difference (m)	Average slope
From	To	From	To			
-8.4	-1.6	73.57	74.13	6.8	0.562	1:12100
-1.6	11	74.13	76.22	12.6	2.081	4.277778
11	23	76.22	77.41	12	1.197	1:10000

Chainage at BMs (km)		Water Level w.r.t MSL (m)		Distance Between BM's (km)	Height Difference (m)	Average slope
From	To	From	To			
23	33	77.41	78.23	10	0.815	1:12300
33	42.2	78.23	79.66	9.2	1.435	4.486111
42.2	43.6	79.66	81.83	1.4	2.168	0.458333
43.6	64.2	81.83	83.10	20.6	1.269	1:16200
64.2	75	83.10	84.79	10.8	1.689	4.486111
75	83.9	84.79	86.91	8.9	2.118	2.958333
83.9	94.7	86.91	88.17	10.8	1.268	5.944444
94.7	105.8	88.17	74.13	11.1	5.167	1.5

The river meets Brahmaputra near zero chainage. Sediments carried by Subansiri and Brahmaputra pose complications at the confluence and the morphodynamics of both the rivers are highly complicated at this location. However, the channels present in this region show larger depths. All the channels present near the confluence have and average depth of more than 2m. regions with 10m depths were also observed during the survey. Sediment movement at this region often create problems in NW 2 (Brahmaputra River) as they create deltaic features along the region. Therfore for effective longitudinal connectivity of Subansiri with the Brahmaputra River specific studies including 2D numerical modelling may have to be carried out for developing and maintaining navigation channel with 2 m depth in a sustainable manner on this confluence.

2.1.2 Existing Reference levels

2.1.2.1 Topographical reference Level

Vertical control established at Chauldhowa Ghat by CWC, Govt. of India was taken as the reference level and the same RL was used as origin of survey with vertical value as 100.650 m w.r.t. MSL and the same was considered for calculating the vertical levels. The Levels were transferred from the zero of tide pole to the gauge station. Details are discussed in the hydrographic survey report submitted along with this report.

2.1.2.2 Hydrographical reference level

CWC data provided by IWAI was used as the hydrological reference level. The details are discussed in the detailed hydrographic survey report.

2.1.3 Chart Datum / Sounding Datum

IWAI had provided Sounding Datum at Chauldhowa Ghat, Badothi Ghat and at the confluence with Brahmaputra River. The same was used to calculate the sounding datum values at BM Pillars and at tide gauges. The sounding datum was derived from the CWC data available. As the slope in the area is high, the data is interpolated within two CWC gauges and ratio for per Km is derived. Average of 06 years minimum Water Levels were used to arrive at Chart Datum (CD) / Sounding Datum (SD). The water level and discharge at Chauldhowa Ghat is available from 1983. The Chart datum at the gauge is 91.63m above sounding Datum.

The details are given in the Hydrographic Survey Report (Volume # IIIA).

Table 2.2 Chart Datum / Sounding Datum and Reductions details

SL. No.	Stations	Location	Chainage (km)	Stretch for corrected sounding and topo levels	Established Sounding datum (MSL)	Sounding Datum at tide gauge w.r.t MSL (m)	Correction in water level (m)
1	SBM 12	Jamuguri	-8.4	-8.4 to -5.0			**Details in Volume IIIA**
2.	SBM 11	Tintia	-1.6	-5.0 to 4.7		73.64	
3.	CWC		0		73.64		
4.	SBM 10	Badothighat	11	4.7 to 17.0		75.9	
5.	CWC	Badatighat	12.6		77.03		
6.	SBM 9	Bhalukhaguri	23	17.0-28.0		77.1	
7.	SBM 8	Bhoginiya ghat	33	28.01-37.6		77.91	
8.	SBM 7	Kabhuli Ghat	42.2	37.61-47.9		79.25	
9.	SBM 6	Kagha	53.6	47.91-58.9		81.52	
10.	SBM 5	Mohaijan	64.2	58.91-69.6		82.53	
11.	SBM 4	Sunaval	75	69.6-79.45		84.47	
12.	SBM 3	Bhimpara	83.9	79.45-89.3		86.57	

SL. No.	Stations	Location	Chainage (km)	Stretch for corrected sounding and topo levels	Established Sounding datum (MSL)	Sounding Datum at tide gauge w.r.t MSL (m)	Correction in water level (m)
13.	SBM 2	Katari Chapari	94.7	89.3-100.25		87.84	
14.	CWC	Chouldhowaghat	105		91.63		
15.	SBM 1	Chauldhowa	105.8	100.26-end		91.63	

2.2 Existing Cross Structures

2.2.1 Bridges

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		No of Piers	Horizontal clearance (clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks
					Left Bank	**Right Bank**				
1	Bridge Highway (Road)	105.4	RCC Road Bridge (NH 52)	Chawoldhowa	Lat: 27°26'47.18"N Long: 94°15'27.13"E	Lat: 27°26'55.86"N Long: 94°14'59.11"E	18	45	4.4	Completed in Use
2	Bridge (Railway)	105.8	Girder Steel Bridge	Chawoldhowa	Lat: 27°26'57.92"N Long: 94°15'33.17"E	Lat: 27°27'6.83"N Long: 94°15'4.76"E	13	60.5	3.6	Completed in Use

2.2.2 Electric Lines / Communication Lines

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		No of Piers	Horizontal clearance(clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS	Remarks (complete / under - construction), in use or not, condition
					Left Bank	**Right Bank**				
1	HTPL Line	105.5	High Tension Power Line	Chawol Dhowa	Lat: 27°26'50.14"N Long: 94°15'27.67"E	Lat: 27°26'58.11"N Long: 94°15'1.17"E	-	980 m	13.9	Completed in Use
2	HTPL Line	40.4	High Tension Power Line	Kabhuli Ghat	Lat: 27° 2'29.15"N Long: 94° 7'45.52"E	Lat: 27° 2'38.57"N Long: 94° 7'10.23"E	2	400 m	12.5	Completed in Use

2.3 Velocity and Discharge Details

The data was collected between 17th November 2016 and 5th January 2017

Stretch No.	Chainage (km)	Position		Observed Depth (m)	Average Velocity (m/sec)	X-Sectional area (sq. m.)	Discharge (Cum/s)
		Latitude	**Longitude**				
1	104.3	27°26'28.9559"N	094°14'42.5565"E	2.0	1.72	93.0	159.96
2	94.3	27°22'38.3252"N	094°12'57.8886"E	2.2	0.86	125	107.5
3	83.6	27°19'36.2263"N	094°12'41.4476"E	6.0	0.73	222	162.06
4	74.6	27°15'43.3594"N	094°12'07.5158"E	3.0	0.91	102.5	93.27
5	64.2	27°12'01.2061"N	094°11'02.8603"E	3.0	0.89	247.5	220.27
6	55.7	27°08'00.7019"N	094°11'08.6046"E	2.0	0.88	189.25	166.54
7	41.3	27°02'45.0970"N	094°07'46.8600"E	2.5	0.91	145	131.95
8	33	27°01'39.8573"N	094°04'39.0685"E	6.5	0.9	166.25	149.62
9	22.5	26°59'02.1701"N	094°00'30.6920"E	2.5	0.98	172.5	169.05
10	10.9	26°55'54.4586"N	093°56'52.5083"E	3.0	0.83	231.62	192.24
11	4.8	26°53'22.4126"N	093°55'55.5155"E	7.5	0.9	596.25	536.62

2.4 Waterway description

The proposed Subansiri River can be broadly divided in to eleven stretches in accordance with the gradient of the river. The details of all the stretches are provided in the following sections. The minimum and maximum depths provided in the following sections were obtained by analysing the observed and reduced depths of various sections

2.4.1 Sub Stretch 1: Chainage 0 km to 4.7 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 0 km to 4.7 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and auto level on the riverbanks, sandbars and at shallow water patches from Chainage 0 km to 4.7 km.

Class	Chainage (km)		Observed (17 Nov to 28 Dec 2016)			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	0	4.7	0.5	7.4	1200	0.3	6.4	1000
II					1400			1800
III					1800			2000
IV					2200			0

2.4.1.1 Description of Sub-Stretch 1 (Chainage 0 km to 4.7 km)

This stretch is the downstream portion of the Subansiri river where the river meets with Brahmaputra River is considerably wide. The agricultural fields in the area largely depend on this river for irrigation. There are no overhead obstructions/crossovers in this stretch. There is no ferry service along this stretch of the River. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.1 m and 7.7 m respectively. The average width of the river along this stretch is about 1000 m and the width of water spread is around 400 m. The average discharge in this stretch is 600 m^3/s.

Condition of River banks

The riverbanks in this stretch are unprotected as the riverbanks are highly dynamic and hence is constantly changing due to floods of very high magnitude, channel widening, and change in channel pattern and of riverbank erosion.

Encroachment to the waterway

Encroachments on the riverbanks by the local village people for agriculture purpose was noticed along this stretch. However these encroachments are of seasonal nature.

NH/SH/MDR within 5 km

No major roads such as NH/SH were observed within 5 km from this stretch. The National Highways NH52 is 6 km away on the right bank side. Local village road connects this region with the NH.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river was observed.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Prominent city/town/place of worship/historical place for tourism

Narayanpur is one of the major town exists within 10 km on the right bank side of the river stretch. No other major city, place of worship and historical place of tourism is present along this stretch.

Village colonies along the sub-stretch and approximate population

Jamuguri, Latabari and Anubori are the important villages present on the right bank of the river with an approximate population of about 1500.

Tributaries

This stretch is at the downstream portion of the Subansiri River where it is confluencing with Brahmaputra River. No tributaries are present along this stretch.

Usage of water & water quality

Water used for domestic purpose and for irrigatingthe agricultural land. Water quality is good.

2.4.2 Sub Stretch 2: Chainage 4.7 km to17.0 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 4.7 km to 17.0 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, total station and auto level on the river banks, sandbars and at shallow water patches of the river stretch from Chainage 4.7 km to 17.0 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	4.7	17	0.5	13.3	2400	0.3	12.3	2600
II					3000			3000
III					3800			4000
IV					6800			7000

2.4.2.1 Description of Sub-Stretch 2 (Chainage 4.7 km to 17.0 km)

Stretch is between CH 4.7 km to CH 17.0 km of the Subansiri River. The maximum width at CH 9.4 km is around 2500 m. There are two ferry services operated in this stretch viz; Badothi Ghat (CH 13.4 km) and Jamuguri ghat (CH 7.6 km). Fishing activity seems to be active in this stretch as broken logs and fishing nets were noticed in this stretch. At CH 6.5 km, Subansiri River starts to merge with Brahmaputra. The nearest villages Badothighat and Jamuguri are located on the right bank. The average water velocity in this stretch is

about 0.85 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 13.0 m respectively. The average width of the stretch is about 1000 m and the water spread width is around 300 m. The average discharge in this stretch is 200 m^3/s.

Condition of River banks

The riverbanks in this stretch are unprotected as the river banks are constantly changing due to flood of very high magnitude, channel widening, and change in channel pattern and riverbank erosion.

Encroachment to the waterway

Encroachments on the riverbanks by the local village people for agriculture purpose was noticed. However, these encroachments are of seasonal nature.

NH/SH/MDR within 5 km

There are no major roads such as NH or SH within 5 km from the waterway. The National Highways is NH52, which is 7 km away from the waterway on the right bank and is connected by local village road.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Prominent city/town/place of worship/historical place for tourism

Narayanpur is one of the major town exists at 10 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism.

Village colonies along the sub-stretch and approximate population

Badothighat, Jamuguri are the important villages present on the right bank of the river with approximate population of about 3000 members.

Available of passenger ferry service

There are two ferry services operated in this stretch, one is at Badothi ghat operated at CH 13.4 km and another is Jamuguri ghat operated at CH 7.6 km.

Usage of water & water quality

Water used for domestic purpose and some extend for agricultural land. Water quality is good.

2.4.3 Sub Stretch 3: Chainage 17.0 km to 28.0 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 17.0 km to 28.0 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 17.0 km to 28.0 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	17	28	0.5	11.2	2400	0.3	10.2	2600
II					3000			3000
III					3800			4000
IV					6800			7000

2.4.3.1 Description of Sub-Stretch 3 (Chainage 17.0 km to 28.0 km)

Stretch is between CH 17.0 km to CH 28.0 km of the Subansiri River. The maximum width in this stretch is at CH 20.0 km is around 2600 m. Fishing activity seems to be less in this stretch. Broken logs and fishing nets were noticed in this stretch. The nearest villages are Dhunabhari, Bhalughaguri and Badothi ghat located on the right bank and Senimora located on the left bank of the river. Ruined building was there at CH 21.2 km on the left bank of the river. The average water velocity in this stretch is about 1.0 m/s during the

survey period. The minimum and maximum reduced depth is 0.2 m and 10.9 m respectively. The average width of the water spread is around 150 m. The average discharge in this stretch is 300 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed by means of flood of very high magnitude, channel widening, and change in channel pattern and of river bank erosion. Near Dhunabari ghat the shore was protected for about 100 to 200 m by means of concrete triangle shaped structure known as jetty or porcupine. Major erosion observed near Senimora ghat and Dhunabhari ghat.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people used for agriculture purpose.

NH/SH/MDR within 5 km

No major road link such as NH/SH with in 5 km from the waterway. The National Highways is NH52 & SH 43 which is 9 km away from the waterway on the western side connected the village by local village road.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals, jetties. There are three number of ferry services operated in this stretch, one is Dhunabhari ghat operated at CH 25.2 km, Senimora ghat operated at CH 23.4 km and Badothi ghat No.2 is operated at CH 17.8 km.

Prominent city/town/place of worship/historical place for tourism

Bhipuria is one of the major town exists at 10 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism.

Village colonies along the sub-stretch and approximate population

Dunabharigaon, Senimoreghat and Bhalukhaguri are the important villages present on the right bank of the river with approximate population of about 5000 members.

Available of passenger ferry service

There are three number of ferry services operated in this stretch, one is Dhunabhari ghat operated at CH 25.2 km, Senimora ghat operated at CH 23.4 km and Badothi ghat No.2 is operated at CH 17.8 km.

Fishing activities

Fishing activity seems to be active in this stretch at Dhunabhari.

Tributaries

River Kaniyajan joining Subansiri at 22.4 km Chainage on the left bank and River Dikrong joining with Subansiri at Chainage 18.6 km on the right bank of the river.

Usage of water & water quality

Water used for domestic purpose and some extend for agricultural land. Water quality is good.

2.4.4 Sub Stretch 4: Chainage 28.0 km to 37.6 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 28.0 km to 37.6 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 28.0 km to 37.6 km km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	28.0	37.6	0.5	9.0	2600	0.3	8.3	2800
II					3400			3400
III					5000			5000
IV					6800			6600

2.4.4.1 Description of Sub-Stretch 4 (Chainage 28.0 km to 37.6 km)

Stretch is between CH 28.0 km to CH 37.6 km of the Subansiri River. The maximum width at CH 35.2 km is around 2500 m and minimum width at CH 33.2 is around 1450 m.

Agriculture combined with fishing is the main occupation along the stretch. There are no overhead obstructions/crossovers in this stretch. Bhoginiya ghat is the only ferry services operated in this stretch at CH 33.2 km. The nearest villages are Puma and Dhunabharigaon on the right bank. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 10.6 m respectively. The average width of the water spread is around 300 m. The average discharge in this stretch is 500 m^3/s.

Condition of Riverbanks

The major stretch of the river are unprotected as the River banks are constantly being changed by means of flood of very high magnitude, channel widening, and change in channel pattern and river bank erosion.

Encroachment to the waterway

Encroachment on the river banks along this stretch was observed mainly for agriculture purpose.

NH/SH/MDR within 5 km

No major road link such as NH/SH with in 5 km from the waterway. The National Highways is NH52 & SH 43 which is 15 km away from the waterway on the western side connected the village by local village road.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals, jetties. Bhoginiya ghat is the only ferry services operated in this stretch at CH 33.2 km.

Prominent city/town/place of worship/historical place for tourism

Bangalmora is one of the major town exists at 12 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism.

Village colonies along the sub-stretch and approximate population

Solmara, Hastnapur are the important villages with approximate population of about 1200 members.

Available of passenger ferry service

Bhoginiya ghat is the only ferry services operated in this stretch at CH 33.2 km.

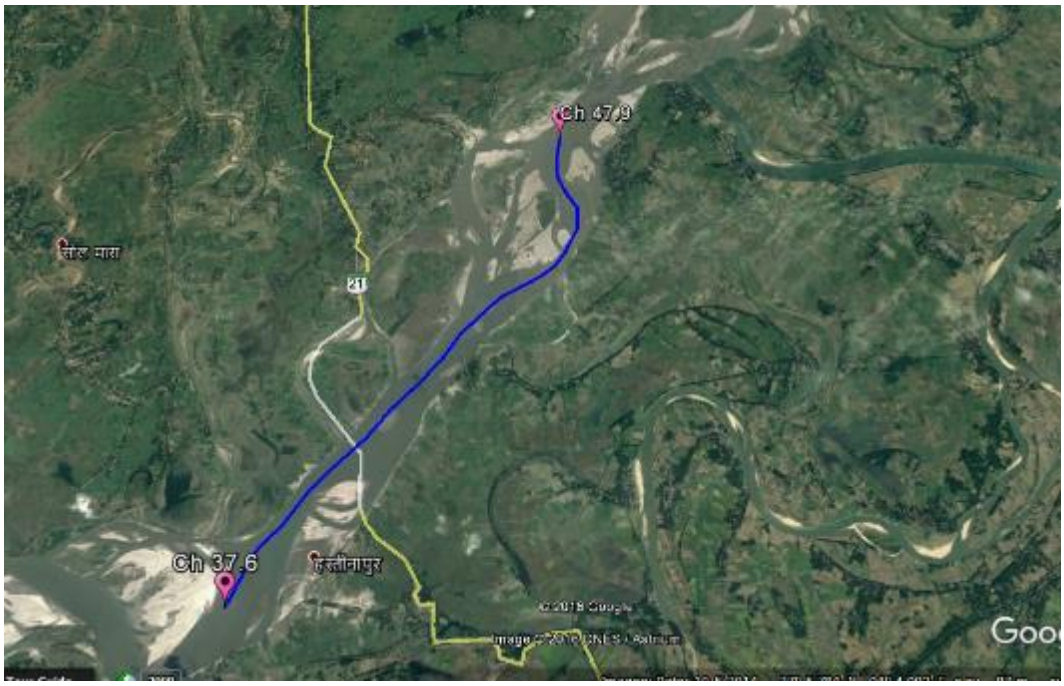
Fishing activities

Fishing activity seems to be less in this stretch at Bhoginiya ghat.

Usage of water & water quality

Water used for domestic purpose and some extent for agricultural land. Water quality is good.

2.4.5 Sub Stretch 5: Chainage 37.6 km to 47.9 km



Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 37.6 km to 47.9 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 37.6 km 47.9 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	37.6	47.9	0.3	11.5	7000	0.3	10.5	7000
II					7200			7800
III					7200			8000
IV					9000			8800

2.4.5.1 Description of Sub-Stretch 5 (Chainage 37.6 km to 47.9 km)

Stretch is between CH 37.6 km to CH 47.9 km of the Subansiri River. The maximum width at CH 44.5 km is around 2750 m. Agriculture fields mainly paddy and vegetables were noticed on the both banks of the river which largely depend on this river for irrigation. High Tension Line (HTL) passes across this river in this stretch at CH 40.4 km. A ferry service was operated at Kabhuli ghat in this stretch at CH 41.4 km and this connects the both bank and state highway SH22. Fishing activity seems to be active in this stretch. Broken logs

and fishing nets were noticed in this stretch. The nearest village is Panigaon located on the right bank. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.1 m and 6.8 m respectively. The average width of the water spread is around 500 m. The average discharge in this stretch is 600 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed by means of flood of very high magnitude, channel widening, and change in channel pattern and of river bank erosion.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people used for agriculture purpose.

NH/SH/MDR within 5 km

State Highway (SH21) which connects Panigaon and Khabhuli ghat.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals, jetties. A ferry service was operated at Kabhuli ghat in this stretch at CH 41.4 km and this connects the both bank and state highway SH22.

Prominent city/town/place of worship/historical place for tourism

Panigaon is one of the major town exists at 2 km on the north-western side of the river stretch. North Lakhimpur district headquarters lies about 20 km on the northwestern side of the river.

Village colonies along the sub-stretch and approximate population

Panigaon, Khabhuli ghat are the important villages with approximate population of about 1000 members.

Available of passenger ferry service

Ferry service was operated at Kabhuli ghat in this stretch at CH 41.4 km and this connects the both bank and state highway SH22.

Fishing activities

Fishing activity seems to be less in this stretch at Kabhuli ghat.

Tributaries

Khabhuli river joins Subansiri at chainage 38.2 km.

Usage of water & water quality

Water used for domestic purpose and some extend for agricultural land. Water quality is good.

Photos and details of cross structures

High Tension Line (HTL) passes across this river in this stretch at CH 40.4 km.

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		No of Piers	Horizontal clearance(clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS	Remarks (complete / under - construction), in use or not, condition
					Left Bank	**Right Bank**				
1	HTPL Line	40.4	High Tension Power Line	Kabhuli Ghat	Lat: 27° 2'29.15"N Long: 94° 7'45.52"E	Lat: 27° 2'38.57"N Long: 94° 7'10.23"E	2	400 m	12.5	Completed in Use

Figure 2.1 High Tension Line at CH 40.4 km – Kabhulighat

2.4.6 Sub Stretch 6: Chainage 47.9 km to 58.9 km

Bathymetry Survey

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 47.9 km to 58.9 km.

Topographic Survey

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 47.9 km to 58.9 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	47.9	58.9	0.9	9.1	4200	0.3	8.1	4600
II					5000			5200
III					6000			6200
IV					7200			7800

2.4.6.1 Description of Sub-Stretch 6 (Chainage 47.9 km to 58.9 km)

Stretch is between CH 47.9 km to CH 58.9 km of the Subansiri River. The maximum width at CH 62.5 km is around 4250 m. Agriculture fields mainly paddy and vegetables were noticed on the both banks of the river which largely depend on this river for irrigation. Sparse patches of forest on the left bank. There are no overhead obstructions/crossovers in this stretch. There are two ferry services operated in this stretch, one is Esserakatta operated at CH 56.2 km and another is Nuvalibhali ghat operated at CH 49.4 km. Fishing

activity seems to be less in this stretch. Broken logs and fishing nets were noticed in this stretch. The nearest villages are Khagha and Bhalighat located on the right bank. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 11.3 m respectively. The average width of the water spread is around 350 m. The average discharge in this stretch is 600 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed by means of flood of very high magnitude, channel widening, and change in channel pattern and of river bank erosion.

Hindrance for Navigation

There is so hindrance such ad water fall, rocks, steep gradient, sanctuaries, forests, fishing nets etc.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people used for agriculture purpose.

NH/SH/MDR within 5 km

State Highway (SH21) is 6 km away from the river stretch on the right bank.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals, jetties. There are two ferry services operated in this stretch, one is Esserakatta operated at CH 56.2 km and another is Nuvalibhali ghat operated at CH 49.4 km.

Prominent city/town/place of worship/historical place for tourism

Panigaon is one of the major town exists at 7 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism.

Village colonies along the sub-stretch and approximate population

Kagha and Bhalighat are the important villages with approximate population of about 2500 members.

Availability of passenger ferry service

There are two ferry services operated in this stretch, one is Esserakatta operated at CH 56.2 km and another is Nuvalibhali ghat operated at CH 49.4 km.

Fishing activities

Fishing activity seems to be less in this stretch.

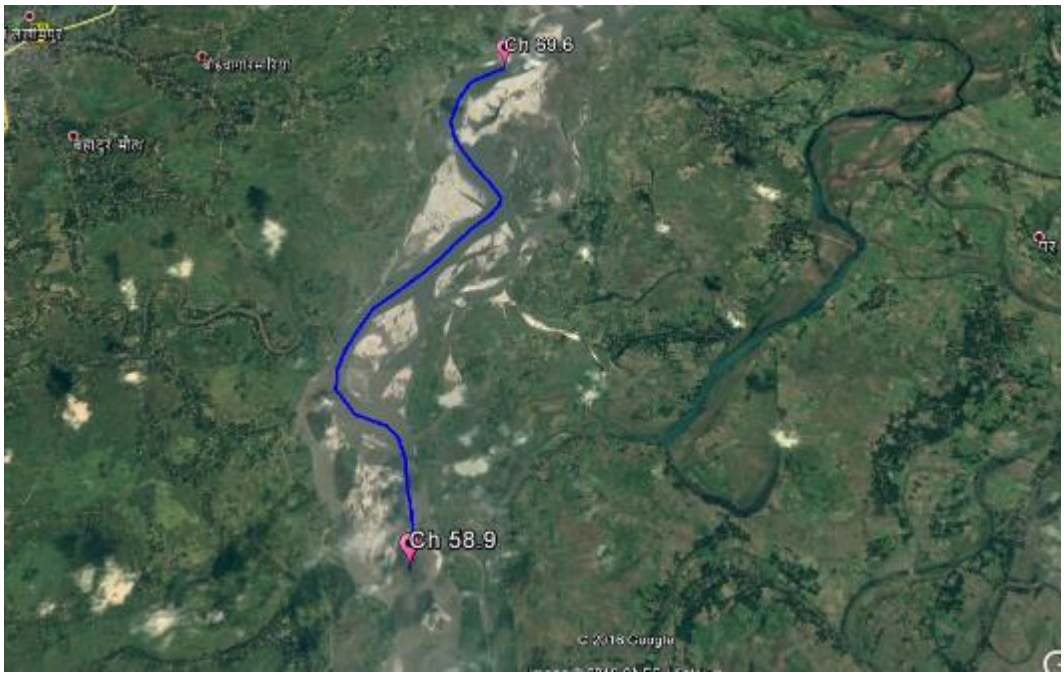
Tributaries

Kerkatta river joins Subansiri at Chainage 51.0 km.

Usage of water & water quality

Water used for domestic purpose and some extend for agricultural land. Water quality is good.

2.4.7 Sub Stretch 7: Chainage 58.9 km to 69.6 km



Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 58.9 km to 69.6 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 58.9 km to 69.6 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	58.9	69.6	0.5	7.4	5600	0.3	6.36	5400
II					6000			6600
III					6200			7600
IV					7600			8000

2.4.7.1 Description of Sub-Stretch 7 (Chainage 58.9 km to 69.6 km)

This stretch is between CH 58.9 km and CH 69.6 km of the Subansiri River. The average width of the river in this stretch is about 2000 m. Agriculture fields mainly with paddy and vegetables were noticed on the both banks of the river which largely depend on this river for irrigation. Sparse patches of forest on the left bank were vissible. There are no overhead obstructions/crossovers in this stretch. There is one ferry service on this stretch

called Ghagar ghat operated at CH 68.0 km. Fishing activity seems to be active in this stretch. Wooden logs and fishing nets were noticed in this stretch. On the other hand a sunken boat was found at CH 61.9 km. The nearest village is Ghagar. The minimum and maximum reduced depth is 0.0 m and 8.6 m respectively. The average width of the water spread is around 250 m. The average water velocity in this stretch is about 0.9 m/s during the survey period. The average discharge in this stretch is 575 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed due to flood of very high magnitude, channel widening, and change in channel pattern and of river bank erosion.

Hindrance for Navigation

There is so hindrance such as water fall, rocks, steep gradient, sanctuaries, forests, fishing nets etc.

Encroachment to the waterway

Encroachment was seen on the river banks along the stretch by the local village people used for agriculture purpose.

NH/SH/MDR within 5 km

There are no major road link such as NH/SH with in 5 km from the waterway. The National Highways is NH52 which is 8 km away from the waterway on the western side is connected to the village by a local village road.

Railway line and stations

No rail connectivity in the vicinity was seen. The nearby railway station is North Lakhimpur which is 10 km away from this river stretch.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals and jetties are present in the area. There is one ferry service on this stretch called Ghagar ghat operated at CH 68.0 km.

Prominent city/town/place of worship/historical place for tourism

North Lakhimpur is the major town that is located at 8 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism exist in the area.

Village colonies along the sub-stretch and approximate population

Ghagar, Hindu and Palsapara are the important villages with approximate population of about 3000 members.

Fishing activities

Fishing activity seems to be less in this stretch.

Usage of water & water quality

Water is mostly used for domestic purpose and to some extent for agricultural land. Water quality is good.

2.4.8 Sub Stretch 8: Chainage 69.6 km to 79.5 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 69.6 km to 79.5 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 69.6 km to 79.5

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	69.6	79.5	0.5	10.7	2000	0.2	9.7	2400
II					3000			3400
III					4800			5000
IV					6400			7000

2.4.8.1 Description of Sub-Stretch 8 (Chainage 69.6 km to 79.5 km)

Stretch is between CH 69.6 km to CH 79.5 km of the Subansiri River. The average width of the river in this stretch is about 2000 m. Agriculture fields with paddy and vegetables were noticed on the both banks of the river which largely depend on this river for irrigation. There are no overhead obstructions/crossovers in this stretch. There are two ferry services on this stretch, one is Dhurgighat operated at CH 74.2 km and another is Hathiyamara ghat operated at CH 73.6 km. Fishing activity seems to be less in this stretch. Wooden

logs were noticed in this stretch. The nearest villages are Badagara, Sunavalgaon and Ghagar. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 10.4 m respectively. The average width of the water spread is around 200 m. The average discharge in this stretch is 400 m^3/s.

Condition of River banks

The major stretch of the river is unprotected as the River banks are constantly being changed caused by flood of very high magnitude, channel widening, and change in channel pattern and river bank erosion.

Hindrance for Navigation

There is so hindrance such as waterfall, rocks, steep gradient, sanctuaries, forests, fishing nets etc.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people used for agriculture purpose.

NH/SH/MDR within 5 km

No major road link such as NH/SH exists with in 5 km from the waterway. The National Highways NH52 which is 8 km away from the waterway on the western side is connected the village by local village roads.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops are paddy, mustard, black gram and seasonal vegetables.

Existing Ghats, Jetties and Terminals.

No terminals, jetties exist in the area. There are two ferry services on this stretch, one is Dhurgighat operated at CH 74.2 km and another is Hathiyamara ghat operated at CH 73.6 km.

Prominent city/town/place of worship/historical place for tourism

North Lakhimpur is the major town that exists at 10 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism exists in the area.

Village colonies along the sub-stretch and approximate population

Sonawal, Badagara, Hathiyamara are the important villages with approximate population of about 5000 members.

Availablility of passenger ferry service

There are two ferry services on this stretch, one is in Dhurgighat operated at CH 74.2 km and another is in Hathiyamara ghat operated at CH 73.6 km.

Fishing activities

Fishing activity seems to be less in this stretch.

Usage of water & water quality

Water used for domestic purpose and some extend for agricultural land. Water quality is good.

2.4.9 Sub Stretch 9: Chainage 79.5 km to 89.3 km

Bathymetry Survey:

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 79.5 km to 89.3 km.

Topographic Survey:

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 79.5 km to 89.3 km

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	79.5	89.3	0.3	11.2	2200	0.3	10.2	2200
II					3200			3200
III					3600			4000
IV					6400			5800

2.4.9.1 Description of Sub-Stretch 9 (Chainage 79.5 km to 89.3 km)

Stretch is between CH 79.5 km and CH 89.3 km of the Subansiri River. This stretch is the widest among the entire survey area of the river with maximum width of around 3000 m. Agriculture fields with paddy and vegetables were noticed on both banks of the river which largely depend on this river for irrigation. There are no overhead obstructions/crossovers in this stretch. There is one ferry services on this stretch, which is operated at CH 83.2 km. Fishing activity was seen along the entire stretch. Many wooden logs were noticed in this stretch. The nearest town is Boginadhi and Greeki village. The average water velocity in

this stretch is about 0.75 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 10.9 m respectively. The average width of the water spread is around 200 m. The average discharge in this stretch is 450 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed due to flood of very high magnitude, channel widening, and change in channel pattern and river bank erosion. Some portion of Bhimpara is protected and the details are given below.

Sl. No	Start	End	Chainage (km)		River Bank	Condition	Distance in Meters	Location
	Lat / Lon	**Lat/ Lon**	**From**	**To**				
1	27°21'32.88"N 94°13'33.88"E	27°21'8.99"N 94°14'11.10"E	88.2	89.4	Left	Protected (Geo bags/Sand bags)	1250	Bhimpara

Figure 2.2 Sandbag protection on riverbank at Bhimpara

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people was seen for agriculture purpose.

NH/SH/MDR within 5 km
National Highway (NH52) runs parallel to the river in this stretch for about 4 km from the right bank.

Railway line and stations
Boginadhi railway station is 5 km away from the river stretch on the northwest side of the right bank. The nearby railway station is North Lakhimpur which is 15 km away from this stretch of the river.

Land use pattern along the Waterway on visual assessment
Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment
The major crops are paddy, mustard, black gram and seasonal vegetables.

Prominent city/town/place of worship/historical place for tourism
North Lakhimpur is the major town that exists at 15 km on the southwest side of the river stretch. No other major city, place of worship and historical place of tourism exists in the area.

Village colonies along the sub-stretch and approximate population
Greeki, Bhimpara are the important villages with approximate population of about 2500 members.

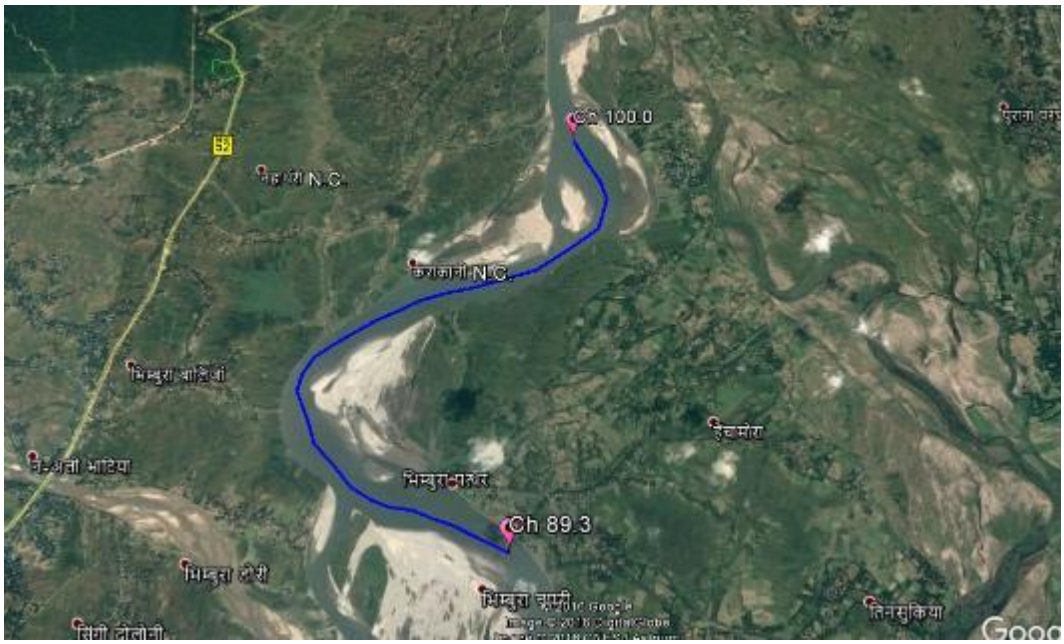
Available of passenger ferry service
There is one ferry services on this stretch, which is operated at CH 83.2 km which connects right bank at Boginadhi to left bank at Bhimpara.

Fishing activities
Fishing activity seems to be less in this stretch.

Tributaries
Boginadhi joins river Subansiri on the right bank at chainage 84.4 km.

Usage of water & water quality
Water is mainly used for domestic purpose and to some extent for agricultural land. Water quality is good.

2.4.10 Sub Stretch 10: Chainage 89.3 km to 100.25 km



Bathymetry Survey

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 89.3 km to 100.25 km.

Topographic Survey

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 89.3 km to 100.25 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)
I	89.3	100.25	0.9	9.4	4600	-0.3	8.4	4400
II					5800			5400
III					5800			6400
IV					6600			6800

2.4.10.1 Description of Sub-Stretch 10 (Chainage 89.3 km to 100.25 km)

This stretch is between CH 89.3 km to CH 100.25 km of the Subansiri River. This stretch is considerably wide with some portion of the river bank being protected in nature. Agriculture fields were noticed on the both banks of the river which largely depend on this river for irrigation. There are no overhead obstructions/crossovers in this stretch. There is

one ferry services on this stretch, which is operated at CH 90.6 km near Bhimpara. Fishing activity was more in this stretch when compared with the rest of the survey area. Many wooden logs were noticed in this stretch. The nearest town is Boginadhi. The average water velocity in this stretch is about 0.9 m/s during the survey period. The minimum and maximum reduced depth is 0.2 m and 9.8 m respectively. The average width of the water spread is around 200 m. The average discharge in this stretch is 550 m^3/s.

Condition of River banks

The major stretch of the river are unprotected as the River banks are constantly being changed due to flood of very high magnitude, channel widening, and change in channel pattern and river bank erosion. However, some protection was seen along this stretch and the details are given below.

Sl. No	Start	End	Chainage (km)		River Bank	Condition	Distance in Meters	Location
	Lat / Long	**Lat/ Long**	**From**	**To**				
1	27°23'01.09"N 94°13'17.41"E	27°22'51.97"N 94°13'08.72"E	94.8	95.2	Right	Protected (Procupine/Jetty Type)	375	Karakani
2	27 24 24.83 N 94 14 9.93 E	27 24 12.58 N 94 14 10.41 E	99.8	100.2	Right	Protected (Geo bags/Sand bags)	350	NHPC (Katari Chapari)

Figure 2.3 Shore protection at Karakani and Katari Chapari

Hindrance for Navigation

There is so hindrance such ad water fall, rocks, steep gradient, sanctuaries, forests, fishing nets etc.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people was seen for agriculture purpose.

Details of Protected areas
There are no protected areas such as wildlife, defense, atomic power plants etc in this stretch of the river.

NH/SH/MDR within 5 km
National Highway – NH52 lies about 3 km from the waterway on the western side that is connected to the village by local village roads.

Railway line and stations
Boginadhi railway station lies at 5 km on the north west side.

Land use pattern along the Waterway on visual assessment
Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment
The major crops are paddy, mustard, black gram and seasonal vegetables.

Prominent city/town/place of worship/historical place for tourism
Boginadhi is the major town that exists at 4 km on the western side of the river stretch. No other major city, place of worship and historical place of tourism exists in the area.

Village colonies along the sub-stretch and approximate population
Karakani, Katari are the important villages with approximate population of about 3000 members.

Available of passenger ferry service
There is one ferry services on this stretch, which is operated at CH 90.6 km near Bhimpara.

Fishing activities
Fishing activity seems to be less in this stretch.

Usage of water & water quality
Water is used for domestic purpose and to some extent for agricultural land. Water quality is good.

2.4.11 Sub Stretch11: Chainage 100.25 km to 106.452 km

Bathymetry Survey

Bathymetry survey was conducted using echo sounder at the sub-stretch from Chainage 100.25 km to 106.452 km.

Topographic Survey

Topographic survey was conducted using RTK, DGPS, Total Station and Auto level on the river banks, sandbars and at shallow water patches from Chainage 100.25 km to 106.452 km.

Class	Chainage (km)		Observed			Reduced w.r.t. Sounding Datum		
	From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**
I	100.25	106.0	0.3	8.6	4400	-0.3	7.6	4200
II					4400			4400
III					4600			4400
IV					4600			4800

2.4.11.1 Description of Sub-Stretch 11 (Chainage 100.25 km to 106.452 km)

This stretch is the upstream portion of the survey area of the River Subansiri. This stretch is between CH 100.25 and CH 106.0 km of the Subansiri River. This stretch is considerably narrow and width of the river remains less when compared with the downstream of the river. The banks are mostly protected by nature when compared to the downstream. There

are three overhead obstructions/crossovers in this stretch. They are i) Railway Bridge at CH 105.8 km, ii) High Tension Line (HTL) at CH 105.5 km and iii) National Highway (NH52 Road Bridge) at CH 105.4 km. There exists no ferry services on this stretch of the River. The nearest town area is Chauldhowa situated at the right bank and Goghamukh situated on the left bank of the river. Central Water Commission (CWC) office, Govt. of India, and Gauge station are located on the right bank at CH 105.0 km. Indian Army Camp, NHPC Camp and Govt. School located on the right bank at CH 105.0 km of this river stretch. The average water velocity of the stretch is comparably high about 1.5 m/s as compared to the velocity at downstream locations. The minimum and maximum reduced depth are 0.2 m and 7.0 m respectively. The average width of the water spread is around 150 m. The average discharge in this stretch is 500 m^3/s. The right bank is occupied mostly with agricultural land and the left bank is covered with forest.

Condition of Riverbanks

The major stretch of the river are unprotected as the River banks are constantly being changed due to flood of very high magnitude, channel widening, and change in channel pattern and of river bank erosion. However some portion of the river stretch is protected with sandbags and the details are given below.

Sl. No	Start	End	Chainage (km)		River Bank	Condition	Distance in Meters	Location
	Lat / Lon	**Lat/ Lon**	**From**	**To**				
1	27 26 22.34 N 94 14 34.91 E	27 26 18.17 N 94 14 25.83 E	103.8	104.0	Right	Protected (Geo bags/Sand bags)	320	Chowldhowa

Figure 2.4 Shore protection at Chowldhowa – Chainage 104.0 km

Hindrance for Navigation

There is presence of small boulders in the river bed in the upstream at 104 to 106 km chainage. This stretch is characterised by steep gradient and the water velocity is high around 2.5 m/s. There are no other hindrances such as water fall, rocks, sanctuaries, forests, fishing nets etc.

Encroachment to the waterway

Encroachment on the river banks along the stretch by the local village people is visible for mostly for agriculture purpose.

Details of Protected areas

Central Water Commission (CWC) office, Govt. of India, and Gauge station are located on the right bank at CH 105.0 km. Indian Army Camp, NHPC Camp and Govt. School are located on the right bank at CH 105.0 km of this river. There are no protected areas such as wildlife, defense, atomic power plants etc in the area.

NH/SH/MDR within 5 km

The National Highways is NH52 which cross the river at 105.4 km chainage.

Railway line and stations

Northeast frontier railways crossing thee river at Chainage 106.0 km which connects Demaji and Lakhimpur. The nearest railway station is Subansiri station which is 1 km from the right bank and Demaji is 5 km away on the left bank.

Land use pattern along the Waterway on visual assessment

Mostly agricultural lands with habitation along the banks of the river in the region are noted.

Crop/Agriculture in this region on visual assessment

The major crops grown are paddy, mustard, black gram and seasonal vegetables.

Existing Cargo Movement

Gravels is generally transported by truck on the river banks collected from the river bed between the chainage 105 and 106 km.

Prominent city/town/place of worship/historical place for tourism

Demaji and Chauldhowa are the major towns that exist near this stretch. No other major city, place of worship and historical place of tourism exist nearby.

Village colonies along the sub-stretch and approximate population

Chowldhowa, Ruphai, Demaji, Gogamukh are the important villages with approximate population of about 5000 members.

Figure 2.5 Gravel Mining at CH 105.5 km at Chauldhowa

Figure 2.6 Gravel Mining at CH 105.5 km at Chauldhowa

Tributaries

Lataijan river joins Subansiri at Chainage 101.2 km.

Usage of water & water quality

Water is used for domestic purpose and to some extend for agricultural land. Water quality is good.

There are three overhead obstructions/crossovers in this stretch. They are i) Railway Bridge at CH 105.8 km, ii) High Tension Line (HTL) at CH 105.5 km and iii) National Highway (NH52 Road Bridge) at CH 105.4 km. the details are given below.

Table 2.3 Details of cross structure

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		Zone	Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks
					Left Bank	**Right Bank**		**Left Bank**	**Right Bank**						
1	Bridge Highway (Road)	105.4	RCC Road Bridge (NH 52)	Chawol Dhowa	Lat: 27°26'47.18"N Long: 94°15'27.13"E	Lat: 27°26'55.86"N Long: 94°14'59.11"E	46	X: 624275.98 m Y: 3036512.70m	X:623504.03 m Y: 3036772.05 m	810	8	18	45	4.4	Completed in Use
2	Bridge (Railway)	105.8	Girder Steel Bridge	Chawol Dhowa	Lat: 27°26'57.92"N Long: 94°15'33.17"E	Lat: 27°276.83"N Long: 94°15'4.76"E	46	X: 624438.45 m Y: 3036844.88 m	X: 623655.75 m Y: 3037111.19 m	786.5	6	13	60.5	3.6	Completed in Use
3	HTPL Line	105.5	High Tension Power Line	Chawol Dhowa	Lat: 27°26'50.14"N Long: 94°15'27.67"E	Lat: 27°26'58.11"N Long: 94°15'1.17"E	46	X: 624290.340 m Y: 3036604.816 m	X: 623560.829m Y: 3036842.512 m	800	4	-	980 m	13.9	Completed in Use

Figure 2.7 Northeast Frontier Railway track at CH 106 km

Figure 2.8 National Highway NH 52, at Chowldhowa CH 105.5 km

Figure 2.9 High Tension Line at CH 105.5 km - Chowldhowa

2.5 Water and Soil Samples analysis and Results

Sediment samples were collected using Van Veen grab at all stations to analyze particle size, specific gravity and pH value. The samples were collected in clean polythene cover which was neatly labeled for further analysis. The samples were analyzed for grain size distribution, specific gravity, pH, clay and silt percentage as per the standard methods. The samples were analyzed by Creative Engineering Labs, Chennai; a NABL accredited laboratory.

Table 2.4 Soil sample locations

Sample No.	Chainage (km)	Position				Depth (m)
		Latitude	**Longitude**	**Easting (m)**	**Northing (m)**	
SS1	104.3	27°26'28.9559"N	094°14'42.5565"E	623057.88	3035939.6	2.0
SS2	94.3	27°22'38.3252"N	094°12'57.8886"E	620253.57	3028814.1	2.2
SS3	83.6	27°19'36.2263"N	094°12'41.4476"E	619856.37	3023206.2	6.0
SS4	74.6	27°15'43.3594"N	094°12'07.5158"E	618992.77	3016031.4	3.0
SS5	64.2	27°12'01.2061"N	094°11'02.8603"E	617279.46	3009178.5	3.0
SS6	55.7	27°08'00.7019"N	094°11'08.6046"E	617507.44	3001779.5	2.0
SS7	41.3	27°02'45.0970"N	094°07'46.8600"E	612040.53	2992017	2.5
SS8	33	27°01'39.8573"N	094°04'39.0685"E	606883.73	2989964.3	6.5
SS9	22.5	26°59'02.1701"N	094°00'30.6920"E	600078.33	2985055.7	2.5
SS10	10.9	26°55'54.4586"N	093°56'52.5083"E	594107.18	2979233.5	3.0
SS11	4.8	26°53'22.4126"N	093°55'55.5155"E	592569.85	2974543.6	7.5

Table 2.5 Result of Soil sample analysis

Station	Depth (m)	Description	Grain Size Analysis				Specific Gravity (g/cm3)	pH
			Gravel %	**Sand %**	**Silt %**	**Clay %**		
SS1	2.0	SANDY CLAY	-	49.09	15.07	35.85	1.36	6.50
SS2	2.2	LOAM	-	37.54	44.39	18.07	1.31	5.94
SS3	6.0	LOAM	-	42.91	45.22	11.87	1.40	6.35
SS4	3.0	LOAM	-	66.25	24.75	9.00	1.37	7.15
SS5	3.0	SANDY LOAM	-	78.32	3.61	18.06	1.38	6.40
SS6	2.0	SANDY LOAM	-	68.67	19.60	11.73	1.31	6.20

SS7	2.5	SANDY LOAM	-	73.66	13.23	13.11	1.39	6.88
SS8	6.5	SANDY LOAM	-	71.74	18.62	9.64	1.35	6.80
SS9	2.5	SANDY LOAM	-	74.15	7.67	18.17	1.36	6.76
SS10	3.0	CLAY	-	44.70	13.86	41.44	1.32	6.34
SS11	4.0	SANDY LOAM	-	58.44	31.66	9.90	1.40	5.09

Table 2.6 Water sample locations

Sample No.	Chainage (km)	Position				Total Depth (m)	Mid - Depth (0.5d) (m)
		Latitude	**Longitude**	**Easting (m)**	**Northing (m)**		
C1	104.3	27°26'28.9559"N	094°14'42.5565"E	623057.88	3035939.6	2	1
C2	94.3	27°22'38.3252"N	094°12'57.8886"E	620253.57	3028814.1	2.2	1.1
C3	83.6	27°19'36.2263"N	094°12'41.4476"E	619856.37	3023206.2	6	3
C4	74.6	27°15'43.3594"N	094°12'07.5158"E	618992.77	3016031.4	3	1.5
C5	64.2	27°12'01.2061"N	094°11'02.8603"E	617279.46	3009178.5	3	1.5
C6	55.7	27°08'00.7019"N	094°11'08.6046"E	617507.44	3001779.5	2	1
C7	41.3	27°02'45.0970"N	094°07'46.8600"E	612040.53	2992017	2.5	1.25
C8	33	27°01'39.8573"N	094°04'39.0685"E	606883.73	2989964.3	6.5	3.25
C9	22.5	26°59'02.1701"N	094°00'30.6920"E	600078.33	2985055.7	2.5	1.25
C10	10.9	26°55'54.4586"N	093°56'52.5083"E	594107.18	2979233.5	3	1.5
C11	4.8	26°53'22.4126"N	093°55'55.5155"E	592569.85	2974543.6	7.5	3.75

Table 2.7 Result of Soil sample analysis

Sample No.	Observed Water Depth (m)	Water Sample Depth (0.5D-m)	Sediment Concentration (mg/L)	pH
C1	2.0	1.0	2.3	6.57
C2	2.2	1.0	16.6	6.46
C3	6.0	3.0	2.6	6.59
C4	3.0	1.5	BDL (DL-2.0)	6.84
C5	3.0	1.5	3.0	7.02
C6	2.0	1.0	2.9	6.65
C7	2.5	1.5	2.5	6.81
C8	6.5	3.0	BDL (DL-2.0)	6.68
C9	2.5	1.5	3.0	6.42
C10	3.0	1.5	2.0	5.90
C11	4.0	2.0	2.7	6.35

3 Chapter 3: Traffic Study

3.1 General

Subansiri River flows through Lakhimpur District of Assam State in India. The river originates near Chayang Miri, a small village in Majuli Tehsil of Jorhat District and flows through whole of Lakhimpur District. The length of the proposed stretch of the river under study is 106.45 km.

3.2 Hinterland Analysis

Hinterland of Subansiri River includes the areas, which are situated near the river; entire Lakhimpur district would fall in the hinterland. This district is located at the northeast corner of Assam with Arunachal Pradesh on North, Dhemaji district on east, Majuli on south & Gahpur on west. Apart from Lakhimpur, west part of Dhemji District has also been studied. Target of this study was to analyse the flow of goods between industries and look for possibility of diverting this movement from rail/road to waterways.

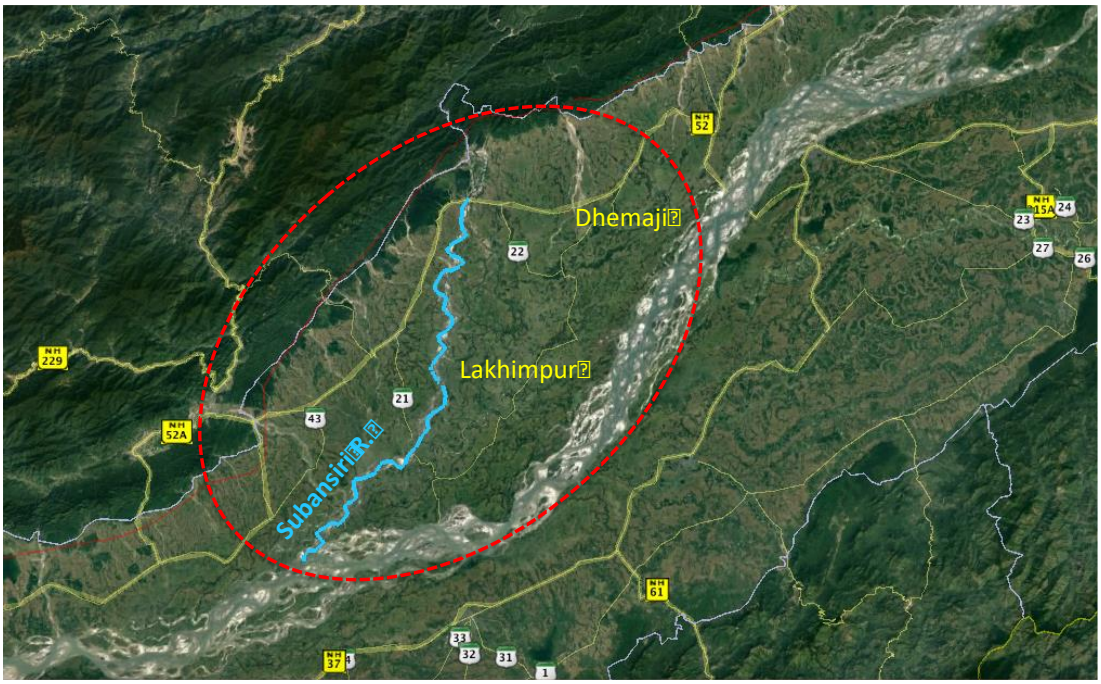


Figure 3.1 Location of Subansiri River & its hinterland around 40km with road connectivity

The above map depicts that southern end part of Subansiri River merges with Brahmaputra River. Brahmaputra river is one of the major rivers of Asia. It passes diagonally across the whole Assam state by touching a large number of districts. The river flows along the southern region of Lakhimpur & Dhemaji districts. There exist riverine activities on Brahmaputra; many ferry services are opertional across and along the river. The ferry movement on the Brahmaputra river would pose competition to the proposed waterway on Subansiri River for attracting potential traffic.

3.2.1 Infrastructure

The existing infrastructure in the defined hinterland covers only road and rail connectivity. There is no major infrastructure, like Ports, Terminals, Silos, Cold Storage etc in the hinterland. Lakhimpur has good road connectivity. Out of total length of roads in this district, i.e. 3,570 km, 121 km is covered by

State Highways and 640 km by National Highways. SH 21 which runs on both sides of the river is connected with Khaboli Ferry service on Subansiri River. The below given map shows rail, road and air connectivity around the river.

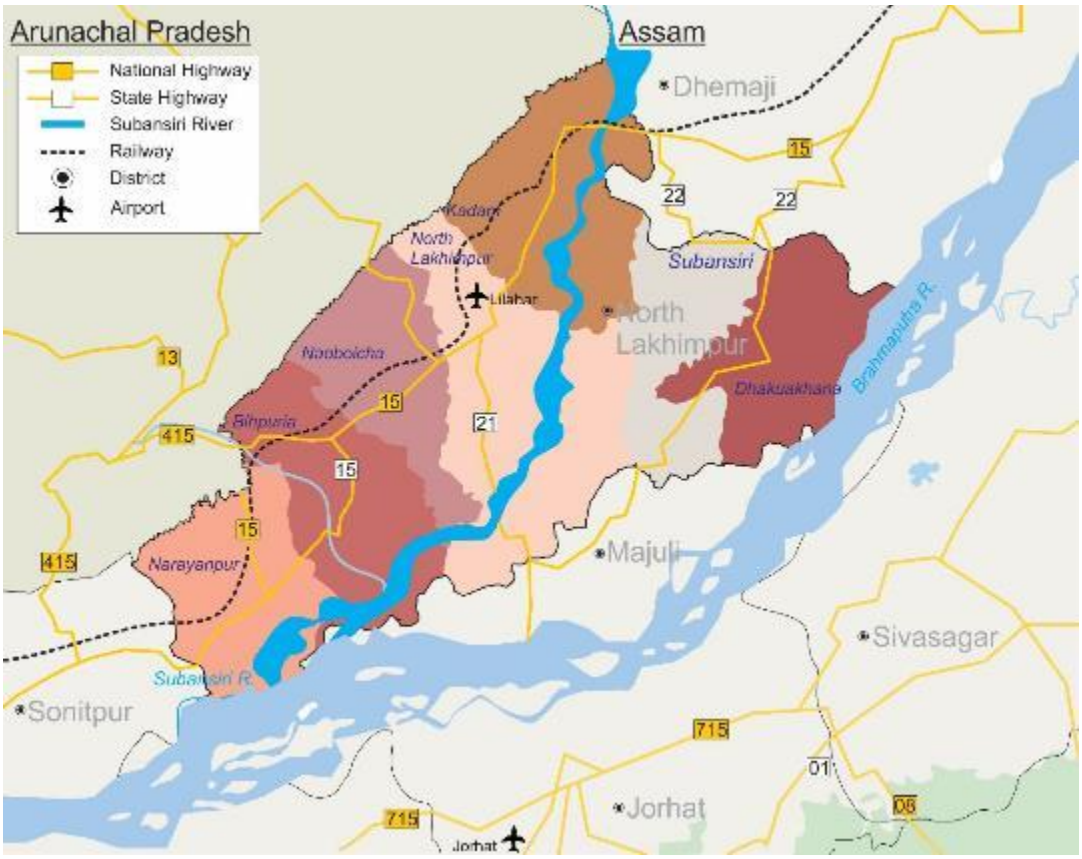


Figure 3.2 Connectivity Infrastructure on and around Subansiri River

Table 3.1 Length of Roads under PWD as on 2013 (km)

Roads	Lakhimpur	Dhemaji
State Highways	121	45
Major District Road	97	42
Rural Road	828	1168
Urban Road	44	86
National Highways	640	585
Under Construction	451	755
Newly Declared	1091	1340

There is total road length of 1,840 km under the state PWD and 585 km is covered under the National Highway. NH 52 passes through Dhemaji Crossing River at Dal Bhasti in Lakhimpur district and further connects to Sonitpur district, passing by Lakhimpur. Train is available from Guwahati and Alipur stations for Dhemaji. Ferry service is available from Dibrugarh through Dibru Sonari Burisuti, Dibru Sissi Machkhowa, Dibru Majarbari and Bogibeel Kareng Ghats.

There are some warehouse facilities in the hinterland for storage. The table below shows the exisiting warehouses in the region.

Table 3.2 Warehouse Centers in region as on 2013 (MT)

Infrastructure	Lakhimpur	Dhemaji
Own Constructed	4,877	11,632
Temporary Shed	-	-
Hired Godown	-	-

3.2.2 Population of Hinterland

Lakhimpur covers around 80% of the total hinterland of Subansiri River. It is situated in the northeast corner of Assam. It is a small district with only Agriculture as an economic activity. People of Lakhimpur are largely dependent on agriculture for their livelihood, as there is no industry in this district. Other activities like livestock rearing, Handloom & Textile, Handicraft & Weaving are also source of income for the local people.

Table 3.3 District wise population of considered villages

District	Population	Taluka in hinterland	Villages (No.)
Lakhimpur	1,042,137	Bihpuria	172
		Dhakuakhana	162
		Kadam	155
		Naobaicha	148
		Narayanpur	200
		North Lakhimpur	222
		Subansiri	114
Dhemaji	683,133	Dhakuakhana	51
		Dhemaji	278
		Gogamukh	173
		Jonai	374
		Sissiborgaon	390
		Subansiri	38

Dhemaji District is situated on the northeast side of Subansiri River. About 98% of total population in the district lives in rural areas and 65% of population is involved in agro-based activities. Dhemaji is a small remote district, with hilly range on north, which acts as a boundary between Assam and Arunachal Pradesh. At present, the district receives additional funds from the Backward Region Grant

Fund Programme (BRGF) for filling infrastructural gaps in connectivity, health, education, social sectors, electrification, etc.

Sericulture is done at a very small scale in the district. Forest produces, Textile & handlooms are the major source of income of local people. The below given table shows the distribution of population into various occupations in the district. It depicts that very less population is involved in Trade, Commerce & Manufacturing sectors in the district.

Figure 3.3 Typical stilt house of villagers in Lakhimpur district

All areas, including North Lakhimpur town, have a mix of temporary and permanent sheds for accomodation. Majority of people live in kachcha houses, as shown in the above image. These people are not financially capable of building pakka houses. Agriculture is the only source of income for 85% of total population of Lakhimpur district.

Table 3.4 % Share of Population involved in various occupations

Activities	Lakhimpur	Dhemaji
Cultivators	56	73
Agriculture Labours	10	6
Households Industry	2	2
Others	32	19

3.2.3 Economy

Agriculture is the principal occupation of locals. The contribution of Agriculture and allied activities in the Economy of Lakhimpur is 65%, followed by 13% from non-farm sector and 22% contribution from other sectors. Paddy crops are grown in large scale and are locally known as Lakhimi. It is grown in 66% of total arable area of the district.

Table 3.5 Crop production in Lakhimpur District

Crops	Units	Production/hec
Winter Paddy	kg	3541
Summer Paddy	kg	4353
Autumn Paddy	kg	2440
Arecanut	No.	99
Cononut	No.	16

Apart from agriculture, sericulture also has a significant share in the district's economy. It is a major agro-based industry which generates employment for rural population in the region. During off-agricultural season, when locals have no other source of employment, sericulture plays a vital role by providing employment to rural population. Dhemaji & Lakhimpur districts contribute good share in production of Silk, which has high demand in both national & international market.

3.2.4 Existing & Proposed Industries

Guwahati & Tejpur are two major industrial centres in Assam. Both these industrial areas are located far from the river. Other industrial areas are located in the southwest part of the district, within 200 km to 600 km from the river. Hence, it is very unlikely that any industry in the industrial areas, except those located in the city, would prefer Subansiri River for cargo movement. Industries would rather transport their goods directly via roadways or railways, as it is less time consuming and economical mode.

Industries in Assam, which are located within 40 km from Subansiri River are either micro or small scale units. Roadways is the only mode of transportation used by these industries. Lakhimpur district is a landlocked area; and there exist no ports or terminal. Lack of such infrastructure in the region is a major hinderance for industries to setup units in the region or do EXIM trade. Commodities that originate here are consumed locally. The objective of the study is to develop waterway connectivity for industrial cargo movement between industries and factories. This section would study in detail the types of existing industries and their contribution in multimodal transportation

Table 3.6 District wise MSME's units as on 2014

Type of Industries	Lakhimpur	Dhemaji
Micro	50	39
Small	3	0
Medium	0	0

Out of the total micro and small unit listed above, only 22 units in Lakhimpur and 27 units in Dhemaji are functional, which generates very small volume. Raw materials for these units are procured from same region while finished products are consumed locally only. There exists no medium scale industry in the hinterland of Subansiri River. In industrial segment, the region is underdeveloped. Such micro and small units located in Lakhimpur and Dhemaji does not create any opportunity for cargo movement via proposed route.

There are 5 small textile industrial setups in Lakhimpur district, namely Jyoti Industry, Ranu Industry, Subhalakshmi Industry, Tilutamma Industry and Upasana Industry. These industries are very small scale with negligible production volume.

Table 3.7 Industrial Estates & other Infrastructure available

	Unit	Lakhimpur	Dhemaji
Type of Infrastructure		Industrial Estates	Integrated Infrastructure Development
Name of Estate	-	Rajabari, Bihpuria	Silapathar
Total Area	Sq. M	51,092	140,469
Sheds Constructed	No.	6	-
Sheds Alloted	No.	2	-
Other Area Alloted	Sq. M	0	-
Units functional	No.	1	-

Assam state has 9 functional Integrated Infrastructure Development Centres, out of which two are under construction. Out of 9 completed IICs, one is located in Banderdewa, Lakhimpur and another in Silapathar, Dhemaji with total 140.469 Sq. M land area. Lakhimpur also has Industrial estates at Rajabari & Bihpuria with land area of 51,092 sq. m. At present, there is only 1 operational unit in this estate. Out of 6 constructed sheds, 2 are allotted to this industry.

3.3 Commodity Composition / Categorization

The table below shows number of industrial units located in Lakhimpur & Dhemaji. In Lakhimpur, there are total 56 functional units in Food, Chemical & Metal manufacturing sectors. While in Dhemaji, there are only 4 units in working condition, 3 of Food and 1 of minerals. Production volume of these units is negligible and these units would not provide any opportunity for the proposed waterway. There is no potential to divert the produced commodities to the waterway, as moving such small volume to the waterway would not be commercially viable. Also, the entire production volume of these units is locally consumed.

Table 3.8 Type of industries in hinterland as on 2013 (No. of factories)

Industries	Lakhimpur	Dhemaji
Food Products & Beverages	31	3
Chemical Products	2	-
Non-Metallic Minerals	21	1
Basic Metals	1	-
Fabricated Metal Products	1	-

Government of Assam is taking initiatives to develop the backward regions in Lakhimpur district. State government has developed Infrastructure for Agro Food processing at 5 locations to promote food-processing sector and provide storage facilities to farmers. Dhemaji is one of the 5 locations, where infrastructure is developed.

3.3.1 Sericulture

Assam is famous for the production of 3 types of silk namely Eri, Muga & Mulberry. Muga is a unique type of silk produced in the state. The state government is trying to develop silk based industries by infusing capital and promoting modern methods of silk production.

Lakhimpur is one of the major silk producing districts in the state. It contributes 25% to 30% of domestic silk production. Large-scale production of varieties of silk is now becoming an identity of Lakhimpur. Dhemaji has less area under silkworm, food (mulberry) plants and no. of units, compared to Lakhimpur, but the silk production volume of Dhemaji district is more.

Table 3.9 Sericulture activities in hinterland as on 2013

	Unit	Lakhimpur	Dhemaji
No. of Sericulture units	-	861	652
Area under silk worm Food Plant	Hec	2,438	1,933
Production of Silk Yarn	MT	125	259
Training Centre	No.	4	2
Weavers Production	Mtr	941	2480
Handloom Production	Mtr		426

3.3.2 Fertilizer

Agriculture is the primary and only occupation of local people; hence a substantial volume of fertilizer is consumed for cultivation purpose. These fertilizers are mainly produced by local industries, situated in the hinterland. The production volume of these local fertilizer units is too low to divert to the waterway. The table below shows district wise fertilizer consumption in the hinterland of Subansiri river.

Table 3.10 Fertilizer consumption in region as on 2013 (MT)

Fertilizer	Lakhimpur	Dhemaji
Nitrogen	4,816.13	487.47
Phosphorous	431.68	633
Murate of Potash	177.71	965.06
Total	5,425.52	2,085.53
Consumption/Hec (Kg)	56.55	15.04

3.3.3 Forest Products

There are 9 reserved forests, covering 53,224 hec area which is about 16% of total Dhemaji district. Forest of Dhemaji contributes Rs. 8.14 lac in total annual revenue of the district. Below table shows the reserves of forest products and other natural products of Lakhimpur and Dhemaji districts.

Table 3.11 Productions from Forest Products as on 2013

Forest Products (m^3)	Lakhimpur	Dhemaji
Industrial Timber	1,208	45
Fuel-Wood	---	---
Sand	21	24,032
Stone	25	28,284
Silt/Clay	521	---
Others	54,890	13,875
Total	56,665	66,236

3.3.4 Tea & Rubber

Apart from Agriculture, Sericulture, Forestries & Fertilizers; Tea and Rubber are also produced in the hinterland. Production of tea in Lakhimpur is in very small volume which is consumed locally. Land area for Rubber is also allotted in Lakhimpur, but production has not started yet. In Dhemaji district, on an average, 22 Tonnes of rubber is produced annually in raw form.

Table 3.12 Commodities produced in region as on 2012

Commodities	-	Unit	Lakhimpur	Dhemaji
Tea	Area Under cultivation	Hec	6984	-
	Production	MT	11	-
Rubber	Area Under cultivation	Hec	17.69	69.66
	Production	MT	-	22

3.3.5 Bulk Commodities

Assam has abundance of Coal, PNG, limestone & minor mineral reserves. Limestone & Kaolin are found in Lakhimpur. Lakhimpur also has Digboi oil fields, which is a major source of Oil & Gas in the country. Apart from this, no other mineral is found in the district. Dhemaji does not have any reserve of natural resources.

3.4 Originating / Terminating Commodities

Originating & terminating traffic in and around Subansiri River would be from Revenue Circles of Lakhimpur. There are 2 divisions in Lakhimpur District, namely Dhakuakhana & North Lakhimpur. North Lakhimpur has 4 revenue circles, while Dhakuakhana has 3 revenue circles. Following section explains the revenue circles and opportunity they would provide for Subansiri River.

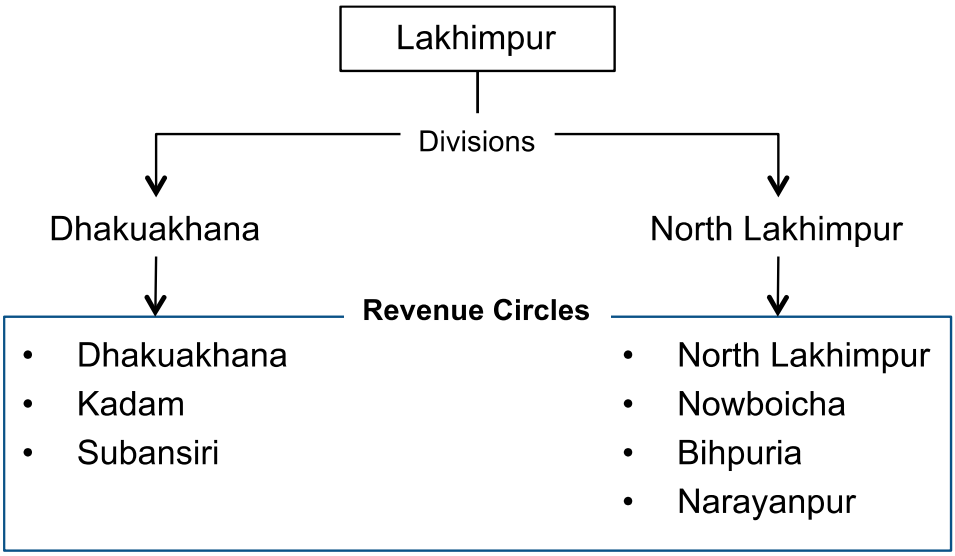


Figure 3.4 Revenue Circles in Lakhimpur District

3.4.1 Revenue Circles

Below map shows the revenue circles of Lakhimpur district. Railways & Roadways connectivity has been marked on the map along with most populated villages & cities. Considered Ghats along the river are also shown on the map. Highly populated places are located near the National Highways & Railway line, and are far from Subansiri River.

Local people residing on the eastern side of Subansiri cross the river for their daily requirement, like travel to workplace, schools & colleges, purchase of essential items, visit hospitals, etc. People living on the western side of Subansiri rarely cross the river. Mostly people, who are employed on the east side do the river crossing. Western side of the river is more prosperous (Economically, Infrastructure etc) than the Eastern side.

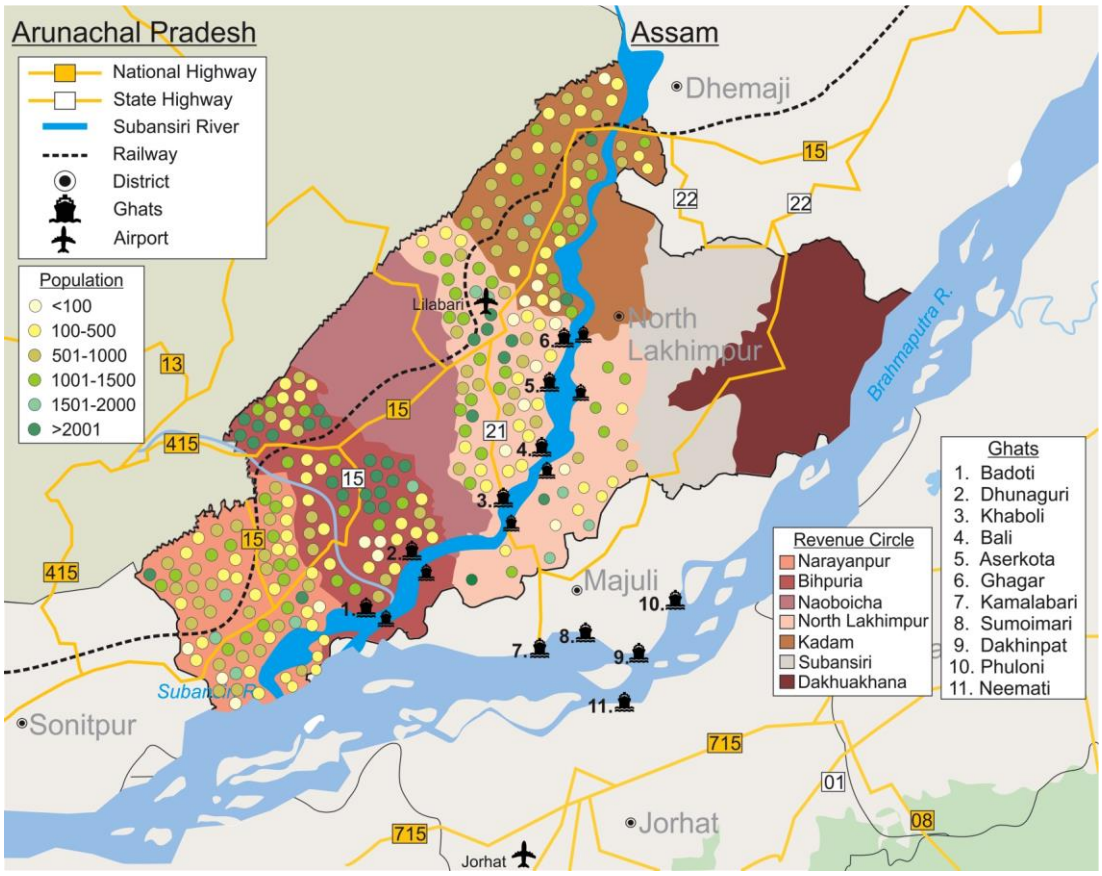


Figure 3.5 Revenue Circles of Lakhimpur with populated villages

3.4.2 Dhakuakhana

Dhakuakhana is surrounded by Brahmaputra & Subansiri Rivers. The total geographical area is 695.9 Sq Km. Dhakuakhana sub division is the area surrounding Subansiri and Brahmaputra. On the north and east, it is bounded by Gogamukh and Machkhowa of Dhemaji, Kherkata suti on south; Subansiri river and Lakhimpur sub division on the west.

Geographical structure of this division consists of the main river systems Subansiri, Champara, Karha and Charikaria. The number of river is more in comparison to its geographical area. Some river formed Dead River as they suddenly changed their actual direction due to the turns and curves of the river path. According to a census the present number of this type of lake in the sub division are 37. Bordoibam lake among the many lake is where the second Bird Sanctuary of Assam is established centering it.

- Forest: The forest of this district resembles the damp savanna forests and is endowed around year. Tax is collected during the early period by forest office established by the government. Due to cultivation and other reasons only 75% remains whereas 25% has become extinct.
- Agriculture: Agriculture forms a principal activity and way of life for people in Dhakuakhana. The staple cultivation being rice and muster crops. The soil around is suitable for muster, which is grown in winter season around riverbanks. The pulses are an important cereal crop for Dhakuakhana. Other than agriculture animal husbandry and fishing form an important part of this circle's economy. This entire area is known for rare fish species and the demand for fish is inelastic. Rearing of livestock for meat, fat, milk, egg, etc create a subsidiary occupation.
- Sericulture: The major contribution to sericulture activity in Assam is from Dhakuakhana, which contributes significantly to rural income, employment and to exports besides internal consumption of the area. This high labour intensive industry is common practice of the inhabitants. It specializes in

three varieties of silk i.e. eri, muga and mulberry. Villagers taking sericulture as a primary as well as side occupation have made this industry the most profitable and progressive industry of the area.

Dhakuakhana Revenue Circle

Dhakuakhana revenue circle is located in between Subansiri & Brahmaputra River. The below table shows the most populated villages/cities of this circle. Subansiri would not get any opportunity from this circle because it is nearer to Brahmaputra than Subansiri. Subansiri River is more than 30 kms away from this revenue circle. People of Dhakuakhana circle would prefer Brahmaputra River, which is closer to the revenue circle.

Table 3.13 Most Populated Villages/Cities in Dhakuakhana Circle

Sr. No.	Name	Population
Villages		
1	Bantow Gaon	2,740
2	Namrupia Jalbhari	2,658
3	Charanchuk Madarguri	2,546
4	Dighala Hiloi Dhari	2,539
5	N.C. Lutachur Indur	2,438
6	Jiamoria Gaon	2,351
7	Deolia Gobindapur	2,080
8	No.1 Alimurbazar	2,076
9	Kala Kata Chetia	2,032
10	N.C. Kangkan Chapari Baghchuk	1,887
Cities		
11	Dhakuakhana	13,502
12	Others	100,757
13	Total	114,295

Kadam Revenue Circle

Kadam revenue circle is located on north of Lakhimpur district. The state capital Itanagar is at a distance of 55.1 km from Kadam. The revenue circle is surrounded by Seajuli, Bhimpara, Boginadi villages. This circle has got good road & rail connectivity. As per the scope of IWAI, Subansiri River starts from Kadam revenue circle, just before National highway Railway line bridge on the river. This circle would not provide much opportunity to proposed waterway on Subansiri. The below table shows the populated villages of Kadam revenue Circle. Most of these populated villages are located around road and railway lines.

Table 3.14 Most Populated Villages in Kadam Circle

Sr. No.	Name	Population
1	Ananda Bagan	2,714
2	Darga Gaon	2,462
3	Goriamari	2,028
4	New Cinatoli	2,018
5	No.2 Ghagarmukh	1,997
6	No.2 Dakhin Rupahi	1,934
7	Bhurbandha	1,698
8	No.3 Gereki	1,698
9	Tanga Basti (Tenga Basti)	1,647
10	No.3 Badhakara Majgaon	1,627
11	Others	121,725
12	Total	107,330

Subansiri Revenue Circle

Subansiri Revenue Circle is located 36 km towards east from District head quarter North Lakhimpur. It is surrounded by Bordoloni in North, Machkhowa in East, Dhemaji in North and Lakhimpur in west. Subansiri would not create much opportunity for this river as major populated cities/villages are located far away from the river. The below table shows the populated villages of Subansiri revenue Circle.

Table 3.15 Most Populated Villages in Subansiri Circle

Sr. No.	Name	Population
Villages		
1	Lamudeowalia	3,402
2	Ghilamara 1/2	2,834
3	Alimur	2,680
4	No.1 Barkhamukh N.C.	2,678
5	Bogichur Koligaon	2,570
6	Maji Gaon	2402
7	Jalbhari Dimaruguria	2,344
8	Patri Chuk	2,178
9	No.2 Hatimara	2,121

10	Chakuli Gaon	1,889
11	Others	49,992
12	Total	75,090

3.4.3 North Lakhimpur

North Lakhimpur division is spread over an area of 2,323 sq. km. It is located at the foothills of Himalayas in the north and exhibits a decline from south till Lohit Suti. The division is a composition of hilly lands, low lands and plain levels. The soil composition in the plains consists of a mixture of clay and sand in varying proportions and is composed of sandstones and shales in the north. The soil composition is best suited for paddy crop cultivation. The various irrigation schemes lead to Kharif and Rabi crop cultivation in the area. Agriculture forms a major source of income for North Lakhimpur. Various rivers and their tributaries distinguish this area from others. This area is also known for educational colleges.

