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DPR – MAPUSA-MOIDE RIVER (26.638KM) NW-71

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RESTRICTED

Client: **INLAND WATERWAYS AUTHORITY OF INDIA**

Project: **CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER – 7 OF NATIONAL WATERWAYS**

Subject: **DETAILED PROJECT REPORT – MAPUSA-MOIDE RIVER (26.638KM) NW-71**

Comments:

Revision No.	Date	Prepared / Revision By	Description
01	2019 05 14	Bidhan Chandra JHA	Final Submission

01	19/05/14	Active	SARIKA KUMARI	ARUN KUMAR	N SIVARAMAN	B.C.JHA
REV.	YY/MM/DD	STAT.	WRITTEN	VERIFIED	APPROVED	VALIDATED

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Inland Waterways Authority of India (IWAI) assigned the Consultancy Services for “Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 7 of National Waterways”. The study has been carried out for this assignment and the result has been compiled in the present study.

The consultant would like to put on record their deep appreciation of cooperation and ready access to information and advice rendered by IWAI.

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(B. C. JHA)

Tractebel Engineering Pvt Ltd

DISCLAIMER / PROPREITORY RIGHTS

M/s Tractebel Engineering Pvt., Ltd., (M/s TEPL), Gurgaon has been assigned with the Consultancy Services for the "Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 7 of National Waterways" by Inland Waterways Authority of India (IWAI). Accordingly, the study on NW – 71 – Mapusa – Moida River has been carried out for this assignment / analysed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 22/12/2016 to 05/01/2017.

Traffic Survey was carried out, as detailed and summarized in Annexure 4.2.

Terminal Land Survey was carried out on 29/04/2017.

Geotechnical Borehole was carried out from 18/05/2017 to 21/05/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

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This Report can be updated at a later stage, when required by considering the fresh cargo analysis, change in requirement of the Government (or) Change in policy either of State Government or Government of India.

(B. C. JHA)

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LIST OF ABBREVIATIONS

Abbreviations	Acronyms
AIS	Automatic Identification System
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DPR	Detailed Project Report
EIA	Environmental Impact Assessment
FSL	Full Supply Level
FSR	Feasibility Study Report
HC	Horizontal Clearance
HT	High Tension
HW	High Water
IO	Iron Ores
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
KP	Km Points
LAD	Least Available Depth
LW	Low Water
MHWS	Mean High Water Spring
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NMPT	New Mangalore Port Trust
NW	National Waterway
PWD	Public Works Department
RIS	River Information System
SD	Sounding Datum
SEB	State Electricity Board
SH	State Highway
SPV	Self-Propelled Vessel
VC	Vertical Clearance
VHF/HF	Very High Frequency/ High Frequency
WRD	Water Resources Department
WRIS	Water Resources Information System of India

SALIENT FEATURES

#	Particulars	Details	
		MAPUSA RIVER (NW-71)	
A	**GENERAL**		
1	***Location***		
a	Cluster	Cluster-7	
b	State(s)	Goa	
c	Co-ordinates& Name of Place	**Start**	**End**
	Place	Porvolim	Edapally-Panvel Highway at Mapusa
	Latitude	15°30'22.0887"N	15°35'20.51"N
	Longitude	73°50'36.2908"E	73°49'19.61"E
B	**TECHNICAL**		
1	***Waterway***		
a	National Waterway Number	NW-71	
b	Class	IV	
c	Type (Tidal/Non-Tidal)	Fully Tidal	

#	Particulars	Total	Tidal	Non-Tidal
	Length (Km.)	26.638km	26.638km	Nil

#	Particulars	Details
d	Average Tidal Variation, if applicable	1.31m

Chainage (km)	Tidal Variation (m)
-1.600	1.27
0.000	1.27
14.250	1.34
19.785	1.37

#	Particulars			
e	Chart Datum			
	Description/Basis	BRITONA Jetty 15°30'22.923" N 73°50'33.499" E	Aldona Bridge 15°35'37.655" N 73°52'35.633" E	Quitila 15°36'29.151" N 73°52'05.279" E
	Value (from Zero of Gauge)	+0.020 m	- 0.448m *	- 0.601m *
		* CD below Zero of Gauge		

#	Particulars	Stretch-1	Stretch-2	Stretch-3	Stretch-4	Total
f	LAD Status (w.r.t. CD)	**Stretch-1**	**Stretch-2**	**Stretch-3**	**Stretch-4**	**Total**
	Stretch (From…...To……)	0.0 – 8.00 km	8.00 – 16.00 km	16.00 – 24.00 km	24.00 - 26.638 km	(km)
	Length with LAD < 1.2 m	0	0	1.6	2.05	3.65
	With LAD from 1.2-1.4 m	0	0	1.1	0.238	1.338
	With LAD from 1.5-1.7 m	0	0	0.95	0.15	1.1
	With LAD from 1.8-2.0 m	0.05	0	0.65	0.05	0.75
	With LAD > 2.0 m	7.95	8	3.7	0.15	19.8
	Total	8.0	8.0	8.0	2.638	26.638

#	Particulars	Details
g	Target Depth of Proposed Fairway (m)	2.00m
h	Conservancy Works	

#	Particulars	Details
	Required	

#	Type of Work	Stretch-1	Stretch-2	Stretch-3	Total
		(0.00-8.00km)	(8.00-16.00km)	(upto Ch 17.00km)	
	Dredging Required (Cum.)	52.93	79072.5	6256.77	85382.2
	Bandalling	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil
	River Training/Bank Protection (Km.)	3000 m at 5 locations (Bank Protection of 500 m at Ch. 11.5 km; 1000 m at Ch. 12.2 km to Ch. 13.2 km; 500 m at Ch. 14.2 km; 500 m at Ch. 15.0 km and 500 m at Ch. 17.5 km. are suggested.)			
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.	Nil	Nil	Nil	Nil
	Bridges	Road	3	20m to 128m	2.50m to 8.50m
	HT/Tele-communication lines	HT Lines/LT Line	3	140m to 430	7.30m to 8.5m
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil

#	Particulars	Details
2	***Traffic***	
a	Present IWT Operations (type of services)	No cargo operation at present. In the past Mapusa river was used for iron ore transportation through barges.
b	Major industries in the hinterland (i.e. within 25 km. on either side)	No major industries. Only iron ore mines in the catchment area of river. Chowgule, Fomento (Iron ore mine owners).
c	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Major roads - NH 66 is major highway passing nearby Mapusa river. Major railway – Konkan railway line is the only line near to Mapusa river. Karamli & Thivim are the two nearby railway stations.

#	Particulars	In-bound	Out-bound
d	Commodities	**In-bound**	**Out-bound**
1	Coal	n/a	Mormugao Port - Export

#	Particulars					
e	Future Potential (MMT)					
	Name of Commodity	**5 years**	**10 years**	**15 years**	**20 years**	**25 years**
	Proposed IWAI Terminal on Mapusa-Moide River					
1	Iron Ore	0.1	0.5	0.5	0.6	0.9

#	Particulars	Details
3	***Terminals/Jetties***	
a	Terminal/Jetty - 1	LO-LO
	Location (Bank/city/district)	15°36'57.02" N & 73°52 '51.56"E near Sircaim (Bardez Taluka) on the right bank
	Type/Services	Handling of Bulk Cargo
	Facilities	Cranes and Forklifts are provisioned
	Approach	Road is available
	Land Ownership	Private

#	Particulars	Details				
	Area (ha.)	**Govt.**			**Private**	
		NIL			3.02	
4	***Design Vessel***					
a	Type	Pusher Tug & Dumb Barges				
b	No. & Size	ONE Unit of 1 PT + 2 DBs (1000 T) by 2033 & Other Unit by 2038				
c	Loaded Draft	1.80 m				
d	Capacity	Each DB of 1000 Tonne				
5	***Navigation Aids***					
a	Type	Beacon and Light / Buoy and Light				
b	Nos.	7 / 45				
b	Communication Facilities	--				
C	**FINANCIAL**					
1	***Project Cost***					
a	Capital Cost	With Development				Without Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal		Fairway
	Cost (INR)	6.8 cr	51.85cr	55.1 cr		6.8 cr
b	O & M Cost	0.24 cr	6.43 cr	12.62 cr		0.38 cr
2	***User Charges***					
a	For IWAI	-				
b	For Operator	-				
3	***Financial Internal Rate of Return (%)***	With Development				Without Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal	Whole project	Fairway
a	For IWAI	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
b	Operator	--				
4	***Economic Internal Rate of Return (%)***	With Development				Without Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal	Whole project	Fairway
		40%	Non-existent	-14%	15%	41%
5	***Any other Important Feature***					

EXECUTIVE SUMMARY

Mapusa – Moida River is one of the waterways declared as National Waterway in March, 2016 as NW 71. The Mapusa / Moide River is a right bank (North bank) tributary of River Mandovi. The River originates in the jungles of Dumacem and Amthane. The total length of the river Mapusa-Moide is about 31 kms from its origin till joining the River Mandovi. The river is under tidal effect of the Arabian Sea (backwater effect) up to Mapusa about 27 km from the river confluence with River Mandovi. The total catchment area of Mapusa-Moide River basin is 190 Sq. Km. The catchment, mostly in Bardez Taluka, receives an average annual rainfall of about 3948.30 mm.

The stretch of Mapusa-Moide River for 27 Kms starting from the Bridge on NH 17 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 has been proposed for undertaking the two stage DPR. M/s Tractebel has been assigned with the work of Preparation of a two stage DPR. Subsequent to the Stage 1 preliminary findings, the Waterway stretch of 26.638 Kms from Lat 15° 30' 22.0887" N, Long 73° 50' 36.2908" E has been taken up for the Stage 2 Detailed Project Report (DPR) so as to assess the required developments and the IWT Traffic potential along with inter alia activities including the working out of Cost / Return factors for taking a decision on developments / investments.

The major components in the DPR can be considered as Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement and Financial Analysis. Bathymetric Survey of the study stretch has been carried out along with the Topographical Survey so as to arrive at the conservancy requirements including Dredging; Channel demarcation and other Waterway requirements for safe navigation. The next one is Traffic Confirmations. The present Traffic scenario, possible divertible traffic to IWT is to be estimated. In sequence, Terminal Development, Vessel Requirement and Financial Analysis have been considered.

Based on the Hydrographic Survey inputs and other site data collected, it has been noticed that 3 Nos of Bridges are located with the least vertical clearance of 2.5 m w.r.t. MHWS at Ch. 26.612 Km (Development is limited at Ch. 17 km).. The Bridges at Ch. 11.05 km and Ch. 14.175 km are having sufficient Navigational clearances. 2 Nos. HT Lines are located at Ch. 15.95 and 18.330 having sufficient vertical clearance of 8.5 m. Keeping in view the connectivity and close proximity, a Terminal location has been considered at the Downstream of the existing infrastructure of M/s Vedanta etc., (Left Side), near Ch. 17 km. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 17 Nos of Bend locations have been identified in the study stretch, with 120 m as lowest at Ch. 12.5 km.

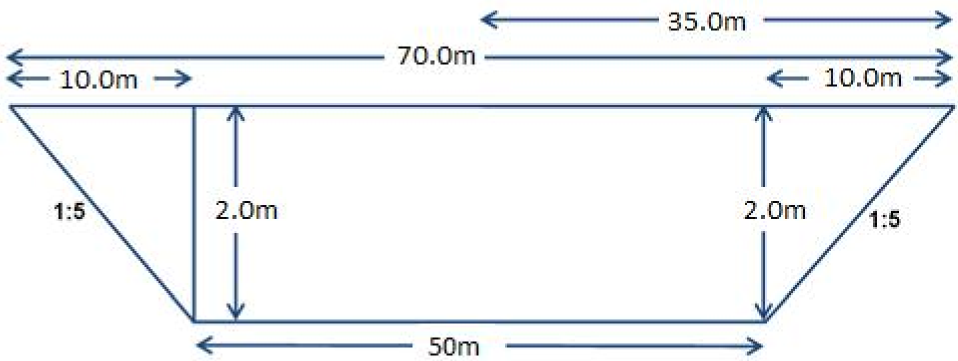
Existing waterway of the study stretch was used in the past for mobility of the Iron Ore Cargo from the Hinterland Mines. The operations were considered through the jetties / terminals developed by the stake holders. M/s Vedanta is having their captive terminals in Ch 17 km – 18 km. The traffic has come down to – Nil – due to the cases in the courts. Keeping in view the recent relaxations on the mining by Courts, there is an expectation of good mobility of Iron Ore destined for export through Marmugoa Port / through Mandovi River. The estimated traffic beyond the M/s Vedanta jetties will be about 0.1 MMTPA in FY 20 and expected to increase to 0.9 MMTPA in FY 40. In order to meet the same, it is proposed to develop a terminal by IWAI. However, as a part of suggestion / recommendation for the development of Mapusa River, no recommendation is proposed. The low profile Phase 1 development is suggested. Phase 2 requirements are projected (indicative) with a limitation of any development only up to Ch. 17 km. after having a careful analysis and confirmation over the increase in IWT mobility.

The fairway requirements are being considered for analysis for its maximum / optimum utilization. Based on the existing fairway and the hindrances etc., it has been observed that the initial 7 to 8 kms stretch is having sufficient waterway standards. It is proposed to consider the development as Class IV for mobility of 2000 T as a convoy of 2 x 1000 T. The vessel / convoy requirement is 170 m (Length) x 12 m (Breadth) x 1.8 m / 2.0 m (Draft / Depth). Accordingly, the fairway requirement is 50 m (Bottom Width) x 2.0 m (Depth) with Bend Radius of 800. Clearance corridor of 50 m Horizontal Clearance (HC) and 9 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel / Convoy.

Keeping in view the proposed IWAI Terminal at Ch 17 km, it has been considered to develop Class IV waterway up to the IWAI proposed Terminal and it is not suggested for any development beyond.

The fairway size and dredging quantities up to Ch. 17 km are placed below for Class IV waterway for the study stretch of Mapusa.

Class-IV



Observed						Reduced w. r. t. Sounding Datum			
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)
From	To	Max.	Min.		Per km drg	Max.	Min.		Per km drg
0.0	8.00	TIDAL ZONE				14.9	1.7	100	52.93
8.00	16.00					9.3	-3.1	3100	79072.5
16.00	17.00					4.6	-1.7	500	6256.77
							Total	3700	85382.2

Accordingly, the shoal length is of 3,700 m and the respective Dredging quantity has been taken into consideration for 0.85 Lakhs Cu. M and the estimated quantity has been taken into consideration as 1.0 Lakhs Cu. M, duly considering some addition for variation. In order to provide a safe navigable fairway, as a Phase 2 development, Dredging of about 1.00 Lakhs Cu. M of ordinary soils; Bank Protection (5 locations with 3000 m); Beacon / Lights (7 Nos-Phase 1); Buoy / Lights (45 Nos); Institutional Requirements (Phase 1) etc., have been worked out. The Bend locations will be tackled with Bank Protection, as above.

The Terminal requirement has been considered with 1 Lift-on Lift-off (Lo-Lo) IWT Terminal along with handling facilities in Phase 2. Taking into the consideration of the origin and destination and fairway, the most probable location identified is at Ch 17 km, on the left side of the river at approx. Lat 15°36'57.02" N and Long 73°52'51.56" E. This location can be developed with good road accessibility. A tentative Land requirement has been worked out and arrived at with 30,256 Sq. M and the Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Sircaim Village; Bardez Taluka; North Goa District of Goa state. Geotechnical Investigations have been conducted at this location.

As per the Class IV waterway classification, the maximum of 2000 T is to be mobilized in 2 x 1000 T Dumb barges of 70 m to 75 m LOA with 12 m width and 1.8 m Loaded Draft / 2.0 m Depth in front of the Berthing Structure. Considering the vessel size of berthing of 1 DB of 70 m to 75 m, the optimum length of Berth requirement has been taken as 75 m. In this length of 75 m, 2 cranes shall be made operational at any point of time.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
LO LO	75	32

Preliminary Designs have been worked out for Spurs; Bank Protection with Gabions; Navigational Aids through Buoys (Polyethylene) and Lights (4 NM); Lo-Lo Jetty.

The following Vessel standard is suggested for a cautious deployment in Phase 2, as a long term requirement.

Self-Propelled Vessel: (1000 T) INR 800 Lakhs each. {Not Recommended}

Length:	75 m
Breadth:	14 m
Loaded Draft / Depth:	1.8 m / 2.5 m +
Cargo Capacity:	1000 T
Propulsion:	Marine Diesel Engines of 2 x 625 Bhp

Tug Barge Combination: (1 P. T + 2 DBs of 1000 T each – 2000 T)

Pusher Tug	**INR 900 Lakhs each**
Length:	30 m to 40 m
Breadth:	12 m to 14 m
Draft / Depth:	1.7 m / 2.0 m +
Cargo Capacity:	- -
Propulsion:	Marine Diesel Engines of 3 x 800 Bhp
Speed (with Load):	16 kmph to 20 kmph in D/s and 12 kmph to 16 kmph in U/s

Dumb Barge	**INR 500 Lakhs each**
Length:	70 m to 75 m
Breadth:	12 m
Loaded Draft / Depth:	1.8 m / 2.0 m +
Cargo Capacity:	1000 T

Note: Depth + is an indication for provision of increased depth for the vessel mobility as a coaster.

1 PT + 2 DBs may be required by 2033. {Construction from 2030 to 2033}
1 PT + 2 DBs may be required by 2038. {Construction from 2035 to 2038}

Regarding the Navigation & Communication System, it has been worked out the provision of RIS / AIS / Locating the Vessels / Buoys. An attempt has been made to ascertain the details on the Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed. It was understood that the Ministry of Shipping, Govt. Of India has already initiated the working about feasibility and implementation of "National Coastal Grid of VTMS". This proposal is from the strategic safety point of view and is expected to take some more time. It is suggested to have a dialogue at later date by IWAI for a fool proof communication / navigation system in the National Waterways joining the sea in both west / east coast. Hence, a feasible system could not be recommended at this point of time.

With regard to the Environmental aspects, considering the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices. Since limited dredging is involved, impact on aquatic ecology is also anticipated to be negligible. No structures are present over the land identified for construction of terminals or related project components. Therefore, the project does not involve any dislocation of population. The entire project area falls under the tidal zone. As such the project shall require obtaining clearance under the CRZ Notification 2011. Consent to Establish and Consent to Operate from the SPCB shall be required under the Air and Water Acts. No other major clearances / approvals / permits relating to environmental and social aspects are applicable to the project. No wildlife clearance is envisaged for the proposed waterway. Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

Regarding the Institutional requirements, it has been proposed to establish a Regional office to look after the Waterways under Cluster 7 covering Maharashtra and Goa. The office will be supported with appropriate Manpower and other office infra requirements. Further, it is proposed to have 2 Nos. Survey Vessels (2 engines of 175 Bhp each) fitted with Survey Instruments; Related Software; Laptop; 2 Nos. Tug – cum – Buoy Maintenance vessels and 2 Nos. Speed Boats etc.

The cost estimates have been worked out and segregated into Phase 1 with a capital cost of 6.8 Cr. Phase 2 Fairway at a cost of 51.85 Cr. The cost of Lo-Lo jetty at a capital cost of 55.07 Cr. is suggested, on need basis. Implementation of phase 1 is 12 months on immediate basis and phase 2 is 36 months commencing 2030.

The FIRR and EIRR have been worked out and the details are placed, with an alternative of investment only for Fairway and fairway + Terminal.

Parameter	Unit	With Development			Without Development	With Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal	Fairway	Whole Project
Project Cost	INR Cr.	6.8	51.85	55.07	6.8	113.7
Revenue (FY40)	INR Cr.	0.69 (Fy'30)	1.1	1.57	2.21	2.7
FIRR	%	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
EIRR	%	40%	Non-existent	-14%	41%	15%

Not recommended any investment till the confirmations of the traffic, except a nominal infrastructure creation at a cost of INR 6.8 Cr. Development / Investment is recommended after considering a critical analysis before FY 30. If there is no much increase in cargo volumes by FY 30, there is no need of any investment / development.

CHAPTER 1 INTRODUCTION

1.1 Project Background and Summary of Previous Study

Globally, the renewal of Inland Water Transport (IWT) is under serious consideration predominantly due to its energy efficient aspect and cheaper mode on comparison. Further overburdening of the Rail and Road network are also the dominant factors. Transport planners are now leaning towards the development of IWT system for transportation of bulk / IWT sensitive cargo.

India has about 14,500km of navigable waterways which comprise Rivers, Canals, Backwaters, Creeks, etc., out of which about 5200km of the river and 4000km of canals can be used by mechanized crafts. Yet, IWT mode remains underdeveloped / underutilized in India and its share in overall internal cargo transport remains abysmally low. IWT sector presently has a meager modal share of 0.1% in India compared to other large countries and geographic areas like the United States, China and the European Union.

Inland Waterways Authority of India (IWAI), a statutory authority under the Ministry of Shipping, came into existence on 27th October 1986 with the prime responsibility of development and regulation of inland waterways for shipping and navigation including the development and maintenance of IWT infrastructure on national waterways. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration. The head office of the Authority is at Noida (Uttar Pradesh). The regional offices of IWAI are at Patna (Bihar), Kolkata (West Bengal), Guwahati (Assam) and Kochi (Kerala) whereas sub-offices are at Allahabad & Varanasi (Uttar Pradesh), Bhagalpur (Bihar), Farakka & Hemnagar (West Bengal), Dibrugarh (Assam), Kollam (Kerala), Vijayawada (Andhra Pradesh), Chennai (Tamilnadu) and Bhubaneshwar (Orissa).

There are now one hundred and eleven national waterways (NW) across the country which includes five existing national waterways besides 106 waterways which have recently been declared as national waterways through a central legislation i.e., through a bill passed in the Parliament in March 2016.

NW 1, the Ganga – Bhagirathi – Hooghly river system between Haldia (Sagar) & Allahabad was declared in October 1986 for a Length of 1620 km.

NW 2, the Dhubri – Sadiya stretch of Brahmaputra River was declared in September 1988 for a Length of 891 km.

NW 3, the Kottapuram – Kollam stretch of the West Coast Canal along with the Udyogmandal Canal and Champakkara Canal was declared in February 1993 for a Length of 205 km.

NW 4, the Kakinada – Puducherry stretch consisting of canals and the Kaluvelly Tank along with Bhadrachalam – Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna was declared in November 2008 for a Length of 1095 km.

NW 5, the Talcher – Dhamra stretch of the Brahmani River, the Geonkhali – Charbatia stretch of the East Coast Canal, the Charbatia – Dhamra stretch of Matai river and the Mangalgadi – Paradip stretch of the Mahanadi River Delta was declared in November 2008 for a Length of 623 km.

Regarding the **106 Newly Declared National Waterways,** IWAI is carrying out feasibility studies / Detailed Project Report (DPR) preparation through a number of consultants. Two stage preparation of DPR for 53 Waterways have been initiated through 8 Clusters, whereas M/s Tractebel Engineering had been awarded with 2 Clusters i.e., Custer-VI (consisting of 11 waterways – 7 waterways in Karnataka & 4 waterways in Kerala) & Cluster-VII (consisting of 10 waterways – 7 waterways in Maharashtra & 3 waterways in Goa).

The Waterways considered for the study of DPR under Cluster VII are detailed herewith.