North Lakhimpur Revenue Circle

The river flows across the revenue circle and villages are located on both sides of the river. This revenue circle would provide opportunity for Subansiri River because people cross the river, for daily needs as well as occasionally for tourism purpose. Traffic from Roadways & Railways could be diverted to the waterways on Subansiri river. Upper region of the river is more developed and have facilities like Hospitals, Markets for trading, Scools & Colleges etc. People from southern region come to this place for trading and other purpose across the river. At present, across the river movement takes place from Ghats on the bank of the river. Government as well as private parties operate boats across the river. There is direct connectivity from North Lakhimpur town to ghats and from there, peple can take boats to go to the other side of the river. The table below shows populated villages/cities in North Lakhimpur Circle.

Table 3.16 Most Populated Villages/Cities in North Lakhimpur Circle

Sr. No.	Name	Population
Villages		
1	9/6 Koilamari	4,438
2	Bocha Gaon	4,339
3	Ghagarmara	4,031
4	Chaboti	3,119
5	Kumarkata	2,875
6	Bantow Bangali	2,814
7	Moidamia	2,759
8	Japisajia	2,707
9	Barali Mora N.C.	2,641
10	Nalkata Bowalguri	2,543
Cities		

11	North Lakhimpur	59,814
12	Others	158,563
13	Total	250,643

There is a proposal to move bamboos on waterways of Subansiri River from Guwahati to Jagiroad paper Mill in North Lakhimpur.

Lakhimpur Circle is dependent on Guwahati for essential supplies. Around 20 trucks to 25 trucks with supplies call everyday to the revenue circle. It is mostly one-way traffic. Trucks are filled with following items

- Food products
- Hardware
- Building materials
- Cloths

Everyday around 1 to 2 loaded trucks are transported back to Guwahati from Lakhimpur revenue circle. The revenue circle has a population of 250,643. There are no industries in this revenue circle. Some of the small-scale industries are Tea Gardens & Silk production units, located in Dhokua khan.

Number of passengers moving between the circle and Guwahati is small. It is estimated that around 30 to 40 people would travel between circle and Guwahati everyday. Khaboli Ghat, Bali Ghat, Aserkota & Ghagar Ghat are the four ghats identified by IWAI in Lakhimpur circle. These ghats are the points of traffic movement across the river. In below sections, each ghat with its traffic movement is shown in detail.

Bihpuria Revenue Circle

River Dikrong flows through this area. One can reach the river island district Majuli through Bihpuria. It is one of the newly constituted sub-division in Lakhimpur district. The below table shows the most populated villages/ cities in Bihpuria Circle.

Table 3.17 Most Populated Villages/Cities in Bihpuria Circle

Sr. No.	Name	Population
Villages		
1	Ahmedpur Gaon No.2	3,413
2	Bangal Mara P.G.R	4,857
3	Doulatpur	5,839
4	Foteh Pur	3,934
5	Harmoti 95 F.S. Grant	7,619
6	Harmoti Patta No.5	3,905
7	Islampur Beshpati	3,819
8	Islampur No.2 (Block)	3,725
9	Petition No.3	3,332

10	Sonapur No.2	3,898
Cities		
11	Bihpuria	12,016
12	Others	153,808
13	Total	210,165

Nowboicha Revenue Circle

Naoboicha is located 1.6 km away from Lakhimpur. Other nearby district head quarter is Yupia, situated at a distance of 30.1 km from Naoboicha. Naoboicha Revenue Circle is surrounded by few villages namely Yupia, Ziro, Daporijo, Mokokchung and Seppa. The table below shows most populated villages in this revenue circle.

Table 3.18 Most Populated Villages in Nowboicha Circle

Sr. No.	Name	Population
Villages		
1	Maghuli Bargola	8,319
2	Pandhowa	5,138
3	No.30 F.C. Grant Dolohat	4,676
4	No.2 Barchala	3,555
5	No.1 Barchala	3,461
6	Grant No.107/110	3,372
7	Bhoroluwa Gaon	2,883
8	Sariah Bari	2,868
9	Konwarpur	2,858
10	Dijoo Pathar	2,525
11	Others	109,318
12	Total	148,973

Narayanpur Revenue Circle

Narayanpur Revenue circle is located between Dholpur and Bihpuria. It is located south to the district headquarter. Narayanpur is surrounded by Bihpuria on east, Bandardewa on north and Gohpur is on the western side.

Table 3.19 Most Populated Villages/Cities in Narayanpur Circle

Sr. No.	Name	Population
Villages		
1	Bordeori	2,659
2	No.2 Rampur	2,280
3	Dakuwa	2,081
4	Simaluguri No.3	2,009
5	Dhalpur	1,988
6	Bonpuroi Latabari	1,655
7	Bandardewa	1,651
8	Ganakdoloni	1,592
9	Pullnaharani	1,567
10	Na-Pamua	1,523
Cities		
11	Narayanpur	6,001
12	Others	110,635
13	Total	135,641

The table below shows region wise distribution of population & households on both side (East & West) of the river in Lakhimpur district.

Table 3.20 Region wise distribution of Population

Revenue Circle	Households (On each side)			Population(On each side)			Opportunity for Subansiri
	West Bank	East Bank	Total	West Bank	East Bank	Total	
Narayanpur	28,679	275	28,954	133,705	1,936	135,641	✓
Bihpuria	39,485	-	39,485	210,165	-	210,165	✓
Naobaicha	27,936	-	27,936	148,973	-	148,973	✗
North Lakhimpur	46,164	4,032	50,196	223,438	27,205	250,643	✓
Kadam	19,992	691	20,683	103,824	3,506	107,330	✓
Subansiri	-	2,827	2,828	-	75,090	75,090	✗

Dhakhuakhana	-	5,733	5,733	-	114,295	114,295	✗
Total	162,256	13,558	175,814	820,105	222,032	1,042,137	

People residing on the eastern side of the river are dependent on agriculture and it is their primary source of income. West bank of the river is more developed and has proper connectivity & infrastructure. There exists regular movement of goods & passengers across the river on this part.

Narayanpur, Bihpuria, Lakhimpur & Kadam offer potential opportunity for across the river movement because villagers living on east side are dependent on markets & trade centers located on the west side of the river. Other two revenue circles, i.e. Subansiri & Dhakhuakhana are located far away from the river, hence no opportunity exists from these circles. Naoboicha circle touches the river, but population is located on the upper side of the circle, which is too far from the river.

3.4.4 Diversion from Revenue Circles

Opportunity from every revenue circle is analysed below for Subansiri River based on existing trade & population there. Ony the villages, which are located around the river would provide business to the river. The below table shows a list of revenue circles with their population and potential for the river.

Table 3.21 Opportunity for Subansiri River from Revenue Circles

Sr. No.	Revenue Circles	Population	Population on East side of River	Potential	Reasons
1	Narayanpur	135,641	1,936	Yes	People cross river to buy household goods & sell agri products in nearby areas. This could be shifted on waterways in future.
2	Bihpuria	210,165	0	Yes	Movement across the river is happening between Bihpuria & people residing in Majuli i.e other side of river
3	Nowboicha	148,973	0	No	River does not connect much with this circle. As all the villages are located far away from it.
4	North Lakhimpur	250,643	27,205	Yes	Highly populated circle amongst all and movement across the river is very frequent. Potential for this river exists.
5	Kadam	107,330	3,506	May be	Major population is located along the river only. In this circle waterway movement could be viable.

6	Subansiri	75,090	NA	No	River does not touch this circle. Opportunity does not exist.
7	Dhakuakhana	114,295	NA	No	Subansiri River would not get any opportunity from this circle, as Brahmaputra is more nearer to it.
-	Total	1042,137	32,647	-	

3.5 Passenger/Ro-Ro Traffic

Mostly passenger movement takes place between north & south stretch of Lakhimpur for across the river movement. Populated villages are located far from the river bank and are adjacent to well connected highways & railways. Direct road/rail connectivity restricts the possibility of shifting trade from road to the river. Villages which are located on the river bank are less populated. Movement between these villages rarely happens,other than festivals or any other occassion. Hence, there exists no opportunity for along the river movement in Subansiri River.

Across the river movement exists to support villagers by connecting the east bank with west bank. People cross the river for employment and for purchasing basic household items. There is potential of some diversion from across the river movement.

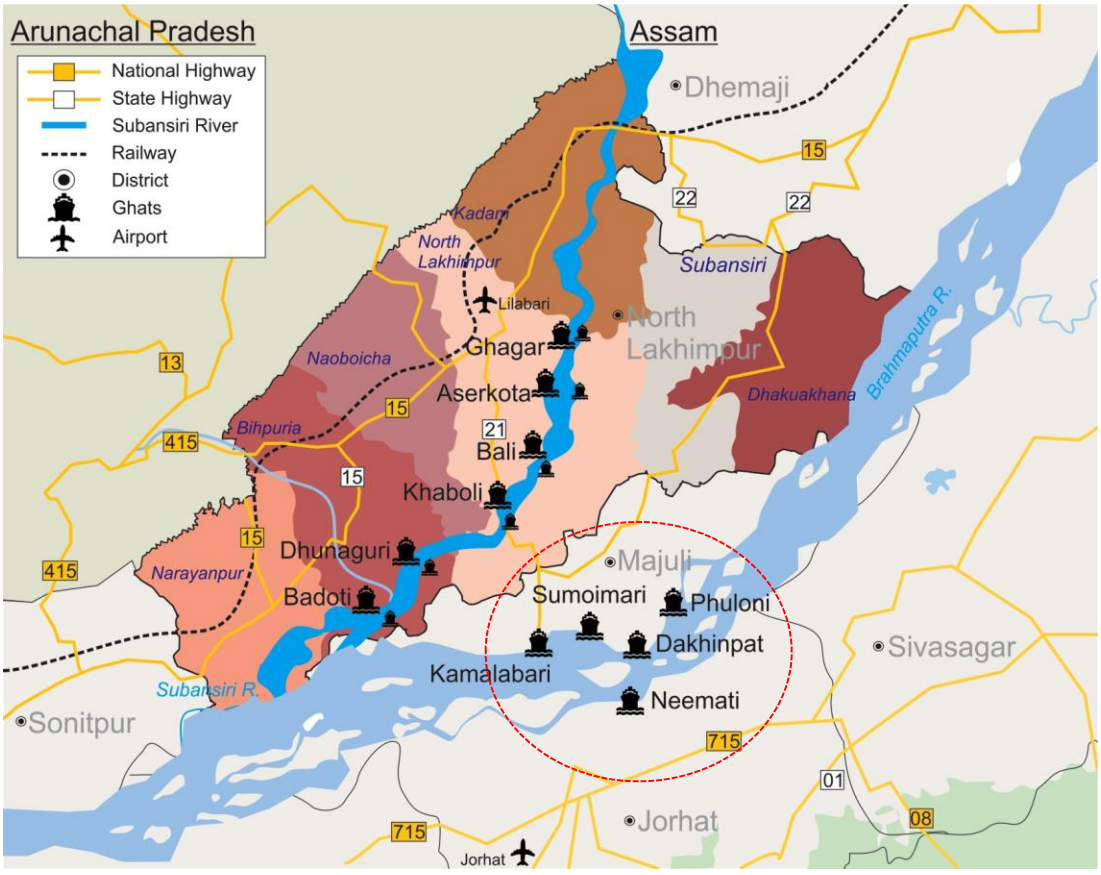


Figure 3.6 Operational Ghats of Lakhimpur & Majuli

3.5.1 Lakhimpur

As per the above market analysis, Lakhimpur does not have any Major or Medium scale Industry. Micro & small industries exist, which could provide some opportuity for passenger movement through Subansiri River. Local people of North Lakhimpur travel from one village to another along the river on daily basis. Major traffic is originated from the ghats that are located on the bank of the river. So traffic counts are done on some of the busiest ghats that are shown in below section. This traffic count would provide information for the Origin & Destination of traffic moving across and along the river. These findings will also help to understand the commercial viability of the river and the traffic diversion on the waterway from the existing mode of transportation.

3.5.2 Ghagar Ghat

People residing in Ghunasuti village are the frequent commuters, who travel via Ghagar Ghat ferry to reach to the other side of the river. Ghunasuti village is in Lakhimpur district. Naharlagun, Itanagar, Jorhat, Sibsagar are nearby cities around Ghunasuti.

Figure 3.7 Ferry at Ghaghar Ghat (Source: Site Visit)

North Lakhimpur railway station is nearby to Ghunasuti village (about 1 km) but the major railway station Dibrugarh is 93 km away from Ghunasuti. Lilabari airport is the nearest airport located 7km away from Ghunasati.

Table 3.22 Traffic count at Ghagar Ghar

Origin - Ghagar Ghat **Destination** - Gunakhuti **Start Point** - K. B. IN. North Lakhimpur			
Type of Vehicles -Bikes, Cycles, Private Cars & Tempos			
	Units	**Village-Ghat**	**Ghat-Ghat (Across the River)**
		Tempos	**Motor Boats(Big)**
Vehicles	No.	6-7	4

Capacity	Persons	12-15	40
	Bikes	-	12
	4 Wheelers	-	2-3
Trips (Average)	No. (Each side)	12-15	5
Tariff			
Passengers	Rs/per	30	10
Bicycles	Rs/per	-	20
Bikes	Rs/per	-	30
Cars	Rs/per	-	200-300

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

It can be seen from the above table that utilizing Motor boat is the only option for the people for river crossing. These motorboats carry large number of passengers. Ghagar Ghat is the second busiest Ghat in Lakhimpur district. All the basic amenities and other welfare facilities are well developed in Lakhimpur, thereby people residing on the opposite side of north Lakhimpur have to cross the river for buying daily needs and other requirements. Employment opportunity is also more in North Lakhimpur compared to the opposite side. The opposite side of North Lakhimpur also faces electrification problem. Agriculture is the only revenue generation activity on the opposite side of North Lakhimpur, thereby people cross the river to sell their agriculture produce.

3.5.3 Aserkota Ghat

Aserkota Ghat is located on the west bank of the river in Lakhimpur revenue circle. This Ghat connects to Khoga Ghat, which is located on the opposite side, i.e. on the east bank of the river. There are private boat operators who have taken the Ghat on lease basis and work under the Government. This is a moderately busy Ghat. At the ghat, ferries wait till passengers are filled up and then they start moving. Due to the sand erosion, many places near Ghats are eroded. If the Government takes some corrective measures to stop erosion, it could help to boost ferry services.

Table 3.23 Traffic count at Aserkota Ghat

Origin - Aserkota Par Ghat (Khoga) **Destination** - Aserkota **Start Point** - K. B. IN. North Lakhimpur				
Type of Vehicles - Bikes, Cycles, Private Cars & Tempos				
	Units	**Village-Ghat**	**Ghat-Ghat (Across the River)**	
		Tempos	**Motor Boats(Big)**	**Motor Boats (Small)**
Vehicles	No.	6-8	1	1
Capacity	Persons	12-15	40	20
	Bikes	-	10	6
	4 Wheelers	-	3	-
Trips (Average)	No. (Each side)	6-8	6	6

Tariff				
Passengers	Rs/per	30	15	15
Bicycles	Rs/per	-	20	-
Bikes	Rs/per	-	30	30
Cars	Rs/per	-	250	-

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

Figure 3.8 Ferry waiting for Passengers at Aserkota Ghat

3.5.4 Balighat

This is the busiest Ghat in North Lakhimpur district. There are both Government and private operators on this Ghat, who operate ferry services. Government Ferry services run between Bali Ghat to Bali village and private operators run ferry services from Bali Ghat to Na Ali Koibarta. Both Koibarta and Bali Ghat ferry services are equally busy and run simultaneously.

Figure 3.9 Ferry filling up at Bali Ghat (Source: Site Visit)

It can be seen from the below table that Bali Ghat is handling more types of vehicles compared to other Ghats; this also proves that this is the busiest Ghat. Tempo, Jeep & winger are mostly used by commuters rather than bus. Number of trips on this route are also more compared to other Ghats. Motor boat that plies on this Ghat also has capacity to carry heavy vehicles, like tractors & jeeps. Region nearby Bali Ghat has higher population and there are no basic amenities like medical facility, so for daily basic needs also people use river route to go to North Lakhimpur.

Table 3.24 Traffic count at Bali Ghat

Origin - Balighat **Destination** - Ghagarmukh Baligaon/Noali **Start Point** - K. B. IN. North Lakhimpur							
Type of Vehicles - Bikes, Cycles, Private Cars, Bus, Tempos, Winger And Jeeps							
	Units	**Village-Ghat**				**Ghat-Ghat (Across the River)**	
		Bus	**Tempo**	**Jeep**	**Winger**	**Motor Boat (Big)**	**Motor Boat (Small)**
Vehicles	No.	1	6-7	2	3	1	1

Capacity	Persons	30	12-15	15-18	14-16	60-70	15
	Bikes	-	-	-	-	10	6
	4 Wheelers	-	-	-	-	2-3	-
Trips (Average)	No.(Each side)	2	4-5	3-4	4-5	8	8
Tariff							
Passengers	Rs/per	25	30	30	30	10	10
Bicycles	Rs/per	-	-	-	-	20	-
Bikes	Rs/per	-	-	-	-	30	30
Cars	Rs/per	-	-	-	-	400	-
Tractor	Rs/per	-	-	-	-	1,500-2,000	-
Jeeps	Rs/per	-	-	-	-	1,000-1,200	-

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

3.5.5 Khaboli Ghat

Khaboli Ghat is located in North Lakhimpur Circle near Loliti Morang village just opposite to Hastinapur Village. Ferry service from this ghat connects State Highway 21 on both sides of the river. This ghat is also one of the busiest ghats, after Ghagar Ghat. Traffic of this ghat consists of people mostly who come for tourism. World's largest river island, i.e. Majuli is located on the other side of the river which is 20 km away. People from North Lakhimpur come to this ghat by roadways, take ferry service to cross the river and further take road to the Island. Mostly people staying near Majuli come to North Lakhimpur to purchase their daily requirement and goods for their shops.

Table 3.25 Traffic count at Khabuli Ghat

Origin - Khabuli Ghat **Destination** - Luit Khabulu Panchayat **Start Point** - K. B. IN. North Lakhimpur						
Type of Vehicles - Bikes, Cycles, Private Cars, Bus, Mini Tempos & Tempos						
	Units	**Villages-Ghat**			**Ghat-Ghat (Across the river)**	
		Bus	**Mini Temp**	**Tempo**	**Motor Boats(Big)**	**Motor Boats (Small)**
Vehicle	No.	1	5-6	6-7	2	1
Capacity	Persons	25	8-10	12-15	30	15
	Bikes	-	-	-	10	6
	4 Wheelers	-	-	-	2	-
Trips (Average)	No. (Each side)	2-3	6-7	6-8	8	8

Tariff						
Passengers	Rs/per	40	50	50	10	10
Bicycles	Rs/per	-	-	-	20	25
Bikes	Rs/per	-	-	-	25	-
Cars	Rs/per	-	-	-	200	-

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

Schools & Colleges are located in southern region of Subansiri River. People of North Lakhimpur cross this river to go to the other side for teaching or study purpose. This movement happens on daily basis. People staying on the other side of the river come to the market in North Lakhimpur by crossing the river to sell agricultural products like Mustard Seeds, Black Gram & Tea. Anand Bagan, which is a big tea garden is located near North Lakhimpur.

Also, people living on the other side come to this market to purchase their daily requirement like grocery & household goods by using ghats. Not only commodities, livestock like cows, goats & chickens are also traded across the river in ferry boats. Local movement of passengers and goods from either side of the river creates good opportunity for Subansiri River. North Lakhimpur is well developed. People, across the river come here for medical, education and trading purpose. These people would provide opportunity for the river.

3.5.6 Dhunaguri Ghat

Dhunaguri village is located in Sissibargaon Tehsil of Dhemaji district. Dhunaguri Ghat is between Khaboli & Badoti Ghat. The distance between Badoti & Dhunaguri Ghat is about 20 km. Dhunaguri is located 40 km away from North Lakhimpur. Traffic at Dhunaguri Ghat is generated by three sources, i.e. Bihpuria, Bongalmara & Laluk. People living/destined at these places come to the ghat. Following table shows the traffic coming from the above said places to the ghat by various types of vehicles for crossing the river.

Table 3.26 Traffic count at Dhunaguri Ghat

Origin -Dhunaguri (Bongalmara) Destination - Selek Ghat (Majuli District)				
Type of Vehicles - Bikes, Cycles, Private Cars & Tempos				
	Units	**Village-Ghat**		**Ghat-Ghat (Across the River)**
		Tempo	**Bus**	**Motor Boats (Big)**
Start & End Point	-	Bihpuria to Bongalmara Ghat to Laluk Ghat	North Lakhimpur to Ghat	-
Vehicles	No.	20 (From all 3 places)	1	2
Capacity	Persons	10-15	30	60
	Bikes	-	-	10
	4 Wheelers	-	-	3

Trips (Average)	No. (Each side)	8	1	10
Tariff				
Passengers	Rs/per	30	50	10
Bicycles	Rs/per	-	-	10
Bikes	Rs/per	-	-	20
Cars	Rs/per	-	-	200-300

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

Local people use this ghat to go on other side of the river. Mostly teachers from Lulak, Bihpuria & Bongalmara cross the river go to schools, located on other side of the river in Selek, Majuli district. Bongalmara & Bihpuria are well developed places compared to other nearby places, so people from other side come here for Medical, education, commercial purpose. Cash crops cultivated in Majuli district are brought here in upper region of Subansiri river for selling in the Market by crossing the river. Livestock trading is done in both sides of the river. People living in lower region of Subansiri River; like Majuli, are mostly dependent on Ghats for crossing the river for their daily needs.

Figure 3.10 Passengers & Vehicles loading in Ferry on Dhunaguri Ghat

3.5.7 Bodoti Ghat

Badoti Ghat is the least busy ghat among all ghats, mainly due to its poor local road connectivity on North Lakhimpur side. People who use ferries have to walk at least 2-3 kms to reach Bihpuria and then take bus or any other vehicle to travel further. Bihpuria connects to SH 43, which then further connects to NH 52. Due to poor road connectivity, it is difficult to cross the river with vehicles.

Table 3.27 Traffic count at Bodoti Ghat

Origin -Bodoti (Bihpuria) **Destination**- Sepakhuwa (Majuli District)		
Type of Vehicles - Bikes & Cycles		
	Units	**Ghat-Ghat (Across the River)**
		Motor Boats (Small)
Vehicles	No.	1
Capacity	Persons	30
	Bikes	4
	Cycles	20
Trips (Average)	No. (Each side)	8
Tariff		NIL
Passengers	Rs/per	20
Bicycles	Rs/per	10
Bikes	Rs/per	40

Note: Vehicles are from Ghat to Villages; Motor Boats are to cross the river from Ghat to other side

Businessmen from both the sides cross the river for trade on the opposite side. Production of commercial crops, like Mustard seeds & Black gram in lower region of Subansiri River are brought in the market of Bongalmara & Bihpuria by crossing the river. Apart from trading, people living on the other side cross the river for medical, education and purchase of household goods from the market area.

Figure 3.11 Bodoti Ghat

3.5.8 Majuli

Majuli is world's largest and India's first island district. It is the largest river island in the world. It is located between Subansiri river & Brahmaputra river. Majuli island has shrunk in its size owing to soil erosion along the banks by Brahmaputra river. Presently, Majuli's area is 522 sq.km, which has reduced from 1,256 sq.km in 1991. The preventive and protective measures of Brahmaputra Board and the inputs provided by the Ministry of Water Resources has lead to reclamation of 20 sq.km of land increasing the district's area from 502 sq. km in 2004 to 522 sq. km.

The primary occupation of the people in the district is agriculture and paddy cultivation is at the forefront. The district cultivates nearly 100 varieties of rice along with other crops. Fishing as an occupation also provides livelihood and is the staple diet of locals, as the area is covered by water on three sides. Cattle Farming, Dairy, Pottery, Handicraft making, Handloom weaving, Boat making, Sericulture and Horticulture are important economic activities of the district that provide livelihood to locals. Farming and Dairy activities take place in the district owing to huge green pasture lands. Boat making has been a traditional business in the district's households. 20 villages in the district are solely dependent on raw silk from sericulture. Handloom weaving is the highlight of the district. The district is known for its quality weaving of 'Mirzim' fabric cloth by women. This fabric is comfortable and its designs are quite exquisite. Horticulture is popular in the district due to fertile soil and favorable climate, yet it is operated on non-commercial basis.

Majuli is isolated and has no road connectivity with outside region. There exist 6 ghats in Majuli, namely Kamalabari, Salmori, Sumeimari, Dakhinpat, Phuloni, and Aphalamukh. At present, these ghats are the only mode for connectivity with the mainland, i.e. Jorhat, which is located 2.5 kms away from the island. Neemati Ghat is the only river port in Jorhat district that connects 6 ghats of Majuli. There exist regular movement of passenger between ghats of Majuli and Jorhat's river port. Amongst these 6 ghats, two are owned and operated by IWT namely Kamalabari and Aphalamukh, while others

are operated by local authorities. Kamalabari Ghat is the busiest ghat among all, mostly ferries are destined to Neemati Ghat in Jorhat district.

Table 3.28 Ghats of Majuli & its movement to Jorhat

Sr. No	Ghats	Operator	Arrival (Hrs)	Departure (Hrs)
1	Kamalabari	IWT	9.45 to 17.15	7.15 to 15
2	Sumoimari	Majuli Anchalik Panchayat	15.3	8.3
3	Dakhimpur	Majuli Anchalik Panchayat	15.3	8.30 & 9.15
4	Salmora	Majuli Anchalik Panchayat	15.3	8.3
5	Phulani	Ujani Majuli Anchalik Panchayat	15	830
6	Aphalamukh	IWT	11.15	15

In 2013, Jorhat district administration had started a special boat service between Majuli & Jorhat. Two floating platforms were stationed at Kamalabari Ghat and Neemati to facilitate safe loading & unloading of vehicles & passengers. Since this service became operational, it has reduced pressure on passenger ferries between Kamalabari and Neemati.

Figure 3.12 Passengers & Vehicles loading in ferry at Kamalabari Ghat

Figure 3.13 Ferry movement between Neemati Ghat and Kamalabari Ghat

Figure 3.14 Ferry at Neemati Ghat (Jorhat) from Majuli (Brahmaputra). Source: Internet

90% of ferries that ply on Brahmaputra between Jorhat & Majuli are operating illegally without any license, valid papers & safety measures. Service to Salmori, Sumeimari & Dakhinpat ghats from Neemati had stopped operation for sometime, due to checking done by officials. Due to the sudden shut down, traffic of these ghats has shifted to other two ghats which are operated by IWAI. This

results in overloaded ferries. Passengers are facing problems due to congestion on the operational route.

3.5.8.1 Diversion from Ghats

Passenger movement across the river along with vehicles, cattle & goods are happening at large scale. People residing on east side of the river are more dependent on west side of the river due to the market in North Lakhimpur circle. At present, country boats are used for passeneger movement, which lack safety measures and other basic facilities. Due to lack of safety measures, many accidents occurred to both operators and passengers.

Out of the above studied 6 ghats, Khaboli, Ghagar and Dhunaguri Ghat handled the heavy traffic of passengers, along with 2 and 4 wheelers. If IWAI develops these ghats for passenger handling and upgrade ferries with safety measures and basic facilities, then people would not hesitate to take ferry rides and would extensivly use ferries to cross the river. IWAI could provide proper facilities and good service to attract more villagers for crossing the river. It would result in growth in passenger traffic for across the river movement in future.

At present, both way movement is happening on the river. Upper region refers to the western part of Subansiri river, i.e hinterland around the west bank, while eastern part of the river is referred as lower region. Upper region is well developed with all basic amenities and welfare facilities. North Lakhimpur is the biggest market place in the hinterland, which attracts a large number of people from the other side of the river. Lower region of Subansiri river is not much developed as compared to upper region. Agriculture is the only income generating source in the lower region. People living in this region are totally dependent on the uppper region for employment opportunities and daily needs. People travel to the other side of the river for purchasing their daily household requirements.

The table below shows the Origin – Destination of traffic flow across Subansiri River. This analysis is done only for the identified locations for terminal development, i.e. Ghagar, Dhunaguri and Khaboli.

Table 3.29 O-D Pair Analysis of identified terminal locations

River movement	Proposed Locations	Origin	Destination	Purpose for crossing the river
Upper to Lower region	Ghagar	Ghunasuti	Lower Region	Mostly teachers & students travel to schools and colleges located on the other side of the river on daily basis.
	Dhunaguri	Lulak, Bihpuria & Bongalmara	Selek	
	Khaboli	North Lakhimpur	Majuli	Tourists who travel to Majuli Island need to cross the river.
Lower to upper region	Ghagar	Lower Region	Naharlagun, Itanagar, Jorhat, Sibsagar	Agricultural labours / Cultivators travel to the markets to sell their crops. People living in lower region are dependent on other side of the river for purchase of their daily needs.
	Dhunaguri	Lower region of Subansiri and Majuli	Bongalmara and Bohpuria	
	Khaboli	Lower region of Subansiri and Majuli	North Lakhimpur (Market)	People purchase daily household requirements from market located at North Lakhimpur. Shopkeepers of Majuli travel across the river to buy inventory for their shops. Farmers/ Cultivators sell their crops in the market of North Lakhimpur.

3.6 Tourism Traffic

The penetration of river Subansiri in the hinterland is good, but due to lack of cargo generation volume, it is commercially less attractive. There is potential to use this river for tourism purpose.

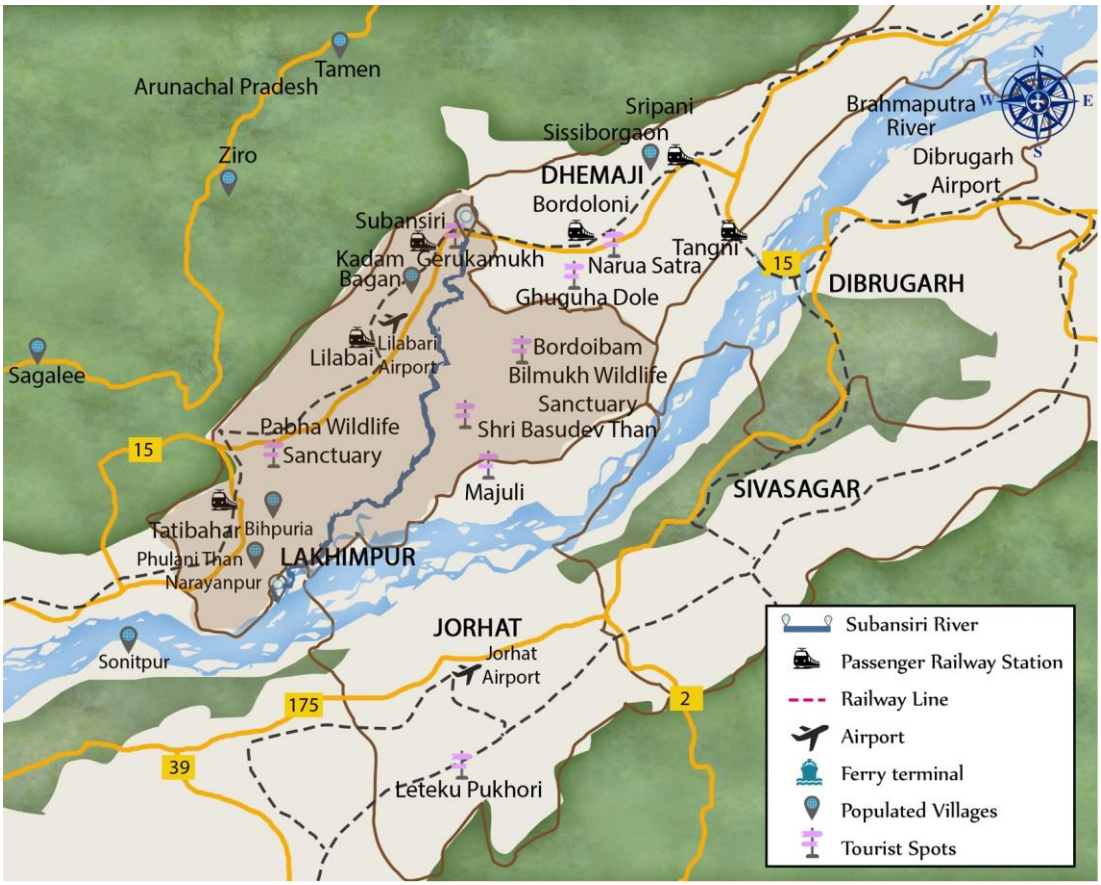


Figure 3.15 Tourism around Subansiri River

3.6.1 Lakhimpur

The main attraction of this district is its natural beauty. Forest & Rivers have created an ambiance of typical northeast greenery and peaceful environment. Several historical temples are situated here, which attract tourists. Lakhimpur is also the gateway to many districts of Arunachal Pradesh. The district's strength is its good rail, road & air connectivity. Nearest airport namely Lilabari is just 5 km away and nearest railway station Nakari is only 5 km away from the center of the city.

- Leteku Pukhori: This place is famous as the birthplace of Saint. Madhabdev. It is located around 10km away from river by road & 15kms from North Lakhimpur town.
- Narua Satra: Built by Damodar Aata, the grandson of Srimanta Sankara deva, this satra is situated in the northeastern part of Dhakuakhana. This place is located 33km away from river by road route.
- Shri Shri Basudev Than: This temple is located 37km away from river via roadways
- Phulani Than: Temple is situated 49km away from river by road.

Apart from Temples, 2 wildlife sanctuaries exist in Lakhimpur, which are known as Pabha Wildlife & Bordoibam Bilmukh.

- Pabha or Milroy Wildlife Sanctuary:

Pabha Sanctuary spreads in an area of 49 sq km. The main reason for creation of sanctuary was to protect wild water buffalo. Great opportunity to see buffaloes, elephants & migratory birds at this place

- Bordoibam Bilmukh Wildlife Sanctuary:
  Located between Lakhimpur & Dhemaji district covering 11.25 sq.km. area. One would get opportunity to see different species birds like large whistling teal, kingfisher bird, pheasant tailed Jacana, black headed gull.

3.6.2 Dhemaji

Dhemaji is mostly preffered by Travellers when they are in northeast side. Best season to visit this place is between Octobers to December. There are total 7 beautiful tourist places in this district. Some of them are listed below.

- Gerukamukh: It is located in west side of district. Regular flow of tourist is happening between Dhemaji, Lakhimpur & Guwahati. It is situated around 24km away from river.
- Ghuguha Dole: Son of Bamuni Konwar was born at this place. This place is built in the memory of Bamuni Konwar's mother Ghuguhi. It is located 28km away from river by roadways.

3.6.3 Majuli

Majuli Island is one of the important tourist destinations of Assam. It comes under Jorhat district on Brahmaputra River. It is situated 20 km away from Jorhat town and 330 km from Guwahati, covering an area of around 880 sq. km. Jorhat city is the only point that connects this island with the other parts of the country by Roads, Railway & Airport.

It is the largest River Island in the world, with 144 villages and total population of 150,000. People living on this island are mostly tribals. Economy is mainly dependent on agriculture. The Island has a rich agricultural tradition. Over 100 varieties of Rice are produced here, like Komal Saul, Bora Saul etc. which are locally consumed. Apart from agriculture, Handloom is also the main occupation of locals. The unique designs of handloom here have received international fame.

Visitors from North Lakhimpur & Dhemaji can take buses or hired taxis to Luit-Khabolughat and Dhokuakhana respectively, and further ferries to reach the Island.

Following are some main festivals celebrated in Majuli Island, which attract whole Assam.

3.6.3.1 Raas Festival

A festival of 3 days, known as 'Raas' is celebrated every year on this island. It depicts the whole life story of Lord Krishna in a very unique manner. People from whole Assam and also from different corners of the country come here to celebrate this festival.

3.6.3.2 Ali aye Ligang

This festival is celebrated with great enthusiasm on February. It starts on 2nd Wednesday of February and lasts for 5 days, i.e. till next week. Traditional dance and songs are performed in every village to worship God for good harvest. Many local dishes are prepared during this festival.

3.7 Growth Trend

The map below shows primary and secondary catchment area of Subansiri River.

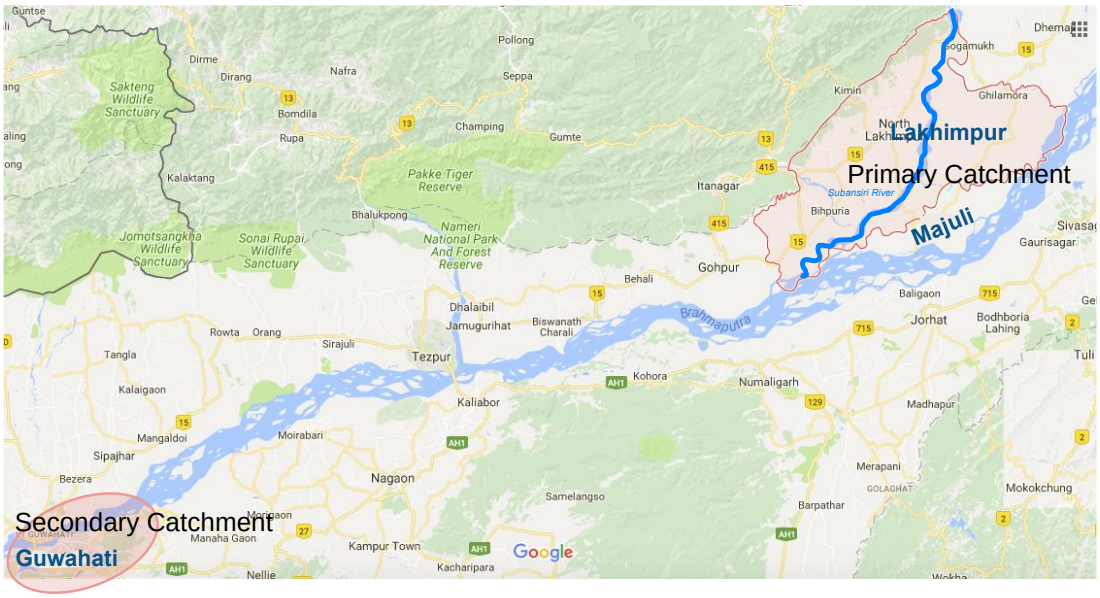


Figure 3.16 Primary & Secondary Catchment Area of Subansiri River

Opportunity for Subansiri River from the primary & secondary catchment area is shown in the below figure. This figure depicts traffic generating sources for river movement. In primary catchment area, opportunity from both across the river and along the river movement have been evaluated. Across the river movement frequently happens, which is likely to increase in future. There is no along the river movement of passengers and cargo. Hence, movement of goods and passenger is only possible in the primary catchment area.

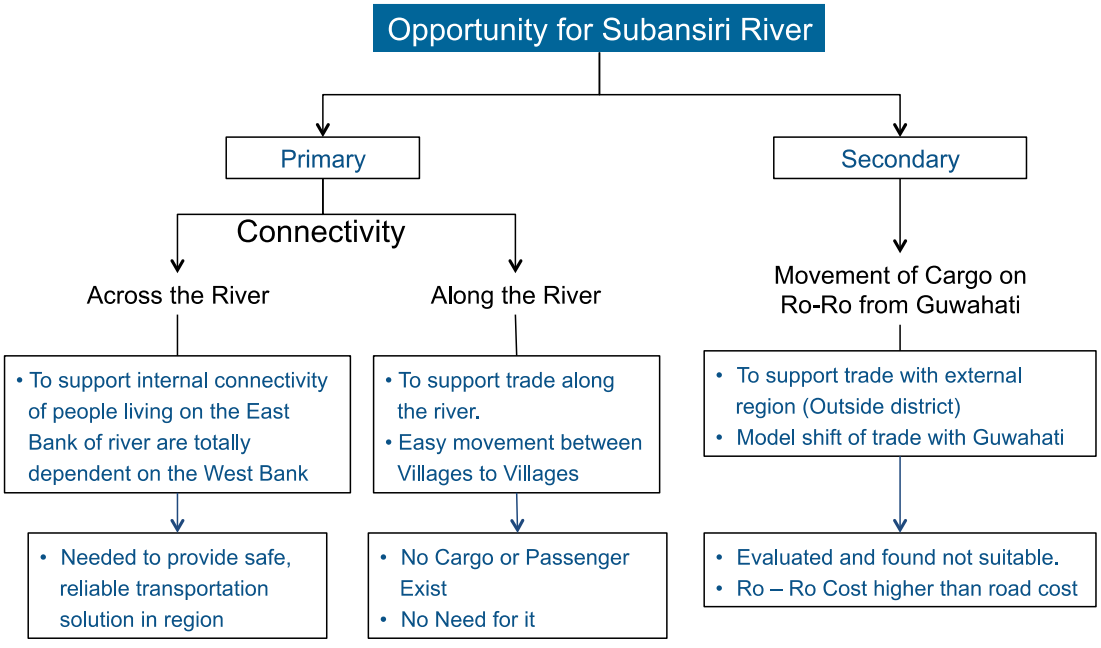


Figure 3.17 Opportunity for Subansiri River

Secondary catchment area for Subansiri River is stretched till Guwahati. At present, few trucks stuffed with building materials are transported from Guwahati to Lakhimpur circle. After the detailed study, it is found that diversion of these trucks from roads to waterway is not possible. The cost involved in Ro-Ro service is far higher than the existing mode of transportation (i.e. INR 9,000).

Detailed cost comparison between trucks moving by roadways & waterways (Ro-Ro service) is shown in the below figure.

Origin	Destination	Distance
Guwahati	North Lakhimpur	380 Kms

Truck Cost Dynamics (21Ft.)

Components	Cost (Rs.)	
Fuel	6,774	(Rs. 17.15/Km)
General R&M	3,600	(Approx. 10%)
Truck Finance Cost	1,850	(Per day)
Driver/Crew	1,000	(Per day)
Profit + Other Cost	9,300	
Toll Charges	1,500	-
Total Cost	**24,024**	**(Rs. 1,144/Ton)**

Ro-Ro Cost Dynamics

Steps involved	Cost (Rs.)	
1st Mile connectivity	1,575	Rs. 60/km (approx. 25kms)
Loading Charges	0	
Ro-Ro Vessel Charge	15,000	(One way)
Unloading Charge	0	
Truck Transportation	15,781	
Last Mile	600	Rs. 60/km (approx. 10kms)
Total Cost	**32,956**	

Figure 3.18 Transportation Cost Comparison for Guwahati – Lakhimpur route

3.7.1 Cargo Growth

There does not exist any industry in the catchment area of Subansiri river. Production of existing industries is very low in volume and is locally consumed. Also, these industries have no future development plans. Therefore, existing industries are unable to provide any cargo opportunity for the river development. These industries would not provide any opportunity even in future.

Apart from industries, there exists one Hydroelectric project on the River, namely Subansiri Lower Hydroelectric Project (SLHEP), which is under final stage of construction. The project site is located near Chauldowa Ghat, which falls at the beginning of Subansiri river stretch, marked for development. SLHEP is owned by NHPC Ltd, and is expected to supply 2,000 MW of power after completion. Construction of SLHEP began in the year 2005, and operation was expected to commence by 2014. Over 60% of the project work is complete. For construction, concrete is procured locally, while cement, iron & steel are procured from other states in small volume. The project is expected to be commissioned by 2018. As this project is near completion, hence future requirement for raw material is very less. The project would be complete by the time the proposed development on Subansiri River materializes. Indicative future prospects from this project have been evaluated. However, the project will not hold any traffic potential for Subansiri River.

3.7.2 Passenger/Ro-Ro Growth

Traffic on Subansiri River is generated by nearby villages which are located on the west bank. People of these villages frequently visit the other side, i.e. east of the river for their basic needs. Road connectivity on both the sides are very poor, as only one National highway that is NH 52 and three state highways i.e. SH 21, SH 22 & SH 43 pass through the district. NH 52 has the only cross over bridge on the river and is located at end point of the river in Kadam. People residing on either side cross the river via Ghats. If these existing Ghats get developed, then across the river movement would increase because people on west bank are completely dependent on other side of the river. Hence, high growth in Passenger & Ro-Ro traffic is expected in future.

3.7.3 Tourism

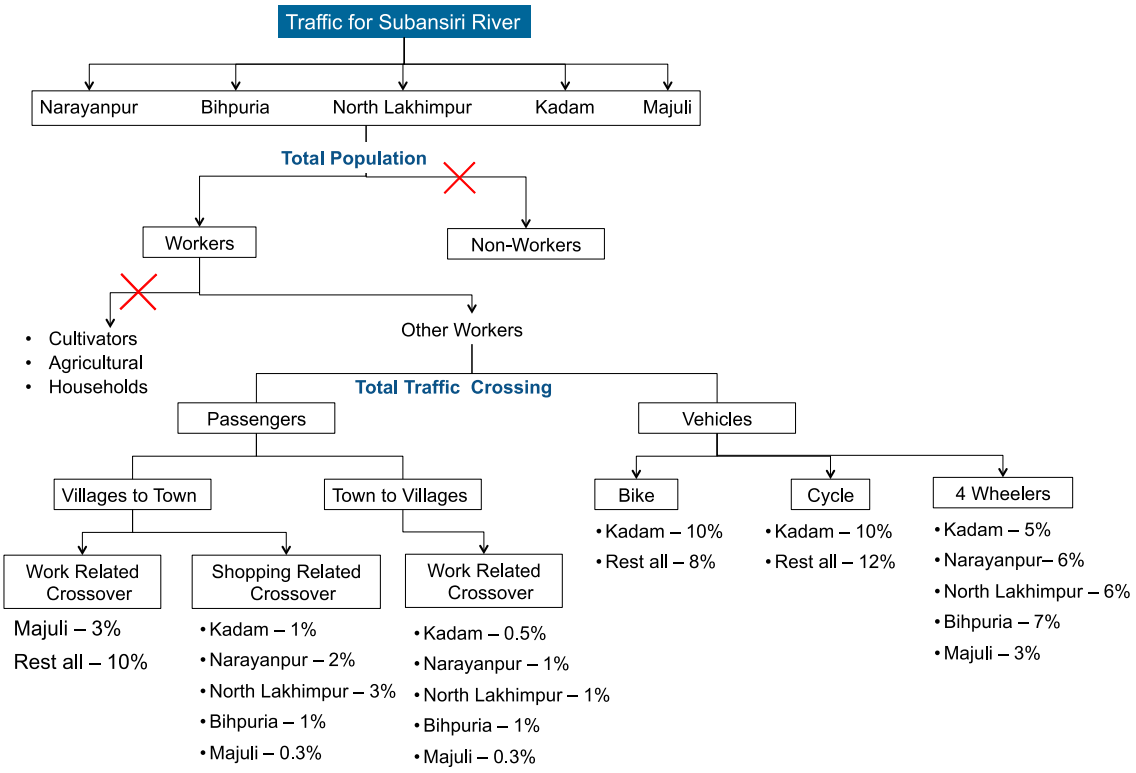
There exist some tourist places, like temples & sanctuaries in Lakhimpur, which fall in the western region of Subansiri river. These places are not much popular and mostly visited by local people. While eastern hinterland of Subansiri River is a big tourist attraction point. Majuli Island is the world's largest river Island which is located in the lower region of Subansiri. Visitors from one side of the river can take the ferry and cross the river to go on the other side. For such ferry services, terminal locations can be identified and further developed for tourism purpose.

As cargo traffic is not possible in the river, so passenger & Ro-Ro facility can be started. If IWAI looks for opportunity in the river from passenger perspective, then good business could be generated.

3.8 Forecasting & Potential IWT Assumptions

Projection of Passenger & Ro-Ro is done for 20 years, under three different scenarios - Optimistic, Base growth & Pessimistic. In traffic projections, various factors are taken into consideration like profiling of population, analysis of hinterland, need for infrastructure to improve connectivity in the region, support to villagers selling their produce in market, need to provide safe mechanism for connecting villages/cities located on the banks of river, etc. The major growth drivers of the proposed waterway in Subansiri river are population and consumption growth in the hinterland, growth in economy and trade of the region, increase in transportation demand for river crossing. These growth drivers are also considered for projecting traffic growth in future.

Below flow chart depicts the detailed methodology used in current traffic identification & projection for next 20 years.



Existing traffic on Subansiri River has been identified by using the above methodology. The ghats which are recommended for upgradation fall under North Lakhimpur, Bihpuria and Majuli revenue circles; only these identified revenue circles are considered for further traffic calculation of each ghat.

Detailed break up of population of villages located on east bank of the river is shown in the below table. Out of these, some particular segments of population are considered for traffic count, while others are ignored.

Table 3.30 Population break up of villages on East bank of Subansiri River

Revenue Circle	Bihpuria	N. Lakhimpur	Majuli
No. of Villages (East of River)	105 (West side)	27	37
Households	22,757	4,032	19,274
Total Population	126,547	27,205	98,457
Total Workers	**47,178**	**13,143**	**46,465**
Others	12,675	675	12,055
Cultivators, Agricultural & Households	32,976	12,468	34,410
Non Workers	79,369	14,062	51,992

Type of Population considered in Traffic count for Subansiri river is as follows; projections of traffic is done on the basis of these assumptions only.

- Work related crossovers involves all those people who works in Hospitals, Schools, Trade centers, Small industries.
- Shopping related crossovers i.e purchase of essential households. East side of the river is totally agri based, for other utilities people has to travel to markets of North Lakhimpur by crossing river.
- Type of Population Excluded from Traffic Count for Subansiri river is as follows; these are the exceptions considered for projecting the future traffic for river.
- Children under 6 years of age are not considered in traffic count for river crossing.
- It is assumed that the people under Non Working class rarely cross the river.
- Agricultural Workers & Cultivators cross the river only to sell their agri products in market of North Lakhimpur i.e after harvesting season.
- Household workers do not travel on other side of river, mostly they work locally only.

Based on the above flow chart, following prominent projections have been made while differentiating different case of Optimistic (7% growth rate), Base Growth (5%) and Pessimistic Scenario (3%). The following projections are made considering Financial Year 2016 data as base data.

Table 3.31 Ghat wise Traffic Projections – Passengers (Daily Crossing Volume (units in numbers)

	Ghats	Fy' 16	Fy' 20	Fy' 22	Fy' 24	Fy' 26	Fy' 28	Fy' 30	Fy' 32	Fy' 34	Fy' 36	Fy' 38	Fy' 40
Pessimist	Ghagar	157	173	185	197	210	224	238	254	270	288	306	326
	Dhunaguri	379	416	442	470	500	531	564	599	636	676	718	763
	Khaboli	224	246	262	279	297	316	336	358	381	405	431	458
Base	Ghagar	157	183	203	225	249	276	305	338	373	412	455	502
	Dhunaguri	379	439	485	536	592	654	722	797	879	970	1070	1181
	Khaboli	224	261	289	320	353	390	431	476	525	580	640	706
Optimist	Ghagar	157	193	222	255	293	336	386	443	509	584	669	767
	Dhunaguri	379	466	534	613	702	805	923	1058	1213	1389	1592	1824
	Khaboli	224	275	316	363	417	479	549	630	723	829	951	1090

Table 3.32 Ghat wise Traffic Projections – 2' Wheelers (Daily Crossing Volume (units in numbers))

	Ghats	Fy' 16	Fy' 20	Fy' 22	Fy' 24	Fy' 26	Fy' 28	Fy' 30	Fy' 32	Fy' 34	Fy' 36	Fy' 38	Fy' 40
Pessimist	Ghagar	18	21	23	25	27	29	31	33	36	40	44	48
	Dhunaguri	53	59	63	67	73	79	85	91	97	103	111	119
	Khaboli	56	62	66	71	77	83	89	95	101	109	117	125
Base	Ghagar	18	21	25	29	33	37	41	47	53	59	66	74
	Dhunaguri	53	62	70	78	87	97	108	120	133	147	163	181
	Khaboli	56	66	74	82	92	102	114	126	140	155	172	191
Optimist	Ghagar	18	24	28	33	39	45	53	61	71	82	95	110
	Dhunaguri	53	66	76	88	102	118	136	157	180	207	238	273
	Khaboli	56	70	81	94	109	126	145	167	192	221	254	292

Table 3.33 Ghat wise Traffic Projections – 4' Wheelers (Daily Crossing Volume (units in numbers))

	Ghats	Fy' 16	Fy' 18	Fy' 20	Fy' 22	Fy' 24	Fy' 26	Fy' 28	Fy' 30	Fy' 32	Fy' 34	Fy' 36	Fy' 38	Fy' 40
Pessimist	Khaboli	29	30	32	34	36	38	40	42	44	46	48	50	53
	Dhunaguri	32	33	35	37	39	41	43	45	47	49	51	55	59
Base	Khaboli	29	31	35	39	44	50	56	62	70	78	87	97	108
	Dhunaguri	32	34	38	42	48	54	60	67	75	83	93	103	115
Optimist	Khaboli	29	32	38	44	52	60	70	81	94	109	126	145	167
	Dhunaguri	32	35	41	48	56	65	75	87	101	117	135	156	179

3.9 Terminal wise IWT Traffic Analysis

Development of Water transport across Subansiri river is the need of the day. This is required to meet essential logistics requirement on Lakhimpur, through which Subansiri passes along with Majuli. There are 6 operational ghats, operating with makeshift arrangement. Majority of the Ghats have been transporting passengers and two wheelers, using wooden boats. Some of them could also transport four wheelers. The demand for cargo and passenger transportation infrastructure in the river would be linked to the growth in passenger, goods and vehicle movement. The catchment area of Subansiri does not have any industries. Hence, there is no requirement to move industrial cargo in the river. The need for development of waterways would be to provide an alternative mode of transportation to local population and help make their day-to-day commute convenient.

The following three modes of transportation were evaluated:

- Cargo or Ro-Ro movement across river – Ro-Ro movement is needed
- Cargo or Ro-Ro movement along river – There is no need for this movement
- Ro-Ro movement from Guwahati – Commercially not viable for regular service. However, this could be used for transporting Over Dimension Cargo (ODC) on a case to case basis

Out of the above studied 6 operational ghats, heavy traffic is found on 3 ghats at Dhunaguri, Ghagar and Khaboli. These ghats need to be upgraded. Ghats on the other 3 locations, i.e. Bali, Aserkota and Badoti are used by passengers on foot and 2 wheelers to cross over to the other side of banks for their daily commute. The present volume of passengers and vehicles is small on these ghats to justify the upgradation of existing infrastructre. It would be advisable for phase wise upgradation of ghats on the identified locations for movement of bigger Ro-Ro ferries that could even carry cars across the river.

- Phase 1 – Upgradation of 4 ghats at Dhunaguri and Ghagar; 2 ghats at each location on both the banks of the river. Large volume of passengers and vehicles are moving across the river on these locations.

Sl. No.	Origination ghat	Destination ghat	Proposed traffic handling
1	Ghagar	Ghunakhuti	Passenger + 4 wheeler
2	Dhunaguri (Bongalmara)	Selek (Majuli District)	Passenger + 4 wheeler

- Phase 2 – Upgradation of 2 ghats at Khaboli; each on both the banks of the river. The landing point on the eastern bank of the river is also closer to Majuli, where heavy flow of traffic exists.

Sl. No.	Origination ghat	Destination ghat	Proposed traffic handling
1	Khaboli	Luit Khabulu Panchayat	Passenger + 4 wheeler

Developing a new terminal would not be advised, as there already exist landing points, which lacks even basic facilities. It is recommended that IWAI would develop these exisitng landing points. Upgrading existing terminals could be cost effective and convenient. These identified locations have good road connectivity with other parts of the district in Lakhimpur. It is recommended to IWAI to upgrade the facilities and infrastrutre at the identified existig Ghats, as the locations are selected on the basis of population residing in the hinterland, present traffic on ghats, need and requirement of locals, connectivity and future prospects. Upgradation and development of these terminals would not only smoothen and boost the traffic, but also would provide locals a safer and convenient mode of transportation. Lack of alternate mode of transportation to cross the river is the reason for locals opting for the existing ferry service, despite lack of safety measures and basic facilties. If IWAI develops infrastructure, then traffic would definitely grow manifold and would generate revenue in near future.

4 Chapter 4: Fairway Development

4.1 General

There is a need to specify the minimum necessary requirements on waterway dimensions, especially from the nautical point of view. Looking on the aspects of Safety and Ease of navigation (defined in PIANC guidelines WG 141 report) and the operational economy of shipping, the design should be generally as generous as possible. Taking into account the traffic density (prognosis), considering impacts on the environment, socio-economic aspects of the waterway improvement, the design should be as narrow as necessary. So, it makes sense to define just these lower limits.

In order to understand the present scenario of available depth in Subansiri River, data collected during the detailed hydrographic survey was analysed for various classes defined .by IWAI. (Classification of inland waterways in india – Regulations 2006)

According to this classification, Water ways have been classified into various classes based on the dimensions of channel depth, width, horizontal and vertical clearances, radious of bends etc. Description of the first four classes is provided in the following table. This description is used to assess the dredging quantity for each sector of the river under consideration.

Sl No	Class	Description
1	Class I	Waterways with navigable channel of minimum depth 1.2 m, bottom width 30 m (in case of rivers) and depth 1.5 m, bottom width 20 m (in case of canals) with minimum radius at bends 300 m, minimum vertical clearance 4 m, and horizontal clearance between piers 30 m, (in case of rivers) and 20 m, (in case of canals)
2	Class II	Waterways with navigable channel of minimum depth 1.4 m, bottom width 40 m, (in case of rivers) and depth1.8 m, bottom width 30 m, (in case of canals) with minimum radius at bends` 500m, in minimum vertical clearance 5 m, and horizontal clearance between piers 40 m, (in case of rivers) and 30 m, (in case of canals)
3	Class III	Waterways with navigable channel of minimum depth 1.7m, bottom. Width 50, m, (in case of rivers) and depth 2.2 m bottom width 40 m, (in case of canals) with minimum radius at bends 700m minimum. vertical clearance 6 m, and horizontal clearance between piers 50 m, (in case of rivers) and 40 m, (in case of canals)
4	Class IV	Waterways with navigable channel of minimum depth 2.0 m, bottom width 50 m, (in case of rivers) and depth 2.5m, bottom width 50 m, (in case of canals) with minimum radius at bends 800m, minimum vertical clearance 10 m, and horizontal clearance between piers 50 m, (in case of rivers) and 50 m, (in case of canals)

Details of shoal lengths and dredging quantity was calculated for four classes. The details of the analysis is presented below.

4.2 Details of Shoals

Shoals and dredging quantity, for various sub stretches calculated as per the detailed hydrographic survey data (Volume # 3) is provided below.

4.2.1 Sub Stretch 1: Chainage 0 km to 4.7 km

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	4.7	0.5	7.4	1200	2016.4	0.3	6.4	1000	4307.1
II					1400	4307.1			1800	7328
III					1800	7328			2000	15199.1
IV					2200	15199.1			2400	27569

4.2.2 Sub stretch 2: Chainage 4.7 km to17.0 km

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	4.7	17	0.5	13.3	2400	9435.0	0.3	12.3	2600	25362.6
II					3000	18960.6			3000	37893.2
III					3800	29942.1			4000	62392.6
IV					6800	61938.0			7000	118494

4.2.3 Sub stretch 3: Chainage 17.0 km to 28.0 km

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	17	28	0.5	11.2	2400	10886.2	0.3	10.2	2600	129716.3
II					3000	23010.7			3000	198997.4
III					3800	41728.6			4000	258011.5
IV					6800	104265.7			7000	440090.6

4.2.4 Sub stretch 4: Chainage 28.0 km to 37.6 km

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	28.0	37.6	0.5	9.0	2600	21313	0.3	8.3	2800	140600.3
II					3400	41980.5			3400	228626.5
III					5000	73977.6			5000	311617
IV					6800	169022.8			6600	558199.3

4.2.5 Sub stretch 5: Chainage 37.6 km to 47.9 km

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	37.6	47.9	0.3	11.5	7000	41328	0.3	10.5	7000	332035.1
II					7200	77903.5			7800	519144.9
III					7200	129880.5			8000	675183.6
IV					9000	288213.8			8800	1119229

4.2.6 Sub stretch 6: Chainage 47.9 km to 58.9 km

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	47.9	58.9	0.9	9.1	4200	54024.7	0.3	8.1	4600	374052.9
II					5000	104242.4			5200	585506.9
III					6000	183256.3			6200	779683.1
IV					7200	398922.5			7800	1294525

4.2.7 Sub stretch 7: Chainage 58.9 km to 69.6 km

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	58.9	69.6	0.5	7.4	5600	63968.2	0.3	6.36	5400	447662.2
II					6000	131050.9			6600	712007.4
III					6200	237984.7			7600	971023.2
IV					7600	523237.2			8000	1622867

4.2.8 Sub stretch 8: Chainage 69.6 km to 79.5 km

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	69.6	79.5	0.5	10.7	2000	65232.3	0.2	9.7	2400	528127.4
II					3000	136053.5			3400	832486
III					4800	255106.2			5000	1138874
IV					6400	575707.2			7000	1893855

4.2.9 Sub stretch 9: Chainage 79.5 km to 89.3 km

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	79.5	89.3	0.3	11.2	2200	68220	0.3	10.2	2200	593478.2
II					3200	143911.1			3200	953555.5
III					3600	272714.4			4000	1288546
IV					6400	616340			5800	2164409

4.2.10 Sub stretch 10: Chainage 89.3 km to 100.25 km

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	89.3	100.25	0.9	9.4	4600	77815	-0.3	8.4	4400	727072.3
II					5800	163890.6			5400	1147469
III					5800	305088.2			6400	1526669
IV					6600	685903			6800	2545813

4.2.11 Sub stretch 11: Chainage 100.25 km to 106.0 km

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	100.25	106.0	0.3	8.6	4400	108437.2	-0.3	7.6	4200	1271533
II					4400	218662.8			4400	1858835
III					4600	383886			4400	2290616
IV					4600	820625.5			4800	3545951

4.2.12 Shoals and dredging quantity for the entire stretch

Total length of shoal and dredging quantity is provided in Table 4.1. shoal lengths and the dredging quantity calculated using the data collected during the detailed hydrographic survey shows that to develop waterway and maintain it is only economically feasible if the cargo volumes are high.

Table 4.1 Shoals and dredging quantity for the entire stretch

Class	**Chainage (km)**		**Observed (during 17 Nov 2016 to 28 Dec 2016)**				**Reduced w.r.t. Sounding Datum**			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)
I	0	106	0.3	13.3	38600	0.5	-0.3	12.3	39200	4.5
II					45400	1.2			47200	7.0

Class	Chainage (km)		Observed (during 17 Nov 2016 to 28 Dec 2016)				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Quantity (MCM)
III					52600	1.9			56800	9.3
IV					69800	4.2			74300	15.3

4.3 Fairway for Subansiri

The need for development of waterway is to provide an alternative mode of transportation to local population and help make their day-to-day commute convenient. A detailed traffic survey was conducted to identify and assess the traffic potential of the proposed waterway and details are given in the previous chapter. The results of the traffic study strongly advocate against developing and maintaining the river for longitudinal traffic other than for ODC cargo.

Three modes of transportation were evaluated for financial feasibility analysis and the details follows:

- Cargo or Ro-Ro movement across river – Ro-Ro movement is needed
- Cargo or Ro-Ro movement along river – There is no need for this movement
- Ro-Ro movement from Guwahati – Commercially not viable for regular service. However, this could be used for transporting Over Dimension Cargo (ODC) on a case to case basis

The study suggests that developing a new terminal would not be advisable, as there already exist landing points, which lacks even basic facilities. It is recommended that IWAI would develop six exisitng landing points where the traffic is high. Upgrading existing terminals could be cost effective and convenient. These identified locations have good road connectivity with other parts of the district in Lakhimpur. The locations are selected on the basis of population residing in the hinterland, present traffic on ghats, need and requirement of locals, connectivity, geomorphological analysis and future prospects.

Upgradation and development of these terminals would not only smoothen and boost the traffic, but also would provide locals a safer and convenient mode of transportation. Lack of alternate mode of transportation to cross the river is the reason for locals opting for the existing ferry service, despite lack of safety measures and basic facilties. If IWAI develops infrastructure, then traffic would grow manifold and would generate revenue in near future.

Hence it is proposed that fairway may be maintained at three locations in Subansiri River. The suggested waterway class is class II.

4.4 Proposed Conservancy Activities

4.4.1 Low Cost structures

Structures like bandalling (Figure 4.1) are used to maintain the longitudinal fareway especially during the lean season. A detailed study including 2D numerical modelling may be taken up to understand the effectiveness of these structures in maintaining transverse channels.

Figure 4.1 Bandalling in Brahmaputra River

4.4.2 Dredging

Dredging has to be performed only at the stretches for cross river traffic for movement of passenger and vehicle ro-ro traffic. Locations identified for developing cross-shore transport is listed below.

The Total dredging quantity for cross shore movement alone is worked out as 199930.7cum

The capital cost for dredging is estimated to be ₹ 3,99,86,000 considering per cum cost of approx. ₹ 200.

Table 4.2 Regions where fairway need to be developed

Sl. No.	Main Ghat	Auxiliary Ghat	Proposed traffic handling	Proposed developments
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4-wheeler	Dredging and developing cross-shore channel to the level of Class II.
2	Khaboli/Khabolu (Chainage 41.00 km	Luit Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4-wheeler	
3	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Chainage 27.00 km)	Passenger + 4-wheeler	

4.4.3 River Training

River training activities are not proposed for maintaining cross shore channel.

4.5 Bank Protection / Embankment Strengthening

The terminal design (Chapter 5) do not propose any permanent structures near the bank as classical terminals have. Hence, bank protection is not proposed for Subansiri River.

4.6 Navigation Markings / Navigation Aids

Floating buoys are proposed as navigation aids. VHF radio is also proposed to be engaged and costing is included in the CAPEX.

4.7 Modification Requirement in existing Bridges / Cables / Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

No modification is suggested as there is no existing structures that obstruct the navigation

4.8 Fairway Costing

4.8.1 Capital Cost

The capital cost for dredging and aids to navigations under various phases are provided below

Sl. No.	Description	Total (in Rs.) (lakhs)
Fairway development		
1	Dredging	₹ 399.86
2	River training/ Bank protection / embankment strengthening works	₹ 0
3	Navigation markings / Navigational aids	₹ 3.00

4.8.2 O&M Cost

The O&M cost is estimated as 5% annually of capital cost for dredging and that for navigational aids as 2%.

5 Chapter 5: Terminals

5.1 General Review

As discussed in chapter 3, traffic in Subansiri River is basically generated by people commuting across the river. The road connectivity from city being poor near the banks of Subansiri, local people rely on local country boats for travel and cargo movement (though volume is less) across the river. Terminals in Subansiri River should be strategically placed in such a way that enough traffic passes through the terminals and should help in developing the hinterland associated with the terminals. Facilities associated with the terminal should meet the traffic demand nevertheless, as the resources are scare, the investment made should be economically viable.

5.2 Factors influencing terminal locations

Terminals are centers of receipt, export, storage distribution of cargo and embarkation of passengers. They are the shelter where vessels can berth and load and unload cargo and get its supplies. At present local ferry services (mainly using motorised country boats) are operated at many places however, no basic infrastructure such as berths or jetties are available currently. Planning of inland terminals and other associated development works should consider changes patterns of trade, future expansions etc. Accordingly, main aspects requiring careful consideration in selection of terminal locations are

- Site condition
- Water area planning
- Navigational aids
- Berths
- Cargo handling systems
- Sufficiency of land provision

5.2.1 Challenges in Subansiri River

5.2.1.1 Traffic

Locations of terminal have the major role in making a waterway successful. Thus, terminals are to be located at high traffic region. Traffic study revealed that the present/ forecasted volume of cargo, passengers and vehicles are negligible to justify large scale engineering intervention on the banks of Subansiri River. The study recommended that upgrading existing terminals could be cost effective and convenient instead of developing a new terminal.

5.2.1.2 Morphology

It was observed during the morphometric analysis that the river I highly braided and meandering in nature and hence is not morphologically stable. Majority of the existing ghats analysed are found to be stabe for the past 5 years except Ghagar Ghat. However, being a meandering river, the stability of the banklines may not be taken for granted. This factor is taken into consideration while designing the terminal.

5.2.2 Approach

It was noticed that even though quite small, there is a cross-shore (transverse) movement at various locations of the river. Keeping the above challenges in mind a masterplan was made to vitalise the cross-shore transport by identifying optimum terminal locations and cost effective terminal design.

5.3 Identification of terminal Locations

The economic and commercial aspects being fundamental considerations which guide the terminal site selection; however, there are 6 main operational ghats at the right bank of the river. Their complementary ghats that are in the left bank are smaller in nature, operating with makeshift arrangement namely Ghagar, Khaboli/Khabolu, Dhunaguri, Ghagar, Bali and Badoti. Main ghats are in the right bank of the river and in the left bank., these locations of existing ferry ghats are also given preferences mainly because the road connectivity is already present for these locations..

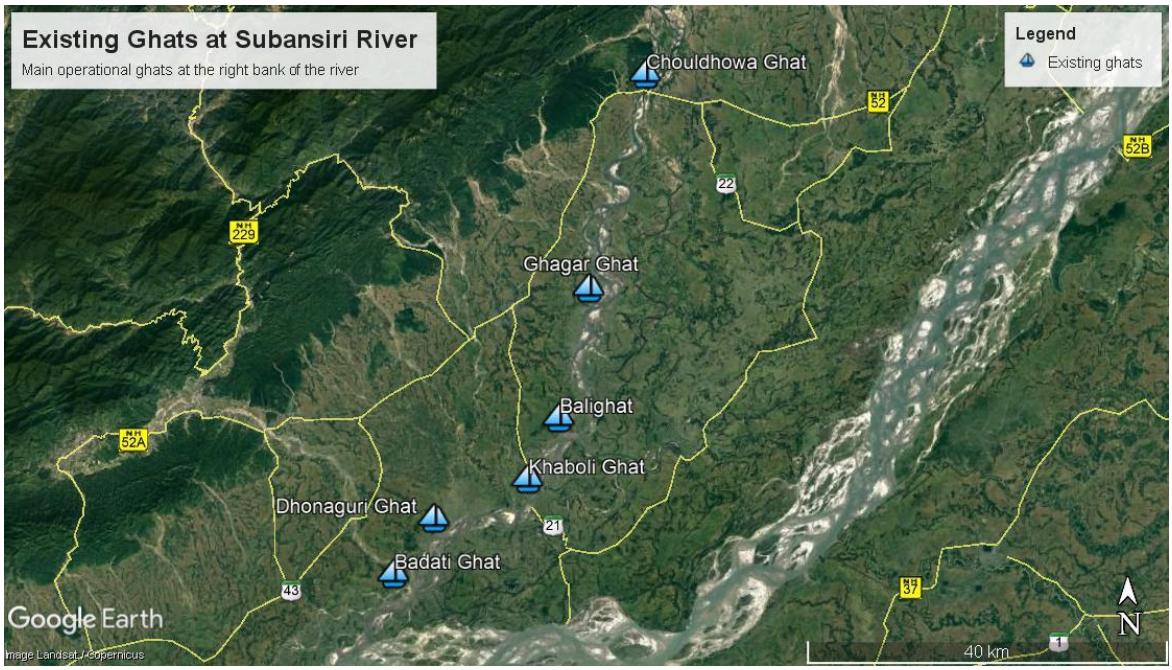


Figure 5.1 The locations of main existing ghats

Landside and waterside considerations for identifying terminal locations for the current project is explained below.

5.3.1 Water side considerations

The capacity of the water area was evaluated based on the requirements. The major requirements for the harbour basin includes:

Berthing area

Berthing area based on the dimensions of the largest design ship and number and type of ships to be attended. The dimensions of the berthing area to be 1.1 times length of the design vessel X 1.15 times the beam of the design vessel.

Width required for manoeuvring

The width required for manoeuvring is approximately 0.6 times the length of the vessel for berthing parallel to the fairway.

The diameter of turning circle

The diameter of turning circle will depend on the method used for turning. If the vessels are turned by warping around the dolphins, the requirement is 1.2 times the length of the design vessel. The minimum diameter of the turning circle should be 1.7 to 2 times the length of the design vessel if vessels turn by free interplay of the propeller and rudder assisted by tugs. For no tug assistance, the diameter is taken as 4 times the length of the design vessel. In the present project, it is proposed to have turning circles of 2 times the length of the design vessel.

Most of the existing ghats satisfy the water side considerations. Since priority is for passenger and ferry crafts, water side requirements are relatively small.

5.3.2 Land side considerations

Availability and price of waterfront land, soil conditions and elevation, utilities connection, minimum environmental impacts, etc. are the basic considerations. The minimum area required in the land side depends on the type and amount of cargo to be handled, type of equipment to be used, extend of storage required, layout of connectivity inside the terminal area, etc.

field visit have made it clear that all the locations that is identified are goventment land. Hence land acquisition is not a problem for the project even if a future extension is planned.

Transportation considerations

The terminal regions are required to have good network of roads and rails. The NH-15, along with SH-15, 21 and 22 connects the Ghats to the hinterland. SH-21 is on both the sides of the river. NH-52 passes through Dhemji crossing the river at Dal Bhasti. The ghats like Boginadi, Ghagar, Asserakata, Boginiya, Dhunabari, Senimora, Badoti1, etc., are connected directly to NH52 via local roads. A railway bridge (of Northern Frontier Railways) crosses the river near Chauldhowa ghat.

Cost considerations

This includes availability of reliable and cost-effective utilities, availability of financial incentives if applicable.

Traffic potential

This is one of the major factors to be considered while selecting the location to be developed to a terminal. The traffic either passenger or industrial available in the hinterland is a governing factor. The extent of investment is determined based on the local community that will be benefited or based on the industrial cluster that enjoys the benefit.

Regarding the industrial spots, the originating and terminating traffic in and around the entire river is from revenue circle of Lakhimpur. But due to their proximity to rail and road connectivity and existing connectivity to the ghats, for the present study, industrial traffic is considered as a secondary potential only for the time being. Passenger movement, transport of agricultural products and small scale industrial output transport are given priority here.

Emphasising is given to the ghats with relatively good traffic potential among the existing ones. The traffic generating from Ghagar ghat moves towards Gunakhuti, which includes cycles, bikes, private cars and tempos. The traffic from Dhunaguri (Bongalmara) are destined to Selek Ghat (Majuli). Bongalmara and Bhimpara are well developed places as compared to the nearby areas, hence they are relied for medical, education and commercial purposes

Other factors

presence of cross-river structures like bridges and HT lines, land availability etc were also given preference.

Considering the above factors along with the tourism potential and forecasted traffic scenario of the traffic study, it is suggested to provide terminal infrastructure at 4 Ghats (2 on each bank) in Phase I

for movement of passengers and two wheelers. These ghats can be made capable of handling passengers and vehicles up to 4 wheelers.

5.3.3 Identified terminal locations

Considering all the above factors, it is identified that providing RO – RO facility at selected locations is feasible, and this will support the villegers especially residing at the right bank with little road connectivity to the towns at the right bank. Six (6) locations is identified for terminals. Three each on both sides of the river.

Table 5.1 The identified terminal locations

Sl. No.	Main ghat	Auxiliary ghat	Proposed traffic handling
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4 wheeler
2	Khaboli/Khabolu (Chainage 41.00 km)	Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4 wheeler
3	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Majuli District) (Chainage 27.00 km)	Passenger + 4 wheeler

The snapshot of the locations of the terminals (topography & bathymetry) are provided in Figures below. For detailed map, please refer Volume # 2 – Drawings.

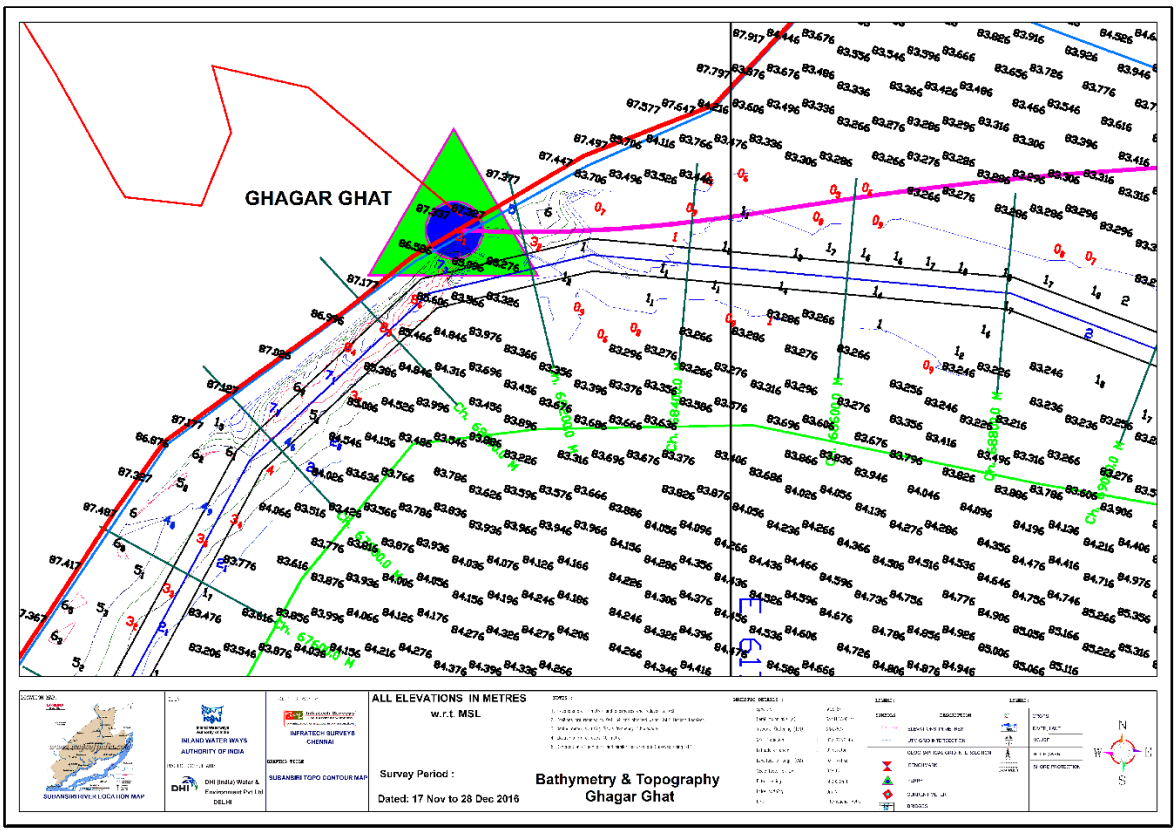


Figure 5.2 Topography and bathymetry of identified terminal location at Ghagar

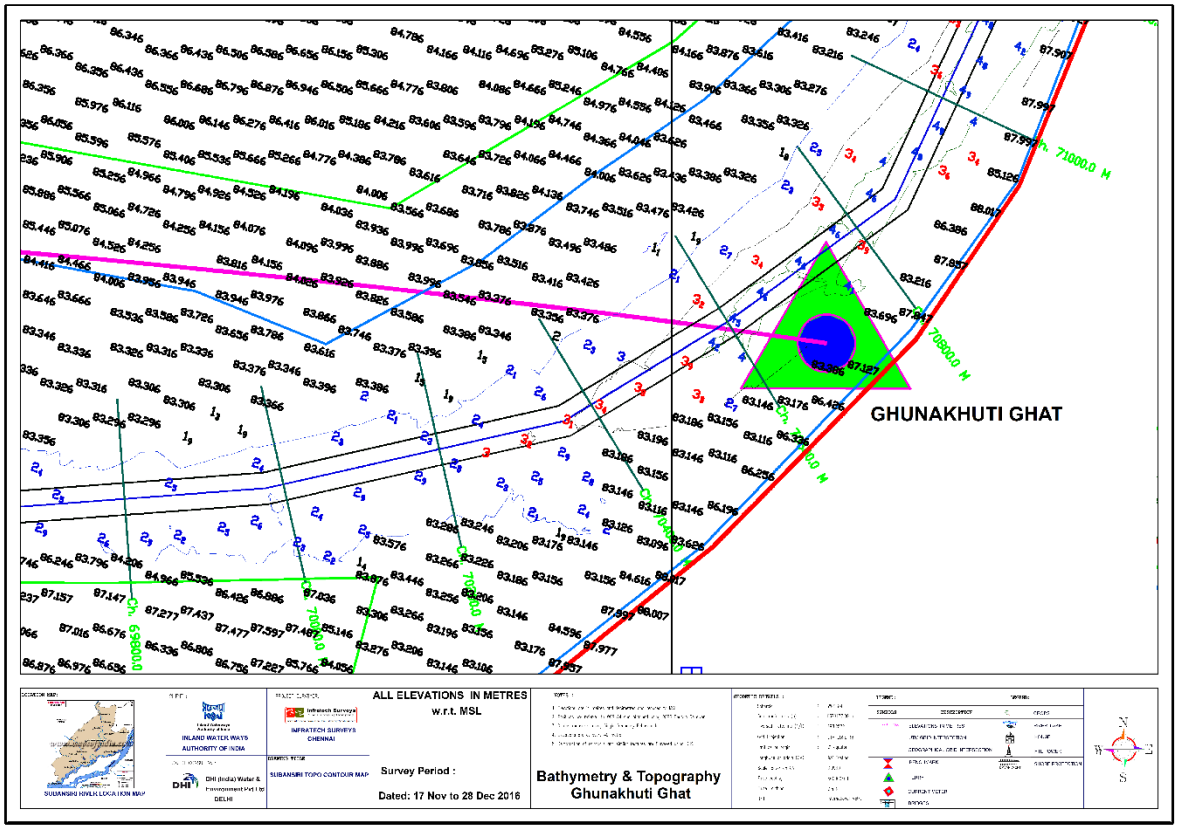


Figure 5.3 Topography and bathymetry of identified terminal location at Ghunakhuti

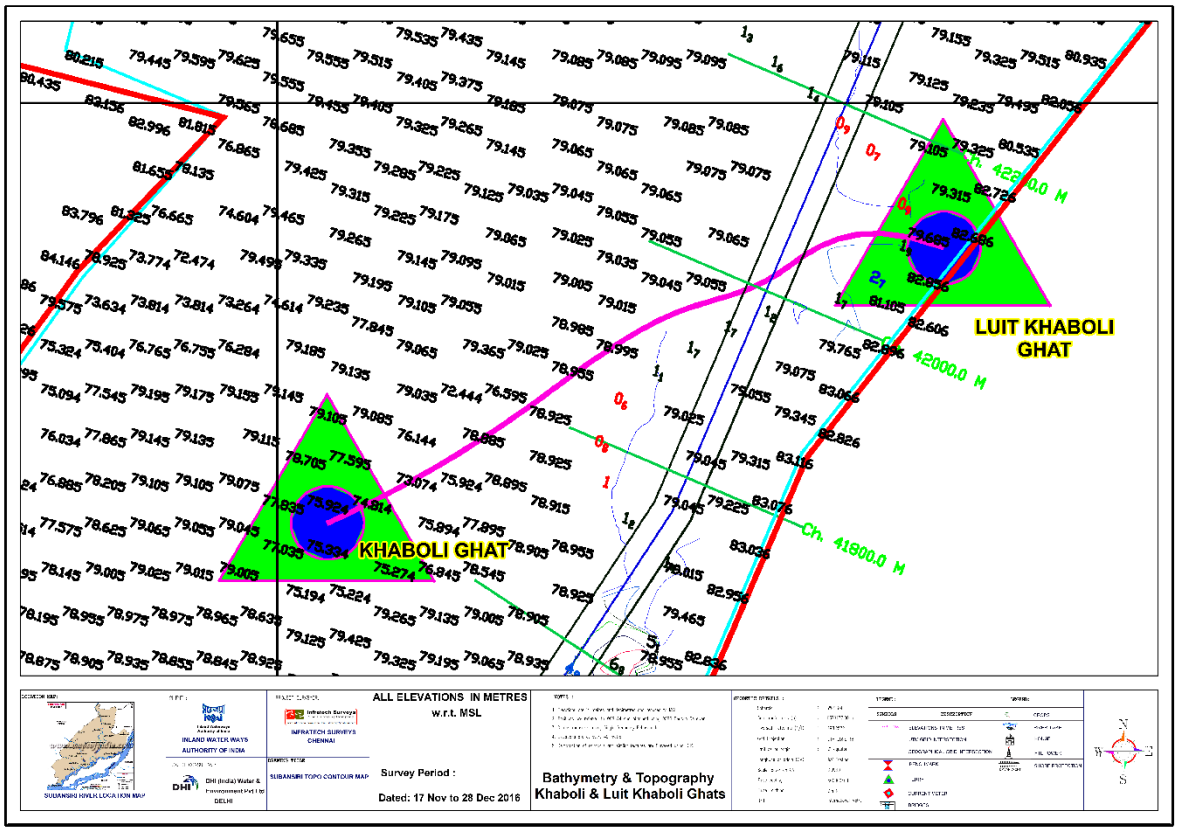


Figure 5.4 Topography and bathymetry of identified terminal location at Khaboli and Luit Khaboli

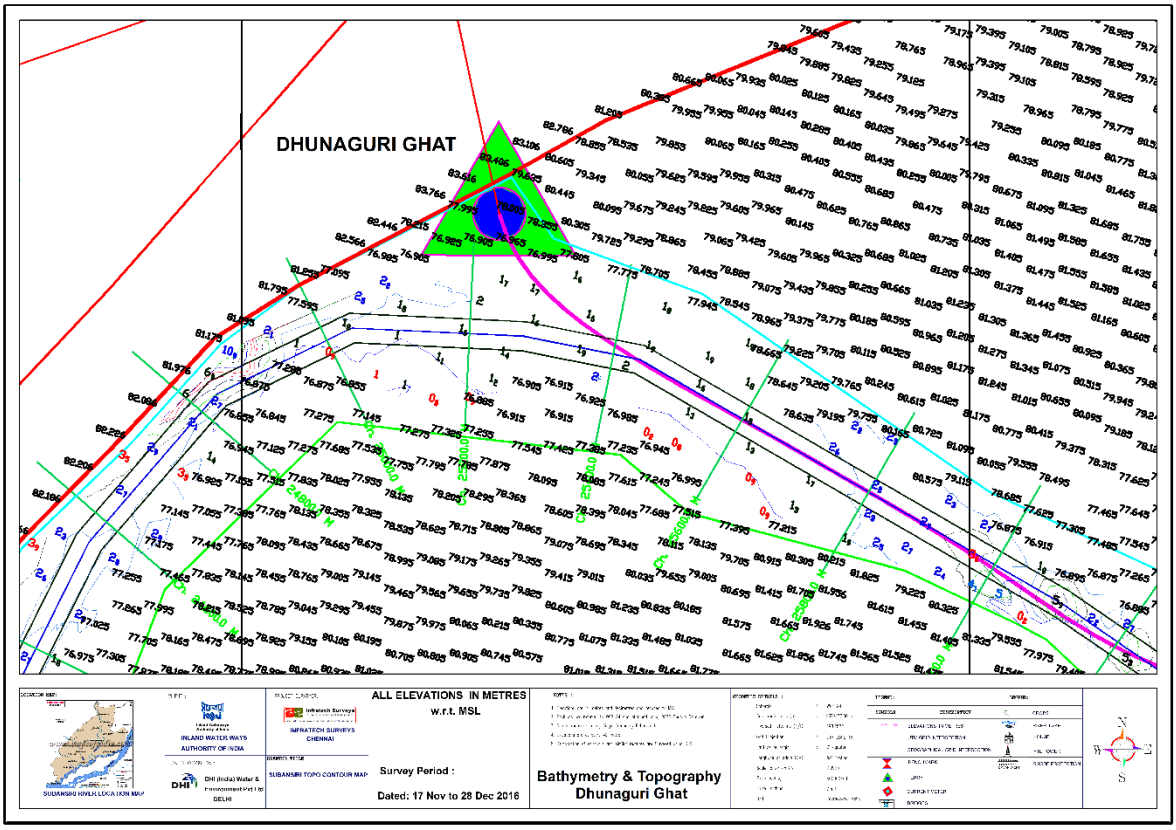


Figure 5.5 Topography and bathymetry of identified terminal location at Dhunaguri

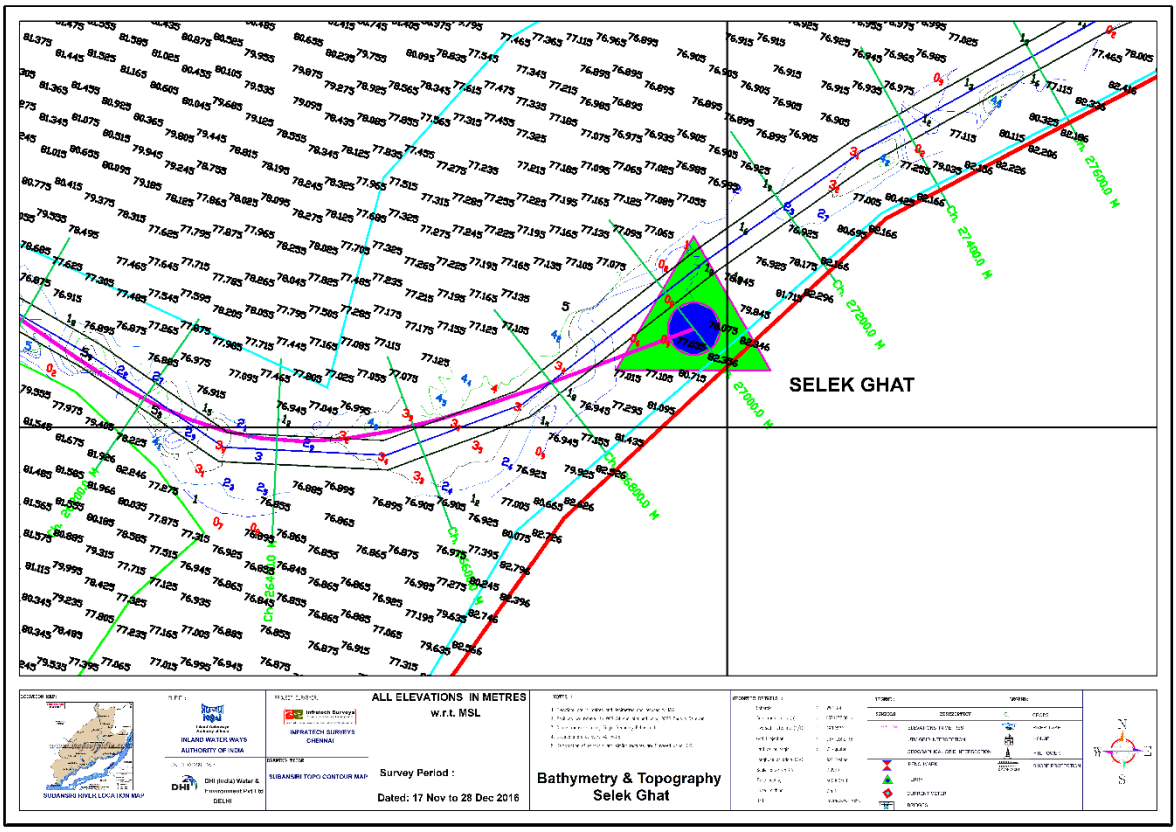


Figure 5.6 Topography and bathymetry of identified terminal location at Selek

5.4 Land Details

The location of terminals proposed are at Ghagar, Khaboli and Dhunaguri on both banks. Amongst this, Khaboli Ghat is famous for its proximity to Majuli Island. Cross river movement is more relevant along the river stretch. People on east side of the river depend on the west side i.e., the market in North Lakhimpur circle. The major portion of the right bank of the river is occupied by agriculture. Major crops are rice, tea, mustard, sugarcane, black dhal, vegetables like, radish, cabbage, cauliflower, etc. The left bank mostly occupied with scattered forest area and agriculture. The most important forest products are timber, bamboo and firewood. In the Bongalmara ghat (Dhunaguri) and Ghagar ghat, the road connectivity exists till the terminal location as per the topographic survey report. In locations of Selek ghat and Ghunakhuti ghat, the terminal needs to be connected to nearby road way which seems to be almost 5km away. The Selek ghat is proposed to be connected to SH 21 (Jengraimukh road) and the Ghunakhuti ghat is suggested to be connected to the Baghmara Gaon road.

5.4.1 Land owenership

The land owenership details were collected from respective revenue circles. It was found that all the locationso of the proposed terminals are gorvenment land except Khabuli Ghat. Location identified for the proposed Kabuli ghat is a forest land and need approval from the department of forest, before proceeding with any construction in this location. Certificates from the revenue officials are attached as Annexure B

As per the Revenue circle officers, all the locations in the left bank of the river are non cadastral villages (implies that no survey have taken place yet in those villages till date and hece they are all considered as government lands.

Sl. No	Location at Subansiri River	Termainal location	Remarks
1	Land identified for Ghagar Ghat is approximately 9 km from North Lakhimpur (NH 52). It is Govt. land located in Dag No. 32 of 4 No. Hindu Village under Lakhimpur Mouza in North Lakhimpur revenue circle	Right bank of Subansiri River	Repair works are already taking place on the road to the land identified. Area need some levelling
2	Land identified for Ghunasuti is Govt. land located in Palashpara NC Village under Lakhimpur Mouza in North Lakhimpur revenue circle	Left bank of Subansiri River	Road present is kachcha road, catering to nearby villages
3	Land identified for Dhunaguri Ghat is adjacent to exisiting facility of IWT. It is Govt. land located in Daf No. 408 of Dhunabari map under Bihpuria Mouza of Bihpuria revenue circle	Right bank of Subansiri River	Land needs some levelling. A few temporary shops are present in the identified land
4	Land identified for Selek Ghat is Govt. land located in Chelek Village (NC) under Dhalpur mouza in Narayanpur Revenue circle	Left bank of Subansiri River	Land needs some levelling. Road present is kachcha road, catering to nearby villages and Majuli island

5	Land identified for Khabuli terminal office is Govt land located in Alisinga Village under Telahi Mouza in North Lakhimpur revenue circle	Right bank of Subansiri River	Land needs levelling, road from North Lakhimpur is pakka road. Land is under forest department
6	Land identified for Luit Khabuli terminal office is Govt land located in Alisinga Village under Telahi Mouza in North Lakhimpur revenue circle	Left bank of Subansiri River	land needs levelling. Road is kachcha road catering to small NC villages

5.5 Geotechnical Investigations

From the observations and literature available regarding the soil properties at these locations, it is observed that the soil is fairly good for construction. Also, since no major fixed constructions are proposed, detailed sub-soil study (geo-technical investigation) may not be necessary, at least at this stage.

5.6 Master Planning

In the current scenario, the traffic status implies that terminals at 6 locations may be provided by upgrading the facilities at existing ghats. Two sets of amenities (one for right bank terminals and another for the left bank terminals) are proposed for the proposed terminals. Based on this a master plan for development is made.

5.7 Terminal Layout

Considering the cargo, passenger and vehicle traffic the master plan for the terminal locations is prepared. It is suggested to provide the essential amenities in phase I to different terminals, by prioritising the terminals based on their present and forecasted traffic potentials.

Since it is observed that the course of the river is unstable, with the bank/ ghat location changing after flood every year, options with maximum makeshift arrangement is considered. The typical master plan layout for the options are attached in Volume –II.

For the terminals at the right bank of the river – ie; Ghagar, Khaboli and Dhonaguri; a main terminal building with vessel crew resting area, office block, passenger waiting area and security staff room is proposed. For the terminals at the left bank (Ghunasuti, Luit Khaboli and Selek) auxiliary terminal building with passenger waiting area and a security staff room are proposed. It is also proposed that the fairway (cross-shore only) may be developed to a class II type.

5.7.1 Terminal Connectivity

The road connectivity to the terminals proposed can be seen in the Figures below.

In Dhunaguri Khaboli and Ghagar ghat, the road connectivity exists till the terminal location as per the topographic survey report. In locations of Selek ghat, Luit Khaboli and Ghunasuti ghat, Kutcha village roads exist.

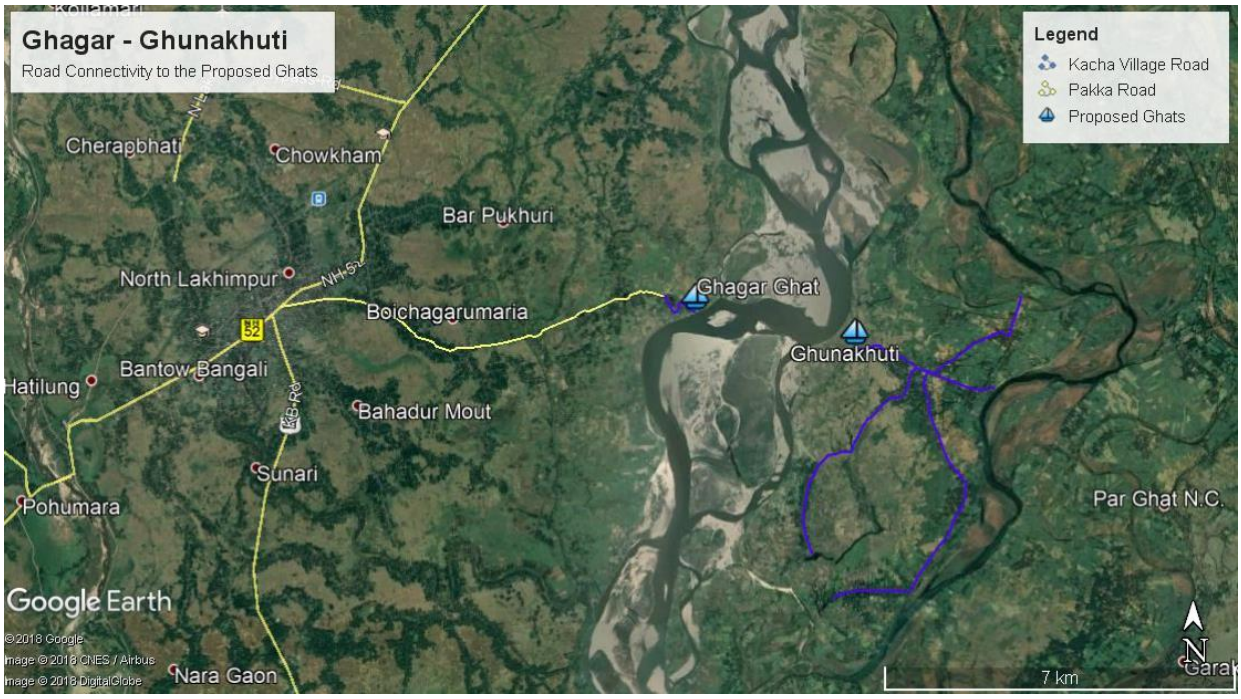


Figure 5.7 Road connectivity – proposed Ghagar Ghat

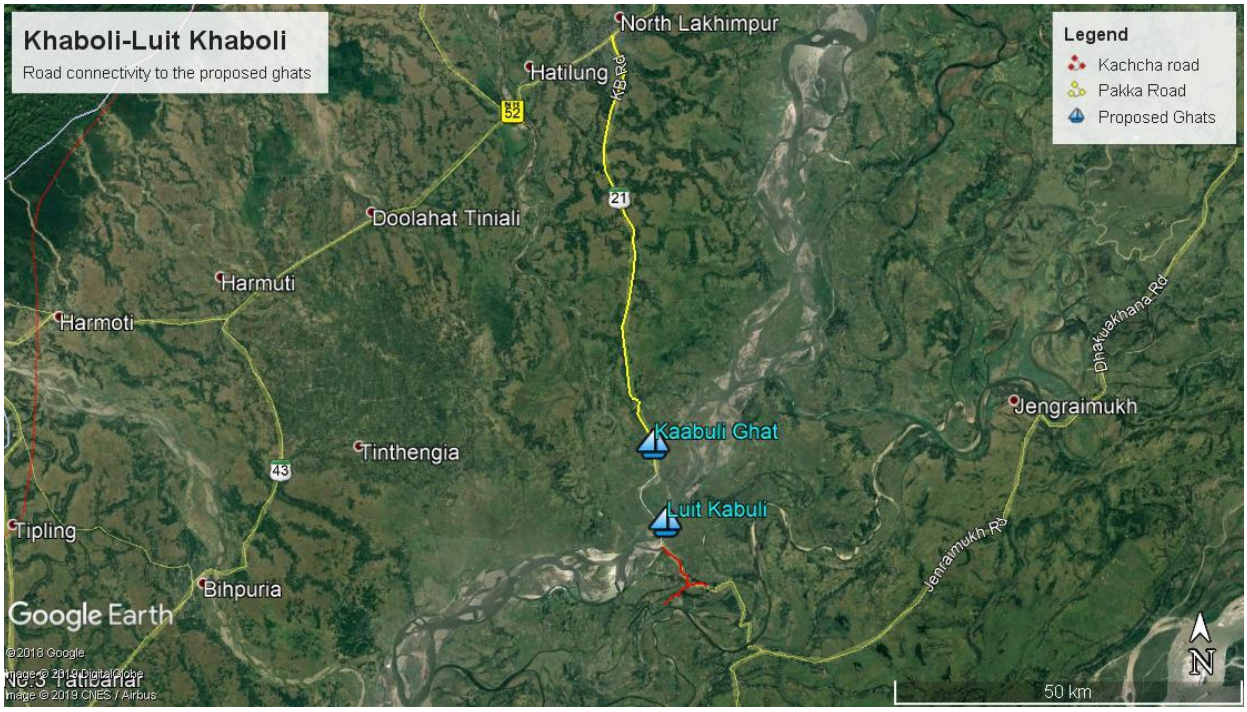


Figure 5.8 Road connectivity – proposed Khabuli ghat

Figure 5.9 Road connectivity – proposed Dhonaguri ghat

5.8 Berthing Structure

Berthing structures are used for berthing and mooring the vessels while they are loading or unloading the passengers/ vehicles. The length of the berthing quay is required to be sufficient to safely accommodate the largest vessel or barge expected.

The major concern in the present project is regarding the unreliable nature of river channel and large water level fluctuations. By referring to details from secondary sources, remote sensing data and from inferences of the site visit by technical experts, it is observed that the banks of the river exhibits frequent shifts, the extent of flood plain is large and varying and water level fluctuations in the river channel is large. Assuming these factors to be governing, different alternative solutions were considered and two options which proved to suite the situation are described below.

5.8.1 Option 1: Floating pontoon quay and access trestle

A floating structure and access system which can be easily shifted to different locations is considered as first option. The Figure 5-13 below gives a typical pictorial representation of the proposed arrangement.

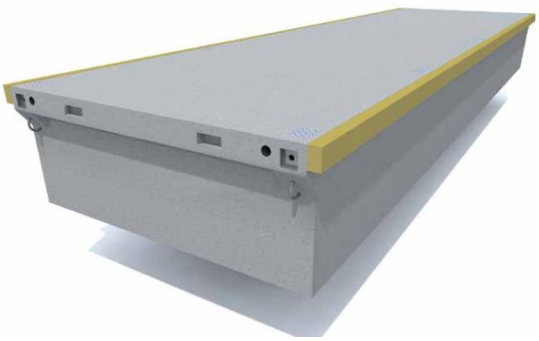


Figure 5.10 A retractable pontoon jetty and pictorial view of a floating pontoon

The floating pontoon is to be anchored to the river bottom, such that the transverse movement of the pontoon is resisted at the same time the anchorage shouldn't have any permanent arrangements. The recommend anchoring arrangements includes those shown in the figure 5-14 below. Either dead weights may be tied to the bottom of the pontoon and anchored to the river bed or mooring chains can be used. Hence the free vertical movement of the pontoons are possible without any transverse movement. The pontoon is connected to the access trestle via hinged connection. The other end of the trestle which is in contact with the shore ground is suggested to have roller support so that smooth movement of the trestle over the ground is possible. The trestle is required to be tied via rope to wooden poles on the shore.

Figure 5.11 Detachable anchorage options for the floating quay

The quay structure may be floating pontoon of around 10m X 5m. It is required to carry the load of moving passengers and two/ four-wheeler vehicles. They need to be flexible as they are supposed to adjust with varying water levels and permissible general movements. They also need to have the ability to be taken out of water and located at a different place during off seasons. If the docks are in several modules, or pieces, they can be easily manoeuvred to different places as and how required. The material of the berthing structure hull is recommended to be of high quality plastic so that it will be light in weight enabling easy hauling to various locations. The hull is filled with buoyant material and the buoyancy required depends on the amount of load it is supposed to take. In the present case, it is required to carry the weight of four-wheeler vehicles among others. The top of the pontoon is suggested to be made of wood. Such kinds of retractable pontoons seem to have a life of not less than 15 years. The pontoon is proposed to be connected via hinge to a 1in 10 sloping ramp of treated wood. The other end of the ramp is supported on wheels which can move over the ground depending on the movement of pontoon corresponding to the fluctuations in water levels. For locations like that of Subansiri, where the river is unstable and water level fluctuations are high, such kinds of arrangements seem to be acceptable. The berthing structure is proposed to be moored to the river bed using suitable anchor arrangement to minimise the horizontal movement of the pontoon.

The quay structure is to be protected using fenders to absorb the berthing energy imparted by the vessels. Few typical types of fenders used in pontoon quays are shown in the figure 5-15 below. The vessels can be moored to the pontoon quay.

Figure 5.12 Fenders for pontoon quays

This option has the disadvantage of shifting the quay and associated trestle after every flood season. Post flood maintenance of mooring facility of the pontoon is also essential. These all can lead to increased operational difficulties.

5.8.2 Option 2: Employing modular ferry barges

These types of vessels can carry both passengers and vehicles with them. They are provided with foldable access ramps of length ranging from 3 to 5m and can serve at any location even without a quay. A typical modular ferry is shown in figure 5-16 below. This eliminates the need for a quay structure and has the advantage that this facility can easily accommodate the frequent shifting of river shore line and water levels. For a location like that of Subansiri, this seems to be the most suitable one of all the options analysed.

Hence this option is proposed for the present project. The ferry can offer a heavy-duty ramp for smooth movement of vehicles on and off. The deck can be provided with railing and seats with sun-awning for passengers. Since the ramp can be extended to the shore, a quay structure is not important. Maintaining the draft after the flood should be the only major operational requirement. The operational of a modular ferry is shown in figure 5.13 and Figure 5.14 below.

Figure 5.13 A typical modular ferry

Figure 5.14 Operational features of a modular ferry

5.9 Terminal associated amenities

Amenities proposed for the terminal locations are divided into waterside amenities and land based amenities. Details are given below. It is to be noted that the meandering and continuously changing nature of the river, it is recommented that the land based aminities are kept to the minimum and the master plan is designed accordingly. The options of terminal/vessel is also designed keeping this in consideration. The proposed amenities is same for option 1 and option 2 discussed above.

5.9.1 Water side amenities

5.9.1.1 Berthing area

Sufficient space is proposed in front of the vessel landing location for maintaining continuity of two-way navigation of barges and for the safe waiting of the vessels.

5.9.1.2 Mooring facilities

Mooring piles are suggested to be placed behind the berths to minimize the movement of the vessel during transfer of passengers from the vessel to the land.

5.9.1.3 Access Bridge

The connecting link between the berthing location of the vessel, is suggested to be an articulated trestle structure made of steel or wood so that dismantling and shifting is easy. The existing practice of using retractable wood is also suggested considering the regional features.

5.9.2 Land based amenities

Infrastructure in inland waterway ports, depends upon the type of cargo handled, modes of connected transport, etc. These terminals usually being multi modal in nature, provides a wide range of facilities. In case of the proposed terminals the major aim is movement of local traffic across the river. The catchment area of Subansiri has limited infrastructural developments. The width of the river is of the order of 2km to 2.8km at many places including proposed terminal locations. Also, the channel of the river is frequently shifting the location after every flood season. As other rivers in the region, the sediment load brought down by Subansiri is also too large. Thus, constructing bridges or other fixed waterfront structures are not viable or recommendable.

The proposed terminals are required to have the following basic amenities:

a. Mooring facility
b. Amenities for passengers waiting and refreshment
c. Parking areas for vehicles
d. Land transport accesses

Since the proposal is for inland waterways in sheltered body of water, requirement for any protective structures like breakwaters is avoided. The function of the moorage structure is to secure the vessels (ships or barges) in place and to restrain its water-related movements

All basic amenities pertaining to good standards including medical aids, freshwater supply, waiting room, toilets etc. are proposed be made available for the passengers (details are given in the terminal building drawings in Volume 2. The functions of the gate and related facilities include passenger exchange; parking; general security, etc. The terminal building electrical power, fresh water supply and clear communication to support the operation of all the equipment and all the people there. Since the terminal locations don't seem to have proximity to freshwater pipeline, borewell is also suggested to ensure uninterrupted freshwater availability for vessels as well as for domestic use. Clear telecommunication is required for terminal operation. In general, the following facilities are proposed:

5.9.3 Water drainage

The drainage system for the terminal building region is recommented to be an open system. In the open system, the top surface of the the terminal building area may be designed to allow spray from rainwater to be drained away directly to the water body. No separate design is proposed for the same.

5.9.3.1 Terminal building

Two types of terminal buildings are proposed for the project. Right bank of the river will have the main terminal with office area, resting area, toilets and security. Auxiliary terminal at the left bank will have a smaller terminal building with resting area security and toilets. It is recommended to have a building beyond the HFL, to house basic facilities like administrative or security or information office, passenger waiting area, toilets, etc. detailed drawing is attached as Volume II and the details of the structure and other works associated with the building is given in Annexure D Detail Estimates: Phase I and Annexure E Detailed Estimates: Phase II.

5.9.3.2 Water supply

It is suggested to have borewell at the location of terminal building to ensure uninterrupted delivery of potable water. It is also recommended to have an overhead water tank in the terminal building area with a capacity of around 10,000 litres.

5.9.3.3 Sewage treatment plant (optional)

As the world is moving towards a sustainable living, we suggest that a small sewage treatment plant also be installed with the terminal building. The cost of the STP is not added in the cost estimate of the terminal facilities.the plant may be installed separately in the terminal building compound.

Figure 5.15 Example of a low-cost sewage treatment plant

5.9.3.4 Electricity

The terminal is suggested to have good electric connection. Ghagar and Dhonaguri locations are electrified and the power supply may be taken from the state electricity board. For other locations, solar powered electric supply is suggested. As there is no operation envisaged during night, the power usage is assumed to be minimal. Hence 0.5kWp On-grid solar power generating system with required nos. of poly/multi crystalline silicon PV modules which shall be rated above 320Wp having efficiency not less than 17 %, DC distribution box with necessary protection, power conditioning system, charge control unit, necessary KWp 3 phase string Inverters of suitable capacity is suggested to be installed.

5.10 Terminal costing

After considering the morphometric, traffic and other details, two options for terminals were considered. As discuissed in earlier, due to the similarities in the morphology similar designs were considered for main terminal buildings on the right bank of the river. Similarly, same design of terminal building is considered for the auxiliary terminal buildings in the left bank of the river. Terminal capital and OM cost estimation of the both the design options were considered and the same is discussed in the following section.

Please note that the abstract estimate didn't consider the dredging, aids to navigation etc in this stage as these are going to be the same for both the options

5.10.1 Terminal costing option I

Option 1 suggests using floating pontoon quay and access trestle. The capital cost is estimated to be Rs 4.71 crores. The abstract of the estimate is given in Table 5.2. *Please note that the abstract estimate didn't consider the dredging, aids to navigation etc in this stage*

Table 5.2 Terminal capital costing estimate for the terminal option 1 floating pontoon quay and access trestle

Description	Cost (Lakhs ₹)	Units	Quantity	Total (Lakhs ₹)
Main Terminal building (at Ghagar, Dhonaguri and Khaboli on right bank)	22.63	Nos	3	67.89
Auxiliary Terminal Building (at Gonasuti, Selek and Luit Khaboli on left bank)	5.98	Nos	3	11.96
Vessel	30	Nos	3	90
Pontoon	40	Nos	6	240
Walkway 3m wide	0.15	RM	18	27
Landscaping	1.5	LS		4.5
Utility Shifting	1.5	LS		4.5
Auxiliary items	25	LS		25
Total				**470.85**

5.10.2 Terminal Costing Option II

Option 2 suggests employing modular ferry barges and thereby avoiding the option for normal terminal. The capital cost is estimated to be Rs 4.14 crores. The abstract of the estimate is given in . *Please note that the abstract estimate didn't consider the dredging, aids to navigation etc in this stage*

Table 5.3 Terminal capital costing estimate for the proposed terminal facility (Option II) in Phase I for Ghagar-Gonasiti and Dhonaguri – Selek cross-shore routes

Description	Cost (Lakhs ₹)	Units	Quantity	Total (Lakhs ₹)
Main Terminal building (at Ghagar, Dhonaguri and Khaboli on right bank)	22.63	Nos	3	67.89
Auxiliary Terminal Building (at Gonasuti, Selek and Luit Khaboli on left bank)	5.98	Nos	3	11.96
Vessel	100	Nos	3	300.0
Landscaping	1.50	LS		4.50
Utility Shifting	1.50	LS		4.50
Auxiliary items	25.00	LS		25.00
Total				**413.85**

For all civil works under the terminal premise, 1% maintenance cost is suggested.

5.11 Recommendation

Cost estimate and operational ease, option 2: Employing modular ferry barges is recommented for the proposed RO-RO facilities at all proposed locations with a main terminal building at the right bank of the river and an auxiliary terminal at the left bank.

5.12 Implementation plan

The construction and implementation of the project is envisaged in two phases. It is planned that the development of waterway system will take place in two phases. It includes all development works including fairway development and terminal infrastructure development.

5.12.1 Phase 1

In the inintial phase four locations are proposed to be developed (Table 5.4). Each location will have one ghat each at each bank of the river. As explained earlier, main terminal buildings are proposed on the right bank (Ghagar and Dhonaguti) and auxiliary terminal buildings on the left bank (Ghunaguti and Selek) of the river.

Table 5.4 Locations identified to be developed in Phase I

Sl. No.	Main Ghat	Auxiliary Ghat	Proposed traffic handling	Proposed developments
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4-wheeler	Dredging and developing cross-shore channel to the level of Class II.
2	Khaboli/Khabolu (Chainage 41.00 km	Luit Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4-wheeler	

5.12.2 Phase 2

In the second phase, remaining two locations are suggested to be developed Khaboli at the right abnk and Luit Khaboli in the left bank (Table 5.5).

Table 5.5 Identified terminal locations in Phase II

Sl. No.	Main Ghat	Auxiliary Ghat	Proposed traffic handling	Proposed developments
1	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Chainage 27.00 km)	Passenger + 4-wheeler	Dredging and developing cross-shore channel to the level of Class II.

6 Chapter 6: Preliminary Engineering Designs

Subansiry is highly braided river and have high sediment dynamics. At the upper streams of the river, the flood plain is large. At many locations, high erosion is observed due to the river's meandering nature. While preparing the preliminary designs for developing the waterway, cost effectiveness was given priority in providing connectivity for the local public accommodating the regional peculiarities.

6.1 River training / bank protection

As mentioned, Subansiri River is a highly meandering river and designing river training or bank protection structures is really complex for such rivers. 2D numerical modelling studies (Annexure C) (with limited data) for selected location showed that introduction of simple river training/protection structure like spurs has reduced the available water depth and velocity near the structure. Structures that are more complex are not considered.

Type of the proposed vessel - modular ferry (Chapter 7 of this report) can operate even without typical permanent terminal structure. Before finalising the vessel design, probable future bank erosion was also considered. This give the possibility of not constructing permanent structures for terminals and hence avoiding the risk of damage to property due to erosion.

6.2 Cargo terminals and river ports

As discussed in Chapter 3, there are no large-scale industrial clusters which are likely to contribute to the traffic potential of Subansiri River. Thus, it is not recommended to have large sophisticated cargo terminals. The proposal is for terminals/locations that handles passengers, commodities and vehicles associated with the passengers. Small scale cargo handling is possible in the terminal by manual means without use of any unloading facility.

During the site visit, it was observed that the locations identified for terminals have similar topographical features. A main terminal building is proposed at all three locations for the right bank of the river. Main terminal building with same engineering design is proposed for all three locations on the left bank of the river. Similarly, auxiliary terminal buildings with same engineering design is proposed for the locations on the left bank of the river.

6.2.1 Main terminal building

In the initial phase, to provide basic passenger amenities, a trussed elevated structure, is recommended beyond the HFL at the right bank of the river. Facilities like waiting halls, toilets, administrative office, cafeteria, ticket counter, etc., are proposed in the main terminal building. A barbed fencing is proposed for security of the building. Presently no provision for protected parking is made, however open parking may be arranged based on land availability. The live load considered for terminal building design is 5KN/sq.m. The plan and elevation of the proposed Terminal building is provided in Figure 6-1. Priliminary engineering drawings in A3 formant of the proposed terminal buildings are enclosed in Volume 2.

6.2.2 Auxiliary terminal building

It was learned that the facilities needed at the left bank of the river is minimal as no commodity is being taken from this bank. Hence, for the ghats on left bank of the river, an auxiliary terminal building with a security staff is proposed. This auxiliary building is envisaged to be of trussed structure aiming to provide shelter to the passengers. Since the main intention of the project is only crossing of the river, it is reasonable that better facilities can be limited to main terminal building alone.

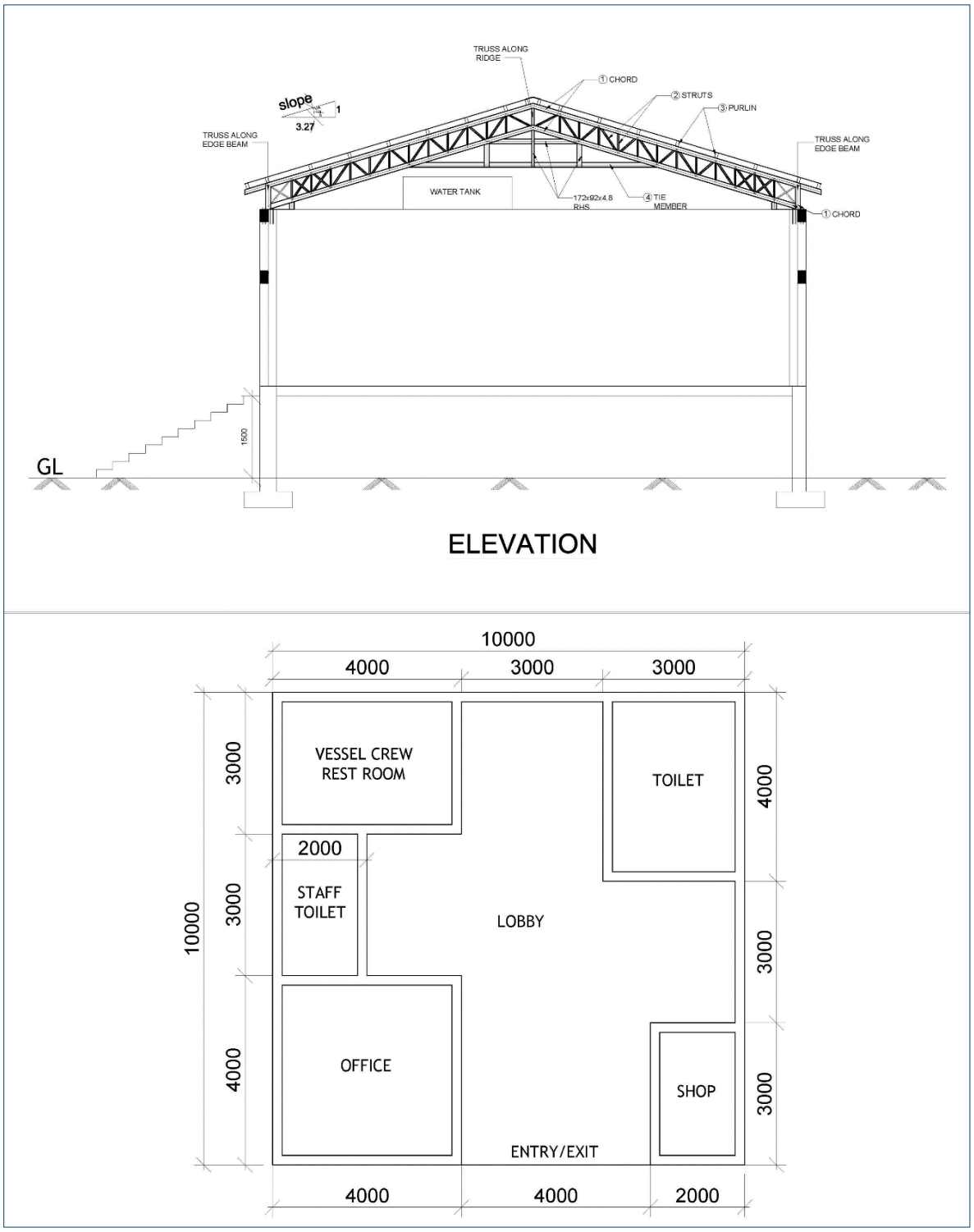


Figure 6.1 Plan and elevation of the proposed main terminal building

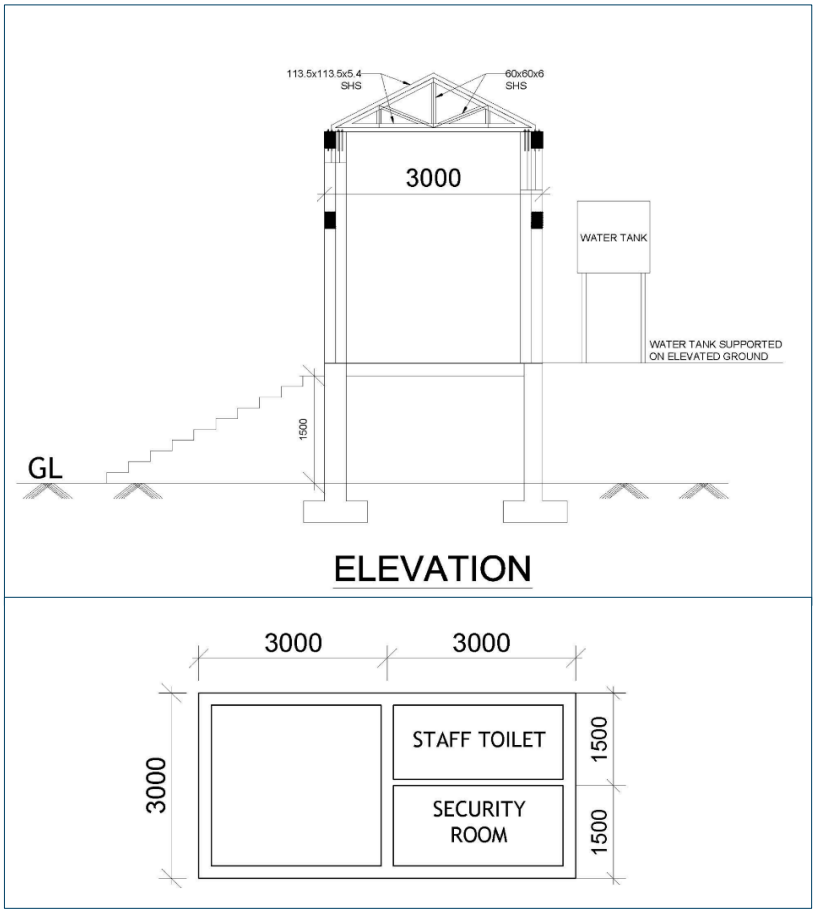


Figure 6.2 Plan and elevation of auxiliary terminal building

Kachcha road may be maintained from the terminal buildings to the location to the modular ferry mooring location. This is proposed to be prepared/maintained when needed usually when the water level receeds during the lean period. No engineering intervensions are proposed for this, manual workers may be hired locally for this when necessary.

6.3 Aids to navigation

Aids to navigation is important especially in waterways like Subansiri where channels migrate from season to season. In the present project, it is proposed to have buoys to demarcate the channel boundaries and ranges to mark the centre line of the channel as shown in Figure 6.3.

Figure 6.3 Buoys and Ranges

6.3.1 Buoys

These aids are used to mark channel boundaries, turns, and hazards and are held in place by a chain and anchor mooring. Buoys are proposed to be placed at 1 km interval. During lean season, it is proposed to have manually check the availability of water and re fix the position of the buoys. During lean season, in addition to the buoy it is also suggested to mark the shallow water regions using temporary markers like the one shown in Figure 6.4 if necessary.

Figure 6.4 Temporary marker to demarcate navigation channel in Brahmaputra river

6.3.2 Ranges (optional)

Ranges are fixed structures aligned with a straight section of channel and are used by pilots to determine the position of a vessel in the channel.

6.3.3 Wooden mooring piles

More than navigation, mooring piles are proposed to reduce the movement of the ferry during boarding and alight of the passengers in severe weather. Usually mooring piles are part of the terminal design which are fixed at a given location on a terminal. In the proposed design, temporary wooden mooring piles are suggested. The location of these temporary piles will not be fixed, this can be changed as per availability of water.

It is to be noted that when the water receeds, mooring piles in the dry lands need to be removed as this might cause obstruction to the vessel during flood season.

7 Chapter 7: Vessel Design

7.1 General Review

Channel depth and channel width are two main design parameters for all inland waterways. Yet, in free-flowing waterways like Subansiri, they are of paramount importance because they widely vary along the route and during the year. Therefore, it is necessary to define and quantify channel depths and widths to assess whether the water area and water depth are enough to accommodate, sailing vessels.

Largest sized vessel tha can ply on river would depend on whether one way or two way navigation is to be catered to. There are several guidelines which have been evolved by various authorities about the relationship between dimensions of any restricted warerway and the vessel that may ply in it. To have a good planning of the proposed water way and associated facilities, a logical decision must be made about the vessels to be permitted. Apart from the above said different guidelines, the proposed characteristics of the vessel are arrived at considering the cargo to be handled, forecasted traffic data and the facilities available at the terminal. As far as Subansiri is concerned, the major traffic targeted is local passenger and two and four -wheeler crossings. Hence the vessels required are those for moving passengers and two and four -wheelers.

7.2 Design Basis

The vessel dimensions are arrived at primarily based on the horizontal and vertical dimensions of the water way under consideration. The design also considers the safety aspects while manoeuvring in the shallow waters and the availability of local resources. The conclusion of traffic study infers that, the proposed vessel shall be capable of moving passengers and four-wheelers. The limiting channel dimensions are a bottom width of 40m, limiting bend radius of 500m and depth of 1.4m.

For the current study, PIANC guidelines were followed for vessel design.

7.2.1 Channel Depth

Design vessel draught and underkeel clearance is driven on the basis of design channel depth. The clearance is a kind of safety margin, depending on vessel types and nature of river bottom. It also depends on driving dynamics.

Design depth of 1.4 m is taken as the limiting facter for the current study as the proposed fareway is pertains to class II waterway.

7.2.2 Channel Width

The channel width (measured at a given depth) influences the beam of the vessel. Conversely, in the case of a ODC, ship's beam is the major scaling parameter in the design process of a waterway. In 2019 PIANC working group (WG 141) has reviewed existing ratios and, starting from the vessel's beam, proposed a channel width of 3B ~ 5B for two-way traffic (Figure 7.1).

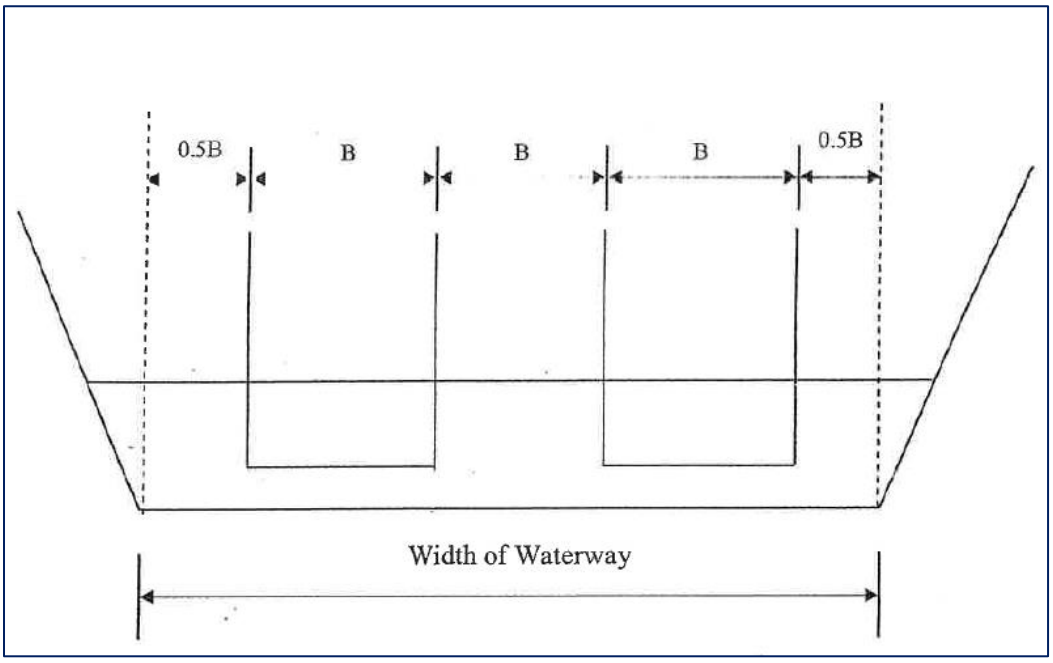


Figure 7.1 Normal width of waterway required for two way navigation of barge with beam size B in river (schematic)

Combined with the radius (R) of the sharpest bend, the channel width imposes restrictions to the length (L) of the convoy or of the vessel. There are approximate formulae to describe this relationship. If the vessels dimensions and the radius are known, the increase of channel width (ΔW) needed in a sharp bend, which should better be located in the inside of the bend, is usually calculated by the Graewe formula.

The same formula enables the calculation of the design length of the vessel L (the radius R and the maximum width of channel W+ΔW are imposed), or the design radius R (if the design length L and the design width W+ΔW are imposed).

However, in the current project, more than technical restrictions like the ones described above, it is the volume of cargo/passengers that is given priority as the projected projected traffic quantities do not advocate for bigger vessels.

7.2.3 Speed

PIANC guidelines do not take the speed of the vessel into consideration.

7.3 Type of proposed Vessels

The vessels plying in this route is suggested to have facility for handling both passengers and vehicular traffic at a time safely. As discussed in Chapter 5 (Terminals), the type of vessel recommended is modular barges having access ramp for beaching.

Figure 7.2 A typical modular ferry in operation (note no terminal is needed for loading / unloading)

The vessels are required to have the basic amenities like fire extinguishers, life jackets, etc., on board.

A representative drawing of the proposed vessel is provided in Figure 7.3.

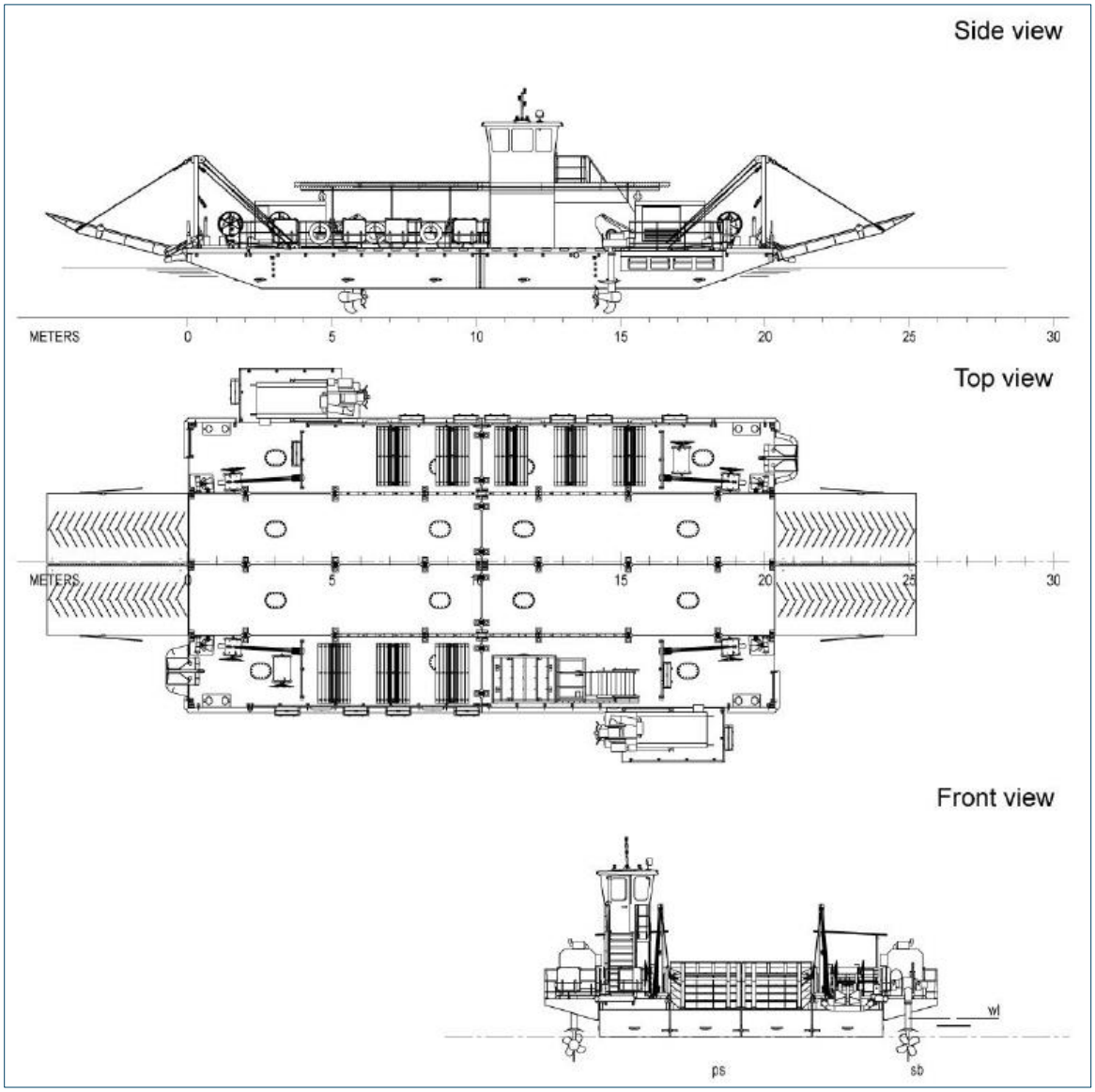


Figure 7.3 Representative drawing of the proposed modular ferry

7.4 Proposed Vessel Size and Specifications

The size of vessel is related to channel width and depth of waterway available for navigation. The maximum beam of design vessel is limited to1/5th of the width of navigable water and its length is assumed between 4 to 8 times the vessel's beam. Being a protected water, no natural severe wave action is expected, also due to low speed of the vessel owing to soft bed and bank materials, the under-keel clearance can be limited to some10% of max-draft. When a vessel is navigating in a shallow channel, its manoeuvrability as well as speed suffers due to a kind of drag that is imposed on the moving hull by the relative lack of water around it. This is explained by a factor 'n' defined as 'the ratio of wetted cross-sectional area of the channel to the wetted largest cross-sectional area of the vessel', should be large, around 10 or above with a lower tolerable limit of 6. Hence the maximum draft for the design vessel is limited to 1.2m.

From speed consideration, the longer vessels yield a faster speed for a given engine. It is however, important to note one limitation on vessel length viz. that the length of vessel on water-line (LWL) should be less than the width of the channel. If the length is kept the same or more than this, it would

become virtually impossible for a vessel to be turned around even in an emergency. This would be an unacceptable condition for obvious reason, unless special turning areas are provided at relatively short intervals. It is also necessary to turn vessels around in rivers through which the route passes. Therefore, the largest vessel should not be longer than, say, 30m at water line for the 40m wide channel. In this manner, the following dimensions for the proposed vessel is permissible for the present project:

Table 7.1 Proposed vessel dimensions

Type	Modular ferry having access ramp for beaching
Length overall (LOA)	30 m
Beam	7-8m
Draft	1.2m

7.5 Turnaround Time

It is the length of the time between arriving at a terminal, unloading and loading the passenger and cargo, refuelling, etc. and being set to depart from that point. Apart from the actual time for loading/ unloading cargo, additional time is required for other activities such as berthing and de-berthing, waiting for clearance for navigation etc.

The average speed of the vessel is assumed as 9 knots and for crossing 2 to 3km and average of 15 minutes is the travel time. Halt for passenger boarding and alight is assumed as 15 minutes at one terminal. Manoeuvring the vessels at the destination terminal and getting ready for new journey is allocated a time of 10 minutes in addition to the passenger boarding time of 15 minutes. Thus, to complete a cycle of operation, an average of 1 hour/ vessel is allowed.

7.6 Number of Vessel Required

The number vessels to be deployed to serve the hinterland are arrived at based on the projected traffic data. Currently only the local public and few tourists are expected, the vessel services are to be planned for this. It is suggested to have total 2modular ferry barges for crossing at two ghat locations as Ghagar and Dhunaguri, with each having 1 ferry. Thus, each terminal location can have a barge service every one hour, which seems sufficient with respect to the traffic study.

7.7 Vessel Costing

7.7.1 Capital Cost

Based on discussion with the suppliers of modular ferry barges and considering the market rates through secondary sources, the unit price of the ferry is around Rs. 1 Cr.

7.7.2 O&M Cost

An operation and maintenance cost of 10 % is considered annually based on secondary data. Hence this comes around 10 lakhs/ ferry annually.

8 Chapter 8: Navigation aids

8.1 General Requirements

The main aim of navigational communication systems is locating the vessels during their voyage and ensuring good communication between shore and vessel during all possible emergency situations. The communications network shall be a converged communication solution capable of transporting voice and data traffic on a common backbone, consistent with the global trend towards the converged communication solution in both the carrier and end user network environments.

As far as Subansiri river is concerned, the extreme weather conditions are common. Therefore, the proposal is for crossing the river during the day time alone. Hence a system that ensures all time shore to vessel communication alone is recommended. Since the full signal coverage for uninterrupted mobile phone communication cannot be ensured due to regional peculiarities, it is proposed to have portable VHF radio communication systems. The vessels proposed are required to be equipped with VHF radio systems. It is recommended to have arrangements for the IWAI Assam office to keep connected with the IMD for timely reception of weather forecasts and the same shall be conveyed to the local office in the terminal building proposed. The VHF radio communication system can be used for transferring information between terminal office (proposed at southern bank) and the vessel. It is required to have two VHF receiving offices one at Dhunaguri and the others at Ghagar in Phase I, the terminal operator itself can handle the same. As Phase II, the same can be provided at Khabuli ghat.

8.2 Aids to navigation

Aids to navigation is important especially in waterways like Subansiri where channels migrate from season to season. A navigable channel may be marked to indicate safe limits of the Channel by channel marks like bamboo marks or buoys.

8.2.1 Buoyage and marking of the waterway

The direction of buoyage as per IWAI regulations is defined as follows

a. The general direction taken by the mariner when approaching harbour, river or estuary or waterway from seaward.
b. In case of non-tidal rivers the direction against the flow of the river.
c. The direction in which the kilometer chainage increases in case of estuary

In case of the waterway under consideration, only cross-shore movement is proposed. Above regulations do not define the boyage in case of only cross-shore waterway. It is suggested that the boyage be from right bank to the left bank of the river.

8.2.2 Conventional marks

Conventional marks are made of bamboo strips Figure 8.1. It is low cost aids and hence needs no maintenance.

- Direction of Marking
  - From right bank to left bank

Various conventions used for the placement of these marks are presented from

Figure 8.1 Conventional marker

Bamboo mat marks at the beginning and end of the channel

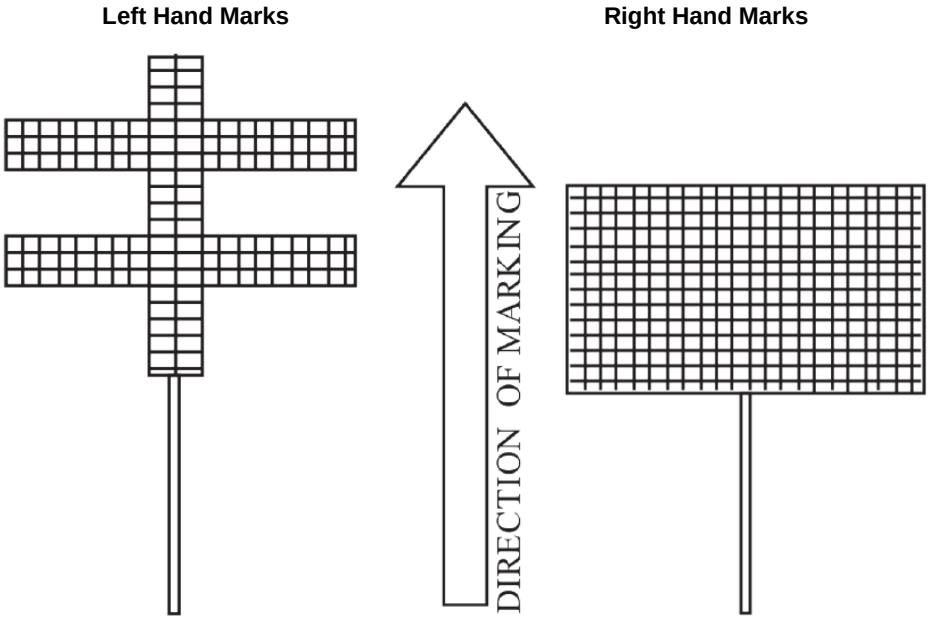


Figure 8.2 Bamboo mat marks at the beginning and end of the channel

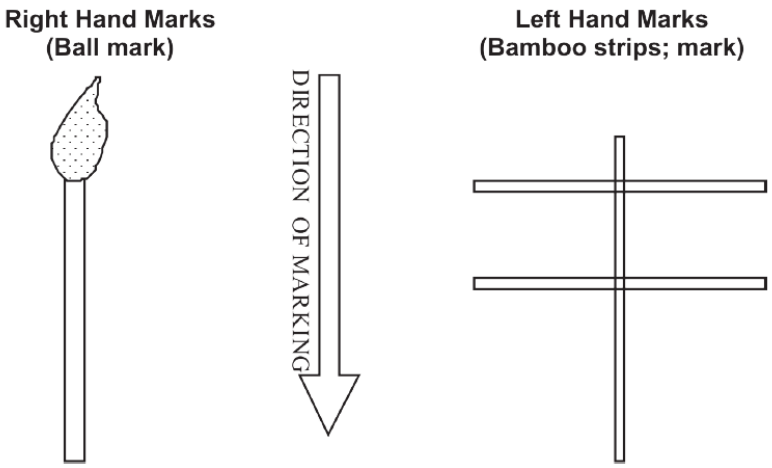


Figure 8.3 Bamboo marks in between and marks

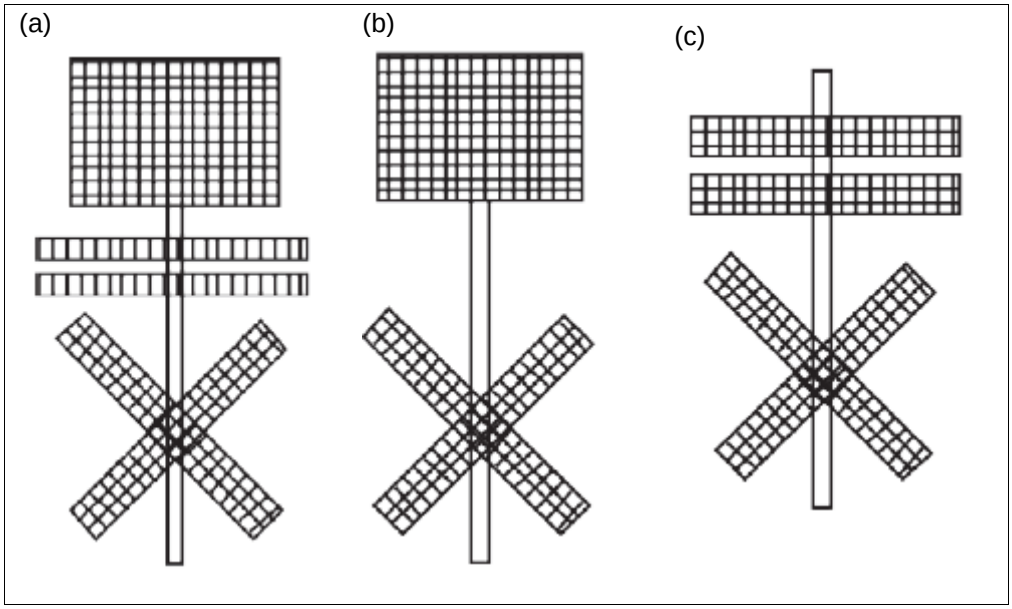


Figure 8.4 Under water snag marks (painted with lime) (a) to indicate snag which can be crossed from either side, (b) snag to be kept on left and (c) snag to be kept on right

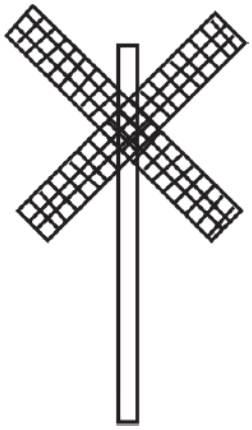


Figure 8.5 Closing of channel

8.2.3 Wooden mooring piles

More than navigation, mooring piles are proposed to reduce the movement of the ferry during boarding and alight of the passengers in severe weather. usually mooring piles are part of the terminal design which are fixed at a given location on a terminal. In the proposed design, temporary wooden mooring piles are suggested. The location of these temporary piles will not be fixed, this can be changed as per availability of water.

It is to be noted that when the water receeds, mooring piles in the dry lands need to be removed as this might cause obstruction to the vessel during flood season.

8.2.4 Survey equipment

Not proposed

8.3 Existing System

Presently no systems exist at the Ghats.

8.4 Additional requirement

The proposal is to have VHF radios and good telecommunication facility between the ghats and the IWAI nodal office.

8.5 Costing

8.5.1 Capital Cost

Table 8.1 Capital expenditure for proposed navigation systems

Sl. No.	Specification	Unit	Quantity	Cost	Amount
1	Conventional marks are made of bamboo strips (PHASE I)	Nos	12.00	₹ 20,000.00	₹ 240,000.00
2	Conventional marks are made of bamboo strips (PHASE II)	Nos	3.00	₹ 20,000.00	₹ 60,000.00
Phase I Total					₹ 240,000.00
Phase II Total					₹ 60,000.00

Table 8.2 Capital expenditure for proposed Communication system

Sl. No.	Specification	Unit	Quantity	Cost	Amount
1	VHF radio set (PHASE I)	LS		₹500,000.00	₹500,000.00
2	VHF radio set (PHASE II)	Nos		₹2,50,000.00	₹2,50,000.00
Phase I Total					₹500,000.00
Phase II Total					₹2,50,000.00

8.5.2 O&M Cost

The operation and maintenance cost for the system proposed is around 5% of the capital cost.

Table 8.3 O&M expenditure for proposed communication systems

Description	Phase I	Phase II
	Cost (Lakhs)	Cost (Lakhs)
VHF Radio	₹ 0.25	₹ 0.125

9 Chapter 9: Environmental and Social Aspects

9.1 Objective of Environmental and Social Studies

The development of any infrastructure project causes various environmental and social impacts during different stages of its implementation. The objective of this study focuses on assessment of associated environmental and social impacts (for all its offshore as well as onshore components), during designing, construction as well as operational stages of proposed waterways project. Present chapter discusses all the aspects of environment starting from baselines assessment and assessment of impacts, development of mitigation plan then development of monitoring plans to have a check on successful implementation of mitigations measures. Institutional mechanism is also designed to ensure an effective implementation of proposed EMP. This chapter also covers some important points as mentioned in Environment Impact Assessment Guidance Manual of MoEF & CC guidelines for carrying out such Environment Impact Assessment (EIA) studies.

Details of River Stretch & Map

Subansiri River, better known as the "Gold River" is the largest tributary of the Brahmaputra River. Subansiri flows into the states of Arunachal Pradesh and Assam. It joins the mighty Brahmaputra at the mystic confluence of Majuli Island, which is the largest inhabited river island in the world. Subansiri River flows through the difficult terrain with vertical rock faces. This is one of the fast-flowing and adrenal-pumping rivers set in a scenic breath-taking environment. The Subansiri is 442 km long, with a drainage basin of 32,640 km^2. It contributes 7.92% of the Brahmaputra's total flow. Subansiri in Assam flows by touching the northern boundary of Lakhimpur district and northeastern boundary of Dhemaji district. The river maintains a stable course in the upstream before entering Assam, and then it becomes unstable. The riverbed mainly consists of gravels, silt and sand in the survey area. Subansiri is the lifeline of the people of Lakhimpur and Dhemaji districts. Subansiri provides diverse habitat in its downstream for living biota such as stream, riparian zones wetlands etc. The wetlands are ecologically and economically important for the local people. Fishing in Subansiri is very famous among the people.

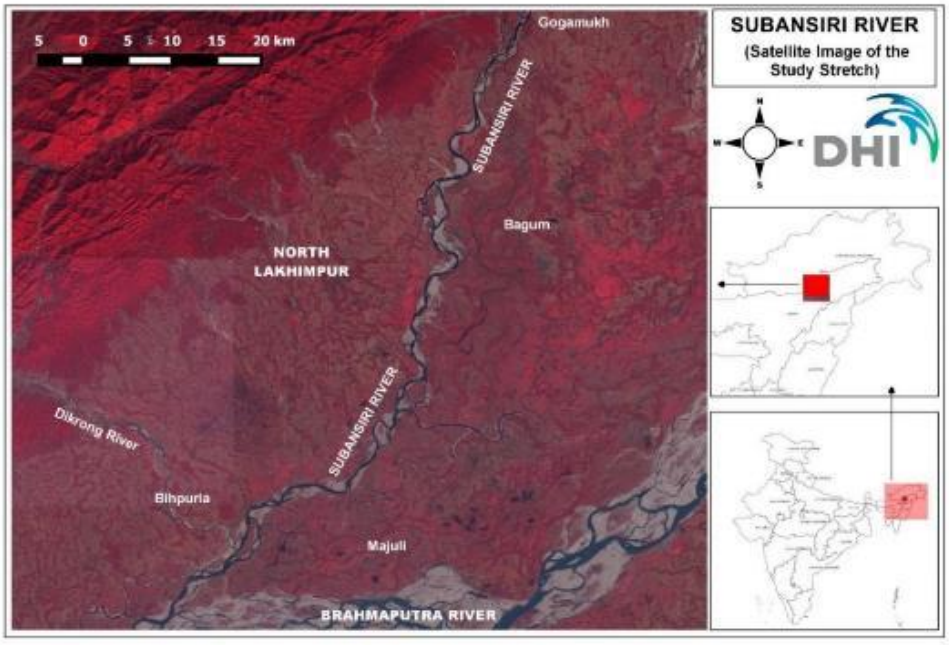


Figure 9.1 Location map of Subansiri River

The scope of the present study is limited to 106.45 km of Subansiri River stretch.

Table 9.1 Details of the study region

Name of the River	Description of Inland Waterway	Districts through which River flows
Subansiri River	106.45 km length	Dhemaji
In Assam State	From Chouldhowa Ghat to Brahmaputra confluence (Lat 27°27'2.96"N, Long 94°15'16.12"E) to (Lat 26°52'24.93"N, Lon 93°54'31.26"E)	Lakhimpur

9.2 Environmental Setting in the Project Area

Environment conditions of the area have been studied through the secondary information collected. Based on analysis of Forest Map available at Website of Assam, http://online.assam.gov.in/AopHome-theme/images/aop/maps/Forest_CoverMap.jpg, no forest land is located alongside the project river stretch.

No Wildlife sanctuary or Natioinal Park is located adjacent to proposed stretch of Subansiri River under study (http://natureconservation.in/list-of-national-parks-in-assam-updated/)

9.2.1 Physiographic

River Subansiri rises from the Kangig glacier range in Tibet at an elevation of 7090 m (23260 ft) above mean sea level. Total length of the river in India is around 326 km up to its confluence with Brahmaputra. Major tributaries of the river are Laro, Nye, Yume, Tsari, Kamla, Jiyadhol, Ranganadi and Dikrong. The Subansiri River meets Brahmaputra about 25 Km downstream of Jorhat.

The total length of the river in the mountainous terrain is about 208 km. Within Indian Territory the foothills, the riverbed falls from a height of 4206 m to 80 m near Dulangmukh. After flowing for about 70 km from the hills, the river falls into the Kherkutia Suti and thereafter flowing for another 60 km it outfalls into the River Brahmaputra.

The Subansiri basin can be divided into four parts viz.; A) Chinese / Tibetan high elevation stretch till the international border; B) the stretch lying between the international boundary and upper reaches of Arunachal Pradesh; C) the Arunachal Pradesh stretch upto the interstate boundary of Assam and Arunachal Pradesh and D) the plains of Assam. The first two belong to the great Himalayan range, the third belonging to the Sub-Himalayas and the fourth in the fertile plains of Assam.

9.2.2 Geology and Seismicity (From Primary / Secondary Sources)

Geological features in the Subansiri Basin show marked variation ranging from Higher / Lesser Himalayas, foothills and plains falling in Bomdila group, Miri Group, Gondwana Group and Siwalik Group as well as Alluvium. This indicates that the basin has different

types of formation with very significant slopes, ultimately terminating into plains at the confluence with Brahmaputra.

The geological features further indicate the tendency of the river to bring down material, which deposits as alluvium in the plain. It can be inferred that though significant slopes in the basin offer good hydropower potential, it also indicates the vulnerability of the catchment at the proposed sites, the degradation of which if any in future can lead to soil erosion & siltation.

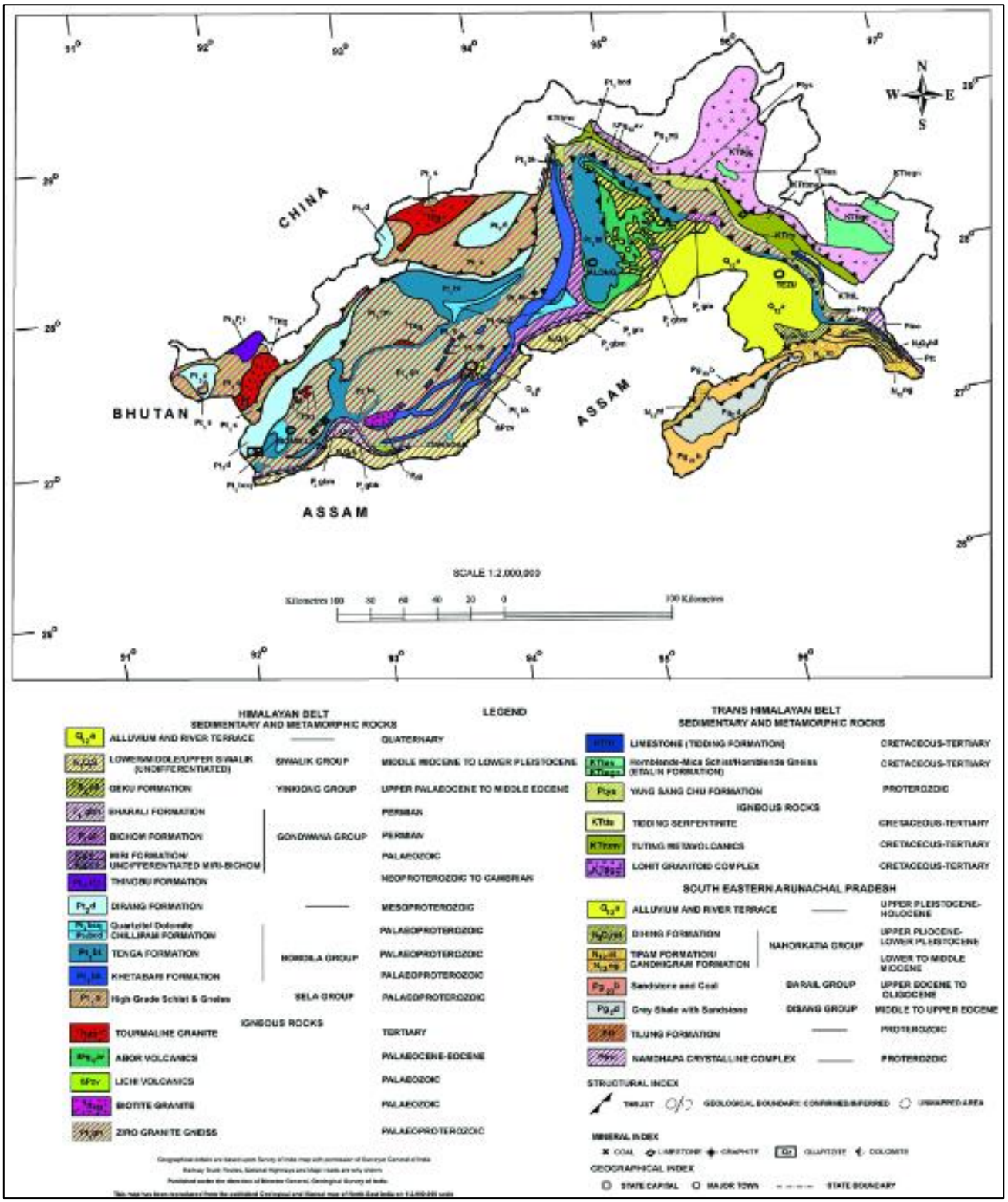
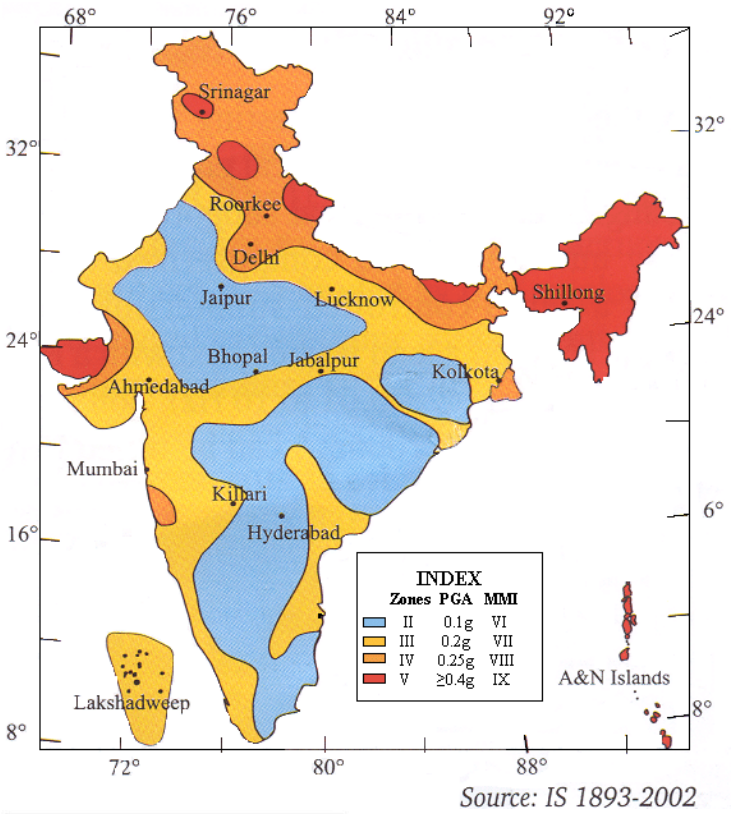


Figure 9.2 Geological Features and Mineral Map of Arunachal Pradesh including Subansiri Basin

Source: Geological Survey of India

As per the 2002 Bureau of Indian Standards (BIS) map (Figure 9.3), all districts of the state of Assam falls in Zone V. According to GSHAP data (Global Seismic Hazard Assessment Program), the state of Assam lie in a region with high to very high seismic hazard. Historically, parts of this state have experienced seismic activity greater than **M**6.0. Approximate locations of selected towns and basic political state boundaries are displayed in Figure 9.4.