TABLE 1-1: List of Rivers/Creeks of under Cluster VII in the States of Maharashtra and Goa (Length-460.043km)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
1.	Amba River	NW-10	44.971	Maharashtra
2.	Dabhol Creek/ Vashishti River	NW-28	45.228	Maharashtra
3.	Kalyan-Thane-Mumbai waterway, Vasai creek and Ulhas River	NW-53	145	Maharashtra
4.	Rajpuri Creek	NW-83	31	Maharashtra
5.	Revadanda creek / Kundalika River	NW-85	30.736	Maharashtra
6.	Savitri River (Bankot creek)	NW-89	45.47	Maharashtra
7.	Shastri River/ Jaigad creek	NW-91	52	Maharashtra

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
8.	Chapora River	NW-25	25	Goa
9.	Mapusa / Moide River	NW-71	26.638	Goa
10.	Sal River	NW-88	14	Goa
	Total		460.043	

	Waterways restricted to Stage I study.

Accordingly, the Stage II study for the River Mapusa-Moide (NW 71) is under consideration in the present DPR.

1.2 Brief Scope of Work and Compliance statement

The Scope of the Work for the present study is well defined in the Work allocation along with the Terms of Reference (ToR). The same is annexed herewith at Annexure 1.1.

The ultimate requirement from the study is to get a conclusion on the aspect of implementation. Whether the study stretch under consideration is amenable for implementation or not is the final derivative from the study. In order to get this conclusion, the study is subjected to the Infrastructure Requirement for development, the cost for the development with the Expenditure schedules and the viability of the project with the possible revenues and by meeting the social commitment and responsibilities.

The IWT project for development of a waterway stretch can be broadly segregated into the following aspects viz., Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement; Financial Analysis.

1.2.1 Fairway Development

In order to ascertain the existing condition of any waterway, the Bathymetric Survey data along the full stretch at the specified intervals and specified width and the Topographical Survey at important / appropriate locations are required. Based on these site surveys, Conservancy requirements including dredging; Channel demarcation requirements can be arrived at.

1.2.2 Traffic Confirmations

The present Traffic scenarios in the hinterland and along the waterway are to be ascertained and possible volumes of divertible traffic to IWT including the type of cargo are to be assessed for planning and development. The possibility of Passenger and Tourism potential are also to be ascertained.

1.2.3 Terminal Development

Terminal development may have to be initiated with the Site confirmation linking up with various intricacies including the origin and destination of the Traffic. According to the type of cargo and quantum of cargo, the Terminal Infrastructure requirements are to be firmed up. The possibility of moulding the Terminal operation and maintenance as a separate business unit also can be looked into.

1.2.4 Vessel Requirement

Based on the type of cargo, quantum of cargo, distance to be moved etc., also keeping in view the travel time, the type of vessel and No. of vessels requirement are to be worked out. As per the existing / present industry standards, the vessel deployment and its operation and maintenance will not form part of the development except the projection of the requirements for the project, as a whole. Hence this aspect is only indicative.

1.2.5 Financial Analysis

Any project, without the mention of the Cost and economic viability will end up as incomplete. Hence, the detailed Cost analysis; Firming up of the cost for all the items indicated for development; implementation schedule and phasing of the project; operation and maintenance cost etc., are the key factors to be looked into. Working out the possible revenues will be the other key factor. Subjecting the above for a critical Financial and Economic analysis will provide clarity on the implementation of the project, as a whole.

1.3 Brief Methodology & Approach:

The Terms of Reference of the subject study, the scope of work defined for the study itself are indicative about the Methodology to be adopted for the study. Further, the Approach and Methodology had already been explained in the Stage I report and at this juncture, it is prudent to mention the sequential and systematic approach to the project. Accordingly, a flow diagram has been placed at Annexure

1.2, which is self-explanatory and by following the activities as specified, the project report will be in complete shape.

1.4 Project Location / Details of Study Area:

Stage 1 study was completed for all the 10 National Waterways under Cluster VII and the Feasibility Study Reports of individual National Waterways have been presented to IWAI. Based on the inputs of the FSR, IWAI asked M/s Tractebel to go ahead with the Stage II study on 6 out of 10 National Waterways i.e., 4 in the state of Maharashtra and 2 in the state of Goa, as detailed.

TABLE 1-2: Waterways for Stage II study

Sl. No.	NW-No. / Name of the Waterway	Defined Limits
Cluster 7	(Maharashtra)	
1.	NW-10 / AMBA RIVER	44.971 kms from starting point Lat 18°50' 26.7055" N, Long 72° 56' 44.2695" E.
2.	NW-28 / DABHOL CREEK / VASHISHTI RIVER	45.228 kms from starting point Lat 17°34'31.1762" N, Long 73°09'09.5984" E.
3.	NW-85 / REVADANDA CREEK / KUNDALIKA RIVER	30.736 kms from starting point Lat 18°32'16.7857" N, Long 72°55'33.4735" E.
4.	NW-89 / SAVITRI RIVER (BANKOT CREEK)	45.47 kms from starting point Lat 17°58'47.2472" N, Long 73°02'15.0195" E.
Cluster 7	(Goa)	
1.	NW-25 / CHAPORA RIVER	25 kms from starting point Lat 15°36'31.2547" N, Long 73°44'06.5695" E.
2.	NW-71 / MAPUSA / MOIDE RIVER	26.638 kms from starting point Lat 15°30'22.0887" N, Long 73°50'36.2908" E.

The present study is about the Mapusa-Moide River – NW 71 for a distance of 26.638 kms from the confluence of river Mandovi to Upstream, in the state of Goa.

TABLE 1-3: Description of Mapusa-Moide River (NW-71)

Sl No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Mapusa / Moide River (NW-71)
2	State/ District through which river passes	The Mapusa / Moide River passes through the North Goa District of Goa State.
3	Length of the river / canal	The Mapusa / Moide River is a right bank (North bank) tributary of River Mandovi. The River originates in the jungles of Dumacem and Amthane. Out of the total length of 31 km of Mapusa-Moide River, 26.638kms of the stretch from confluence point of Mapusa & Mandovi rivers at Porvorim Lat 15°30'22.0887"N, Long 73°50'36.2908"E to Bridge on NH-17 at Mapusa Lat 15°35'20.51"N, Long 73°49'19.61"E has been declared as new national waterway and proposed to undertake the DPR.
4	Map	The index map of Mapusa-Moide River showing proposed waterway stretch, topographic features and road networks are shown in Figure1.1. The study stretch of the Mapusa-Moide River for the Detailed Project Report (DPR) is presented in Volume-II Drawing No**. P. 010257-W-20301-A02 (Sheet – 1 to 3).**
Characteristic of River		
5	River Course	The river originates from the jungles of Dumacem and Amthane, meanders eastward and then southward before it drained itself into the Mandovi River at Penha de France (Bardez) in North Goa district. The total length of the river is about 31 km before joining the sea. The river is under tidal effect of the Arabian Sea (backwater effect) up to Mapusa about 27 km from the river confluence with River Mandovi.
6	Tributaries / Network of Rivers / Basin	Mapusa River has a relatively small catchment area and its tributaries are small feeder streams and canals. Mapusa town is located on the banks of river.
7	Catchment Area	The total catchment area of Mapusa / Moide River is 190sqkm.

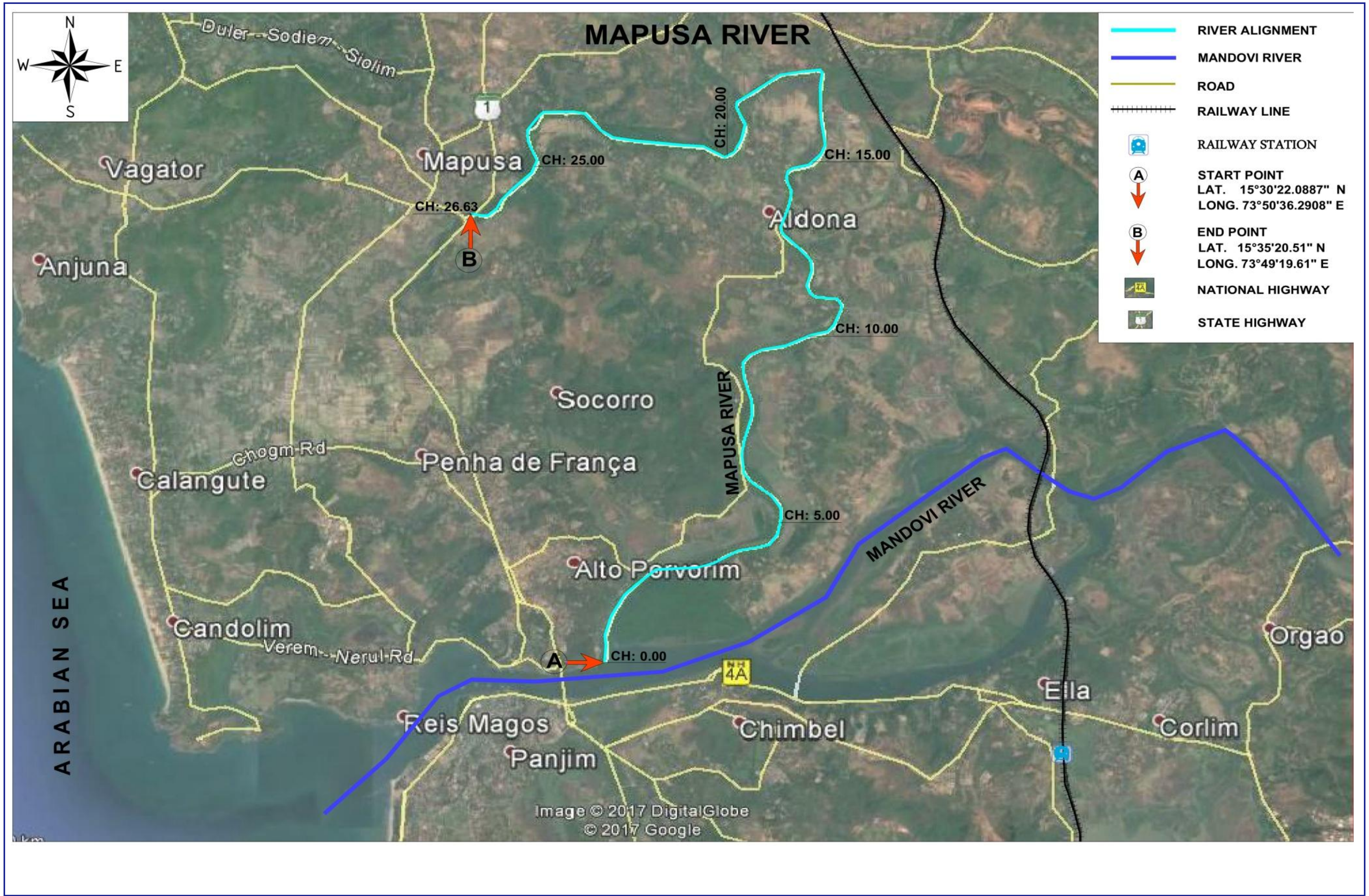


FIGURE 1.1 : INDEX MAP

CHAPTER 2 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 Hydrographic Survey

Hydrographic survey is the science of measurement of Water depths and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration / offshore oil drilling and related activities. Hydrographic survey are being carried out for one or more of the following activities like measurement of tides for sea coast works (e.g. construction of sea defence works, harbors etc.), determination of bed depth of water bodies, by soundings (for navigation, location of rocks, sand bars, navigation light).

2.1.1 Waterway in General and Hydro-morphological Characteristics

Waterway in General

Mapusa River is a right bank (North bank) tributary of the River Mandovi in the state of Goa. The river originates from the jungles of Dumacem and Amthane, meanders eastward and then southward before it drained itself into the Mandovi River at Penha de France (Bardez) in North Goa district. Mapusa River is responsible for separating Corjuem from mainland Aldona.

The Mapusa river is bounded by Mapusa town, Tivim, Sircaim, Punola, Moira and Aldona in the upper stretch and Calvin, Ambarim, Caarain, Olaulim and Pomburpa in the middle stretch and Salvadore Do Mundo, Alto Porvorin and Charao in the lower stretch. The total length of the river from origin to its outfall into the Mandovi River is 31.00km. The present study focusses on 26.638 km.

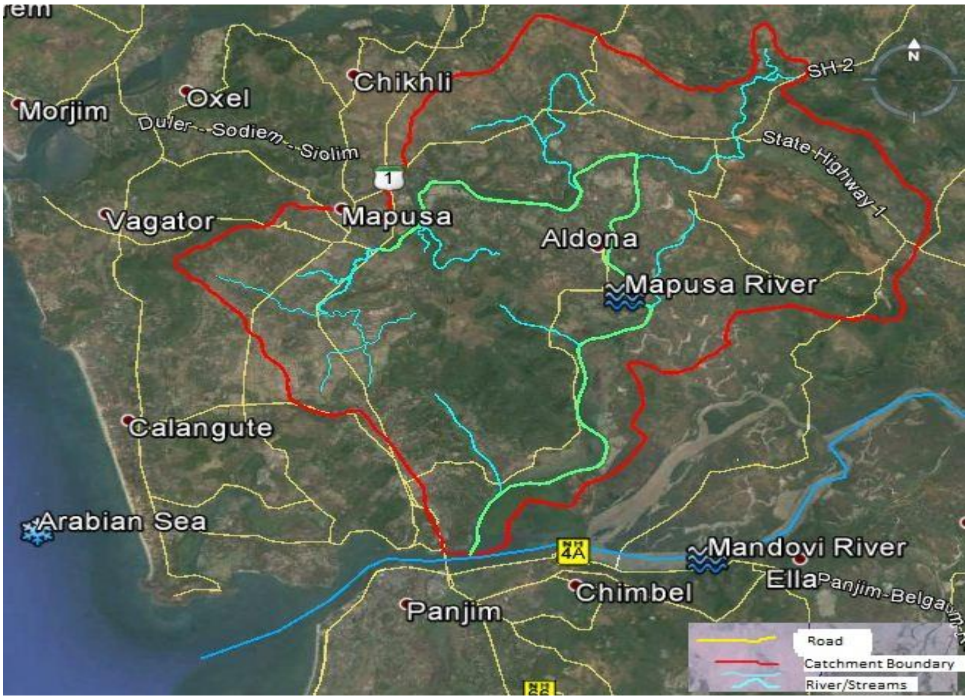


FIGURE 2.1: Catchment Area Map of Mapusa River (Source: Google Earth)

The total catchment area of Mapusa River basin is 190sqkm. Mapusa River has a relatively small catchment area and its tributaries are small feeder streams and canals. Mapusa town is located on the banks of river. The Mapusa River enters Goa close to Khanapur border just below Sosodurg (named Dara Singha peak on the Karnataka side). This river enters Goa on the highest peak in Goa. In the upper part of the river in Sattari valley, it is called the Mhadei and flows for approximately 20 km westward until it reached Bembol, where it joins with the Kandepar River. From here onwards the river is referred to as the Mandovi until it falls into the Arabia Sea.

A map showing Mapusa catchment basin is shown in above figure. The figure indicates that the river flows close to the coastal region; thus the lower stretch of river is expected to be tidal affected zone and the tidal reaches may have navigation potential.

Hydro-morphological Characteristics

The combined study of hydrology and morphology gives a clear picture of hydro morphological characteristics of any water body.

Hydro morphology of the study area

Due to maritime influence, the diurnal range of temperature during the day is not large. The diurnal range is the least being 4 to 6 °C during monsoon season and increases to the maximum of 10 to 20° C during December & January. May is the hottest month where the mean daily temperature increases to 30 °C. January is the coolest with mean daily temperature of about 23 °C. It is noted that the day temperature is the lowest in monsoon months of July and August and not in the cool winter months of December and January.

Due to proximity to the Arabian Sea, humidity throughout the year is more than 60% with range from 80 to 90% during monsoon period. Over 90% of annual rainfall occurs during monsoon months of June to September. About 32% of the annual rainfall is received during July. The average annual rainfall of Goa is 3005 mm.

Soils of north Goa can be classified into 3 types namely (i) Laterite soil (ii) Saline soil and (iii) Alluvial soil. Saline soil occurs in the flood plains of Bardez into which river Mapusa drains itself. The soil texture of the river bed has been observed at 10km interval which indicates that clayey sand soil is present in most part of the river under study stretch. Formation of braiding pattern is popularly attributed to heavy sediment load in a river having a wide and shallow cross section. Rise in river bed levels, rise in flood levels, accumulation of silt rendering channels shallow, bank erosion as a result of development of multiple channels and sudden change in flow direction are some of the conditions associated with braided rivers. However from the survey it was seen that there is no braiding in this river course.

The river slope between Ch 0.00 km and Ch 10.00 km is 1 in 10000. It remains same in (1in10000) between Ch 10.00 km and Ch 20.00 km. However the river slope becomes a bit steeper comparatively between Ch 20.00 km and Ch 26.4 km with slope 1 in 3200 m. The velocity is found to be higher between Mapusa town and Moira than between Moira and Charao.

Any part of river falls under rapid zone if the river bed has a relatively steep gradient which causes increase in velocity and turbulence. Thus rapid zone characterization is important as it indicates whether navigation will be safe or not. The slope of this river indicates that the river does not fall under rapid zone.

Due to the topography of Western Ghats, rivers flowing in this region do not have the capacity to flood the banks or nearby areas. During reconnaissance survey this fact was checked and found that the discharge of River Mapusa is influenced by tide.

Geomorphology

According to the classification of the waterway (from class I to class VII), the maximum width and maximum depth requirement have been considered as 100 m and 2.75 m for two way navigation. Keeping aside the FSR stage recommendation and keeping in view the recent Administrative circulation etc., the present analysis has been relooked with the possibilities for 100 m width and 2.75 m depth for Class VII and also being considered with the stake holder's requirement, if any.

Mapusa River (Ch 0.00 km - Ch 10.00 km)

The satellite image for the stretch of first 10 km for four time periods have been placed (December 2003, April 2010, March 2014 and November 2016).

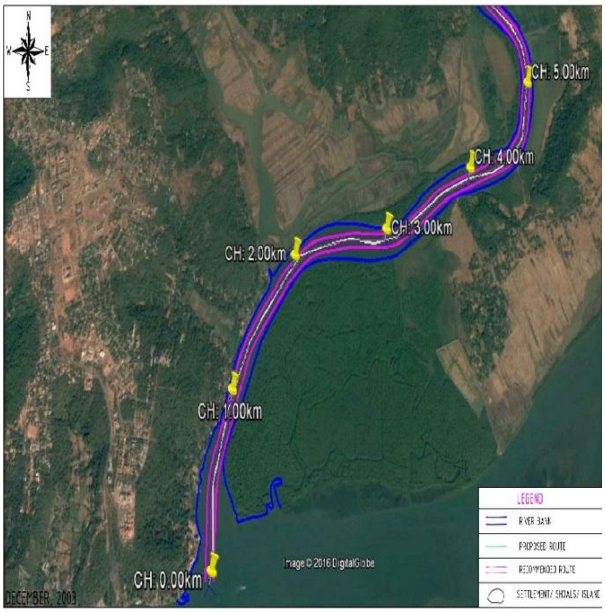


FIGURE 2.2: River stretch from Ch 0.00km to 5.00km in December, 2003(Source: Google Earth)

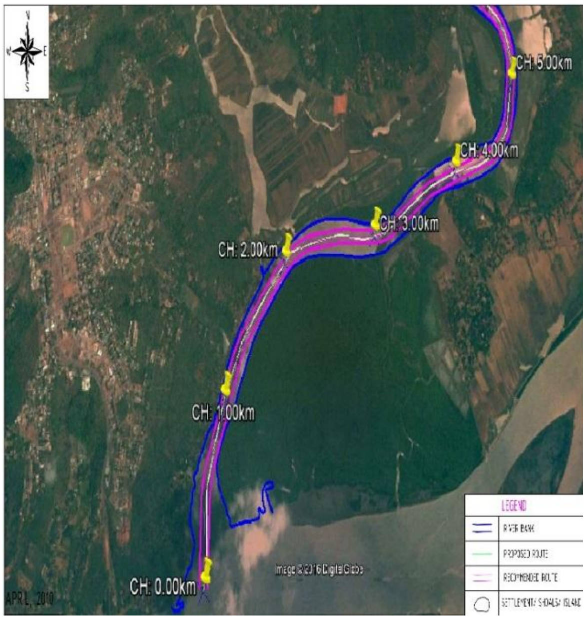


FIGURE 2.3: River stretch from Ch 0.00km to 5.00km in April, 2010(Source: Google Earth)

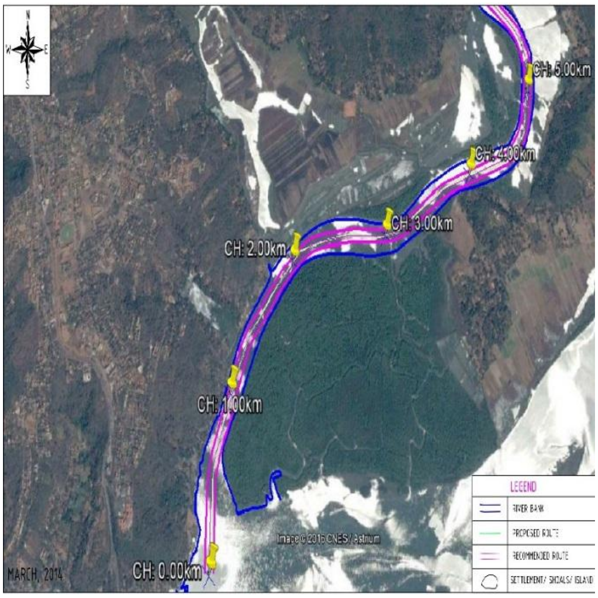


FIGURE 2.4: River stretch from Ch 0.00km to 5.00km in March, 2014(Source: Google Earth)

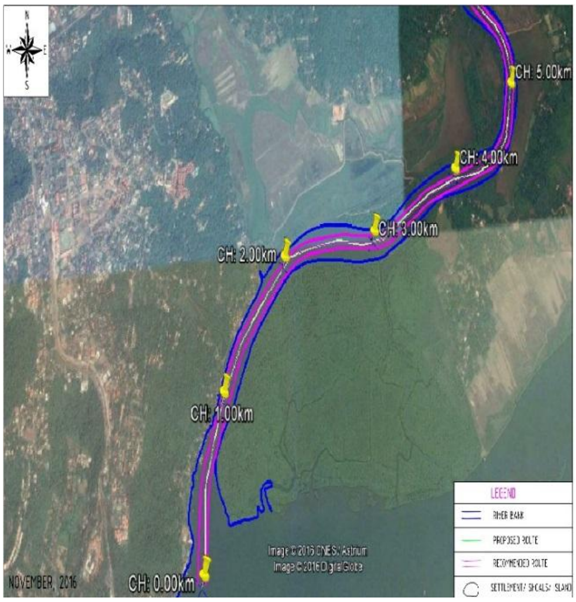


FIGURE 2.5: River stretch from Ch 0.00km to 5.00km in March, 2016(Source: Google Earth)