Zone	Intensity
Zone V	Very High Risk Zone Area liable to shaking Intensity IX (and above)
Zone IV	High Risk Zone Intensity VIII
Zone III	Moderate Risk Zone Intensity VII
Zone II	Low Risk Zone VI (and lower)

Figure 9.3 Seismic map of India

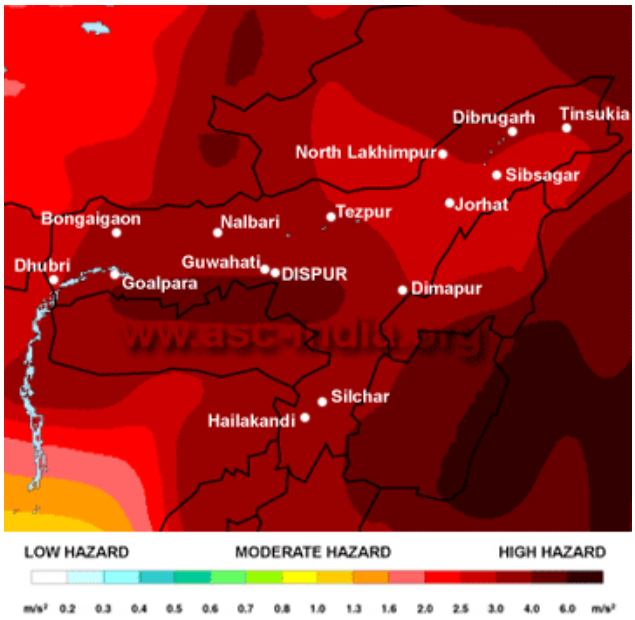


Figure 9.4 Seismic map of Assam (*source: http://asc-india.org/maps/hazard/haz-assam.htm*)

9.2.3 Climate

9.2.3.1 Temperature

The proposed stretch of Subansiri River comes in Lower Subansiri basin and temperature profile in the Subansiri basin districts has been compiled and analysed from 1901 to 2002 based on IMD data and the same is given in the table below:

Table 9.2 Mean Monthly Temperature in Lower Subansiri from 1901 to 2002

Temp/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (ºC)	8.95	10.03	13.68	16.01	18.75	21.12	21.82	22.08	20.99	17.84	13.55	9.66
Maximum (ºC)	12.70	16.14	18.37	21.32	22.71	24.49	24.46	24.32	23.65	21.74	17.42	13.55

Source: Cumulative Impact and Carrying Capacity Study of Subansiri Sub Basin including Downstream Impacts

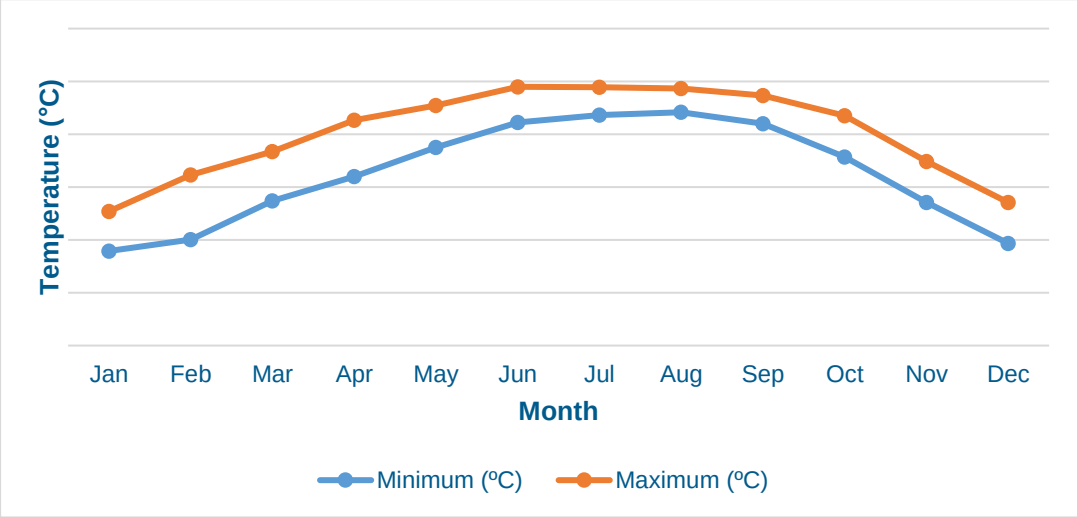


Figure 9.5 Mean Monthly Temperature in Lower Subansiri from 1901 to 2002.

9.2.3.2 Rainfall

The Subansiri basin in Assam has several rain- gauge stations viz. Chouldhoaghat, North lakhimpur Airport (Lilabari), Ananda Tea Estate, Khabolughat, NHPC Gerukamukh, Bordeobam Tea estate and Seajuli Tea estate etc.

Table 9.3 shows the monthly average of the daily rainfall data of some of the stations of the study area. The average rainfall in the basin in Assam is 3525.89 mm.

Figure 9.5 shows the monthly average of daily rainfall at different stations, which indicate that rainfall, occurs nearly all the year round, being least in amount in the period November to February. In the period from March to May, the rainfall occurs mostly as thundershowers and because of the arrival of the southwest monsoon from about the beginning of the June, heavy spell of rainfall occurs in the area. June, July and August are recognised as the monsoon months of the year with highest rainfall. The high monsoonal precipitations encourage the high rates of discharge of the Subansiri and its tributaries during monsoon season and occurrence of flood in the study area. Gerukamukh, which is situated in the foothills of the Arunachal Himalaya, shows the highest rainfall record compared to other stations situated in the plains of Assam.

Table 9.3 Monthly average of daily rainfall along with total rainfall of different stations in the study area in mm.

Rain gauge station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Lakhimpur	30.5	65.0	107.8	192.2	407.6	641.6	578.0	584.7	361.6	163.6	30.3	16.4
Bordeobam tea estate	29.0	53.3	107.6	191.6	405.9	543.2	509.0	486.6	371.6	168.9	24.1	9.9
Ananda Tea Garden	39.9	61.5	90.3	170.1	437.3	750.2	732.3	704.7	456.7	162.6	27.8	12.2
Seajuli tea Estate	29.8	48.3	84.1	141.6	372.6	609.3	590.9	572.0	364.2	143.8	21.2	16.1

Rain gauge station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lilabari Airport	29.3	23.3	122.3	227.7	801.3	539.9	574.3	461.5	319.5	264.7	9.1	27.5	3400.1
Gerukamukh	68.0	71.3	100.2	211.9	474.1	954.1	1242.1	1126.7	572.8	194.4	11.5	8.7	5035.8

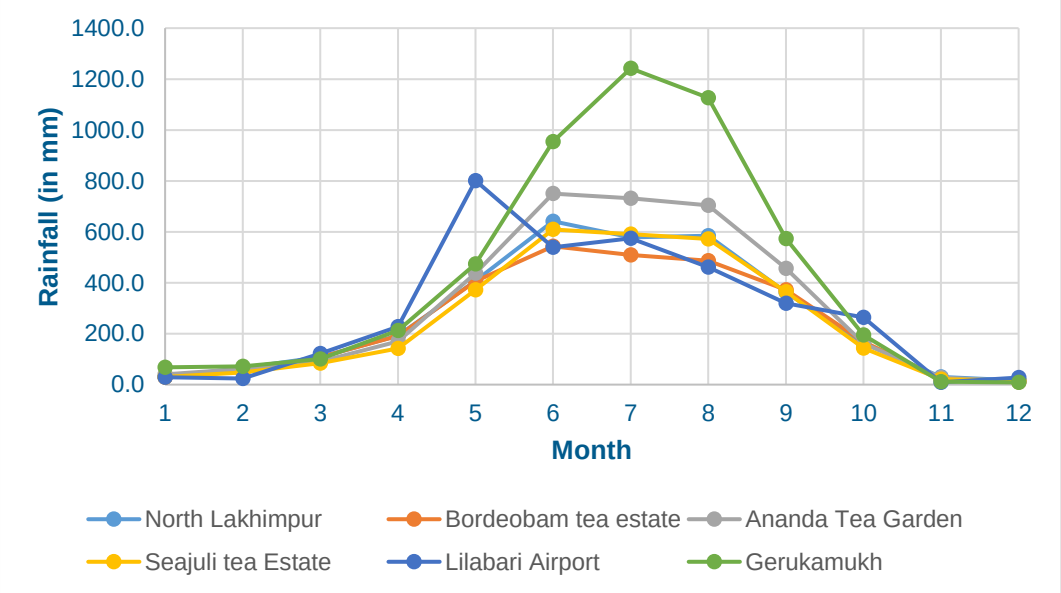


Figure 9.6 Monthly average of daily rainfall in different stations.

9.2.4 Soils

Based on the varying geological conditions, topographical characteristics and agro- climatic situations, broadly three types of soils are found in the Lower Subansiri basin.

Alluvial soils

As the most part of the Lower Subansiri basin is in the floodplains of the Subansiri and its tributaries, the soils are mostly alluvial. These soils are very fertile as they are formed from the alluvium, deposited by the Subansiri and its tributaries. Two types of alluvial soils are mainly found in the region, viz; Younger alluvium and older alluvium.

Piedmont soils

The piedmont soils are confine to the northern narrow zone along the piedmont zone of the Subansiri sub basin. These soils mainly comprise the Bhabar and Terai soils. Bhabar soils occurs in a narrow belt along the right bank and in a small patch in the left bank of the Subansiri River characterised by unsorted detritus of boulders, pebbles, cobbles, sand and silts.

Hill soils

The hill soils are mainly red loamy soils that occur in a narrow southern foothill belt running along the border of Assam and Arunachal Pradesh towards the northernmost part of the Subansiri sub-basin in Assam. These soils are very deep, dark brown to yellowish red and

fine to coarse-loamy. They are slightly too moderately acidic and lack in nitrogen, phosphoric acid, humus and lime.

The detailed taxonomical classification of the soil types of Subansiri catchment in Assam is extracted from the NBSS & LUP map and is presented as Table 9.4. The characteristics of the various soils of the study area with their textural classification are briefly describe in Figure 9.7. The map symbols are the standard ones used by NBSS & LUP.

Table 9.4 Description of the soil categories (After NBSS & LUP, 1993)

Soil Mapping Unit	Description	Taxonomy
12	Moderately deep, well drained, coarse loamy soil having sandy surface occurring on moderately sloping plain with severe erosion and slight stoniness.	Coarse loamy Typic Udorthents
13	Deep, well drained, coarse loamy soils occurring on very gently sloping piedmont plain having loamy surface with moderate erosion and slight flood hazard: associated with: Deep, well drained, coarse silty soils occurring on very gently sloping concave plain with slight erosion and moderate flood hazard.	Coarse loamy Typic fluvaquents Coarse silty Typic Haplaquents
20	Deep, well drained, fine loamy soils occurring on very gently sloping plain having loamy surface with slight erosion hazard. Associated with deep, imperfectly drained, coarse loamy soils occurring on very gently sloping plain with slight erosion and slight flood hazard	Fine loamy Dystric Eutrochrepts Coarse loamy Typic Haplaquents
24	Deep, moderately well drained, fine loamy soils occurring on very gently sloping flood plain having loamy surface with moderate flood hazard; associated with deep, well drained, fine silty soils with slight erosion and slight flood hazard.	Fine loamy Typic Haplaquents Fine silty
32	Moderately deep, moderately well drained, fine silty soils occurring on level to nearly level active flood plain encompassing 'char' and chapori' having loamy surface with very severe flooding; associated with Deep, well drained sandy soils occurring on char, chapori and river islands of active floodplain with severe flood hazard.	Fine silty Typic Udifluvents Typic Psammaquents
33	Deep, moderately well drained, sandy soils occurring on level to nearly active flood plain having loamy surface with severe flood hazard; associated with: Deep, well drained, coarse loamy soils occurring on nearly level active flood plain having loamy surface with moderate flood hazard.	Sandy Typic Udipsamments Coarse loamy Aeric Fluvaquents
34	Very deep, well drained, coarse loamy soils occurring on very gently sloping flood plain having loamy surface with moderate erosion and moderate flood hazard; associated with: Very deep, moderately well drained, fine loamy soils occurring on level to nearly level flood plain with slight erosion and moderate flood hazard.	Coarse loamy Aeric Fluvaquents Fine loamy Typic Haplaquepts
35	Deep, well drained, coarse silty soils occurring on river islands of active flood plain having loamy surface with very severe flood hazard; associated with: Moderately shallow, well drained coarse loamy soils with severe flood hazard.	Coarse silty Mollic Fluvaquents Coarse loamy Aquic Udifluvents

84	Marshy land	

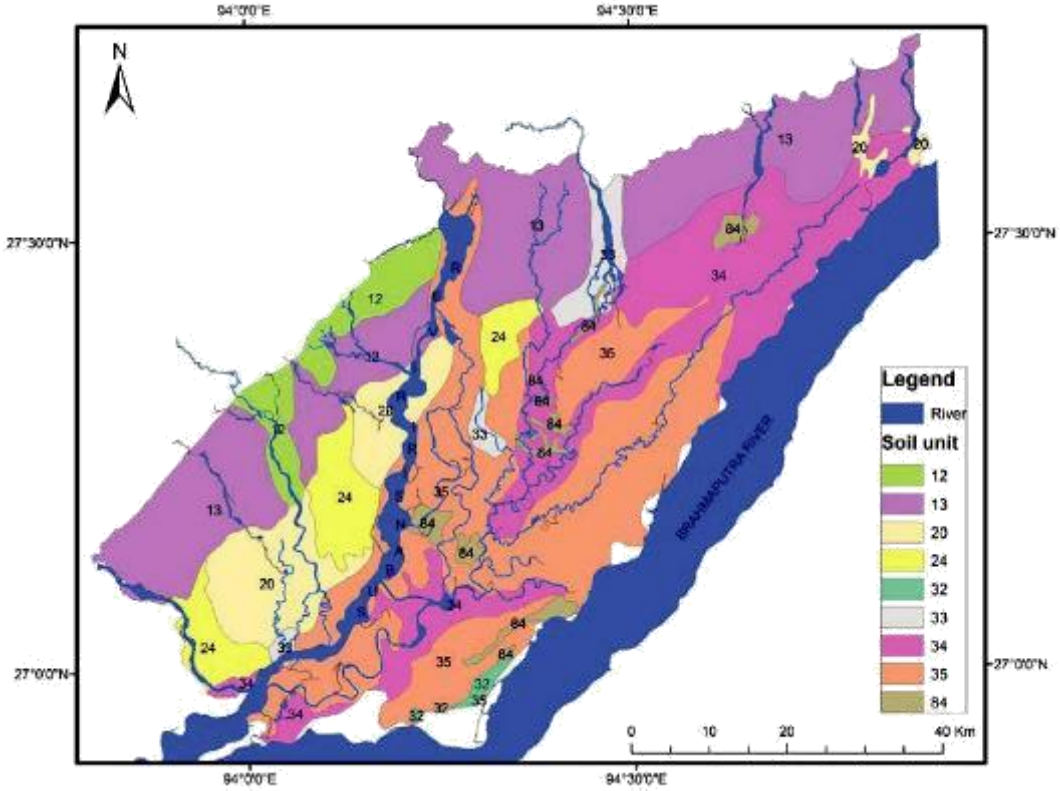


Figure 9.7 Soil map of the Subansiri sub-basin in Assam (*source: NBSS & LUP, 1993*)

9.2.5 Land Use Pattern

The land use map of the Subansri basin have been prepared and analysed based on the LISS III satellite images. Most of the area belongs to dense forest and agricultural area (Table 9.5) and along the river corridor marshy land exists.

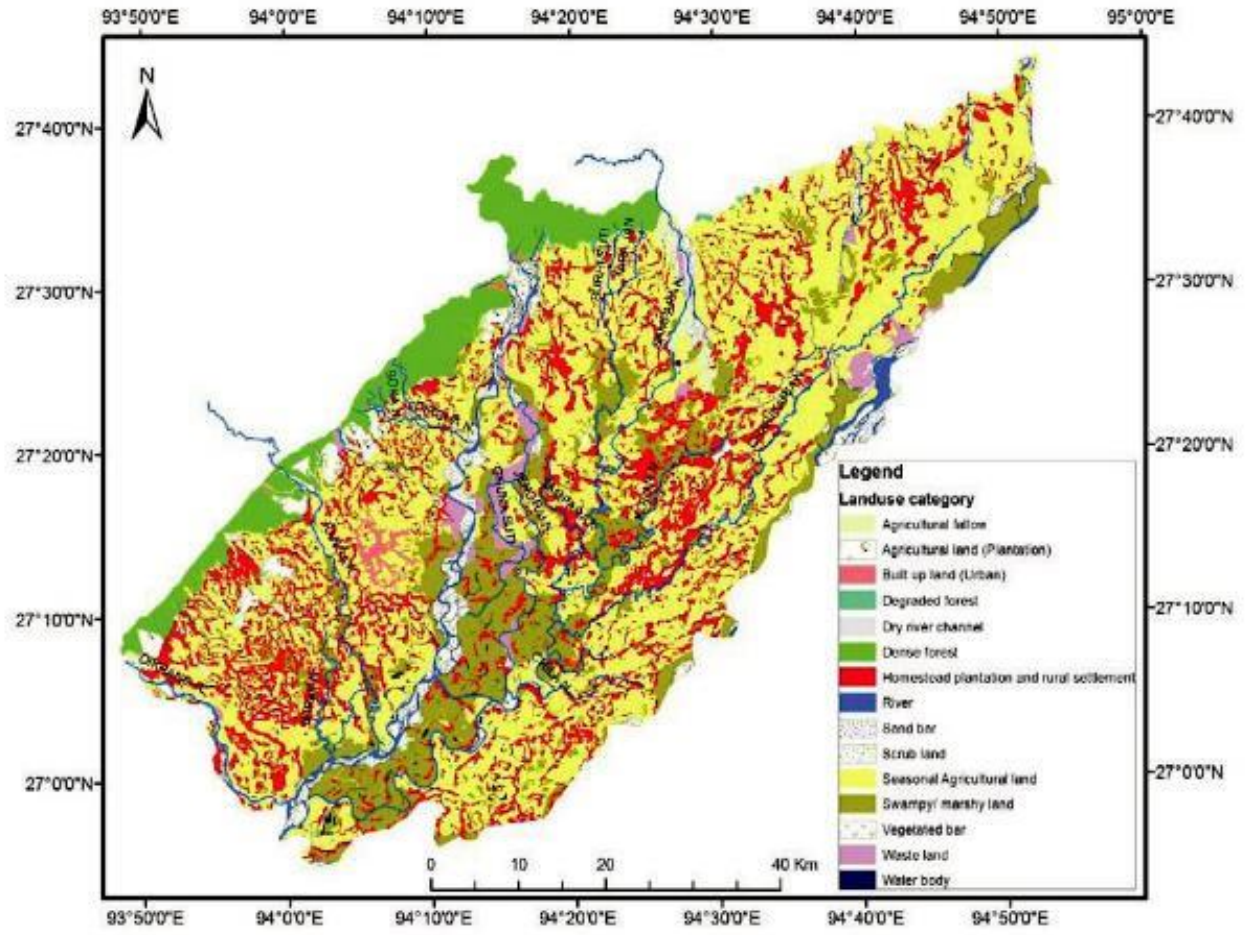


Figure 9.8 Landuse map of the Subansiri Basin in Assam (Source:LISS III Satellite)

The land use category reveals that almost 48.36% of the total area is covered by seasonal agricultural land. These are paddy lands, locally known as “dhan kheti” along with different other Rabi and Kharif crops. The other dominant landuse categories are homestead plantation and rural settlement (16.92% area) and swampy/ marshy land (14.87% area). Other landuse categories cover only the remaining 19.85% of the total area.

Table 9.5 Areas of land covered by different landuse categories in the study area.

SN	Landuse/ landcover type	Area (in sq km)
1	Agricultural fallow	43.31
2	Agricultural land (plantation)	61.49
3	Built up land (Urban)	25.49
4	Degraded forest	5.52
5	Dense forest	268.85
6	Dry river channel	22.64
7	Homestead plantation and rural settlement	734.27
8	River	137.83

SN	Landuse/ landcover type	Area (in sq km)
9	Sand bar	128.79
10	Scrubland	27.29
11	Seasonal Agricultural land	2098.98
12	Swampy/ marshy land	645.51
13	Vegetated bar	44.64
14	Waste land	82.17
15	Water body	13.68

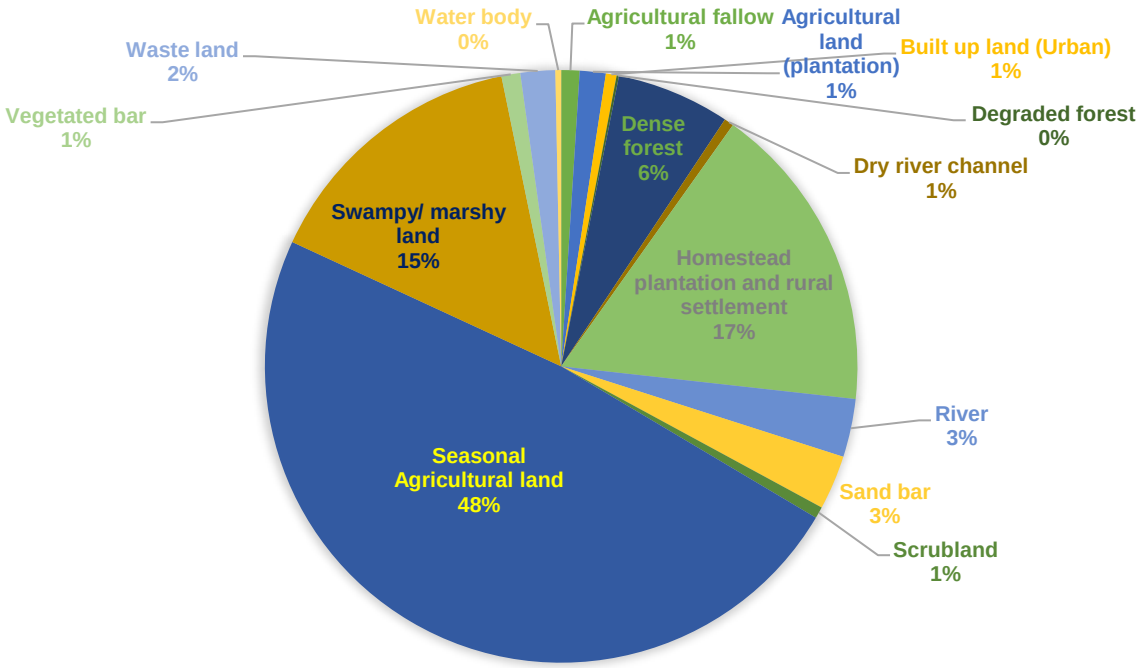


Figure 9.9 Area wise (in %) land use category of the Lower Subansiri Basin in Assam.

9.2.6 Ambient Air Quality (From Primary / Secondary Sources)

City	Location	Station Code	Type	No. of mon. days (n)	A/IA	Min	Max	Annual average (µg/m3)	10 percentile	50 percentile	90 percentile	Std. Dev.	% exceedance (24 hourly)	Air Quality	
Lakhimpur	Bazar Patti, North Lakhimpur	587	RIRuO	102	A	4	10	6	5	6	8	1	0	L	SO_2 levels (Annual average) in Ambient Air Quality Stations under NAMP during 2010
Lakhimpur	Bazar Patti, North Lakhimpur	587	RIRuO	102	A	10	23	15	12	14	18	2	0	L	NO_2 levels (Annual average) in Ambient Air Quality Stations under NAMP during 2010
Lakhimpur	Bazar Patti, North Lakhimpur	587	RIRuO	102	A	15	201	76*	26	59	149	49	31	H	Air Quality with Respect to PM (Particulate Matter Having Aerodynamic Diameter Less Than or Equal to 10 µm
Lakhimpur	Bazar Patti, North Lakhimpur	587	RIRuO	102	A	38	348	143				81			SPM levels (Annual average) in Ambient Air Quality Stations under NAMP during 2010

Source: National Ambient Air Quality Status & Trends in India -2010

Table 9.6 Ambient Air Quality in Lakhimpur District

City	SO_2		NO_2		PM10	
	Annual average ($\mu g/m^3$)	Air Quality	Annual average ($\mu g/m^3$)	Air Quality	Annual average ($\mu g/m^3$)	Air Quality
Lakhimpur	6	L	15	L	76*	H

Source: National Ambient Air Quality Status & Trends in India -2010

9.2.7 Noise Levels (From Primary / Secondary Sources)

The ambient noise level at Lakhimpur district is within the national noise level standards. As per Table 9.7, which shows noise level 80-91.

Table 9.7 Noise level in Db (A) in the study area

Name of the District	Noise level in dB(A) near DG Set			Noise level in dB(A) inside Factory		
	L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}
Dibrugarh	94.11	101.11	98.23	73.067	87.08	77.68
Tinsukia	94.06	99.31	97.85	71.85	84.08	78.63
Sibsagar	95.61	98.78	96.45	60.22	71.42	64.94
Jorhat	93.25	96.71	95.17	----	----	----
Golaghat	94.9	100.70	99.05	----	----	----
Sonitpur	93.18	96.26	94.69	68.53	77.067	71.7
Nagaon	91.58	94.24	93.18	----	----	----
Lakhimpur	89.188	93.017	91.16	59.23	73.80	68.73
Karimganj	91.24	92.40	91.83	68.15	73.05	70.75
Hailakandi	95.27	96.23	95.7	66.95	76.8	69.45
Cachar	95.80	97.16	96.57	67.03	71.37	69.40

Source: PCBA- Paribesh Batori, Newsletter-2010

9.2.8 Susceptibility to Natural Hazards

There are many disasters (Natural & Man-made), which are normally experienced in the district. Some of these natural disasters i.e. seasonal flood, earthquake, hailstorm and epidemic occurring in the district are as follows:.

Table 9.8 Seasonality of Hazard in the district.

Type of Hazards	Jan-Mar				April-June				July-Sep				Oct-Dec			
	H	C	A	I	H	C	A	I	H	C	A	I	H	C	A	I
Cyclone					*	*	*	*	*	*	*	*				
Flood						*	*	*	*	*	*	*				
Drought					*	*			*	*						
Earthquake	*		*	*	*		*	*	*		*	*	*		*	*
Sunstroke									*				*			
Fire	*			*									*			*
Chemical Accidents	*				*				*				*			
Boat capsize					*				*							
Epidemic					*				*		*		*		*	
Accident	*				*				*				*			
Lightening	*		*		*		*									
Food Poisoning	*				*				*				*			
Bomb blast etc.	*			*	*			*	*			*	*			*
Agriculture poisoning (pesticides)	*	*											*			

(* mark indicate substantial threat and loss to the assigned category)
H: Human, C: Crop, A: Animals, I: Infrastructure
Source: District Disaster Preparedness and Response Plan (2012-13).

9.2.9 Estuary and Coastal Zone

Not applicable

9.2.10 Archaeological and Heritage Locations

The secular archaeological sites of Lakhimpur are found in the form of ruins of garhs, tanks, epigraphs and other structures that were apparently constructed under the patronage of royal power or nobility.

Table 9.9 Protected Monuments in Lakhimpur District. *Source: Archaeological Survey of India.*

S.N	Name of the Monuments	Location
1	Maghnowa Temple	North Lakhimpur
2	Baghar Chukar Doul	North Lakhimpur
3	Gosaipukhuri Ruins	North Lakhimpur

9.2.11 Flora and Fauna

Lakhimpur district is situated in eastern corner of Assam. The district lies between 26° 48' and 27° 53' northern latitude, and between 93° 42' and 94° 21' eastern longitude. The mighty river Brahmaputra touches all along the southern and south eastern boundary of the district.

The District of Lakhimpur has good varieties of wood and bamboo. Gamari, Jutuli, Chapa, Sissu, Silkha, Chom, Sualu, Neem etc. are abundantly found in the District. Besides that Hollock, Urium, Nahar, Ajhar, Simul, Silikha etc. are also available in the forests of Lakhimpur District in quite large numbers. Silk and Beeway Indian rubber form a bulk of main jungle products. Cane is found in unclassified forests areas in great abundance.

The forest of Lakhimpur district offer the much needed shelter to wild elephants, Rhinos, Tigers, Deer, Hogs, Sambhow Deer, Buffalo, Pigs, Methan etc. On the other hand Cobra, Lizard, Python are valuable reptiles found in the forest. Parrot with vivid colours, Queh Aorican, Blue coat pelician, Hornbill, Duck, Goose etc. are common in these forests. Besides various kinds of colorful land and water birds like fowls, Crow, Parakeets or Bhatau, Maina Charai, Gray mynas, Pigeons, Doves or Kapon charai, Bulbuls, Woodpeckers, Salika etc are some of the various kinds of other jungle birds and hill birds. The birds that live in the neighbourhood or human habitation are Crows, Sparrow, Ghanchirika, Salika, Balimahi, Owls etc. There are Vultures or Sagun, Chalani, Kuruha in the district. Water birds of both indigenous and migratory natures are seen in the beels, swamps and rivers. Storks or Bartokola, Bagali, PaniKauri, Kam Charai, Ganga Chilani, Manihari (snakebird) are some of the water and marsh birds seen in the district. Ducks are generally found in the beels as winter visitors. Chakai chakua, Saralihanh, and Pintail ducks are some of the winter visitor birds, which come to the district in winter season.

Tortoises, crocodiles, lizards and sakes are grouped as reptilian. Tortoises of various kinds are found in the beels and rivers of the district. Crocodiles are rarely seen in the Brahmaputra. The green lizards are found almost in every part of the district.

Fishes of various kinds are found in the beels and rivers. The bigger fish are Rau, Barali, Chital, Bahu, Kalijara, Ari, Gagal, Bhakuwa, etc.

With the increase of human population and large-scale deforestation of existing forest, the wild animal of various species are dwindling due to loss of habitat etc.

Plants have major role in the daily life of people of this area, and they have strong belief in both plant and animal based folk medicines. However, due to lack of proper communication system linking villages with towns, folk medicines become main choice for primary health care.

Table 9.10 The Folk medicine used by some rural people of Lakhimpur district.

Diseases	Family name	Local name	Scientific name
Ascites	Papillionaceae	Aparajita	*(Clitoria ternatea L.)*
Ascites	Asteraceae	Bhringaraj	*(Wedelia chinensis Merrill.)*
Ascites	Rutaceae	Bel	*(Aegle marmelos (L.) Correa)*
	Solanaceae	Jalakia	*(Capsicum annum L.)*
Allergy	Boraginaceae	Hatishuria	*(Heliotropium indicum L.)*
Allergy	Acamthaceae	Teetaful	*(Phlogacanthus thyrsiflorus Nees.)*

Diseases	Family name	Local name	Scientific name
Blood dysentery	Papillionaceae	Aparajita	*(Clitoria ternatea L.)*
Blood dysentery	Anacardiaceae	Am	*(Mangifera indica L. L.)*
	Myrtaceae	Kalajamu	*(Syzygium cumini L.)*
	Euphorbiaceae	Amlakhi	*(Emblica officinalis Gaertn.)*
Cough	Rutaceae	Narasingha	*(Murraya koenigii (L.) Spreng.)*
Cough	Bromeliaceae	Matikathal	*(Annanas comosus (L.) Merrill.)*
	Liliaceae	Naharu	*(Allium sativum L.)*
Constipation	Combretaceae	Hilikha	*(Terminalia chekula Retz.)*
Epilepsy	Moringaceae)	Chajina	*(Moringa oleifera Lam.)*
Eczema	Oxalidaceae	Tengesi	*(Oxalis corniculata L.)*
Gastritis	Cucurbitaceae	Patal	*(Trichosanthes cordata Roxb.)*
	Musaceae	Bhimkal	*(Musa balbisiana Colla)*
Gout	Moraceae	Borgach	*(Ficus bungalensts L.)*
Gout	Cucurbitaceae	Kuwabhaturi	*(Citrullus colocynthis Schrad.)*
Loss of appetite	Brassicaceae	Mula	*(Raphanus sativus L.)*
Loosening of teeth	Sapotaceae	Bakul	*(Mimosops elengi L.)*
Piles	Araceae	Ulkachu	*(Amorphophallus paeoniifolius)*
	Caesalpiniaceae	Teteli	*(Tamarindus indica L.)*
Tonsillitis	Mimosaceae	Tarua kadam	*(Acacia nilotica (L.) Delile)*
Pinworm infection	Rutaceae	Narasingha	*(Murraya koenigii (L.) Spreng)*

Source: Some folk medicines from Lakhimpur district, Assam (Dilip Kalita & Rajib Lochan Bora)*

The geographical location of the Lakhimpur and Dhemaji districts have enhanced the entire area as a suitable location for a large number of residential as well as migratory birds. The riverine sand bars and islands of the river Brahmaputra and its numerous tributaries like Jiadhal, Subansiri, Ranganadi and Dikrong and its innumerable fresh water lakes (locally called beel), or ox-bow lakes (era suti), marshy tracts and seasonally flooded plains creates an ideal wetland eco-system.This complicated ecosystem serve as a rare refuge for a large number of water birds, including some rare and Red Data Book species. In Lakhimpur and Dhemaji districts the number of wetland are 151 (3033.50 ha) and 139 (3960.00 ha) respectively.

This area has many habitat types that are important for many globally threatened species. Some of Important Bird Area (IBA) sites are very important for the threatened species. If these IBAs are not protected, the global status of such birds will be adversely affected.

- Oriental White-backed Vulture Gyps bengalensis and Slender-billed Vulture Gyps tenuirostris - *Critically Endangered*

  Once, both these species were common in this area but have experienced sharp population decline in recent years. Although still sighted sporadically in all the plain districts of the state, the number of birds seen was alarmingly low. This decline is projected to increase in the near future because of continued use of diclofenac in veterinary medicines. (Bird Life International)

- White-bellied Heron Ardea insignis - Endangered

  This heron qualifies as endangered because it has a very small, declining population. This decline is projected to increase in the near future because of the loss and degradation of lowland forests and wetlands (Bird Life International 2001).

  Sighting Records: Jamjing beel (Choudhury 1992),

  It is difficult to estimate the total number of this highly secretive bird. However, there is little doubt that the population is very low and is in grave danger due to habitat loss.

- White-winged Duck Cairina scutulata - Endangered

  This forest duck qualifies as Endangered because it has a very small, rapidly declining, severely fragmented population because of deforestation, wetland drainage and exploitation (BirdLife International 2001).

  Sighting Records: Jamjing, (Choudhury 1996b, Choudhury 2000),

- Greater Adjutant Leptoptilos dubius - Endangered

  Still widely but sparsely distributed throughout the Brahmaputra Valley. This stork qualifies as Endangered as it has a very small, declining population. This decline is projected to increase in the future based on current levels of exploitation, the effects of pollutants and continuing reduction in the availability of nesting sites and quality of feeding sites (Bird Life International 2001).

  Sighting Records: Bordoibam-Bilmukh Sanctuary (Choudhury 2000): Bordoibam-Bilmukh Sanctuary (Bikul Goswsmi and Bhaskar Bora 2003) The main problem for this species is lack of food during its breeding season due to over-fishing. Destruction of large nesting trees could also be affecting its population.

- Spot-billed Pelican Pelecanus philippensis - Vulnerable

  An important breeding population survives in Assam, mainly along the Brahmaputra Valley.

  Sighting Records: Koabari Doloni, (Talukdar 1995); Koabari Doloni (Bhaskar Bora and M.Das 1994), Satajan Wetland, (Anonymous 2000)

- Lesser Adjutant Leptoptilos javanicus - Vulnerable

  This stork qualifies as Vulnerable because it has a small, declining population as a result of habitat loss and degradation, hunting and disturbance (BirdLife International 2001).

  Sighting Records: In Lakhimpur and Dhemaji District, this species has reported extensively. Jamjing beel (Choudhury 1992), Koabari Doloni(Bhaskar Bora and Bikul Goswami1995), Bordoibam-Bilmukh Bird Sanctuary(Bhaskar Bora and Bikul Goswami 1995),Bangalmara area of Lakhimpur District(Lakhi prashad Hazarika and BhaskarBora 2009)

- Pallas's Fish-Eagle Haliaeetus leucoryphus - Vulnerable

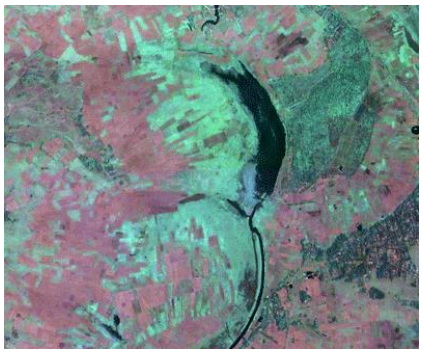
  This species is inferred to have a small, declining population because of widespread loss, and degradation and disturbance of wetlands and breeding sites throughout its

range. It therefore qualifies as Vulnerable (BirdLife International 2001). This species was once very common in the Brahmaputra valley, and remains fairly common in this Lakhimpur and Dhemaji District.

Sighting Records: Bordoibam-Bilmukh Bird Sanctuary (Bhaskar Bora and Bikul Goswami 1994)

9.2.12 Important bird areas (IBA) in the district

1. Bordoibam-Bilmukh Bird Sanctuary



IBA Site Code: IN-AS-07
State: Assam
District: Dhemaji and Lakhimpur
Coordinates: 27°19'60" N, 94°19'60" E
Area: 1,124 ha
Altitude: 90 - 95 m
Rainfall:> 2,000 mm
Temperature: 7 °C to 35 °C
Biogeographic Zone: Northeast
Habitats: Flooded Valley Grassland, Wetland
IBA CRITERIA: A1 (Threatened Species)
Protection Status: Wildlife Sanctuary, established in July 1996, Vulnerable

Critically Endangered: Oriental White-backed Vulture Gyps bengalensis

Endangered: Greater Adjutant Leptoptilos dubius

Vulnerable:

- Spot-billed Pelican Pelecanus philippensis
- Lesser Adjutant Leptoptilos javanica
- Pallas's Fish-Eagle Haliaeetus leucoryphus
- Greater Spotted Eagle Aquila clanga
- Swamp Francolin Francolinus gularis

Near Threatened

- Darter Anhinga melanogaster
- Painted Stork Mycteria leucocephala
- Ferruginous Pochard Aythya nyroca
- Greater Grey-headed Fish-Eagle Ichthyophaga icthyaetus

Other Key Fauna: Other important fauna of the site includes the Fishing Cat Prionailurus viverrina, and Hog Deer Axis porcinus. The latter has become very rare due to the destruction of its grassland habitat. Some Smooth Indian Otters Lutrogale perspicillata still survive. Not much work has done on amphibians and reptiles, although Hoplobatrachus tigerinus, Bufo melanostictus, and Rhacophorus spp. have also recorded.

2. Kuarbari Dalani

IBA Site Code: IN-AS-26
State: Assam
District: Lakhimpur
Coordinates: 27°14'03" N, 94°18'40" E
Area: 15 ha
Altitude: 90 m
Rainfall:>2,000 mm
Temperature: 7 °C to 35 °C
Biogeographic Zone: North-East
Habitats: Tropical Marsh
IBA CRITERIA: A1 (Threatened Species)
Protection Status: Not officially protected

General Description: Kuarbari or Koabari is a small marshy area near Dhakuakhana township in Lakhimpur district, eastern Assam. Surrounded by villages with cultivation, this site attracts a large number of waterfowl including Spot-billed Pelican Pelecanus philippensis, Greater Leptoptilos dubius and Lesser L. javanicus Adjutants and Asian Openbill Anastomus oscitans (Choudhury 2000). The villagers in the area are highly motivated to protect the area and there is virtually no hunting, although poisoning was regular in the past. Dalani means swamp. Dal is a kind of aquatic grass. This wetland IBA has the usual short grasses on the fringe. Bamboos and tall trees are found in the surrounding villages.

AVIFAUNA: Detailed study on this site has conducted since 1989. Due to the protection by villagers, quite a large number of waterfowl are found here, although the site still does not qualify in A4iii criteria (≥ 20,000 waterbirds). This site has been selected purely on the basis of regular and significant numbers of the adjutant storks found here. Critically Endangered Oriental White-backed Vultures Gyps benghalensis and Slender-billed vulture's G. tenuirostris are also seen, but they are widespread, move around a lot and are found in numerous other areas.

Critically Endangered

- Oriental White-backed Vulture Gyps benghalensis
- Slender-billed Vulture Gyps tenuirostris

Endangered

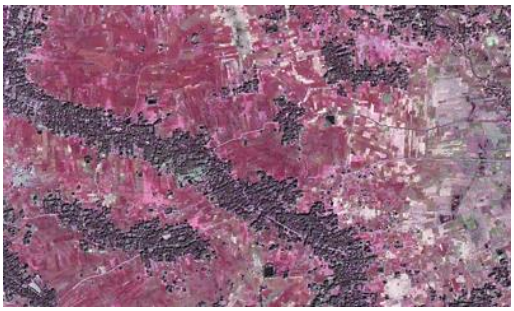
- Greater Adjutant Leptoptilos dubius

Vulnerable

- Spot-billed Pelican Pelecanus philippensis
- Lesser Adjutant Leptoptilos javanicus

Other Key Fauna: As the wetland is surrounded by human habitation, not many wild mammals are found in the site.

3. Pabho Reserve Forest



IBA Site Code: IN-AS-34
Administrative Region: Assam
District: Lakhimpur
Coordinates: 27°03'13" N, 93°59'49" E
Area: 4900 ha
Altitude: 90 m
Rainfall: 2,500 – 3,500 mm
Temperature: 7 °C to 35 °C
Biogeographic Zone: North-East
Habitats: Freshwater Swamp, Sub Tropical Secondary Scrub
IBA CRITERIA: A1 (Threatened Species), A2 (Endemic Bird Area 131: Assam Plains)
Protection Status: Not officially protected

General Description: This site is located near the confluence of the Ranga river with the Khabolu river and consists of degraded grassland with beels and marshes. The woodland area has completely destroyed due to felling. This site was known as Milroy Buffalo Sanctuary during British days as a good number of Asiatic Wild Buffalo Bubalus arnee (= bubalis) used to occur (Choudhury 1994). Situated 20 km south of Lakhimpur town, the district headquarters, and this wetland complex is an important site for waterbirds.

AVIFAUNA: More than 130 species have been listed but more are likely to occur (A. U. Choudhury pers. comm. 2003). Among threatened species, regularly seen are the Greater Adjutant Leptoptilos dubius and Lesser Adjutant Leptoptilos javanicus, Spot-bill Pelican Pelecanus philippensis and Swamp Francolin Francolinus gularis. The White-winged Duck Cairina scutulata has not been reported in recent years (Choudhury 2000). A few thousand waders' andducks winter in the area. It is also a potential site for the Vulnerable species Black-breasted Parrotbill Paradoxornis flavirostris.

Critically Endangered

- Oriental White-backed Vulture Gyps bengalensis
- Slender-billed Vulture Gyps tenuirostris

Endangered

- Greater Adjutant Leptoptilos dubius

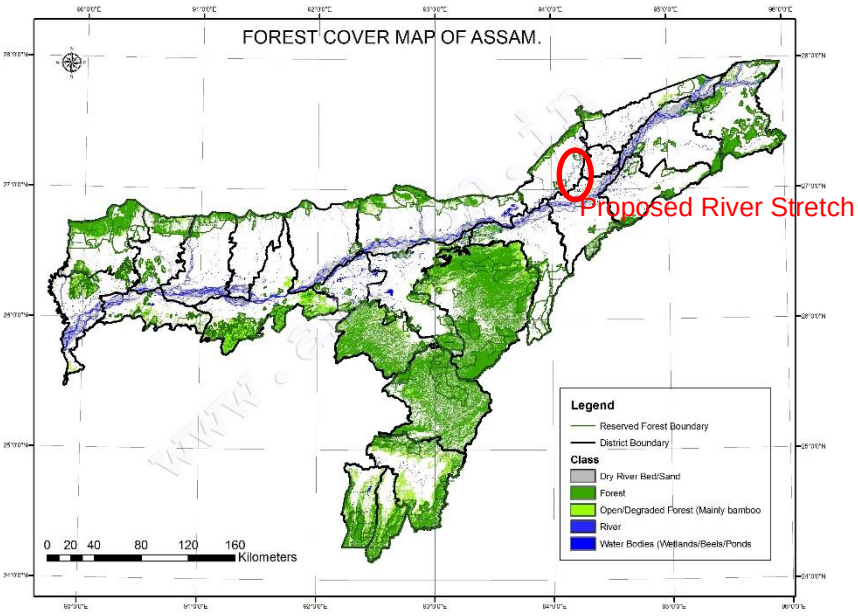
Vulnerable

- Spot-bill Pelican Pelecanus philippensis
- Lesser Adjutant Leptoptilos javanicus
- Greater Spotted Eagle Aquila clanga
- Swamp Francolin Francolinus gularis
- Black-breasted Parrotbill (?) Paradoxornis flavirostris
- Endemic Bird Areas131: Assam Plains
- Black-breasted Parrotbill (?) Paradoxornis flavirostris

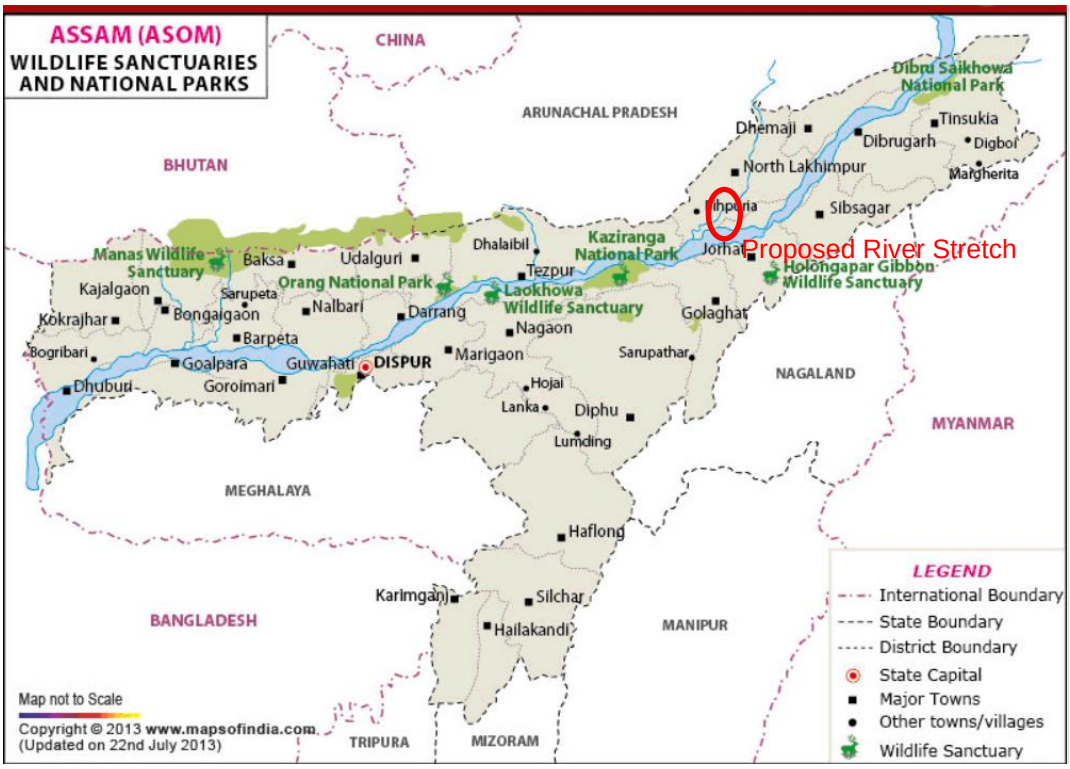
Other Key Fauna: Gangetic Dolphin Plantanista gangetica is seen in the Khabolu river while the Water Buffalo has become stray. Tiger Panthera tigris is an occasional visitor (A.U. Choudhury pers. comm. 2003).

9.2.13 Forests, Wildlife Sanctuaries and Reserves

Based on analysis of Forest Map available at Website of Assam, http://online.assam.gov.in/AopHome-theme/images/aop/maps/Forest_CoverMap.jpg, no forest land is located alongside the project river stretch.



The project river stretch under study is not crossing any national park wildlife sanctuaries and conservation reserves according to secondary sources.



9.2.14 Socio-economic Profile

The Subansiri basin in Assam comprises mainly the plains of Lakhimpur, Dhemaji and a small part of Majuli of Jorhat district. The floodplain of this basin in Assam is densely populated. The extensive and fertile plains support a large population base. According to the Census 2011, the population density per sq.km of Lakhimpur district is 458 as against 390 in 2001.

Table 9.11 Social and Poverty Indicators.(*Source: Census 2011*)

Sl. No.	Social and Poverty Indicators – Lakhimpur District		
1	**Population**	Male	529674
		Female	512463
		Total	1042137
		Urban	91333
		Rural	950804
		Population density (per sq.km)	458
		Decadal growth (%)	17.2
2	**Demography**	ST (%)	23.9
		SC (%)	7.9
		Others	68.2
		Sex ratio (F/1000 M)	968
3	**Economic Status**	BPL households	44% of total population
		Average income/BPL family	Rs. 2200/- per month per family
		Average income per family	Rs. 3000/- per annum
		Average land-holding size (ha)	0.35 ha
4	**Literacy**	Male	83.5%
		Female	70.7%
		Total	77.2%
5	**Energy Use**	Cooking	Wood/bamboo/kerosene/LPG
		Lighting	Electricity and Kerosene
		Agriculture	Diesel

Sl. No.	Social and Poverty Indicators – Lakhimpur District		
		Others	Wood/bamboo/Coal/bio-mass
6	**Social Infrastructure**	Schools	103 (High School=86, SS School=17)
		Colleges	7
		Hospitals (Civil)	7
		Post office	262
		Police station	1
		Railway station	7
		Drinking water source	Mostly pond followed by ring well/tube well
7	**Electric Connection**	Domestic	18444
		Commercial	2744
		General Purpose	458
		Public lighting	5
8	**Level of Social Crime**		Low
9	**Road Details (km)**	State Highway	56 Km
		Major District Road	62 Km
		Rural Road	923 Km
		Urban Road	8 Km
		Total	1049 Km
		Road length/lakh population	118 Km
		Road density	46.1 Km/100 sq.km

9.2.14.1 Demographic Status

The total population of Lakhimpur district as per Census 2011 is 1042137. Male comprises 529674 while female consists of 512463. Out of the total population of the district, 950804 falls under rural and 91333 are under urban areas of the district. In rural area, 482582 and 468222 are males and female respectively. Accordingly 47092 and 44241 are males and females respectively in urban of the district.

a. The percentage distribution of the working and nonworking population of the district is as follows.- Out of total population of the district, 41.3% are workers of which 53.3 % and 28.8 % are male and female respectively. The percentage of non- workers is

58.7% in the district. The worker are categorised as Cultivators, Agricultural Labourers, Household Industry Workers and Other Workers. The percentages of these categories are 55.7 %, 10.2%, 2.6% and 31.6% respectively.

b. In the district, there are four statutory towns.viz. Narayanpur (TC), Bihpuria (TC), North Lakhimpur (MB) and Dhakuakhana (TC). There are no Census towns in the district

Table 9.12 Decadal change in population of tehsil by residence, 2001-11.

Tahsils	Population (2011)					Percentage Decadal Variation 2001-2011		
	Total	**Rural**	**Urban**	**SC**	**ST**	**Total**	**Rural**	**Urban**
Narayanpur	135,641	129,640	6,001	13,479	26,464	10.41	5.52	0.00
Bihpuria	210,165	198,149	12,016	15,321	26,656	24.23	25.16	10.56
Naobaicha	148,973	148,973	0	12,280	18,511	22.16	22.16	0.00
Kadam	107,330	107,330	0	4,183	38,225	17.87	17.87	0.00
North Lakhimpur	250,643	190,829	59,814	23,809	58,601	15.48	17.24	10.19
Dhakuakhana (Pt)	114,295	100,793	13,502	9,947	46,023	12.17	-1.08	0.00
Subansiri (Pt)	75,090	75,090	0	2,821	34,946	15.46	15.46	0.00
District Total	1,042,137	950,804	91,333	81,840	249,426	17.22	15.41	40.18

9.2.14.2 Literacy Rate

Table 9.13 Number of literates and illiterates, literacy rate by sex in CD Blocks (rural), 2011.

Sr.No.	Name of CD Block	Number of literates and illiterates						Literacy rate			Gap in male-female literacy rate
		Number of literates			Number of illiterates						
		Persons	Males	Females	Persons	Males	Females	Persons	Males	Females	
1	Narayanpur	95694	51392	44302	33946	13990	19956	84.37	90.02	78.64	11.38
2	Karunabari	106021	58217	47804	71953	32158	39795	72.57	78.52	66.44	12.08
3	Bihpuria	28712	15691	13021	13450	5782	7668	79.74	85.68	73.59	12.09
4	Nowboicha	74373	41740	32633	52613	22616	29997	70.63	78.2	62.84	15.36
5	Boginadi	65554	37104	28450	44346	18858	25488	71.33	79.14	63.19	15.95
6	Lakhimpur	76356	41945	34411	39119	17100	22019	77.07	82.86	71.03	11.83
7	Telahi	49698	27447	22251	25656	10915	14741	77.31	83.85	70.53	13.32
8	Dhakuakhana	69109	37797	31312	31684	13152	18532	79.45	86.28	72.53	13.75
9	Ghilamara	47659	26473	21186	24861	10205	14656	77.55	85.38	69.58	15.8
	Total	613176	337806	275370	337628	144776	192852	76.22	82.8	69.44	13.36

9.2.14.3 Working profile in the district

Table 9.14 shows the number and percentage of main workers, marginal workers, and non-workers by sex in sub district. In the district, the total population is 10,42,137, and the number of main workers are 2,83,533, marginal workers are 1,46,462, and non-workers are 6,12,142. In the break-up of male female workers, male workers are 53.29 percent and females workers are 28.83 percent. Among the Revenue Circles, the highest percentage of total workers is noticed in Kadam RC with 48.99 percent, and the highest proportion of non-worker is noticed in Naobaicha RC with 62.68 percent. The highest percentage of main workers is noticed in Kadam RC with 30.31 percent and the lowest in Naobaicha RC with 24.46 percent. In terms of Marginal workers, Subansiri (Pt) RC recorded the highest with 19.02 percent and the lowest is 10.38 percent in North Lakhimpur RC.

Table 9.14 Number and percentage of main workers, marginal workers, and non-workers by sex in Sub-districts, 2011.

Sl. No.	Name of Subdistrict	Persons/ Males/ Females	Total population	Main workers		Marginal workers		Total workers (main and marginal workers)		Non workers	
				Number	%	Number	%	Number	%	Number	%
1	Narayanpur	Persons	135641	35909	26.47	23554	17.36	59463	43.84	76178	56.16
		Males	68468	28976	42.32	8772	12.81	37748	55.13	30720	44.87
		Females	67173	6933	10.32	14782	22.01	21715	32.33	45458	67.67
2	Bihpuria	Persons	210165	57634	27.42	22881	10.89	80515	38.31	129650	61.69
		Males	106886	46724	43.71	10686	10.00	57410	53.71	49476	46.29
		Females	103279	10910	10.56	12195	11.81	23105	22.37	80174	77.63
3	Naobaicha	Persons	148973	36440	24.46	19154	12.86	55594	37.32	93379	62.68
		Males	75537	30398	40.24	8230	10.90	38628	51.14	36909	48.86
		Females	73436	6042	8.23	10924	14.88	16966	23.10	56470	76.90
4	Kadam	Persons	107330	32534	30.31	20052	18.68	52586	48.99	54744	51.01
		Males	54590	23096	42.31	6965	12.76	30061	55.07	24529	44.93
		Females	52740	9438	17.90	13087	24.81	22525	42.71	30215	57.29
5	North Lakhimpur	Persons	250643	69691	27.80	26022	10.38	95713	38.19	154930	61.81
		Males	128254	56280	43.88	11257	8.78	67537	52.66	60717	47.34
		Females	122389	13411	10.96	14765	12.06	28176	23.02	94213	76.98
6	Dhakuakhana	Persons	114295	31765	27.79	20516	17.95	52281	45.74	62014	54.26
		Males	57889	23829	41.16	7559	13.06	31388	54.22	26501	45.78

Sl. No.	Name of Subdistrict	Persons/ Males/ Females	Total population	Main workers		Marginal workers		Total workers (main and marginal workers)		Non workers	
				Number	%	Number	%	Number	%	Number	%
		Females	56406	7936	14.07	12957	22.97	20893	37.04	35513	62.96
7	Subansiri	Persons	75090	19560	26.05	14283	19.02	33843	45.07	41247	54.93
		Males	38050	14497	38.10	4981	13.09	19478	51.19	18572	48.81
		Females	37040	5063	13.67	9302	25.11	14365	38.78	22675	61.22
	District	Persons	1042137	283533	27.21	146462	14.05	429995	41.26	612142	58.74
		Males	529674	223800	42.25	58450	11.04	282250	53.29	247424	46.71
		Females	512463	59733	11.66	88012	17.17	147745	28.83	364718	71.17

The main occupation of the people in the plains of the Subansiri sub-basin is agriculture. The cultivators practice permanent cultivation in the study area. About 2099 sq.km of the study area are used for agricultural purpose. Rice is the principal crop grown in the sub-basin in Assam. Based on the season of cultivation, the rice variety may be of Sali, Ahu and Bao. Sali is harvest in November-January and Ahu during early summer. The Bao rice is a long stemmed variety, which can withstand a long period of inundation. Another variety is Boro, which is grown in low-lying areas in the months of December-January. Besides rice, mustard, potato, vegetables etc. are also grown in the fertile floodplains. Among the cash crops, jute and tea are most important.

Table 9.15 Distribution of workers by sex in four categories of economic activity in Sub-District, 2011.

Sl. No.	Name of Subdistrict	Persons/ Males/ Females	Total population	Total workers + (main marginal workers)	Category of workers			
					Cultivators	Agricultural labourers	Household industry workers	Other workers
1	Narayanpur	Persons	135641	59463	36991	6103	2144	14225
		Males	68468	37748	22886	2715	897	11250
		Females	67173	21715	14105	3388	1247	2975
2	Bihpuria	Persons	210165	80515	36045	11324	2626	30520
		Males	106886	57410	24588	7348	1245	24229
		Females	103279	23105	11457	3976	1381	6291
3	Naobaicha	Persons	148973	55594	26396	10405	1167	17626
		Males	75537	38628	19027	6099	724	12778

Sl. No.	Name of Subdistrict	Persons/ Males/ Females	Total population	Total workers + (main marginal workers)	Category of workers			
					Cultivators	Agricultural labourers	Household industry workers	Other workers
		Females	73436	16966	7369	4306	443	4848
4	Kadam	Persons	107330	52586	31889	6120	830	13747
		Males	54590	30061	18299	2418	429	8915
		Females	52740	22525	13590	3702	401	4832
5	North Lakhimpur	Persons	250643	95713	42426	5956	1696	45635
		Males	128254	67537	28423	2529	980	35605
		Females	122389	28176	14003	3427	716	10030
6	Dhakuakhana	Persons	114295	52281	38786	1701	1313	10481
		Males	57889	31388	23346	508	305	7229
		Females	56406	20893	15440	1193	1008	3252
7	Subansiri	Persons	75090	33843	26844	2313	1207	3479
		Males	38050	19478	15809	771	389	2509
		Females	37040	14365	11035	1542	818	970
	District	Persons	1042137	429995	239377	43922	10983	135713
		Males	529674	282250	152378	22388	4969	102515
		Females	512463	147745	86999	21534	6014	33198

9.2.14.4 Village Amenities

Sr. No.	Name of CD Block	Number of inhabited villages	Type of amenity available									
			Education	**Medical**	**Drinking water**	**Post office**	**Telephone**	**Transport communications**	**Banks**	**Agricultural credit societies**	**Approach by pucca road**	**Power supply**
1	Narayanpur	199	193 (96.98)	71 (35.68)	199 (100)	11 (5.53)	157 (78.89)	80 (40.2)	3 (1.51)	0 (0)	5 (2.51)	186 (93.47)
2	Karunabari	109	108 (99.08)	69 (63.3)	109 (100)	13 (11.93)	102 (93.58)	97 (88.99)	8 (7.34)	2 (1.83)	41 (37.61)	108 (99.08)
3	Bihpuria	62	56 (90.32)	24 (38.71)	62 (100)	4 (6.45)	53 (85.48)	47 (75.81)	0 (0)	0 (0)	3 (4.84)	54 (87.1)
4	Nowboicha	134	128 (95.52)	68 (50.75)	134 (100)	17 (12.69)	72 (53.73)	63 (47.01)	2 (1.49)	0 (0)	12 (8.96)	128 (95.52)
5	Boginadi	153	142 (92.81)	57 (37.25)	153 (100)	7 (4.58)	105 (68.63)	90 (58.82)	1 (0.65)	0 (0)	9 (5.88)	130 (84.97)
6	Lakhimpur	122	110 (90.16)	56 (45.9)	122 (100)	13 (10.66)	93 (76.23)	66 (54.1)	1 (0.82)	0 (0)	15 (12.3)	97 (79.51)
7	Telahi	103	93 (90.29)	40 (38.83)	103 (100)	12 (11.65)	60 (58.25)	35 (33.98)	2 (1.94)	0 (0)	2 (1.94)	62 (60.19)
8	Dhakuakhana	156	141 (90.38)	59 (37.82)	156 (100)	9 (5.77)	73 (46.79)	77 (49.36)	0 (0)	0 (0)	8 (5.13)	80 (51.28)
9	Ghilamara	108	94 (87.04)	37 (34.26)	108 (100)	7 (6.48)	51 (47.22)	23 (21.3)	2 (1.85)	0 (0)	5 (4.63)	57 (52.78)
	Total	1146	1065 (92.93)	481 (41.97)	1146 (100)	93 (8.12)	766 (66.84)	578 (50.44)	19 (1.66)	2 (0.17)	100 (8.73)	902 (78.71)

9.3 Potential Environmental and Social Impacts of the Project

The proposed project in Subansiri River only have potential for cross river traffic in the projected future. There are 6 operational ghats, operating with makeshift arrangement. Majority of the Ghats have been transporting passengers and 2- wheelers, using wooden boats. Some of them could also transport 4- wheelers. The demand for cargo and passenger transportation infrastructure in the river would be linked to the growth in passenger, goods and vehicle movement. The catchment area of Subansiri does not have any industries. Hence, there is no requirement to move industrial cargo in the river. The need for development of waterways would be to provide an alternative mode of transportation to local population and help make their day-to-day commute convenient.

Out of the above studied 6 operational ghats, heavy traffic is found on 3 ghats at Dhunaguri, Ghagar and Khaboli. These ghats need to be upgraded. Ghats on the other 3 locations, i.e. Bali, Aserkota and Badoti are used by passengers on foot and 2 wheelers to cross over to the other side of banks for their daily commute. The present volume of passengers and vehicles is small on these ghats to justify the upgradation of existing infrastructre. Phase wise upgradation of ghats is proposed on the identified locations for movement of bigger Ro-Ro ferries that could even carry cars across the river.

The project is proposed to be completed in the following two phases. No fairway development is proposed along the river as no along river transport could be predicted by traffic analysis.

- Phase 1 – Upgradation of 4 ghats at Dhunaguri and Ghagar; 2 ghats at each location on both the banks of the river. Large volume of passengers and vehicles are moving across the river on these locations.
- Phase 2 – Upgradation of 2 ghats at Khaboli; each on both the banks of the river. The landing point on the eastern bank of the river is also closer to Majuli, where heavy flow of traffic exists.

At the construction stage, environment impact will be less due to its dimensions.

Not much dredging is required to construct the terminal and these terminals will be connected through road.

Considering some of the adverse environmental impacts associated with project, these impacts have to be mitigated and mitigation measures need to be incorporated. Environmental mitigation measures represent the project's endeavour to reduce its environmental footprint to the minimum possible. These are conscious efforts from the project to reduce undesirable environmental impacts of the proposed activities and offset these to the degree practicable. Enhancement measures are project's efforts to gain acceptability in its area of influence. They reflect the pro-active approach of the project towards environmental management.

9.3.1 Impacts on Climate

Waterway is more environment friendly compared to other conventional sources of transport namely road or rail transport modes. However, slight change in the micro-climate of the area is expected due to Heat Island Effect near paved areas as likely to develop for loading and unloading point. However, Impact on the climate conditions from the proposed project will not be significant in long run as deforestation and / or removal of vegetation will be compensated by compensatory plantation to the tune of double the area denuded.

9.3.2 Impact on Air Quality

There may be rise in PM levels during the construction activities of loading-unloading point and strengthening of approach road, which shall again be within prescribed limit once the construction activities are over.

Dredging does not significantly affect the air quality, but operation of dredgers involves generation of emissions which may have effect on the air quality. However, the impact anticipated are localized and short term as it will be confined for the duration for which dredger will be operated and to the area where the dredger will be operated.

9.3.3 Impact on Noise Levels

Dredging will be carried out within the navigation channel for crossshore movement only, and therefore, impacts of the dredging noise on the nearby settlements are likely to be insignificant. Noise generating activities should be carried out in day time only.

9.3.4 Impact on Water Resources and Quality

Turbidity of water also increases substantially close to dredging point but it reduces with distance and almost gets normal at a short distance from dredging point.

Vessels generate garbage, oily waste, sewage, bilge water & ballast water which can affect the water quality of the river. Usage of anti-fouling paints may also impact the water quality as the paints may contain toxins. Settling of the dust of the material transported on river surface again can impact the river water quality. Management of wastewater, oily waste, bilge water, noxious waste (if any), air emissions and garbage from vessels as per Marine Pollution (MARPOL) can prevent the water quality pollution. All maintenance & repair works should be carried out at designated locations only. Only toxin-free paints should be used for anti-fouling purpose.

9.3.5 Impact on Ecological Resources

No major forest area is observed along the proposed waterways stretch. However, study area has good bio-diversity in terms of flora and fauna as brought out in earlier sections.

Development of the civil interventions may require clearing of the vegetation from the proposed site. However, most of civil intervention impact shall be limited in proposed terminal areas.

Positive impact on ecology is also anticipated due to development of peripheral green belt and avenue plantation.

9.3.6 Impact on Land

Land use along the proposed waterway is majorly agriculture land followed by settlement and some vegetation areas. Impact due to maintenance dredging on land environment is anticipated only due to dredge disposal. Impact in terms of land and soil contamination is expected if the dredged material was found contaminated by pollution load of nearby areas. Solid waste to be generated during the operation phase includes waste generated at terminal sites and waste generated in vessels which is to be received at terminal sites till the time vessel maintenance and repair facility is developed. The waste may include food waste, plastic, metal tins, papers, dredged sediments, and used oil from Diesel Generator (DG) sets at terminal site These impacts could be significant and may persist for long periods if left unaddressed and unless mitigated. Hence, appropriate mitigation measures are warranted to minimize the impacts.

9.3.7 Impact on Socio-Economy

Due to project activity, socio-economic condition of the area is benefited such as local employment generation and better transportation system.

9.4 Environment Management Plan

Mitigation measures have been planned for identified adverse impacts. The project impacts and management plan suggested thereof are summarized in table below.

Table 9.16 Probable Impact and Mitigation Measures

Particulars	Stages	Potential Impacts	Mitigation Measures
Land & Soil			
Contamination	Construction & Operation	Disposal of dredged material	Scientifically demarcated areas for disposal of contaminated waste and dredged material
Induced Development	Preconstruction & Construction	Insignificant change in the landuse pattern	Civil authorities to plan and guide any induced development using the prevailing regulatory framework
Water			
Impact on Water Resource	Design, Preconstruction, Construction & Operation	Increase in turbidity; reduced light transmittance; reduced DO during dredging Dumping or leakage of vessels generated garbage, oily waste, sewage, bilge water & ballast water Usage of anti-fouling paints as the paints may contain toxins.	Effective study of river profiles to reduce dredging quantity. Wise selection of dredger depending on strata and depth Management of wastewater, oily waste, bilge water, noxious waste (if any), air emissions and garbage from vessels as per MARPOL All maintenance & repair works should be carried out at designated locations only. Only toxin-free paints should be used for anti-fouling purpose.
Climate			

Particulars	Stages	Potential Impacts	Mitigation Measures
Temperature / Rainfall / Humidity	Preconstruction & Construction	Slight heat increases due to movement of ship Tree felling will have an impact on micro-climate of the area	Compensatory afforestation of the trees to be cut as per Forest Dept. guidelines
Air			
Dust generation	Preconstruction& Construction	Removal of trees & vegetation	Regular Sprinkling of Water Regular monitoring of particulate matter in Ambient Air
Gaseous pollutants	Preconstruction, Construction & Operation	Vehicle operation Emission from dredgers	Air pollution Norms will be enforced. Only Pollution Under Control (PUC) certified vehicles and machineries shall be deployed Labourers will be provided with mask. Regular gaseous pollution monitoring in ambient air
Noise			
Dredging Activity	Construction	Noise generation due to dredging activities	Dredging activities should be limited for day time near to settlement areas Dredging should be limited for navigation channel only
Ecology			
Flora	Preconstruction, Construction	Loss of vegetation cover Felling of trees	Felling of only unavoidable trees Compensatory Afforestation as per Forest Dept. guidelines
Fauna	Preconstruction, Construction & Operation	Impact on behavioural response & tissue injury of aquatic organism due to increased noise levels,	proper planning of dredging activities should be carried out Maintenance of speed to avoid any collision

Particulars	Stages	Potential Impacts	Mitigation Measures
		Blocking of fish gills due to increased sediments, Fishes and other aquatic mammals collision by vessel speeds causing injury and death.	
Social			
Socio Environment	Design, Preconstruction & Construction	Disturbance due to noise generating activities	Noise generating activities near to settlement areas shall be limited during day time only No hooter sign during operation phase

9.4.1 Implementation of EMP

The Environmental Officer of the Contractor should be available for the entire construction period of the project. The Environmental Officer shall be primarily responsible for compliance of EMP. The Environmental Specialist of the Monitoring Consultant who should ideally be deployed for the entire duration shall monitor the compliance of the EMP.

9.5 Applicable Legal and Regulatory Framework

The Government of India has formulated various policy guidelines; acts and regulation aimed at protection and enhancement of environmental resources. The following table summarises the existing legislations pertaining to the project, the various clearances required for the project and the status as on date. The summary of environment laws and their applicability is also given in the Table below

Table 9.17 List of Legal & Regulatory Framework

S. NO.	Law / Regulation / Guidelines	Relevance	Applic-ability (Yes / No)	Reason for Application	Implementing / Responsible Agency
1.	The Environmental (Protection) Act. 1986, and the Environmental	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere	Yes (By Project Proponent)	All environmental notifications, rules and schedules are	MoEF & CC, State Dept. of Environment & Forest, CPCB and SPCB

S. NO.	Law / Regulation / Guidelines	Relevance	Applic-ability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	(Protection) Rules, 1987-2002 (various amendments)			issued under the act	
2.	**The EIA Notification, 14th September 2006 & subsequent amendments**	Considered Not Applicable (EIA Notification 2006 does not classify terminals on river or dredging in the river as a project requiring environmental clearance. The applicability of this legislation should be reconfirmed from the concerned authority).	No	-	MoEF & CC & SEIAA
3.	**The Water (Prevention and Control of Pollution) Act, 1974**	Central and State Pollution Control Board to establish/enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction / operation of certain facilities.	Yes (By Contractor)	Consent required for not polluting ground and surface water during construction and operation	State Pollution Control Board
4.	**The Air (Prevention and Control of Pollution) Act. 1981**	Empowers OSPCB to set and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.	Yes (By Contractor)	Consent required for not polluting ambient air quality during construction and operation phase	State Pollution Control Board
5.	**Noise Pollution (Regulation and Control) Act, 1990, 2010**	Standards for noise emission for various land uses	Yes (By Contractor)	Construction including dredging to conform to the	State Pollution Control Board

S. NO.	Law / Regulation / Guidelines	Relevance	Applic-ability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	and its subsequent amendments.			prescribed standards	
6.	**Forest (Conservation) Act, 1980 its subsequent amendments.**	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the Forest Conservation Act.	No	No forest land is located alongside the project river stretch. Presence of revenue forest land shall be established in project execution stage	State Forest Department, MoEF & CC
7.	**Coastal Regulatory Zone Notification, 2011 its subsequent amendments)**	Protect and manage coastal areas	No	Not applicable	MoEF, State Department of Environment
8.	**Wildlife Protection Act, 1972 its subsequent amendments.**	**Protection of wildlife in sanctuaries and National Park**	**No**	The project river stretch under study is not crossing any national park wildlife sanctuaries and conservation reserves	NBWL, SBWL & Chief Wild Life Warden
9.	**Ancient Monuments and Archaeological sites & Remains Act 1958 its subsequent amendments.**	**To protect and conserve cultural and historical remains found.**	**No**	No archaeological monuments found within the project	Archaeological Survey of India, State Dept. of Archaeology
10.	**The Motor Vehicle**	Empowers State Transport Authority to enforce standards for	Yes (By contractor)	All vehicles used for construction	State Motor Vehicles

S. NO.	Law / Regulation / Guidelines	Relevance	Applic-ability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	Act. 1988 its subsequent amendments.	vehicular pollution. From August 1997, the "Pollution Under Control Certificate is issued to reduce vehicular emissions		will need to comply with the provisions of this act.	Department
11.	**Public Liability and Insurance Act,1991**	Protection to the general public from accidents due to hazardous materials	No Yes if any Hazardous materials is for construction (By Contractor)	-	Ministry of Law and Justice
12	**Hazardous and Other Wastes (Management, &Transboundary Movement) Rules, 2016 and its subsequent amendments**	Protection to the general public against improper handling and disposal of hazardous wastes	Yes (By Contractor)	Hazardous wastes shall be generated due to activities like of maintenance and repair work on vehicles	State Pollution Control Board
13.	**Construction and Demolition Waste Management Rules 2016 and Solid Waste Management Rules 2016**	Safe disposal of construction waste and municipal solid waste	Yes (By Contractor)	Construction waste shall be generated due to the demolition of existing structures and municipal waste shall be generated from the construction worker camp	State Pollution Control Board
14.	**Chemical Accidents (Emergency Planning, Preparedness**	Protection against chemical accident while handling any hazardous chemicals	No	Not Applicable	District & Local Crisis Group headed by the DM and SDM

S. NO.	Law / Regulation / Guidelines	Relevance	Applic-ability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	and Response) Rules, 1996				
15.	**The Building & Other Construction Workers (Regulation of Employment & Conditions of Service) BOCW Act, 1996**	Employing Labor / workers	Yes (By Contractor)	Employment of labors	District labor Commissioner

9.6 Need for Environmental Clearance

Considered Not Applicable as EIA Notification 2006 does not classify terminals on river or dredging in the river as a project requiring environmental clearance. The applicability of this legislation should be reconfirmed from the during commencement stage.

9.7 Other Major Clearances / Approvals / Permits Applicable to the Project

- Forest clearance if revenue forest is required during commencement
- Tree felling permission if any tree cutting
- Social Impact Assessment

9.8 Cost implications

For the environment studies, various monitoring and sampling of environment parameter required;

- Air quality
- Noise
- Water quality
- Soil

Table 9.18 Cost for Environmental Study and Monitoring

Item	component	Description	Cost (Lump Sum) (INR)	Cost in Crores
1.	Air	Sampling and monitoring ambient Air Quality and	4,00,000.00	0.04

Item	component	Description	Cost (Lump Sum) (INR)	Cost in Crores
		gaseous pollutants as per CPCB Standard Procedures at 2 locations on once in a month basis for 2 years		
2.	Water	Collection of grab samples of water quality at 2 locations 5 years (twice a year) in pre-& post monsoon seasons	2,00,000.00	0.02
3.	Noise	Monitoring Noise level near jetties at 2 locations on six monthly basis for 2 years	20,000.00	0.002
4.	Soil	Collection of grab samples of water quality at 2 locations 5 years (twice a year) in pre-& post monsoon seasons	40,000.00	0.004
	Total		6,60,000.00	0.066

*****based on past experience and may vary at the time of commencement based on Consulting Scope and Quality*

10 Chapter 10: Institutional Requirements

10.1 Organizational Set up / Establishment

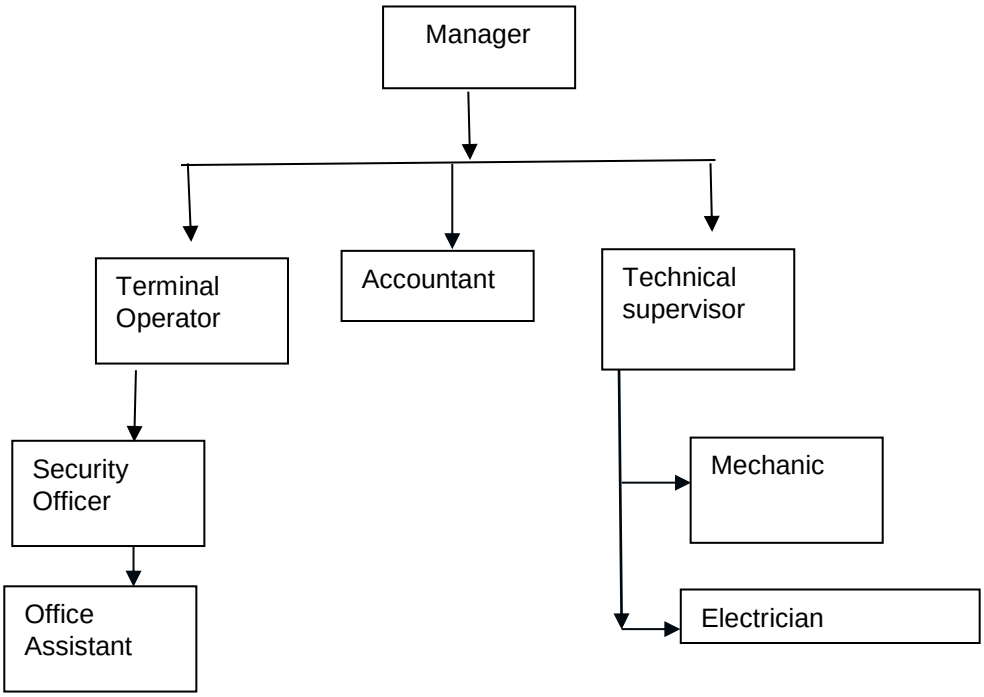


Table 10.1 Proposed Organizational Setup

10.2 Manpower requirement

Major assumptions made in the calculation of the manpower are:

- The terminal operates only in the daytime and 365 days per annum
- Two terminals are operating along the waterway with one terminal operator at each terminal
- Two vessels are used for the waterway transportation with one vessel driver and one security officer in each vessel

Manpower proposed for each department is given in Tables 10.1, 10.2 and 10.3 below:

Table 10.2 Manpower Requirement for Administration/Finance Department

Employee	Nos.
Accountant	1

Table 10.3 Manpower Requirement for Operations Department

Employee	Nos.
Terminal Operator	2
Office Assistant	2
Security officer	4
Vessel staffs (2*2)	4

Table 10.4 Manpower Requirement for Engineering/Maintenance Department

Employee	Nos.
Technical Supervisor	1
Electrician	1
Mechanic	1

Table 10.4 Manpower Requirement for Phase II

Employee	Nos.
Terminal Operator	1
Office Assistant	1
Security officer	2
Vessel staffs (2*1)	2

10.3 Training Requirement / Capacity Building

The employees of each department should be capable of doing their work assigned to them. Also, each department should provide necessary trainings for the employees if needed like terminal operating training, vessel driving training, maintenance training etc. In order to efficiently run the operations, it is suggested that an integrated training programme may be planned by IWAI for setting up the institutional framework and terminal operations. This may include training for crews, terminal operations and other necessary training facilities for consolidated operations of the waterway.