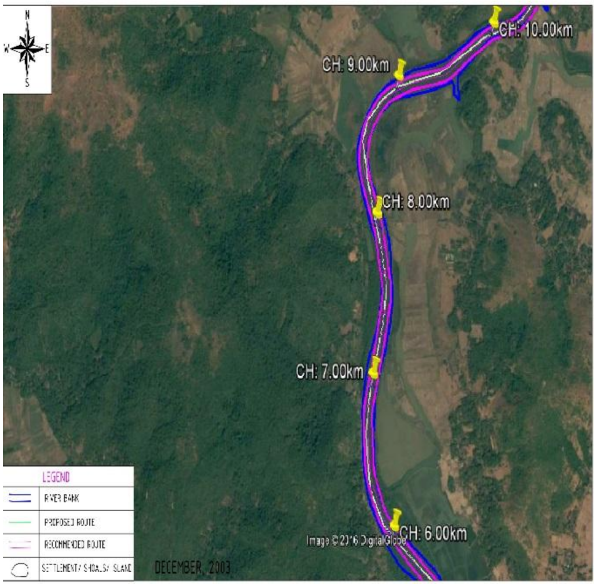


FIGURE 2.6: River stretch from Ch 6.00km to 10.00km in December, 2003(Source: Google Earth)

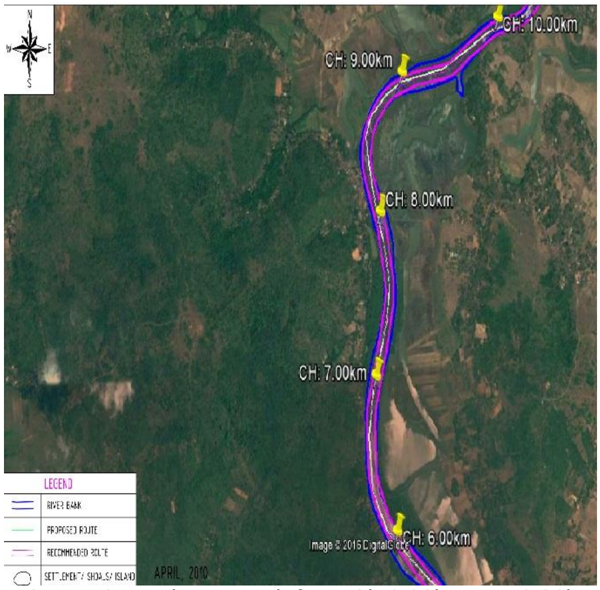


FIGURE 2.7:: River stretch from Ch 6.00km to 10.00km in April, 2010(Source: Google Earth)

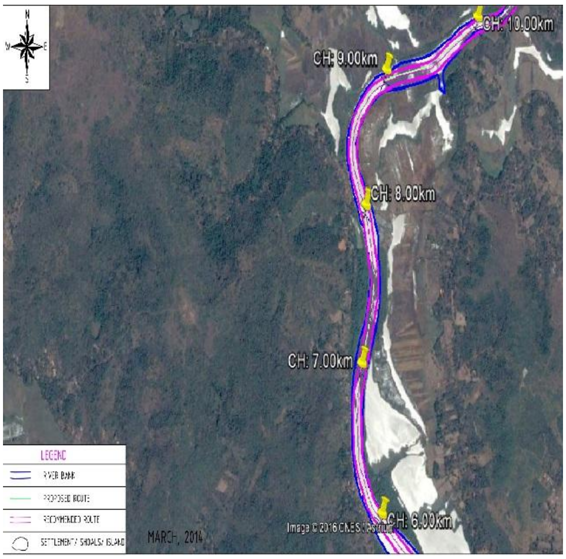


FIGURE 2.8: River stretch from Ch 6.00km to 10.00km in March, 2014(Source: Google Earth)

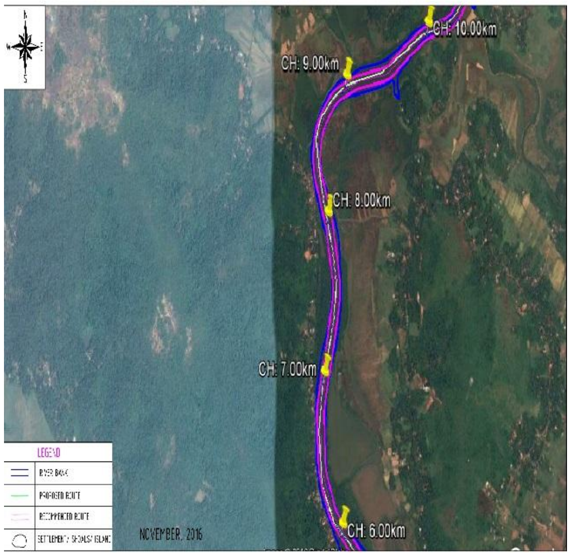


FIGURE 2.9: River stretch from Ch 6.00km to 10.00km in March, 2016(Source: Google Earth)

The water depth is observed to become shallow in April, 2010. This is seen upto Ch 7.00 km. Again in March, 2014 the water depth is very shallow throughout the stretch where prominent effect of accretion is noted especially near the mouth. From the time periods of the images it can be seen that the depth of water decreases drastically during the pre-monsoon season.

There are no shoals or settlements of soil observed in this stretch. In all the below four figures it has been noted that the river flow passes through a narrow strip with bend near Ch 5.00 km and Ch 9.00 km. No significant variation observed.

Mapusa River (Ch 11.00 km - Ch 20.00 km)

The satellite image for the stretch of next 10 km for four time periods have been placed (December 2003, April 2010, March 2014 and November 2016).

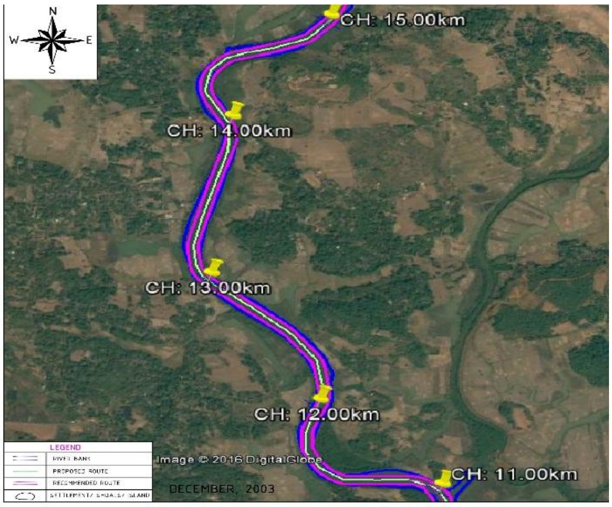


FIGURE 2.10: River stretch from Ch 11.00km to 15.00km in December, 2003(Source: Google Earth)

FIGURE 2.11: River stretch from Ch 11.00km to 15.00km in April, 2010(Source: Google Earth)

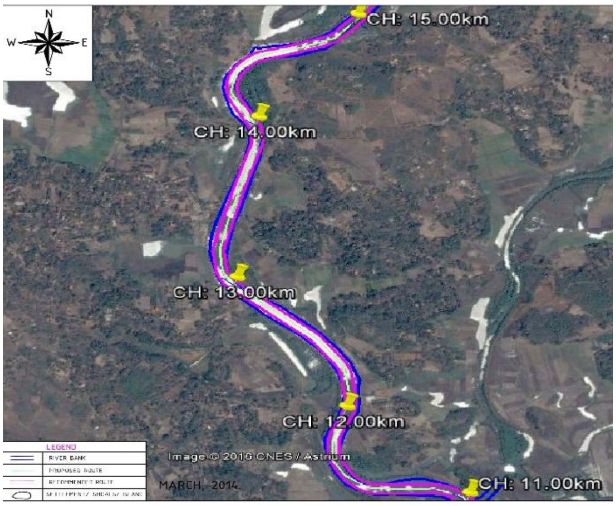


FIGURE 2.12: River stretch from Ch 11.00km to 15.00km in March, 2014(Source: Google Earth)

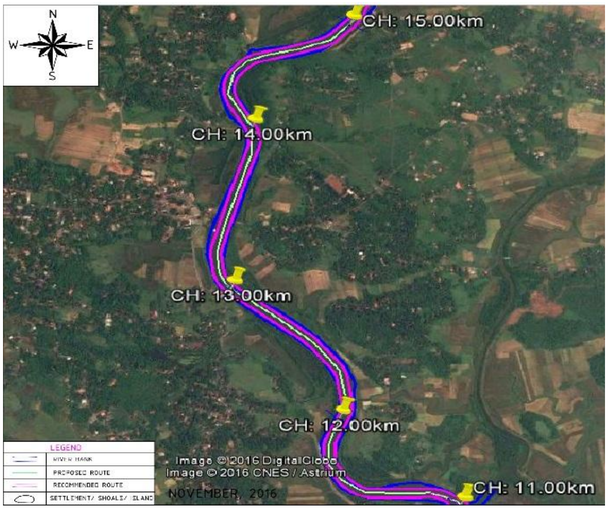


FIGURE 2.13: River stretch from Ch 11.00km to 15.00km in March, 2016(Source: Google Earth)

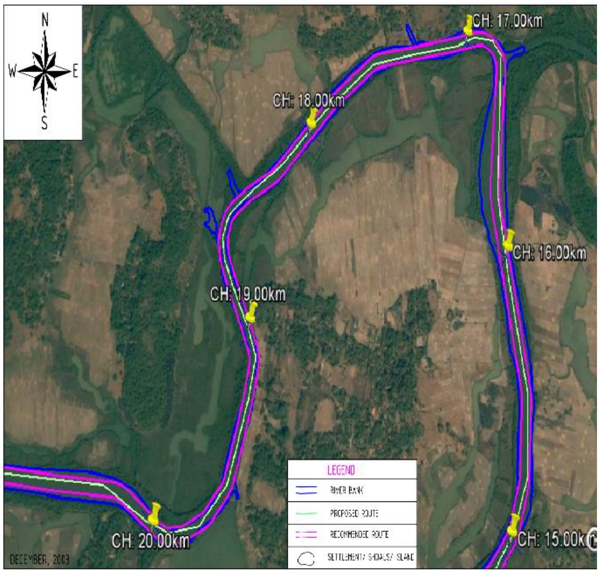


FIGURE 2.14: River stretch from Ch 11.00km to 15.00km in December, 2003(Source: Google Earth)

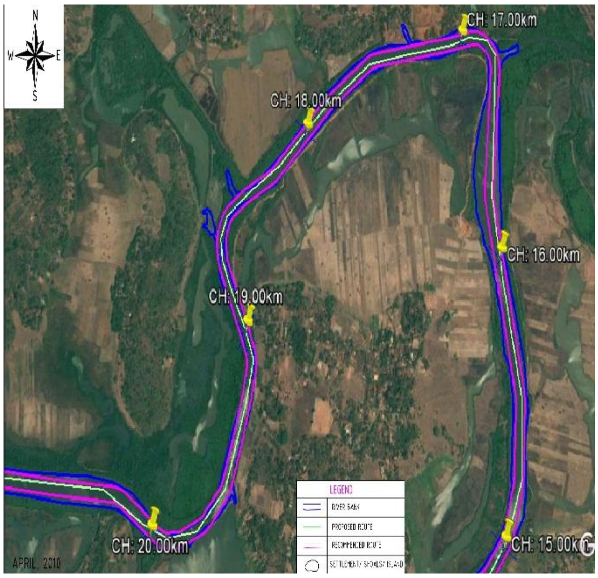


FIGURE 2.15: River stretch from Ch 11.00km to 15.00km in April, 2010(Source: Google Earth)

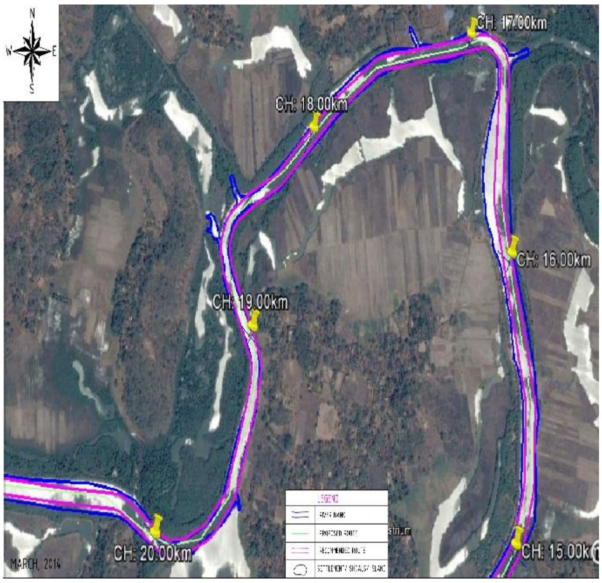


FIGURE 2.16: River stretch from Ch 11.00km to 15.00km in March, 2014(Source: Google Earth)

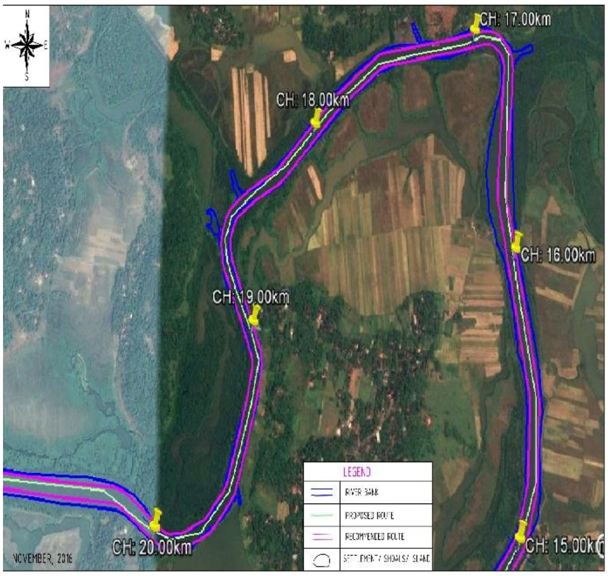


FIGURE 2.17: River stretch from Ch 11.00km to 15.00km in March, 2016(Source: Google Earth)

Unlike the scenario in the first 10 km, the water depth is observed to become shallow in some parts near Ch 15.00 km, Ch 16.00 km and Ch. 19.00 km in April, 2010. However in March, 2014 the water depth is very shallow throughout the stretch. From the time periods of the images it can be seen that the depth of water decreases drastically during the pre-monsoon season.

There are no shoals or settlements of soil observed in this stretch.

In all the below four figures it has been noted that the river flow passes through a narrow strip with a total of 7 bends near Ch 11.00 km to Ch 20.00 km. No significant variation observed.

Mapusa River (Ch 21.00 km - Ch 26.638 km)

The satellite image for the stretch of last 6.638 km for four time periods have been placed (December 2003, April 2010, March 2014 and November 2016).

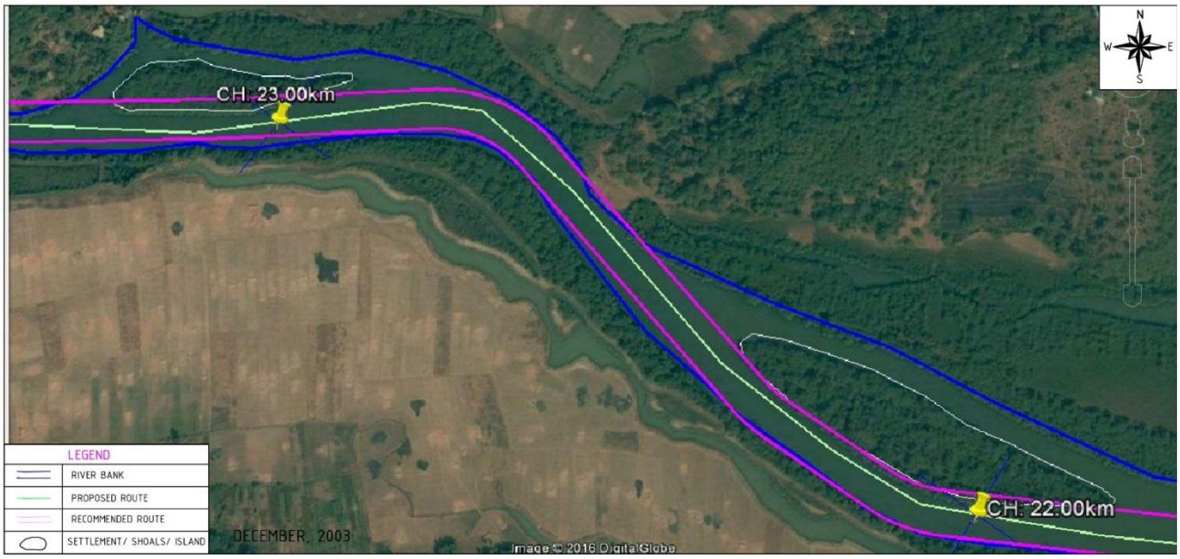


FIGURE 2.18 : River stretch from Ch 22.00km to 23.00km in December, 2003 (Source: Google Earth)

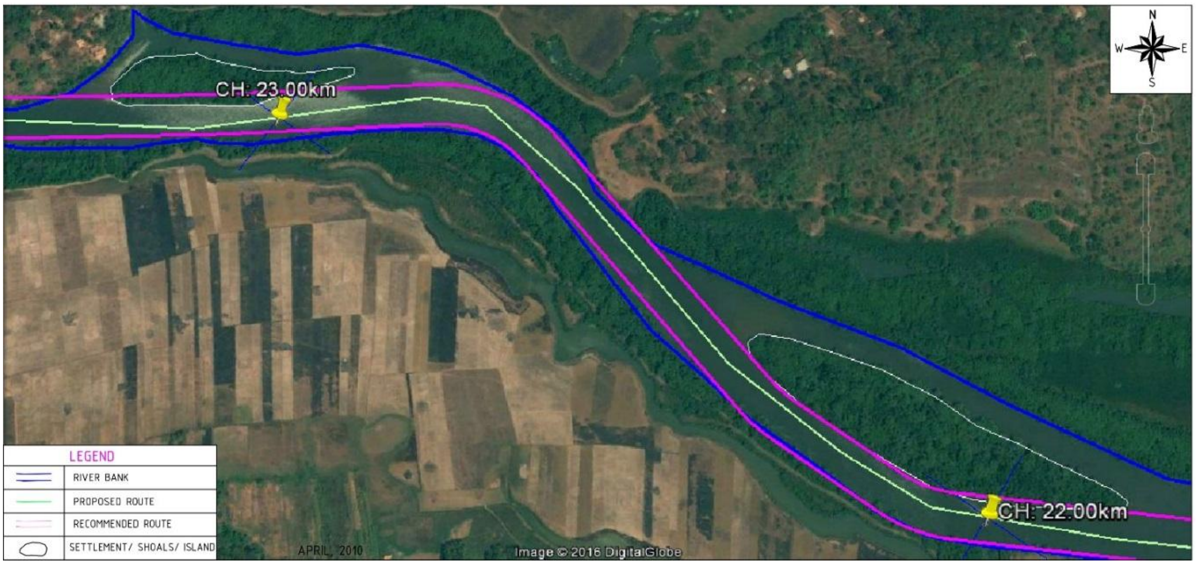


FIGURE 2.19 : River stretch from Ch 22.00km to 23.00km in April, 2010 (Source: Google Earth)

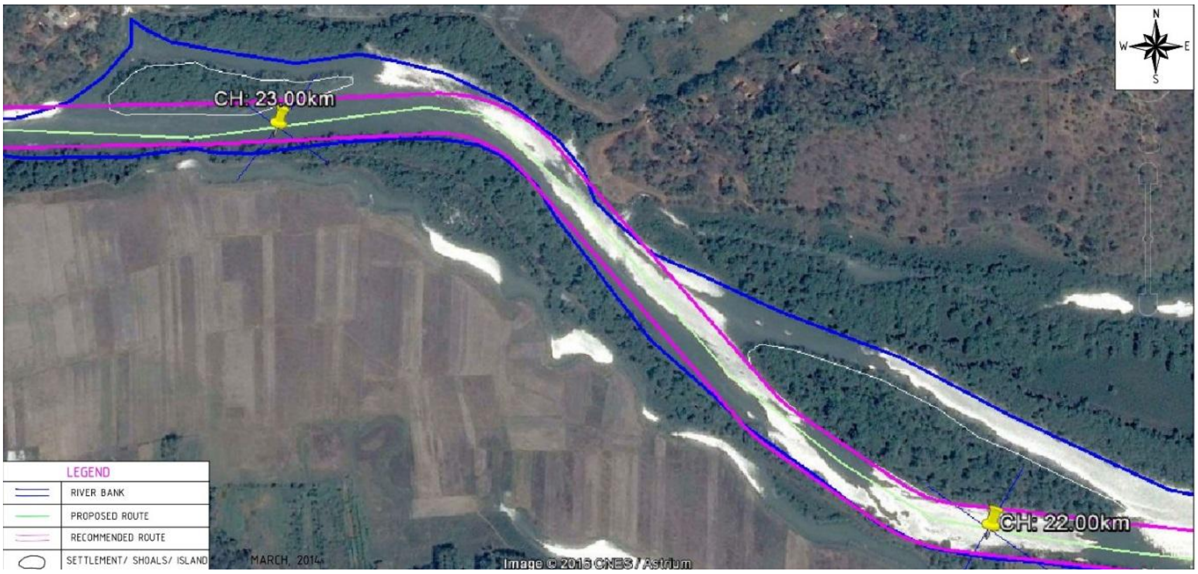


FIGURE 2.20 : River stretch from Ch 22.00km to 23.00km March, 2014 (Source: Google Earth)

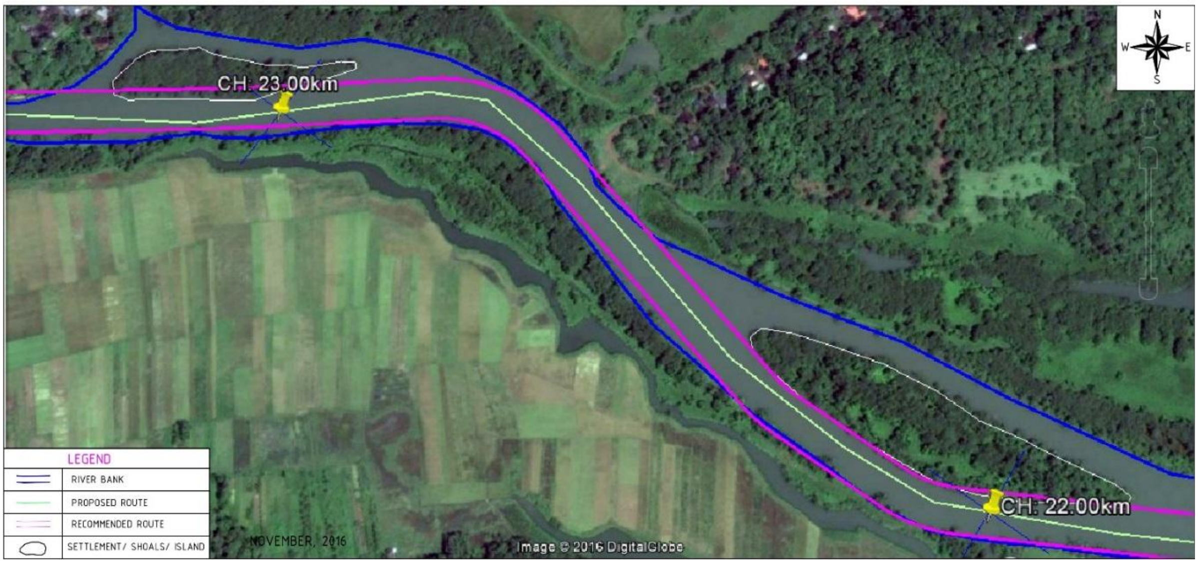


FIGURE 2.21 : River stretch from Ch 22.00km to 23.00km in November, 2016 (Source: Google Earth)

FIGURE 2.22 : River stretch near Ch 25.00km in December, 2003 (Source: Google Earth)