10.4 Infrastructure

10.4.1 Immovable

A building premise is required to house the staffs and their activities for the efficient running of the organizational set up. It is proposed to locate the team head, Manager and the accountant in the IWAI office premise and the terminal operator and security staff can be placed at the individual terminal locations.

10.4.2 Movable

Movable infrastructures like inspection vessels may also be required for the proper functioning of the organization. These may be rented periodically, at the interval of two weeks or so.

10.5 Cost Implications

As per the assumptions and criteria mentioned in the previous sections, an overview of the operating staff structure and costing is highlighted in the Table 10.4 below.

Table 10.5 Costing of Staff Structure

Labour	Nos.	Wage per annum per position (Rs.)
Manager	1	3,00,000
Supervisor	1	2,00,000
Accountant	1	4,80,000
Office Assistants	1	1,80,000
Terminal operator	4	7,20,000
Security officer	4	4,80,000
Electrician	1	2,00,000
Mechanic	1	2,00,000
Movable facilities		1,50,000

10.6 Proposed Dams / Barrages / Locks / Weirs to improve depth

None

11 Chapter 11: Project Costing

11.1 Introduction

The present chapter deals with the cost estimates for development of Subansiri River.

Inland Waterway Transportation system cost is built upon the cost of development, operation and maintenance of the following subsystems:

I. Fairway
II. Terminals
III. Vessel

11.2 Basis of Costing

The estimate of capital costs has been worked out based on the project components as detailed in Annexure D and Annexure E and the drawings presented in Volume II. Rates for works given in this chapter are taken from Delhi Schedule of Rates 2014 by CPWD and Standard Data Book 2014 by Ministry of Road Transportation and Highways and escalated by 7% per annum for year 2016. Rates for works that are not available in above standards, were taken as per local market rates.

An escalation of 30% may be applied to the rates given in this chapter to achieve current rates for 2019 – 20.

11.3 Capital Expenditure

In order to carry out economically sustainable navigation, waterway is proposed to be developed in two phases (section 5.11). Accordingly, the cost estimate of these two phases has been evaluated separately and is presented in this chapter.

The abstract of total cost of the terminal infrastructure is given in Table 11.1. The detailed split up for each can be read from the Annexure D – Detail Estimates: Phase I and Annexure E – Detail Estimates: Phase II enclosed. Details of the annexures related to costing is given in Table 11.4

Table 11.1 Summary of Capital Expenditure

Sl. No.	Description	Phase I (lakhs)	Phase II (lakhs)	Total (Lakhs)
I Fairway development				
1	Dredging	₹ 106.26	₹ 293.60	₹ 399.86
2	River training/ Bank protection / embankment strengthening works	₹0	₹ 0	₹ 0
3	Navigation markings / Navigational aids	₹ 2.40	₹ 0.60	₹ 3.00
II Terminals				
I	Main Terminal Building	₹ 45. 26	₹ 22.63	₹ 67.89
II	Auxiliary Terminal Building	₹ 11.97	₹ 5.98	₹ 17.95
III	Navigation and Communication	₹ 5.00	₹ 2.50	₹ 7.50
IV	Auxiliary items	₹ 20.00	₹ 5.00	₹ 25.00
V	Landscaping	₹ 3.00	₹ 1.50	₹ 4.50

VI	Utility shifting*	₹ 3.00	₹ 1.50	₹ 4.50
VII	Modular Ferry Vessel	₹ 200.00	₹ 100.00	₹ 300.00
	Total (lakhs)	**₹ 396.89**	**₹ 433.3**	**₹ 830.2**
	Total (Crores)	**₹ 3.969**	**₹ 4.333**	**₹ 8.302**

* Shiftings existing road through the terminal premises, water supply line, electricity cables, etc

Terminal block Auxiliary items break up - Phase - 1

Sl No	Item Description	Amount in Rs
1	Electrical	1.79
2	Plumbing	0.96
3	Fire	0.09
4	Fencing	1.80
5	Solar	0.36
	Total	5.00
	No of terminal blocks	4.00
	Grand total	**20.00**

Terminal block Auxiliary items break up - Phase - 2

Sl No	Item Description	Amount in Rs
1	Electrical	0.87
2	Plumbing	0.31
4	Fencing	1.32
	Total	2.5
	No of terminal blocks	2.00
	Grand total	**5.00**

11.4 Operational and Maintenance Expenditure

The annual operational and maintenance expenditure on the different components of the project is asserted taking in to account the life of component, repair and maintenance requirements, wages of personnel and cost of consumables. For a correct assessment of this expenditure, the maintenance schedule for each structure and equipment is determined, personnel strength fixed and requirement of consumables quantified. Even then, the estimation cannot be precise because of the unpredictable breakdown necessitating considerable expenditure on repairs and replacement. The only practical approach in the situation is to fix the annual expenditure as a percentage of the capital cost of the project. This percentage is to be judged based on the past performance of similar structures and equipment functioning.

11.4.1 Operation Cost

The operational cost of the waterway will include the following:

- Manpower –It is observed that the IWAI Guwahati can head the manpower for the functioning of the terminal operations. It is proposed to have one official housed in the terminal building to monitor the operations. One security official like local police or so is suggested to be deputed to the terminal office and waiting building to ensure safety. The vessel is suggested to have 2 staffs on board.

11.4.2 Maintenance Cost

In the initial stages the maintenance of Inland Waterways System is to be handled by the SPV through the construction agency for a period specified in the tender document. Afterward operations and maintenance shall be handled through the combination of in-house capacity building & outsourcing.

It has been observed that there will be requirement of dredging and channel marking which are to be executed annually to maintain the navigable depth (1.4 m) throughout the year. It is presently assumed that some 5% of the dredging will be required to be undertaken as maintenance of dredging in each year. The need for maintenance of terminal infrastructure is less noticeable than in the case of mechanical equipment or electrical supply breakdowns where the need for maintenance is obvious.

The percentage for the various items of the project normally adopted is as follows:

- Dredging -5 %
- Navigation aids – 2%
- Civil works – 1%
- Vessel – 10%
- Navigation and communication- 1%

The O&M cost for the project in Phase I and II is shown in the following Table 11.2:

Table 11.2 Summary of Operation and Maintenance Cost

Sl. No.	Description	Percentage of Capex	Phase I Annual cost*	Phase II Annual cost*
I	Fairway maintenance			
1	Dredging	5	₹ 19.84	₹ 21.66
2	Navigation markings / Navigation aids	2	₹ 7.93	₹ 8.66
II	Terminal maintenance			
1	Terminal infrastructure	1	₹ 1.98	₹ 4.33
2	Navigation and Communication	5	₹ 19.84	₹ 21.66
3	Modular Ferry Vessel	10	₹ 39.68	₹43.33
4	Administrative Cost		₹ 58.76	
	Total (lakhs)		**₹ 148.06**	**₹ 99.66**
	Total (Crores)		**₹ 1.481**	**₹ 0.996**

**in Lakh rupees*

11.5 Phasing of Expenditure

The cost of civil and other works has been asserted for the first two stages of waterway development and their phasing derived. The phasing of expenditure is shown in Table. 11-3

Table 11.3 Phase wise costing

Phase	Cost (Crores)
I	₹ 3.97
II	₹ 4.33

Details of annexure is presented in Table 11.4

Table 11.4 Details of annexures related to costing

12 Chapter 12: Implementation Schedule

The detail plan for developing Subansiri River into National Waterway 95 suggest a few engineering interventions. The civil works and other related activities are proposed to be implemented within a period of 16 months after getting Technical and Administrative Sanction from the Government or from the respective funding agency. The entire implementation plan has been proposed into two phases as given below. The project implementation is proposed to be undertaken by IWAI in an EPC mode.

12.1 Phasing

The development can be divided in to pre-construction and construction activities. Various activities identified under pre-construction are:

I. Clearance from various authorities
II. Preparation of detailed engineering drawings/ Layouts
III. Preparation of tender related documents
IV. Tender process

It is assumed that the above-mentioned activities can be completed within three months after Government's approval. Various activities identified under construction are:

i. Dredging:
Dredging is the major activity in the development of the channel, which is critical. In this implementation schedule, it is assumed that the whole of the dredging is to be carried out in as a single contract.

ii. Construction of terminal structures:
Construction of terminals is an important stage in the development of waterway projects. In Subansiri waterway development project, the terminals are developed in phased manner, the same is explained in Section 12.2 Phasing.

iii. Procurement of vessels and navigation aids:
The procurement of vessels and navigation aids can be so planned that the same and construction of floating terminals are completed simultaneously.

iv. Commissioning:
After completion of works of Phase I, the waterway will be ready for commissioning by concerned authorities. The bar chart for implementation schedule is prepared and presented in Figure 12.1.

12.1.1 Phase I Development

As mentioned in section 5.11, In the phase I, it is suggested to have the water way developed to the class II intented for crossing of the river at four locations, with the dredging and removal of shoals and attaining the minimum water depth of 1.4m at the channels for crossing.

Sl. No.	Main ghat	Auxiliary ghat	Proposed traffic handling
1	Ghagar (Chainage 68.20 km)	Ghunakhuti (Chainage 70.60 km)	Passenger + 4 wheeler
2	Dhunaguri (Bongalmara) (Chainage 25.20 km)	Selek (Majuli District) (Chainage 27.00 km)	Passenger + 4 wheeler

The dredged channel is required to be demarcated using aids to navigation. The channel for cross shore movement is to be dredged and marked at two locations as Ghagar and Dhunaguri in Phase I. The main terminal buildings are planned at the right banks of the two said locations, on the other banks of Ghagar and Dhunaguri ghat, passenger waiting building is proposed.

12.1.2 Phase II Development

In this phase, it is suggested to have a similar terminal development at two locations and the channel for cross shore movement at Khabuli to be dredged and marked using aids to navigation.

Sl. No.	Main ghat	Auxiliary ghat	Proposed traffic handling
1	Khaboli/Khabolu (Chainage 41.00 km)	Luit Khabulu Panchayat (Chainage 42.00 km)	Passenger + 4 wheeler

12.1.3 Time Frame Calculation

The assumptions used in calculating the time frame are listed here.

Dredging has to be performed only at the stretches for cross river traffic. Under Phase I, the channel for cross shore movement is to be dredged and marked at two locations as Ghagar (at Chainage 68.20 km at Ghunakhuti and Chainage 70.60 km for passenger + 4-wheeler traffic, and at Dhunaguri (Bongalmara) at Chainage 25.20 km and Selek (Majuli District) at Chainage 27.00 km also for passenger and 4 wheeler traffic. Under Phase II it is suggested to have terminal development at Khaboli ghat and the channel for cross shore movement at Khabuli to be dredged and marked using aids to navigation. The Total dredging quantity in phase I for cross shore movement alone is worked out as 53,132.6 cum, and that for Phase II, cross movement: 146798.10 cum

For dredging it is assumed that the rate of dredging is 300 cum / hr and the considered working time is 12 hours per day. Thus in phase 1, dredging component takes around 15-20 days. The tendering process for procurement of vessels and other items need to be initiated from the beginning itself. A time span of 3 months is proposed between Phase I and Phase II so that the response of the local public to the system introduced can be studied and Phase II can be implemented correcting all flaws thereby increasing the utility of the system.

For timely completion of projects planning and implementation of various modules is important. It should be noted that the timeframes have been estimated based on an assumed construction methodology. The EPC contractor may choose a different construction methodology depending on their capability and understanding and this may change the calculations presented below. It should also be noted that delays in project implementation due to environmental or other statutory approvals, financial closure, construction delays etc., have not been factored in the implementation schedule.

12.1.4 Phase I implementation schedule

Sl no	Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Part A: Civil works																		
1	Tendering and awarding of work	■	■	■	■	■													
2	Construction of foundation and substructure for Main/ auxiliary terminal building						■	■											
3	Fabrication of roof truss							■	■										
4	Construction of super structure of buildings and installation of roof								■	■	■								
5	Plumbing, electrification											■	■						
6	Landscaping													■					
7	Dredging											■	■	■	■	■	■		
8	Installation of channel markings																	■	
9	Commissioning																		■
	Part B: Ferry Vessel																		
1	Tendering and awarding of work	■	■	■	■														
2	Tendering, procuring, commissioning, placement and mobilisation of Modular ferry to the site					■	■	■	■	■	■	■	■	■	■	■	■	■	■

Figure 12.1 Phase I implementation schedule

12.1.5 Phase II implementation schedule

Sl no	Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Part A: Civil works																		
1	Tendering and awarding of work																		
2	Construction of foundation and substructure for Main/ auxiliary terminal building																		
3	Fabrication of roof truss																		
4	Construction of super structure of buildings and installation of roof																		
5	Plumbing, electrification																		
6	Landscaping																		
7	Dredging																		
8	Installation of channel markings																		
9	Commissioning																		
	Part B: Ferry Vessel																		
1	Tendering and awarding of work																		
2	Tendering, procuring, commissioning, placement and mobilisation of Modular ferry to the site																		

Figure 12.2 Phase II implementation schedule

12.2 Suggested Implementation Mechanism

To develop the project and to manage the common infrastructure facilities, it is necessary to establish an independent team under the IWAI Guwahati, as the implementing agency. This team shall be the agency for service delivery, operation and maintenance of the Project. The option of office owned by the Government entities is best suited for the Subansiri inland waterway development and operation. In the construction phase of the proposed project IWAI shall be the main implementing agency. The process of awarding the contract shall be on tender or deposit basis. IWAI shall invite, process and award the tenders. As and when necessary the team shall invite the offer from government construction agencies on limited tender or deposit basis. An apex coordination committee shall be formed to co-ordinate between the departments related to the project and issue guidelines to the team for execution of the works. A policy framework and operating manual containing detailed system and structure of execution shall be prepared for effective control and delivery of the services.

The entire construction (including capital dredging) would be through EPC contracts. The maintenance of Inland Waterways system is to be handled by the IWAI team through the construction agency for a period specified in the tender document. Thereafter O&M shall be handled through the combination of in-house capacity building & outsourcing. The revenue connected with these activities will also be collected by the IWAI in the shape of tariff & user charges. IWAI team will also have to be provided with the necessary power for building bye-laws for efficient functioning of Inland Waterways System.

It is recommended that the team have full right to fix its own tariff, based on the market realities. IWAI should involve the private sector participation as much as possible with a view to achieving higher efficiency with participation in the construction, operation and maintenance (after a suitable time lag).

12.2.1 Options for private sector participation

The options for private sector participation can be ranged along a spectrum. At one end are those in which the government retains full responsibility for ownership, operations, maintenance, capital investment, financing, and commercial risk – at the other, those on which the private sector takes on much of these responsibilities.

Considering the socio-economic status of the project, obtaining private psector partnership might be challenging. However, as an option the following forms of private partnertships are presented.

12.2.1.1 Service contract

Service contracts secure private sector assistance for performing specific tasks – operations and maintenance of channel, vessels etc. their main benefit is that they take advantage of private sector expertise for technical tasks or open these tasks to competition. Service contracts are the best and cost-effective way to meet technical needs for a project that is already well managed.

12.2.1.2 Management contract

Management contracts transfer responsibility for the operations and maintenance of government owned business to the private sector. It ranges from paying a private firm a fixed fee for performing managerial tasks to sophisticated management contracts with incentives for efficiency, by defining performance targets and basing remuneration at least in part of their fulfilment. Management contracts leave all responsibility for investment with the government. Management contracts are likely to be useful where main objective is to rapidly enhance a

private sector player's technical capacity and its efficiency in performing specific tasks, or to prepare for greater private involvement.

12.2.1.3 Lease

Under a lease agreement a private firm leases the assets from the government and takes on the responsibility for operating and maintaining them. Leases leave the responsibility for financing and planning investments with the government. So, if major new investments are needed, the government must raise the finance and coordinate its investment program with the operator's operational and commercial program. Leases are most appropriate where there is scope for big gains in operating efficiency but only limited need or scope for new investments.

12.2.1.4 Concession

A concession gives the partner responsibility not only for the operational and maintenance of a project's asset but also for investments. Asset ownership remains with the government, however, and full use rights to all the assets, including those create by the private partner, revert to the government when the contract/concession ends-usually after 25 to 30 years. There are several variants of concession viz. Build Own Operate (BOO), Build Operate Transfer (BOT), Build Own Operate and Transfer (BOOT), etc.

As an example, the proposed project implementation structure for the proposed Mahanadi & Luna Inland Waterway project is outlined below.

- IWAI owns the project with no involvement of private sector participant. All capital and maintenance works shall be implemented through contracting system prevalent in the IWAI.

13 Chapter 13: Economic and Financial Analysis

This chapter analyses the viability of the project from financial and economic perspectives. Only the ~107 km stretch of NW-95 has been considered for the analysis. While financial analysis focuses on the project specific expenditures and revenues accounting for time value of money, economic analysis focuses more on larger socio-economic impact of the project in quantifiable terms.

13.1 Revenue

Since the project is proposed to be structured in a mode where the IWAI is directly performing the operations, the revenue in generated out of the ticketing and any other user revenues shall be the preferred revenue source. The revenue shall be utilised for hte operation & maintenance of the the channel system and to meet the administrative expenses in connection with the O&M activities of the ferry system.

13.2 Possible Ancillary Revenue

Based on the Origin – Destination study, it is ascertained that the major traffic through the subject water way is across the river transportation. However, the proposed corridor has ample tourism resources, which are yet to be capitalised. The option of integrating tourism circuits along the project corridor will fetch additional revenue and local employment generation. This option may be explored in the subsequent phases after streamlining the project corridor.

13.3 Financial Analysis

The financial feasibility of the project has been determined in the form of Net Present Value (NPV) of pre-tax cash flows projected up to 2049. Following sub-sections detail the assumption, capital cost calculation, O&M costs, revenues estimated for the project.

Two scenarios have been considered for financial analysis

- Scenario 1: Current tariff structure (as per IWAI guidelines)
- Scenario 2: Proposed tariff structure (as per proposed revised tariffs)

13.3.1 Scenario 1: Current Tariff Structure

This scenario assumes that the guidelines tariffs published by IWAI for Indian waterways would be applicable. However, it should be noted that the tariffs are significantly outdated, being published in 2011. Hence, in absence of any revised tariffs, Scenario 1 has been constructed based on existing tariffs.

13.3.2 Scenario 2: Proposed Tariff Structure

Transportation through waterways enjoys significant cost benefits as compared to road or rail transport. This significant cost differential drives the possibility of escalation of key tariffs as listed below:

- Fairway charges – since the waterway involves significantly high dredging, increasing the fairway charges would significantly help in recovering the capital expenses in dredging and sustaining the recurring maintenance expenses.
- Terminal charge – While it is recommended to exclude investment in equipment / machinery at the terminal, still the terminal charges can be escalated for provision of multi-modal connectivity (both highway and railways), logistic operators and various facilities.

While tariff escalation is warranted due to price escalation and the O&M costs, the waterway tariffs should remain cost effective as compared to other modes of transport. Further reduction in barge operator charges can be expected once the waterway is fully operational due to improved capacity utilization, turn-around time and traffic. Hence the waterway would not only be the most cost effective transport mode but also ensure appreciable returns for barge operators.

13.3.3 Financial Assumptions

The following general assumptions have been considered:

- Capital Costs escalation: 5% p.a.
- Operational Expenditure escalation: 5% p.a.
- Revenues / Tariff escalation: 6% p.a.
- Yearly maintenance cost (% of Capex)
    - Dredging @ 5%
    - Navigation aids @ 2%
    - Civil works @ 1%
    - Vessel @ 10%
    - Navigation & communication @ 5%
- Average route length @ 1.8 Km
- Average no of round trips @ 8 Nos
- HSD consumption/trip @ 3 Ltr
- Number of vessels @ initial period: 2 Nos

13.3.4 Capital Expenditure Phasing Schedule

The Capital Expenditure Phasing Schedule has been worked out as follows:

Table 13.1 CAPEX Schedule

Sl. No.	Description	Phase I (lakhs)	Phase II (lakhs)	Total (Lakhs)
I Fairway development				
1	Dredging	₹ 106.26	₹ 293.60	₹ 399.86
2	River training/ Bank protection / embankment strengthening works	₹0	₹ 0	₹ 0
3	Navigation markings / Navigational aids	₹ 2.40	₹ 0.60	₹ 3.00
II Terminals				

I	Terminal Building	₹ 45. 26	₹ 22.63	₹ 67.89
II	Waiting Building	₹ 11.97	₹ 5.98	₹ 17.95
III	Navigation and Communication	₹ 5.00	₹ 2.50	₹ 7.50
IV	Auxiliary items	₹ 20.00	₹ 5.00	₹ 25.00
V	Landscaping	₹ 3.00	₹ 1.50	₹ 4.50
VI	Utility shifting	₹ 3.00	₹ 1.50	₹ 4.50
VII	Modular Ferry Vessel	₹ 200.00	₹ 100.00	₹ 300.00
	Total (lakhs)	**₹ 396.89**	**₹ 433.33**	**₹ 830.2**
	Total (Crores)	**₹ 3.969**	**₹ 4.333**	**₹ 8.302**

13.3.5 Operations & Maintenance Expenditure

As mentioned in the Project Costing chapter, O&M expenses comprises mainly of manpower and various maintenance charges (dredging, bank, navigation aids, terminal). Following maintenance assumptions have been used for the analysis.

Table 13. 1 Yearly Maintenance rates

Task	% of capex
Dredging	5%
Navigation aids	2%
Civil works	1%
Vessel	10%
Navigation and Communication	5%

Following table shows the year-on-year breakup of Capex and O&M costs:

Table 13.2 Year-on-year breakup of Capex and O&M costs for phase I and II combined

	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25	Mar-26	Mar-27
CAPEX (in Crores)								
TERMINAL AT 4 LOCATIONS								
Terminal Building	₹ 0.45	₹ 0.226	-	-	-	-	-	-
Waiting Building	₹ 0.119	₹ 0.059	-	-	-	-	-	-
FAIRWAY DEVELOPMENT								
Dredging	₹ 1.06	₹ 2.94	-	-	-	-	-	-
NAVIGATION & COMMUNICATION								
VHF Radio	₹ 0.05	₹ 0.025	-	-	-	-	-	-
AIDS TO NAVIGATION	₹ 0.024	₹ 0.006	-	-				
LANDSCAPING	₹ 0.03	₹ 0.015	-	-				
UTILITY SHIFTING	₹ 0.03	₹ 0.015	-	-				
AUXILARY ITEMS	₹ 0.2	₹ 0.05	-	-				
MODULAR FERRY VESSEL	₹ 2.0	₹ 1.0	-	-	-	-		
Total Capex	**₹ 3.969**	**₹ 4.333**	-	-				
OPEX								
Dredging	-	₹ 0.194	₹ 0.155	₹ 0.116	₹ 0.114	₹ 0.097	₹ 0.094	₹ 0.077
Navigation aids	-	₹ 0.074	₹ 0.062	₹ 0.046	₹ 0.046	₹ 0.039	₹ 0.037	₹ 0.031
Civil works		₹ 0.019	₹ 0.015	₹ 0.012	₹ 0.0114	₹ 0.0096	₹ 0.0093	₹ 0.0077
Administrative Cost		₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876
Total Opex		**₹ 0.878**	**₹ 0.8199**	**₹ 0.7618**	**₹ 0.7589**	**₹ 0.7328**	**₹ 0.728**	**₹ 0.704**

13.3.6 Revenues

For estimating the revenues, the tariff structure provided by Inland Waterways Authority of India has been used. The tariff structure for passenger and vehicles for each terminal has been separately captured. Accordingly, the projections are made with 80% capacity utilisation and a sensitivity to capture the variations in capacity utilisation has been built in the financial model. The project has been structured in two (2) phases with a minimal interval of 6 months. The revenue from the operational activities of phase 1 is considered to be commencing from 11 months onwards and that of phase II has been captured from 17th month onwards. Farebox revenue is the only source considered for the projections since IWAI has proposed to perform the O&M directly.

Operator's Revenue (crores)(Ticketing)		Mar-19	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25
Farebox Revenue	-	-	-	-	-	-	-	-
Passenger	-	-	₹ 1.92	₹ 2.22	₹ 2.55	₹ 2.91	₹ 3.32	₹ 3.79
2-wheeler	-	-	₹ 0.93	₹ 1.05	₹ 1.12	₹ 1.25	₹ 1.33	₹ 1.49
4-wheeler	-	-	₹ 1.51	₹ 1.63	₹ 1.81	₹ 1.94	₹ 2.15	₹ 2.31
Total	-	-	**₹ 4.37**	**₹ 4.90**	**₹ 5.47**	**₹ 6.10**	**₹ 6.80**	**₹ 7.60**
Capacity Utilisation@ 20%		20%	₹ 0.874	₹ 0.979	₹ 1.09	₹ 1.22	₹ 1.36	₹ 1.52
IWAI SPV's Revenue (From Lease & Revenue Sharing)								
Lease Rent		-	-	-	₹ 2.00	₹ 2.00	₹ 2.60	₹ 2.60
Revenue Sharing @ 5%		-	-	-	₹ 0.49	₹ 0.54	₹ 0.61	₹ 0.68
Total		-	**-**	**-**	**₹ 2.24**	**₹ 2.27**	**₹ 2.90**	**₹ 2.94**

13.3.7 Cash flow

The total operation expense over a period of 30 years is estimated to be ~ Rs.78 Cr. The project is structured in a way that, the authority is operating the ferry service directly. A conservative approach was adopted for the extrapolation of the cashflow. Hence the project may require more time to break even considering the recurring O&M expenses. Based on the financial projections it is observed that, the cashflow has turned out to be positive over a period of 14 years.

13.3.8 Financial Analysis Conclusion

Based on the financial analysis it is observed that the project is yielding with the FIRR stands @ 8.68%. This is quite acceptable.

13.4 Economic Analysis

The DPR proposed the development of Subansiri river in Assam as NW-95 for a length of about 107 kilometer between Brahmaputra confluence (downstream) and NH 52 bridge (upstream). The waterway final DPR proposal consists of 6 terminals at 3 ferry locations for ferrying people and vehicles by mechanized boats.

The project proposal is for two Phases

Phase I	Ghagar (Chainage 70.00 km) & Dhunagiri (Chainage 27.00 km)
Phase II	Khabuli (Chainage 41.00 km)

Each location will have a terminal building at one ferry end and a passenger waiting shed on the other side of the river bank. Modular boat service will be operated for ferrying passengers and their vehicles at these locations.

The hinterland is mostly open with many tracts of cultivable land with paddy as the main crop with occasional crops of mustard, black gram and seasonal vegetable cultivation done by local village men. There is a huge demand for movement of local villagers and settlers for ferrying

across the river for employment, sales and purchase of farm produces and other service purposes. At present adequate river crossing facilities are grossly absent and at some places ferrying of people and vehicles are done with obsolete boats by private operators in highly unsafe environment.

The river environment is highly treacherous during flooding season where people's cross movement will be curtailed for many days. If proper terminal and modern vessels can be introduced, people will get opportunity for safe, cheap and uninterrupted cross movement from their villages to market places, health centers, schools and employment centers. The land use pattern in the hinterland suggest that the western part of the river basin is relatively developed as compared to the eastern region. The NW 95 project will benefit the people living immediately 5-6 km alongside of both river banks covering the villages of Narayanpur, Bhipuria, Naobaicha, North Lakhimpur, Kadam, Subansiri and Dhakuakhana with a catchment area of about 1400 sq. km. and population of 3.50 lakh. With assured state of transport infrastructure, the people will find it extensively happy and become more mobile for productive and leisure purposes. The production multiplier effect will increase the total production and per capita income, thereby increasing the consumption and development of the local population.

13.4.1 ECONMIC ANALYSIS

Economic analysis is carried out by assessing the economic cost and benefits and the socio-economic impacts in 'without' and 'with' project. At present (without project situation) people have to wait for many hours and walk long distances to find a ferry boat and boatmen who is willing to help them cross the river at his own whims and fancies that too in a very unsafe condition. The NW-95 project will connect the hinterland population who are divided at present due the North-South flowing Subansiri river over a length of 107 km. In the new situation (with project) the people will gain valuable time spent on waiting which otherwise could have been utilized for production activities.

In without the project situation over 1367 people are found crossing the river on an average per day from one bank to other for their social and economic purposes. Over 279 two wheelers and 61 four wheelers are found to transported through old barges operated especially in Khaboli and Dhunagiri locations. These private barge operations are not at all reliable and often the users lose their valuable time in waiting at the barge/boats to cross the river. On an average 2-3 hours is lost by the people in depending on the present ferry system (without project) which is very uncertain and unsafe. It is estimated that the passengers will gain at least 2 hours per trip resorting to the new organized ferry system to be operated by IWAI (with Project). This is a huge benefit that will be accrued to the passengers and the savings in time can be well utilized more productively. Even if this small saving in time per trip cannot be converted into production, it will give the user a leisure value which has an economic value. The new ferry system will boost and induce employment, output and consumption which in turn further boost the economy with multiplier effect. More uncultivated land will be put into cultivation and hence agriculture production will increase immediately. The farm production may double or double within 2-3 years' time. This ne w addition to the agricultural output can be considered as a direct economic benefit due to the improvement of NW 95.

The opening of the well-organized safe Inland Water System is expected to attract tourist travel and related commercial activities which will increase the land value of the hinterland. The land value at the proximity to the waterways especially at ferry locations will increase gradually as commercial and tourism activities will flourish in next 10 – 20 years. The higher land value can be attributed as indirect long-term benefit due to the new project.

13.4.2 Estimation of Economic Benefits

13.4.2.1 Assumptions

- Length of waterway considered for study ~107 km, Subansiri river in Assam, NW 95, between NH52 crossing bridge point at Ch. 106/45 km (upstream) and Brahmaputra confluence point at Ch. 0/0 km (downstream). However the river only has potential for cross river traffic in the projected future.

- Number of ferry locations being developed -3, viz. Ghagar (Ch. 70 km), Dhunagiri (Ch. 27 km) during phase 1 and Khaboli (Ch. 41 km) in Phase 2

- Nature of development-construction of terminal building, waiting shed for passengers, capital and maintenance dredging for fairway, navigational aids, running of modular vessels etc. Rs. 396.89 lakhs will be spent in 2019 (Phase 1) and Rs. 433.33 lakhs will be spent in 2020(Phase 2) towards terminal building, dredging and other capital items. The running expenses for managing and operating ferry will be Rs. 146 in 2019 and Rs. 153.3 lakhs from 2020 onwards. The inflation rate is taken as 4 percent per annum.

- In existing case (without project situation), people living on both sides the river are faced with many difficulties for crossing the river for eking their livelihood. They are subject to many uncertainties, lack of sufficient ferry points, long waiting for ferry boat, inordinate delay in ferry time and exposed to high risk of boat/barge accidents while ferrying the river by untrained private boat/barge operators. On an average 3-4 hours are taken for crossing the river both for waiting for the boat and ferrying due to unregulated private ferry operation. Passengers venturing out for crossing the river become fatigued and lose the whole day which could otherwise be used for productive purposes.

- The existing fare charged by private boat operators for ferrying passengers and vehicles and that to be charged by IWAI in without and with project situations are assumed to be same and hence no saving is considered.

- In 'with project' situation passengers will gain average 2 hours per trip due to regulated ferry services operated by IWAI. This saving in time is a huge benefit to the people who could utilize the time savings for productive purposes. However, the leisure value of time saved by passengers and commercial time value of commercial vehicles are only considered as direct benefits due to project. A ratio of 60:40 is taken as proportion of private and commercial 4-wheeler traffic. Opportunity cost and shadow pricing techniques are used for estimating value of time gained by different categories of people and vehicles.

- In the case of 'with project' situation, the existing operators will find themselves displaced from their present activities which involve diseconomies. However, it is assumed that they will be absorbed in the new project at proposed locations, or they will find alternative jobs in fishing, sand mining etc. in other locations.

- The project will benefit people living in close proximity to the project area. The project influenced area is taken as up to 5 km towards eastern and western sides of the river bank. The catchment area covers around 1400 sq. km with average population density of 450 people per sq.km.

- In the existing situation around 1367 passengers, 279 two wheelers and 61 four wheelers were found crossing the river on an average day. It is assumed that due to increased transport and communication facilities there will be increased opportunity for people to find out productive employment, easy market access for selling farm produce and purchasing fertilizers etc. There will be increase in agricultural production by bringing more area under cultivation and commercialization of crops. About 10 percent of the net addition in agricultural output is taken as direct benefit due to the project.

- Investment in the present project will cause an overall economic growth multiplier to set in and sustain for 10 to 15 years, thereby improving the land value and quality of life of people. This is a long term indirect benefit due to the project. An annual growth multiplier factor of 1.05 is taken in the present case.
- The passenger traffic will increase minimum by 5 percent per annum initially which may reduce to 3 percent per annum in future. The two-wheeler traffic is expected to grow by 5 percent per annum initially and further increase to 8 percent. The four-wheeler traffic growth will be in the range of 5-6 percent per annum. Financial costs are converted to Economic cost by applying a conversion factor of 0.8 as applicable in highway and water transport projects in the country.

13.4.2.2 Direct Benefits

13.4.2.2.1 Savings in Value of Time

Passengers

The average income of passengers who have mixed occupation level such as farmers, traders, house wives, students, fishermen, manual laborers, etc. crossing the river is taken as Rs. 200 per day

The passenger's income per hour (considering working hours of 10 hours) = Rs. 20 per hour

Average savings in the time per trip = 2 hours per trip

Total time value benefits due to savings in time by 1367 passengers per day for 300 days= Rs. 20 X 2 hours X 1367 X 300 days= Rs. 1,64,04, 000 i.e. about 1.64 Crore

20 percentage of productivity/wages is assumed to be the value of leisure and attributed as direct benefits due to the savings in time, i.e., Rs. 32, 80,000 i.e. about 0.33 Crore

Vehicles

Two Wheelers – 279
Four Wheelers – 61
Two-wheeler users time value is calculated as how the time savings in ferrying can be converted into economic performance by the two wheelers users.
The income earning of two wheelers user is taken as Rs. 300 per day.

If 10 hours of work a day is assumed, the income of two-wheeler per hour will be Rs. 30 per hour.

The savings in time per ferry trip = 2 hours per trip

Total benefits due to savings in time for 279 two wheelers = Rs. 30 X 2 hours X 279 X 300 days = Rs. 50, 23, 000 i.e. about 0.50 Crore

30 percentage of income is assumed to be direct savings of two wheelers due to the savings in time, i.e., Rs. 15, 07, 000 i.e. about 0.15 Crore

Four wheelers twice savings

Commercial vehicles can be employed more productively for every hour of savings in time they gain.

The fixed cost/rent of commercial vehicles per hour can be calculated as Interest + Depreciation+ Road tax +Insurance + other annual maintenance expenses
Average cost of vehicle = Rs. 3.00 lakh

Life = 15 years

Interest - @ 15.00 % =Rs 45,000.00 per annum
Depreciation = Rs. 20,000
Road Tax = Rs. 3000 per year
Insurance Rs. 2000 per year
Other = Rs. 5000 per year
Total Fixed cost = Rs. 75,000 per year
Total commercial hours of operation for 4 wheelers = 12 hours per day X 300 days = Rs 3600 hours per year

Fixed Cost of 4-wheelerper Hour = $\frac{Rs.\ 75{,}000}{3600}$ = Rs 21.00 per hour

Estimation of Earnings Per hour of commercial vehicle operation

Average performance of 4-wheeler per hour = 30 km
Rate per km = Rs 12.00 per km
Total income earned per hour by commercial vehicles if fully operated = Rs 360.00

As a conservative estimate only 20% of potential income is taken as likely savings of commercial vehicles per hour of time saved = Rs 72.00 per hour
Productivity loss of commercial vehicles per hour = Rs. 21.00 (Fixed cost/hour) + Rs 72.00 (commercial cost/hour) = Rs. 93.00 per hour

Total Savings in time by four wheelers (Commercial) = Rs. 93.00 per hour X 2 hours X 61 X 300 = Rs. 34, 03, 800 per annum i.e. about 0.34 Crore

As a conservative estimate only 40 percentage of this savings is assumed to be accrued due to the savings in time with new project, i.e., Rs. 13, 61, 500 i.e. about 0.14 Crore

The mix of commercial /Private is taken as 40:60. For private vehicles only, fixed time cost is taken as savings

Savings in time by four wheelers (Private)= Rs. 21.00 per km X 2 hours X 37 X 300 = Rs. 4, 66, 200 per annum

13.4.2.2.2 Savings Due to Increased Agricultural Output

Total geographical area under direct influence = 106 km X 10 km = 1060 sq. km

Probable potential land area under cultivation = 20 – 40% = 212.00 sq. km = 21, 20, 00, 000.00 sq. m = 53, 000 acres

Average agricultural productivity = 1.50 tonnes per acre (3.50 tonnes per hectare)

Total agricultural production in the region = 53,000 acres X 1.50 tonnes= 79, 500tonnes

Average value of crop = Rs. 15.00 per kg = Rs. 15, 000 per tonnes

Total potential value of agricultural production = Rs. 119 ,25, 00, 000 i.e. about 119.25 Crore

Present cultivation/productivity is very low due to non-availability and lack of introduction of mechanized cultivation and scientific application of fertilizers. It is assumed that only 30% of cultivable land is put to effective cultivation at present

Hence, the present value of agricultural production = Rs. 35, 89, 00, 000 i.e. about 35.89 Crore

The NW 95 project is likely to increase the agricultural production minimum by 10 percent of existing production in the initial years, which amounts to Rs. 3, 58, 00, 000 i.e. about 3.58 Crore

There may be so many other factors that contribute to the increase in farm of income. However, 10 percent of the net addition can be taken as direct benefit due to project.

Hence, the benefit towards agricultural production = Rs. 35, 80, 000

13.4.2.2.3 Benefits Due to Reduction in Accidents

The passengers and vehicles are also exposed to high risk of vessel/ crafts getting collided, capsized or submerged due to overload or hostile weather and there have been occasional mishaps taking place in the region involving the loss of perceivable 5-10 human lives every year, especially during festival and monsoon seasons.

The value of human lives cannot be expressed in monetary terms. In view of the project situation, the mishap of vessel collision, submerging etc. are controlled through navigation aids and better electronic communication systems.

The State and Central Government will be relieved from paying compensation to victims of such accidents. A token provision of Rs. 20 Lakhs per annum is provided in the analysis as benefits due to the present project, and introduction of safety measures to passengers while ferrying by IWAI boats.

13.4.2.3 Indirect Benefits

13.4.2.3.1 Increase in Land Value in The Hinterland

Total geographical area under direct influence = 106 km X 10 km = 1060 sq. km

It is assumed that the present land values for Agricultural land vary in the range of Rs. 500 – 1000 per cent and Commercial land as Rs. 1000– 2000 per cent.

It is expected that the land value in the influence area will increase due to increase in the agricultural/ commercial productivity due to the project. It is assumed that the average increase in

Agricultural land will be in the range of Rs. 2000 – 5000 per cent and Commercial land value will increase to Rs. 5000 – 20, 000 per cent

The assumed area under commercial and agricultural use are 5% and 20 % respectively.

Area under agricultural use = 53, 000 acres

Area under commercial use = 13, 250 acres

Increase in land value in agricultural area = 53, 000.00 acres X Rs. 500 per cent

Total value= Rs. 265, 00, 00, 000 i.e. about 265 Crore
Increase in land value in agricultural area = 13, 250.00 acres X Rs. 300 per cent

Total value = Rs. 397, 50, 00, 000 i.e. about 397.50 Crore

As a conservative estimate only, 2 percent of this increased land value of agriculture and 3% of increase in commercial land value are taken as benefits due to NW 95 project.

Benefits from the increased agricultural land value = Rs. 5, 30, 00, 000 i.e. about 5.30 Crore

Benefits from the increased commercial land value = Rs. 11, 93, 00, 000 i.e. about 11.93 Crore

The land value benefits are expected to be realized over a period of 20 years only after opening of the project. Hence these benefits are allocated from 2025 only.

13.4.2.3.2 Estimation of benefits due to induced growth and employment in the region due to positive externalities

The local villagers at present are immobile, unproductive and not fully employed due to lack of sufficient transport and communication facilities. The new project will not only provide full employment to the local population but also attract employment opportunities from other regions. The higher growth and employment due to opening up of new economic opportunities will set in a multiplier growth effect which will be continued for a long time to come.

The growth multiplier for road projects will usually be higher as they are faster modes of transport. Hence, a growth multiplier factor of 1.05 is assumed for the present project which will be felt during the initial period of investment and will sustain for the next 10-15 years.

Growth multiplier effect suggests that for every investment of Rs. 1.00 Lakh in projects will result in aggregate output and effective demand to the tune of Rs. 1.05 Lakh in the economy, thereby adding further employment and output to the extent of 5% of previous year investment. Hence, 5% addition in output from the previous year's investment is taken as indirect and long-term benefit due to the project.

13.4.2.4 Estimation of dis-economies or negative externalities

There are a few existing private ferry service operators who offer ferry services to people on temporary basis at their own whim and fancies with their primitive crafts. They are sparsely distributed over the river system and are charging higher fare rates from passengers and vehicles than those will be fixed by IWAI after implementation of the project. In the event of 'with' project situation, some of these operators and crafts will become redundant or displaced from operation thereby bringing diseconomies. However, these aspects have been taken care of in the project cost estimate. The crafts can be used alternatively for other water-based activities such as fishing, sand mining, loading etc. The existing operators can be absorbed in the new type of operation after giving them adequate training.

13.4.2.4.1 Urbanization effects

There is risk of urban type commercial activities to flourish in the region brought about by better transport and communication due to project development. This may result in increased emissions, sound pollution, deforestation, etc. especially in North Lakhimpur region which falls in the project influence area. Adequate care has been taken in the project to reduce the above negative effects in the environment and flora and fauna and regulate the negative economies within safer limits.

13.4.2.5 Project Analysis

Table 13.3 Capital Financial Cost (Lakhs)

Sl. No.	Item	2019	2020
1.0	Terminal Building	₹ 45.26	₹ 22.63
2.0	Waiting Building	₹ 11.96	₹ 5.98
3.0	Dredging	₹ 106.26	₹ 293.60
4.0	VHF Radio	₹ 5.0	₹ 2.50
5.0	Navigation aids	₹ 2.40	₹ 0.60
6.0	Landscaping	₹ 3.00	₹ 1.50
7.0	Utilities Shifting	₹ 3.00	₹ 1.50
8.0	Auxiliary Item	₹ 20.00	₹ 5.00
9.0	Modular Vessel	₹ 200.00	₹ 100.00
TOTAL		**₹ 396.89**	**₹ 433.3**

Table 13.4 Annual Recurring Cost Estimate (Lakh Rs.)

Sl. No.	Item	Cost (Lakhs)
1.0	Maintenance Dredging	₹ 11.62
2.0	Administration / Office expense	₹ 58.76
3.0	Navigational Aids	₹ 4.65
4.0	Civil Works	₹ 1.16
5.0	Vessel operation	₹ 23.23
6.0	Navigation and Communication	₹ 11.61
7.0	Depreciation of boat (2019)	₹ 13.33

Table 13.5 Project Cost

Year	Capital Fixed Cost (Lakhs)	Recurring/Runningcost (Lakhs)
2019	₹396.89	-
2020	₹ 433.3	₹ 129.36
2021	-	₹ 136.03

Table 13.6 Benefits

Sl. No.	Items	2019	2020	2025
	A. Direct Benefits (Lakhs)			
1.0	Benefits attributed to time savings of ferry passengers	-	₹ 32.8	-
2.0	Benefits attributed to time savings of two-wheeler passengers	-	₹ 15.07	-
3.0	Benefits attributed to time savings of private and four-wheeler passengers	-	₹ 4.66	-

Sl. No.	Items	2019	2020	2025
4.0	Savings in time of commercial 4-wheeler operations	-	₹ 13.61	-
5.0	Benefits estimated due to reduction in vessel accidents and increased passenger safety	-	₹ 20.00	-
6.0	Benefits due to increase in farming income	-	₹ 35.80	-
	B. Indirect Benefits			
1.0	Benefits attributed to increase in value of farm land	-	-	₹ 530.00
2.0	Benefits attributed to increase in value of commercial land	-	-	₹ 1193.00
3.0	Benefits attributed to positive growth multipliers and other external ties (0.05 % of investment)	-	₹ 19.38	₹ 70.5

13.4.3 Economic Internal Rate of Return (EIRR)

EIRR is found out after analyzing positive and negative costs to the society over next 23 years (up to 2040) due to the project using discount cash flow techniques.

Case 1 -EIRR with only direct benefits of saving in trip time by passengers and vehicles and increase in farm income = 4.09%

Case 2-EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output = 20.09 %

Case 3- EIRR with direct benefits and indirect benefits of economic multiplier effect in employment and output and long-term benefits due to increase in land value = 52.49 %

13.4.3.1 Sensitivity Analysis

Sensitivity analysis is carried out by assuming 15 percent increase in cost and 15 percent decrease in benefits. The EIRR reduces to zero percent in Case 1, 9.28 percent in Case 2 and 43.72 percent in Case 3.

Table 13.7 Economic Analysis Case 1

CASE 1 - DIRECT BENEFITS ONLY																
	COST (In Lakhs)							BENEFITS (In Lakhs)						SENSITIVITY ANALYSIS WITH 15 PERCENT COST HIKE AND 15 PERCENT BENEFIT DOWN		
YEAR	CAPITAL	RUNNING	TOTAL	ECO. COST	TIME PASS	TIME 2W	TIME 4 W	AGR INCO	ACCIDENT	G MULTPR	LAND VAL	TOT BENE	NET BENE	COST 15% UP	BENE 15% DOWN	NET BENE
2019	₹ 387.61		₹ 387.61	₹ 310.09	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -310.09	₹ 356.60	₹ -	₹ -356.60
2020	₹ 156.32	₹ 129.36	₹ 285.68	₹ 228.54	₹ 32.80	₹ 15.07	₹ 18.27	₹ 35.80	₹ 20.00	₹ -	₹ -	₹ 121.94	₹ -106.60	₹ 262.83	₹ 103.65	₹ -159.18
2021	₹ -	₹ 136.03	₹ 136.03	₹ 108.82	₹ 34.44	₹ 15.82	₹ 19.18	₹ 36.87	₹ 20.80	₹ -	₹ -	₹ 127.12	₹ 18.30	₹ 125.15	₹ 108.05	₹ -17.09
2022	₹ -	₹ 141.47	₹ 141.47	₹ 113.18	₹ 36.16	₹ 16.61	₹ 20.14	₹ 37.98	₹ 21.63	₹ -	₹ -	₹ 132.53	₹ 19.35	₹ 130.15	₹ 112.65	₹ -17.50
2023	₹ -	₹ 147.13	₹ 147.13	₹ 117.70	₹ 37.97	₹ 17.45	₹ 21.15	₹ 39.12	₹ 22.50	₹ -	₹ -	₹ 138.18	₹ 20.48	₹ 135.36	₹ 117.45	₹ -17.90
2024	₹ -	₹ 153.02	₹ 153.02	₹ 122.41	₹ 39.87	₹ 18.32	₹ 22.21	₹ 40.29	₹ 23.40	₹ -	₹ -	₹ 144.08	₹ 21.67	₹ 140.77	₹ 122.47	₹ -18.30
2025	₹ -	₹ 159.14	₹ 159.14	₹ 127.31	₹ 41.86	₹ 19.23	₹ 23.32	₹ 41.50	₹ 24.33	₹ -	₹ -	₹ 150.25	₹ 22.94	₹ 146.40	₹ 127.71	₹ -18.69
2026	₹ -	₹ 165.50	₹ 165.50	₹ 132.40	₹ 43.96	₹ 20.20	₹ 24.48	₹ 42.75	₹ 25.31	₹ -	₹ -	₹ 156.69	₹ 24.29	₹ 152.26	₹ 133.18	₹ -19.08
2027	₹ -	₹ 172.12	₹ 172.12	₹ 137.70	₹ 46.15	₹ 21.21	₹ 25.71	₹ 44.03	₹ 26.32	₹ -	₹ -	₹ 163.41	₹ 25.72	₹ 158.35	₹ 138.90	₹ -19.45
2028	₹ -	₹ 179.01	₹ 179.01	₹ 143.20	₹ 48.46	₹ 22.27	₹ 26.99	₹ 45.35	₹ 27.37	₹ -	₹ -	₹ 170.44	₹ 27.24	₹ 164.69	₹ 144.87	₹ -19.81
2029	₹ -	₹ 186.17	₹ 186.17	₹ 148.93	₹ 50.88	₹ 23.38	₹ 28.34	₹ 46.71	₹ 28.47	₹ -	₹ -	₹ 177.78	₹ 28.85	₹ 171.27	₹ 151.11	₹ -20.16
2030	₹ -	₹ 193.61	₹ 193.61	₹ 154.89	₹ 53.43	₹ 24.55	₹ 29.76	₹ 48.11	₹ 29.60	₹ -	₹ -	₹ 185.45	₹ 30.56	₹ 178.12	₹ 157.63	₹ -20.49
2031	₹ -	₹ 201.36	₹ 201.36	₹ 161.09	₹ 56.10	₹ 25.77	₹ 31.25	₹ 49.56	₹ 30.79	₹ -	₹ -	₹ 193.47	₹ 32.38	₹ 185.25	₹ 164.45	₹ -20.80
2032	₹ -	₹ 209.41	₹ 209.41	₹ 167.53	₹ 57.78	₹ 27.84	₹ 33.12	₹ 50.55	₹ 32.02	₹ -	₹ -	₹ 201.31	₹ 33.78	₹ 192.66	₹ 171.11	₹ -21.55
2033	₹ -	₹ 217.79	₹ 217.79	₹ 174.23	₹ 59.52	₹ 30.06	₹ 35.11	₹ 51.56	₹ 33.30	₹ -	₹ -	₹ 209.55	₹ 35.32	₹ 200.37	₹ 178.12	₹ -22.25
2034	₹ -	₹ 226.50	₹ 226.50	₹ 181.20	₹ 61.30	₹ 32.47	₹ 37.22	₹ 52.59	₹ 34.63	₹ -	₹ -	₹ 218.21	₹ 37.01	₹ 208.38	₹ 185.48	₹ -22.90
2035	₹ -	₹ 235.56	₹ 235.56	₹ 188.45	₹ 63.14	₹ 35.07	₹ 39.45	₹ 53.64	₹ 36.02	₹ -	₹ -	₹ 227.32	₹ 38.87	₹ 216.72	₹ 193.22	₹ -23.50
2036	₹ -	₹ 244.98	₹ 244.98	₹ 195.99	₹ 65.03	₹ 37.87	₹ 41.82	₹ 54.71	₹ 37.46	₹ -	₹ -	₹ 236.90	₹ 40.91	₹ 225.38	₹ 201.36	₹ -24.02
2037	₹ -	₹ 254.78	₹ 254.78	₹ 203.83	₹ 66.99	₹ 40.90	₹ 44.33	₹ 55.81	₹ 38.96	₹ -	₹ -	₹ 246.98	₹ 43.15	₹ 234.40	₹ 209.93	₹ -24.47
2038	₹ -	₹ 264.97	₹ 264.97	₹ 211.98	₹ 68.99	₹ 44.17	₹ 46.99	₹ 56.92	₹ 40.52	₹ -	₹ -	₹ 257.59	₹ 45.62	₹ 243.78	₹ 218.95	₹ -24.82
2039	₹ -	₹ 275.57	₹ 275.57	₹ 220.46	₹ 71.06	₹ 47.71	₹ 49.80	₹ 58.06	₹ 42.14	₹ -	₹ -	₹ 268.78	₹ 48.32	₹ 253.53	₹ 228.46	₹ -25.07
2040	₹ -	₹ 286.59	₹ 286.59	₹ 229.28	₹ 73.20	₹ 51.52	₹ 52.79	₹ 59.22	₹ 43.82	₹ -	₹ -	₹ 280.56	₹ 51.28	₹ 263.67	₹ 238.48	₹ -25.19
2041	₹ -	₹ 298.06	₹ 298.06	₹ 238.45	₹ 75.39	₹ 55.65	₹ 55.96	₹ 60.41	₹ 45.58	₹ -	₹ -	₹ 292.98	₹ 54.54	₹ 274.21	₹ 249.03	₹ -25.18
												EIRR	4.09%	Sensitivity		0.00%

Table 13.8 Economic Analysis Case 2

CASE 2 - DIRECT BENEFITS & INDIRECT BENIFTS EXEMPTING LAND BENEFITS																
	COST (In Lakhs)							BENEFITS (In Lakhs)						SENSITIVITY ANALYSIS WITH 15 PERCENT COST HIKE AND 15 PERCENT BENEFIT DOWN		
YEAR	CAPITAL	RUNNING	TOTAL	ECO. COST	TIME PASS	TIME 2W	TIME 4 W	AGR INCO	ACCIDENT	G MULTPR	LAND VAL	TOT BENE	NET BENE	COST 15% UP	BENE 15% DOWN	NET BENE
2019	₹ 387.61	₹ -	₹ 387.61	₹ 310.09	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -310.09	₹ 356.60	₹ -	₹ -356.60
2020	₹ 156.32	₹ 129.36	₹ 285.68	₹ 228.54	₹ 32.80	₹ 15.07	₹ 18.27	₹ 35.80	₹ 20.00	₹ 19.38	₹ -	₹ 141.32	₹ -87.22	₹ 262.83	₹ 120.12	₹ -142.70
2021	₹ -	₹ 136.03	₹ 136.03	₹ 108.82	₹ 34.44	₹ 15.82	₹ 19.18	₹ 36.87	₹ 20.80	₹ 33.66	₹ -	₹ 160.79	₹ 51.96	₹ 125.15	₹ 136.67	₹ 11.52
2022	₹ -	₹ 141.47	₹ 141.47	₹ 113.18	₹ 36.16	₹ 16.61	₹ 20.14	₹ 37.98	₹ 21.63	₹ 40.47	₹ -	₹ 173.00	₹ 59.82	₹ 130.15	₹ 147.05	₹ 16.89
2023	₹ -	₹ 147.13	₹ 147.13	₹ 117.70	₹ 37.97	₹ 17.45	₹ 21.15	₹ 39.12	₹ 22.50	₹ 47.54	₹ -	₹ 185.72	₹ 68.02	₹ 135.36	₹ 157.86	₹ 22.50
2024	₹ -	₹ 153.02	₹ 153.02	₹ 122.41	₹ 39.87	₹ 18.32	₹ 22.21	₹ 40.29	₹ 23.40	₹ 54.90	₹ -	₹ 198.98	₹ 76.57	₹ 140.77	₹ 169.13	₹ 28.36
2025	₹ -	₹ 159.14	₹ 159.14	₹ 127.31	₹ 41.86	₹ 19.23	₹ 23.32	₹ 41.50	₹ 24.33	₹ 62.55	₹ -	₹ 212.80	₹ 85.49	₹ 146.40	₹ 180.88	₹ 34.47
2026	₹ -	₹ 165.50	₹ 165.50	₹ 132.40	₹ 43.96	₹ 20.20	₹ 24.48	₹ 42.75	₹ 25.31	₹ 70.50	₹ -	₹ 227.19	₹ 94.79	₹ 152.26	₹ 193.11	₹ 40.85
2027	₹ -	₹ 172.12	₹ 172.12	₹ 137.70	₹ 46.15	₹ 21.21	₹ 25.71	₹ 44.03	₹ 26.32	₹ 78.78	₹ -	₹ 242.19	₹ 104.50	₹ 158.35	₹ 205.86	₹ 47.51
2028	₹ -	₹ 179.01	₹ 179.01	₹ 143.20	₹ 48.46	₹ 22.27	₹ 26.99	₹ 45.35	₹ 27.37	₹ 87.38	₹ -	₹ 257.83	₹ 114.62	₹ 164.69	₹ 219.15	₹ 54.47
2029	₹ -	₹ 186.17	₹ 186.17	₹ 148.93	₹ 50.88	₹ 23.38	₹ 28.34	₹ 46.71	₹ 28.47	₹ 96.34	₹ -	₹ 274.12	₹ 125.18	₹ 171.27	₹ 233.00	₹ 61.73
2030	₹ -	₹ 193.61	₹ 193.61	₹ 154.89	₹ 53.43	₹ 24.55	₹ 29.76	₹ 48.11	₹ 29.60	₹ 105.64	₹ -	₹ 291.10	₹ 136.21	₹ 178.12	₹ 247.43	₹ 69.31
2031	₹ -	₹ 201.36	₹ 201.36	₹ 161.09	₹ 56.10	₹ 25.77	₹ 31.25	₹ 49.56	₹ 30.79	₹ 115.32	₹ -	₹ 308.79	₹ 147.70	₹ 185.25	₹ 262.47	₹ 77.22
2032	₹ -	₹ 209.41	₹ 209.41	₹ 167.53	₹ 57.78	₹ 27.84	₹ 33.12	₹ 50.55	₹ 32.02	₹ 125.39	₹ -	₹ 326.70	₹ 159.17	₹ 192.66	₹ 277.70	₹ 85.04
2033	₹ -	₹ 217.79	₹ 217.79	₹ 174.23	₹ 59.52	₹ 30.06	₹ 35.11	₹ 51.56	₹ 33.30	₹ 135.86	₹ -	₹ 345.41	₹ 171.18	₹ 200.37	₹ 293.60	₹ 93.23
2034	₹ -	₹ 226.50	₹ 226.50	₹ 181.20	₹ 61.30	₹ 32.47	₹ 37.22	₹ 52.59	₹ 34.63	₹ 146.75	₹ -	₹ 364.96	₹ 183.76	₹ 208.38	₹ 310.22	₹ 101.84
2035	₹ -	₹ 235.56	₹ 235.56	₹ 188.45	₹ 63.14	₹ 35.07	₹ 39.45	₹ 53.64	₹ 36.02	₹ 158.08	₹ -	₹ 385.39	₹ 196.94	₹ 216.72	₹ 327.58	₹ 110.87
2036	₹ -	₹ 244.98	₹ 244.98	₹ 195.99	₹ 65.03	₹ 37.87	₹ 41.82	₹ 54.71	₹ 37.46	₹ 169.85	₹ -	₹ 406.75	₹ 210.76	₹ 225.38	₹ 345.74	₹ 120.35
2037	₹ -	₹ 254.78	₹ 254.78	₹ 203.83	₹ 66.99	₹ 40.90	₹ 44.33	₹ 55.81	₹ 38.96	₹ 182.10	₹ -	₹ 429.08	₹ 225.26	₹ 234.40	₹ 364.72	₹ 130.32
2038	₹ -	₹ 264.97	₹ 264.97	₹ 211.98	₹ 68.99	₹ 44.17	₹ 46.99	₹ 56.92	₹ 40.52	₹ 194.84	₹ -	₹ 452.44	₹ 240.46	₹ 243.78	₹ 384.57	₹ 140.80
2039	₹ -	₹ 275.57	₹ 275.57	₹ 220.46	₹ 71.06	₹ 47.71	₹ 49.80	₹ 58.06	₹ 42.14	₹ 208.09	₹ -	₹ 476.87	₹ 256.41	₹ 253.53	₹ 405.34	₹ 151.81
2040	₹ -	₹ 286.59	₹ 286.59	₹ 229.28	₹ 73.20	₹ 51.52	₹ 52.79	₹ 59.22	₹ 43.82	₹ 221.87	₹ -	₹ 502.43	₹ 273.15	₹ 263.67	₹ 427.07	₹ 163.40
2041	₹ -	₹ 298.06	₹ 298.06	₹ 238.45	₹ 75.39	₹ 55.65	₹ 55.96	₹ 60.41	₹ 45.58	₹ 236.20	₹ -	₹ 529.18	₹ 290.74	₹ 274.21	₹ 449.80	₹ 175.59
												EIRR	20.09%		Sensitivity	9.28%

Table 13.9 Economic Analysis Case 3

CASE 3 - DIRECT BENEFITS & INDIRECT BENEFITS														SENSITIVITY ANALYSIS WITH 15 PERCENT COST HIKE AND 15 PERCENT BENEFIT DOWN		
	COST (In Lakhs)							BENEFITS (In Lakhs)								
YEAR	CAPITAL	RUNNING	TOTAL	ECO. COST	TIME PASS	TIME 2W	TIME 4 W	AGR INCO	ACCIDENT	G MULTPR	LAND VAL	TOT BENE	NET BENE	COST 15% UP	BENE 15% DOWN	NET BENE
2019	₹ 387.61	₹ -	₹ 387.61	₹ 310.09	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -	₹ -310.09	₹ 356.60	₹ -	₹ -356.60
2020	₹ 156.32	₹ 129.36	₹ 285.68	₹ 228.54	₹ 32.80	₹ 15.07	₹ 18.27	₹ 35.80	₹ 20.00	₹ 19.38	₹ -	₹ 141.32	₹ -87.22	₹ 262.83	₹ 120.12	₹ -142.70
2021	₹ -	₹ 136.03	₹ 136.03	₹ 108.82	₹ 34.44	₹ 15.82	₹ 19.18	₹ 36.87	₹ 20.80	₹ 33.66	₹ -	₹ 160.79	₹ 51.96	₹ 125.15	₹ 136.67	₹ 11.52
2022	₹ -	₹ 141.47	₹ 141.47	₹ 113.18	₹ 36.16	₹ 16.61	₹ 20.14	₹ 37.98	₹ 21.63	₹ 40.47	₹ -	₹ 173.00	₹ 59.82	₹ 130.15	₹ 147.05	₹ 16.89
2023	₹ -	₹ 147.13	₹ 147.13	₹ 117.70	₹ 37.97	₹ 17.45	₹ 21.15	₹ 39.12	₹ 22.50	₹ 47.54	₹ -	₹ 185.72	₹ 68.02	₹ 135.36	₹ 157.86	₹ 22.50
2024	₹ -	₹ 153.02	₹ 153.02	₹ 122.41	₹ 39.87	₹ 18.32	₹ 22.21	₹ 40.29	₹ 23.40	₹ 54.90	₹ -	₹ 198.98	₹ 76.57	₹ 140.77	₹ 169.13	₹ 28.36
2025	₹ -	₹ 159.14	₹ 159.14	₹ 127.31	₹ 41.86	₹ 19.23	₹ 23.32	₹ 41.50	₹ 24.33	₹ 62.55	₹ -	₹ 212.80	₹ 85.49	₹ 146.40	₹ 180.88	₹ 34.47
2026	₹ -	₹ 165.50	₹ 165.50	₹ 132.40	₹ 43.96	₹ 20.20	₹ 24.48	₹ 42.75	₹ 25.31	₹ 70.50	₹ 1,723.00	₹ 1,950.19	₹ 1,817.79	₹ 152.26	₹ 1,657.66	₹ 1,505.40
2027	₹ -	₹ 172.12	₹ 172.12	₹ 137.70	₹ 46.15	₹ 21.21	₹ 25.71	₹ 44.03	₹ 26.32	₹ 78.78	₹ 1,791.92	₹ 2,034.11	₹ 1,896.42	₹ 158.35	₹ 1,729.00	₹ 1,570.64
2028	₹ -	₹ 179.01	₹ 179.01	₹ 143.20	₹ 48.46	₹ 22.27	₹ 26.99	₹ 45.35	₹ 27.37	₹ 87.38	₹ 1,863.60	₹ 2,121.42	₹ 1,978.22	₹ 164.69	₹ 1,803.21	₹ 1,638.52
2029	₹ -	₹ 186.17	₹ 186.17	₹ 148.93	₹ 50.88	₹ 23.38	₹ 28.34	₹ 46.71	₹ 28.47	₹ 96.34	₹ 1,938.14	₹ 2,212.26	₹ 2,063.32	₹ 171.27	₹ 1,880.42	₹ 1,709.15
2030	₹ -	₹ 193.61	₹ 193.61	₹ 154.89	₹ 53.43	₹ 24.55	₹ 29.76	₹ 48.11	₹ 29.60	₹ 105.64	₹ 2,015.67	₹ 2,306.76	₹ 2,151.87	₹ 178.12	₹ 1,960.75	₹ 1,782.62
2031	₹ -	₹ 201.36	₹ 201.36	₹ 161.09	₹ 56.10	₹ 25.77	₹ 31.25	₹ 49.56	₹ 30.79	₹ 115.32	₹ 2,096.29	₹ 2,405.08	₹ 2,244.00	₹ 185.25	₹ 2,044.32	₹ 1,859.07
2032	₹ -	₹ 209.41	₹ 209.41	₹ 167.53	₹ 57.78	₹ 27.84	₹ 33.12	₹ 50.55	₹ 32.02	₹ 125.39	₹ 2,180.14	₹ 2,506.85	₹ 2,339.32	₹ 192.66	₹ 2,130.82	₹ 1,938.16
2033	₹ -	₹ 217.79	₹ 217.79	₹ 174.23	₹ 59.52	₹ 30.06	₹ 35.11	₹ 51.56	₹ 33.30	₹ 135.86	₹ 2,267.35	₹ 2,612.76	₹ 2,438.53	₹ 200.37	₹ 2,220.85	₹ 2,020.48
2034	₹ -	₹ 226.50	₹ 226.50	₹ 181.20	₹ 61.30	₹ 32.47	₹ 37.22	₹ 52.59	₹ 34.63	₹ 146.75	₹ 2,358.04	₹ 2,723.01	₹ 2,541.81	₹ 208.38	₹ 2,314.55	₹ 2,106.17
2035	₹ -	₹ 235.56	₹ 235.56	₹ 188.45	₹ 63.14	₹ 35.07	₹ 39.45	₹ 53.64	₹ 36.02	₹ 158.08	₹ 2,452.37	₹ 2,837.76	₹ 2,649.31	₹ 216.72	₹ 2,412.09	₹ 2,195.38
2036	₹ -	₹ 244.98	₹ 244.98	₹ 195.99	₹ 65.03	₹ 37.87	₹ 41.82	₹ 54.71	₹ 37.46	₹ 169.85	₹ 2,550.46	₹ 2,957.21	₹ 2,761.23	₹ 225.38	₹ 2,513.63	₹ 2,288.25
2037	₹ -	₹ 254.78	₹ 254.78	₹ 203.83	₹ 66.99	₹ 40.90	₹ 44.33	₹ 55.81	₹ 38.96	₹ 182.10	₹ 2,652.48	₹ 3,081.56	₹ 2,877.74	₹ 234.40	₹ 2,619.33	₹ 2,384.93
2038	₹ -	₹ 264.97	₹ 264.97	₹ 211.98	₹ 68.99	₹ 44.17	₹ 46.99	₹ 56.92	₹ 40.52	₹ 194.84	₹ 2,758.58	₹ 3,211.02	₹ 2,999.04	₹ 243.78	₹ 2,729.36	₹ 2,485.59
2039	₹ -	₹ 275.57	₹ 275.57	₹ 220.46	₹ 71.06	₹ 47.71	₹ 49.80	₹ 58.06	₹ 42.14	₹ 208.09	₹ 2,868.92	₹ 3,345.79	₹ 3,125.33	₹ 253.53	₹ 2,843.92	₹ 2,590.39
2040	₹ -	₹ 286.59	₹ 286.59	₹ 229.28	₹ 73.20	₹ 51.52	₹ 52.79	₹ 59.22	₹ 43.82	₹ 221.87	₹ 2,983.68	₹ 3,486.11	₹ 3,256.83	₹ 263.67	₹ 2,963.19	₹ 2,699.52
2041	₹ -	₹ 298.06	₹ 298.06	₹ 238.45	₹ 75.39	₹ 55.65	₹ 55.96	₹ 60.41	₹ 45.58	₹ 236.20	₹ 3,103.03	₹ 3,632.21	₹ 3,393.76	₹ 274.21	₹ 3,087.38	₹ 2,813.16
												EIRR	52.49%		Sensitivity	43.72%

13.5 Socio-Economic Analysis

Inland waterways as a means of transportation has been harnessed worldwide in the face of expanding economies as it is considered as a preferred alternative due to its various direct and indirect benefits as mentioned in this section.

13.5.1 Direct Benefits

13.5.1.1 Employment Generation

Employment occurs both during the construction and operation phases of the transport infrastructure. Inland waterways perform several non-transport related functions that can be easily considered as benefits of economic assessment. Its use to move goods and services was found to fuel the economic growth and rural development of the local communities especially where it is the only means of transport available. It would boost the economy of nearby districts by promoting all facets of agro and other businesses such as crop production, fishery, production of basic materials, processing of timber products etc.

13.5.1.2 Creation of Business Opportunity

Due to the proposed project, the local economy can be promoted through income from barge/ boat hires, mooring and licensing fee, canoeing, and other recreational activities for further tourism development.

13.5.1.3 Vessel Operating Cost

Comparing the vessel operation cost of the three most common modes of traffic, inland waterways turn out to be the cheapest mode of transport. Transport by road costs INR 2.58 per tonne-km and transport by rail costs INR 1.41 per tonne-km. The cost for inland waterways is considerably lower at INR 1.06 per tonne-km.

13.5.1.4 Environmental and Social Benefits

Carbon Saving

Estimating transport-related carbon savings depends on calculating the difference in emissions between the type of transport that is offset or equivalent vehicles that are offset. Tyndall Centre for Climate Change Research has estimated that freight transport produces one-third of carbon emissions of road transport. Road freight transport produces 0.08 tons of CO2 per thousand tonne-km. The carbon emission through waterway transportation is 0.02 tons per thousand tonne-km. The saving in this regard is 0.06 tons of carbon per thousand tonne-km because 1 liter of fuel moves 24 tonne-km by road and 85 tonne-km by rail as compared to 105 tonne-km by waterways.

The shadow price of carbon is used to estimate the value of carbon saving in many government projects. The methodology is based on a damage cost approach and provides values for a tonne of carbon in any given year and requires the costs to be inflated annual to account for increased damages over time. The benefits of carbon savings arising from renewable energy production should be valued at the market price of carbon. The carbon shadow price value of damages on society at large due to emissions is 20$ / tonne. Reduction in carbon emission is a direct factor for damages on society which can be calculated based on this price.

Air / Noise pollution

Some of the most pervasive and intrusive sources of noise and air pollution are transportation systems. Air pollution comes from a wide variety of man-made and natural sources, with fossil fuel combustion as the largest contributor. Air pollution caused by transportation includes pollutants directly emitted by engines as well as secondary pollutants formed by chemical reactions. Road traffic is, by far, the greatest source of air emissions.

Water transport, conversely, causes far less air pollution than trucking, and less or comparable amounts, than rail. Cumulatively, it has a relatively minor effect on air quality, consumes much less energy (and thus, produces less air pollution) per tonne-km of freight carried than either rail or truck. For the most part, waterway operations are conducted away from population centres, which reduces the impact of its exhaust emissions. Little data exists on noise levels of barge operations, mainly because they are not considered a problem. Towboats operate well away from shore, with the sound of their engines muffled below the water line, and any noise levels are hardly audible beyond the immediate area of the town.

13.5.2 Indirect Benefits

13.5.2.1 Traffic Congestion Solution

The steady increase in highway traffic has outstripped any increase in infrastructure capacity, resulting in delays, safety problems, and congestion which costs the nation in crores annually. Other impacts of traffic congestion include accidents, increased energy consumption, environmental damage, increased commuting times, and greater social tension. Water transport is currently underutilized and optimizing the modal shift would reduce congestion problems in the country.

13.5.2.2 Economic Boost

Inland waterways can generate an economic benefit in the form of property premiums beyond the average rent or sale of residential and commercial property. The available studies show that proximity to waterway has effect of price of property. There is an average 8-20% increase in value of land and properties around waterways. There has been significant increase of property prices around project catchment area. The actual economic benefit is location specific and depends on the existing property prices and rental rates in the area.

13.5.2.3 Land Usage and Social Impact

The impact of rail lines passing through urban areas, and trucking operations occurring near high-density population areas, can become a disturbing element to an otherwise reasonably calm environment in settled areas. By contrast, water transport has little impact on densely populated areas since shallow-draft vessels operate in mid-river, well away from shore, and because of the large tonnage moved at one time, tow passages are infrequent.

Since most of the right-of-way for water transport is provided by nature, navigation is less likely than other transport forms to compete with non-transportation uses for land area, an important consideration in urban locations. Extensive land area can be taken up by new highways and railroad corridors, but apart from a few connections and waterside terminals, waterways pre-empt very little land.

13.6 Sensitivity Analysis

A sensitivity analysis also referred to as what if analysis is a way to determine how different values of an independent variable impact a particular dependent variable under a given set of

assumptions. This technique is used within specific boundaries that depend on one or more input variables, such as the effect of capacity utilisation on the financial return of the project, tariff determines the nature of inflows to the project etc. The financial model has been prepared in a way to test the sensitivity of various options such as capacity utilisation, inflations in pricing etc.

13.7 Risk Factors and Mitigation

In this model of development, the route operator has the exclusive rights to operate the ferry service, however at present this ferry service has been operated by various legitimate and illicit players. This has to be controlled by the appropriate intervention of SPV. If not controlled this will be a threat to the Private operator and in turn will affect the performance of the ferry service in project catchment area. Proper regulatory measures need to be imposed to forefend the occurrence of such unwarranted practice.

Since the tidal influence on banks is apparent, the cost of maintaining the terminal might spiralled, this may affect the operational effectiveness and thus lead to increase in operational expenditure.

13.8 Project Financing Aspects / Transaction Structuring

Since this project is structured in a way that the entire CAPEX is bourne by the authority, the possibility of exploring the various debt instruments may be explored. Since the CAPEX is very low, this can be sourced through budgetary allocations also. The farebox revenue is only revenue option which is explored, this project may not have the threshold to attract external funds.

13.9 Necessity of Govt. Support

It is to be noted that the present traffic is not adequate to bridge the shortfall in the operational funds, hence the option of gap funding from the government during the operational period has been factored in the financial model. Based on the projections, it is quite evident that the option of integrating lease rent & percentage revenue sharing model (PPP mode) would reduce the operational expenditure of SPV at an average rate of ~82%. The details of savings are Provided in Section 13.9.