FIGURE 2.23 : River stretch near Ch 25.00km in April, 2010 (Source: Google Earth)

FIGURE 2.24 : River stretch near Ch 25.00km in March, 2014 (Source: Google Earth)

FIGURE 2.25 : River stretch near Ch 25.00km in November, 2016 (Source: Google Earth)

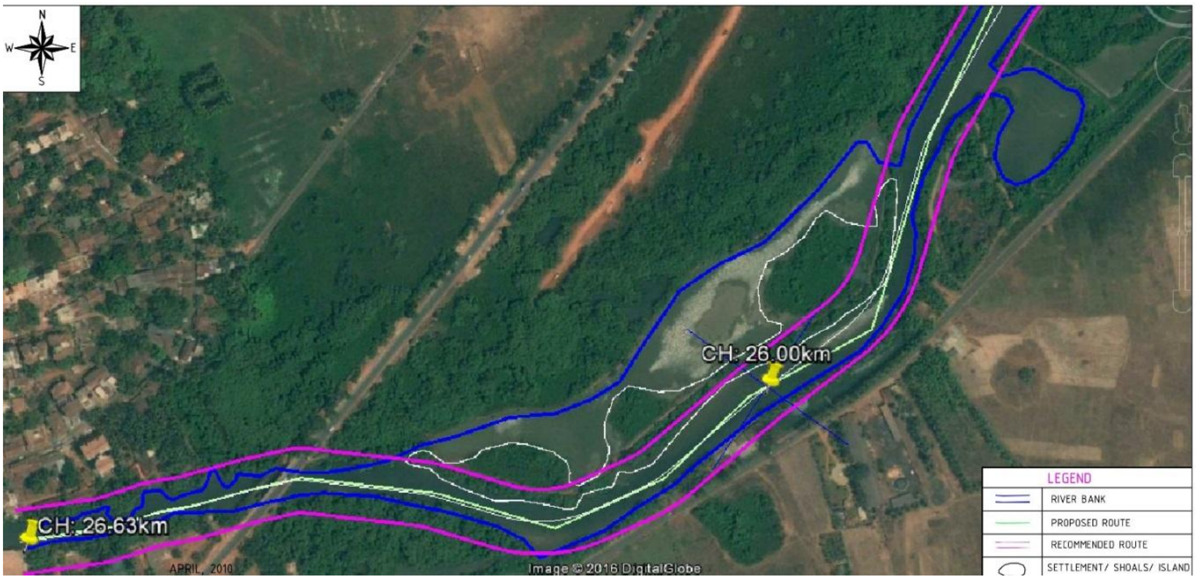


FIGURE 2.26 : River stretch near Ch 26.00km in December, 2003 (Source: Google Earth)

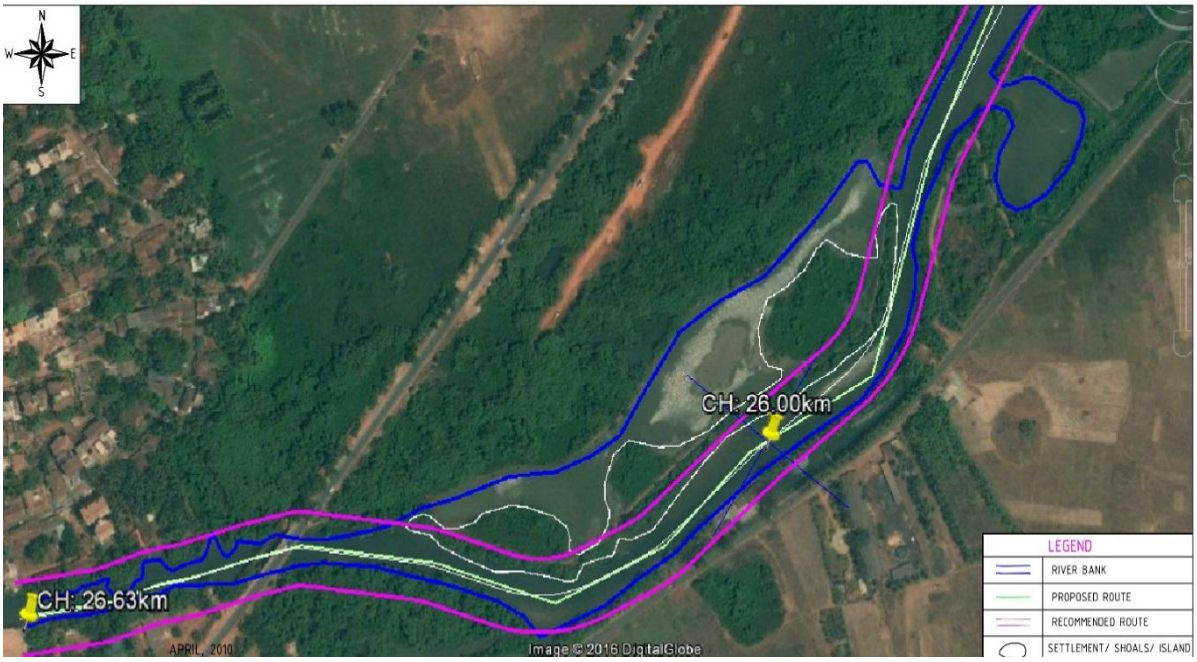


FIGURE 2.27 : River stretch near Ch 26.00km in April, 2004 (Source: Google Earth)

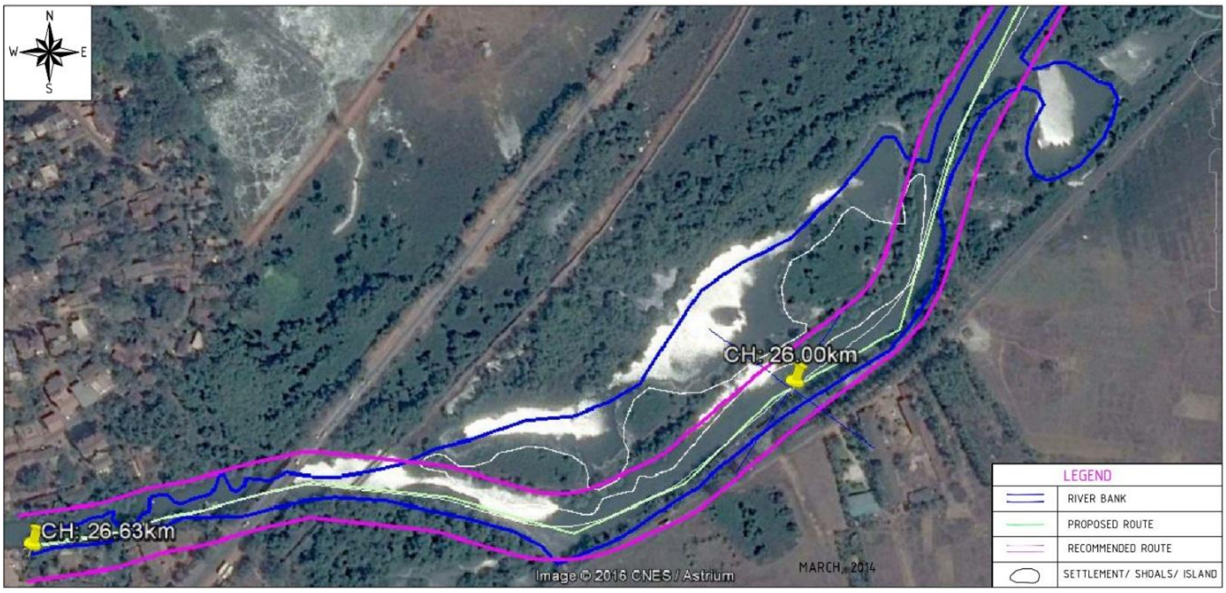


FIGURE 2.28 : River stretch near Ch 26.00km in March, 2014 (Source: Google Earth)

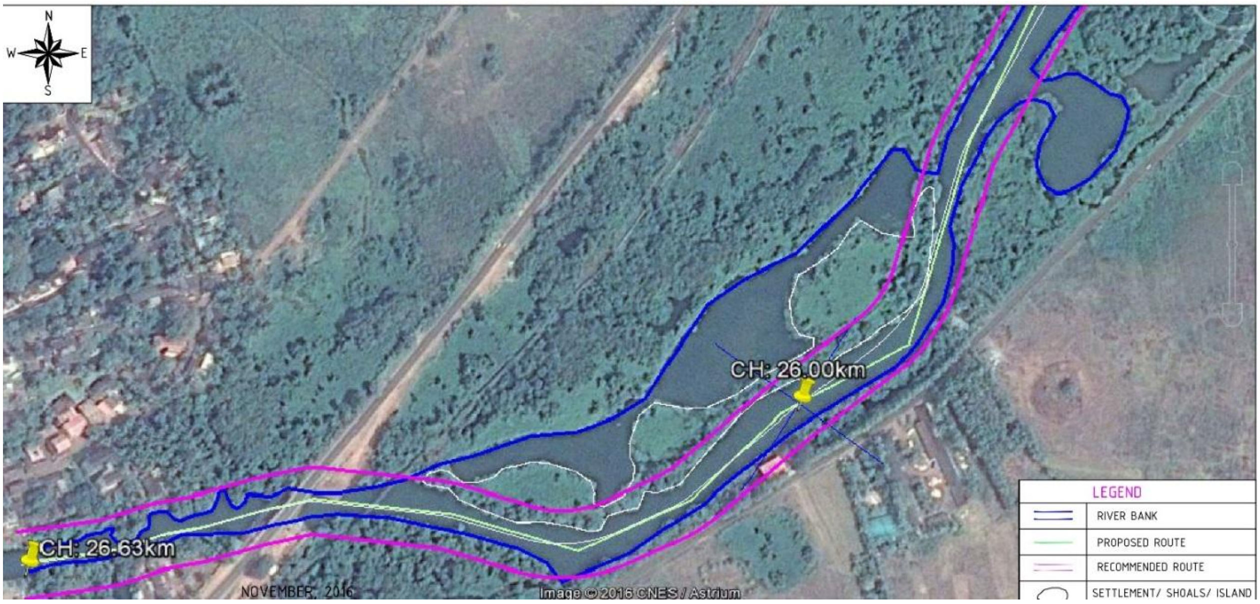


FIGURE 2.29 : River stretch near Ch 26.00km in November, 2016 (Source: Google Earth)

Two shoals are observed between Ch 21.00 km and Ch 24.00 km. From December, 2003 to April, 2010, no movement of shoals are observed. However in March, 2014 slight movement is observed. The water depth is shallow in between Ch 22.00 km and Ch 23.00 km in March, 2014.

In all the below four figures it has been noted that the river flow passes through a narrow strip with bend near Ch 23.00 km. No significant variation observed.

One shoal is seen at Ch 25.00 km. From December, 2003 to April, 2010 the shoal is seen to migrate downstream. In March, 2014 the shoal moves towards the left bank but comes back to its previous position in December, 2016. However the shoal comes in the route of waterway. Thus dredging may be required. The bank line also shifts in 2014. Shallow water is observed during April, 2010.

One more shoal at Ch 26.00 km moves towards the left bank In March, 2014 but comes back to its previous position in December, 2016. The bank line also shifts in 2014.

In all the below four figures it has been noted that the river flow passes through a narrow strip with bend between Ch 26.00 km and Ch 26.638. No significant variation observed.

Conclusion

From Ch 0.00 km to Ch 26.63 km, a total of four shoals were present which some migration. Some of the shoals after Ch 25.00 km come in the route of the waterway. Therefore dredging may be required for hindrance free navigation. The river observes many bends during its course. Bankline shift is observed in April, 2014 mainly in the upper stretch of the river.

From the satellite images of the above mentioned time periods, it is seen that river bank line experiences some shift during April, 2014 as compared to that in December, 2016. This shift is predominant in the upper stretch of the river i.e. Ch 17.00 km onwards. Since the bank has mangroves on both sides, it can be concluded that due to some change in the density of mangroves, the river bank might have shifted. Major changes in the bank shape is observed between Ch 18.00 km and Ch 19.00 km on the left side. Noticeable changes can be seen after Ch 25.00 km, especially near Ch 26.63 km on the right bank.

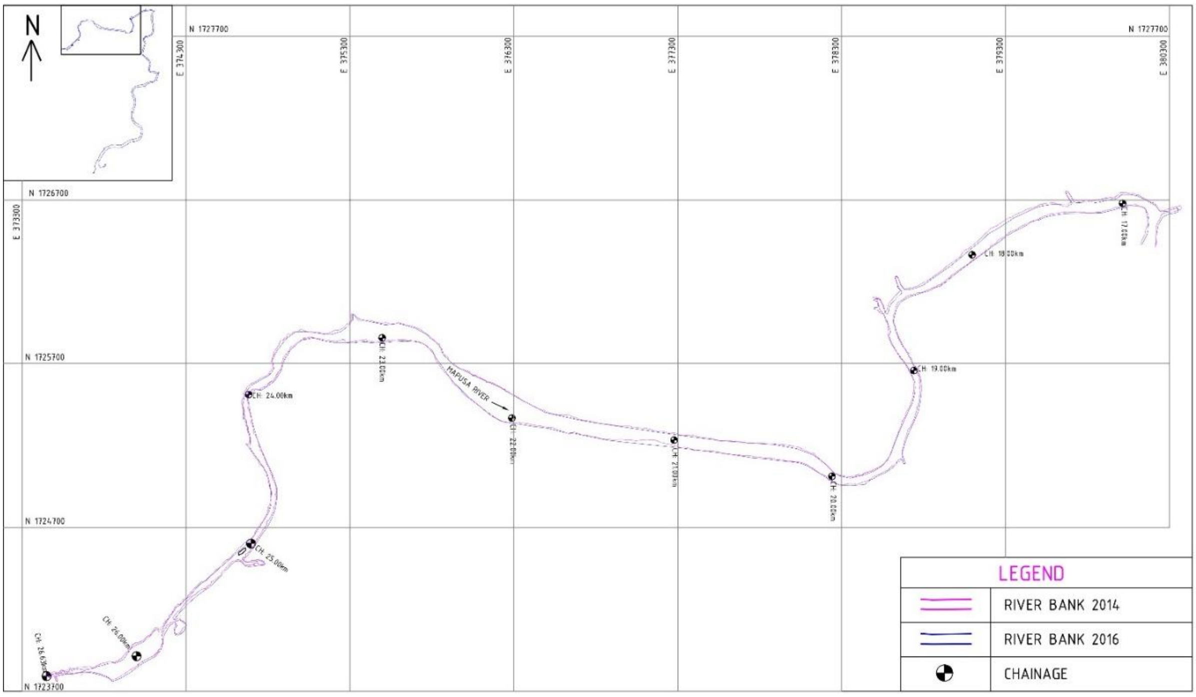


FIGURE 2.30: River bank in 2014 and 2016 in the upper stretch of the river

2.1.2 Existing Hydrological / Topographical Reference levels

TABLE 2-1: Accepted Station coordinates (WGS-84)

Station	Chainage (KM)	Latitude (N) Longitude (E)	Easting Northing	Height above MSL (m)	Height above CD (m)
MAP-1	0.000	15°30'23.1768"N 73°50'33.6607"E	375870.22m E 1714676.73 m N	1.672	2.972
MAP-2	14.175	15°35'36.1647"N 73°52'36.7389"E	379588.11m E 1724275.35m N	1.558	2.933
MAP-3	19.785	15°36'02.9227"N 73°52'05.7895"E	378670.67m E 1725102.50m N	2.039	3.005

TABLE 2-2: Details of Chart Datum used for Data Reduction

Sr. No.	Location	Latitude	Longitude	Z_0*(m)
1	Marmagao	15°25'00"	73°48'00"	-1.30

** Below Mean Sea Level*

Note: The bench mark is marked by cut on the south east corner at Orando jetty on the eastern bank of Mapuca River. The value of benchmark is 3.3m above Chart datum. This value is transferred by leveling at panjim jetty, and Marked 4.073m above Chart Datum at Panaji jetty.

2.1.3 Chart Datum / Sounding Datum

The water depths have been determined as a result of short period observations at both an established gauge (where the chart datum is known) and new gauge (where the chart 2 datum has been established) in the area. The four consecutive low waters and the three intervening high waters have been recorded during spring tide, when the range of differences between high and low waters was the greatest. The locations with coordinates of established gauge and new gauge that have been used to reduce the soundings along the surveyed stretch are tabulated below.

TABLE 2-3: Details of Chart Datum Used for Data Reduction

Transfer of Sounding Datum	**H- 533**
For Semi - Diurnal Tides	

Date and Time of 1st LW Observation at Established Guage = 28.12.2016, 16.00 hrs

Position of Established Guage			Position of Established Guage		
	Lat	15°30'5.79"N		Lat	15°30’22.923” N
	Long	73°49'43.11"E		Long	73°50’33.499” E
	Name	**PANJIM JETTY**		Name	**BRITONA Jetty**

	At Established Guage						At New Guage					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.733	x	1		0.73	-	0.753	x	1		0.75
b	2.493	-	x	1	2.49		2.513	-	x	1	2.513	
c	-	1.553	x	3		4.66	-	1.573	x	3		4.72
d	2.236	-	x	2	4.47		2.256	-	x	2	4.512	
e	-	0.673	x	3		2.02	-	0.693	x	3		2.08
f	2.563	-	x	1	2.56		2.583	-	x	1	2.583	
g	-	1.493	x	1		1.49	-	1.513	x	1		1.51
	Sum of Contribution				9.53	8.90	Sum of Contribution				9.608	9.06
	Observed M. H.W.				2.38		Observed M.H.W.				2.402	
	Observed M.L.W.					1.11	Observed M.L.W.					1.13
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	1.27	Observed Mean Range = r				=	1.269
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	1.75	Observed Mean Level = m'				=	1.7675
	M' = (M.H.W +M.L.W.)/2						m' = (M.H.W.+M.L.W.)/2					
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.											
	Observed Mean Level = (Observed MHW + Observed MLW) /2											

Calculation of Sounding Datum (d) at New Guage					
(A) Where 'True Spring M.L (M)' at			(B) Where 'True Spring M.L (M)' at		
Established gauge is known			Established gauge is not known		
From A.T.T (Table V of Part II)					
MHWS	=				
MLWS	=				
True Spring M.L. (M)	=	0.00			
Note : True Spring M.L. (M) = (MHWS + MLWS)/2					
SD =	m' (M'-M) - M*(r/R)		SD =	m'-((M*r)/R)	
SD =	**0.00**	m above of Zero of Guage	SD =	**0.020**	m above Zero of Guage

TABLE 2-4: Details of Chart Datum Used for Data Reduction

Transfer of Sounding Datum	**H- 533**
For Semi - Diurnal Tides	

Date and Time of 1st LW Observation at Established Guage = 28.12.2016, 16.00hrs

Position of Established Guage		Position of Established Guage	
Lat	15°30'5.79"N	Lat	15°35'37.655" N
Long	73°49'43.11"E	Long	73°52'35.633" E
Name	**PANJIM JETTY**	Name	**Aldona Bridge**

	At Established Guage						At New Guage					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.733	x	1		0.73	-	0.408	x	1		0.41
b	2.493	-	x	1	2.49		2.171	-	x	1	2.171	
c	-	1.553	x	3		4.66	-	1.071	x	3		3.21
d	2.236	-	x	2	4.47		1.789	-	x	2	3.577	
e	-	0.673	x	3		2.02	-	0.393	x	3		1.18
f	2.563	-	x	1	2.56		2.544	-	x	1	2.544	
g	-	1.493	x	1		1.49	-	1.044	x	1		1.04
	Sum of Contribution				9.53	8.90	Sum of Contribution				8.291	5.84
	Observed M. H.W.				2.38		Observed M.H.W.				2.073	
	Observed M.L.W.					1.11	Observed M.L.W.					0.73
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	1.27	Observed Mean Range = r				=	1.3428
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	1.75	Observed Mean Level = m'				=	1.4014
	M' = (M.H.W +M.L.W.)/2						m' = (M.H.W.+M.L.W.)/2					
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.											
	Observed Mean Level = (Observed MHW + Observed MLW) /2											

Calculation of Sounding Datum (d) at New Guage

(A) Where 'True Spring M.L (M)' at Established gauge is known			(B) Where 'True Spring M.L (M)' at Established gauge is not known		
From A.T.T (Table V of Part II)					
MHWS	=				
MLWS	=				
True Spring M.L. (M)	=	0.00			
Note : True Spring M.L. (M) = (MHWS + MLWS)/2					
SD =	m' (M'-M) - M*(r/R)		SD =	m'-((M*r)/R)	
SD =	**0.00**	m above / below of Zero of Guage	SD =	**-0.447**	m below Zero of Guage

TABLE 2-5: Details of Chart Datum Used for Data Reduction

Transfer of Sounding Datum												H- 533
For Semi - Diurnal Tides												
Date and Time of 1st LW Observation at Established Guage = 1.12.2016, 18.45hrs												
	Position of Established Guage		Lat	15°30'5.79"N			Position of Established Guage		Lat	15°36'29.151" N		
			Long	73°49'43.11"E					Long	73°52'05.279" E		
			Name	**PANJIM JETTY**					Name	**QUITILA**		
	At Established Guage						At New Guage					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.733	x	1		0.73	-	0.310	x	1		0.31
b	2.493	-	x	1	2.49		2.073	-	x	1	2.073	
c	-	1.553	x	3		4.66	-	0.893	x	3		2.68
d	2.236	-	x	2	4.47		1.691	-	x	2	3.382	
e	-	0.673	x	3		2.02	-	0.295	x	3		0.89
f	2.563	-	x	1	2.56		2.446	-	x	1	2.446	
g	-	1.493	x	1		1.49	-	0.946	x	1		0.95
	Sum of Contribution				9.53	8.90	Sum of Contribution				7.901	4.82
	Observed M. H.W.				2.38		Observed M.H.W.				1.975	
	Observed M.L.W.					1.11	Observed M.L.W.					0.60
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	1.27	Observed Mean Range = r				=	1.3728
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	1.75	Observed Mean Level = m'				=	1.2889
	M' = (M.H.W +M.L.W.)/2						m' = (M.H.W.+M.L.W.)/2					
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.											
	Observed Mean Level = (Observed MHW + Observed MLW) /2											
	Calculation of Sounding Datum (d) at New Guage											
	(A) Where 'True Spring M.L (M)' at						(B) Where 'True Spring M.L (M)' at					
	Established gauge is known						Established gauge is not known					
	From A.T.T (Table V of Part II)											
	MHWS			=								
	MLWS			=								
	True Spring M.L. (M)			=	0.00							
	Note : True Spring M.L. (M) = (MHWS + MLWS)/2											
	SD =	m' (M'-M) - M*(r/R)					SD =	m'-((M*r)/R)				
	SD =	**0.00**	m above / below of Zero of Guage				SD =	**-0.601**	m below Zero of Guage			

2.2 Existing Waterway Structures

2.2.1 Bridges

The details of Bridges crossing the Mapusa River are given below in Table. Total four numbers of Bridges are present in the study stretch.

The clearance (vertical and horizontal) up to Aldona Calvim-Carona at Ch 11.05km is sufficient for all Classes. Thereafter, vertical clearance up to Ch 26.73km is sufficient for Class III. The Mapusa Pipe line Bridge (Ch 26.612km) is at the end and hence need not be considered for analysis. Edapally – Panvel Bridge at Ch 26.675km located at the upstream end location of the proposed waterway; hence its vertical clearance has not been considered for analysis.

TABLE 2-6: Details of cross structures

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS* (m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank **Right Bank**	**Left Bank** **Right Bank**						
1	Aldona Calvim - Carona Bridge	11.050	Iorn & RCC	Aldona	Left Bank: 15°35'36.6"N 73°52'34.45"E Right Bank 15°35'35.3"N 73°52'41.2"E	Left Bank: 1721899.45N 380480.62E Right Bank: 1721888.43N 380609.02E	240	13	2	104.00	8.5	Complete
2	Aldona-Corjuem Bridge	14.175	Iorn & RCC	Aldona	Left Bank: 15°34'18.99"N 73°53'07.10"E Right Bank: 15°34'18.65"N 73°53'11.43"E	Left Bank: 1724289.95N 379520.44 E Right Bank: 1724248.42N 379721.27E	500	13	2	128.00	8.5	Complete
3	Mapusa Pipe Line Bridge	26.612	RCC	Mapusa	Left Bank: 15°35'20.17N 73°49'19.04E	Left Bank: 1723815.7 N 373697.13E	50	1.75	3	20	2.5	Complete

Sl No	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS* (m)	Remarks (complete / under - construction), in use or not, condition
					Right Bank: 15°35'21.2N 73°49'20.18E	Right Bank: 1723847.57 N 373730.26E						
4	Panvel Edapally Bridge	26.675	RCC	Mapusa	Left Bank: 15°35'19.86N 73°49'16.79E Right Bank: 15°35'21.16N 73°49'17.88E	Left Bank: 1723806.32 N 373628.64E Right Bank: 1723846.21 N 373662.64E						Beyond Study Stretch

* MHWS (2.3m from Marmagoa Port.) is considered.

2.2.2 Electric Lines / Communication Lines

From the above information, waterway Ch 0.00km to Ch 15.95km, sufficient vertical clearance is available from HT line. Support base of HT lines at Ch 15.95km and Ch 18.33km are to be raised to about 10.5m to get the required clearance. Support base of LT lines at Ch 19.785km is to be raised 8m to get the required clearance.

TABLE 2-7: Details of High Tension Lines

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	No. of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. MHWS (m)	Remarks (complete / under - construction)
1	High Transmission Line	15.95	Quitila	**Left Bank:** 15°36'19.88"N 73°52'51.97"E **Right Bank:** 15°36'12.41"N 73°53'02.18"E	**Left Bank:** 1725616.39N 380048.76E **Right Bank:** 1725385.22N 380351.75E	2	375	8.5	Complete

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	No. of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. MHWS (m)	Remarks (complete / under - construction)
2	High Transmission Line	18.33	Quitila	**Left Bank:** 15°36'38.40"N 73°52'27.42"E **Right Bank:** 15°36'47.11"N 73°52'15.80"E	**Left Bank:** 1726181.40N 379316.77E **Right Bank:** 1726458.34N 378976.06E	2	430	8.5	Complete
3	Low Transmission Line	19.785	Quitila	**Left Bank:** 15°36'38.40"N 73°52'27.42"E **Right Bank:** 15°36'47.11"N 73°52'15.80"E	**Left Bank:** 1726181.40N 379316.77E **Right Bank:** 1726458.34N 378976.06E	2	140	7.3	Complete

2.2.3 Pipe Lines / Cables

There is no Pipe lines, under water cable present in the entire survey stretch of Mapusa River.

2.2.4 Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

There are no Dam, Barrages, Weirs, Anicut, Locks etc. in Mapusa River in the entire survey stretch.

2.3 Bends

River bend radius before Ch 12.50km is sufficient for Class I vessel. Thereafter, the river takes sharp bends at various locations. In the study stretch, based on the bend radius criteria, it can be considered for elevation to Class III / Class V by smoothening of the bends.

TABLE 2-8: River Bend Radius in Mapusa-Moide River

Sr. No.	Chainage (Km)	Radius
1	0.75	310
2	2.90	660
3	6.00	640
4	7.25	920
5	9.40	440
6	11.50	420
7	12.50	120
8	12.60	200
9	14.20	350
10	15.00	200
11	17.50	150
12	19.00	140
13	20.60	230
14	23.50	310
15	24.25	180
16	24.75	160
17	25.20	290

2.4 Velocity and Discharge Details

The details of Velocity and Discharge in the Mapusa River are given below in Table.

TABLE 2-9: Current meter deployment locations and discharge details

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
1	0.550	15°30'37.9209" 73°50'40.0625"	376063.42 E 1715128.79 N	2.16	1.08	0.97	472.100	457.9370
2	14.175	15°35'36.0512" 73°52'37.2636"	379603.72 E 1724271.78 N	2.02	1.01	0.86	367.275	315.8565
3	19.785	15°36'03.3757" 73°52'05.4588"	378660.90 E 1725116.48 N	1.806	0.903	0.81	212.250	171.9225

The period of survey is December-January, which is a normal flow condition. As per the statistics collected, the maximum velocity is 1.08 m/s and discharge is 457.937m^3/s at the gauging station at Ch 0.55km near the confluence of the river and the Arabian Sea.

2.5 Waterway description

Mapusa River (Ch 0.00km – Ch 8.00km)

FIGURE 2.31: Mapusa River from Ch 0.00km to Ch 8.00km

TABLE 2-10: Reduced depth from Ch 0.00km to Ch 8.00km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty. (cu.m)
From	To	Max	Min			
0	1	14.9	1.7	50	11.8	11.8
1	2	5.1	2.8	0	0	11.8
2	3	4.5	2.6	0	0	11.8
3	4	4.8	2	0	0	11.8
4	5	6.1	2	0	0	11.8
5	6	6.5	2.2	0	0	11.8
6	7	6.8	1.7	50	41.13	52.93
7	8	7.4	3	0	0	52.93

Two Bridges (Edapally - Panvel Highway) crosses the Mandovi River at distance of about 300 m prior from Ch 0.00km. A boat jetty is on the West (Right) bank of the Mapusa River before 60m of Ch 0.00km followed by a boat Jetty (Ch 0.51km) and floating jetty (Ch 0.71km & Ch 0.89km). Fishing stakes (left bank up to the middle of river) were seen near Ch 3.27km. Boat Jetty is on the South (left) bank of the river at Ch 3.94km. Ponds are seen on the North (right) bank of the river. There are mangroves observed on the East (left) bank from Ch 0.50km to Ch 4.50km.

Settlements are observed on the West (right) bank between Ch 6.10km to Ch 8.60km. Fishing Jetty is observed on the right bank (Ch 6.42km). Ponds are seen along the left bank. Fishing stakes are present near the West bank at Ch 7.07km.

Mapusa River (Ch 8.00km – Ch 16.00km)

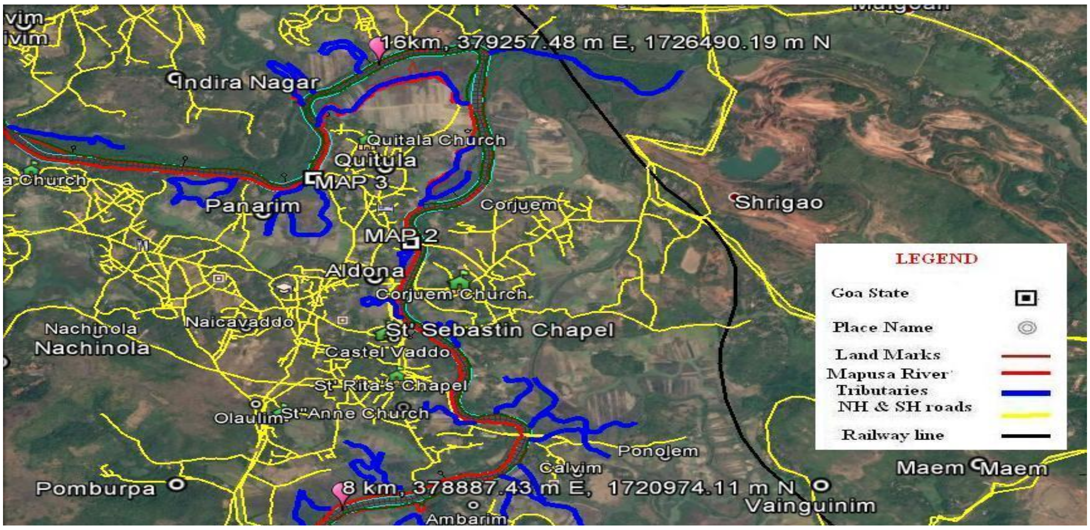


FIGURE 2.32: Mapusa River from Ch 8.00km to Ch 16.00km

TABLE 2-11: Reduced depth from Ch 8.00km to Ch 16.00km

Chainage (km)		**Reduced w. r. to Sounding Datum**				
		Reduced Depth (m)		**Length of Shoals (m)**	**Dredging Qty (cu.m)**	**Cumulative Qty. (cu.m)**
From	To	Max	Min			
8	9	8.4	-2.5	100	2265.78	2265.78
9	10	7.3	3.1	0	0	2265.78
10	11	9.1	-1.4	300	6026.02	8291.8
11	12	9.1	-3.1	500	21139.76	29431.56
12	13	7.6	-0.3	300	3220.12	32651.68
13	14	9.3	-1.4	800	18213.48	50865.16
14	15	7.3	-0.4	450	5796.58	56661.74
15	16	5.4	-2.8	650	22410.76	79072.5

Pomburpa Ferry Terminal is observed at the left bank (Ch 8.26km) and Chorao Ferry Terminal is observed at the right bank (Ch 8.34km). These two terminals are connected as a ferry route. Fishing Jetty is on the Left bank at Ch 10.01km. Calvim Ferry Jetty is on the East (left) bank at Ch 11.12km. Aldona Calvim - Carona Bridge crosses the river at Ch 11.16km. A left bank rivulet joins the Mapusa River at Ch 11.40km. Ponds are observed along the banks. Fishing Jetty and Aldona Ferry Jetty are on the right (West) bank at Ch 13.69km and Ch 13.76km respectively. There are mangroves seen along both the banks of the river with a few scattered settlements.

Mapusa River (Ch 16.00km – Ch 26.638km)

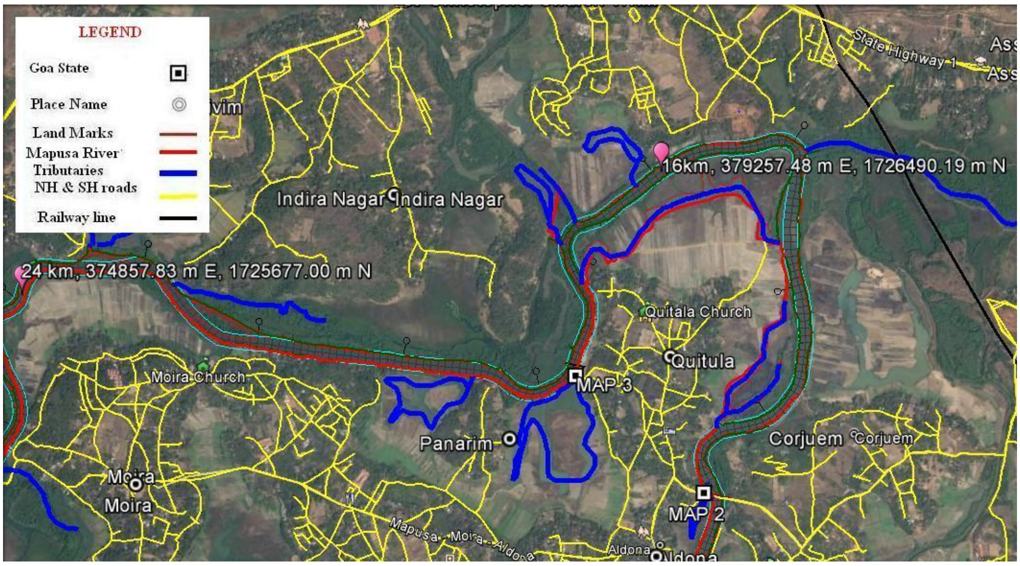


FIGURE 2.33: Mapusa River from Ch 16.00km to Ch 26.638km

TABLE 2-12: Reduced depth from Ch 16.00km to Ch 26.638km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty. (cu.m)
From	To	Max	Min			
16	17	4.8	-1.7	500	6256.77	6256.77
17	18	5.6	-0.5	900	27616.94	33873.71
18	19	4.8	-0.5	950	21747.97	55621.68
19	20	4.9	-1.7	1000	64902.63	120524.3
20	21	3.6	-1.8	700	17306.1	137830.4
21	22	2.5	-0.5	900	18279.1	156109.5
22	23	2.1	-0.4	1000	71339.96	227449.5
23	24	2.3	-0.3	1000	72574.79	300024.3
24	25	3.9	-0.3	1000	81878.15	381902.4
25	26	1.1	-0.3	1000	100202	482104.4
26	26.638	1.1	-0.3	600	69070.5	551174.9

Open fields have been observed along the right (East) bank (Ch 15.60km to Ch 16.60km) and the left bank (Ch 16.10km to Ch 16.90km). Assonora Rivulet joins Mapusa River at Ch 17.20km on the right bank. Old Jetty is on the left bank at Ch 17.46km. Two High Tension Lines cross the river at Ch 15.95km and Ch 18.33km. A shipyard is on the right (North) bank at Ch 17.73km. A newly constructed jetty is seen adjacent to the shipyard at Ch 17.57km. A right bank stream joins Mapusa River at Ch 19.00km. Vegetation has been observed from Ch 18.80km to Ch 20.50km. Ponds are seen along both the banks. Mangroves were observed along the banks of the river.

A stream originating from river forms a pond on the right bank at Ch 25.60km. Intermittent vegetations are observed on the river banks from Ch 25.20km to Ch 26.95km. The Mapusa Pipeline Bridge crosses at Ch 26.73km. The Mumbai Goa Highway Bridge crosses the river at approx. 50 m after the Ch 26.95km. Mapusa River waterway stretch ends near the Dangui Colony, Mapusa at the Edapally - Panvel Bridge at Ch 27.0km

2.6 Water and Soil Samples analysis and Results

TABLE 2-13: Water sample results

SAMPLE NO.	LOCATION	Easting	Northing	WATER SAMPLES	
				Sediment concentration (ppm)	pH
Map-1	Britona Jetty	355871.28	1714676.03	1698	7.74
Map-2	Aidona	379603.72	172.4271.78	1470	7.82
Map-3	Quitla	378660.90	1725116.48	979	6.90

The river water is slightly basic in nature with average pH being 7.49

TABLE 2-14: Soil sample results

SAMPLE NO.	LOCATION	Easting	Northing	Specific Gravity	Grain Size Analysis (%)				Cu	Cc
					Gravel	Sand	Silt	Clay		
Map-1	Britona Jetty	355871.28	1714676.03	2.58	28	32	33	7	340.00	0.26
Map-2	Aldona	379603.72	172.4271.78	2.64	10	29	43	18	-	-
Map-3	Quitla	378660.90	1725116.48	2.68	3	19	44	34	-	-

The river bed is silty sand with gravel at Britona jetty, silty sand with clay at Aldona and silty clay at Quitla. Thus the river bed can be concluded to be silty at most parts with sand and gravels in the remaining stretch.

CHAPTER 3 FAIRWAY DEVELOPMENT

3.1 Proposed Class / Type of Waterway

The Fairway availability and its utilization along with the developments required etc., are to be concluded based on the detailed Hydrographic survey, Traffic mobilization including the hinterland requirement, future planning of the hinterland amenability and the stake holder's view point etc.,

The detailed Hydrographic survey and charts have been referred. As per the data available, the study stretch of the waterway is amenable for up to class VII of the waterway for the majority of the initial stretch of about 8 Kms and nominal Dredging may be required thereafter to maintain as Class III / Class IV waterway in the rest of the stretch from the fairway point of view. The river Mapusa is the tributary to the River Mandovi and accordingly the starting point i.e., Ch 0 km is the confluence of both Mandovi and Mapusa.

As per the IWT traffic data, the river Mandovi was earlier used for mobility of Iron Ore from the mines in Bardez in the hinterland and the infrastructure is already available. The Iron ore mobility had a ban on mining and got a set back. The same is under revision and hence, there is an expected growth in the traffic of IWT. The excess traffic over the existing infrastructure may have to be taken up by IWAI. The same is being envisaged.

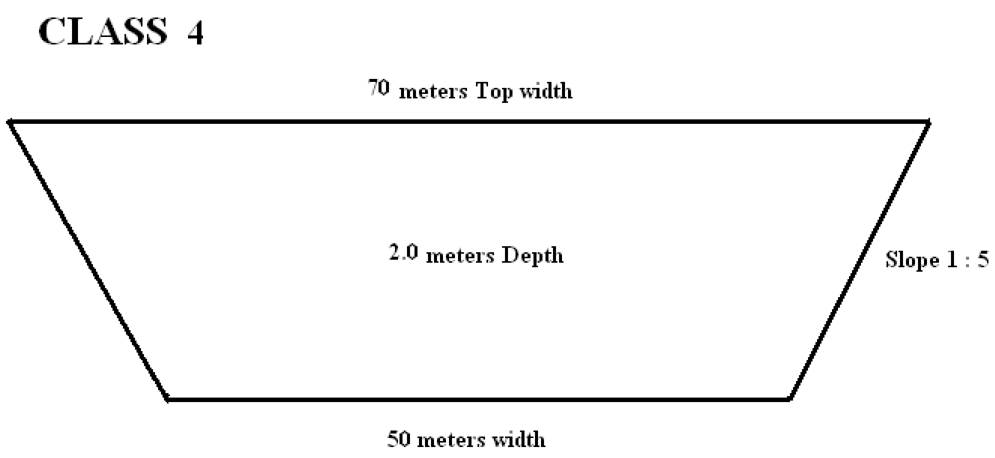
Initial stretch from Ch 0.00km to Ch 17.00km: According to the requirement of the existing stake holders of the area and keeping in view the fairway condition, 2000 T vessel mobility with 2 m depth and with Day / Night navigation facilities, uninterrupted mobility can be established. Hence, the class of waterway can be concluded as ***Class IV*** for mobility of 2000 T as a ***convoy*** of 2 x 1000 T up to the existing jetty i.e., upto Ch. 17.00 km. The vessel / convoy requirement is 170 m (Length) x 12 m (Breadth) x 1.8 m (Draft). Accordingly, the fairway requirement is 50 m (Bottom Width) x 2.0 m (Depth) with Bend Radius of 800. Clearance corridor of 50 m Horizontal Clearance (HC) and 8 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel / Convoy.

With regard to the cross structures in the stretch up to Ch 17 km, Two Bridges are existing with 104 m HC and 8.5 VC @ Ch 11.05 km and 128 m HC and 8.5 VC @ Ch 14.175 km, which are amenable for the mobility of Class IV standard vessels. One HTL has been observed up to Ch 17 Km with 8.5 m VC @ Ch 15.95 km.

Stretch beyond Ch 17km: May have to be considered at later date.

3.2 Details of Shoals (Length, Width and proposed development works)

In order to meet the mobility of 2 x 1000 T, the convoy system of Class IV has been concluded. An alternative of mobility of Self Propelled Vessel also was thought of as a Coaster vessel, which is approximately leading to the requirement of fairway with 50 m Bottom width with 2.0 m depth. (Class IV). The same is not amenable from the fairway and operational point of view. Accordingly, the Dredging quantities have been worked out for the convoy system as per Indian classification of Class IV for the study stretch only upto the proposed Terminal Location i.e., @ ch 17 km. The rest of the stretch is not suggested with any development.



Chainage (km)		Observed: Observed depth (m)		Observed: Length of Shoal (m)	Observed: Dredging quantity (cu.m.)	Reduced w. r. t. Sounding Datum: Reduced depth (m)		Reduced w. r. t. Sounding Datum: Length of Shoal (m)	Reduced w. r. t. Sounding Datum: Dredging quantity (cu.m.)
From	To	Max.	Min.		Per km drg	Max.	Min.		Per km drg
0.0	8.00	TIDAL ZONE				14.9	1.7	100	52.93
8.00	16.00					9.3	-3.1	3100	79072.50
16.00	17.00					4.8	-1.7	500	6256.77
							Total	3700	85382.20

Accordingly, the shoal length is of 3,700 m and the respective Dredging quantity has been taken into consideration for 0.86 Lakhs Cu. M. Considering 10 % addition for variation, the same is working out to 1.00 Lakhs Cu. M.

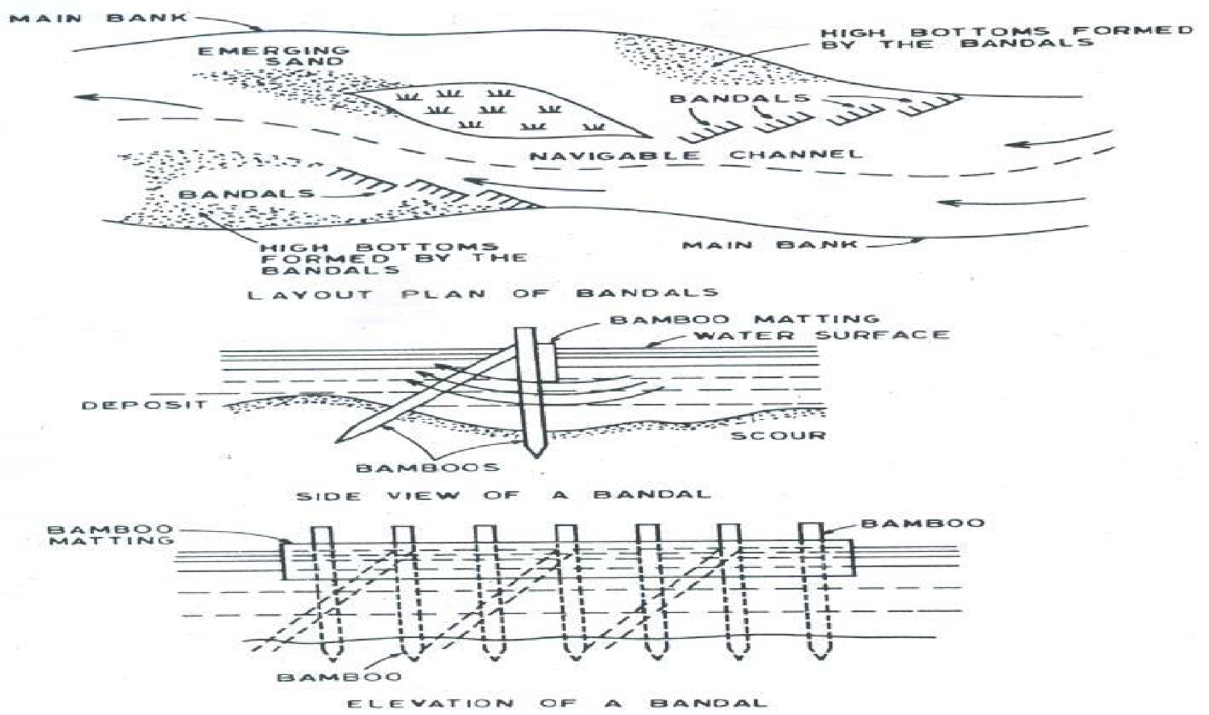
3.3 Proposed Conservancy Activities

Rivers are the natural channels of drainage carrying water along with sediments from the catchment to the sea. The main river course will be joined with various tributaries depending on its catchment configuration carrying the water from run-off and also carrying the sediments enroute. The dynamic equilibrium of such river flow tends to change the course of the river on the Geometric cross section and on the Gradient. The braiding channel of the river will create meandering streams leading to multiple channel flow. This type of distribution of the cross section discharge into multiple channels is a major threat for safe navigation in the particular stretch of the river / waterway. The meandering tendency of a particular stretch / river always leads to the formation of loops / bends. Hence, the perspective appreciation over the behaviour of the river / study stretch for navigation is most essential to arrive at a dependable River Training measures for achieving the safe navigational fairway of the study stretch.