13.10 Detailed Financial Cash Flow

13.10.1 Profitability Statement

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20	Yr 21	Yr 22	Yr 23	Yr 24	Yr 25	Yr 26	Yr 27	Yr 28	Yr 29	Yr 30
Revenue	0.87	0.98	1.09	1.22	1.36	1.52	1.70	1.89	2.11	2.34	2.60	2.89	3.20	3.55	3.94	4.43	4.96	5.57	6.21	6.94	7.78	8.70	9.72	10.83	12.20	13.72	15.40	17.30	19.38	21.70
Expenditure																														
Running Cost	0.15	0.16	0.17	0.18	0.19	0.29	0.31	0.32	0.45	0.48	0.62	0.66	0.83	0.87	1.06	1.12	1.34	1.41	1.66	1.75	2.04	2.35	2.69	2.83	3.22	3.64	4.09	4.58	5.11	6.00
Administration and office expenses/year	0.59	0.62	0.65	0.68	0.71	0.75	0.79	0.83	0.87	0.91	0.96	1.00	1.06	1.11	1.16	1.22	1.28	1.35	1.41	1.48	1.56	1.64	1.72	1.80	1.90	1.99	2.09	2.19	2.30	2.42
Operational Expenditire	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.29	0.30	0.32	0.33	0.35	0.37	0.38	0.40	0.42	0.44	0.47	0.49	0.51	0.54	0.57	0.59	0.62	0.66	0.69	0.72	0.76	0.80
Dredging	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.28	0.29	0.30	0.32
Navigation aids	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08
Civil works	0.39	0.41	0.43	0.45	0.47	0.49	0.52	0.54	0.57	0.60	0.63	0.66	0.70	0.73	0.77	0.80	0.85	0.89	0.93	0.98	1.03	1.08	1.13	1.19	1.25	1.31	1.38	1.45	1.52	1.59
Vessel	0.19	0.20	0.21	0.22	0.24	0.25	0.26	0.27	0.29	0.30	0.32	0.33	0.35	0.37	0.38	0.40	0.42	0.44	0.47	0.49	0.51	0.54	0.57	0.59	0.62	0.66	0.69	0.72	0.76	0.80
Navigation and communication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amortisation of Marketing expenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation on Initial capital expenditure of Rs.10 lacs	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total cost per year	1.75	1.83	1.91	2.00	2.09	2.29	2.40	2.51	2.74	2.87	3.13	3.28	3.58	3.75	4.09	4.28	4.66	4.88	5.31	5.56	6.04	6.55	7.09	7.44	8.06	8.71	9.41	10.16	10.97	12.14
Profit/loss per year	-0.87	-0.85	-0.82	-0.78	-0.73	-0.77	-0.70	-0.62	-0.64	-0.53	-0.53	-0.39	-0.38	-0.20	-0.15	0.15	0.31	0.68	0.90	1.38	1.74	2.15	2.62	3.39	4.14	5.01	5.99	7.13	8.41	9.56
Net Profit After lease	-0.87	-0.85	-0.82	-0.78	-0.73	-0.77	-0.70	-0.62	-0.64	-0.53	-0.53	-0.39	-0.38	-0.20	-0.15	0.15	0.31	0.68	0.90	1.38	1.74	2.15	2.62	3.39	4.14	5.01	5.99	7.13	8.41	9.56

13.10.2 Balance sheet

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20	Yr21	Yr22	Yr23	Yr24	Yr25	Yr26	Yr27	Yr28	Yr29	Yr30
Source of funds																														
Capital	3.97	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
Reserves & Surplus	-0.69	-2.36	-3.95	-5.44	-6.83	-8.09	-9.22	-10.18	-10.98	-11.58	-11.97	-11.73	-11.26	-10.50	-9.43	-7.95	-6.03	-3.60	-0.63	2.97	7.30	12.41	18.42	25.39	33.57	43.11	54.14	66.87	81.47	98.15
	3.28	5.94	4.36	2.86	1.48	0.21	-0.91	-1.88	-2.67	-3.28	-3.67	-3.43	-2.95	-2.20	-1.13	0.35	2.27	4.70	7.67	11.27	15.60	20.72	26.72	33.69	41.88	51.41	62.45	75.17	89.77	106.45
Working Capital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Source of Fund	3.28	5.94	4.36	2.86	1.48	0.21	-0.91	-1.88	-2.67	-3.28	-3.67	-3.43	-2.95	-2.20	-1.13	0.35	2.27	4.70	7.67	11.27	15.60	20.72	26.72	33.69	41.88	51.41	62.45	75.17	89.77	106.45
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Application of funds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fixed Assets	3.97	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
Less: Depreciation	0.08	0.25	0.41	0.58	0.74	0.91	1.08	1.24	1.41	1.57	1.74	1.91	2.07	2.24	2.40	2.57	2.74	2.90	3.07	3.23	3.40	3.57	3.73	3.90	4.06	4.23	4.40	4.56	4.73	4.89
	3.89	8.06	7.89	7.72	7.56	7.39	7.23	7.06	6.89	6.73	6.56	6.40	6.23	6.06	5.90	5.73	5.57	5.40	5.23	5.07	4.90	4.74	4.57	4.40	4.24	4.07	3.91	3.74	3.57	3.41
Cash & Bank balance	-0.61	-2.11	-3.53	-4.86	-6.08	-7.18	-8.14	-8.94	-9.57	-10.01	-10.23	-9.83	-9.18	-8.26	-7.03	-5.38	-3.29	-0.70	2.44	6.21	10.70	15.98	22.15	29.29	37.64	47.34	58.54	71.43	86.20	103.04
Total Application of funds	3.28	5.94	4.36	2.86	1.48	0.21	-0.91	-1.88	-2.67	-3.28	-3.67	-3.43	-2.95	-2.20	-1.13	0.35	2.27	4.70	7.67	11.27	15.60	20.72	26.72	33.69	41.88	51.41	62.45	75.17	89.77	106.45
Check	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

13.10.3 Cashflow Statement

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20	Yr21	Yr22	Yr23	Yr24	Yr25	Yr26	Yr27	Yr28	Yr29	Yr30
Cashflow from operations	-0.69	-1.67	-1.59	-1.49	-1.39	-1.26	-1.12	-0.97	-0.80	-0.60	-0.39	0.23	0.48	0.76	1.07	1.48	1.92	2.43	2.97	3.60	4.32	5.12	6.00	6.97	8.18	9.54	11.03	12.73	14.60	16.68
Add: Depreciation	0.08	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	-0.61	-1.51	-1.42	-1.33	-1.22	-1.10	-0.96	-0.80	-0.63	-0.44	-0.22	0.40	0.64	0.92	1.23	1.65	2.09	2.60	3.14	3.77	4.49	5.28	6.17	7.14	8.35	9.70	11.20	12.89	14.76	16.85
Capital	3.97	4.33	0.00	0.00	0.00																									
Fixed Assets	3.97	4.33	0.00	0.00	0.00																									
Opening Cash Balance	0.00	-0.61	-2.11	-3.53	-4.86	-6.08	-7.18	-8.14	-8.94	-9.57	-10.01	-10.23	-9.83	-9.18	-8.26	-7.03	-5.38	-3.29	-0.70	2.44	6.21	10.70	15.98	22.15	29.29	37.64	47.34	58.54	71.43	86.20
Closing Cash Balance	-0.61	-2.11	-3.53	-4.86	-6.08	-7.18	-8.14	-8.94	-9.57	-10.01	-10.23	-9.83	-9.18	-8.26	-7.03	-5.38	-3.29	-0.70	2.44	6.21	10.70	15.98	22.15	29.29	37.64	47.34	58.54	71.43	86.20	103.04

13.10.4 Cost Benefit Analysis

(INR Cr)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Lease Revenue	-	-	-	2.0	2.0	2.6	2.6	2.6	2.6	2.6	3.4	3.4	3.4	3.4	3.4	4.4	4.4	4.4	4.4	4.4	5.7	5.7	5.7	5.7	5.7	7.4	7.4	7.4	7.4	7.4
Revenue sharing from Operations	-	-	-	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.4	1.6	1.7	1.9	2.2	2.4	2.7	3.1	3.5	3.9	4.3
Total Revenue	**-**	**-**	**-**	**2.2**	**2.3**	**2.9**	**2.9**	**3.0**	**3.0**	**3.1**	**3.9**	**4.0**	**4.0**	**4.1**	**4.2**	**5.3**	**5.4**	**5.5**	**5.6**	**5.8**	**7.3**	**7.5**	**7.7**	**7.9**	**8.2**	**10.2**	**10.5**	**10.9**	**11.3**	**11.8**
Expenditure																														
Dredging	-	-	-	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Bank maintenance	-	-	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Navigation aids	-	-	-	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Civil works	-	-	-	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Administrative Cost	0.0	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3
Total Opex	**0.0**	**0.3**	**0.3**	**5.5**	**5.5**	**5.6**	**5.6**	**5.6**	**5.6**	**5.7**	**5.7**	**5.7**	**5.7**	**5.8**	**5.8**	**5.8**	**5.9**	**5.9**	**5.9**	**6.0**	**6.0**	**6.0**	**6.1**	**6.1**	**6.2**	**6.2**	**6.3**	**6.3**	**6.4**	**6.5**
Profit/Loss	-0.0	-0.3	-0.3	-3.3	-3.3	-2.7	-2.6	-2.6	-2.6	-2.6	-1.8	-1.7	-1.7	-1.7	-1.6	-0.5	-0.5	-0.4	-0.3	-0.2	1.3	1.4	1.6	1.7	2.0	3.9	4.2	4.5	4.9	5.3
GAP funding with lease revenue	-	-	-	4.0	3.5	3.0	2.5	2.5	2.5	2.5	2.0	2.0	1.5	1.5	1.5	0.5	0.5	0.5	0.2	-	-	-	-	-	-	-	-	-	-	-
GAP funding without lease revenue	0.0	0.3	0.3	5.5	5.5	5.6	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.8	5.8	5.8	5.9	5.9	5.9	6.0	6.0	6.0	6.1	6.1	6.2	6.2	6.3	6.3	6.4	6.5
% savings	100%	100%	100%	28%	37%	46%	55%	55%	56%	56%	65%	65%	74%	74%	74%	91%	91%	92%	96%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Average savings				**82%**																										

14 Chapter 14: Conclusions and Recommendations

14.1 Introduction

With the consent of IWAI, the work of DPR study for the present waterway was undertaken by DHI. After survey work and field investigations including traffic studies, different options for developing the waterway was analysed and proposed. Finally, the cost estimates for the present project were prepared and economic and financial evaluation of the project was carried out.

14.2 Conclusions

The present and projected volume of passengers and vehicles is small in the river to justify the upgradation of existing infrastructure or developing and maintaining a waterway along the river. It is proposed that six ghats along the river (there on each banks) may be upgradated in two phases, with basic infrastructure and be used for cross-shore transportation of passengers and vehicles including four wheelers.

Two options (floating pontoon and and modular ferry without any terminal) were analysed in detail for implementation. The traffic, geomorphological, economical and social aspects of the region ware considered for analysing various options. Due to the high unstability of the river banks, permenant structures for terminals were not a viable option for the identified ghats. Both the suggestions were found feasible and economic. However, considering the operational easiness, and low cost, the option for employing modular ferry is proposed.

14.2.1 Capital Expenditure

	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25	Mar-26	Mar-27
	CAPEX (in Crores)							
TERMINAL AT 4 LOCATIONS								
Terminal Building	₹ 0.45	₹ 0.226	-	-	-	-	-	-
Waiting Building	₹ 0.119	₹ 0.059	-	-	-	-	-	-
FAIRWAY DEVELOPMENT								
Dredging	₹ 1.06	₹ 2.94	-	-	-	-	-	-
NAVIGATION & COMMUNICATION								
VHF Radio	₹ 0.05	₹ 0.025	-	-	-	-	-	-
AIDS TO NAVIGATION	₹ 0.024	₹ 0.006	-	-				
LANDSCAPING	₹ 0.03	₹ 0.015	-	-				

	Mar-20	Mar-21	Mar-22	Mar-23	Mar-24	Mar-25	Mar-26	Mar-27
CAPEX (in Crores)								
UTILITY SHIFTING	₹ 0.03	₹ 0.015	-	-				
AUXILARY ITEMS	₹ 0.2	₹ 0.05	-	-				
MODULAR FERRY VESSEL	₹ 2.0	₹ 1.0	-	-	-	-		
Total Capex	**₹ 3.969**	**₹ 4.333**	-	-				
OPEX								
Dredging	-	₹ 0.194	₹ 0.155	₹ 0.116	₹ 0.114	₹ 0.097	₹ 0.094	₹ 0.077
Navigation aids	-	₹ 0.074	₹ 0.062	₹ 0.046	₹ 0.046	₹ 0.039	₹ 0.037	₹ 0.031
Civil works		₹ 0.019	₹ 0.015	₹ 0.012	₹ 0.0114	₹ 0.0096	₹ 0.0093	₹ 0.0077
Administrative Cost		₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876	₹ 0.5876
Total Opex		**₹ 0.878**	**₹ 0.8199**	**₹ 0.7618**	**₹ 0.7589**	**₹ 0.7328**	**₹ 0.728**	**₹ 0.704**

14.2.2 Financial analysis

14.2.2.1 Financial Internal Rate of Return (FIRR)

Based on the financial analysis it is observed that the project is yielding with the FIRR stands @ 8.68%. This is quite acceptable.

14.2.2.2 Cash flow

- The total operation expense over a period of 30 years is estimated to be ~ Rs.78 Cr.
- The project is structured in a way that, the authority is operating the ferry service directly.
- A conservative approach was adopted for the extrapolation of the cashflow. Hence the project may require more time to break even considering the recurring O&M expenses.
- Based on the financial projections it is observed that, the cashflow has turned out to be positive over a period of 14 years.

14.2.2.3 Economic Internal Rate of Return (EIRR)

Based on the economic evaluationcarried out, the computed EIRR for various cases are summarised in Table 14.1

Table 14.1 Computed EIRR

Case nos	Assumption	EIRR
Case 1	With only direct benefits of saving in trip time by passengers and vehicles and increase in farm income	4.09 %
Case 2	With direct benefits and indirect benefits of economic multiplier effect in employment and output	20.09 %
Case 3	With direct benefits and indirect benefits of economic multiplier effect in employment and output and long-term benefits due to increase in land value	52.49 %

14.3 Recommendations

Based on the conclusions discussed, the following recommendations are put forward for Subansiri River

- Three locations on the right bank (Ghaghar, Khaboli and Dhonaguri) and three on the left bank (Ghunasiti, Luit Khaboli and Selek) may be developed for ro ro transport
- It is not recommended to develop and maintain fairway along the entire stretch of the river.
- Dredging for class II waterway may be carried out during lean season for maintaining cross-shore transport
- No permanent structures are recommended for the terminals
- Modular ferry may be employed for the cross-bank transport of passenger, two-wheeler and four wheelers.
- For demarcating the fairway, conventional marks made of bamboo stripes may be used
- The river is recommended to be developed in two phases.
    - Phase I: Four locations (Ghaghar – Ghunasuti and Dhonaguri – Selek)
    - Phase II: Two locations (Khaboli – Luit Khaboli)

Steps towards the sustenance of the proposed project is discussed below.

14.4 Measures of sustenance of IWT

- Since this project is structured in a way that the entire CAPEX is bourne by the authority, the possibility of exploring the various debt instruments may be explored. Since the CAPEX is very low, this can be sourced through budgetary allocations also. The farebox revenue is only revenue option which is explored, this project may not have the threshold to attract external funds
- The present traffic is not adequate to bridge the shortfall in the operational funds, hence the option of gap funding from the government during the operational period has been factored in the financial model.
- In the proposed waterway, there are ferry services – legitimate and illicit players. Proper regulatory measures need to be imposed to forefend the occurrence of such unwarranted practice
- Midway attendance to minor repairs, upkeep and touch-ups to barges to ensure uninterrupted operational sustenance

15 Chapter 15: Templates

15.1 Environmental & Social Screening Template

S.N.	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 project site			
	a) National Park		No	
	b) Wildlife Sanctuary		No	
	b) Bird Sanctuary	Yes		Kuarbari Dalani
	c) Tiger or Elephant Reserve		No	
	d) Biosphere Reserve		No	
	e) Reserved / Protected Forest	Yes		Pabho Reserve Forest
	f) Wetland	Yes		Kuarbari Dalani
	g) Important Bird Areas	Yes		Pabho Reserve Forest & Kuarbari Dalani
	h) Mangroves Areas		No	
	i) Estuary with Mangroves		No	
	j) Area used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	Yes		Pabho Reserve Forest & Kuarbari Dalani
	k) World Heritage Sites		No	
	l) Archeological monuments/sites (under ASI's Central/State list)	Yes		Maghnowa Temple, Baghar Chukar Doul & Gosaipukhuri Ruins
2.	Is the project located in whole or part in/near any Critically Polluted Areas identified by CPCB?		No	
3.	Is there any defense installations near the project site?		No	
4.	Whether there is any Government Order/Policy relevant/ relating to the site?		No	Currently there are no government order/policy relevant / relating to the proposed site. However, future orders will need to be addressed if related.
5.	Is the project-involved clearance of existing land, vegetation and building?		No	

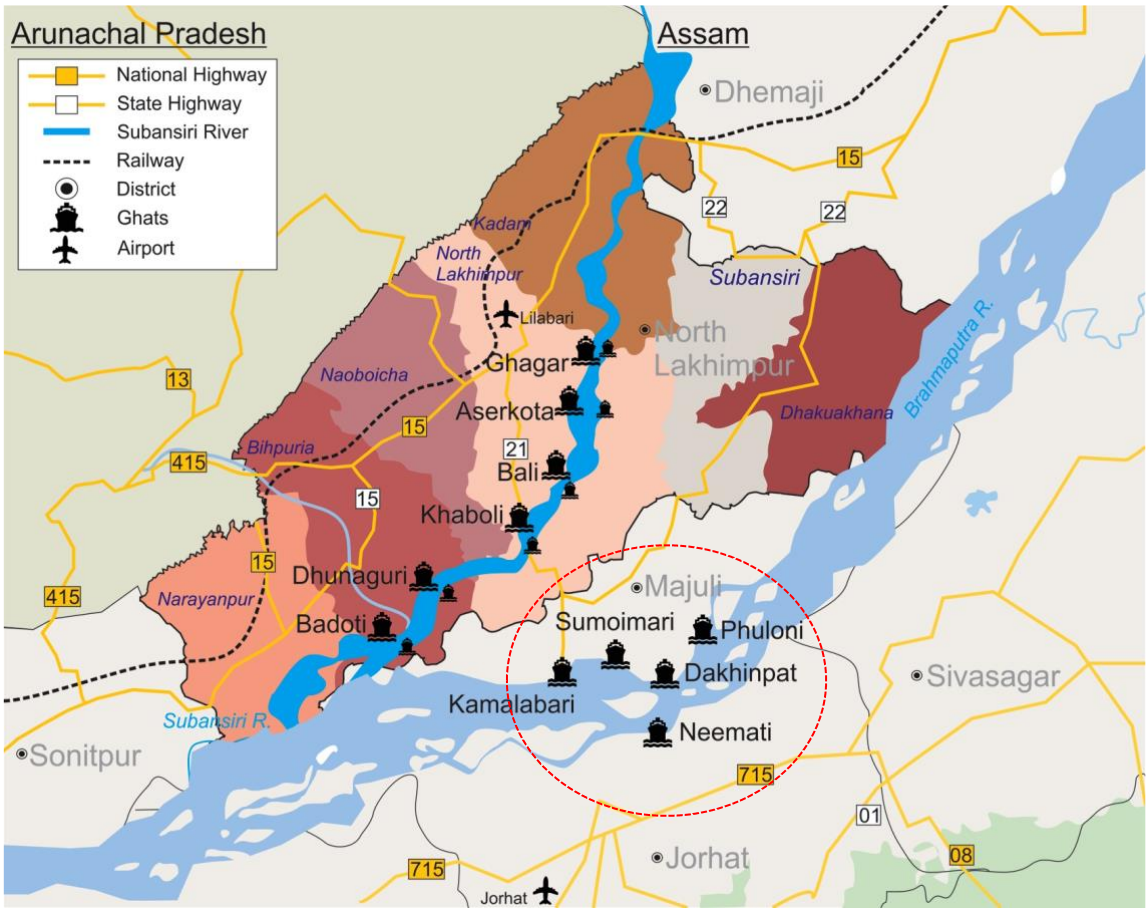
6.	Is the project involved dredging?	Yes		In selected stretches as detailed in the DPR.
7.	Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)	Yes		Earthquakes, erosion and flooding
8.	Is the project located in whole or part within the Coastal Regulation Zone?		No	
9.	Is the project involved any demolition of existing structure?		No	There is no such existing structures to demolish.
10.	Is the project activity require acquisition of private land?		No	
11.	Is the proposed project activity result in loss of direct livelihood/ employment?		No	Due to project activity no loss of direct livelihood and employment is anticipated.
12.	Is the proposed project activity affect schedule tribe/ caste communities?		No	

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

15.2 Traffic Template

15.2.1 Catchment Baseline

- Local Economic Geography – Subansiri river originates near Chayang Miri, a small village in Majuli Tehsil of Jorhat District and flows through Lakhipur District. As per IWAI, the identified length of the River is 111 km.
- Catchment Area –Lakhimpur & Dhemaji Districts of Assam
- Population – As per census 2011, total population residing in Lakhimpur district is 1,042,137 & Dhemaji district is 683,133.
- Economic Activities – Agriculture is the only economic activity in the catchment area. Paddy crop covers 66% of total cropped area.
- Industrial Cluster - There exist Micro & Small scale industries with negligible production in the catchment of Subansiri river.
- Connectivity
    - NH 52 passes through Dhemaji,crossing River at Dal Bhasti, Lakhimpur and further connects to Sonitpur district, across whole Lakhimpur
    - SH 21 runs on both the sides of the river. SH 21 connect both the sides, by Khabolu River Ferry service,through Subansiri River.
    - The railway line runs parallel to the river & crosses river at the Dhal Basti. Lakhimpur is the main & nearest railway station.
- Specific Developments
    - Assam state has 9 functional Integrated Infrastructure Development Centres, out of which two are under construction.
    - 2 Integrated Infrastructure Development Centres are located in the hinterland of Subansiri River, one is located in Banderdewa, Lakhimpur and another in Silapathar, Dhemaji with total land area of 140.469 Sq. M.
    - Lakhimpur also has Industrial estates at Rajabari & Bihpuri, with land area of 51,092 sq. M. Only 1 unit is operational. Total 6 sheds are constructed, but only 2 of them are used by industries at present.
- Catchment Area Map



15.2.2 Navigation Baseline

- Existing Waterway Usage
  - There exist 6 operational Ghats on the river. Majority of the Ghats are used to transport passengers and two wheelers by wooden boats. Some of them are also transporting four wheelers.
- Existing cross structures

Bridges

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		No of Piers	Horizontal clearance(clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks
					Left Bank	**Right Bank**				
1	Bridge Highway (Road)	105.4	RCC Road Bridge (NH 52)	Chawoldhowa	Lat: 27°26'47.18"N Long: 94°15'27.13"E	Lat: 27°26'55.86"N Long: 94°14'59.11"E	18	45	4.4	Completed in Use

2	Bridge (Railway)	105.8	Girder Steel Bridge	Chawoldhowa	Lat: 27°26'57.92"N Long: 94°15'33.17"E	Lat: 27°27'6.83"N Long: 94°15'4.76"E	13	60.5	3.6	Completed in Use

Electric Lines / Communication Lines

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat&Long)		No of Piers	Horizontal clearance(clear distance between piers) (m)	Vertical clearance w.r.t. HFL / MHWS	Remarks (complete / under - construction), in use or not, condition
					Left Bank	**Right Bank**				
1	HTPL Line	105.5	High Tension Power Line	Chawol Dhowa	Lat: 27°26'50.14"N Long: 94°15'27.67"E	Lat: 27°26'58.11"N Long: 94°15'1.17"E	-	980 m	13.9	Completed in Use
2	HTPL Line	40.4	High Tension Power Line	Kabhuli Ghat	Lat: 27° 2'29.15"N Long: 94° 7'45.52"E	Lat: 27° 2'38.57"N Long: 94° 7'10.23"E	2	400 m	12.5	Completed in Use

15.2.3 Market Baseline

- Potential Market
  - Passengers & Ro-Ro Movement

Type	Source	Reasoning
Passenger & Ro-Ro	Across the River Movement	Passenger movement across the river with vehicles, cattle & goods take place at large scale. At present, small wooden boats at Ghats are used for crossing the river, without any safety measures. Passengers also face congestion problem on operational routes. If IWAI upgrades existing Ghats on the river & provides proper infrastructure & facilities for passengers & Ro-Ro movement, then the frequency of river crossing by people, residing on both sides of the river would definitely increase. Hence, opportunity for movement across the river exists.

15.2.4 Forecasting Years

Sl. No.	Name of Cargo	Type of Cargo	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Coordinates	Unit	Daily Crossing Volume					
									Fy-17	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Upgradation of Khaboli Ghat - Large Terminal														
1	Passenger	Passenger	N. Lakhimpur	Khaboli	N. Lakhimpur, Majuli	Across the river	n/a	No.	224	261	336	431	552	706
2	Cycle/ Bike	Ro-Ro	N. Lakhimpur	Khaboli	N. Lakhimpur, Majuli	Across the river	n/a	No.	56	66	87	114	147	191
3	4 Wheelers	Ro-Ro	N. Lakhimpur	Khaboli	N. Lakhimpur, Majuli	Across the river	n/a	No.	29	35	47	62	82	108
Upgradation of Dhunaguti Ghat - Large Terminal														
1	Passenger	Passenger	Bihpuria	Dhunaguri	Bihpuria	Across the river	n/a	No.	379	439	563	722	923	1181
2	Cycle/ Bike	Ro-Ro	Bihpuria	Dhunaguri	Bihpuria	Across the river	n/a	No.	53	62	82	108	140	181
3	4 Wheelers	Ro-Ro	Bihpuria	Dhunaguri	Bihpuria	Across the river	n/a	No.	32	38	51	67	88	115
Upgradation of Ghagar Ghat - Small Passenger Terminal														
1	Passenger	Passenger	N Lakhimpur	Ghagar Ghat	North Lakhimpur	Across the river	n/a	No.	157	183	237	305	392	502
2	Cycle/ Bike	Ro-Ro Cargo	N Lakhimpur	Ghagar Ghat	North Lakhimpur	Across the river	n/a	No.	18	21	31	41	56	74
Sl. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Origin Terminal on NW**	**Final Destination**	**Destination Terminal on NW**	**Coordinates**	**Unit**	**Daily Crossing Volume**					
									Fy-17	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Upgradation of Aserkota Ghat - Small Passenger Terminal														

1	Passenger	Passenger	N Lakhimpur	Aserkota Ghat	North Lakhimpur	Across the river	n/a	No.	98	115	150	194	250	322
2	Cycle/ Bike	Ro-Ro Cargo	N Lakhimpur	Aserkota Ghat	North Lakhimpur	Across the river	n/a	No.	22	28	38	51	67	88
Upgradation of Bali Ghat - Small Passenger Terminal														
1	Passenger	Passenger	N Lakhimpur	Bali Ghat	North Lakhimpur	Across the river	n/a	No.	263	306	393	503	645	826
2	Cycle/ Bike	Ro-Ro Cargo	N Lakhimpur	Bali Ghat	North Lakhimpur	Across the river	n/a	No.	56	66	87	114	147	191
Upgradation of Badoti Ghat - Small Passenger Terminal														
1	Passenger	Passenger	Bihpuria	Badoti Ghat	Bihpuria	Across the river	n/a	No.	246	286	368	473	606	776
2	Cycle/ Bike	Ro-Ro Cargo	Bihpuria	Badoti Ghat	Bihpuria	Across the river	n/a	No.	74	87	114	147	191	247
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.														

All the 6 operational ghats need to be upgraded. The present volume of passengers and vehicles is small to justify large scale infrastructure on the bank of the river. Hence, it would be advisable to upgrade terminal infrastructure at multiple ghats for movement of passengers and 2 & 4 wheelers across the river.

- Develop 2 large terminals for movement of bigger Ro-Ro ferries that could transport Cars across the river

  i. Upgrading existing terminals of Khaboli Ghat could be cost effective and convenient. The Ghats have good road connectivity with other parts of district in Lakhimpur.

  ii. Dhunaguri Ghat could be developed as a large terminal because it has large volumes of passengers and vehicles moving across the river.

- The other 4 existing Ghats could be upgraded into small passenger terminals. This could be used by passengers on foot and 2 wheelers to cross over to the other side of the river for day-to-day commuting.

15.3 Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	• Land, compensation and resettlement: NIL (After land details Survey) • Dredging: Phase I - Rs. 1,06,26,520.00 Phase II – Rs. 2,93,59,620.00 • River training: NA • Bank protection: NA • Locks: Rs.0.00 • Barrages: Rs.0.00 • Channel marking: Phase I - Rs. 2,40,000.00, Phase II – Rs. 60,000.00 • Night navigation: Rs.0.00 • Other (including utility shifting, auxiliary items, landscaping): Phase I - Rs.26,00,000.00, Phase II – Rs. 8,00,000.00
	Terminal Infrastructure	• Fixed infrastructure: Phase I ✓ Terminal building: Rs. 45,26,044.00 ✓ Waiting Building: Rs. 11,96,604.00 Phase II ✓ Terminal building: Rs. 22,63,022.00 ✓ Waiting Building: Rs. 5,98,302.00 • Loading/uploading and other equipment: Rs.0.00 • Navigation and communication equipment: Phase I - Rs.5,00,000.00, Phase II – Rs. 2, 50, 000.00 • Other: Modular Ferry Vessel: Phase I – Rs. 2,00,00,000.00 (2 Nos), Phase II – Rs. 1,00,00,000.00 (1 Nos)
Operation and maintenance (O & M) costs	Waterways	• Dredging: 5% annually; Phase I - Rs. 5,31,326.00, Phase II – Rs. 14,67,981.00 • Markings and nav.-aids: 2% annually; Phase I - Rs. 4,800.00, Phase II – Rs. 1,200.00 • River training: NA • Embankment protection:NA • Other (including utility shifting, auxiliary items, landscaping): 1% annually, Phase I - Rs. 26,000.000, Phase II – 8,000.00
	Terminals	• Terminal operations: Phase I - Rs. 35,94,000.00 PA, Phase II – Rs. 8,42,000.00 PA • Terminal maintenance: 1% annually; Phase I ✓ Terminal building: Rs. 45,260.44 ✓ Waiting Building: Rs. 11,966.04 Phase II ✓ Terminal building: Rs. 22,630.22 ✓ Waiting Building: Rs. 5,983.02 Navigation and communication: 5% annually; Phase I – Rs. 25,000.000, Phase II – Rs. 12,500.00

		• Berthing structure:NA • Other: NIL
	Vessel: (NB vessel operating costs/tons-km fall sharply with larger capacity vessel, when there is sufficient traffic to utilize them)	Modular Ferry Vessel: 10% annually per ferry; Phase I – Rs. 20,00,000.00 (2 Nos), Phase II – Rs. 10,00,000.00 (1 Nos)
Recurrent costs	Periodic major capital costs that may occur over life of assets	Except maintenance cost, no recurrent cost is noted for the period till 2050, unless any development plan to upgrade the Class of waterway is considered.
Price levels	-	
Value engineering	-	
Cost verification	-	

15.4 Economic Evaluation Template

Item	**Requirements**
Objective	• Considered
Economic evaluation approach	Economic evaluation of each river upgrading project may include: • Navigation Infrastructure Capital cost Phase 1: Rs. 5 lakhs, Phase2: 2.5 lakhs. • O& M Phase 1: Rs. 0.25 lakhs and phase 2: Rs. 0.125 lakh. • Terminals capital cost phase 1: Rs. 83.226 lakh and phase 2: Rs. 36.61 lakh • O&M Phase 1: Rs. 0.832 lakh and Phase 2: Rs. 0.3661 lakh. • Savings in transport resource costs between IWT and road transport: Rs. 2.58 per tonne km. • Savings in transport resource costs between IWT and rail transport: Rs.1.41 per tonne km. • Savings in transport resource costs between IWT and water transport: Rs.1.06 per tonne km. • Saving in carbon emissions: Rs 0.06 Ton/1000 tonne Km
Standard values	• Considered as per guidelines
Other benefits	• Considered
Cash flows in real terms	• Considered
Resource cost adjustments	• Considered

Evaluation period	• Evaluation done for 30 years
EIRR	• Considered
Checking and Replicability	• Considered

15.5 Financial Evaluation Template

Item	Requirements
Objective	• Same financial and economic assumptions considered between waterway stitches
Financial evaluation approach	• Navigation infrastructure – rates as per prevalent market rates • Terminal operations – rates considered at IWAI guideline rates • Barging operators – Considered to be operated by private operators
Disaggregation	• Cash streams not segregated by sector due to high dredging costs and low IWAI charges thus rendering it grossly unviable • Barge operations excluded
Transfers between Subsectors	• Disaggregation not considered
Incremental barging operations	• Incremental costs and incremental revenue considered
Cash flows in real terms	• Current prices considered along with relevant escalation rates to arrive at the realistic cash flows • Revenue inflation rates are higher than costs thus improving project returns with further years
Evaluation period	• Evaluation done for 30 years
FIRR and payback period	• FIRR – 8.68% and payback period is 18 years
Ramp-up period	• Considered
Commentary on FIRR	• Considered
Risks to financial outturn	• Ferry service by both legitimate and illicit players. • Tidal influence.
Checking and Replicability	• Considered

Annexures

A Scope of work of Agreement

SECTION-6 TERMS OF REFERENCE

1.0 OBJECTIVE OF THE STUDY:

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India. After carrying out the feasibility study if there is scope for navigation and potential to develop waterway transport facility, a Detailed Project Report needs to be prepared for those waterways which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

The study would consist of 2 stages:

1. **Stage-1**
2. **Stage-2**

1.1 STAGE-1

Stage-I is only for feasibility of the waterway for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-1 would consist of the following activities:

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

1.1.1 Reconnaissance Survey

The detailed field reconnaissance survey may be taken up immediately after the analysis of available data. The primary tasks to be accomplished during the reconnaissance surveys include:

i- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the proposed waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

ii- Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks enroute are also to be collected. horizontal and vertical clearance is to be given as approximate on visual assessment. Photographs are required to be submitted in the report.

iii- Topographical features of the proposed Inland Waterways.
iv- Typical physical features along the alignment i.e. land use pattern:
v- Preliminary identification of stretches having year round flow and critical depth for navigational purpose.
vi- Preliminary Traffic identification on the proposed Inland Waterways.
vii- Inventory of major aspects including proposed Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features
viii- Critical areas requiring detailed investigations and
ix- Requirements for carrying out supplementary investigations
x- Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.
xi- Type and extent of existing utility services along the alignment.
xii- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

The data derived from the reconnaissance surveys may be utilized for planning and programming the detailed surveys and investigations. All field studies including the traffic surveys should be taken up on the basis of information derived from the reconnaissance surveys. For the critical locations, River cross sections survey needs to be carried out.

1.1.2 Collection and Review of Available Data

A review has to be done based on the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Consultant has to collect available data for the proposed Inland Waterways from the State Agencies and Central Water Commission. An introductory letter will be issued by IWAI for collecting information from State / Central Government.

An inception report has to be prepared which would consist of the findings based on the analysis of the existing data and reconnaissance surveys.

1.1.3 Feasibility Report

The Consultant has to prepare Feasibility Report for the proposed waterways based on the available data and reconnaissance survey. It must include the following prospects:

1. **Introductory considerations:**
   The Consultant shall provide an introduction, describing the scope of the assignment, its methodology in fulfilling the assignment and the expected outcome of the assignment.

2. **Analysis of present state of affairs:**
   The Consultant shall provide a quantitative and qualitative description of the current utilization of proposed inland waterways. In addition, the Consultant shall describe the status of goods transport, including utilization of road and transport, as well as river facilities.

3. **Market Analysis:**
   The consultant shall analyze the market and potential usage of proposed Inland Waterways. This analysis shall examine both the existing market and the potential future market. Contractor has to collect the details of available Industries along the waterway, type of production in these industries, ferry services, type of crop along the waterway, previous history of movement of cargo in the waterway etc. Above is to be collected after discussion with local village people while conducting reconnaissance survey etc. and also after interaction with State Govt. Officials, Irrigation / Water Resources departments.

4. **Reconnaissance Survey:**
   Analysis of the data collected in the reconnaissance survey should reflect the possibility of year round flow in the proposed Inland Waterways to achieve the commercial navigation. It should also consist the map of proposed Inland Waterways indicating existing cross structures viz. bridges, dams etc. Navigability of the waterway (for the periods) is to correlate with CWC/Irrigation water level data.

The Consultant has to submit the Feasibility Report for proposed Inland Waterways. Consultant also has to emphasize that which stretches of proposed inland waterways has potential of possible navigation. Only for those stretches of proposed inland waterways, which have potential of possible navigation, Stage 2 has to be carried out.

After obtaining approval from IWAI for identified stretches, Consultant may proceed for Stage - 2. Based on the feasibility report, IWAI will accord the approval for Stage-II, and stretch for DPR will be based on feasibility study.

1.2 STAGE-2

For Stage-2, Consultant has to carry out detailed hydrographic survey, topographic survey, traffic survey and selection of terminal locations.

Stage-2 would consist of the following activities:

1A. Hydrographic Survey & hydro-morphological survey

1B. Traffic Survey & Techno economic feasibility

1C. Preparation of Detailed Project Report

1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY

Based on the recommendation after reconnaissance survey of proposed Inland Waterways,

Hydrographic survey may be carried out as per the International Standards including the following for finding the potential of proposed Inland Waterways for inland navigation:-

(i) The detailed hydrographic survey is to be carried out in WGS'84 datum.

(ii) The horizontal control is to be made using DGPS with minimum 24 hours observations at some platform/base.

The vertical control is to be established with respect to the chart datum / sounding datum from the following methods:-

i. Chart datum/ sounding datum already established by Port Authorities (Chart Datum), Central Water Commission (Average of last six years minimum Water Level) / State Irrigation Department (Full Supply Level (FSL)) and at their gauge stations along the river/canal. Secrecy undertaking forms etc. will be provided by IWAI for collection of CWC data. Introductory letter will be issued to the successful Consultant for collection of other required information from State Departments.

ii. Standard method shall be adopted for transfer of datum in rivers/canals. For tidal reaches standard transfer of datum as per Admiralty Manual shall be adopted.

iii. **By erection of tide gauges – at every 10km interval and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc.**

Other Terms of Reference for the survey work shall be as given below: -

1.2.1.1 BENCH MARK PILLARS

a. Construct Bench Mark Pillars of dimension 0.3m x 0.3m x 1.5m (0.6m above GL) RCC pillar with 6mm thick 50mm dia GI pipe inserted (as per construction drawing of Survey Pillar in the tender document), at every 10km interval. Detailed description of the bench mark along with its position and value to be given in the report for future recovery.

1.2.1.2 WATER LEVEL GAUGES

i. Water level gauges are to be erected at every 10 km interval along the canal/river **and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc. simultaneously.** Readings are to be taken at 1 hr interval for 12 hours (6 AM to 6 PM) or for the entire period of survey. The gauges are to be connected to a nearest Bench Mark by leveling and its datum value shall be established w.r.to MSL & CD. Water level gauges are to be installed temporarily during the survey period.

ii. At least 2 gauges (one U/s and one D/s at 10 Km apart) shall be read simultaneously and soundings to be carried out within the gauge stations. Soundings are to be reduced for datum of a gauge for 5km length of the canal/river on both side of a gauge.

1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY

Sl. No.	Name of the River / Canal	Description of Inland Waterway
CLUSTER-2		
1	DHANSIRI / CHATHE	110 km length of the river from Bridge near Morongi T.E. village Lat 26°24'40.65"N, Lon 93°53'46.75"E to Numaligarh Lat 26°42'1.20"N, Lon 93°35'15.42"E
2	LOHIT RIVER	100 km length of the river from Parasuram Kund Lat 27°52'40.06"N, Lon 96°21'39.70"E to Saikhowa Ghat, Sadiya Lat 27°47'49.14"N, Lon 95°38'13.84"E

3	SUBANSIRI RIVER	111 km length of the river from Gerukamukh Lat 27°27'3.14"N, Lon 94°15'16.12"E to Brahmaputra confluence at Lat 26°52'24.93"N, Lon 93°54'31.26"E
4	TIZU and ZUNGKI RIVERS	42 km length of the river from Longmatra at Lat 25°46'11.98"N, Lon 94°44'35.04"E to Avanghku at Myanmar border Lat 25°35'2.94"N, Lon 94°53'6.12"E and in Zungki river from bridge at Lat 25°48'26.10"N, Lon 94°46'35.96"E to confluence of Zungki and Tizu rivers at Lat 25°46'58.03"N, Lon 94°45'20.51"E
	CLUSTER-3	
1	BIDYA RIVER	55 km length of the river from Lot No. 124 at Lat 21°54'42.88"N, Lon 88°41'8.48"E to near Uttar Danga at Lat 22°11'47.93"N, Lon 88°51'54.93"E
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	15 km length of the river from near Rajani ferry ghat Lat 22°19'57.49"N, Lon 88°54'21.40"E to near Nazat at Lat 22°26'5.40"N, Lon 88°50'11.69"E
3	DVC CANAL	130 km length of the canal from Durgapur Barrage Lat 23°28'47.36"N, Lon 87°18'19.04"E to Confluence point of DVC canal with Hooghly river near Tribeni Lat 23° 0'30.95"N, Lon 88°24'54.72"E
4	GOMAR RIVER	7 km length of the river from near Ramkrishnapur Lat 22°11'53.35"N, Lon 88°44'41.97"E to near Gosaba Kheya ghat at Lat 22°10'5.44"N, Lon 88°47'37.17"E
5	HARIBHANGA RIVER	16 km length of the river from Bangladesh Border Lat 21°53'18.81"N, Lon 89° 1'23.61"E to confluence with Jhila river at Lat 21°58'17.66"N, Lon 88°55'8.38"E
6	HOGLA (HOGAL)-PATHANKHALI RIVER	37 km length of the river from near Parandar Lat 22°12'22.05"N, Lon 88°40'42.77"E to near Sandeshkhai Ferry Ghat at Lat 22°21'12.26"N, Lon 88°52'47.99"E
7	KALINDI (KALANDI) RIVER	8 km length of the river from Bangladesh Border at Hingalganj Lat 22°28'8.48"N, Lon 88°59'46.19"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
8	KATAKHALI RIVER	23 km length of the river from Bangladesh Border near Barunhat Lat 22°30'31.44"N, Lon 88°58'24.53"E to Lebukhali ferry at Lat 22°21'45.36"N, Lon 88°57'30.27"E
9	MATLA RIVER	98 km length of the river from Bay of Bengal at Lat 21°33'4.13"N, Lon 88°38'25.65"E to Canning ferry ghat at Lat 22°18'38.87"N, Lon 88°40'42.65"E
10	MURI GANGA (BARATALA) RIVER	27 km length of the river from Bay of Bengal near Bisalakshmipur Lat 21°37'51.94"N, Lon 88°10'0.24"E to near Kakdwip at Lat 21°52'17.39"N, Lon 88° 9'7.52"E
11	RAIMANGAL RIVER	52 km length of the river from Hemnagar at Lat 22°11'40.58"N, Lon 88°58'1.08"E to Rajnagar at Lat 22°33'56.95"N, Lon 88°56'16.64"E
12	SAHIBKHALI (SAHEBKHALI) RIVER	14 km length of the river from near Ramapur Lat 22°17'52.04"N, Lon 88°56'34.78"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
13	SAPTAMUKHI RIVER	37 km length of the river from Bay of Bengal at Henry Island Lat 21°34'57.35"N, Lon 88°19'8.47"E to near Chintamanipur at Lat 21°51'14.01"N, Lon 88°18'40.50"E
14	THAKURRAN RIVER	64 km length of the river from Bay of Bengal at Lat 21°33'31.95"N, Lon 88°27'45.40"E to Madhabpur at Lat 22° 2'52.19"N, Lon 88°33'27.96"E
	CLUSTER-4	
1	BAITARNI RIVER:	49 kms length of the river from Dattapur village at Lat 20°51'44.61"N, Long 86°33'30.45"E to confluence with Dhamra river near Laxmiprasad Dia at Lat 20°45'13.32"N, Long 86°49'15.36"E

2	BIRUPA / BADI GENGUTI / BRAHMANI RIVER SYSTEM:	102 kms length of the river from Birupa Barrage at Choudwar at Lat 20°30'49.00"N, Long 85°55'20.17"E to confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E including alternative route of 25 kms from Samaspur village at Lat 20°35'40.59"N, Long 86° 6'31.50"E to near Kharagpur village at Lat 20°38'27.77"N, Long 86°17'31.81"E and additional 54 kms length of Brahmani river from confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E to Brahmani river at Katana Lat 20°39'26.28"N, Long 86°44'52.86"E
3	BUDHA BALANGA:	56 kms length of the river from Barrage (approx 300m from Patalipura village) at Lat 21°38'12.96"N, Long 86°50'53.17"E to confluence of Budha Balanga river with Bay of Bengal at Chandipur Fishing Port Lat 21°28'12.14"N, Long 87° 4'11.60"E
4	MAHANADI RIVER:	425 kms length of the river from Sambalpur Barrage at Lat 21°27'34.33"N, Long 83°57'49.80"E to Paradip at Lat 20°19'38.12"N, Long 86°40'16.96"E
	CLUSTER-5	
1	PENNAR RIVER:	29 kms length of the river from Penna Barrage, Pothireddypalem at Lat 14°28'8.38"N, Long 79°59'9.31"E to confluence with Bay of Bengal near Kudithipalem at Lat 14°35'36.75"N, Long 80°11'30.61"E
2	KAVERI / KOLLIDAM RIVER:	364 kms length of the river from Uratchikottai Barrage at Lat 11°29'3.09"N, Long 77°42'13.68"E to confluence with Bay of Bengal at Pazhaiyar Lat 11°21'37.97"N, Long 79°49'53.23"E
3	PALAR RIVER:	141 kms length of the river from rail bridge at Virudampattu, Vellore Lat 12°56'14.07"N, Long 79° 7'29.70"E to confluence with Bay of Bengal at Sadurangapattinam Lat 12°27'52.16"N, Long 80° 9'13.47"E
4	PAZHYAR RIVER:	20 kms length of the river from Bridge near Veeranarayana Mangalam village at Lat 8°13'48.97"N, Long 77°26'27.34"E to confluence with Arabian Sea at Manakudi at Lat 8° 5'15.01"N, Long 77°29'7.61"E
5	PONNIYAR RIVER	125 km length of the river from Sathanur Dam at Lat 12°11'0.06"N, Lon 78°51'1.25"E to Cuddalore at confluence of Bay of Bengal at Lat 11°46'21.76"N, Lon 79°47'41.70"E
6	TAMARAPARANI RIVER:	64 kms length of the river from Sulochana Mudalir bridge, Tirunelveli at Lat 8°43'43.17"N, Long 77°42'53.94"E to confluence with Bay of Bengal near Punnaikayal at Lat 8°38'24.90"N, Long 78° 7'37.85"E
	CLUSTER-6	
1	West Coast Canal	160 kms length of the canal as extension of NW-3 towards north of Kottapuram - from Kottapuram at Lat 10°11'38.32"N, Long 76°12'4.39"E to Kozhikode at Lat 11°13'38.83"N, Long 75°46'43.90"E
2	ALAPPUZHA-CHANGANASSERY CANAL	28 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Changanassery Jetty at Lat 9°26'41.61"N, Lon 76°31'41.76"E
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	38 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Changanassery Jetty Lat 9°26'41.61"N, Lon 76°31'41.76"E
4	KOTTAYAM-VAIKOM CANAL	28 km from Kottayam, near Kodimatha at Lat 9°34'38.67"N, Lon 76°31'7.67"E to Vechoor joining National Waterway no. 3 at Lat 9°40'0.19"N, Lon 76°24'10.65"E
5	GURUPUR RIVER	10 km length of the river from confluence of Netravathi river at Lat 12°50'44.04"N, Lon 74°49'44.51"E to confluence of Mangalore Port Bridge at Lat 12°55'34.81"N, Lon 74°49'37.34"E

6	KABINI RIVER	23 km length of the river from Kabini Dam Lat 11°58'24.52"N, Lon 76°21'9.69"E to Beeramballi at Lat 11°56'9.55"N, Lon 76°14'17.58"E
7	KALI RIVER	54 km length of the river from Kodasalli Dam Lat 14°55'8.24"N, Lon 74°32'6.90"E to confluence of Kali river with Arabian Sea near Sadashivgad bridge at Lat 14°50'30.95"N, Lon 74° 7'21.32"E
8	NETRAVATHI RIVER	78 km length of the river from Netravathi Dam, Dharmsthala Lat 12°57'55.23"N, Lon 75°22'10.19"E to confluence with Arabian sea at Bengre Lat 12°50'42.73"N, Lon 74°49'28.86"E
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	23 km length of the river from Gangoli Port at Lat 13°38'1.30"N, Lon 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Lon 74°39'15.13"E
10	SHARAVATI RIVER	29 km length of the river from Honnavar Port Sea Mouth at Lat 14°17'56.23"N, Lon 74°25'27.04"E to link at highway at Gersoppa Lat 14°14'14.73"N, Lon 74°39'6.15"E
11	UDAYAVARA RIVER	16 km length of the river from Arabian Sea Mouth at Malpe Lat 13°20'57.24"N, Lon 74°41'28.22"E to Bridge near Manipura Lat 13°17'32.70"N, Lon 74°46'25.56"E
	CLUSTER-7	
1	CHAPORA RIVER	33 kms length of the river from Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E to Confluence of Chapora river with Arabian Sea at Morjim Lat 15°36'33.27"N, Long 73°44'0.93"E
2	MAPUSA / MOIDE RIVER	27 kms length of the river (including Moide river) from bridge on NH17 at Mapusa Lat 15°35'20.79"N, Long 73°49'17.20"E to confluence point of Mapuca & Mandovi rivers at Porvorim Lat 15°30'20.01"N, Long 73°50'42.09"E
3	SAL RIVER	14 kms length of the river from Orlim Deusa Bridge at Lat 15°13'11.41"N, Long 73°57'29.77"E to confluence with Arabian Sea at Mobor Lat 15° 8'31.93"N, Long 73°56'59.89"E
4	AMBA RIVER	45 kms length of the river from Arabian Sea, Dharamtaar creek near village Revas at Lat 18°50'15.14"N, Long 72°56'31.22"E to a Bridge near Nagothane ST Stand at Lat 18°32'19.82"N, Long 73° 8'0.29"E
5	DABHOL CREEK/VASHISHTI RIVER	45 km length of the river from Arabian Sea at Dabhol Lat 17°34'51.33"N, Lon 73° 9'17.83"E to bridge at Pedhe Lat 17°32'39.45"N, Lon 73°30'35.56"E
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	145 km length of the waterway from Arabian Sea at Navi Mumbai Lat 18°55'49.78"N, Lon 72°53'21.67"E via Ulhas river to bridge on State Highway No.76 near Malegaon T. Waredi Lat 19° 2'38.20"N, Lon 73°19'53.79"E Bridge on Kalyan-Badlapur road near Kalyan railway yard at Kalyan Lat 19°14'6.39"N, Lon 73° 8'49.13"E to Kalyan Lat 19°15'35.03"N, Lon 73° 9'27.77"E Vasai Creek from Lat 19°18'53.50"N to Lon 72°47'30.18"E to Kasheli at Lat 19°13'22.84"N, Lon 73° 0'21.44"E
7	RAJPURI CREEK	31 km length of the river from Arabian Sea at Rajpuri Lat 18°18'3.15"N, Lon 72°56'42.94"E to Mhasala at Lat 18° 8'15.37"N, Lon 73° 6'45.35"E
8	REVADANDA CREEK / KUNDALIKA RIVER	31 km length of the river from Arabian Sea at Revadanda Lat 18°32'19.85"N, Lon 72°55'32.80"E to bridge on Roha-Astami Road near Roha Nagar Lat 18°26'31.50"N, Lon 73° 7'10.74"E
9	SAVITRI RIVER (BANKOT CREEK)	44 kms length of the river from Bridge near Sape at Lat 18° 5'54.11"N, Long 73°20'8.81"E to Arabian Sea at Harihareswar Lat 17°58'47.10"N, Long 73° 2'15.01"E
10	SHASTRI RIVER / JAIGAD CREEK	52 kms length of the river from Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57"E to confluence with Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E

CLUSTER-8		
1	MAHI RIVER:	248 kms length of the river from Kadana Dam at Lat 23°18'22.35"N, Long 73°49'37.45"E to confluence with Gulf of Khambhat near Kavi railway station at Lat 22°10'34.71"N, Long 72°30'36.31"E
2	NARMADA RIVER	227 km length of the river from Pandhariya at Lat 21°57'10.37"N, Lon 74° 8'27.46"E to confluence of Narmada with Arabian Sea at Gulf of Khambhat Lat 21°38'26.81"N, Lon 72°33'28.24"E
3	SABARMATI RIVER:	212 kms length of the river from Barrage near Sadoliya at Lat 23°26'49.66"N, Long 72°48'34.85"E to confluence with Gulf of Khambhat near Khambhat at Lat 22° 9'17.99"N, Long 72°27'27.81"E
4	TAPI RIVER:	436 kms length of the river from Hatnur Dam near Mangalwadi at Lat 21° 4'21.99"N, Long 75°56'44.88"E to confluence with Gulf of Khambhat (Arabian Sea) at Lat 21° 2'15.51"N, Long 72°39'29.63"E

#	River/Canal	State	Length (km)	Spacing (m)	Ave. width (m)
		CLUSTER-2			
1	Dhansiri / Chathe	Assam	110	150	150
2	Lohit	Assam & Arunachal Pradesh	100	200	1000
3	Subansiri	Assam	111	200	1000
4	Tizu and Zungki	Nagaland	42	50	100
			363		
		CLUSTER-3			
1	BIDYA RIVER	West Bengal	55	200	1500
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	West Bengal	15	200	500
3	DVC CANAL	West Bengal	130	100	100
4	GOMAR RIVER	West Bengal	7	200	400
5	HARIBHANGA RIVER	West Bengal	16	200	2000
6	HOGLA (HOGAL)-PATHANKHALI RIVER	West Bengal	37	200	300
7	KALINDI (KALANDI) RIVER	West Bengal	8	200	500
8	KATAKHALI RIVER	West Bengal	23	200	200
9	MATLA RIVER	West Bengal	98	200	2000
10	MURI GANGA (BARATALA) RIVER	West Bengal	27	200	3000
11	RAIMANGAL RIVER	West Bengal	52	200	800
12	SAHIBKHALI (SAHEBKHALI) RIVER	West Bengal	14	200	300
13	SAPTAMUKHI RIVER	West Bengal	37	200	700
14	THAKURRAN RIVER	West Bengal	64	200	1000
			583		
		CLUSTER-4			
1	Baitarni	Odisha	49	100	100
2	Birupa / Badi Genguti / Brahmani	Odisha	156	100	200
3	Budha Balanga	Odisha	56	100	100
4	Mahanadi	Odisha	425	200	500
			686		

		CLUSTER-5			
1	Pennar	Andhra Pradesh	29	100	400
2	Kaveri / Kollidam	Tamil Nadu	364	200	400
3	Palar	Tamil Nadu	141	200	500
4	Pazhyar	Tamil Nadu	20	50	100
5	PONNIYAR	Tamil Nadu	125	200	300
6	Tamaraparani	Tamil Nadu	64	150	300
			743		
		CLUSTER-6			
1	West Coast Canal	Kerala	160	50	100
2	ALAPPUZHA- CHANGANASSERY CANAL	Kerala	28	50	100
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	Kerala	38	50	100
4	KOTTAYAM-VAIKOM CANAL	Kerala	28	50	100
5	GURUPUR RIVER	Karnataka	10	100	400
6	KABINI RIVER	Karnataka	23	200	500
7	Kali	Karnataka	54	150	450
8	Netravathi	Karnataka	78	100	300
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	Karnataka	23	150	600
10	SHARAVATI RIVER	Karnataka	29	150	400
11	UDAYAVARA RIVER	Karnataka	16	100	250
			487		
		CLUSTER-7			
1	CHAPORA RIVER	Goa	33	100	250
2	MAPUSA / MOIDE RIVER	Goa	27	50	100
3	SAL RIVER	Goa	14	50	100
4	AMBA RIVER	Maharashtra	45	150	300
5	DABHOL CREEK/VASHISHTI RIVER	Maharashtra	45	150	400
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	Maharashtra	145	150	350
7	RAJPURI CREEK	Maharashtra	31	150	1000
8	REVADANDA CREEK / KUNDALIKA RIVER	Maharashtra	31	150	400
9	SAVITRI RIVER (BANKOT CREEK)	Maharashtra	46	150	400
10	SHASTRI RIVER / JAIGAD CREEK	Maharashtra	52	150	300
			469		
		CLUSTER-8			
1	MAHI RIVER	Gujarat	248	200	400
2	NARMADA RIVER	Maharashtra & Gujarat	227	200	500
3	SABARMATI RIVER	Gujarat	212	200	150
4	TAPI RIVER	Maharashtra & Gujarat	436	200	350
			1123		

Note:- Bathymetric and Topographical survey of specified Waterways is to be conducted for average width specified in above table. Average width of the Waterways is the average of narrow and wider portions of the river. For reservoir / ponding areas, only bathymetric survey of maximum 500m width in the deepest channel is to be carried out. Minimum 100m wide corridor is to be surveyed (only for rivers / canals having less than

60m water width). 100m wide corridor includes width of proposed Waterways. Bathymetric and topographic survey is to be carried out for 50m width on both side from the centre line of the channel.

a. Bathymetric and Topographical survey of proposed Inland Waterways is to be conducted for width specified in above table. Minimum 100m wide corridor is to be surveyed to assess the extent of land acquisition required for 100m wide corridor (100m wide corridor includes width of proposed Inland Waterways).
b. Cross-section sounding lines / leveling are to be run from bank to bank at spacing specified in above table, to identify the navigable channel.
c. Continuous soundings are to be taken by running the sounding boat at constant speed on the cross-section so as to get smooth contours. Intermediate line is to be run at bends, if the line spacing is more than the specified above.
d. For cross-sectional bathymetric survey more than 60m in proposed Inland Waterways, spot levels at line spacing x 20m length grid, on both banks should be taken. If Island or sandchur exist in the middle of the waterway, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
e. If bathymetry cross-section is limited up to 60 mts width in waterway, then Consultant has to cover 100m corridor including spot levels in line spacing x 20m length grid on both banks.
f. If bathymetry cross-sectional is limited up to 20 mts width in waterway, then Consultant has to run three (03) nos. longitudinal lines. One in centre and one each at equal interval (near the edges of water).
g. If bathymetry cross-sectional is limited up to 10 mts width in waterway, then Consultant has to run one (01) no. longitudinal line at centre only.
h. If Island or sandchur exist in the middle of the river, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
i. Surveys in non-approachable areas are to be informed by the Consultant and joint inspection (Consultant's representative & Engineer-In-Charge or his representative) will be held to confirm the non-approachable areas.
j. The survey area may consist of canal sections, rivers, sea openings of different dimensions. Hence, Consultant has to inspect the area to be surveyed and satisfy themselves with respect to site conditions before submission of bid. However, variation in quantity will be considered only for length of the river/canal (longitudinal length).
k. The soundings are to be reduced to the chart datum/ sounding datum established at every gauge stations.

2.1.4 CURRENT VELOCITY AND DISCHARGE MEASUREMENT

a. The current velocity and discharge at every 10 km interval shall be observed once in a day during the survey period. Current velocity and discharge at every 10 km interval are to be measured only once at different depths while carrying out survey in that region.
b. Current meter measurement should be taken at 1m below water surface or 0.5d (if depth is less than 1m), where d is measured depth of water & values indicated in the report along with position.
c. Measurements at different depths may be taken by single equipment over three different time spans.
d. Measurement of current velocity at different depth is to be measured for at least 15

minutes or as per listed calibration period of the equipment, under use for this project.

e. Current velocity and discharge can also be measured with the help of ADCP during survey, at every 10km interval. Discharge can be measured either by ADCP or standard formulas.

1.2.1.5 WATER AND BOTTOM SAMPLES

a. Water and bottom samples are to be collected from the deepest route at every 10 km interval and are to be tested and the results/characteristics of the soil and the water are to be incorporated in the report. Soil sample can be collected by a grab and water sample at 0.5d (d-measured depth of water) by any approved systems. The following tests are to be carried out for Bottom samples:-

i) Grain size distribution
ii) Specific gravity,
iii) PH value
iv) Cu, Cc
v) Clay silt%
and Sediment concentration for Water Samples.

1.2.1.5 COLLECTION OF TOPOGRAPHICAL FEATURES

a. Photographs of the prominent features are to be taken and included in the report along with its position.
b. Permanent structures located within this corridor are also required to be indicated on the report & charts.
c. All prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) and other conspicuous objects are to be fixed and indicated on the chart and included in the report.
d. Identify cross structures which are obstructing navigation.
e. Details (horizontal and vertical clearances above High Flood Level in non-tidal area and High Tide Level in tidal area) of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location.
f. Details of water intake/ structures are to be collected and shown on the charts and include in the report.
g. Availability of berthing place, existing jetty, ferry ghats, approach roads etc. are to be indicated on the charts and include in the report.
h. During the survey, conditions of the banks are also required to be collected. It is to be noted that banks are pitched (protected) or not protected. Estimate the length of bank protection, where banks erosion is taking place.
i. Positions and levels of corners of permanent structures within the corridor are to be physically surveyed and marked on survey charts.
j. Approachable roads / rails / places outside the corridor may be incorporated from Toposheets/Google Map/Google Earth.

1.2.1.6 SURVEY CHART PREPARATION

a. The survey chart is to be prepared on a scale of 1:1,000 for Waterways width less than 100m. On a scale of 1:2,000 for Waterways width between 100m to 300m. On a scale

of 1:5,000 for Waterways width between 300m to 500m and On a scale of 1:10,000 for Waterways width more than 500m.

b. Contours of 0m, 1m, 2m, 3 m, 5m and 10 m are to be indicated on the charts with respect to Chart Datum / Sounding Datum.
c. Reduced spot levels w.r.to MSL to be indicted on the charts. Spot level values are to be given w.r.t. Mean Sea Level (MSL) & Soundings w.r.t. Chart Datum / Sounding Datum. A separate file (xyz) (soft copy only) is also to be created for spot levels w.r.t. Chart Datum / Sounding Datum for dredging calculation purpose.
d. On completion of the cross-sections, dredge channel is to be identified/ established by linking deepest soundings on the cross-sections. Dredging quantity is to be estimated for developing a navigational channel of
   i. dimension of 32m x 1.8m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is less than or equal to 100m).
   ii. dimension of 45m x 2.0m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is more than 100m).
e. Dredging quantity is to be indicated in the report for per km length of the waterway.
f. Minimum & maximum reduced depth and length of shoal for per km length of the waterway is also to be indicated in the report.
g. Current meter measurement values shall be indicated in the report along with position.
h. The results/characteristics of the soil and the water are to be incorporated in the report.
i. Shallow patches /shoal and submerged sand-chur having less than 1.0 m depth, rocky outcrops, rapids and other navigational impediments are to be indicated on the charts.
j. A brief write up on condition of the locks, Sluice gates, Barrages, Dams etc. (if available) are also to be included in the report. Brief write up based on visual observation, photographs and information from State Irrigation Deptt. and local sources.
k. The chart shall also be suitably updated with prominent land features from the Topo-sheets/site. Available Survey of India (SOI) Topographic sheet will be shared with successful Consultant on receipt of Undertaking. Satellite imageries are not available with IWAI for the designated area. Route map and survey plan will be provided by IWAI to the successful Consultant.
l. All raw data and processed data of Automatic Hydrographic Survey System are required to be submitted. Standard procedure is to be adopted for data processing. All RAW, EDIT, SORT and field data are required to be submitted by the Contractor.
m. All surveyed field data including leveling data (csv file) are required to be submitted.
n. All position data of ground features, waterway structures are to be submitted in both hard copies and soft copies.

1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY

This is a detailed study to make a forecast of the traffic prospects to facilitate the projection of the most promising route for waterway transport and to assess the quantum of traffic of vessels/cargo on that route. This survey is to be under-taken in conjunction with Reconnaissance and Hydrographic surveys so that the Techno Economic feasibility and costs of the alternative proposals can be taken into account while formulating the recommendations.

Modality of conducting traffic survey shall be based on industrial surveys and a traffic projection for a horizon period (say 5, 10, 15 and 20 years) has to be forecasted based

on standard methods. Divertible traffic to IWT is also to be assessed.

1.2.3 DETAILED PROJECT REPORT

The scope of works is as follows:

a. Assessment of the morphological, hydrological, hydrographical conditions, and operation and maintenance requirements of the proposed waterways to identify works in sufficient details that are required in respect of:
   - River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation.
   - Navigational aids and communication facilities.
   - Improvements with reference to horizontal and vertical clearances required on the existing or proposed cross structures such as bridges, power cables, locks etc.

b. Geo-tech investigation will be carried out by the consultant as per standard guidelines of Geological Survey of India, Government of India.

c. To conduct necessary investigations for the preliminary design, to ensure a coordinated development to cover waterways engineering works and structures, waterway crossing, navigational structures, riverine ports and terminals, land and rail access.

d. Prepare preliminary engineering designs, drawings and estimates for the optimum structure of river training and bank protection measures and navigational aids to develop and maintain a navigable channel for the waterway system in an EPC mode.

e. For preliminary engineering designs, the data about soil characteristics shall be collected from the local sources based on the structures constructed nearby. In case of critical structures, consultant can suggest that detailed soil investigation including borehole tests etc.

f. River training/bank protection works particularly for those stretches where either the channel is narrow and needs to be widened by dredging or where it is anticipated that the bank can erode due to continuous movement of barges.

g. Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.

h. Prepare a realistic construction schedule for the whole project indicating the priority of different components of the project. The phasing of expenditure is also to be worked. Also suggest phased programs of construction including riverine terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities.

i. Prepare cost estimate for various possible alternatives for the entire proposed infrastructure, handling, and other allied facilities. While comparing the different alternatives, the cost and economy factors shall also be evaluated. The most suitable alternative recommended shall have detailed costing for all the components of the project. The Consultant is to propose the River conservancy including river training,

bank protection, dredging etc. needed for shipping and navigation. Alternate possible methods for water augmentation are also to be suggested in detail. FIRR, EIRR, NPV and SWOT analysis are also to be carried out by the Consultant.

j. Assess the environmental impacts due to these development works and suggest suitable environmental management plan (EMP) to mitigate the adverse impacts, if any, including its cost. Flood Plain specialist will be responsible to assess the Environmental Impact and preparation of EMP. Consultant has to identify the Authorities who will give the clearances for EIA/EMP. Consultant will not be required to take clearances from these identified Authorities.

k. Suggest horizontal and vertical clearances to be provided on cross structure such as bridges, power cables, locks etc. for commercial viable navigation in present as well as in future. For this, IWAI guidelines Section-IV, may also be referred to.

B Land Ownership Certificates

B.1 Land ownership certificate for proposed terminal location: Ghagar

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER:: NORTH LAKHIMPUR REVENUE CIRCLE:: LAKHIMPUR

No.NLC.2/94-09/ 204 Dtd. N.L. the 22/02/2019

TO WHOM IT MAY CONCERN

This is to certify that the land as shown and requested by the consultant, DHI (India)Water & Environment Pvt. Ltd., is a Govt. land located in Dag No. 32 of 4 No. Hindu Village under Lakhimpur Mouza under North Lakhimpur Revenue Circle.

This Certificate is issued to the applicant Sri Debashish Goswami, Ph.D., Senior Water Resources Engineer DHI, India after perusal of the report of concerned Lot Mondol.

Signature of L.M. 22/2/19

Signature of S.K.

Circle Officer
North Lakhimpur Rev. Circle

Circle Officer
North Lakhimpur Revenue Circle
Lakhimpur, Assam

B.2 Land ownership certificate for proposed terminal location: Gunasuti

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER:: NORTH LAKHIMPUR REVENUE CIRCLE:: LAKHIMPUR

No.NLC.2/94-09/ 201 Dtd, N.L. the 22/02/2019

TO WHOM IT MAY CONCERN

This is to certify that the land as shown and requested by the consultant, DHI (India) water & Environment Pvt. Ltd., is a Govt. land located in Palashpara NC Village under Lakhimpur Mouza under North Lakhimpur Revenue Circle.

This Certificate is issued to the applicant Sri Debashish Goswami, Ph.D., Senior Water Resources Engineer DHI, India after perusal of the report of concerned Lot Mondol.

Signature of L.M.
22/2/19

Signature of S.K.

Circle Officer
North Lakhimpur Rev. Circle

Circle Officer
North Lakhimpur Revenue Circle

B.3 Land ownership certificate for proposed terminal location: Khabuli

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER:: NORTH LAKHIMPUR REVENUE CIRCLE:: LAKHIMPUR

No:NLC.2/94-09/ 202 Dtd. N.L. the 22.1.02 /2019

TO WHOM IT MAY CONCERN

This is to certify that the land as shown and requested by the consultant, DHI (India) water & Environment Pvt. Ltd., is a Govt. land located in Alisinga Village under Telahi Mouza under North Lakhimpur Revenue Circle.

This Certificate is issued to the applicant Sri Debashish Goswami, Ph.D., Senior Water Resources Engineer DHI, India after perusal of the report of concerned Lot Mondol.

Signature of L.M. Signature of S.K.

Circle Officer
North Lakhimpur Rev. Circle

Circle Officer
North Lakhimpur Revenue Circle
Lakhimpur, Assam

B.4 Land ownership certificate for proposed terminal location: Luit Khabuli

GOVT. OF ASSAM
OFFICE OF THE CIRCLE OFFICER:: NORTH LAKHIMPUR REVENUE CIRCLE:: LAKHIMPUR

No.NLC.2/94-09/ 203 Dtd. N.L. the 22/02/2019

TO WHOM IT MAY CONCERN

This is to certify that the land as shown and requested by the consultant, DHI (India) water & Environment Pvt. Ltd., is a Govt. land located in Hastinapur N.C. Village under Telahi Mouza under North Lakhimpur Revenue Circle.

This Certificate is issued to the applicant Sri Debashish Goswami, Ph.D., Senior Water Resources Engineer DHI, India after perusal of the report of concerned Lot Mondol.

Signature of L.M. Signature of S.K.

Circle Officer
North Lakhimpur Rev. Circle

Circle Officer
North Lakhimpur Revenue Circle
Lakhimpur, Assam

B.5 Land ownership certificate for proposed terminal location: Dhonaguri

GOVT. OF ASSAM
OFFICE OF THE CIRCLE OFFICER :: BIHPURIA REVENUE CIRCLE
BIHPURIA

No. BC.102/2016/115 Date: 22-02-2019

TO WHOM IT MAY CONCERN

This is to certify that a plot of land measuring 1Bigha 2 Katha 14 Lessa as showr by the representative of DHI(India) water & Environment Pvt Ltd to the Land Revenue staf of Bihpuria Revenue Circle is covered by Dag. No. 408 of Dhunabari map under Bihpuria Mouza which is Govt. Khas land and the classification of land is Bari class as per land records and as per report submitted by concerned LR staff.

22/2/19

Circle Officer
Bihpuria Revenue Circle
Bihpuria.

Circle Officer
Bihpuria Rev. Circle
Bihpuria

B.6 Land ownership certificate for proposed terminal location: Selek

GOVT. OF ASSAM

OFFICE OF THE CIRCLE OFFICER :: NARAYANPUR REVENUE CIRCLE

NO.NC.53/Pt – I /2018-19/106 DATE: 22/02/2019

TO WHOME IT MAY CONCERN

This is to certify that Chelek village under Dhalpur mouza is a Non Cadestral village , having 126 Bigha 3 Katha 12 Lessas of Annual Patta Land which has been erored by the Brahmaputra and Sobansiri River and Rest of the village is Non Cadestral village .

Circle Officer
Circle Office
Narayanpur Rev. Circle
Narayanpur Revenue Circle

C 2D Hydrodynamic Modelling

C.1 Hydrology and morphology study of the river

C.1.1 Hydrology

Data Available

Monthly maximum and minimum discharge and water level data from 2006-2015 are available.

Analysis of minimum and maximum discharge and water level

C.1.2 Discharge (Q)

In order to study the available depth throughout the year along the river stretch considered (Subansiri chainage 0 km to 106.5 km), flow data and observed water level data is required for minimum of 10 to 15 years. Within the limit of data availability and access, the statistical analysis and probability of exceedance of both water level and discharge are carried out at the station Chouldhwoghat and results have been used to simulate hydrodynamic model for a stretch of 25 km. From the available minimum and maximum discharge and water level on monthly basis for the year of 2006-2015, the probability of exceedance flow is extracted.

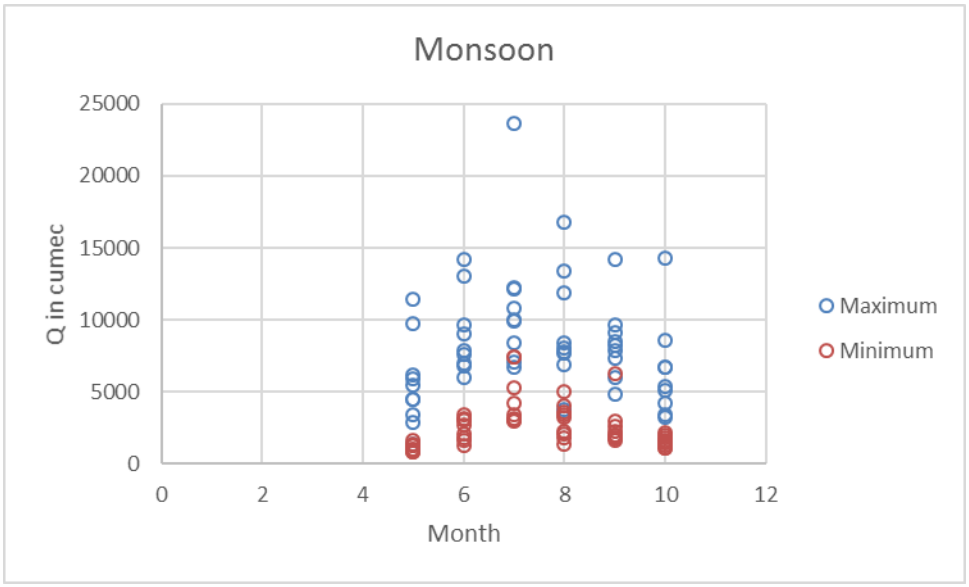


Figure a 1 Maximum and minimum flow on monthly basis during monsoon (May to Oct)

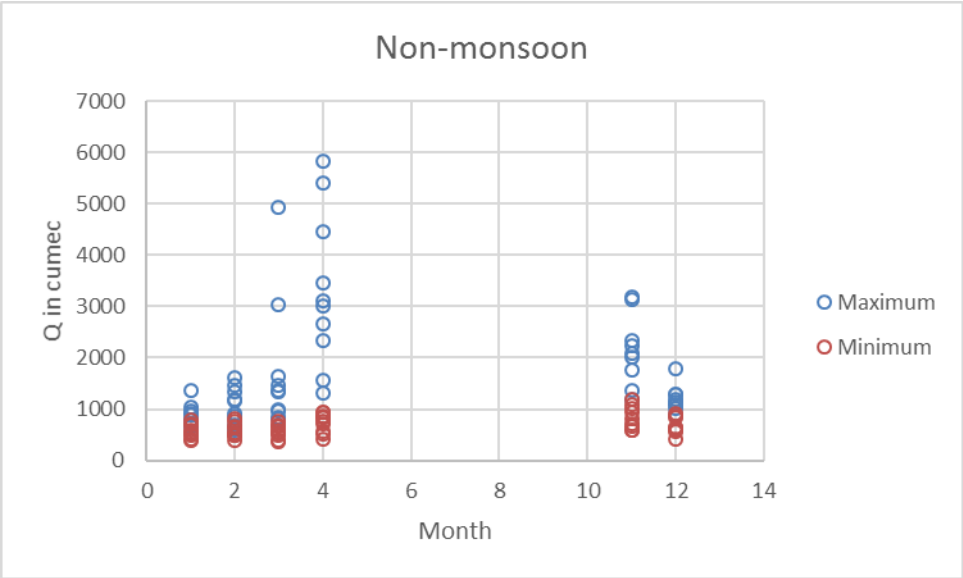


Figure a 2 Maximum and minimum flow on monthly basis during non-monsoon (Nov to April)

Table a 1 Flow at 50%, 75% & 90% exceedance probability at Chouldhwoghat

Period	Q at 50% exceedance probability m3/s	Q at 75% exceedance probability m3/s	Q at 100% exceedance probability m3/s
Monsoon	4050	1939	775
Non-monsoon	2336	1100	410

At Chouldhwoghat 50% probability of exceedance is estimated as 4050 m3/s which can be considered as a predominant normal discharge passes through the river stretch considered for every years during monsoon period but during non-monsoon 50% probability of exceedance is only 2336 m3/s.

Design discharge

In order to find out the design discharge for different years, flood frequency analysis is carried out which further used for simulating the hydrodynamic model. The flood frequency analysis have been carried out for inflow at Chouldhwoghat station using Gumbel's extreme value distribution. Peak flood discharge data for a period of last 10 years at Chouldhwoghat gauging site is used for obtaining the flood frequency analysis for a return period of 5,10,25,50,100 years respectively and presented in **Error! Reference source not found.**.

Table a 2 Frequency analysis for annual peak discharge series at Chouldhwoghat

Return Period(T)	**Flood flow (m3/s)**
25	19674
50	21802
100	23914

C.2 Waterlevel (WL)

The water level at Chouldhwoghat is also analyzed and found that the water level variation follows the discharge pattern. So it can be concluded that the observed water level data is consistent with respect to the flow.

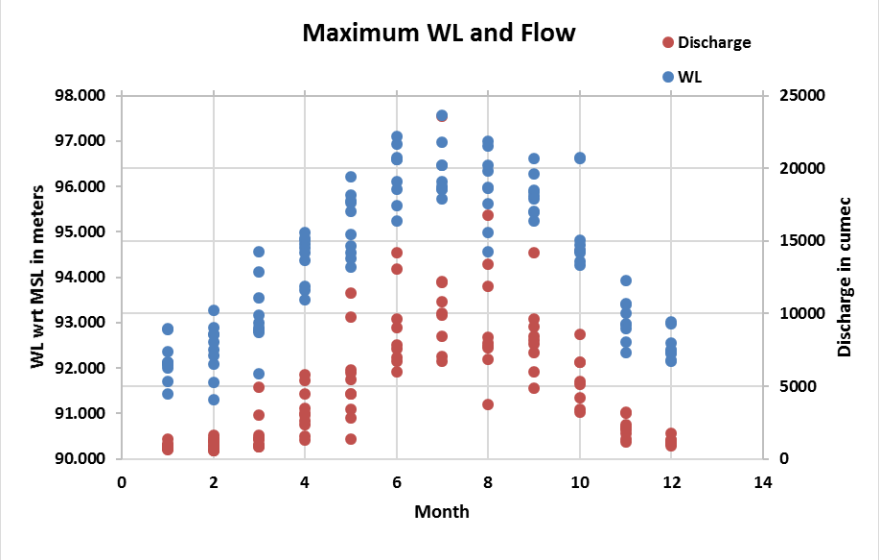


Figure a 3 Maximum water level data with respect to flow observed

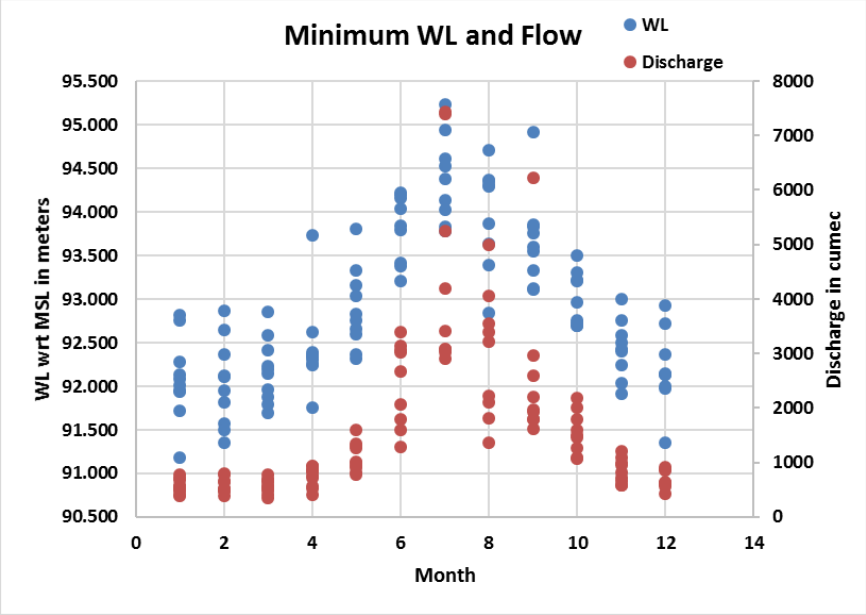


Figure a 4 Minimum water level data with respect to flow observed

C.3 Hydrodynamic model

In the present study 2D hydrodynamic models using MIKE 21 C have been prepared for two different conditions in order to understand the availability of water throughout the river stretch considered as a sample study as well as the velocity distribution along the river and in and around the islands present in the river. The main objective of the study is to find out the hydrodynamic parameters near the ghats in the first phase of the DPR. There are mainly three ghats which are

functioning for cross navigation in the river stretch considered. Out of three, Dhonaguri ghat location is the most promising location for further development of IWAI terminal location. Therefore model stretch is taken from the 9km upstream and 14km downstream of Dhonaguri ghat. The same is shown in **Error! Reference source not found.**.

Figure a 5 Map showing model domain selected for hydrodynamic study

C.3.1 Model set-up

Two dimensional hydrodynamic model is developed using DHI's propriety software MIKE21C.

Stretch Covered: 23 km

Domain: 9km upstream and 14km downstream of Dhonaguri ghat.