The taming of the river / study stretch for provision of a safe fairway for navigation is ultimately depending on the cost criteria and also the economics. Certain low cost solutions are already in practice in the national waterways on NW 1 and NW 2 systems viz., Bandalling; Bottom Panelling; Submerged Vanes etc., Considering the seasonal aspects in the river like Lean season and Flood season and in order to meet the quick time lines for providing the safe channel, the Dredging of the river is also under consideration. However, to have a sustainable channel with long term requirement, the permanent solution of taming the river through the training measures viz., Spurs; Groins etc.,. Bank protection measures also can be adopted at certain critical locations as Training measures.

3.3.1 Low Cost structures

Bandalling” is a low cost and ancient technique adopted in NW 1 & NW 2 in order to improve the navigation conditions. Bandalling is the temporary structure made up of “Bamboos” and “Bamboo Mats”. The ideology of this structure is to divert the flow of secondary channel to main channel, where split discharge observed. Bamboos will be driven in line for 25m to 30m (1 Chute) and arranged with the screen made up of Bamboo Mats placed / immersed from the surface of water by a third of the depth. This structure will be placed at 35 degrees to 45 degrees to the secondary channel flow. No. Of Chutes will vary on the width of the secondary channel. These Chutes will be supported by cross Bamboos to withstand the flow. This can improve the channel depths from 1.8 m to 3.0 m. The process ultimately silts up the secondary channel and improves the velocity / discharge in the main channel. The below mentioned Figure will give an idea about the structure. The Bandalling locations may have to be identified, during the receding stage of the Flood and are to be placed while considerable flow is observed both in main and secondary channels.



In the study stretch, no divided discharge locations have been observed and hence there is no need of implementation of Bandalling in this stretch. However, at the seasonal maintenance, such structures can be considered at later date, as amenable.

3.3.2 Dredging

“Dredging” is the removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies. It is a routine necessity in waterways around the world because of the sedimentation process (the natural process of sand and silt washing downstream and gradually fills channels and harbors). Dredging often is focused on maintaining or increasing the depth of navigation channels, anchorages, or berthing areas to ensure the safe passage of boats and ships. Vessels require a certain amount of water in order to float and not touch bottom. This water depth continues to increase over time as larger and larger ships are deployed and with the increased volumes of bulk cargo operation, dredging plays a vital role in the nation's economy.

Dredging is also performed to reduce the exposure of fish, wildlife, and people to contaminants and to prevent the spread of contaminants to other areas of the water body. Environmental dredging is often necessary because sediments in and around cities and industrial areas are frequently contaminated with a variety of pollutants. The sediment management and disposal of dredged material are also important issues to be managed and carried out effectively.

Dredging used to be carried out in the river by various types of Dredgers viz., Bucket and grab dredgers; Suction and Cutter-Suction dredgers; Trailing hopper dredgers etc.,. However, the most acceptable form of the dredger is “Cutter Suction Dredger” (CSD) being deployed on National Waterways by IWAI. The type of soil, if hard, may have to be tackled with the appropriate dredger. In the morphological rivers, the shoals will be formed with divided discharge and accordingly, the dumping of dredged soil is preferred in closing the secondary channel and within the flood plains. In the West Flowing Rivers, in general, the velocities are comparatively higher. Once the dredged cross section is achieved, the maintenance will be automatic in the natural way for longer period. The catered provisions in the O & M will take care of such minimal nominal requirements.

In the stretch, up to ch 17 km, there is a need of dredging the shoal length of about 3700 m with an estimated quantity of 1.00 Lakhs Cu. M of general soil which may have to be taken up through CSD.

Regarding the disposal of dredged material, a portion of the same can be considered, as explained above for closing the secondary channel. Further, as observed, the sand from the river is being considered as a valuable construction material in the entire Arabian Sea coast. Hence, the disposal is not a problem. In addition, the dredged spoil can be dumped in the low lying areas on the nearest amenable locations, wherever feasible. The dumping can also be prudently / effectively utilized to protect the banks in vulnerable stretches and near the terminal area by constructing a layer of “Gabion Walls”, which will also prevent the fall back into the Dredged fairway. The type of “Gabion Walls” for such arrangement is shown below.

3.3.3 River Training

River Training is nothing but taming of a river section to achieve the objective / purpose with the encroachment over the natural flow condition. Navigation and Flood Control are generally the common purposes for taming the river with various training measures.

In general, there are two types of waterway training structures: Re-directive and Resistive. Re-directive, as the name implies, is the use of the River's energy and Managing the energy in a way that benefits the system i.e., enhance the navigation channel. A resistive structure acts to maintain the system as status quo i.e., reducing bank erosion.

Re-directive structures are usually a series of dikes placed along the inside of a river bend where sediment usually deposits. Dikes have been known by a variety of names, such as groins (or groynes), contracting dikes, transverse dikes, cross dikes, spur dikes, spur dams, cross dams, wing dams, and spurs. The most common dikes in use today are shown in the Figure, as under.

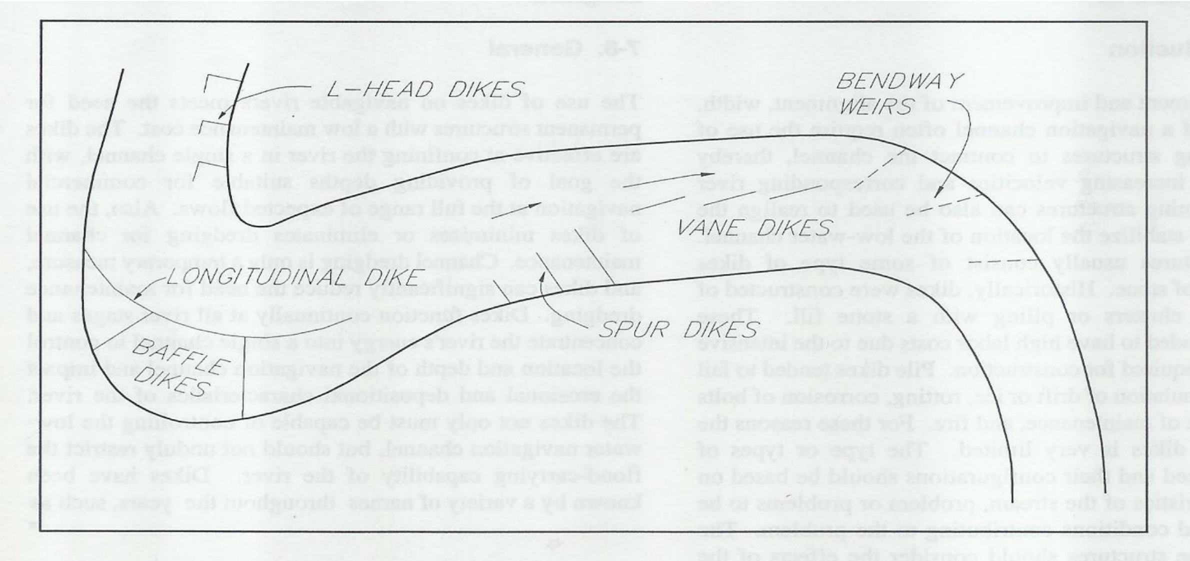


FIGURE 3.1: Types of dike structures

Resistive structures are primarily used to prevent bank erosion and channel migration to establish or maintain a desired channel alignment. Revetments and Bank Protection works are examples for such structures.

In the rivers of Goa, especially the west flowing rivers, in general have the tendency of rapid draining off due to the comparative limitation in traverse length between the lower mountain range and the Arabian Sea.

Keeping in view the above, the suggested River Training works are Spurs; R. C. C. Porcupines; Bamboo Porcupines. Further the Bank Protection / Revetments also can be considered as a part of the River Training at certain amenable locations. The structures are detailed with the figures and the preliminary designs have been placed in appropriate chapter (Chapter 6).

The “Gabions with Boulders” type of structure can be considered as Spurs and also as Bank Protection on these rivers, as detailed in the Figure.

In wider reaches, it is suggested the provision of spurs with “Gabions with Boulders” as detailed in the Figure, given below. The preliminary Design details have been placed in Chapter 6.

River Training works may be essential, in general, at the sharp bend locations and at other locations where there is a need of taming the river with morphological variations / disturbances creating hurdle for smooth navigation.

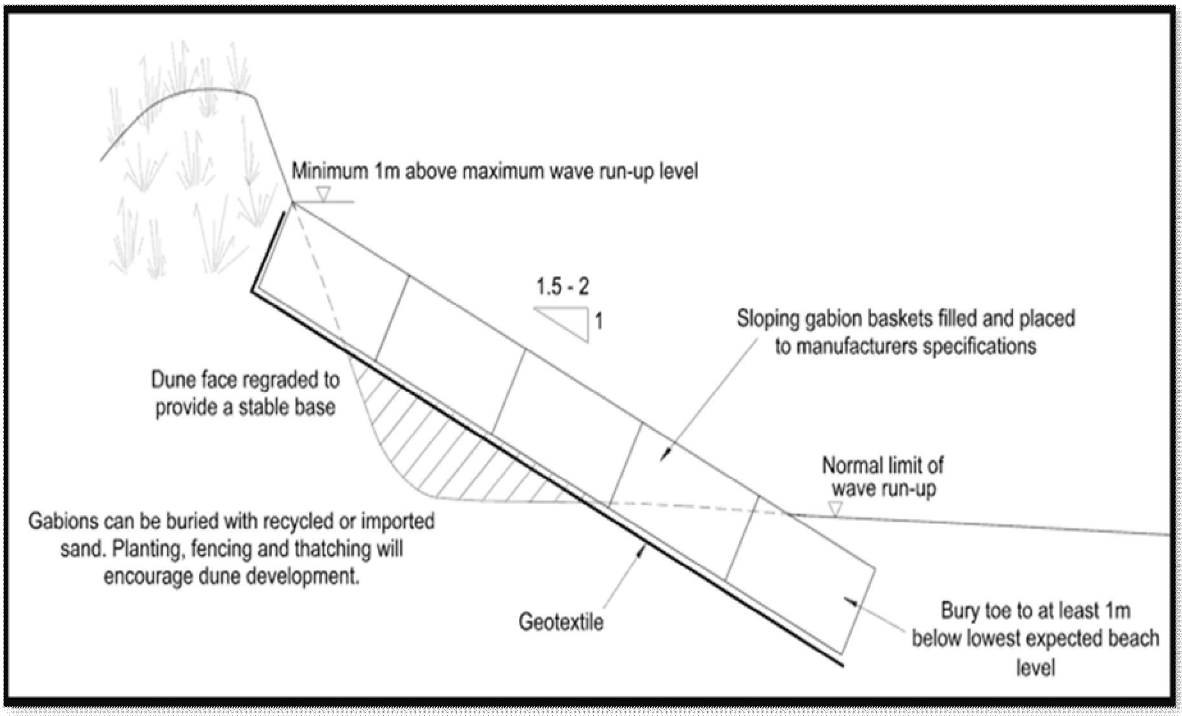
In the stretch, up to Ch 17.00 km, the least bend radius is 120 (against 800) at Ch 12.50 km. It is proposed to tackle the Bend problems through Bank Protection. Hence, the River Training work is not suggested.

3.4 Bank Protection / Embankment Strengthening

In the rivers, wherever bends or curves exist, the concave side of the river will always be subjected to the erosion. The pace of erosion will depend on the soil condition and terrain and also the velocity of the flow at the location.

As early as the seventeenth century, the Germans were protecting the banks of rivers with masses of brush formed into fascines (bundles). This method of bank protection, called blesswerk, was also used for bank and shore protection in Holland.

As explained earlier, the characteristics of the rivers originating from Western Ghats are unique. In such a condition, Gabions filled with rocks will be the most advantageous type of the Bank Protection. Further, the basic raw material, rock, is abundantly available within a reasonable leads. Gabions are wire mesh baskets filled with crushed rock. They are filled in situ, with locally available material (rocks) and thus have a low capital cost. Because they are flexible and porous, they can absorb some wave and wind energy, thereby reducing the scour problems.



It has been proposed to consider the Bank Protection in the vulnerable locations. In the stretch, up to ch 17.00 km, there is no such location with any Bank Protection requirement. However, the proposed Dredging activity may have nominal morphological disturbance, which in turn may lead to the vulnerability of Bank erosion. Keeping in view the above phenomenon, provision of Bank Protection of 500 m at Ch. 11.5 km; 1000 m at Ch. 12.2 km to Ch. 13.2 km; 500 m at Ch. 14.2 km; 500 m at Ch. 15.0 km and 500 m at Ch. 17.5 km. is suggested i.e., a total of 3000 m. The protection work is proposed with the Gabions filled with rocks.

3.5 Navigation Markings / Navigation Aids

Keeping in view the River width / Channel width etc., the Navigational Markings can be considered, either in the Shore or in the River with floating condition. The Shore Markings can be considered with a reasonable Beacon type structure fitted with Light at the top, whereas, the marking in the river can be considered with the floating Buoys as per the IALA standards fitted with Light at the top.

In the Terrain of west flowing rivers, it is amenable to keep the light on a 15 m Trestle Tower with a reasonable illumination of Light for a considerable distance. IWAI is having 2 NM / 4 NM Light systems on NW 1, NW 2 and NW 3 (already operational) and hence it is preferred to consider 15 m Trestle Tower fitted with 4 NM light on the top. The 4 NM illuminations will have a visibility for about 9.0 km and with a rational approach, the same can be considered at every 5 Kms all along the stretch with alternative side of the River.

The preliminary Design of Beacon & Light systems along with the specification are placed at Chapter 6, appropriately.

Regarding the Buoy & Light system, it is proposed to consider the same type of Buoy and Light deployed in NW 1, NW 2 & NW 3 with the details as sketched in the figure below. Further the Technical specifications of Buoy & Light, as available in the Market as a proprietary item are also detailed in Chapter 6. In the study stretch of Mapusa River, it is only suggested to consider the Beacon Light system. However, in due course of time, if need be, the Buoy / Light system also can be considered, for close marking system.

Keeping in view the 4 nm light and considering the clear visibility range as 8000 m, the interval can be considered as 3000 m, keeping in view the bends etc.,. Hence, it is proposed to work out the requirement with 3000 m interval and in Zigzag position (i.e., 1 Left Shore Mark then 1 Right Shore Mark and 1 Left Shore Mark). Accordingly, it is estimated to provide 7 Nos in the initial phase 1 stretch upto Ch. 17 kms {17000 / 3000} of Shore Marks with Beacon Light unit.

It is suggested the Buoy & Light system in the phase 2 development, which can be considered with due analysis at that point of time. The requirement has been worked to 45 Nos {17000 / 500 + 6 Bends + 10 %}. A provision of Tug – cum – Buoy laying vessel has been considered, which will act as a multi-purpose vessel. Provision has been catered as a part of overall cluster 7 requirement for all the waterways.

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

In the stretch up to Ch 17 km (proposed stretch for development), there are only Two Bridges i.e., One Bridge at Ch. 11.05 km having 104 m HC and 8.5 m VC and other at Ch. 14.175 km having 128 m HC and 8.5 m VC and hence no modification is suggested.

In the stretch up to Ch 17 km (proposed stretch for development), only One HT Line is in existence at Ch 15.95 km having VC 8.5 m and hence there is no need of any Power Cable modification.

No cross structures viz., Dams / Barrages & Locks / Weirs / Anicuts / Aqueducts are observed in the present study stretch.

3.7 Proposed Dams / Barrages / Locks / Weirs to improve depth

In order to improve the fairway, including the depth, there is no requirement of Dams / Barrages & Locks / Weirs in the present study stretch.

3.8 Land Acquisition

No Land Acquisition requirement was observed for Fairway Development in the present study stretch. Land Acquisition requirement for Terminal purpose is being considered, as a part of Terminal development, wherever required.

3.9 Fairway Costing

3.9.1 Capital Cost

Mapusa River is the tributary to Mandovi River, which is draining in to the Arabian Sea and having connectivity to Marmugoa Port. As observed / ascertained, the river Mandovi was earlier used for mobility of Iron Ore from the mines in Bardez in the hinterland and the infrastructure is already available.

The Iron ore mobility had a ban on mining and got a set back. The same is under revision in slow pace. Hence, there is an expected growth in the traffic of IWT. The excess traffic over the existing infrastructure may have to be taken up by IWAI for infrastructure provision. The same is being envisaged.

Accordingly, IWAI may have to observe the scenario till FY 30, as Phase1 and if confirmed, then consider the development accordingly. This development has been proposed as Phase 2.

However, as a part of suggestion / recommendation for the development of Mapusa River, no recommendation is proposed. The low profile Phase 1 development is suggested and indicative Phase 2 requirements are projected with a limitation of any development only up to Ch. 17.0 km, after having critical analysis on the investment at that point of time.

The Capital Cost in Phase 1 is in the fairway, which has been considered for 7 Nos. of Beacons with Light (INR 1.38 Cr) and Institutional requirements. Cost estimates are placed with details in Chapter 11.

The Capital Cost in Phase 2 for the fairway has been considered for 1 Lakh Cu. M of Dredging (INR 3 Cr); 3000 m of Bank Protection (INR 36.96 Cr) and 45 Nos. of Buoys with Light (INR 1.93 Cr). Cost estimates are placed with details in Chapter 11.

The Phase 1, Fairway development is INR 6.80 Cr.

The Phase 2, Fairway development is INR 51.85 Cr.

Cost estimates are placed with details in Chapter 11.

3.9.2 O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined, by IWAI, which have been analyzed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 4 TRAFFIC STUDY

4.1 General

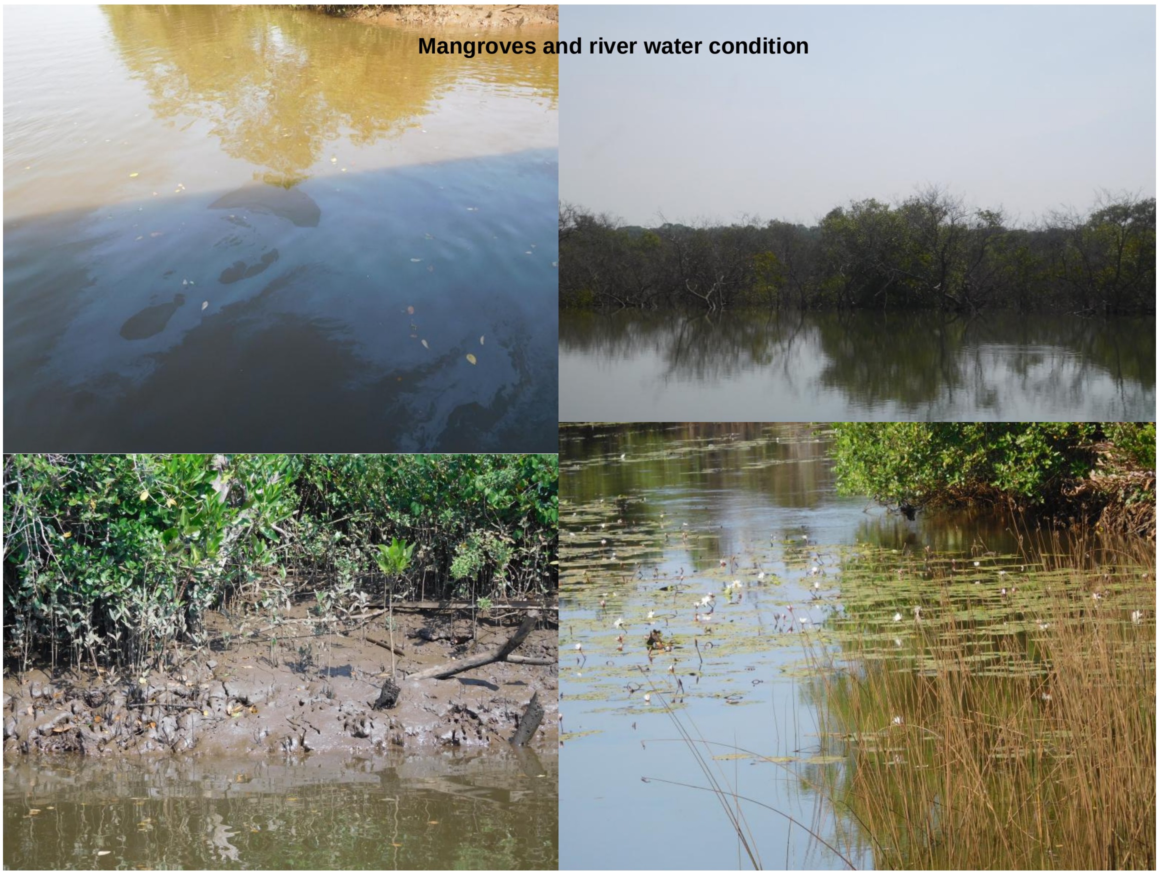
Market analysis for Mapusa river catchment area comprises of the analysis for existing and potential waterway for cargo and passenger traffic. The analysis also covers cargo's existing trends of flow between origin and destination and the feasibility of diversion from existing transport/shipping modes to waterways.

Goa comprises of small mountainous regions. There are nine rivers, which flow through Goa. Most of the industries use Mandovi and Zuari River to export Iron Ore using Mormugao port. These 2 rivers constitute about 70% of geographic region of Goa and rest is covered by other rivers, namely Terekhol, Baga, Sal, Saleri, Talpona, Galgibag, Chapora and Mapusa. These rivers pass through talukas of Goa, which are rich in mineral reserves. All the rivers of Goa are tidal and they are based on rain. Inland Waterways Authority of India (IWAI) intends to develop Mapusa (NW 71) which could help in diversion of a major part of road and rail traffic to the waterways. This could help in decongestion of overly loaded roadways and railways and would help in efficient utilisation of the waterways bestowed by nature. River stretch considered for this study is 27 km for Mapusa. At present, the navigable length of all rivers of is about 253 km only.

Source: Site Visit

Figure 4-1 Mapusa River & Surroundings

It is clearly visible from above images that at some places, river water is very dirty and mangroves have grown on the banks of the river.



Source: Site Visit

Figure 4-2 Mapusa river water condition & Mangroves

Mapusa River is being used for bulk cargo transportation. About 1,000 to 1,100 tons of barges ply on Mapusa River. These barges are used for transporting iron ore. This input was provided by iron ore operators during personal interaction. However no barges were seen on Mapusa River during site visit. At present there is no iron ore transportation from nearby mines using Mapusa River. From Calvim jetty to Mormugao Port, land area around Mapusa River has a strong base. After dredging, the present draft in Mapusa River is in the range of 2.7 meter to 3 meter, whereas the draft of Mandovi River is about 3.2 meter.

Figure 4-3 Mapusa River Overview

4.2 Hinterland Analysis

Mapusa river waterway falls under North Goa district and the district headquarter of North Goa district is at Panajim. Panajim is also the state capital of Goa. The North Goa district is divided into 6 talukas, namely Tiswadi, Bardez, Pernem, Bicholim, Sattari and Ponda, with a total geographical area of 354.48 sq. km. River Mapusa flows through Bardez & Bicholim taluka.