Boundary condition: Outflow from Chouldhwaghat and HFL at Bhimpara for design flood and 100 % probability of exceedance flow during non-monsoon and Q-H relation at the downstream cross-section for lean flow

Initial condition: 2016 surveyed bed level

Roughness coefficient: Chezy's constant with reference to Brahmaputra River from DHI's another project Assam Integrated Flood and Riverbank Erosion Risk Management Investment Program which is calibrated and validated value.

Grid: No of grids=**500,** ds (grid length along the river) = 450 m approx...

dn (grid length normal to the flow) = 150 m approx...

Simulation time: Steady state for different discharge

C.3.2 Model Bathymetry

The generated bathymetry of the 2D model is shown in **Error! Reference source not found.** . T he bathymetry was made from the survey data and has generated hydraulic and morphological design parameters, which are essential for planning and design of river training works, such as revetment work, groynes, dykes, dredging for navigation etc.

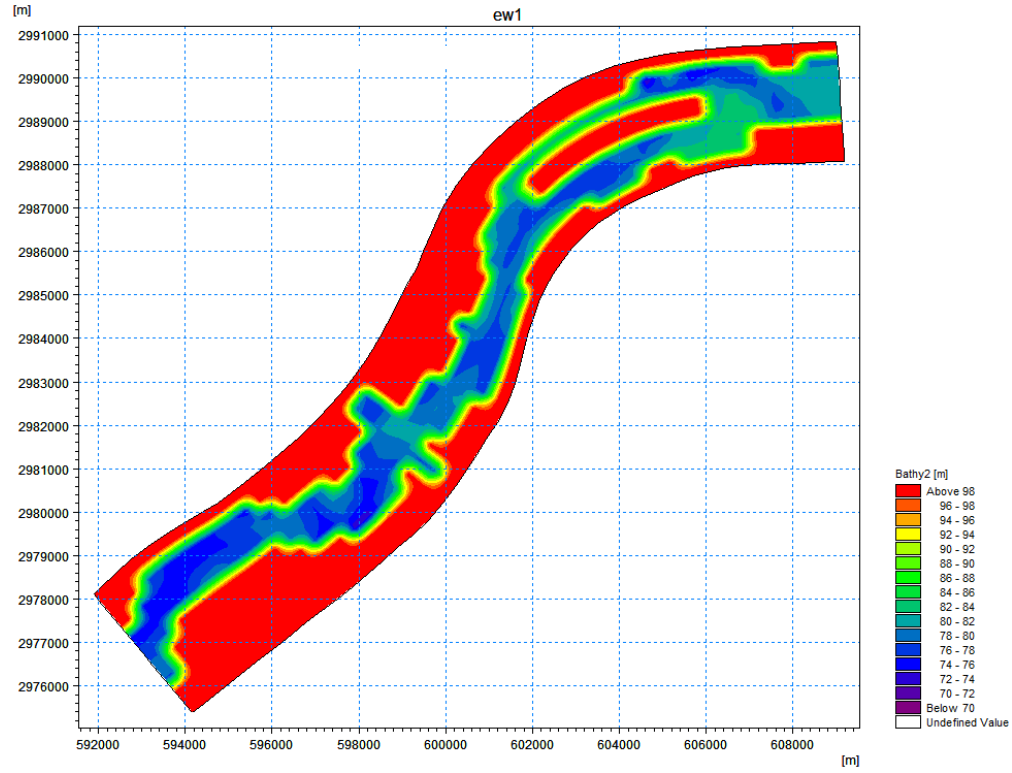


Figure a 6 Bathymetry of the model area

C.3.3 Hydrological conditions

Discharge and water level has been applied as hydrological boundaries to the 2D model simulation

The model has simulated for two conditions

1. Design discharge -100 year design discharge at Chouldhwoghat 23914 m3/s as the upstream boundary and HFL 83.33 MSL at Bhimpara (reference to DHI's Hydrographic Survey report) as downstream boundary condition

2. Low flow conditions for lean period at 100% exceedance probability 410 m^3/s and rating curve relation at the particular cross-section downstream.

Bed resistance

Chezy's constant C is taken 55- 60 for deep channel, 40-45 to more average depth channel, and 25-30 for shallow islands from Brahmaputra modelling studies done by DHI for another project, since any continuous observed data for long [period is not available for the calibration of model.

C.3.4 Hydrodynamic results

The models are not exactly representing the actual field condition since the input data is not the actual observed data and also these are not calibrated models. So it gives the general guide lines and suggestions that can be adapted for the development of navigational channel as references.

Case 1

Q=23914 m3/s HFL = 83.33 at Bhimapara.

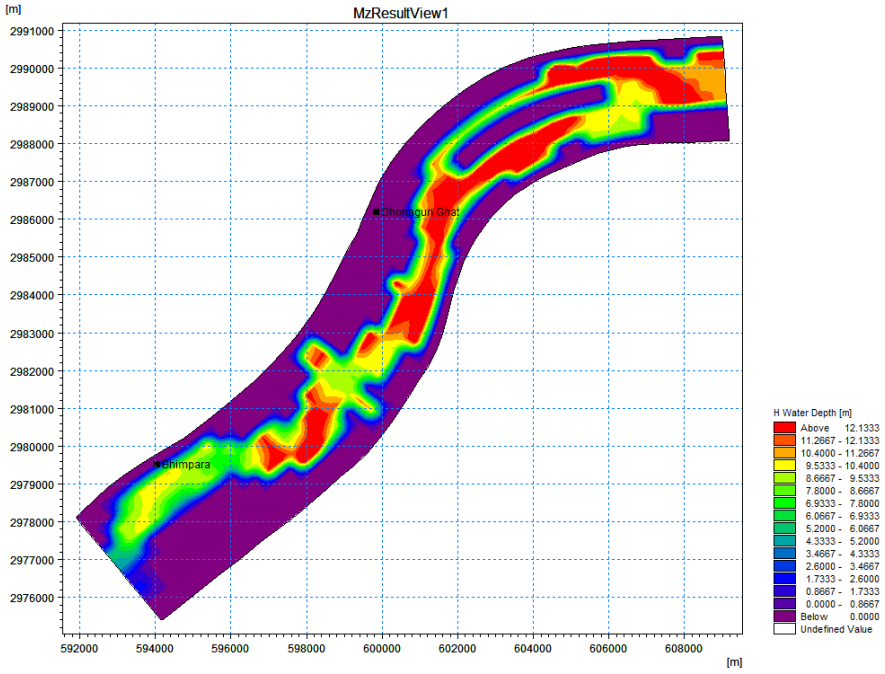


Figure a 7 Water depth corresponding to 100 years flood and HFL

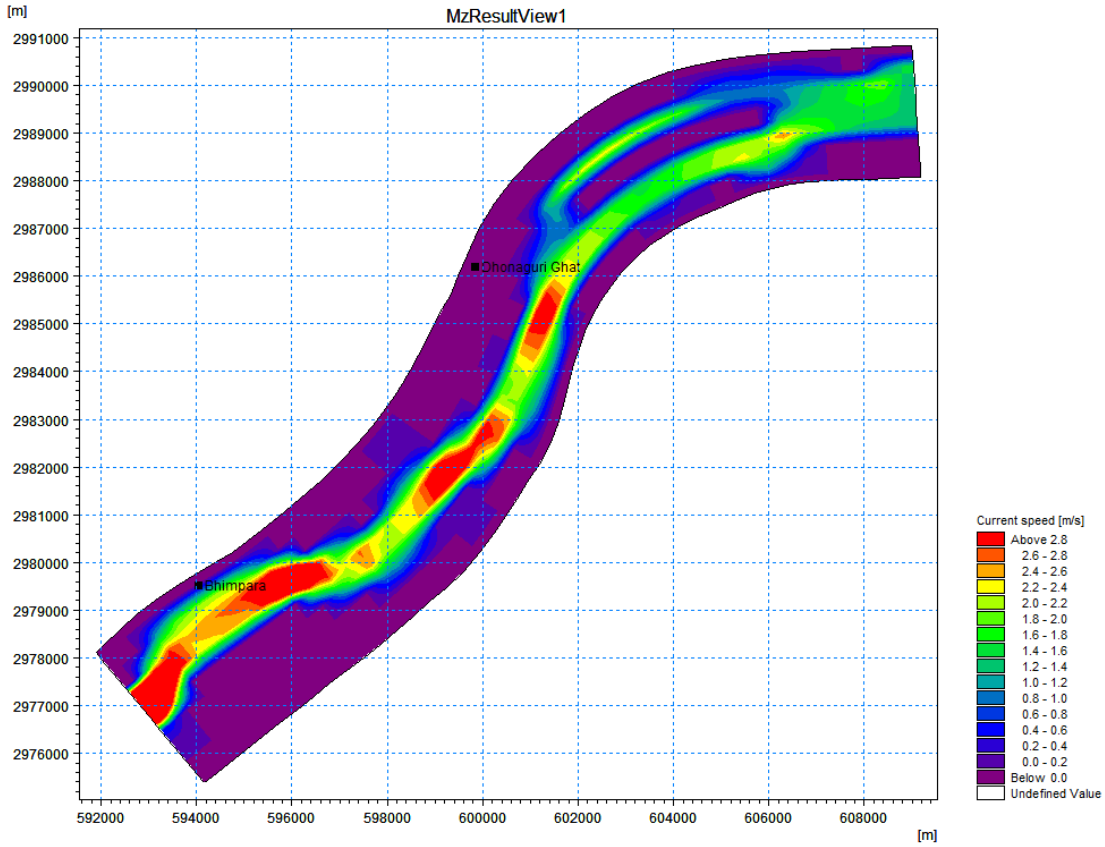


Figure a 8 Velocity profile with respect to 100 year design discharge

This is the velocity profile with respect to 100 year return period flood that can cause the erosion along the bed and river bank. It can be used for bank erosion analysis.

Case 2

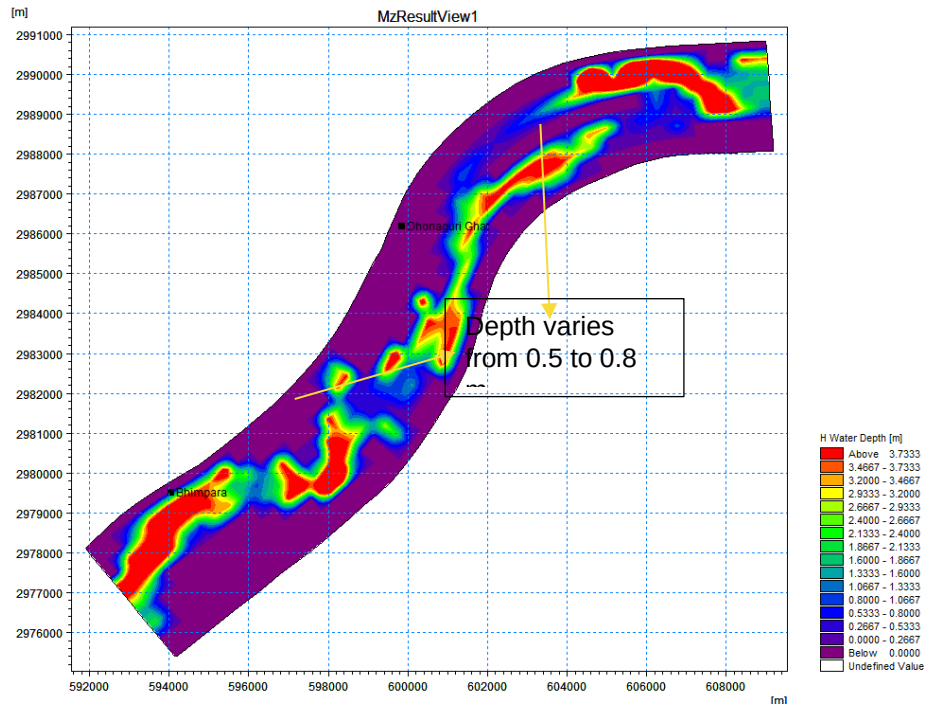


Figure a 9 Water depth corresponding to 100 percentage probability of exceedance during lean period

From **Error! Reference source not found.** it is clear that water depth is not less than 0.5 m even i n lean period. It generally varies from 1.8 to 5 m near the ghat region. The river stretch is also marked where depth varies from 0.5 to 0.8. These locations are to be validated with the observed flow condition during non- monsoon flow. The main reason behind the low depth is due to the presence of islands which are formed due to sand bars over the years. The water depth can be increased by dredging or introducing river training works such as spurs or which will prevent the sedimentation at the particular location. The efficacy of these training works has to be modelled and verified. Only hydrodynamic model will not give any location based on sedimentation or erosion. Hydrodynamic model should be coupled with sediment flow also. This sedimentation model gives the location based scenarios which would further assist in dredging by giving the updated bed profile over the time periods.

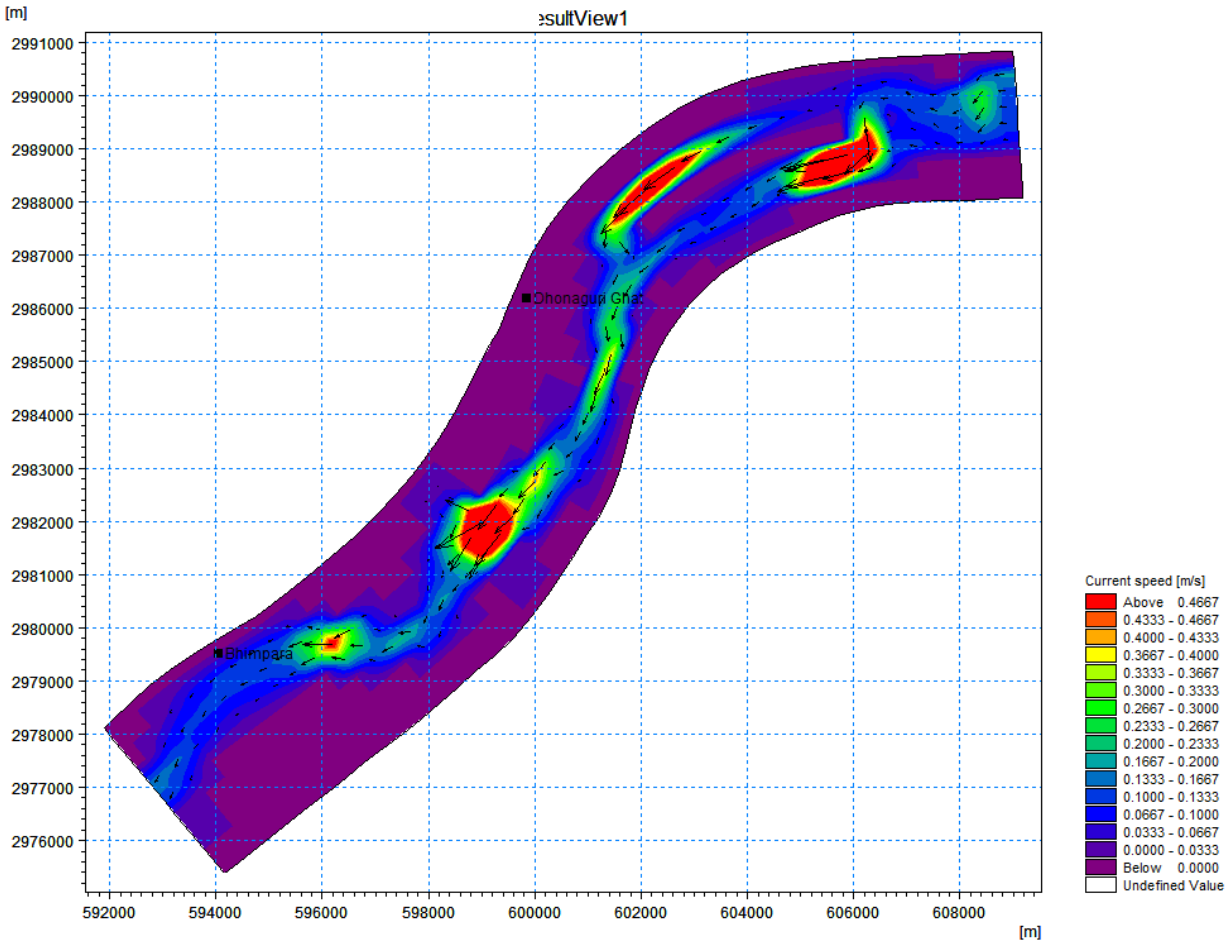


Figure a 10 Velocity profile corresponding to 100 percentage probability of exceedance during lean period

The velocity is in the range of 0.1 m/s to 1 m/s. There are certain locations within the channel with high velocity values which may cause erosion and very low velocity cause sedimentation. The detailed morphological analysis is required using sedimentation model in order to see the erosion or sedimentation pattern in and along the river stretch.

C.3.5 Morphology

Subansiri is one of the tributaries of Brahmaputra. Bristow (1987) identified three scales of channels within the braided river. The first order channel encompasses the whole river and has a variable number of second order channels within it. Each second order channel is itself a large alluvial stream termed an anabranch, and within the second order channels the flow divides and re-joins again to form third order channels. Bristow (1987) showed that first order channels migrate at a rate of 70 m per year; second order channels of width of 5 km migrate at a rate of about 1000 m/year. Migration of third order channel is very erratic and depends on local flow conditions. Therefore the migration of the braided channels has significant influence on the planning and design of any river training works in an affected area which is particularly downstream of another more morphologically active reach.

Braid bars are highly unstable. Their size, shape and position change radically both seasonally and annually (Coleman 1969; Bristow 1987), but the islands are relatively stable; islands are formed by the amalgamation of clusters of braid bars which build up to the surrounding flood plain level. Consequently, some reaches of the river can be classified as anastomosed rather than braided (Bristow 1987). The pattern of anabranches changes through time by lateral shifting of anabranches and through switching of flows between anabranches that drives rapid modifications of channel size and geometry. Therefore, morphologically the river is known to be highly active at all scales.

Large scale bedforms (bars and islands) and micro-scale bedforms (ripples and dunes) are probably the most important river bed features inducing resistance to flow, and thus influences bed shear stress. Braid bars, dunes and ripples are present in abundance in the river. Dunes are the main driver of bedload transport, and responsible for the formation local bed morphology, and initiation of bedforms. The bedload transport in the river may be in the tune of 20 to 30% of total transport (coarse fraction). Determining velocity field and shear stress is truly complex in a braided river. Roughness to flow in moveable/dynamic river bed is mainly induced from skin friction due to grain size, and form friction due to bed-forms. They together form the frictional forces in the elementary flow equation for conservation of momentum. These bed-forms can contribute up to 75% of total channel roughness (Fenton and Abbott, 1977; Powel and Ashworth, 1995; Hey, 1988). Therefore, inclusion of the effect of bed-forms and determining velocity and shear field for unsteady flow condition is only feasible (possible) in a two-dimensional numerical model.

MIK21C modelling technology (DHI 2012), a two-dimensional modelling tool, employs a simplified Chezy model (Eq.1), which can calculate bed friction at temporal and spatial scale to take into account the growth, decay ad movement of bed-forms, particularly large scale bars. This model has been successfully applied in the Brahmaputra (Bangladesh) in many projects. The frictional forces in this model can be determined from calibration of hydraulic models (Abbott, 2002) through trials and then comparing results with observed data and then the flow field, and the erosion/deposition processes in braided river can be quantified.

$C = C_o h^n$ Equation 1

Where C_0 is the coefficient matrix, which can spatially vary over the model domain, h is the dynamic value of depth which varies temporally and spatially as flooding/drying of bedforms continues, and erosion/deposition develops in channels and over bars; n is the calibration parameter; both C_0 and n can be a two dimensional matrix, and can be obtained through calibration of model. MIKE 21C is the only modelling technology capable to account for the flow friction due to the dynamic growth of bars and bedforms in braided river.

The local sediment transport is the key mechanism that controls the development of different types of scour. Therefore, for any planning and design of river training works, prediction of sediment

transport must be carried out. Four principal types of channel scour related to planform characteristics can be distinguished in the river

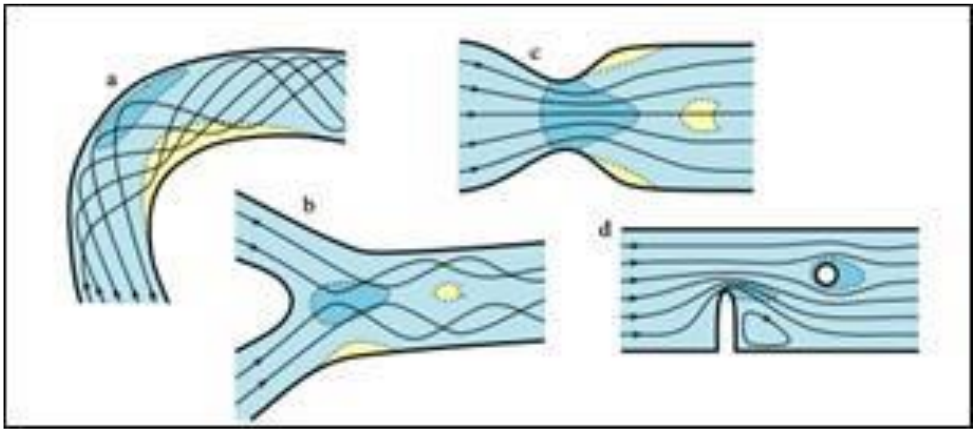


Figure a 11 Schematic figure of principal types of scour commonly available in Brahmaputra

(Source: Jagers B 2003)

a) **Bend scour**: secondary flow generated in channel bends induces a net sediment transport towards the inner bend resulting accumulation of sediment at inner bend, thus extending the point bar (Van Bendegom, 1947) and forming scour holes at outer bend. In Brahmaputra, bed scour have been recorded up to 35 m; 5-6 m of scour developing within a day. This scour initiates bank erosion at the outer bend. Similar extent or even deeper scour holes can develop at the toe where the channel bank is protected.

b) **Confluence scour**: two (or more) channels joining together initiates the formation of this scour hole. The sediment eroded from the scour hole at a symmetric confluence is often deposited in the middle of the channel immediately downstream of the confluence. This may form the initial disturbance from which a new island (or bar) and a new scour hole may form, possibly leading to the onset of braiding. Channels joining at different angles (more skewed) can reorientate the formation of the hole; bank; presence of such confluence scour can turn into bend scour (due to angle of channels joining) leading to bank erosion. Confluence scour in the Brahmaputra can be up to 3 times than general scour depth in the channel (FAP24, 196; Ashmore and Parker, 1983).

c) **Constriction and d) obstruction scour**: constriction of channel size due to human intervention (bridge or long protruding groyne) or natural constriction will lead to develop constriction scour. Obstruction scour is closely related to constriction scour. This occurs when flow encounters a fixed non-erodible point, such as a groyne. This type of scour is sometimes sub-divided further into: protrusion scour (at the upstream edge) and local scour (at the downstream edge). Obstruction scour is in general more localised scour than constriction scour. Up to 20m of constriction scour have been reported in the Brahmaputra. Groynes are flow attacking structures and increase local velocities by many fold, and initiates development of local scour. Flow friendly structures like revetments can also enhance scour development due to the ceasing of lateral supply of sediment to the river from bank erosion. Deeper scour holes in turn can attract flow, and can lead to changes in channel planform.

The development and movement of these scour holes have significant influence on the total sediment transports in the river.

C.3.6 Critical Velocity for Erosion, Deposition and Transportation

Rivers are seldom straight. Depending on discharge, bed slope and sediments, some stretches are meandering with alternate bends while some stretches are braided with main and branches within the same flood plain. Usually a river is found to erode the outer bank and sediments get deposited on inner bank. In brained channels, however, rivers erode both bed and banks at high stage and the eroded materials are deposited on the bed or banks during low stage producing a number of channels within the flood plain with bed bars, dunes, anti -dunes etc.

The sediment transporting capacity of a flow is highly sensitive to the velocity. Higher the velocity, higher rate of erosion and transportation of sediment. Therefore, the dampening of velocity results in deposition of coarser particles in the downstream direction.

C.3.7 The Hjulström curve

The critical velocity for erosion or deposition depends on particle size. The Hjulström curve, named after Filip Hjulström (1902–1982), is a graph between critical velocity and particle size for different morphological phenomena I e, erosion, deposition and transportation. This graph is widely used by hydrologist/ morphologist and geologists to determine which stretch of a river will have erosion, deposition or transportation of sediment for a given discharge and river bed material. The upper curve shows the critical erosion velocity in cm/s as a function of particle size in mm, while the lower curve shows the deposition velocity as a function of particle size. It is important to note that the curve is suggested for water depth in the range 1 m. In the present case, the river is wide and shallow near embankment. The curve could be satisfactorily used as a guideline to understand the velocity vs erodibility.

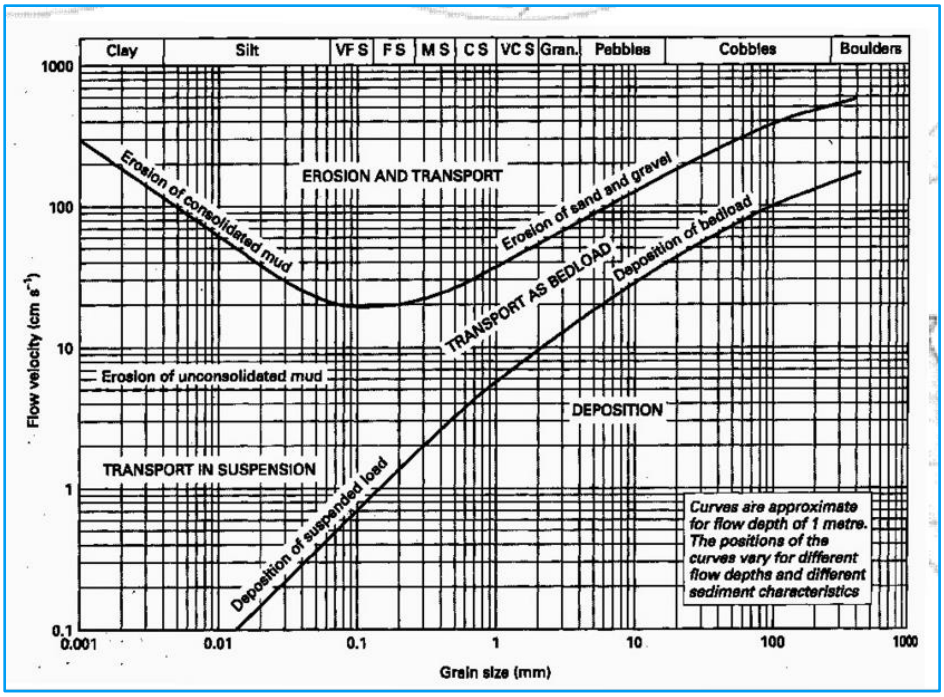


Figure a 12 Hjulstorm curve for critical velocity with respect to grain size

The plot shows several key concepts about the relationships between erosion, transportation, and deposition. For particle sizes where friction is the dominating force preventing erosion, the curves follow each other closely and the required velocity increases with particle size. However, for cohesive particle (very fine particle), mostly silt and clay , the erosion velocity increases with decreasing particle size, as the cohesive forces are relatively more important when the particles get smaller. The critical velocity for deposition, on the other hand, depends on the fall velocity and that decreases with decreasing grainsize.

C.3.8 River bed particle size

The river bed material is sand of size varying from 0.1mm to 0.3 mm. Therefore, from The Hjulström curve, the critical velocity for erosion of particle from 0.1mm -0.3mm, is found to be 0.2 m/s above which it will erode bank or river bed material and sedimentation or deposition will take place below

0.015 m/s. The actual velocity profile generated corresponding to low flow Q= 410 m3/s are mapped in the following figures. Both pre and post spur conditions were compared.

Pre-structure scenario

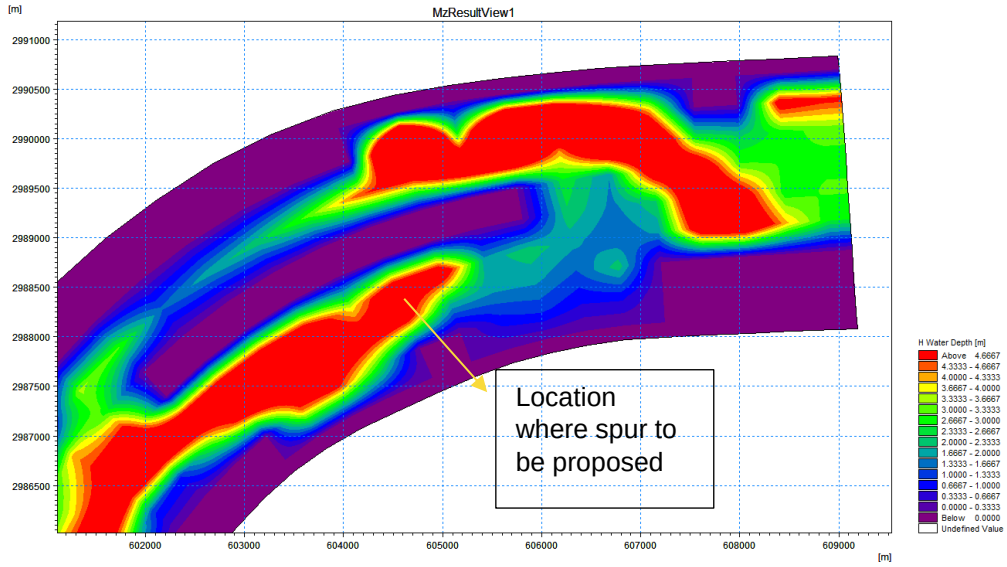


Figure a 13 water depth corresponding to low flow during lean period without spur

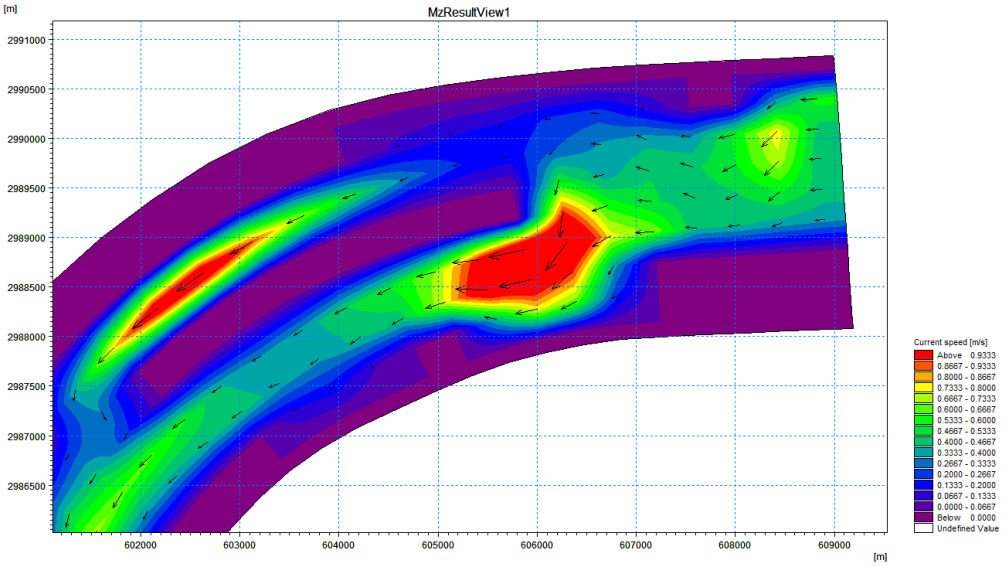


Figure a 14 Velocity corresponding to low flow during lean period without spur

Post-structure scenario

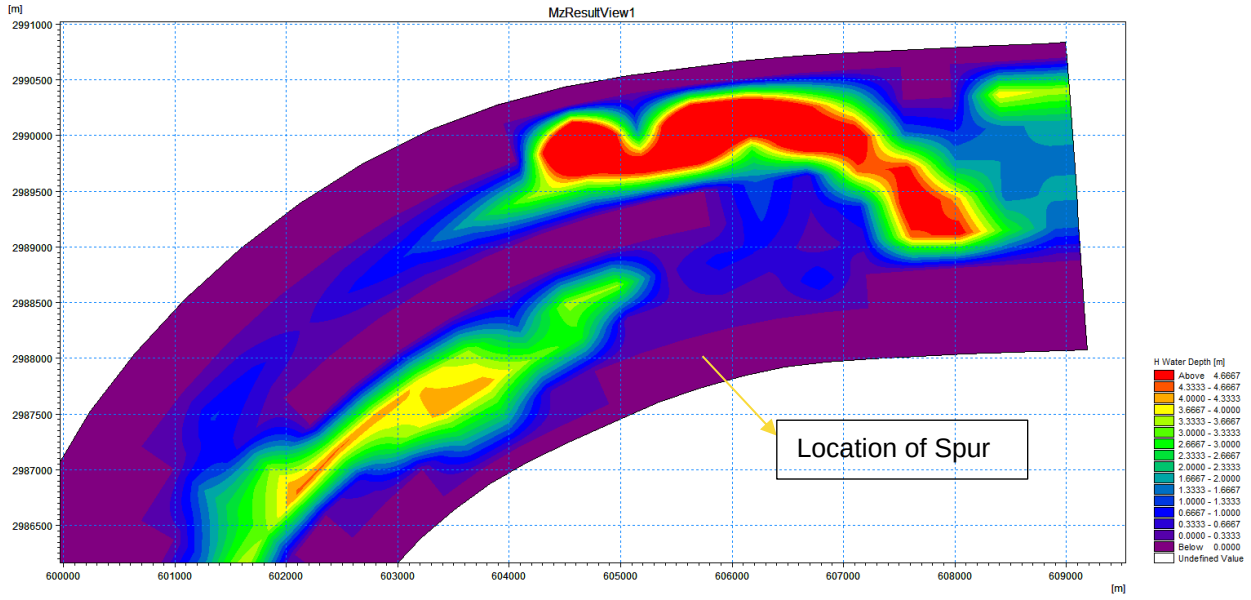


Figure a 15 water depth corresponding to low flow during lean period with spur

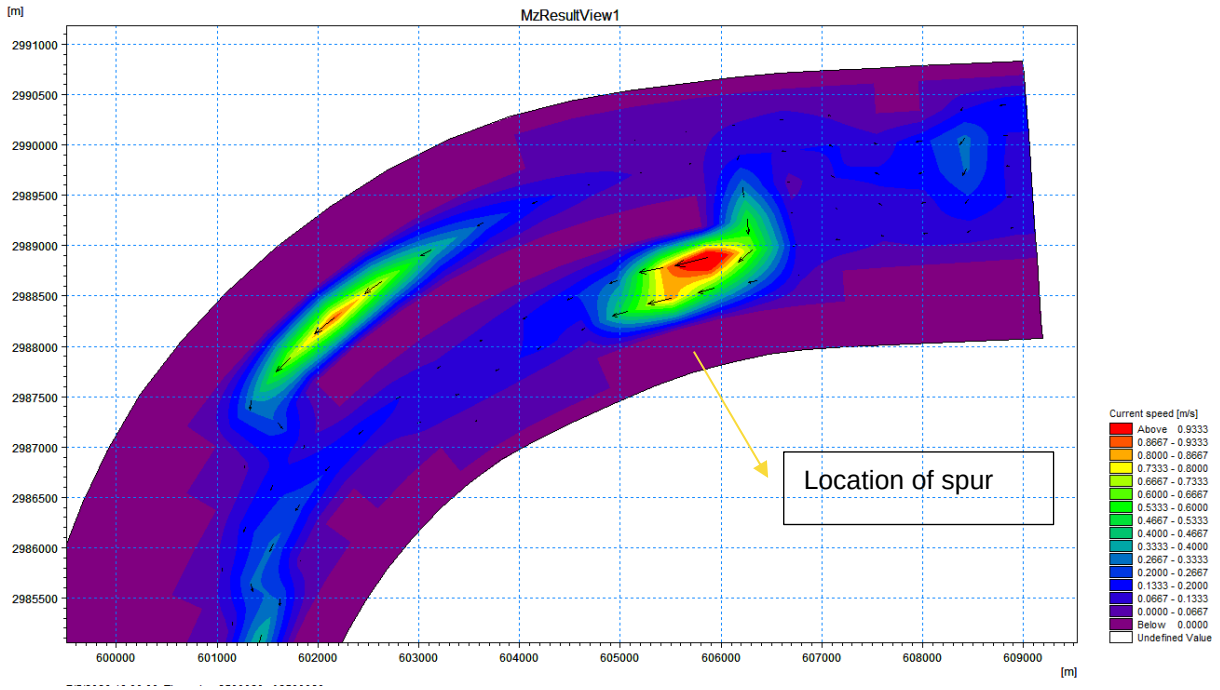


Figure a 16 Velocity corresponding to low flow during lean period with spur

Comparing pre and post structure conditions, there is not much variation in water depth but there is considerable reduction in the velocity near bank. Actually the available water depth near spur has been reduced and comparatively velocity has also reduced. So it is not recommended to propose a spur in order to increase the water depth, but spur will be actively reducing the bank erosion. A series of spurs are also recommended if erosion is severe. The actual trace of bank erosion can only be predicted when the actual sediment data is available. It is also recommended to do the location based numerical modelling (macro scale model) which definitely gives the erosion or sedimentation pattern along with effect of any river training work or any other structures to be proposed.

Since there are plenty of water available in the river during monsoon and most of non-monsoon period water availability will not be a critical issue. But few times during non-monsoon low water depth is observed from model with respect to bed level. It has to be verified with a calibrated model using observed flow and water level data for last 10-15 years. Dredging is another method proposed to locally increase the depth. But morphological impact and how to dispose the dredging materials has to be studied thoroughly.

D Detail Estimates: Phase I

D.1 Abstract of Phase I Capex

Sl. No.	Description	Quantity	Unit	Cost	Total Amount
1	**Terminal at 4 locations**				
1.1a	Main terminal building	2.00	Nos	Rs. 2,263,022.00	Rs. 4,526,044.00
1.1b	Auxiliary terminal building	2.00	Nos	Rs. 598,302.00	Rs. 1,196,604.00
2	**Fairway development**				
2.1	Dredging	53132.60	Cubm	Rs. 200.00	Rs. 10,626,520.00
3	**Navigation andcommunication**				
3.1	Vhf radio		Ls	Rs. 500,000.00	Rs. 500,000.00
4	**Aids to navigation**	12.00	Nos	Rs. 20,000.00	Rs. 240,000.00
5	**Landscaping**		Ls	Rs. 300,000.00	Rs. 300,000.00
6	**Utility shifting**		Ls	Rs. 300,000.00	Rs. 300,000.00
7	**Auxilliary items**				
7.1	Electrical	4.00	Nos	Rs. 179,073.80	Rs. 716295.20
7.2	Plumbing	4.00	Nos	Rs. 95,707.05	Rs. 382828.20
7.3	Fire	4.00	Nos	Rs. 9,456.40	Rs. 37825.60
7.4	Fencing	4.00	Nos	Rs. 180,000.00	Rs. 720000.00
7.5	Solar	4.00	Nos	Rs. 35,764.00	Rs. 143056.00
8	**Modular ferry vessel**	2.00	Nos	Rs.10,000,000.00	Rs. 20,000,000.00
				Total cost for phase I	**Rs. 39,689,168.00**
RUPEES THREE CRORE NINETY SIX LAKH EIGHTY NINE THOUSAND ONE HUNDRED AND SIXTY EIGHT ONLY					

D.2 Detail cost estimate and specifications of main terminal building[1]

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.				
	All kinds of soil	Cum	22.00	₹ 166.40	₹ 3,660.80
2	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum	16.00	₹ 125.75	₹ 2,012.00
3	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum	1.00	₹ 4,478.15	₹ 4,478.15
4	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All works upto plinth level	Cum	16.00	₹ 6,446.45	₹ 103,143.20
5	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All work above plinth level upto floor V level	Cum	11.00	₹ 7,250.05	₹ 79,750.55

[1] Detail estimates and specifications provided here are for one (1) main terminal building. Two main terminal buildings with same specifications are proposed during Phase I of the project.

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.				
	Thermo-Mechanically Treated bars of grade Fe-500D or more	kg	2538.00	₹ 56.60	₹ 143,650.80
7	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level				
	Thermo-Mechanically Treated bars of grade Fe500 or more	kg	1884.00	₹ 56.60	₹ 106,634.40
8	Centering and shuttering including strutting, propping, etc., and removal of form for				
8.a	Foundations, footings, bases of columns, etc., for mass concrete.	Sqm	31.00	₹ 193.95	₹ 6,012.45
8.b	Lintels, beams, plinth beams, girders, bressumers and cantilevers.	Sqm	127.00	₹ 342.90	₹ 43,548.30
8.c	Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	36.00	₹ 467.85	₹ 16,842.60
9	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)	Cum	44.00	₹ 10,148.60	₹ 446,538.40
10	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :	Sqm	82.00	₹ 1,158.10	₹ 94,964.20
	25 mm thick.				
11	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm	18.00	₹ 688.35	₹ 12,390.30

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
12	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete	Sqm	66.00	₹ 744.80	₹ 49,156.80
13	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)	Sqm	383.00	₹ 226.80	₹ 86,864.40
14	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade	Sqm	109.00	₹ 84.35	₹ 9,194.15
15	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications				
	Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm	Sqm	275.00	₹ 98.95	₹ 27,211.25
16	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :				
16.a	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	125.00	₹ 384.50	₹ 48,062.50
16.b	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).				
	Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	196.00	₹ 444.90	₹ 87,200.40

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
17	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge				
	Pre-laminated particle board with decorativelamination on both sides	Sqm	22.00	₹ 866.60	₹ 19,065.20
18	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):				
	With float glass panes of 4.0 mm thickness	Sqm	48.00	₹ 741.50	₹ 35,592.00
19	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.	Rm	29.00	₹ 438.75	₹ 12,723.75
20	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per direction of Engineer -in-charge, manufacture's specification & drawing.				
	30 mm thick pre laminated PVC door shutters	Sqm	9.00	₹ 3,232.70	₹ 29,094.30

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
21	Supplying and fixing rolling shutters of approved make, made of required size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation complete, including the cost of providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 and M.S. top cover of required thickness for rolling shutters.80x1.25 mm M.S. laths with 1.25 mm thick top cover	Sqm	20.00	₹ 2,316.10	₹ 46,322.00
22	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	4511.00	₹ 67.65	₹ 305,169.15
23	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.				
	1.00 mm thick with zinc coating not less than 275 gm/m2	Sqm	105.00	₹ 957.95	₹ 100,584.75
24	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path & courtyard jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)	Sqm	35.00	₹ 878.60	₹ 30,751.00
25	Electrical Arrangemnt	5.25%	5.25% of estimate		₹ 102,407.43
26	Plumbing Arrangements	5.25%	5.25% of estimate		₹ 102,407.43
27	Contigencies	5.00%	5.00% of estimate		₹ 107,588.59
					₹ 2,263,021.26
				Total Rounded to	**₹ 2,263,022.00**
Total In Words - Twenty Two Lakhs Sixty Three Thousand and Twenthy Two Rupees					

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)

D.3 Detail quantity estimates of main terminal building[2]

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
1	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.	Cum					
		All kinds of soil		6.00	1.30	1.30	2.10	21.29
						Total		21.29
						Total Rounded To		22.00
2	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum					
		Earthwork excavation						21.29
		Dedcutions						
		Footing		6.00	1.20	1.20	0.50	4.32
		Pedestral		6.00	0.60	0.30	1.50	1.62
						Total		15.35
						Total Rounded To		16.00
3	4.1.8	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum					
				6.00	1.20	1.20	0.10	0.86
						Total		0.86
						Total Rounded To		1.00
4	5.33.1	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve	Cum					

[2] Detail quatity estimates provided here are for one (1) main terminal building. Two main terminal buildings with same specifications are proposed during Phase I of the project.

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All works upto plinth level						
		Footings		6.00	1.20	1.20	0.50	4.32
		Plinth Beam						
		Horizontal		1.00	33.00	0.30	0.45	4.46
		Vertical		1.00	37.00	0.30	0.45	5.00
		Pedestral		6.00	0.60	0.30	1.50	1.62
						Total		15.39
						Total Rounded To		16.00
5	5.33.2	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All work above plinth level upto floor V level						
		Columns		6.00	0.60	0.30	3.30	3.56
		Beams - 230 X 300						
		Horizontal		1.00	33.00	0.23	0.30	2.28
		Vertical		1.00	17.00	0.23	0.30	1.17
		Beams - 300 X 450		1.00	20.00	0.30	0.45	2.70
		Lintels						
		Window - W1		4.00	1.90	0.23	0.30	0.52
		Doors - D1		2.00	1.25	0.23	0.30	0.17
		Doors - D2		5.00	1.10	0.12	0.30	0.20
		Doors - D3		2.00	0.90	0.23	0.30	0.12
		Ventilator - V1		1.00	1.60	0.23	0.30	0.11
		Window - W2		1.00	2.00	0.23	0.30	0.14
						Total		10.98
						Total Rounded To		11.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
6	5.22.6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.						
		Thermo-Mechanically Treated bars of grade Fe-500D or more	kg					
		Footings @ 175 kg per cum		175.00			4.32	756.00
		Column Peddestral @ 225 kg per cum		225.00			1.62	364.50
		Plinth Beam @ 150 kg per cum		150.00			9.45	1417.50
						Total		2538.00
						Total Rounded To		2538.00
7	5.22.6.A	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level						
		Thermo-Mechanically Treated ibars of grade Fe500 or more	kg					
		Columns @ 225 kg per cum		225.00			3.56	801.90
		Beams @ 150 kg per cum		150.00			6.15	922.50
		Lintels @ 125 kg per cum		125.00			1.27	158.44
						Total		1882.84
						Total Rounded To		1884.00
8		Centering and shuttering including strutting, propping, etc., and removal of form for						
8.a	5.9.1	Foundations, footings, bases of columns, etc., for mass concrete.						
		Footings		6.00	1.20	1.20	0.50	14.40
		Column Pedestral		6.00	0.60	0.30	1.50	16.20
						Total		30.60
						Total Rounded To		31.00
8.b	5.9.5	Lintels, beams, plinth beams, girders, bressumers and cantilevers.						
		Plinth Beams						
		Horizontal		1.00	33.00	0.30	0.45	29.70
		Vertical		1.00	37.00	0.30	0.45	33.30
		Beams - 230 X 300						
		Horizontal		1.00	33.00	0.23	0.30	19.80
		Vertical		1.00	17.00	0.23	0.30	10.20
		Beams - 300 X 450		1.00	20.00	0.30	0.45	18.00
		Lintels						
		Window - W1		4.00	1.90	0.23	0.30	6.31

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Doors - D1		2.00	1.25	0.23	0.30	2.08
		Doors - D2		5.00	1.10	0.12	0.30	3.96
		Doors - D3		2.00	0.90	0.23	0.30	0.12
		Ventilator - V1		1.00	1.60	0.23	0.30	1.33
		Window - W2		1.00	2.00	0.23	0.30	1.66
						Total		126.46
						Total Rounded To		127.00
8.c	5.9.6	Columns, Pillars, Piers, Abutments, Posts and Struts						
		Columns		6.00	0.60	0.30	3.30	35.64
						Total		35.64
						Total Rounded To		36.00
9	4.7.1	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)						
		Vertical						
		Main Wall		2.00	10.00	0.23	3.30	15.18
		Toilet		1.00	3.00	0.12	3.30	1.19
				1.00	4.00	0.12	3.30	1.58
		Office		1.00	4.00	0.23	3.30	3.04
		Crew Waiting		1.00	3.00	0.23	1.20	0.83
		Horizontal						
		Main Wall		1.00	10.00	0.23	3.30	7.59
		Toilet		1.00	3.00	0.12	3.30	1.19
		Office		2.00	4.00	0.23	3.30	6.07
		Shop		2.00	2.00	0.23	3.30	3.04
		Crew Waiting		1.00	4.00	0.23	3.30	3.04
		Toilets						
				5.00	1.00	0.12	3.30	1.98
				1.00	4.00	0.12	3.30	1.58
				5.00	1.00	0.12	3.30	1.98
		Deductions						
		Window - W1		-4.00	1.50	0.23	1.20	-1.66
		Doors - D1		-2.00	1.00	0.23	2.10	-0.97
		Doors - D2		-5.00	0.80	0.12	2.10	-1.01
		Doors - D3		-2.00	0.90	0.23	2.10	-0.87
		Ventilator - V1		-1.00	1.20	0.23	0.45	-0.12

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Window - W2		-1.00	1.50	0.23	1.50	-0.52
						Total		43.14
						Total Rounded To		44.00
10	11.26.1	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :						
		25 mm thick.	Sqm					
		Building		1.00	10.00	10.00	-	100.00
		Deduct Toilets						-18.00
						Total		82.00
						Total Rounded To		82.00
11	11.37	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm					
		Toilet		1.00	4.00	3.00		12.00
				1.00	3.00	2.00		6.00
						Total		18.00
						Total Rounded To		18.00
12	11.36	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete						
		Toilet		1.00	4.00	3.00	2.10	29.40
				5.00	1.00	-	2.10	10.50
				5.00	0.20	-	2.10	2.10
				1.00	1.00	-	2.10	2.10
				1.00	1.00	-	2.10	2.10
				2.00	4.00	-	2.10	16.80

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
				2.00	0.60	-	2.10	2.52
						Total		65.52
						Total Rounded To		66.00
13	13.7.1	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)						
		External						
				2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
		Internal		2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	2.00	-	3.30	13.20
				2.00	3.00	-	3.30	19.80
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-14.40
		Doors - D1		-2.00	1.00	-	2.10	-8.40
		Doors - D2		-5.00	0.80	-	2.10	-16.80
		Doors - D3		-2.00	0.90	-	2.10	-7.56
		Ventilator - V1		-1.00	1.20	-	0.45	-1.08
		Window - W2		-1.00	1.50	-	1.50	-4.50
						Total		382.86
						Total Rounded To		383.00
14	13.60	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade						
		External						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
				2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-7.20
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
		Window - W2		-1.00	1.50	-	1.50	-2.25
						Total		108.81
						Total Rounded To		109.00
15	13.48.1	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications						
		Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm						
		Internal		2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	2.00	-	3.30	13.20
				2.00	3.00	-	3.30	19.80
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-7.20
		Doors - D1		-2.00	1.00	-	2.10	-8.40
		Doors - D2		-5.00	0.80	-	2.10	-16.80
		Doors - D3		-2.00	0.90	-	2.10	-7.56
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
		Window - W2		-1.00	1.50	-	1.50	-2.25
						Total		274.05
						Total Rounded To		275.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
16	21.1.1	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :						
16.a	21.1.1.2	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg					
		Windows						
		Window - W1	m	4.00	1.50	-	1.20	21.60
				2.00	-	-	1.20	2.40
		Ventilator - V1		1.00	1.20	-	0.45	3.30
				2.00	-	-	0.45	0.90
		Window - W2		1.00	1.50	-	1.50	6.00
				2.00	-	-	1.50	3.00
		Doors						
		D1		2.00	1.20	-	2.10	13.20
		D3		2.00	0.90	-	2.10	12.00
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		124.80
						Total Rounded To		125.00
16.b	21.1.2.2	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).	kg					
		Powder coated aluminium (minimum thickness of powder coating 50 micron)						
		Windows						
		Window - W1	m	4.00	0.50	-	1.20	40.80
		Ventilator - V1		1.00	0.60	-	0.45	4.20
		Window - W2		1.00	0.50	-	1.50	12.00
		Doors						
		D1		2.00	1.20	-	2.10	13.20
		D3		2.00	0.90	-	2.10	12.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Ticket Counter		1.00	4.00	-	2.50	13.00
				1.00	-	-	2.50	2.50
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		195.40
						Total Rounded To		196.00
17	21.2.2	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge						
		Pre-laminated particle board with decorativelamination on both sides	Sqm					
		Doors						
		D1		2.00	1.20	-	1.10	9.20
		D3		2.00	0.90	-	2.10	12.00
						Total		21.20
						Total Rounded To		22.00
18	21.3.1	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):						
		With float glass panes of 4.0 mm thickness	Sqm					
		Window - W1		4.00	0.50	-	1.20	7.20
		Ventilator - V1		1.00	0.60	-	0.45	0.54
		Window - W2		1.00	0.50	-	1.50	2.25
		Door - D3		2.00	1.20	-	1.00	7.20
		Ticket Counter		1.00	4.00	-	2.50	30.00
						Total		47.19
						Total Rounded To		48.00
19	9.119	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to	Rm					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.						
		Doors - D2		5.00	0.80	-	2.10	29.00
						Total		29.00
						Total Rounded To		29.00
20	9.120.2	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per direction of Engineer -in-charge, manufacture's specification & drawing.	Sqm					
		30 mm thick pre laminated PVC door shutters						
		Doors - D2		5.00	0.80	-	2.10	8.40
						Total		8.40
						Total Rounded To		9.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
21	10.6.1	Supplying and fixing rolling shutters of approved make, made of required size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation complete, including the cost of providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 and M.S. top cover of required thickness for rolling shutters.80x1.25 mm M.S. laths with 1.25 mm thick top cover	Sqm					
		Entry		1.00	4.00	-	3.30	13.20
		Shop		1.00	2.00	-	3.30	6.60
						Total		19.80
						Total Rounded To		20.00
22	10.2	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg					
		Truss					kg/sqft	
		Assuming 4 kf per sft		2.00	10.00	5.23	4.00	4510.35
						Total		4510.35
						Total Rounded To		4511.00
23	12.1.1	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.						
		1.00 mm thick with zinc coating not less than 275 gm/m2						
		Roofing Sloped half portion		2.00	10.00	5.23	-	104.60
						Total		104.60
						Total Rounded To		105.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
24	11.20.2	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)						
		Road to walkway		1.00	10.00	3.50	-	35.00
						Total		35.00
						Total Rounded To		35.00

D.4 Detail cost estimate and specifications of auxiliary terminal building[3]

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.				
	All kinds of soil	Cum	4.00	₹ 166.40	₹ 665.60
2	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum	2.00	₹ 125.75	₹ 251.50
3	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum	3.00	₹ 4,478.15	₹ 13,434.45
4	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All works upto plinth level	Cum	7.00	₹ 6,446.45	₹ 45,125.15
5	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All work above plinth level upto floor V level	Cum	5.00	₹ 7,250.05	₹ 36,250.25

[3] Detail estimates and specifications provided here are for one (1) auxiliary terminal building. Two auxiliary terminal buildings with same specifications are proposed during Phase I of the project.

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.				
	Thermo-Mechanically Treated bars of grade Fe-500D or more	kg	951.00	₹ 56.60	₹ 53,826.60
7	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level				
	Thermo-Mechanically Treated bars of grade Fe500 or more	kg	767.00	₹ 56.60	₹ 43,412.20
8	Centering and shuttering including strutting, propping, etc., and removal of form for				
8.a	Foundations, footings, bases of columns, etc., for mass concrete.	Sqm	27.00	₹ 193.95	₹ 5,236.65
8.b	Lintels, beams, plinth beams, girders, bressumers and cantilevers.	Sqm	36.00	₹ 342.90	₹ 12,344.40
8.c	Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	30.00	₹ 467.85	₹ 14,035.50
9	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)	Cum	10.00	₹ 10,148.60	₹ 101,486.00
10	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :	Sqm	14.00	₹ 1,158.10	₹ 16,213.40
	25 mm thick.				
11	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm	5.00	₹ 688.35	₹ 3,441.75

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)
12	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete	Sqm	19.00	₹ 744.80	₹ 14,151.20
13	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)	Sqm	41.00	₹ 226.80	₹ 9,298.80
14	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade	Sqm	37.00	₹ 84.35	₹ 3,120.95
15	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications				
	Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm	Sqm	54.00	₹ 98.95	₹ 5,343.30
16	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :				
16.a	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	31.00	₹ 384.50	₹ 11,919.50
16.b	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).				
	Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	61.00	₹ 444.90	₹ 27,138.90

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)
17	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge				
	Pre-laminated particle board with decorativelamination on both sides	Sqm	6.00	₹ 866.60	₹ 5,199.60
18	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):				
	With float glass panes of 4.0 mm thickness	Sqm	3.00	₹ 741.50	₹ 2,224.50
19	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.	Rm	8.00	₹ 438.75	₹ 3,510.00
20	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per				

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
	direction of Engineer -in-charge, manufacture's specification & drawing.				
	30 mm thick pre laminated PVC door shutters	Sqm	4.00	₹ 3,232.70	₹ 12,930.80
21	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	583.00	₹ 67.65	₹ 39,439.95
22	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.				
	1.00 mm thick with zinc coating not less than 275 gm/m2	Sqm	18.00	₹ 957.95	₹ 17,243.10
23	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path & courtyard jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)	Sqm	21.00	₹ 878.60	₹ 18,450.60
24	Electrical Arrangemnt	5.25%	5.25% of estimate		₹ 27,073.97
25	Plumbing Arrangements	5.25%	5.25% of estimate		₹ 27,073.97
26	Contigencies	5.00%	5.00% of estimate		₹ 28,458.85
					₹ 598,301.44
			Total Rounded to		**₹ 598,302.00**

Total In Words - Five Lakh Ninety Eight Thousand Three Hundred and Two Rupees

D.5 Detail quantity estimates of auxiliary terminal building[4]

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
1.00	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.	Cum					
		All kinds of soil		6.00	0.75	0.75	1.00	3.38
						Total		3.38
						Total Rounded To		4.00
2.00	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum					
		Earthwork excavation						3.38
		Dedcutions						
		Footing		6.00	0.75	0.75	0.50	1.69
		Pedestral		6.00	0.45	0.30	0.50	0.41
						Total		1.28
						Total Rounded To		2.00
3.00	4.1.8	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum					
				6.00	0.75	0.75	1.00	3.38
						Total		3.38
						Total Rounded to		3.00
4.00	5.33.1	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in	Cum					

[4] Detail quatity estimates provided here are for one (1) auxiliary terminal building. Two auxiliary terminal buildings with same specifications are proposed during Phase I of the project.

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All works upto plinth level						
		Footings		6.00	0.75	0.75	1.00	3.38
		Plinth Beam						
		Horizontal		1.00	15.00	0.20	0.35	1.05
		Vertical		1.00	9.00	0.20	0.35	0.63
		Pedestal		6.00	0.45	0.30	1.50	1.22
						Total		6.27
						Total Rounded To		7.00
5.00	5.33.2	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All work above plinth level upto floor V level						
		Columns		6.00	0.45	0.30	3.30	2.67
		Beams - 230 X 300						
		Horizontal		1.00	15.00	0.23	0.30	1.04
		Vertical		1.00	9.00	0.23	0.30	0.62
		Lintels						
		Window - W1		1.00	1.90	0.23	0.30	0.13
		Doors - D1		1.00	1.25	0.23	0.30	0.09
		Ventilator - V1		1.00	1.60	0.23	0.30	0.11
						Total		4.66
						Total Rounded To		5.00
6.00	5.22.6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.						
		Thermo-Mechanically Treated bars of grade Fe-500D or more	kg					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Footings @ 150 kg per cum		150.00			3.38	506.25
		Column Peddestral @ 200 kg per cum		200.00			1.22	243.00
		Plinth Beam @ 120 kg per cum		120.00			1.68	201.60
						Total		950.85
						Total Rounded To		951.00
7.00	5.22.6.A	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level						
		Thermo-Mechanically Treated ibars of grade Fe500 or more	kg					
		Columns @ 200 kg per cum		200.00			2.67	534.60
		Beams @ 120 kg per cum		120.00			1.66	198.72
		Lintels @ 100 kg per cum		100.00			0.33	32.78
						Total		766.10
						Total Rounded To		767.00
8.00		Centering and shuttering including strutting, propping, etc., and removal of form for						
8.a	5.9.1	Foundations, footings, bases of columns, etc., for mass concrete.						
		Footings		6.00	0.75	0.75	1.00	18.00
		Column Pedestral		6.00	0.45	0.30	1.00	9.00
						Total		27.00
						Total Rounded To		27.00
8.b	5.9.5	Lintels, beams, plinth beams, girders, bressumers and cantilevers.						
		Plinth Beams						
		Horizontal		1.00	15.00	0.20	0.35	10.50
		Vertical		1.00	9.00	0.20	0.35	6.30
		Beams - 230 X 300						
		Horizontal		1.00	15.00	0.23	0.30	9.00
		Vertical		1.00	9.00	0.23	0.30	5.40
		Lintels						
		Window - W1		1.00	1.90	0.23	0.30	1.58
		Doors - D1		1.00	1.25	0.23	0.30	1.04
		Ventilator - V1		1.00	1.60	0.23	0.30	1.33
						Total		35.14
						Total Rounded To		36.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
8.c	5.9.6	Columns, Pillars, Piers, Abutments, Posts and Struts						
		Columns		6.00	0.45	0.30	3.30	29.70
						Total		29.70
						Total Rounded To		30.00
9.00	4.7.1	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)						
		Main Wall		4.00	3.00	0.23	3.30	9.11
		Toilet		1.00	3.00	0.12	3.30	1.19
		Deductions						
		Window - W1		-1.00	1.50	0.23	1.20	-0.41
		Doors - D1		-1.00	1.00	0.23	2.10	-0.48
		Ventilator - V1		-1.00	1.20	0.23	0.45	-0.12
						Total		9.27
						Total Rounded To		10.00
10.00	11.26.1	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :						
		25 mm thick.	Sqm					
		Building		1.00	6.00	3.00	-	18.00
		Deduct Toilets						-4.50
						Total		13.50
						Total Rounded To		14.00
11.00	11.37	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching	Sqm					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		pigment etc., complete in wash and toilet area						
		Toilet		1.00	1.50	3.00		4.50
						Total		4.50
						Total Rounded To		5.00
12.00	11.36	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete						
		Toilet		1.00	1.50	3.00	2.10	18.90
						Total		18.90
						Total Rounded To		19.00
13.00	13.7.1	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)						
		External						
				4.00	3.00	-	3.30	39.60
		Internal		1.00	3.00	-	3.30	9.90
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-3.60
		Doors - D1		-1.00	1.00	-	2.10	-4.20
		Ventilator - V1		-1.00	1.20	-	0.45	-1.08
						Total		40.62
						Total Rounded To		41.00
14.00	13.60	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade						
		External						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
				4.00	3.00	-	3.30	39.60
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-1.80
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
						Total		37.26
						Total Rounded To		37.00
15.00	13.48.1	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications						
		Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm						
		Internal		6.00	3.00	-	3.30	59.40
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-1.80
		Doors - D1		-1.00	1.00	-	2.10	-4.20
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
						Total		52.86
						Total Rounded To		54.00
16.00	21.1.1	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :						
16.a	21.1.1.2	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg					
		Windows						
		Window - W1	m	1.00	1.50	-	1.20	5.40

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Ventilator - V1		1.00	1.20	-	0.45	3.30
		Doors						
		D1		1.00	1.20	-	2.10	6.60
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		30.60
						Total Rounded To		31.00
16.b	21.1.2.2	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).	kg					
		Powder coated aluminium (minimum thickness of powder coating 50 micron)						
		Windows						
		Window - W1	m	1.00	0.50	-	1.20	10.20
		Ventilator - V1		1.00	0.60	-	0.45	4.20
		Doors						
		D1		2.00	1.20	-	2.10	13.20
				1.00	-	-	2.50	2.50
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		60.20
						Total Rounded To		61.00
17.00	21.2.2	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge						
		Pre-laminated particle board with decorativelamination on both sides	Sqm					
		Doors						
		D1		1.00	1.20	-	1.10	4.60
						Total		4.60
						Total Rounded To		6.00
18.00	21.3.1	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		aluminium snap beading shall be paid in basic item):						
		With float glass panes of 4.0 mm thickness	Sqm					
		Window - W1		1.00	0.50	-	1.20	1.80
		Ventilator - V1		1.00	0.60	-	0.45	0.54
						Total		2.34
						Total Rounded To		3.00
19.00	10.2	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg					
		Truss					kg/sqft	
		Assuming2 kf per sft		2.00	6.00	1.50	3.00	582.12
						Total		582.12
						Total Rounded To		583.00
20.00	12.1.1	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.						
		1.00 mm thick with zinc coating not less than 275 gm/m2						
		Roofing Sloped half portion		2.00	6.00	1.50	-	18.00
						Total		18.00
						Total Rounded To		18.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
21.00	11.20.2	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)						
		Road to walkway		1.00	6.00	3.50	-	21.00
						Total		21.00
						Total Rounded To		21.00

D.6 Detail estimate: cross bank dredging

Sl. No.	Specification	Unit	Quanity	Cost	Amount
1.00	Dredging and deepening in all classes of soil using closed type grab dredger and removing sand, clay,silt, debris, piece of nets, other waste or mixture or combination of two or more including removing all obstacles such as small rocks scattered granite, wood pieces, piece of net etc and depositing this material using bottom open barge and conveying this to sea beyond 3 km and upto 5 km for depositing in sea , as per the direction of departmental officers at site including all hire charges of tools, plants, equipments, accessories, incidental charges, labour charges and all service taxes etc complete. for dredging upto -4.5m bedlevel with respect to CD **(PHASE I)**				
		Cum	53132.60	₹ 200.00	₹ 10,626,520.00
	Total rounded to				**₹ 10,626,520.00**

D.7 Estimate of navigation and communication aids

D.7.1 Navigation aids

Sl. No.	Specification	Unit	Quantity	Cost	Amount
1	Installation of conventional marking made of bamboo strips	Nos	12.00	₹ 20,000.00	₹ 240,000.00
Phase I Total					**₹ 240,000.00**

D.7.2 VHF Radio

Sl. No.	Specification	Unit	Cost	Amount
1	Supply, installation and commissioning of VHF radio for communication for two terminals (Phase I)	LS	₹ 5,00,000.00	₹ 5,00,000.00
Phase I Total				₹ 5,00,000.00

D.8 Detail cost estimate and specifications Auxiliary items

D.8.1 Abstract

Sl No	Item Description	Amount in Rs
1	Electrical	179,073.80
2	Plumbing	95,707.05
3	Fire	9,456.40
4	Fencing	180,000.00
5	Solar	35,764.00
	Total	500,001.25
	No of terminal blocks	4.00
	Grand total	**2,000,005.00**

D.8.2 Detail estimate of electrification

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
1	1.10.3	Wiring for light point/ fan point/ exhaust fan point/ call bell point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit, with modular switch, modular plate, suitable GI box and earthing the point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable etc. as required.	Point	15	984.10	14,761.50
2		Wiring for circuit/ submain wiring alongwith earth wire with the following sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed medium class PVC conduit as required.				-
3	1.14.1	2 x 1.5 sq.mm + 1 x1.5 sq.mm earth wire	m	25.00	145.46	3,636.50
4	1.14.2	2 x 2.5 sq.mm + 1 x 2.5 sq.mm earth wire	m	20.00	178.10	3,562.00
5	1.14.3	2 x 4 sq.mm +1 x 4 sq.mm earth wire	m	15.00	218.14	3,272.10
6		Supplying and fixing of following sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required.				-
7	1.21.1	20 mm	m	50	74.10	3,705.00
8	1.21.2	25 mm	m	60	89.70	5,382.00
9	1.25	Supplying and fixing two module stepped type electronic fan regulator on the existing modular plate switch box including connections but excluding modular plate etc. as required.	Each	4	374.40	1,497.60
10	1.27	Supplying and fixing following size/ modules, GI box alongwith modular base & cover plate for modular switches in recess etc. as required.				-
11	1.27.1	1 or 2 Module (75mm x 75mm)	Each	3	227.50	682.50
12	1.27.2	3 Module (100mm x 75mm)	Each	2	240.50	481.00
13						-
14		Supplying and fixing following modular switch/ socket on the existing modular plate & switch box including connections but excluding modular plate etc. as required.				-
15	1.24.4	3 pin 5/6 A socket outlet	Each	5	105.30	526.50
16	1.24.5	6 pin 15/16 A socket outlet	Each	2	199.00	398.00
17	1.31	Supplying and fixing suitable size GI box with modular plate and cover in front on surface or in recess, including providing and fixing 3 pin 5/6 A modular socket outlet and 5/6 A modular switch, connections etc. as required.	Each	5	407.00	2,035.00
18						-

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
19	1.32	Supplying and fixing suitable size GI box with modular plate and cover in front on surface or in recess, including providing and fixing 6 pin 5/6 A & 15/16 A modular socket outlet and 15/16 A modular switch, connections etc. as required.	Each	2	528.00	1,056.00
20	1.41	Installation, testing and commissioning of pre-wired, fluorescent/LED fitting / compact fluorescent/LED fitting of all types, complete with all accessories and tube/lamp etc. directly on ceiling/ wall/false ceiling, including connections with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable and earthing etc. as required.	Each	8	130.00	1,040.00
21	1.44	Installation, testing and commissioning of ceiling fan, including wiring the down rods of standard length (upto 30 cm) with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable etc. as required.	Each	4	136.50	546.00
22						-
23	1.50.1	Installation of exhaust fan upto 450mm in the existing opening, including making good the damage, connection, testing, commissioning etc. as required.	Each	2	291.20	582.40
24		Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 V, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/Isolator)			`	
25	2.3.3	12 way double door	Nos	2	1,496.30	2,992.60
26		Supplying and fixing of following ways surface/ recess mounting, vertical type, 415 V, TPN MCB distribution board of sheet steel, dust protected, duly powder painted, inclusive of 200 A, tinned copper bus bar, common neutral link, earth bar, din bar for mounting MCBs (but without MCBs and incomer) as required. (Note : Vertical type MCB TPDB is normally used where 3 phase outlets are required.)				-
27	2.5.1	4 way Double door	Each	1	5,852.60	5,852.60
28		Supplying and fixing 5 A to 32 A rating, 240/415 V, 10 kA, “C” curve, miniature circuit breaker suitable for inductive load of following poles in the existing MCB DB complete with connections, testing and commissioning etc. as required.				-
29	2.10.1	Single pole	Each	15	224.90	3,373.50
30	2.10.4	Triple pole	Each	2	910.00	1,820.00
31		Supplying and fixing following rating, double pole, 240 V, isolator in the existing MCB DB complete with connections, testing and commissioning etc. as required.				-
32	2.12.1	40A	Each	1	300.00	300.00
33	2.21	Providing and fixing M.V. danger notice plate of 200 mm X 150 mm, made of mild steel, at least 2 mm thick, and vitreous enameled white on both sides, and with inscription in single red colour on front side as required.	Each	1	194.00	194.00

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
34	5.8	Supplying and laying 25 mm X 5 mm copper strip at 0.50 meter below ground as strip earth electrode, including connection/ terminating with nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of brass nut bolt & spring washer spaced at 50 mm)	m	35	773.50	27,072.50
35	5.14	Providing and fixing 25 mm X 5 mm copper strip on surface or in recess for connections etc. as required.	m	45	907.40	40,833.00
36						-
37	5.50	Earthing with copper earth plate 600 mm X 600 mm X 3 mm thick including accessories, and providing masonry enclosure with cover plate having locking arrangement and watering pipe of 2.7 meter long etc. (but without charcoal/ coke and salt) as required.	No	2	7,500.00	15,000.00
38		Laying and fixing of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 kV grade of following size on wall surface as required.				-
39	7.7.1	Upto 35 sq. mm (clamped with 1mm thick saddle)	m	35	32.50	1,137.50
40	MR	Supply of LED Recessed Downlighter with a nominal system lumen output of 1300 lumens and a minimum system efficacy of 100 lm/W. Luminaire wattage should not exceed 13W. The luminaire should have a color temperature of 6500K and CRI>80. Driver of the luminaire shall have THD<10% and PF > 0.9. The heat sink should be made of die cast aluminium and the luminaire optics shall have a high efficiency PC diffuser. Luminaire cutout diameter should not be more than 135mm. The driver shall comply to IEC 62384 , IEC 61347-2-13, IEC 61547, EMI- CISPR15 standards. (Philips Make GreenLEDi "DN193B LED12S-6500 PSU WH S1" or equivalent)	No	8	1950	15,600.00
41	MR	Supply, installation, testing and commisioning of LED Bollard fixture including foundation with separate adequate size pipes in foundation for incoming and outgoing power cables and earth wires to the cable termination box of standard size of sintex make hard plastic box with IP 64 protection provided on the bottom of the fixture inside, suitable for landscape lighting with IP 65 protection and including all accessories as required for complete installation and making good any damages made during installation as instructed by engineer in charge. (Havells make LHEVBDP6IN6K008 or equivalent)	No	5	2500	12,500.00
42	MR	Supplying ceiling fan of 1200mm sweep, including the down rod of standard length (upto 30 cm.) of (havels make, ES 50 White or CG make, Riveria or equivalent).	No	4	1400	5,600.00
43	MR	Supply of exhaust fan of 250mm sweep in the existing opening, including making good the damage, connection, testing, commissioning etc. as required, including all accessories as rquired for complete installation incluidng shutter etc complete as required.(havells, Ventil Air DX White or equivalent)	No	2	1817	3,634.00
		Total				**179,073.80**

D.8.3 Detail estimate: Plumbing

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
1	MR	Providing and fixing white vitreous china Floor Mounted type water closet (European type W.C.pan) with seat and lid, 3/6 litre low level white vitrous Dual Flushing cistern and C.P flush bend with fitting and C.I brackets, 40mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design complete including painting of fittings and brackets, cutting and making good the walls and floors wherever required. Make: Hindware, Cera, Jaquar etc.., WC pan with ISI marked white solid plastic seat and lid (Lowest retail price not less than 4,000/each. Materials to be selected by the Engineer in charge)	Each	2	6500.00	13000.00
2	MR	Providing and fixing wash basin/ counter wash basin with CI / MS brackets, 15mm CP brass Pillar taps, 32mm CP brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required.: White Vitreous China Wash basin size 630 x 450mm with a single 15mm C.P brass piller tap. Make: Hindware, Cera, Jaquar etc.., (Lowest retail price of basin not less than Rs. 3000/each and Pillar tap not less than Rs. 1500/each. Materials to be selected by the Engineer in charge)	Each	2	4500.00	9000.00
3	18.7	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply including all CPVC plain & brass threaded fittings including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge**.** Make: Supreme, Finolex, Astral **Internal work - Exposed on wall**				
4	18.7.2	20 mm nominal outer dia .Pipes.	Metre	15.00	179.95	2699.25
5	18.7.3	25 mm nominal outer dia .Pipes	Metre	10.00	216.20	2162.00
6	18.7.4	32 mm nominal outer dia .Pipes.	Metre	8.00	289.05	2312.40
7	18.18	Providing and fixing ball valve (brass) of approved quality, High or low pressure, with plastic floats complete				
8	18.18.2	20 mm nominal bore	Each	1	327.05	327.05
9	18.18.3	25 mm nominal bore	Each	1	331.95	331.95
10	MR	Providing & fixing of CP **Health faucet. Hand operated spray unit (instand type).**Make:Jauqar, Hindware, Parryware, crome., (Lowest retail price not less than 1200/each. Materials to be selected by the Engineer in charge)	Set	2	1858.40	3716.80

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
11		Providing and fixing UPVC SWR pipe for soil, waste and vent pipe to IS : 13592 of SWR quality, including all fittings, like: Bends, Tees, Elbows, Collars, junction, inspection doors, clamps for fixing walls and slabs, flanged pipes for providing slab core cutting portion, vent cowls, offsets, access pipes, jointing with rubber ring / solvent cement by application of leak proof adhesive like FRP paste including cutting holes in walls and floors, chasing walls and floors and making good. clipping to walls and slabs, trenching, refilling etc. complete Make: Supreme, Finolex, Prince				
12	MR	110mm dia UPVC SWR Type B pipe	M	15	712.8	10692
13	MR	Providing and fixing **PVC floor trap** self cleansing design with or without vent arm complete including cutting and making good the walls and floors. Make:Supreme,Finolex,Prince etc..,110mm dia inlet 110mm dia outlet	Each	2	732.80	1465.60
14	MR	Supply, erection and commissioning of 0.5HP pump with design head & discharge including cost of valves, pressure gauge, specials and fittings etc. complete	LS	1	10000.00	10000.00
15	MR	Boring / drilling bore well of required dia for casing / strainer pipe, by suitable method prescribed in IS: 2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/ bore log, including hire & running charges of all equipments, tools plants & machineries required for the job, all complete as per direction of Engineer - in- Charge, upto 90 metre depth below ground level. All types of soil	LS	1	40000.00	40000.00
TOTAL						**95707.05**

D.8.4 Detail estimate: Fire fighting equipment

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
1	MR	**ABC (Powder Type) Fire Extinguisher.** In HP Mild Steel Cylinders ISI marked fitted with pressure indicating gauge, internal tube, squeeze lever type valve fully charged with ABC powder (Mono Ammonium Phosphate) pressured by Nitrogen complete in all respects including wall suspension bracket and confoming to IS:1349-1993.	Each	2	2928.20	5856.4
2	MR	Supplying and installing at approved location approved make fire buckets of 24 gauge galvanized steel sheet, standard 9 litre capacity and of round bottom shape, painted white inside and red outside and black on the bottom, inscribed with letters “FIRE” in black and gold. Cost shall be inclusive of providing MS stand for 2 nos of fire buckes, or , duly painted over a coat of primer.	No.	2	1800.00	3600
TOTAL						**9456.40**

D.8.5 Detail estimate: Fencing

Sl. no	Price	Description	Unit	Quantity	rate including cost index	amount
1	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) /manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.All kinds of soil	Cum	6.00	₹ 216.32	₹ 1,297.92
2	*16.15.1*	Supplying at site RCC standard post/struts/rails/pales of mix 1:1.5:3 (1 cement:1.5 coarse sand:3 graded stone aggregate, 12.5mm nominal size) with wooden plugs or 6mm bar nibs wherever required as per direction of engineer in charge (cost of earthworks in excavations, concrete works in foundation to be paid seperately).	Cum	2.00	₹ 25,706.92	₹ 51,413.83
3	*4.1.5*	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level:1:3:6 (cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size)	Cum	4.50	₹ 6,405.10	₹ 28,822.95
4	*4.1.8*	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level:1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 nominal size)	Cum	1.00	₹ 5,821.60	₹ 5,821.60
5	*5.9.1*	Centering and shuttering including strutting, etc. and removal of form for:Foundations, footings, bases ofcolumns, etc for mass concrete	Sqm	4.50	₹ 252.14	₹ 1,134.61
6	*5.9.6*	Centering and shuttering including strutting, etc. and removal of form for:Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	7.00	₹ 608.21	₹ 4,257.44
7	*5.1.2*	Providing and laying in position specified grade of reinforced cement concrete, excluding the cost of centering, shuttering, finishing and reinforcement - All work up to plinth level:1:1:5:3 (1 cement 1.5 coarse sand :3 graded stone aggregate 20 mm nominal size	Cum	1.50	₹ 8,079.96	₹ 12,119.93

Sl. no	Price	Description	Unit	Quantity	rate including cost index	amount
8	*5.22.6*	Steel reinforcement for R.C.C work including straightening, cutting, bending, placing in position and binding all complete upto plinth levelThermo - Mechanically Treated bars of grade Fe-500D or more.	Kg	130.00	₹ 73.58	₹ 9,565.40
9	*13.2.1*	15 mm cement plaster on the rough side of single or half brick wall of mix:1:4 (1 cement :4 fine sand)	Sqm	7.00	₹ 260.33	₹ 1,822.28
10	*13.46.1*	Finishing walls with Acrylic Smooth exterior paint of required shade:New work (Two or more coat applied @ 1.67 ltr/10 sqm over and including prming coat of exterior primer applied@2.20kg/10sqm.	Sqm	7.00	₹ 124.87	₹ 874.06
11	*10.16.1*	Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete.Hot finished welded type tubes	Kg	500.00	₹ 117.33	₹ 58,662.50
12	*16.17*	Fencing with R.C.C. post placed at required distance, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with horizontal lines and two diagonals of barbed wire weighing 9.38 kg per 100 metres (minimum), between the two posts fitted and fixed with G.I. staples on wooden plugs or G.I. binding wire tied to 6 mm bar nibs fixed while casting the post (cost of R.C.C. posts, struts, earth work and concrete to be paid for separately) :- Payment to be made per metre cost of total length of barbed wire used.				
	16.17.1	With G.I. barbed wire	Rm	380.00	₹ 10.73	₹ 4,075.50
						₹ 179,868.00
		Say				**₹ 180,000.00**
		Rupees One Lakh Eighty Thousand Only/-				

D.8.6 Detail estimate: Solar

Sl.NO	Details of items	Unit	Quantity	Rate in Rs.	Amount in Rs.
1	Design, supply, installation, testing and commissioning of **0.5kWp On-grid solar power generating system** with required nos. of poly/multi crystalline silicon PV modules which shall be rated above 320Wp having efficiency not less than 17 %, DC distribution box with necessary protection, power conditioning system, charge control unit, necessary KWp 3 phase string Inverters of suitable capacity with maximum power point tracker/Tracking (MPPT) feature/web based remote monitoring system .Inverter shall be provided with protection against islanding of Grid as per IEEE 7547 /UL174/62116 to isolate it from the grid in case of no supply, under voltage and over voltage conditions so that solar power shall not feed to grid, output AC distribution box with 4 pole MCCBs with thermal over current and earth fault releases, Class 1+2 surge protective device, Fuses for protection, over voltage protection.AC Distribution box, DC Distribution box and inverters shall be IP65 or Higher.Energy meter should be provide for recording Solar power generation. The item shall include all the mounting accessories (Hot dip galvanized with galvanization thickness greater than 120 microns) for the PV module for withstanding 150km/hr wind speed, necessary control cabling to the power conditioning unit, inverter, distribution box, Panels etc. as required. The work shall be executed by MNRE accredited channel partners for the On-grid and de-centralised solar application. The subsidy allocated by the government for the solar system shall be availed to the client. All the materials used shall be approved makes from MNRE. When grid connected system is producing more power than is being consumed, the surplus should be exported into the main power grid with the help of an Inverter & bi-directional HT Meter with CT/PT, accuracy class as per the central Electricity Authority (installation and operation of Meters) Regulations, 2006 and technical specifications of KSEBL. The PR test shall be conducted at site as per IEC 61724 and the performance ratio of the solar plant shall be minimum 75 % for the warranty period. All necessary approvals for satisfactory operation of the system should be obtained from State Electricity Board and CEIG .The complete system shall have minimum 5 years warranty and solar panels shall have minimum 25 years warranty.	Job	1	35,764.00	35764.00
Total					**35764.00**

D.9 Vessel costing

Sl. No.	Specification	Unit	Quantity	Cost	Amount
1	Procuring and commissioning of Modular ferry	Nos	2.00	₹ 10,000,000.00	₹ 20,000,000.00
Phase I Total					**₹ 20,000,000.00**

E Detail Estimates: Phase II

E.1 Abstract of Phase II Capex

Sl. No.	Description	Quantity	Unit	Cost	Total Amount
1	**Terminal at 4 locations**				
1.1a	Main terminal building	1.00	Nos	Rs. 2,263,022.00	Rs. 2,263,022.00
1.1b	Auxiliary terminal building	1.00	Nos	Rs. 598,302.00	Rs. 598,302.00
2	**Fairway development**				
2.1	Dredging	146798.10	Cubm	Rs. 200.00	Rs. 29,359,620.00
3	**Navigation andcommunication**				
3.1	Vhf radio		Ls	Rs. 250,000.00	Rs. 250,000.00
4	**Aids to navigation**	3.00	Nos	Rs. 20,000.00	Rs. 60,000.00
5	**Landscaping**		Ls	Rs. 150,000.00	Rs. 150,000.00
6	**Utility shifting**		Ls	Rs. 150,000.00	Rs. 150,000.00
7	**Auxilliary items**				Rs. 500,000.00
7.1	Electrical			86,732.00	Rs. 173464.00
7.2	Plumbing			31,444.00	Rs. 62888.00
7.3	Fencing			131,824.00	Rs. 263648.00
8	**Modular ferry vessel**	1.00	Nos	Rs. 10,000,000.00	Rs. 10,000,000.00
	Total cost for Phase II				**Rs. 43,330,944.00**
RUPEES FOUR CRORE THIRTY THREE LAKH NINE HUNDRED AND FOURTY FOUR ONLY					

E.2 Detail cost estimate and specifications of main terminal building

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.				
	All kinds of soil	Cum	22.00	₹ 166.40	₹ 3,660.80
2	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum	16.00	₹ 125.75	₹ 2,012.00
3	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum	1.00	₹ 4,478.15	₹ 4,478.15
4	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All works upto plinth level	Cum	16.00	₹ 6,446.45	₹ 103,143.20
5	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All work above plinth level upto floor V level	Cum	11.00	₹ 7,250.05	₹ 79,750.55
6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.				