Coastal region along Mapusa River has less elevated region (25-30 meter). East side of the river near Sattari taluka has hilly areas and high elevation about 500 meter. Mormugao is the major port, which comes within the primary hinterland (25 km). Mormugao port is located within 25 km from Porvorim, which is the last point of the river stretch. Beyond Porvorim, South Goa starts; hence industries located in South Goa would not prefer North goa. They would not use waterway on Mapusa River to go to Mormugao port. North Side of Mapusa River of primary catchment area (25 km) falls in Sawantvadi taluka of Sindhudurg district. There are no major industries in north side of Mapusa River which could use IWT route. If any industry comes in north region of Mapusa River in future, Chapora & Teracol River are already available for handling cargo, before Mapusa would be developed. There does not exist any scope from secondary catchment area for Mapusa River; hence the consultant has not included secondary catchment area in the study.

4.2.1 Demography Profile of Hinterland

Mapusa River falls under Bardez and Bicholim taluka. As per census 2011, total population of these talukas is about 1,30,096. Detail population of each village of Bardez and Bicholim taluka is given below.

Table 4-1 Village wise population around Mapusa river

Division	Villages	Population
Bicholim	Maem	7,544
	Latambarcem	6,722
	Mulgao	3,892
	Surla	3,818
	Sarvona	3,586
	Salem	3,427
	Cudnem	3,308
	Amone	2,963
	Navelim	2,703
	Piligao	2,643
	Velguem	2,617
	Curchirem	2,043
	Naroa	1,897
	Sirigao	1,617
	Maulinguem North	1,457
	Adwalpale	1,412
	Mencurem	1,381
	Vainguinim	706
	Ona	685
	Cotombi	591
	Aturli	467

Division	Villages	Population
	Dumacem	296
Bardez	Tivim	9,076
	Parra	4,449
	Sangolda	4,429
	Assagao	4,367
	Bastora	3,943
	Assonora	3,870
	Verla	3,685
	Canca	3,551
	Arpora	3,255
	Pomburpa	3,095
	Camurlim	3,015
	Sircaim	2,850
	Oxel	2,794
	Corjuem	2,725
	Nachinola	2,725
	Revora	2,630
	Pirna	2,568
	Marra	1,988
	Nagoa	1,455
	Paliem	1,377
	Nadora	1,257
	Marna	1,234
	Ucassaim	1,077
	Punola	864
	Moitem	860
	Olaulim	659
	Calvim	403
	Ponolem	120

Source: Census, 2011

As seen in above table, maximum population is in Thivim in Bardez taluka, i.e. about 9,000 people. Majority of young population have either gone out of Goa for education or job. Very few young locals are opting agriculture as a profession. The consultant has not considered population of South Goa due to its long distance from Mapusa river, its closeness from Mormugao Port and availability of opportunities for young people in South Goa and in other state.

Figure 4-4 Population & Connectivity around Mapusa

4.2.2 Economic profile of Goa

Goa is one of the fastest growing states in the country. The state's Gross State Domestic Product (GSDP) growth rate was about 11.39 per cent between Fy 2004-05 and Fy 2015-16. Goa's per capita Net State Domestic Product (NSDP) in Fy 2015-16 was US $ 4,765, which is one of the highest in India. Goa's economic growth is driven by the strong performance of industrial sectors such as mining, tourism and pharmaceuticals. Goa is also one of the few states in India to achieve 100 per cent rural electrification.

According to the Department of Industrial Policy & Promotion (DIPP), FDI inflows into the state of Goa are total US $ 841 million during April 2000 to March 2016. The main economic activities of Goa include agriculture, tourism and mining. It is assumed that most of the state's income comes only from tourism; however fisheries, exports of iron, manufacturing industries and tourism all contribute to Goa's revenue. The state is highly dependent on foreign exchange, which has helped to boost the growth of resorts, helped in the beautification of Goa, hotels and other businesses related to tourism. Another important source of revenue is the export of manganese and iron ore. The GDP per capita in Goa is two and a half times more than that of the country, most of it comes from foreign remittance. The major contributor of Goa's primary revenue is tourism industry, which handles nearly 12.5% of the tourist flow in India.

Following table shows Gross state domestic product at constant prices of Goa.

Table 4-2 Historic GSDP of Goa

Year	GSDP (Cr.)	% Increase over last year
2007	15,042	10
2008	15,875	6
2009	17,466	10
2010	19,248	10
2011	22,499	17
2012	27,045	20
2013	28,173	4
2014	30,345	8

Source: GOG, Directorate of planning, statistics, evaluation

The graph below shows percentage increase of GSDP of Goa over last 8 years.

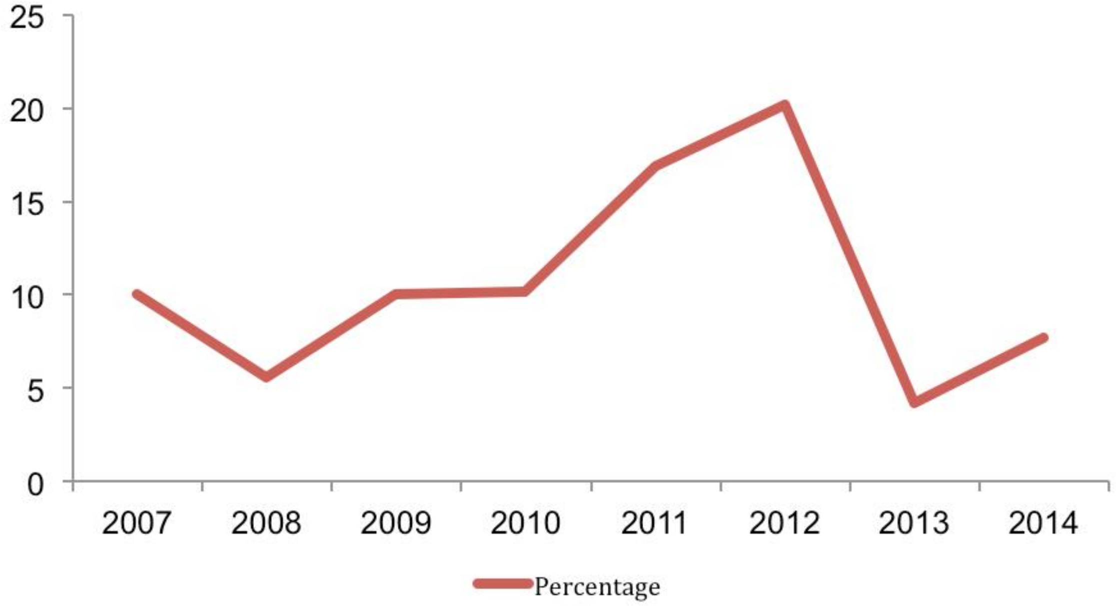


Figure 4-5 Historic Percentage Growth (GSDP) of Goa

Table 4-3 Sectoral annual growth rates of GSDP

Sector	2007	2008	2009	2010	2011	2012	2013	2014
Primary	13	13	12	12	10	8	5	5
Secondary	42	41	39	39	37	32	33	32
Tertiary	45	46	49	49	53	59	63	63

Source: GOG, Directorate of planning, statistics, evaluation

The below chart shows primary, secondary and tertiary sectors of Goa. Detail of each sector is given in below sub sections.

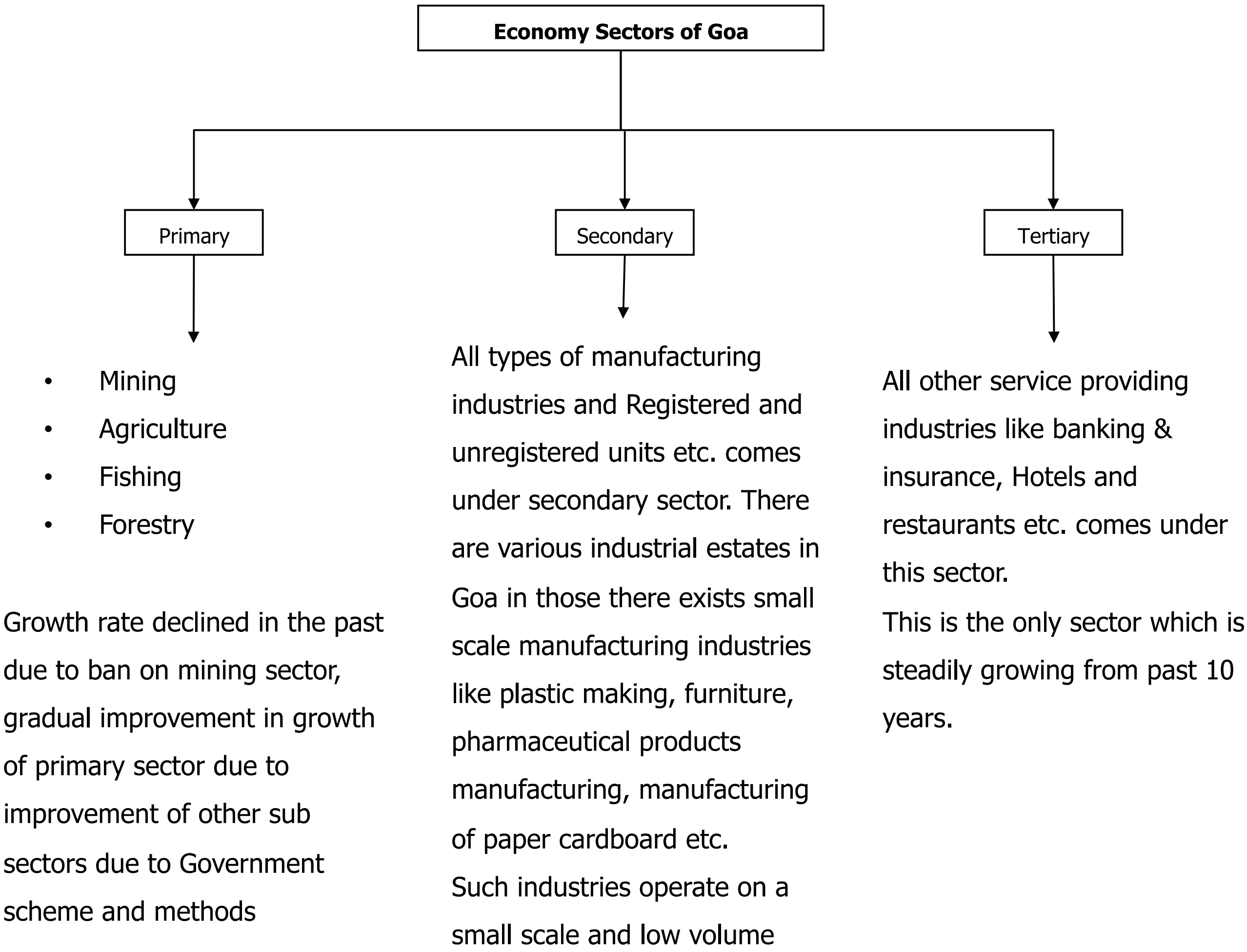


Figure 4-6 Sectors of Goa

4.2.2.1. PRIMARY SECTOR

Primary sector consists of Agriculture, Forestry, Fishing and Mining. Majority of people are involved in agriculture, mining work etc. Ban on mining sector has adverse effects on primary sector. The historic growth in different segments of primary sector is shown in the table below.

Table 4-4 Primary sector historic growth in Goa

Numbers in (%)

Primary Sector	FY 13	FY 14	FY 15
Agriculture	-3.84	4.51	-6.38
Fishing	-11.05	38.72	-0.5
Mining	-68.56	0.17	-55.59
Forestry	9.48	10.37	13.78

Source: State Govt. Economic Survey

As per state government's economic survey, ban on mining and decline in growth rate of agriculture and fishing have affected the economy of Goa in a negative manner.

a. Agriculture

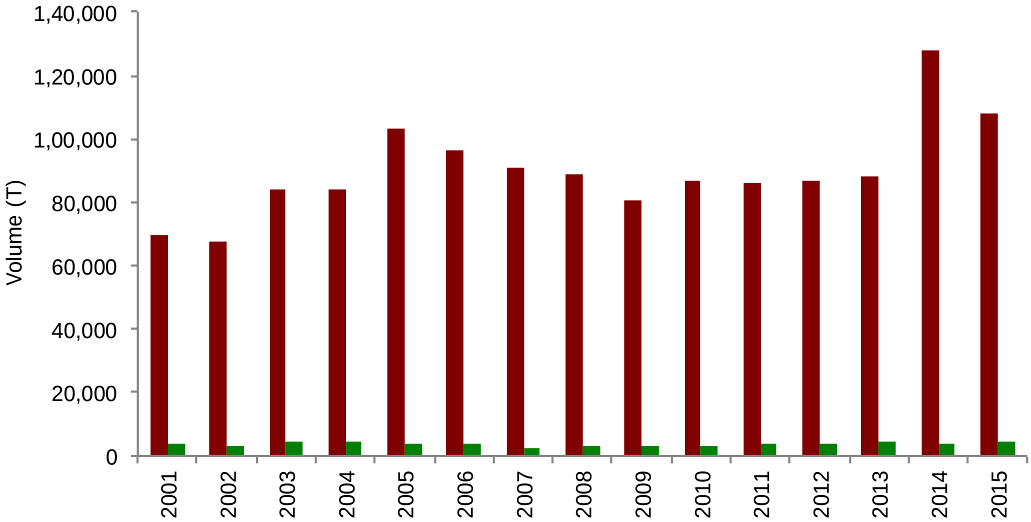
About 40% of population is dependent on agriculture. In recent times, there has been steady decline in agriculture produce in Goa. Lack of available land for agriculture is a major hurdle in the state's agriculture yield. For day-to-day agriculture needs, like vegetables etc. Goa is dependent on Maharashtra and Karnataka. State government has come up with lot of subsidies and schemes to improve quality of agriculture produce of Goa.

The importance of agriculture has been losing its importance in the state, but still it has been offering employment to major local population. Paddy is a major crop, which is cultivated in two seasons. Other crops grown in the state are ragi, maize, jowar, bajra and pulses. Hilly and inferior soil region is used to grow cereals and pulses. The main sources of irrigation are rivers and streams, tanks, wells and canals etc.

Goa has a perennial problem of availability of land for the cultivation of crops. Due to close proximity to the sea and the Western Ghats, there is salinity problem and shortage of land in Goa. One third of the total land mass is covered with forest. The government is taking initiatives for improving agricultural practices. From last 6-7 years, most of the agriculture land was left barren because young population of Goa prefer to go outside of Goa for seeking education and job opportunities. Agriculture would not provide any opportunity for the waterway, as Goa is facing problem to feed it's own population.

b. Fishing

Overall marine fish production of Goa is higher than inland fish production. Till recent times, fishery employed a large number of people because fishing was done by traditional methods. But with technological advancements in the fishing industry like trawling, locals are trying to abandon their long-established occupation and look for other employment opportunities. Following graph clearly depicts that marine fish production in of Goa is much higher compared to inland fish productions.



Source: Consultant's Analysis

Figure 4-7 Fish productions in Goa

Marine Fish Production has grown at a CAGR of 3.23% from 2001-2015 as compared to 1.62% for Inland Fish Production for the same period.

Table 4-5 Historic fish production in Goa

Year	Marine Fish Production in Goa (Tonnes)	Inland Fish Production in Goa (Tonnes)	% Growth Over last year for Inland Fish	% Growth Over last year for Marine Fish
2001	69,386	3,713	n/a	n/a
2002	67,563	3,148	-18	-3
2003	83,756	4,285	27	19
2004	84,394	4,397	3	1
2005	1,03,087	4,194	-5	18
2006	96,326	4,131	-2	-7
2007	91,185	2,447	-69	-6

Year	Marine Fish Production in Goa (Tonnes)	Inland Fish Production in Goa (Tonnes)	% Growth Over last year for Inland Fish	% Growth Over last year for Marine Fish
2008	88,771	3,077	20	-3
2009	80,687	3,283	6	-10
2010	87,062	3,311	1	7
2011	86,185	3,538	6	-1
2012	86,628	3,887	9	1
2013	87,984	4,678	17	2
2014	1,28,107	3,718	-26	31
2015	1,08,240	4,648	20	-18
CAGR	**3.23%**	**1.62%**	n/a	n/a

Source: Fisheries.goa.gov.in

Aldona, Chorao, Pomburpa are existing fishing points where traditional fishermen carry out fishing activity. Following table describes fish catch from each of these areas for past four years. The fish catch from these areas are consumed locally. They are sold in local market of Goa and do not hold export potential. This fish catch is negligible, so some fishermen started LED fishing to increase their fish catch. As a result, customer base also increased, but this method is harmful for fish and marine life. State Government has appealed to Central Government to put Ban on LED lights. Due to low catch and low income from fishing, many local fishing communities are looking for alternative income source. The Department of Fisheries intends to set up a model ornamental fish farm during 2016-17 to boost ornamental fish farming in the state.

Table 4-6 Existing fish landing point in the river

Landing Point	River	2012	2013	2014	2015
Aldona/ Pomburpa	Mapusa	61	255	288	112
Ribandar/ Chorao	Mapusa	168	298	269	223
Total		**229**	**553**	**557**	**335**

Source: Directorate of fisheries, Goa

Local people of Goa are seafood lovers and local fish catch is not enough to meet the demand. Local fish catch serves only 35% of market. Fish are procured from neighboring states to cater to whole market. Due to low catch of fish, Government is encouraging fishermen to start crab farming by providing financial assistance, upto 2 Ha. area. Government is providing training for fishermen, but due to scarcity of land and complicated approval procedures, very few people show interest in crab farming. All these fish catch are consumed locally in nearby villages. Fishermen either sell their fish catch in the village market or sell it in the fish center/ market. They transport their catch to these centres through Roadways on autos. There is no provision for small fishing boat to berth at well-developed jetties; hence department of fisheries has created small landing area near houses of fishermen, so that their small boats would have direct access in river. As fish catch from the river is miniscule, so few fishermen are attracted to the profession. Even if Government decides to develop fish handling infrastructure or set up cold storage facility, it would not prove effective to attract more fishermen. As people have access to small landing points developed near their residents, it would be difficult to convince them to use another bigger platform or transport their fish catch via waterway. Fishermen earn good amount by selling their fish catch in local market; hence there is limited scope to export their fish catch.

c. Mining

Goa is a leading producer and exporter of iron ore, manganese, bauxite, high magnesia, limestone and clay. Important mines are located mostly in northern and eastern parts of Goa, while the Mormagao Port handling the majority of these mines extracts. But uncontrolled mining is leading to destruction of forests and posing health dangers to the workers at the mine. The mining belt of Goa covers approximately 700 sq. km. The maximum area under mining is in Sanguem Taluka, followed by Bicholim, Sattari and Quepem. Quepem & Sanguem do not come under the hinterland of Mapusa River. Parts of Bicholim & Sattari come in the catchment area of Mapusa River.

Contribution of mining sector to GSDP has fallen down to 5% in FY 13 from 20% in FY 11 and almost nil in FY 14. State Government has now pulled the ban on some of the iron ore mines, but it didn’t result in major growth of mining sector, due to limitations of exporting iron ore by the government. Vedanta was the first one who started its operations after ban and is the major iron ore player in Goa. Mining activity has affected the landscape around mining area. Number of private operators, who were dealing in iron ore exports have also declined and almost nil now.

d. Forestry

Around 60% of total geographical area has been covered with forests and tree cover in the state accounts for 9% of total geographical area. Goa has 16 different mangrove species and considered as best mangroves forests in India. Chorao Island is the famous site for mangroves. Agarwada, Shivolim, Colvale, Camurlim are major villages on the banks of the river where mangroves are found. This needs to be taken into consideration for developing any terminal on the river. Forest area of Goa is approximately around 1224.38 sq. km, besides this, the forest land owned by private people and institutions is around 200 sq. km.

Table 4-7 Forest Distribution in Goa

District	Geographical area	Dense forest	Moderately dense forest	Open forest	Total area	% of geographical area
North Goa	1,736	128	236	559	923	53
South Goa	1,966	415	349	532	1,296	66
Total	3,702	543	585	1,091	2,219	59
Tree Cover					334	9
Total Forests					**2,553**	**69**

Source: Department of forest, Goa

Forests and tree cover includes trees of coconuts, mangoes, cashews, jackfruits, etc.

There exist various wildlife sanctuaries such as Bondla Wildlife Sanctuary, Molem Wildlife Sanctuary, Cotigao Wildlife Sanctuary, Madei Wildlife Sanctuary, Netravali Wildlife Sanctuary and Mahaveer Wildlife Sanctuary. The most visited sanctuary is the Salim Ali Wildlife Sanctuary, located on Chorao Island, famous for its bird species.

e. Horticulture

Coconut is grown majorly in Goa. Other major fruits grown in Goa are mangoes, cashews, and jackfruits. Cashew and mangoes are major cash crops. Apart from them, other cash crops such as areca nut, sugar cane, and pineapple are also cultivated. Cashew nut is an important crop, as it is the main ingredient of the popular intoxicating drink, ‘Feni’, which is brewed locally. Government is trying to increase cashew nut productions, so the state would not have to import cashew nuts. The cultivation of cashew nuts is spread over 55,000 H.a. in Goa.

Varieties of mangoes and jackfruits grow in the state, which are then sent to other states in India. Local people have their own coconut plant and grown trees like Cashew, Mango, and Coconut etc. on their land for their own consumption. They sell the surplus production in local markets. According to local farmers, the reasons for decline in agriculture produce including Mango and Cashew Nuts are bad weather conditions, small size of plantation, high cost of labour and nuisance created by Keldi Monkeys at farm area. Local production of horticulture crops is not sufficient for the local residents of Goa.

4.2.2.2. Secondary Sector

Manufacturing industries, Electricity, Gas, Water supply providing and construction companies come under secondary sector. Secondary sector's contribution to GSDP has also declined over the years. There do not exist many major manufacturing industries in the region because there is scarcity of open lands for developing industrial infrastructure in Goa.

4.2.2.3. Tertiary Sector

Hotels, Restaurants, Transport, storage and other communication industries, Banking & insurance, Public administration etc. comes under tertiary sector. Tertiary sector has grown steadily over the years. Growth in service sector indicates that Goa is slowly turning into developed economy. Goa is mainly dependent on tourism sector. It is globally recognized as a leisure destination. Natural beauty of Goa attracts tourists from all over the world creating a flourishing tourism Industry. Due to boost of tourism, hotel and other service industries are major revenue generating segments of the state. There are many hotels, resorts developed around coastal and riverside which also provides watersport and other supportive adventures activity to attract more tourists.

Food & beverage outlets, entertainment centres, handicraft outlets, water sports, adventure sports, hinterland river cruise tourism, heritage tourism, home stays, life guard, travel guide are potential areas of service sector directly related with tourism industry. Other potential service enterprises include electronic device repairing, beauty salon, ayurvedic massage centres, plumbing, auto mechanic, photography, welding, cold storage facilities, and container repairs.

4.2.2.4. Infrastructure Analysis

Infrastructure plays major role in the development. It becomes backbone for any new development. It is essential to understand various types of infrastructure around the river and new development that would provide support by connecting waterway with other modes of transportation. Goa has a well-developed social, physical and industrial infrastructure and connectivity. It also has significant port infrastructure.

Goa has an advantage over other exporting regions in the countries for being a deep sea port and waterways that crisscross the territory facilitating barge transport. The two rivers Mandovi and Zuari also provide cheap river transport. These two rivers and the Mormugao Harbour are nature's gift and are natural resources of Goa.