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
	Thermo-Mechanically Treated bars of grade Fe-500D or more	kg	2538.00	₹ 56.60	₹ 143,650.80
7	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level				
	Thermo-Mechanically Treated bars of grade Fe500 or more	kg	1884.00	₹ 56.60	₹ 106,634.40
8	Centering and shuttering including strutting, propping, etc., and removal of form for				
8.a	Foundations, footings, bases of columns, etc., for mass concrete.	Sqm	31.00	₹ 193.95	₹ 6,012.45
8.b	Lintels, beams, plinth beams, girders, bressumers and cantilevers.	Sqm	127.00	₹ 342.90	₹ 43,548.30
8.c	Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	36.00	₹ 467.85	₹ 16,842.60
9	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)	Cum	44.00	₹ 10,148.60	₹ 446,538.40
10	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :	Sqm	82.00	₹ 1,158.10	₹ 94,964.20
	25 mm thick.				
11	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm	18.00	₹ 688.35	₹ 12,390.30
12	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete	Sqm	66.00	₹ 744.80	₹ 49,156.80

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)
13	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)	Sqm	383.00	₹ 226.80	₹ 86,864.40
14	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade	Sqm	109.00	₹ 84.35	₹ 9,194.15
15	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications				
	Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm	Sqm	275.00	₹ 98.95	₹ 27,211.25
16	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :				
16.a	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	125.00	₹ 384.50	₹ 48,062.50
16.b	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).				
	Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	196.00	₹ 444.90	₹ 87,200.40
17	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge				
	Pre-laminated particle board with decorativelamination on both sides	Sqm	22.00	₹ 866.60	₹ 19,065.20
18	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):				

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
	With float glass panes of 4.0 mm thickness	Sqm	48.00	₹ 741.50	₹ 35,592.00
19	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.	Rm	29.00	₹ 438.75	₹ 12,723.75
20	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per direction of Engineer -in-charge, manufacture's specification & drawing.				
	30 mm thick pre laminated PVC door shutters	Sqm	9.00	₹ 3,232.70	₹ 29,094.30
21	Supplying and fixing rolling shutters of approved make, made of required size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation complete, including the cost of providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 and M.S. top cover of required thickness for rolling shutters.80x1.25 mm M.S. laths with 1.25 mm thick top cover	Sqm	20.00	₹ 2,316.10	₹ 46,322.00

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
22	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	4511.00	₹ 67.65	₹ 305,169.15
23	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.				
	1.00 mm thick with zinc coating not less than 275 gm/m2	Sqm	105.00	₹ 957.95	₹ 100,584.75
24	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path & courtyard jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)	Sqm	35.00	₹ 878.60	₹ 30,751.00
25	Electrical Arrangemnt	5.25%	5.25% of estimate		₹ 102,407.43
26	Plumbing Arrangements	5.25%	5.25% of estimate		₹ 102,407.43
27	Contigencies	5.00%	5.00% of estimate		₹ 107,588.59
					₹ 2,263,021.26
			Total Rounded to		**₹ 2,263,022.00**

Total In Words - Twenty Two Lakhs Sixty Three Thousand and Twenthy Two Rupees

E.3 Detail quantity estimates of main terminal building

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
1	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.	Cum					
		All kinds of soil		6.00	1.30	1.30	2.10	21.29
						Total		21.29
						Total Rounded To		22.00
2	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum					
		Earthwork excavation						21.29
		Dedcutions						
		Footing		6.00	1.20	1.20	0.50	4.32
		Pedestral		6.00	0.60	0.30	1.50	1.62
						Total		15.35
						Total Rounded To		16.00
3	4.1.8	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum					
				6.00	1.20	1.20	0.10	0.86
						Total		0.86
						Total Rounded To		1.00
4	5.33.1	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete,	Cum					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All works upto plinth level						
		Footings		6.00	1.20	1.20	0.50	4.32
		Plinth Beam						
		Horizontal		1.00	33.00	0.30	0.45	4.46
		Vertical		1.00	37.00	0.30	0.45	5.00
		Pedestral		6.00	0.60	0.30	1.50	1.62
						Total		15.39
						Total Rounded To		16.00
5	5.33.2	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All work above plinth level upto floor V level						
		Columns		6.00	0.60	0.30	3.30	3.56
		Beams - 230 X 300						
		Horizontal		1.00	33.00	0.23	0.30	2.28
		Vertical		1.00	17.00	0.23	0.30	1.17
		Beams - 300 X 450		1.00	20.00	0.30	0.45	2.70
		Lintels						
		Window - W1		4.00	1.90	0.23	0.30	0.52
		Doors - D1		2.00	1.25	0.23	0.30	0.17
		Doors - D2		5.00	1.10	0.12	0.30	0.20
		Doors - D3		2.00	0.90	0.23	0.30	0.12
		Ventilator - V1		1.00	1.60	0.23	0.30	0.11
		Window - W2		1.00	2.00	0.23	0.30	0.14
						Total		10.98
						Total Rounded To		11.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
6	5.22.6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.						
		Thermo-Mechanically Treated bars of grade Fe-500D or more	kg					
		Footings @ 175 kg per cum		175.00			4.32	756.00
		Column Peddestral @ 225 kg per cum		225.00			1.62	364.50
		Plinth Beam @ 150 kg per cum		150.00			9.45	1417.50
						Total		2538.00
						Total Rounded To		2538.00
7	5.22.6.A	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level						
		Thermo-Mechanically Treated ibars of grade Fe500 or more	kg					
		Columns @ 225 kg per cum		225.00			3.56	801.90
		Beams @ 150 kg per cum		150.00			6.15	922.50
		Lintels @ 125 kg per cum		125.00			1.27	158.44
						Total		1882.84
						Total Rounded To		1884.00
8		Centering and shuttering including strutting, propping, etc., and removal of form for						
8.a	5.9.1	Foundations, footings, bases of columns, etc., for mass concrete.						
		Footings		6.00	1.20	1.20	0.50	14.40
		Column Pedestral		6.00	0.60	0.30	1.50	16.20
						Total		30.60
						Total Rounded To		31.00
8.b	5.9.5	Lintels, beams, plinth beams, girders, bressumers and cantilevers.						
		Plinth Beams						
		Horizontal		1.00	33.00	0.30	0.45	29.70
		Vertical		1.00	37.00	0.30	0.45	33.30
		Beams - 230 X 300						
		Horizontal		1.00	33.00	0.23	0.30	19.80
		Vertical		1.00	17.00	0.23	0.30	10.20
		Beams - 300 X 450		1.00	20.00	0.30	0.45	18.00
		Lintels						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Window - W1		4.00	1.90	0.23	0.30	6.31
		Doors - D1		2.00	1.25	0.23	0.30	2.08
		Doors - D2		5.00	1.10	0.12	0.30	3.96
		Doors - D3		2.00	0.90	0.23	0.30	0.12
		Ventilator - V1		1.00	1.60	0.23	0.30	1.33
		Window - W2		1.00	2.00	0.23	0.30	1.66
						Total		126.46
						Total Rounded To		127.00
8.c	5.9.6	Columns, Pillars, Piers, Abutments, Posts and Struts						
		Columns		6.00	0.60	0.30	3.30	35.64
						Total		35.64
						Total Rounded To		36.00
9	4.7.1	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)						
		Vertical						
		Main Wall		2.00	10.00	0.23	3.30	15.18
		Toilet		1.00	3.00	0.12	3.30	1.19
				1.00	4.00	0.12	3.30	1.58
		Office		1.00	4.00	0.23	3.30	3.04
		Crew Waiting		1.00	3.00	0.23	1.20	0.83
		Horizontal						
		Main Wall		1.00	10.00	0.23	3.30	7.59
		Toilet		1.00	3.00	0.12	3.30	1.19
		Office		2.00	4.00	0.23	3.30	6.07
		Shop		2.00	2.00	0.23	3.30	3.04
		Crew Waiting		1.00	4.00	0.23	3.30	3.04
		Toilets						
				5.00	1.00	0.12	3.30	1.98
				1.00	4.00	0.12	3.30	1.58
				5.00	1.00	0.12	3.30	1.98
		Deductions						
		Window - W1		-4.00	1.50	0.23	1.20	-1.66
		Doors - D1		-2.00	1.00	0.23	2.10	-0.97
		Doors - D2		-5.00	0.80	0.12	2.10	-1.01

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Doors - D3		-2.00	0.90	0.23	2.10	-0.87
		Ventilator - V1		-1.00	1.20	0.23	0.45	-0.12
		Window - W2		-1.00	1.50	0.23	1.50	-0.52
						Total		43.14
						Total Rounded To		44.00
10	11.26.1	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :						
		25 mm thick.	Sqm					
		Building		1.00	10.00	10.00	-	100.00
		Deduct Toilets						-18.00
						Total		82.00
						Total Rounded To		82.00
11	11.37	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm					
		Toilet		1.00	4.00	3.00		12.00
				1.00	3.00	2.00		6.00
						Total		18.00
						Total Rounded To		18.00
12	11.36	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Toilet		1.00	4.00	3.00	2.10	29.40
				5.00	1.00	-	2.10	10.50
				5.00	0.20	-	2.10	2.10
				1.00	1.00	-	2.10	2.10
				1.00	1.00	-	2.10	2.10
				2.00	4.00	-	2.10	16.80
				2.00	0.60	-	2.10	2.52
						Total		65.52
						Total Rounded To		66.00
13	13.7.1	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)						
		External						
				2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
		Internal		2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	2.00	-	3.30	13.20
				2.00	3.00	-	3.30	19.80
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-14.40
		Doors - D1		-2.00	1.00	-	2.10	-8.40
		Doors - D2		-5.00	0.80	-	2.10	-16.80
		Doors - D3		-2.00	0.90	-	2.10	-7.56
		Ventilator - V1		-1.00	1.20	-	0.45	-1.08
		Window - W2		-1.00	1.50	-	1.50	-4.50
						Total		382.86

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
						Total Rounded To		383.00
14	13.60	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade						
		External						
				2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-7.20
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
		Window - W2		-1.00	1.50	-	1.50	-2.25
						Total		108.81
						Total Rounded To		109.00
15	13.48.1	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications						
		Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm						
		Internal		2.00	10.00	-	3.30	66.00
				1.00	10.00	-	3.30	33.00
				1.00	4.00	-	3.30	13.20
				1.00	2.00	-	3.30	6.60
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	4.00	-	3.30	26.40
				2.00	3.00	-	3.30	19.80
				2.00	2.00	-	3.30	13.20
				2.00	3.00	-	3.30	19.80
		Dedcutions						
		Window - W1		-4.00	1.50	-	1.20	-7.20
		Doors - D1		-2.00	1.00	-	2.10	-8.40
		Doors - D2		-5.00	0.80	-	2.10	-16.80

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Doors - D3		-2.00	0.90	-	2.10	-7.56
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
		Window - W2		-1.00	1.50	-	1.50	-2.25
						Total		274.05
						Total Rounded To		275.00
16	21.1.1	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :						
16.a	21.1.1.2	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg					
		Windows						
		Window - W1	m	4.00	1.50	-	1.20	21.60
				2.00	-	-	1.20	2.40
		Ventilator - V1		1.00	1.20	-	0.45	3.30
				2.00	-	-	0.45	0.90
		Window - W2		1.00	1.50	-	1.50	6.00
				2.00	-	-	1.50	3.00
		Doors						
		D1		2.00	1.20	-	2.10	13.20
		D3		2.00	0.90	-	2.10	12.00
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		124.80
						Total Rounded To		125.00
16.b	21.1.2.2	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).	kg					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Powder coated aluminium (minimum thickness of powder coating 50 micron)						
		Windows						
		Window - W1	m	4.00	0.50	-	1.20	40.80
		Ventilator - V1		1.00	0.60	-	0.45	4.20
		Window - W2		1.00	0.50	-	1.50	12.00
		Doors						
		D1		2.00	1.20	-	2.10	13.20
		D3		2.00	0.90	-	2.10	12.00
		Ticket Counter		1.00	4.00	-	2.50	13.00
				1.00	-	-	2.50	2.50
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		195.40
						Total Rounded To		196.00
17	21.2.2	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge						
		Pre-laminated particle board with decorativelamination on both sides	Sqm					
		Doors						
		D1		2.00	1.20	-	1.10	9.20
		D3		2.00	0.90	-	2.10	12.00
						Total		21.20
						Total Rounded To		22.00
18	21.3.1	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):						
		With float glass panes of 4.0 mm thickness	Sqm					
		Window - W1		4.00	0.50	-	1.20	7.20
		Ventilator - V1		1.00	0.60	-	0.45	0.54
		Window - W2		1.00	0.50	-	1.50	2.25
		Door - D3		2.00	1.20	-	1.00	7.20

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Ticket Counter		1.00	4.00	-	2.50	30.00
						Total		47.19
						Total Rounded To		48.00
19	9.119	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.	Rm					
		Doors - D2		5.00	0.80	-	2.10	29.00
						Total		29.00
						Total Rounded To		29.00
20	9.120.2	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the	Sqm					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per direction of Engineer -in-charge, manufacture's specification & drawing.						
		30 mm thick pre laminated PVC door shutters						
		Doors - D2		5.00	0.80	-	2.10	8.40
						Total		8.40
						Total Rounded To		9.00
21	10.6.1	Supplying and fixing rolling shutters of approved make, made of required size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation complete, including the cost of providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 and M.S. top cover of required thickness for rolling shutters.80x1.25 mm M.S. laths with 1.25 mm thick top cover	Sqm					
		Entry		1.00	4.00	-	3.30	13.20
		Shop		1.00	2.00	-	3.30	6.60
						Total		19.80
						Total Rounded To		20.00
22	10.2	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg					
		Truss					kg/sqft	
		Assuming 4 kf per sft		2.00	10.00	5.23	4.00	4510.35
						Total		4510.35
						Total Rounded To		4511.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
23	12.1.1	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.						
		1.00 mm thick with zinc coating not less than 275 gm/m2						
		Roofing Sloped half portion		2.00	10.00	5.23	-	104.60
						Total		104.60
						Total Rounded To		105.00
24	11.20.2	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)						
		Road to walkway		1.00	10.00	3.50	-	35.00
						Total		35.00
						Total Rounded To		35.00

E.4 Detail cost estimate and specifications of auxiliary terminal building

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.				
	All kinds of soil	Cum	4.00	₹ 166.40	₹ 665.60
2	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum	2.00	₹ 125.75	₹ 251.50
3	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum	3.00	₹ 4,478.15	₹ 13,434.45
4	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All works upto plinth level	Cum	7.00	₹ 6,446.45	₹ 45,125.15
5	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.				
	All work above plinth level upto floor V level	Cum	5.00	₹ 7,250.05	₹ 36,250.25
6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.				

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
	Thermo-Mechanically Treated bars of grade Fe-500D or more	kg	951.00	₹ 56.60	₹ 53,826.60
7	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level				
	Thermo-Mechanically Treated bars of grade Fe500 or more	kg	767.00	₹ 56.60	₹ 43,412.20
8	Centering and shuttering including strutting, propping, etc., and removal of form for				
8.a	Foundations, footings, bases of columns, etc., for mass concrete.	Sqm	27.00	₹ 193.95	₹ 5,236.65
8.b	Lintels, beams, plinth beams, girders, bressumers and cantilevers.	Sqm	36.00	₹ 342.90	₹ 12,344.40
8.c	Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	30.00	₹ 467.85	₹ 14,035.50
9	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)	Cum	10.00	₹ 10,148.60	₹ 101,486.00
10	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :	Sqm	14.00	₹ 1,158.10	₹ 16,213.40
	25 mm thick.				
11	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching pigment etc., complete in wash and toilet area	Sqm	5.00	₹ 688.35	₹ 3,441.75
12	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing	Sqm	19.00	₹ 744.80	₹ 14,151.20

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)
	in white cement mixed with pigment of matching shade complete				
13	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)	Sqm	41.00	₹ 226.80	₹ 9,298.80
14	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade	Sqm	37.00	₹ 84.35	₹ 3,120.95
15	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications				
	Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm	Sqm	54.00	₹ 98.95	₹ 5,343.30
16	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :				
16.a	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	31.00	₹ 384.50	₹ 11,919.50
16.b	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).				
	Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg	61.00	₹ 444.90	₹ 27,138.90

			Cost Index		1.00
Sl. No.	**Specification**	**Unit**	**Quanity**	**DSR 16 Cost**	**Amount (With Cost Index)**
17	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge				
	Pre-laminated particle board with decorativelamination on both sides	Sqm	6.00	₹ 866.60	₹ 5,199.60
18	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of aluminium snap beading shall be paid in basic item):				
	With float glass panes of 4.0 mm thickness	Sqm	3.00	₹ 741.50	₹ 2,224.50
19	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 Nos. of 150 mm long brackets of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door fame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in Charge.	Rm	8.00	₹ 438.75	₹ 3,510.00
20	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes of 19 gauge thickness and sized of 19 mm x 19 mm for styles and 15x15 mm for top & bottom rails. M.S. frame shall have a coat of steel primers of approved make and manufacture. M.S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness, 70 mm width out of which 50 mm shall be flat and 20 mm shall be tapered in 45 degree angle on both side forming styles and 5mm thick, 95 mm wide PVC sheet out of which75 mm shall be tapered in 45 degree on th inner side to form top and bottom rail and 115 mm wide PVC sheet out of which 75 mm shall be flat and 20 mm shall be tapered on both sides to form lock rail. Top, bottom and lock rails shall be provided both side of the panel. 10 mm (5 mmx2) thick, 20 mm wide cross PVC sheet be provided as gap insert for top rail & bottom rail. paneling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded /sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strip of 20 mm width is to be stuck on the interior side of the 'C' Channel using PVC solvent adhesive etc. complete as per				

			Cost Index		1.00
Sl. No.	Specification	Unit	Quanity	DSR 16 Cost	Amount (With Cost Index)
	direction of Engineer -in-charge, manufacture's specification & drawing.				
	30 mm thick pre laminated PVC door shutters	Sqm	4.00	₹ 3,232.70	₹ 12,930.80
21	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	583.00	₹ 67.65	₹ 39,439.95
22	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.				
	1.00 mm thick with zinc coating not less than 275 gm/m2	Sqm	18.00	₹ 957.95	₹ 17,243.10
23	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path & courtyard jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)	Sqm	21.00	₹ 878.60	₹ 18,450.60
24	Electrical Arrangemnt	5.25%	5.25% of estimate		₹ 27,073.97
25	Plumbing Arrangements	5.25%	5.25% of estimate		₹ 27,073.97
26	Contigencies	5.00%	5.00% of estimate		₹ 28,458.85
					₹ 598,301.44
			Total Rounded to		**₹ 598,302.00**

Total In Words - Five Lakh Ninety Eight Thousand Three Hundred and Two Rupees

E.5 Detail quantity estimates of auxiliary terminal building

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
1.00	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan) including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.	Cum					
		All kinds of soil		6.00	0.75	0.75	1.00	3.38
						Total		3.38
						Total Rounded To		4.00
2.00	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.	Cum					
		Earthwork excavation						3.38
		Dedcutions						
		Footing		6.00	0.75	0.75	0.50	1.69
		Pedestral		6.00	0.45	0.30	0.50	0.41
						Total		1.28
						Total Rounded To		2.00
3.00	4.1.8	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: using 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size)	Cum					
				6.00	0.75	0.75	1.00	3.38
						Total		3.38
						Total Rounded to		3.00
4.00	5.33.1	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but iexcluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without	Cum					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		impairing strength and durability as per directionof Engineer-in-charge.						
		All works upto plinth level						
		Footings		6.00	0.75	0.75	1.00	3.38
		Plinth Beam						
		Horizontal		1.00	15.00	0.20	0.35	1.05
		Vertical		1.00	9.00	0.20	0.35	0.63
		Pedestal		6.00	0.45	0.30	1.50	1.22
						Total		6.27
						Total Rounded To		7.00
5.00	5.33.2	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix,ncluding pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate,retard setting of concrete, improve workability without impairing strength and durability as per directionof Engineer-in-charge.						
		All work above plinth level upto floor V level						
		Columns		6.00	0.45	0.30	3.30	2.67
		Beams - 230 X 300						
		Horizontal		1.00	15.00	0.23	0.30	1.04
		Vertical		1.00	9.00	0.23	0.30	0.62
		Lintels						
		Window - W1		1.00	1.90	0.23	0.30	0.13
		Doors - D1		1.00	1.25	0.23	0.30	0.09
		Ventilator - V1		1.00	1.60	0.23	0.30	0.11
						Total		4.66
						Total Rounded To		5.00
6.00	5.22.6	Steel reinforcement for R.C.C. work including straightening, cutting,bending, placing in position and binding all complete upto plinth level.						
		Thermo-Mechanically Treated bars of grade Fe-500D or more	kg					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Footings @ 150 kg per cum		150.00			3.38	506.25
		Column Peddestral @ 200 kg per cum		200.00			1.22	243.00
		Plinth Beam @ 120 kg per cum		120.00			1.68	201.60
						Total		950.85
						Total Rounded To		951.00
7.00	5.22.6.A	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete above plinth level						
		Thermo-Mechanically Treated ibars of grade Fe500 or more	kg					
		Columns @ 200 kg per cum		200.00			2.67	534.60
		Beams @ 120 kg per cum		120.00			1.66	198.72
		Lintels @ 100 kg per cum		100.00			0.33	32.78
						Total		766.10
						Total Rounded To		767.00
8.00		Centering and shuttering including strutting, propping, etc., and removal of form for						
8.a	5.9.1	Foundations, footings, bases of columns, etc., for mass concrete.						
		Footings		6.00	0.75	0.75	1.00	18.00
		Column Pedestral		6.00	0.45	0.30	1.00	9.00
						Total		27.00
						Total Rounded To		27.00
8.b	5.9.5	Lintels, beams, plinth beams, girders, bressumers and cantilevers.						
		Plinth Beams						
		Horizontal		1.00	15.00	0.20	0.35	10.50
		Vertical		1.00	9.00	0.20	0.35	6.30
		Beams - 230 X 300						
		Horizontal		1.00	15.00	0.23	0.30	9.00
		Vertical		1.00	9.00	0.23	0.30	5.40
		Lintels						
		Window - W1		1.00	1.90	0.23	0.30	1.58
		Doors - D1		1.00	1.25	0.23	0.30	1.04
		Ventilator - V1		1.00	1.60	0.23	0.30	1.33
						Total		35.14
						Total Rounded To		36.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
8.c	5.9.6	Columns, Pillars, Piers, Abutments, Posts and Struts						
		Columns		6.00	0.45	0.30	3.30	29.70
						Total		29.70
						Total Rounded To		30.00
9.00	4.7.1	Providing and fixing up to floor five level precast cement concrete solid block, including hoisting and setting in position with cement mortar 1:3 (1 cement :3 coarse sand), cost of required centering, shuttering complete;1:1½:3 (1 Cement: 1½ coarse sand(zone-III) : 3 graded stone aggregate 20 mm ominal size)						
		Main Wall		4.00	3.00	0.23	3.30	9.11
		Toilet		1.00	3.00	0.12	3.30	1.19
		Deductions						
		Window - W1		-1.00	1.50	0.23	1.20	-0.41
		Doors - D1		-1.00	1.00	0.23	2.10	-0.48
		Ventilator - V1		-1.00	1.20	0.23	0.45	-0.12
						Total		9.27
						Total Rounded To		10.00
10.00	11.26.1	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :						
		25 mm thick.	Sqm					
		Building		1.00	6.00	3.00	-	18.00
		Deduct Toilets						-4.50
						Total		13.50
						Total Rounded To		14.00
11.00	11.37	Providing and laying Antiskid Ceramic floor tiles of size 300x300 mm ofapproved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement andmatching	Sqm					

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		pigment etc., complete in wash and toilet area						
		Toilet		1.00	1.50	3.00		4.50
						Total		4.50
						Total Rounded To		5.00
12.00	11.36	Providing and fixing Ist quality ceramic glazed wall tiles conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades except burgundy, bottle green, black of any size as approved by Engineer-in-Charge, in skirting, risers of steps and dados, over 12 mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3kg per sqm, including pointing in white cement mixed with pigment of matching shade complete						
		Toilet		1.00	1.50	3.00	2.10	18.90
						Total		18.90
						Total Rounded To		19.00
13.00	13.7.1	12 mm cement plaster finished with a floating coat of neat cement of mix1:4 (1 cement: 4 fine sand)						
		External						
				4.00	3.00	-	3.30	39.60
		Internal		1.00	3.00	-	3.30	9.90
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-3.60
		Doors - D1		-1.00	1.00	-	2.10	-4.20
		Ventilator - V1		-1.00	1.20	-	0.45	-1.08
						Total		40.62
						Total Rounded To		41.00
14.00	13.60	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade						
		External						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
				4.00	3.00	-	3.30	39.60
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-1.80
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
						Total		37.26
						Total Rounded To		37.00
15.00	13.48.1	Finishing with Deluxe Multi surface paint system for interiors and exteriors using Primer as per manufacturers specifications						
		Two or more coats applied on walls @ 1.25 ltr/10 sqm over and including one coat of Special primer applied @ 0.75 ltr /10 sqm						
		Internal		6.00	3.00	-	3.30	59.40
		Dedcutions						
		Window - W1		-1.00	1.50	-	1.20	-1.80
		Doors - D1		-1.00	1.00	-	2.10	-4.20
		Ventilator - V1		-1.00	1.20	-	0.45	-0.54
						Total		52.86
						Total Rounded To		54.00
16.00	21.1.1	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) :						
16.a	21.1.1.2	For Fixed Portion - Powder coated aluminium (minimum thickness of powder coating 50 micron)	kg					
		Windows						
		Window - W1	m	1.00	1.50	-	1.20	5.40

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		Ventilator - V1		1.00	1.20	-	0.45	3.30
		Doors						
		D1		1.00	1.20	-	2.10	6.60
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		30.60
						Total Rounded To		31.00
16.b	21.1.2.2	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately).	kg					
		Powder coated aluminium (minimum thickness of powder coating 50 micron)						
		Windows						
		Window - W1	m	1.00	0.50	-	1.20	10.20
		Ventilator - V1		1.00	0.60	-	0.45	4.20
		Doors						
		D1		2.00	1.20	-	2.10	13.20
				1.00	-	-	2.50	2.50
		Assuming the weight to be 2 kg/m	kg/m	2.00				
						Total		60.20
						Total Rounded To		61.00
17.00	21.2.2	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade l Type ll, in panelling fixed in aluminum doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of engineer-in-charge						
		Pre-laminated particle board with decorativelamination on both sides	Sqm					
		Doors						
		D1		1.00	1.20	-	1.10	4.60
						Total		4.60
						Total Rounded To		6.00
18.00	21.3.1	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge . (Cost of						

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
		aluminium snap beading shall be paid in basic item):						
		With float glass panes of 4.0 mm thickness	Sqm					
		Window - W1		1.00	0.50	-	1.20	1.80
		Ventilator - V1		1.00	0.60	-	0.45	0.54
						Total		2.34
						Total Rounded To		3.00
19.00	10.2	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg					
		Truss					kg/sqft	
		Assuming2 kf per sft		2.00	6.00	1.50	3.00	582.12
						Total		582.12
						Total Rounded To		583.00
20.00	12.1.1	Providing corrugated G.S. sheet roofing including vertical / curved surfacefixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.						
		1.00 mm thick with zinc coating not less than 275 gm/m2						
		Roofing Sloped half portion		2.00	6.00	1.50	-	18.00
						Total		18.00
						Total Rounded To		18.00

Sl No	Item No	Decription of Work	Unit	No	L	B	H	Quantity
21.00	11.20.2	Chequerred precast cement concrete tiles 22mm thick (tiles should be of approved make like ULTRA / EUROCON or equivalent as per direction of engineer in charge) in foot path jointed with neat cement slurry mixed with pigment to match the shade of tiles including rubbing and cleaning etc. complete on 20mm thick bed of cement mortar 1:4 (1cement:4coarse sand:)						
		Road to walkway		1.00	6.00	3.50	-	21.00
						Total		21.00
						Total Rounded To		21.00

E.6 Detail estimate: cross bank dredging

Sl. No.	Specification	Unit	Quanity	Cost	Amount
1	Dredging and deepening in all classes of soil using closed type grab dredger and removing sand, clay,silt, debris, piece of nets, other waste or mixture or combination of two or more including removing all obstacles such as small rocks scattered granite, wood pieces, piece of net etc and depositing this material using bottom open barge and conveying this to sea beyond 3 km and upto 5 km for depositing in sea , as per the direction of departmental officers at site including all hire charges of tools, plants, equipments, accessories, incidental charges, labour charges and all service taxes etc complete. for dredging upto -4.5m bedlevel with respect to CD				
		Cum	146798.10	₹ 200.00	₹ 29,359,620.00
	PHASE II Total Rounded To				**₹ 29,359,620.00**

E.7 Estimate of navigation and communication aids

E.7.1 Navigation aids

Sl. No.	Specification	Unit	Quantity	Cost	Amount
1	Installation of conventional marking made of bamboo strips	Nos	3.00	₹ 20,000.00	₹ 60,000.00
Phase II Total					**₹ 60,000.00**

E.7.2 VHF Radio

Sl. No.	Specification	Unit	Cost	Amount
1	Supply, installation and commissioning of VHF radio for communication for one terminal(Phase II)	LS	₹ 2,50,000.00	₹ 2,50,000.00
Phase II Total				₹ 2,50,000.00

E.8 Detail cost estimate and specifications Auxiliary items

E.8.1 Abstract

Sl No	Item Description	Amount in Rs
1	Electrical	86,732.00
2	Plumbing	31,444.00
3	Fencing	131,824.00
	Total	250,000.00
	No of terminal blocks	2.00
Grand total		**500,000.00**

E.8.2 Detail estimate of electrification

DSR ITEMS						
Sl. No	**DSR No.**	**Description**	**Unit**	**Qty**	**Rate in Rs**	**Amount in Rs**
1	1.10.3	Wiring for light point/ fan point/ exhaust fan point/ call bell point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit, with modular switch, modular plate, suitable GI box and earthing the point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable etc. as required.	Point	11	984.10	10,825.10
2		Wiring for circuit/ submain wiring alongwith earth wire with the following sizes of FRLS PVC insulated copper conductor, single core cable in surface/ recessed medium class PVC conduit as required.				-
3	1.14.1	2 x 1.5 sq.mm + 1 x1.5 sq.mm earth wire	m	20.00	145.46	2,909.20
4	1.14.2	2 x 2.5 sq.mm + 1 x 2.5 sq.mm earth wire	m	10.00	178.10	1,781.00
5	1.14.3	2 x 4 sq.mm +1 x 4 sq.mm earth wire	m	8.00	218.14	1,745.12
6		Supplying and fixing of following sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required.				-
7	1.21.1	20 mm	m	10	74.10	741.00
8	1.21.2	25 mm	m	20	89.70	1,794.00
9	1.25	Supplying and fixing two module stepped type electronic fan regulator on the existing modular plate switch box including connections but excluding modular plate etc. as required.	Each	4	374.40	1,497.60
10	1.27	Supplying and fixing following size/ modules, GI box alongwith modular base & cover plate for modular switches in recess etc. as required.				-
11	1.27.1	1 or 2 Module (75mm x 75mm)	Each	3	227.50	682.50
12	1.27.2	3 Module (100mm x 75mm)	Each	2	240.50	481.00
13						-
14		Supplying and fixing following modular switch/ socket on the existing modular plate & switch box including connections but excluding modular plate etc. as required.				-
15	1.24.4	3 pin 5/6 A socket outlet	Each	2	105.30	210.60
16	1.24.5	6 pin 15/16 A socket outlet	Each	2	199.00	398.00
17	1.31	Supplying and fixing suitable size GI box with modular plate and cover in front on surface or in recess, including providing and fixing 3 pin 5/6 A modular socket outlet and 5/6 A modular switch, connections etc. as required.	Each	3	407.00	1,221.00
18						-

DSR ITEMS						
Sl. No	**DSR No.**	**Description**	**Unit**	**Qty**	**Rate in Rs**	**Amount in Rs**
19	1.32	Supplying and fixing suitable size GI box with modular plate and cover in front on surface or in recess, including providing and fixing 6 pin 5/6 A & 15/16 A modular socket outlet and 15/16 A modular switch, connections etc. as required.	Each	2	528.00	1,056.00
20	1.41	Installation, testing and commissioning of pre-wired, fluorescent/LED fitting / compact fluorescent/LED fitting of all types, complete with all accessories and tube/lamp etc. directly on ceiling/ wall/false ceiling, including connections with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable and earthing etc. as required.	Each	8	130.00	1,040.00
21	1.44	Installation, testing and commissioning of ceiling fan, including wiring the down rods of standard length (upto 30 cm) with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable etc. as required.	Each	4	136.50	546.00
22						-
23	1.50.1	Installation of exhaust fan upto 450mm in the existing opening, including making good the damage, connection, testing, commissioning etc. as required.	Each	1	291.20	291.20
24		Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 V, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/Isolator)			`	
25	2.3.3	12 way double door	Nos	1	1,496.30	1,496.30
26		Supplying and fixing of following ways surface/ recess mounting, vertical type, 415 V, TPN MCB distribution board of sheet steel, dust protected, duly powder painted, inclusive of 200 A, tinned copper bus bar, common neutral link, earth bar, din bar for mounting MCBs (but without MCBs and incomer) as required. (Note : Vertical type MCB TPDB is normally used where 3 phase outlets are required.)				-
27	2.5.1	4 way Double door	Each	1	5,852.60	5,852.60
28		Supplying and fixing 5 A to 32 A rating, 240/415 V, 10 kA, “C” curve, miniature circuit breaker suitable for inductive load of following poles in the existing MCB DB complete with connections, testing and commissioning etc. as required.				-
29	2.10.1	Single pole	Each	10	224.90	2,249.00
30	2.10.4	Triple pole	Each	2	910.00	1,820.00
31		Supplying and fixing following rating, double pole, 240 V, isolator in the existing MCB DB complete with connections, testing and commissioning etc. as required.				-
32	2.12.1	40A	Each	1	300.00	300.00
33	2.21	Providing and fixing M.V. danger notice plate of 200 mm X 150 mm, made of mild steel, at least 2 mm thick, and vitreous enameled white on both sides, and with inscription in single red colour on front side as required.	Each	1	194.00	194.00

DSR ITEMS						
Sl. No	**DSR No.**	**Description**	**Unit**	**Qty**	**Rate in Rs**	**Amount in Rs**
34	5.8	Supplying and laying 25 mm X 5 mm copper strip at 0.50 meter below ground as strip earth electrode, including connection/ terminating with nut, bolt, spring, washer etc. as required. (Jointing shall be done by overlapping and with 2 sets of brass nut bolt & spring washer spaced at 50 mm)	m	10	773.50	7,735.00
35	5.14	Providing and fixing 25 mm X 5 mm copper strip on surface or in recess for connections etc. as required.	m	10	907.40	9,074.00
36						-
37	5.50	Earthing with copper earth plate 600 mm X 600 mm X 3 mm thick including accessories, and providing masonry enclosure with cover plate having locking arrangement and watering pipe of 2.7 meter long etc. (but without charcoal/ coke and salt) as required.	No	2	7,500.00	15,000.00
38		Laying and fixing of one number PVC insulated and PVC sheathed / XLPE power cable of 1.1 kV grade of following size on wall surface as required.				-
39	7.7.1	Upto 35 sq. mm (clamped with 1mm thick saddle)	m	10	32.50	325.00
40	MR	Supply of LED Recessed Downlighter with a nominal system lumen output of 1300 lumens and a minimum system efficacy of 100 lm/W. Luminaire wattage should not exceed 13W. The luminaire should have a color temperature of 6500K and CRI>80. Driver of the luminaire shall have THD<10% and PF > 0.9. The heat sink should be made of die cast aluminium and the luminaire optics shall have a high efficiency PC diffuser. Luminaire cutout diameter should not be more than 135mm. The driver shall comply to IEC 62384 , IEC 61347-2-13, IEC 61547, EMI- CISPR15 standards. (Philips Make GreenLEDi "DN193B LED12S-6500 PSU WH S1" or equivalent)	No	5	1950	9,750.00
41	MR	Supply, installation, testing and commisioning of LED Bollard fixture including foundation with separate adequate size pipes in foundation for incoming and outgoing power cables and earth wires to the cable termination box of standard size of sintex make hard plastic box with IP 64 protection provided on the bottom of the fixture inside, suitable for landscape lighting with IP 65 protection and including all accessories as required for complete installation and making good any damages made during installation as instructed by engineer in charge. (Havells make LHEVBDP6IN6K008 or equivalent)	No	1	2500	2,500.00
42	MR	Supplying ceiling fan of 1200mm sweep, including the down rod of standard length (upto 30 cm.) of (havels make, ES 50 White or CG make, Riveria or equivalent).	No	1	1400	1,400.00
43	MR	Supply of exhaust fan of 250mm sweep in the existing opening, including making good the damage, connection, testing, commissioning etc. as required, including all accessories as rquired for complete installation incluidng shutter etc complete as required.(havells, Ventil Air DX White or equivalent)	No	1	1817	1,817.00

DSR ITEMS						
Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
Total						86,732.22

E.8.3 Detail estimate: Plumbing

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
1	MR	Providing and fixing white vitreous china Floor Mounted type water closet (European type W.C.pan) with seat and lid, 3/6 litre low level white vitrous Dual Flushing cistern and C.P flush bend with fitting and C.I brackets, 40mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design complete including painting of fittings and brackets, cutting and making good the walls and floors wherever required. Make: Hindware, Cera, Jaquar etc.., WC pan with ISI marked white solid plastic seat and lid (Lowest retail price not less than 4,000/each. Materials to be selected by the Engineer in charge)	Each	1	4892.00	4892.00
2	MR	Providing and fixing wash basin/ counter wash basin with CI / MS brackets, 15mm CP brass Pillar taps, 32mm CP brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls wherever required.: White Vitreous China Wash basin size 630 x 450mm with a single 15mm C.P brass piller tap. Make: Hindware, Cera, Jaquar etc.., (Lowest retail price of basin not less than Rs. 3000/each and Pillar tap not less than Rs. 1500/each. Materials to be selected by the Engineer in charge)	Each	1	3200.00	3200.00
3	18.7	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply including all CPVC plain & brass threaded fittings including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge**.** Make: Supreme, Finolex, Astral **Internal work - Exposed on wall**				
4	18.7.2	20 mm nominal outer dia .Pipes.	Metre	10.00	179.95	1799.50
5	18.7.3	25 mm nominal outer dia .Pipes	Metre	8.00	216.20	1729.60
6	18.7.4	32 mm nominal outer dia .Pipes.	Metre	5.00	289.05	1445.25
7	18.18	Providing and fixing ball valve (brass) of approved quality, High or low pressure, with plastic floats complete				
8	18.18.2	20 mm nominal bore	Each	1	327.05	327.05
9	18.18.3	25 mm nominal bore	Each	1	331.95	331.95
10	MR	Providing & fixing of CP **Health faucet. Hand operated spray unit (instand type).**Make:Jauqar, Hindware, Parryware, crome., (Lowest retail price not less than 1200/each. Materials to be selected by the Engineer in charge)	Set	1	1858.40	1858.40
11		Providing and fixing UPVC SWR pipe for soil, waste and vent pipe to IS : 13592 of SWR quality, including all fittings, like: Bends, Tees, Elbows, Collars, junction, inspection doors, clamps for fixing walls and slabs, flanged pipes for providing slab core cutting portion, vent cowls, offsets, access pipes, jointing with rubber ring / solvent cement by application of leak proof adhesive like FRP paste including cutting holes in walls and floors, chasing walls and floors and making good. clipping to walls and slabs, trenching, refilling etc. complete Make: Supreme, Finolex, Prince				
12	MR	110mm dia UPVC SWR Type B pipe	M	10	712.8	7128

Sl. No	DSR No.	Description	Unit	Qty	Rate in Rs	Amount in Rs
13	MR	Providing and fixing **PVC floor trap** self cleansing design with or without vent arm complete including cutting and making good the walls and floors. Make:Supreme,Finolex,Prince etc..,110mm dia inlet 110mm dia outlet	Each	1	732.80	732.80
14	MR	Supply, erection and commissioning of 0.5HP pump with design head & discharge including cost of valves, pressure gauge, specials and fittings etc. complete	LS	1	8000.00	8000.00
TOTAL						**31444.55**

E.8.4 Detail estimate: Fencing

Sl.no:	Price	Description	Unit	Quantity	Rate including cost index	Amount
1	2.8.1	Earth work in excavation by mechanical means (Hydraulic excavator) /manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift up to 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.All kinds of soil	Cum	4.50	₹ 216.32	₹ 973.44
2	*16.15.1*	Supplying at site RCC standard post/struts/rails/pales of mix 1:1.5:3 (1 cement:1.5 coarse sand:3 graded stone aggregate, 12.5mm nominal size) with wooden plugs or 6mm bar nibs wherever required as per direction of engineer in charge (cost of earthworks in excavations, concrete works in foundation to be paid seperately).	Cum	1.50	₹ 25,706.92	₹ 38,560.37
3	*4.1.5*	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level:1:3:6 (cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size)	Cum	3.00	₹ 6,405.10	₹ 19,215.30
4	*4.1.8*	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level:1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 nominal size)	Cum	1.00	₹ 5,821.60	₹ 5,821.60
5	*5.9.1*	Centering and shuttering including strutting, etc. and removal of form for:Foundations, footings, bases ofcolumns, etc for mass concrete	Sqm	4.50	₹ 252.14	₹ 1,134.61
6	*5.9.6*	Centering and shuttering including strutting, etc. and removal of form for:Columns, Pillars, Piers, Abutments, Posts and Struts	Sqm	7.00	₹ 608.21	₹ 4,257.44
7	*5.1.2*	Providing and laying in position specified grade of reinforced cement concrete, excluding the cost of centering, shuttering, finishing and reinforcement - All work up to plinth level:1:1:5:3 (1 cement 1.5 coarse sand :3 graded stone aggregate 20 mm nominal size	Cum	1.50	₹ 8,079.96	₹ 12,119.93

Sl.no:	Price	Description	Unit	Quantity	Rate including cost index	Amount
8	*5.22.6*	Steel reinforcement for R.C.C work including straightening, cutting, bending, placing in position and binding all complete upto plinth levelThermo - Mechanically Treated bars of grade Fe-500D or more.	Kg	110.00	₹ 73.58	₹ 8,093.80
9	*13.2.1*	15 mm cement plaster on the rough side of single or half brick wall of mix:1:4 (1 cement :4 fine sand)	Sqm	7.00	₹ 260.33	₹ 1,822.28
10	*13.46.1*	Finishing walls with Acrylic Smooth exterior paint of required shade:New work (Two or more coat applied @ 1.67 ltr/10 sqm over and including prming coat of exterior primer applied@2.20kg/10sqm.	Sqm	7.00	₹ 124.87	₹ 874.06
11	*10.16.1*	Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete.Hot finished welded type tubes	Kg	300.00	₹ 117.33	₹ 35,197.50
12	*16.17*	Fencing with R.C.C. post placed at required distance, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with horizontal lines and two diagonals of barbed wire weighing 9.38 kg per 100 metres (minimum), between the two posts fitted and fixed with G.I. staples on wooden plugs or G.I. binding wire tied to 6 mm bar nibs fixed while casting the post (cost of R.C.C. posts, struts, earth work and concrete to be paid for separately) :- Payment to be made per metre cost of total length of barbed wire used.				
	16.17.1	With G.I. barbed wire	Rm	350.00	₹ 10.73	₹ 3,753.75
						₹ 131,824.06
	TOTAL					**₹ 131,824.06**

E.9 Vessel cost estimate

Sl. No.	Specification	Unit	Quantity	Cost	Amount
2	Procuring and commissioning of Modular ferry (PHASE II)	Nos	1.00	₹ 10,000,000.00	₹ 10,000,000.00
Phase II Total					**₹ 10,000,000.00**
RUPEES ONE CRORE ONLY					

E.10 Rate analysis

Sl. No.	Ref.	Item of work	Unit	Quantity	Rate	Amount	Remarks
1.1	MoRTH/12.40	Supplying, Fitting and Placing un-coated HYSD bar Reinforcement in Foundation complete as per Drawing and Technical Specifications.					
		Unit = 1 MT					
		Taking output = 1 MT					
		a) Material					
		HYSD bars including5 per cent overlaps and wastage	tonne	1.05	₹ 46,200.00	₹ 48,510.00	M-082
		Binding wire	Kg	6	₹ 53.00	₹ 318.00	M-072
		b) Labour for cutting, bending, shifting to site, tying and placing in position					
		Mate	day	0.4	₹ 363.00	₹ 145.20	L-12
		Blacksmith	day	2	₹ 435.00	₹ 870.00	L-02
		Mazdoor	day	6	₹ 329.00	₹ 1,974.00	L-13
		c) Overhead charges @ 0.2 on (a+b)				₹ 10,363.44	
		d) Contractor's profit @ 0.1 on (a+b+c)				₹ 6,218.06	
		Rate for per MT (a+b+c+d)				₹ 68,398.70	
					say	**₹ 68,399.00**	
						-	

Sl. No.	Ref.	Item of work	Unit	Quantity	Rate	Amount	Remarks
1.2	MoRTH/13.5.H	Plain/Reinforced cement concrete in sub-structure complete as per drawing and Technical Specifications.					
		RCC Grade M35					
		Unit = cum					
		Taking output = 15 cum					
		a) Material					
		Cement	tonne	6.33	₹ 6,394.65	₹ 40,478.13	M-081
		Coarse sand	cum	6.75	₹ 1,306.49	₹ 8,818.81	M-005
		20 mm Aggregate	cum	8.1	₹ 1,281.49	₹ 10,380.07	M-053
		10 mm Aggregate	cum	5.4	₹ 1,281.49	₹ 6,920.05	M-051
		b) Labour					
		Mate	day	0.86	₹ 363.00	₹ 312.18	L-12
		Mason	day	1.5	₹ 435.00	₹ 652.50	L-11
		Mazdoor	day	20	₹ 329.00	₹ 6,580.00	L-13
		c) Machinery					
		Concrete mixer (cap. 0.40/0.28 cum)	hour	6	₹ 234.00	₹ 1,404.00	P&M-009
		Generator 33 KVA	hour	6	₹ 374.00	₹ 2,244.00	P&M-079
		d) formwork					
		Add 10 per cent of cost of material, labour and machinery (a+b+c) for Formwork		10		₹ 518.60	
		e) Overhead charges @ 0.2 on (a+b+c+d)				₹ 1,140.92	

Sl. No.	Ref.	Item of work	Unit	Quantity	Rate	Amount	Remarks
		f) Contractor's profit @ 0.1 on (a+b+c+d+e)				₹ 684.55	
		Rate per cum (a+b+c+d+e+f)				₹ 7,530.07	
					say	**₹ 7,530.00**	
						-	
1.3	MoRTH/13.6	Supplying, fitting and placing HYSD bar reinforcement in sub-structure complete as per drawing and Technical Specifications.					
		Taking output = 1 MT					
		a) Material					
		HYSD bars including 5 per cent overlaps and wastage	tonne	1.05	₹ 46,200.00	₹ 48,510.00	M-082
		Binding wire	kg	6	₹ 53.00	₹ 318.00	M-072
		b) Labour for cutting, bending, shifting to site, tying and placing in position					
		Mate	day	0.34	₹ 363.00	₹ 123.42	L-12
		Blacksmith	day	2	₹ 435.00	₹ 870.00	L-02
		Mazdoor	day	6.5	₹ 329.00	₹ 2,138.50	L-13
		c) Overhead charges @ 0.2 on (a+b)				₹ 10,391.98	
		d) Contractor's profit @ 0.1 on (a+b+c)				₹ 6,235.19	
		Rate for per MT (a+b+c+d)				₹ 68,587.09	
					say	**₹ 68,587.00**	

Sl. No.	Ref.	Item of work	Unit	Quantity	Rate	Amount	Remarks
1.4	MR	Access ramp - 3m wide	Rm			**₹ 15,000.00**	
1.5	Marinetek Pontoons/ equivalent	Concrete pontoon - 10x4x1.8m	nos			₹ 4,000,000.00	MR
1.6	Modular Ferry		nos			₹ 10,000,000.00	MR
1.7	Boat for passengers and light vehicles		nos			₹ 3,000,000.00	MR
		Analysis of rates for fair way development					
2		Dredging	cub.m.		₹ 200.00		MR
		Rates for landscaping					
3		Lumpsum (pathway, hortilculture development, lawn, etc.)				₹ 300,000.00	
		Rates for utility shifting					
4		Lumpsum (Utility shiftings like existing road through the terminal premises, water supply line, electricity cables, etc.)				₹ 300,000.00	

Sl. No.	Ref.	Item of work	Unit	Quantity	Rate	Amount	Remarks
5		**Auxiliary items**					
		Fire fighting system					
		Safety gadgets					
		Public security services lumpsum				₹ 1,000,000.00	
		Fuel pump					
		Water supply					
		Tele communication facility					
		Lighting					

F Subansiri Financial Model

F.1 Capex

			Months - Phase I											Months - Phase II					
1	**TERMINAL AT 4 LOCATIONS**	**Phase I Total**	1	2	3	4	5	6	7	8	9	10	**Phase II Total**	11	12	13	14	15	16
1.1a	Main Terminal building	4,526,044							2,263,022	2,263,022			2,263,022				2,263,022		
1.1b	Auxiliary Terminal building	1,196,604							598,302	598,302			598,302				598,302		
2	**FAIRWAY DEVELOPMENT**	-											-						
2.1	Dredging	10,626,400							10,626,400				29,359,620				14,679,810	14,679,810	
		-											-						
3	**NAVIGATION ANDCOMMUNICATION**	-											-						
3.1	VHF Radio	500,000							125,000	125,000	125,000	125,000	250,000				83,333	83,333	83,333
		-											-						
4	**AIDS TO NAVIGATION**	240,000							60,000	60,000	60,000	60,000	60,000				20,000	20,000	20,000
		-											-						
5	**LANDSCAPING**	300,000										300,000	150,000						150,000
		-											-						
6	**UTILITY SHIFTING**	300,000							300,000				150,000				150,000		
		-											-						
7	**AUXILLIARY ITEMS**	2,000,000							500,000	500,000	500,000	500,000	500,000				166,667	166,667	166,667
		-											-						
8	**MODULAR FERRY VESSEL**	20,000,000							5,000,000	5,000,000	5,000,000	5,000,000	10,000,000				3,333,333	3,333,333	3,333,333
	Total	39,689,048							19,472,724	8,546,324	5,685,000	5,985,000	43,330,944				21,294,467	18,283,143	3,753,333
	Grnad Total	83,019,992										TRUE							TRUE

F.1.1 Cost per running kilometer

			Cost/Month	Cost/Trip	Cost/Km
Length of route (Avg) (Round)	Km	1.8			
No of trips (Avg) (Round)		8			
HSD charges 3 Ltrs/Trip (Round)		180		180.00	100.00
Manpower					
Driver	1	10000	10000	41.67	23.15
Service Cost/Month			3000	12.50	6.94
Safety equipment			5000	20.83	11.57
Insuarnce			2000	8.33	4.63
				263.33	146.30
Cost/Km				**Rs.**	**146.00**

F.2 Break Even

Revenue model for the proposed Boat services in NW-95					Amount in Rs.					
Particulars	**year 1**	**year 2**	**year 3**	**year 4**	**year 5**	**year 6**	**year 7**	**year 8**	**year 9**	**year 10**
Running Cost per KM - Applicable for Boat Service	146.00	153.30	160.97	169.01	177.46	186.34	195.65	205.44	215.71	226.49
Length of the route	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Number of trips per day per boat	8	8	8	8	8	8	8	8	8	8
KM run per day per boat	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Number of boat	2	2	2	2	2	3	3	3	4	4
Cost per day	4,205	4,415	4,636	4,868	5,111	8,050	8,452	8,875	12,425	13,046
Running cost per year	1,534,752	1,611,490	1,692,064	1,776,667	1,865,501	2,938,164	3,085,072	3,239,325	4,535,055	4,761,808
Seating Capacity / boat	45		45							
Total number of seats offered per day	720		720							

Revenue model for the proposed Boat services in NW-95				Amount in Rs.						
Particulars	**year 11**	**year 12**	**year 13**	**year 14**	**year 15**	**year 16**	**year 17**	**year 18**	**year 19**	**year 20**
Running Cost per KM - Applicable for Boat Service	237.82	249.71	262.20	275.30	289.07	303.52	318.70	334.63	351.37	368.93
Length of the route	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Number of trips per day per boat	8	8	8	8	8	8	8	8	8	8
KM run per day per boat	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Number of boat	5	5	6	6	7	7	8	8	9	9
Cost per day	17,123	17,979	22,654	23,786	29,138	30,595	36,714	38,550	45,537	47,814
Running cost per year	6,249,873	6,562,367	8,268,582	8,682,011	10,635,464	11,167,237	13,400,685	14,070,719	16,621,037	17,452,088
Seating Capacity / boat										
Total number of seats offered per day										

Revenue model for the proposed Boat services in NW-95 Amount in Rs.

Revenue model for the proposed Boat services in NW-95				Amount in Rs.						
Particulars	**year 21**	**year 22**	**year 23**	**year 24**	**year 25**	**year 26**	**year 27**	**year 28**	**year 29**	**year 30**
Running Cost per KM - Applicable for Boat Service	387.38	406.75	427.09	448.44	470.86	494.41	519.13	545.08	572.34	600.96
Length of the route	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Number of trips per day per boat	8	8	8	8	8	8	8	8	8	8
KM run per day per boat	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Number of boat	10	11	12	12	13	14	15	16	17	19
Cost per day	55,783	64,429	73,801	77,491	88,146	99,673	112,132	125,587	140,109	164,422
Running cost per year	20,360,770	23,516,689	26,937,298	28,284,163	32,173,236	36,380,505	40,928,068	45,839,436	51,139,621	60,013,850
Seating Capacity / boat										
Total number of seats offered per day										

F.3 Distribution of passengers

Sensitivity analysis	Capacity utilisation						
	100%	80%	60%	59%	50%	48%	40%
Revenue / Year							
38720000	38,720,000	30,976,000	23,232,000	22,844,800	19,360,000	18,740,480	15,488,000
Total Revenue	**38,720,000**	**30,976,000**	**23,232,000**	**22,844,800**	**19,360,000**	**18,740,480**	**15,488,000**
Running Cost/ Year	-	-	-	-	-	-	-
Administration and office expenses/year	5,876,000	5,876,000	5,876,000	5,876,000	5,876,000	5,876,000	5,876,000
Operational Expenditire							
Dredging	1,936,000	1,548,800	1,161,600	1,142,240	968,000	937,024	774,400
Navigation aids	774,400	619,520	464,640	456,896	387,200	374,810	309,760
Civil works	193,600	154,880	116,160	114,224	96,800	93,702	77,440
Vessel	3,872,000	3,097,600	2,323,200	2,284,480	1,936,000	1,874,048	1,548,800
Navigation and communication	1,936,000	1,548,800	1,161,600	1,142,240	968,000	937,024	774,400
Amortisation of Marketing expenses	-	-	-	-	-	-	-
Depreciation on Initial capital expenditure of Rs.10 lacs	-	-	-	-	-	-	-
Depreciation on Boat	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333
Total cost per year	**15,921,333**	**14,178,933**	**12,436,533**	**12,349,413**	**11,565,333**	**11,425,941**	**10,694,133**
Profit/loss per year	**22,798,667**	**16,797,067**	**10,795,467**	**10,495,387**	**7,794,667**	**7,314,539**	**4,793,867**

Project cost		**Per year**
Cost of 2 Boats		**20,000,000**
Initial expenses		-
Marketing expenses		-
Administration and office expenses		5,876,000
Running Cost		-
Total		**25,876,000**

Note:
Revenue from advertising is not considered here and this can be taken as an additional revenue.
The service is Breakeven @ 48%

Assunptions:
Rs.146 is the present running cost per kilometer of a Boat (all inclusive, except the depreciation).
Rs.1 Cr is the cost of one Boat.

F.4 Vessel Depreciation

Charges of Boats for the proposed Boat services in NW 95			Amount in Rs.
Cost of one Boat	10,000,000		
Cost of two Boats	20,000,000		
Life of Vehicle (years)		15	
Hire Charges per year	3,106,643		
	Value/year	cost & Inflation	Depreciation
Year 1	1,333,333	1,466,667	1,333,333
Year 2	1,333,333	1,613,333	
Year 3	1,333,333	1,774,667	
Year 4	1,333,333	1,952,133	
Year 5	1,333,333	2,147,347	
Year 6	1,333,333	2,362,081	
Year 7	1,333,333	2,598,289	
Year 8	1,333,333	2,858,118	
Year 9	1,333,333	3,143,930	
Year 10	1,333,333	3,458,323	
Year 11	1,333,333	3,804,156	
Year 12	1,333,333	4,184,571	
Year 13	1,333,333	4,603,028	
Year 14	1,333,333	5,063,331	
Year 15	1,333,333	5,569,664	
	20,000,000	46,599,640	
		3,106,643	

G Financials

G.1 Profitability

G.1.1 Profitability (year 1 to year 30)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Revenue	8,736,878	9,793,120	10,946,000	12,207,218	13,599,600	15,197,389	16,973,000	18,941,209	21,071,400	23,431,824
Expenditure										
Running Cost	1,534,752	1,611,490	1,692,064	1,776,667	1,865,501	2,938,164	3,085,072	3,239,325	4,535,055	4,761,808
Administration and office expenses/year	5,876,000	6,169,800	6,478,290	6,802,205	7,142,315	7,499,430	7,874,402	8,268,122	8,681,528	9,115,605
Dredging	1,936,000	2,032,800	2,134,440	2,241,162	2,353,220	2,470,881	2,594,425	2,724,146	2,860,354	3,003,371
Navigation aids	774,400	813,120	853,776	896,465	941,288	988,352	1,037,770	1,089,659	1,144,141	1,201,349
Civil works	193,600	203,280	213,444	224,116	235,322	247,088	259,443	272,415	286,035	300,337
Vessel	3,872,000	4,065,600	4,268,880	4,482,324	4,706,440	4,941,762	5,188,850	5,448,293	5,720,707	6,006,743
Navigation and communication	1,936,000	2,032,800	2,134,440	2,241,162	2,353,220	2,470,881	2,594,425	2,724,146	2,860,354	3,003,371
Depreciation on Boat	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333
Total cost per year	17,456,085	18,262,223	19,108,667	19,997,434	20,930,639	22,889,892	23,967,720	25,099,440	27,421,509	28,725,918
Profit/loss per year	-8,719,207	-8,469,103	-8,162,667	-7,790,216	-7,331,039	-7,692,503	-6,994,720	-6,158,231	-6,350,109	-5,294,094
Net Profit After lease	-8,719,207	-8,469,103	-8,162,667	-7,790,216	-7,331,039	-7,692,503	-6,994,720	-6,158,231	-6,350,109	-5,294,094

G.1.2 Profitability (11th to 20th year)

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Revenue	26,033,000	28,934,196	32,048,600	35,535,756	39,368,000	44,349,722	49,638,200	55,657,538	62,069,000	69,426,442
Expenditure										
Running Cost	6,249,873	6,562,367	8,268,582	8,682,011	10,635,464	11,167,237	13,400,685	14,070,719	16,621,037	17,452,088
Administration and office expenses/year	9,571,385	10,049,954	10,552,452	11,080,074	11,634,078	12,215,782	12,826,571	13,467,900	14,141,295	14,848,359
Dredging	3,153,540	3,311,217	3,476,778	3,650,617	3,833,148	4,024,805	4,226,045	4,437,347	4,659,215	4,892,176
Navigation aids	1,261,416	1,324,487	1,390,711	1,460,247	1,533,259	1,609,922	1,690,418	1,774,939	1,863,686	1,956,870
Civil works	315,354	331,122	347,678	365,062	383,315	402,480	422,605	443,735	465,921	489,218
Vessel	6,307,080	6,622,434	6,953,556	7,301,233	7,666,295	8,049,610	8,452,090	8,874,695	9,318,430	9,784,351
Navigation and communication	3,153,540	3,311,217	3,476,778	3,650,617	3,833,148	4,024,805	4,226,045	4,437,347	4,659,215	4,892,176
Depreciation on Boat	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333
Total cost per year	31,345,521	32,846,131	35,799,868	37,523,194	40,852,039	42,827,975	46,577,792	48,840,015	53,062,131	55,648,571
Profit/loss per year	-5,312,521	-3,911,935	-3,751,268	-1,987,438	-1,484,039	1,521,747	3,060,408	6,817,523	9,006,869	13,777,871
Net Profit After lease	-5,312,521	-3,911,935	-3,751,268	-1,987,438	-1,484,039	1,521,747	3,060,408	6,817,523	9,006,869	13,777,871

G.1.3 Profitability (21st to 30th year)

	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Revenue	77,826,400	87,017,355	97,176,400	108,315,522	121,991,814	137,231,749	154,029,317	172,962,771	193,804,081	216,957,746
Expenditure										
Running Cost	20,360,770	23,516,689	26,937,298	28,284,163	32,173,236	36,380,505	40,928,068	45,839,436	51,139,621	60,013,850
Administration and office expenses/year	15,590,777	16,370,316	17,188,832	18,048,274	18,950,687	19,898,222	20,893,133	21,937,789	23,034,679	24,186,413
Dredging	5,136,784	5,393,624	5,663,305	5,946,470	6,243,793	6,555,983	6,883,782	7,227,971	7,589,370	7,968,839
Navigation aids	2,054,714	2,157,449	2,265,322	2,378,588	2,497,517	2,622,393	2,753,513	2,891,189	3,035,748	3,187,535
Civil works	513,678	539,362	566,330	594,647	624,379	655,598	688,378	722,797	758,937	796,884
Vessel	10,273,569	10,787,247	11,326,610	11,892,940	12,487,587	13,111,966	13,767,565	14,455,943	15,178,740	15,937,677
Navigation and communication	5,136,784	5,393,624	5,663,305	5,946,470	6,243,793	6,555,983	6,883,782	7,227,971	7,589,370	7,968,839
Depreciation on Boat	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333	1,333,333
Total cost per year	60,400,410	65,491,645	70,944,335	74,424,885	80,554,327	87,113,984	94,131,555	101,636,431	109,659,799	121,393,369
Profit/loss per year	17,425,990	21,525,710	26,232,065	33,890,637	41,437,487	50,117,764	59,897,762	71,326,340	84,144,283	95,564,377
Net Profit After lease	17,425,990	21,525,710	26,232,065	33,890,637	41,437,487	50,117,764	59,897,762	71,326,340	84,144,283	95,564,377

G.1.4 Profitability of IWAI's SPV (Year1 to year 10)

Revenue		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Farebox revenue		8,736,878	9,793,120	10,946,000	12,207,218	13,599,600	15,197,389	16,973,000	18,941,209	21,071,400	23,431,824
Expenditure											
Dredging	5%	1,984,452	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000
Navigation aids	2%	793,781	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
Civil works	1%	198,445	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100
Vessel	10%	3,968,905	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999
Navigation and communication	5%	1,984,452	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000
Administrative Cost		5,876,000	6,169,800	6,478,290	6,802,205	7,142,315	7,499,430	7,874,402	8,268,122	8,681,528	9,115,605
Total Expenditure		**14,806,036**	**24,849,298**	**25,157,788**	**25,481,703**	**25,821,813**	**26,178,929**	**26,553,900**	**26,947,620**	**27,361,026**	**27,795,103**
Gross Operating Profit		-6,069,158	-15,056,178	-14,211,788	-13,274,485	-12,222,213	-10,981,540	-9,580,900	-8,006,411	-6,289,626	-4,363,279
Depreciation		793,781	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
Net Profit/Loss		-6,862,939	-16,716,578	-15,872,188	-14,934,885	-13,882,613	-12,641,940	-11,241,300	-9,666,811	-7,950,026	-6,023,679
Cumulative GOP		-6,862,939	-23,579,516	-39,451,704	-54,386,589	-68,269,202	-80,911,141	-92,152,441	-101,819,252	-109,769,279	-115,792,957

G.1.5 Profitability of IWAI's SPV (11th to 20th)

Revenue		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Farebox revenue		26,033,000	28,934,196	32,048,600	35,535,756	39,368,000	44,349,722	49,638,200	55,657,538	62,069,000	69,426,442
Expenditure											
Dredging	5%	4,151,000	1,446,710	1,602,430	1,776,788	1,968,400	2,217,486	2,481,910	2,782,877	3,103,450	3,471,322
Navigation aids	2%	1,660,400	578,684	578,684	578,684	578,684	578,684	578,684	578,684	578,684	578,684
Civil works	1%	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100
Vessel	10%	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999
Navigation and communication	5%	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000
Administrative Cost		9,571,385	10,049,954	10,552,452	11,080,074	11,634,078	12,215,782	12,826,571	13,467,900	14,141,295	14,848,359
Total Expenditure		**28,250,883**	**24,943,447**	**25,601,664**	**26,303,645**	**27,049,261**	**27,880,051**	**28,755,264**	**29,697,559**	**30,691,527**	**31,766,464**
Gross Operating Profit		-2,217,883	3,990,749	6,446,936	9,232,111	12,318,739	16,469,671	20,882,936	25,959,979	31,377,473	37,659,978
Depreciation		1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
Net Profit/Loss		-3,878,283	2,330,350	4,786,536	7,571,711	10,658,339	14,809,271	19,222,536	24,299,579	29,717,073	35,999,578
Cumulative GOP		-119,671,240	-117,340,891	-112,554,355	-104,982,643	-94,324,304	-79,515,033	-60,292,496	-35,992,917	-6,275,844	29,723,734

G.1.6 Profitability of IWAI's SPV (21st to 30th)

Revenue		Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Farebox revenue		77,826,400	87,017,355	97,176,400	108,315,522	121,991,814	137,231,749	154,029,317	172,962,771	193,804,081	216,957,746
Expenditure											
Dredging	5%	3,891,320	4,350,868	4,858,820	5,415,776	6,099,591	6,861,587	7,701,466	8,648,139	9,690,204	10,847,887
Navigation aids	2%	578,684	578,684	578,684	578,684	578,684	578,684	578,684	578,684	578,684	578,684
Civil works	1%	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100	415,100
Vessel	10%	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999	8,301,999
Navigation and communication	5%	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000	4,151,000
Administrative Cost		15,590,777	16,370,316	17,188,832	18,048,274	18,950,687	19,898,222	20,893,133	21,937,789	23,034,679	24,186,413
Total Expenditure		**32,928,880**	**34,167,967**	**35,494,435**	**36,910,832**	**38,497,061**	**40,206,592**	**42,041,381**	**44,032,711**	**46,171,666**	**48,481,083**
Gross Operating Profit		44,897,520	52,849,388	61,681,965	71,404,690	83,494,753	97,025,157	111,987,936	128,930,060	147,632,416	168,476,663
Depreciation		1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
Net Profit/Loss		43,237,120	51,188,989	60,021,565	69,744,290	81,834,354	95,364,757	110,327,536	127,269,660	145,972,016	166,816,263
Cumulative GOP		72,960,854	124,149,842	184,171,408	253,915,698	335,750,051	431,114,808	541,442,344	668,712,004	814,684,020	981,500,283

G.2 Balance Sheet

G.2.1 Balance Sheet of IWAI's SPV (Year1 to year 10)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Source of funds											
Capital		39,689,048	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992
Reserves & Surplus		-6,862,939	-23,579,516	-39,451,704	-54,386,589	-68,269,202	-80,911,141	-92,152,441	-101,819,252	-109,769,279	-115,792,957
		32,826,109	59,440,476	43,568,288	28,633,403	14,750,790	2,108,851	-9,132,449	-18,799,260	-26,749,287	-32,772,965
Working Capital		-	-	-	-	-	-	-	-	-	-
Total Source of Fund		32,826,109	59,440,476	43,568,288	28,633,403	14,750,790	2,108,851	-9,132,449	-18,799,260	-26,749,287	-32,772,965
Application of funds											
Fixed Assets		39689048	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992
Less: Depreciation		793,781	2,454,181	4,114,581	5,774,980	7,435,380	9,095,780	10,756,180	12,416,580	14,076,980	15,737,380
		38,895,267	80,565,811	78,905,411	77,245,012	75,584,612	73,924,212	72,263,812	70,603,412	68,943,012	67,282,612
Cash & Bank balance		-6,069,158	-21,125,336	-35,337,124	-48,611,609	-60,833,821	-71,815,361	-81,396,261	-89,402,673	-95,692,299	-100,055,578
Total Application of funds		32,826,109	59,440,476	43,568,288	28,633,403	14,750,790	2,108,851	-9,132,449	-18,799,260	-26,749,287	-32,772,965
Check		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

G.2.2 Balance Sheet of IWAI's SPV (11th year to 20th)

		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Source of funds											
Capital		83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992
Reserves & Surplus		-119,671,240	-117,340,891	-112,554,355	-104,982,643	-94,324,304	-79,515,033	-60,292,496	-35,992,917	-6,275,844	29,723,734
		-36,651,248	-34,320,899	-29,534,363	-21,962,651	-11,304,312	3,504,959	22,727,496	47,027,075	76,744,148	112,743,726
Working Capital		-	-	-	-	-	-	-	-	-	-
Total Source of Fund		-36,651,248	-34,320,899	-29,534,363	-21,962,651	-11,304,312	3,504,959	22,727,496	47,027,075	76,744,148	112,743,726
Application of funds											
Fixed Assets		83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992
Less: Depreciation		17,397,779	19,058,179	20,718,579	22,378,979	24,039,379	25,699,779	27,360,178	29,020,578	30,680,978	32,341,378
		65,622,213	63,961,813	62,301,413	60,641,013	58,980,613	57,320,213	55,659,814	53,999,414	52,339,014	50,678,614
Cash & Bank balance		-102,273,461	-98,282,711	-91,835,776	-82,603,665	-70,284,925	-53,815,254	-32,932,318	-6,972,339	24,405,134	62,065,111
Total Application of funds		-36,651,248	-34,320,899	-29,534,363	-21,962,651	-11,304,312	3,504,959	22,727,496	47,027,075	76,744,148	112,743,726
Check		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

G.2.3 Balance Sheet of IWAI's SPV (21st year to 30th)

		Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Source of funds											
Capital		83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992	83,019,992
Reserves & Surplus		72,960,854	124,149,842	184,171,408	253,915,698	335,750,051	431,114,808	541,442,344	668,712,004	814,684,020	981,500,283
		155,980,846	207,169,834	267,191,400	336,935,690	418,770,043	514,134,800	624,462,336	751,731,996	897,704,012	1,064,520,275
Working Capital		-	-	-	-	-	-	-	-	-	-
Total Source of Fund		155,980,846	207,169,834	267,191,400	336,935,690	418,770,043	514,134,800	624,462,336	751,731,996	897,704,012	1,064,520,275
Application of funds											
Fixed Assets		83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992	83019992
Less: Depreciation		34,001,778	35,662,178	37,322,577	38,982,977	40,643,377	42,303,777	43,964,177	45,624,577	47,284,976	48,945,376
		49,018,214	47,357,814	45,697,415	44,037,015	42,376,615	40,716,215	39,055,815	37,395,415	35,735,016	34,074,616
Cash & Bank balance		106,962,631	159,812,020	221,493,985	292,898,675	376,393,428	473,418,585	585,406,521	714,336,581	861,968,996	1,030,445,660
Total Application of funds		155,980,846	207,169,834	267,191,400	336,935,690	418,770,043	514,134,800	624,462,336	751,731,996	897,704,012	1,064,520,275
Check		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

G.3 Cashflow

G.3.1 Cashflow (from year 1 to 10)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cashflow from operations		-6,862,939	-16,716,578	-15,872,188	-14,934,885	-13,882,613	-12,641,940	-11,241,300	-9,666,811	-7,950,026	-6,023,679
Add: Depreciation		793,781	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
		-6,069,158	-15,056,178	-14,211,788	-13,274,485	-12,222,213	-10,981,540	-9,580,900	-8,006,411	-6,289,626	-4,363,279
Capital		39,689,048	43,330,944	0	0	0					
Fixed Assets		39,689,048	43,330,944	0	0	0					
Opening Cash Balance		0	-6,069,158	-21,125,336	-35,337,124	-48,611,609	-60,833,821	-71,815,361	-81,396,261	-89,402,673	-95,692,299
Closing Cash Balance		-6,069,158	-21,125,336	-35,337,124	-48,611,609	-60,833,821	-71,815,361	-81,396,261	-89,402,673	-95,692,299	-100,055,578

G.3.2 Cashflow (from year 11 to 20)

		Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Cashflow from operations		-3,878,283	2,330,350	4,786,536	7,571,711	10,658,339	14,809,271	19,222,536	24,299,579	29,717,073	35,999,578
Add: Depreciation		1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
		-2,217,883	3,990,749	6,446,936	9,232,111	12,318,739	16,469,671	20,882,936	25,959,979	31,377,473	37,659,978
Capital											
Fixed Assets											
Opening Cash Balance		-100,055,578	-102,273,461	-98,282,711	-91,835,776	-82,603,665	-70,284,925	-53,815,254	-32,932,318	-6,972,339	24,405,134
Closing Cash Balance		-102,273,461	-98,282,711	-91,835,776	-82,603,665	-70,284,925	-53,815,254	-32,932,318	-6,972,339	24,405,134	62,065,111

G.3.3 Cashflow (from year 21 to 30)

		Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Cashflow from operations		43,237,120	51,188,989	60,021,565	69,744,290	81,834,354	95,364,757	110,327,536	127,269,660	145,972,016	166,816,263
Add: Depreciation		1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400	1,660,400
		44,897,520	52,849,388	61,681,965	71,404,690	83,494,753	97,025,157	111,987,936	128,930,060	147,632,416	168,476,663
Capital											
Fixed Assets											
Opening Cash Balance		62,065,111	106,962,631	159,812,020	221,493,985	292,898,675	376,393,428	473,418,585	585,406,521	714,336,581	861,968,996
Closing Cash Balance		106,962,631	159,812,020	221,493,985	292,898,675	376,393,428	473,418,585	585,406,521	714,336,581	861,968,996	1,030,445,660