4.2.2.5. Connectivity Analysis

Railway, roadway and airports around the waterway help to understand various ways through which evacuation of cargo and passengers could take place. It helps to determine best multimodal route for evacuation. Following image depicts connectivity around Mapusa River, its accessibility by Roadway and Railway.

a. Rail

Karamli and Tivim are the two main railway stations on Konkan railway line, which are near to the river. There is Ro-Ro service for trucks, running from Maharashtra (Kolad) to Karnataka (Suratkal) and Maharashtra (Kolad) to Verna (Goa) to decongest the road traffic. Kolad to Verna distance is covered in less than 12 hrs on this route, which used to take about 24 hrs to reach. This service runs on Konkan Railway Line.

Konkan Railway connects the area with South Western railway at Majorda. Both the Railway sections are Single line sections with Diesel traction of locomotives. Railway connectivity to Mormugao Port Trust is also available.

b. Road

Apart from local and state highway, NH 66 is the major national highway passing nearby Mapusa River.

c. Air

Goa has an international airport at Dabolim that caters to the influx of foreign tourists throughout the year. At present, Dabolim is the only airport of Goa, which is about 45 km away from Chapora River. GOG wants to develop another airport in North Goa in Mopa.

The strong local & regional connectivity of Rail & Road network poses a threat for the development of inland water transport, unless otherwise effectively utilized for IWT mobility.

4.2.2.6. Existing Infrastructure

Following image shows some of the existing landing points on the river, where there is a facility for Ro-Ro or private boats berthing.

Source: Site Visit

Figure 4-8 Existing landing points on Mapusa

Chorao image shows nearby land around Ferry landing point, which connects Chorao to Pomburpa. Pomburpa image shows just near ferry landing point, people have built their houses. Shirigao platform, shown in the above image is used for ‘Ganesh Visarjan’ by local community. Ganesh Chaturthi is the famous festival celebrated all over India, particularly in Maharashtra and Goa.

Following image shows some of the bridges built over Mapusa River.

Source: Site Visit

Figure 4-9 Existing Bridges on river

Source: Site Visit, Internet (Past)

Figure 4-10 Corjuem Poira Openable Bridge

The above image shows that there is a bridge, which connects Corjuem and Poira. This bridge is constructed as an openable bridge so that there will be smooth vessel movement on the river. Navigational clearance of the bridge is 25 meter. The Bridge opened for local commuters by the end of 2007. Due to ban on mining activity, for so many years the bridge didn't open for ships to pass. The following image shows surrounding and condition of the bridge at present and in past. It is clearly visible from below image that in past, the bridge was surrounded by open land but now people have made their houses nearby the bridge area and also planted trees around.

Existing Boats/Ro-Ro on the river

Source: Site Visit

Figure 4-11 Existing boats plying on Mapusa

Following table shows existing jetty or stacking yard available in North Goa region for handling or storage of minerals. As per Department of Mines and Geology at following locations in North Goa, there exists infrastructure platform/ jetty for handling minerals. As stated above, Bicholim and Bardez taluka come under the catchment area of Mapusa River. Traffic generated at these locations could hold potential to divert this cargo to the waterway.

Table 4-8 Existing mineral handling infrastructure in North Goa

Name	Taluka	Type	Distance (Km)	Reasoning
Sinquerim Calvi	Bicholim	Jetty	11	Sircaim is the nearest mineral source located nearby river and has jetty infrastructure. Part of Bicholim taluka could be considered as a possible source for mineral transportation through river. Sircaim is used for transportation of iron ore to Mormugao port. Sattari is closer to Mandovi river, compared to Mapusa river. Hence no iron ore traffic from this district could be shifted to Mapusa river.
Kothambi Plot	Bicholim	Jetty		
Tixem	Bicholim	Jetty		
Maina	Bicholim	Jetty		
Bandekar	Bicholim	Jetty		
Sinori	Bicholim	Jetty		
Surla	Bicholim	Jetty		
Alcon	Bicholim	Jetty		
Siqureim	Bicholim	Jetty		
Amona	Bicholim	Jetty		
Sarmanas	Bicholim	Jetty		
Sircaim(Nrb)	Bardez	Jetty	1	
Sircaim (Ilpl)	Bardez	Jetty		
Mpt -Tv Orissa	Bardez	Port		
Anshul Steel Ltd. Kolhapur	Sattari	STKYD	22	
Trivista Steel & Power Ltd Koppal	Sattari	STKYD		
Venkateshwara Sponge & Power	Sattari	STKYD		
Mahamanav Ispat	Sattari	STKYD		
Vagus Stack	Sattari	Jetty		
Vagus	Sattari	Jetty		
Panajim Port	Tiswadi	Port	12	
Mpd	Ponda	Jetty	33	

Source: Directorate of mines & geology, Goa

Table 4-9 Existing Infrastructure of ports of Goa

Port	Draft (m)	Type	Commodity
Major Port			
Mormugao	14.4	Direct Berthing	Pol, Minerals, Coal, Fertiliser, Dry Bulk, Break Bulk
Non Major Ports			
Panajim	20.0	Anchorage	Iron Ore, Coal
Chapora	3.6		No cargo Operation
Betul	2.4		
Talpona	3.5		
Tiracol	3.7		

Source: IPA, Ministry of shipping

The above table states ports and their existing infrastructure in Goa. Though there are five terminals in the category of non-major ports, only Panajim terminal has facility to handle bulk commodities. 11 berths at Mormugao port handles general, liquid and bulk Cargo. Port has 6 mooring dolphin apart from berthing facility. Mormugao port handles ships with maximum 1,60,000 DWT.

4.2.2.7. Upcoming Infrastructure

- Union ministry of home affairs (MHA) has identified five islands in Goa for holistic development. These islands are St George Island, Grande Island, Pequeno Island, Conco Island and Bhindo Island.

- Goa government has approved INR 981 crore (US$ 144.1 million) proposal for Panajim Smart City. The major focus of the proposal is on eco-mobility, public transport system and improvement of conservation zones. For the development of 'Ease of doing business' and 'investor friendly ecosystem' initiatives in Goa, the state government has proposed to establish an EMS (Electronic Monitoring System) that will track the progress of all IPB granted single window clearances, as per state budget 2016-17. Porvorim, which is the last point of stretch is connected to Panajim by NH 66. The distance from Panajim is less than 1 km.

- There are 16 planned SEZs in Goa. The government has been planning to strengthen IT sector also with the help of IT governance and policies. The first Software Technology Park (STP) complex is coming up in Goa at a place called "Verna", which is 12 km from Dabolim airport.

4.2.3 Existing & Proposed Industries

4.2.3.1. Existing Industries

Table 4-10 Number of registered industrial units in North Goa

Year	Units		
	Micro	Small	Medium
2008	20	5	-
2009	23	8	2
2010	27	15	-
2011	18	7	-
2012	19	9	-
2013	24	12	-
2014	40	14	5
2015	49	22	1
Total	220	92	8

Source: Directorate of Industries Trade and Commerce, Goa

Table 4-11 Number of registered units as per product type in North Goa

Sr. No.	Product Group	Number of Units Registered	
		2014	2015
1	Food Products	10	6
2	Beverages & Tobacco Products	6	4
3	Jute, Hemp & Mesta Textile	0	1
4	Textile Products & Garments	0	0
5	Wood Products & Wooden Furniture, Fixture	3	3
6	Paper Products including Printing / Publishing	2	2
7	Leather & Leather Products	0	0
8	Rubber, Plastic, Petroleum and Coal Products	2	5
9	Chemical Products (except Petroleum and Coal Products)	1	6
10	Non Metallic Minerals	1	0
11	Basic Metal & Alloys	8	10
12	Metal Products & Parts (except M/c. & transport eqpt.)	1	0
13	Machinery, Tools & Parts (except & electrical M/c.)	1	3
14	Electrical Machinery & Apparatus & Supplier Parts	3	1
15	Transport Equipment & Parts	1	0
16	Other Mfg. Industries	11	17
17	Repair / Services	9	15
Total		59	73

Source: Directorate of Industries Trade and Commerce, Goa

a. Tivim & Mapusa Industrial Estate

Tivim and Mapusa are the two major industrial areas around Mapusa River. Most of the industries located in these areas are small scale and not EXIM based. Following map shows location of industrial area and connectivity around it.

Figure 4-12 Industrial Areas & It's Connectivity

Tivim Industrial area has about 75 to 80 small to medium scale industries, comprising of pharmaceuticals, electrical panel, furniture making, fabrication and machinery work etc. Mapusa industrial estate have about 25 working units all on a smaller scale like injection modeling, steel fabricator, cutting of natural stone etc. No major industries are found in this industrial area that hold potential for using IWT route. In the past, there were more than 400 iron ore trades in Goa; at present the number has reduced to less than 100.

Table 4-12 Industrial Cargo Opportunity for Mapusa River

Location	Area (Sq. mtr.)	Year of Establishment	Scale	Type of Industries	Distance (Km)	Opportunity
Tivim	1,77,205	1975	Medium & Small	Paint, Pharmaceutical formulation, Wooden furniture, fabrication, Powder coating, Automobile seat covers etc.	2	No opportunity. Production of these Industrial units in these regions is low in volume, which cannot be moved through barges. Hence, no opportunity

Location	Area (Sq. mtr.)	Year of Establishment	Scale	Type of Industries	Distance (Km)	Opportunity
Mapusa	47,100	1973	Small	Digital watch, Plastic bags, Injection folding, Steel fabrication, Service & repairs etc.	2	for Mapusa river from industrial cargo.

Source: Consultant's Analysis

4.2.3.2. Upcoming Industries

There exists no proposed industry in the catchment area of Mapusa River.

4.2.4 Traffic from Major & Non Major Ports

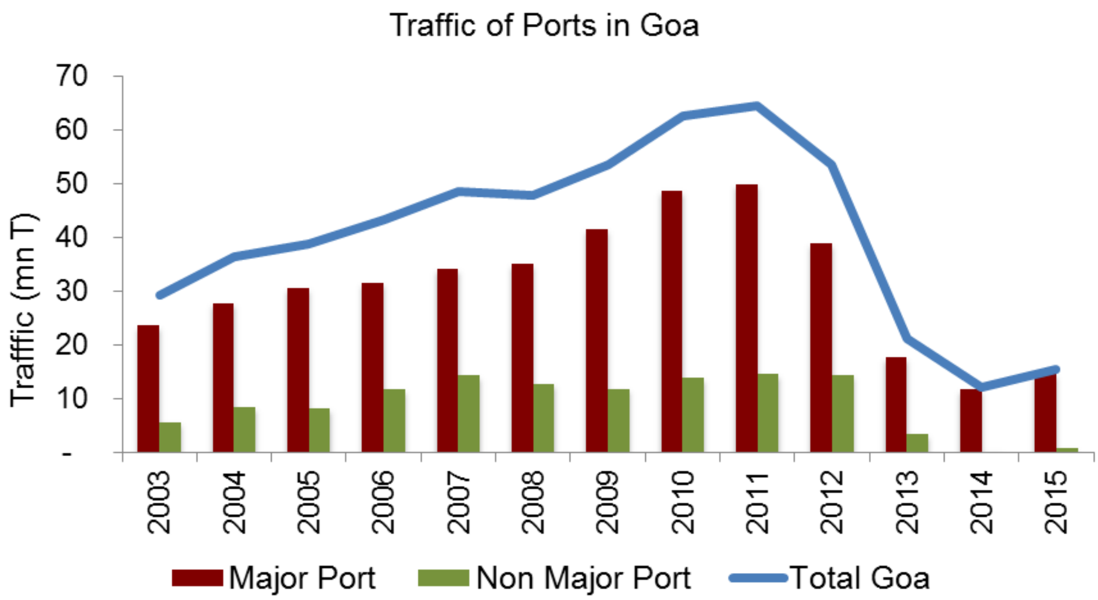
The objective of this section is to show the linkage of industrial areas located on the banks of the river with Mormugao Port and other Non Major Port via waterways. This section would discuss the strategic location and infrastructural advantages of the ports in brief and analyse the amalgamation of river routes with these ports. Industries located nearby banks of river are not large enough in volume that they could use waterway for transportation.

Goa has one Major Port Mormugao and 5 non-major ports, namely Chapora, Betul, Talpona Tiracol and Panajim. Betul and Talpona ports are located in south Goa region and Chapora and Tiracol ports comes in north Goa region. Only Panajim, which is a non-major port handles cargo, rest of the ports have not handled cargo in the last ten to fifteen years.

Government of India along with state government wants to develop Betul Port as a satellite port of Goa. Because of the opposition of local people, no steps have been taken so far to develop it. If this port is developed and becomes operational, it will handle iron ore and other bulk commodities. Mormugao port has 3 lac sq. meter of land at Betul. To develop infrastructure for satellite port, total 8 lac sq. meter of land is required.

At present, mineral is transported in small scale from Mapusa river. Government wants to develop Mapusa and connect it with upcoming Mopa International Airport in North Goa, which is 27 km away from Mapusa river and is expected to commission by Fy 2019-2020.

Following graph presents overall historic traffic generated in Goa and share of Major and Non Major ports.



Source: Ministry of Shipping

Figure 4-13 Total traffic generation of Ports of Goa

It can be seen from the above graph in the past three to four years, major ports traffic as well as overall traffic of Goa has declined and suffered due to government's ban on mine operations. However due to upliftment of ban major ports traffic has witnessed growth in 2015 by 20%. Upliftment of ban does not apply on all mines. At present there are few mine operators who are still in the queue to start operation. Government of Goa has also set a limit on handling of minerals at ports in coming future. Only 30-37 mnT of minerals could be handled at all ports of Goa.

a. Major Port (Mormugao)

Mormugao Port is the major Port of the state, which handles EXIM trade. As Mormugao Port is far from Chapora River, so it would not be considered as port of Primary catchment area. However, due to absence of any other major port in the state, Mormugao Port has an advantage.

Mormugao Port is connected through road with two national highways NH-17 and NH-4A. The NH-4A highway eventually joins with NH-14, which connects Mumbai and Bangalore. NH-17A highway connects Mormugao.

Mormugao port has total 11 berths out of which 8 berths (Berth No. 1,2,3,5,6,7,8,9) are leased out to some other organizations and remaining 3 berths (Berth No. 4,10,11) are under the operation of Mormugao port.

The port has been provided with one breakwater berth and one mole berth. Breakwater and mole are also being used as a berthing for vessels. Breakwater can be used by one side only and mole can be used by both sides.

Facilities in Mormugao Port-

- Berth No. 1,2,3 - The old berths 1 to 3 are leased out to Western India Shipyard Ltd, for installing a modern ship repair facility. The length of the berth is approx. 331 mts with a draft of about 8.5 mts.

- Berth No. 4- Berth No. 4 is under the operation and management of Mormugao Port only and was commissioned in the year 2010. This berth is being used for small crafts only. It is a RCC constructed. The length of the berth is approx. 190 mts, width is 16 mts and depth is 8 mts.

- Berth No. 5 & 6- Berth No. 5 and 6 are leased out to JSW Steel. JSW which imports coal and exports finished steel products annually through the port. The construction of berth is of RCC structured. The length of the berth no. 5 & 6 is approx. 200 mts and 240 mts.

- Berth No. 7- Berth No. 7 is leased out to Adani Mormugao Port Terminal Pvt. Ltd for handling of coal cargos.

- Berth No. 8 & 9- Berth No. 8 is a Liquid cargo handling berth. The commodities like POL product, Furnace oil, Ammonia and other liquid products are being handled and managed by private agencies at this port. Berth No. 9 is dedicated for the handling of iron ore with mechanical ore handling plant (MOHP) and it belongs to Vedanta Limited. The structure is of concrete cribs with RCC decking. The length of the berth no. 8 & 9 is 260 meter and 360 meter respectively.

- Berth No. 10 & 11- Berth No. 10 and 11 are under the operation and management of Mormugao Port. It is being used as a general cargo berths and commissioned in 1985 and 1994 respectively and having a draft of 11.00 mts and 12.50 mts. It is a RCC constructed supported with piles. The length of the berth no. 10 & 11 is approx. 250 mts and 270 mts.

- Storage - There are three dedicated storages provided for material export/import purpose at berth no. 10 & 11 which belongs to Mormugao Port. At present, wood chips have been stored in open shed and steel coils have been stored in closed shed.

Below graph shows unloading of major commodities at Mormugao Port. It can be seen from the Figure 4-14 Figure 4-15 that in the past fifteen years, number of unloaded commodities increased than loaded commodities at the port.

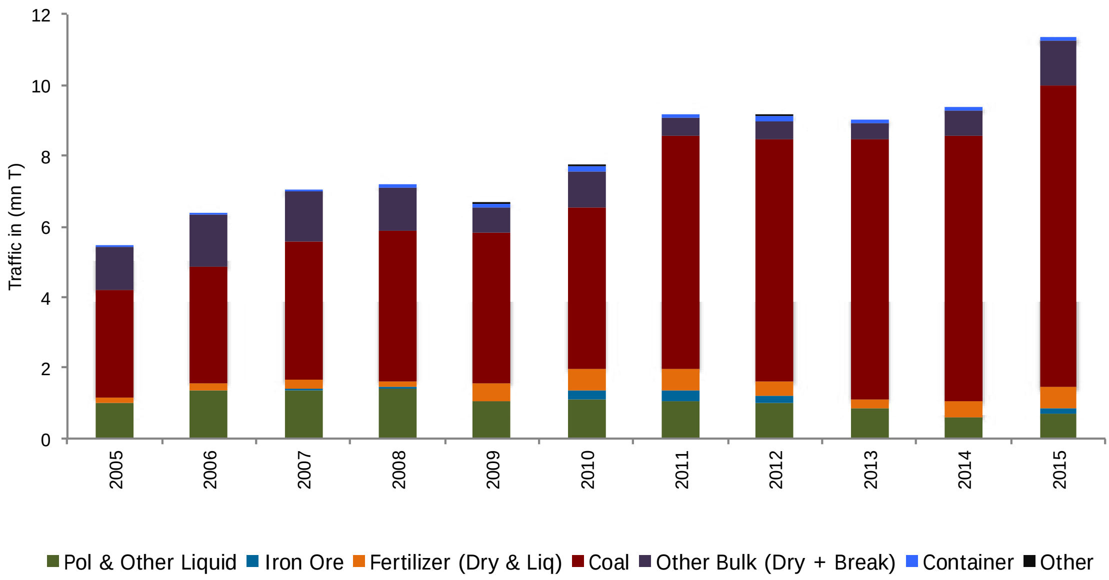


Figure 4-14 Commodity wise historic import traffic of Mormugao Port

Among unloaded commodities at port, Coal is the major commodity followed by POL and Fertiliser. JSW imports coal at Mormugao Port for their Vijaynagar Plant in Bellary district of Karnataka.There exists good and direct railway connectivity from Mormugao Port to JSW Vijaynagar plant. For JSW, using Mormugao Port is cheaper compared to New Mangalore Port for handling coal.

Goa carbon plant is located about 42 km away from Mormugao port. It imports green coke and exports calcined petcoke. Berth no. 10 and 11 are in use for this activity. They do not have any plant in north goa region and currenetly have no expansion plan.

Indian Oil has its plant located in the close proximity of Mormugao port. Indian Oil is also in the process of developing berth no. 8 at Mormugao port for handling more amount of liquid traffic. Zuari Indian Oiltanking has facility for POL products at Goa with 64,000 Kl tankage and 14km long pipeline from MPT. It also provides storage facility to Zuari for Naptha and provides services like storage and distribution to Bharat and Hindustan Petroleum.

Zuari Fertiliser is the sole and major plant located in South Goa which produces DAP or complex fertiliser. This plant has installed capacity of 1 mn T. In FY 2013, Zuari had shut down its plant for annual maintenance. Its Goa unit manufactures Urea, DAP, NPK based fertiliser products.

It can be seen from below graph that Iron Ore is the only major commodity loaded at port followed by other bulk commodities. Containerized commodities contribute very negligible share in the exported commodities from port.

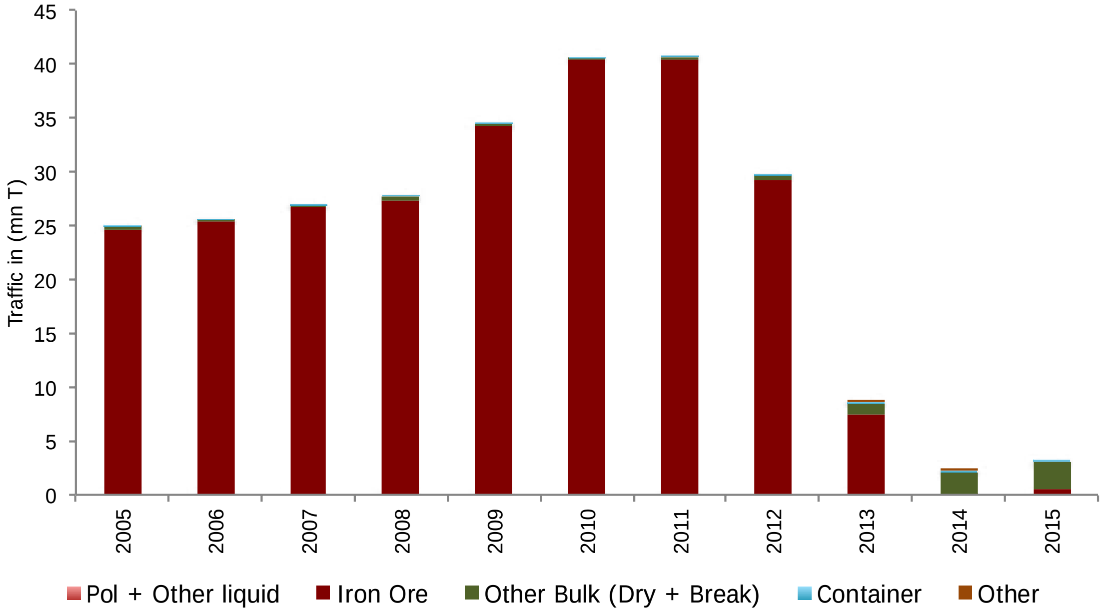


Figure 4-15 Historic commodity wise Export traffic of Mormugao Port

Iron Ore and other bulk commodities fall under major loaded commodities at Mormugao Port. Iron Ore has shown inconsistent growth over the years due to ban on mining activities. Due to upliftment of ban on some of the mines it is expected to increase iron ore traffic. Over the years there has been decline in number of mine owners who loaded minerals at port.

Following table describes different shipper and commodities loaded/unloaded at Mormugao port over the years. It can be seen from below table that Vedanta, Chowgule and Salgaokar are major players in Iron Ore. Vedanta is the major player in handling Coal, Coke and other bulk commodities.

Mandovi and Zuari are the major rivers, used by mine owners for transporting minerals to Mormugao port, as their mines are located near these rivers.

b. Non Major Port (Panjim)

Panjim port is the only Non Major port, which handles cargo. It is located just opposite Mormugao Port. Panjim port lacks infrastructure facility compared to Mormugao port. When Mormugao port reduced its handling charge and other port dues, majority of Panjim port's traffic started moving towards Mormugao port which results in decline in Panjim port's traffic.

Table 4-13 Commodity wise Historic Traffic of Panjim Port

(Volume in mn T)

Commodity	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Iron Ore	8.01	8.19	11.43	14.03	12.74	11.9	13.68	14.58	14.31	3.28	0	0.35
Coal	0.42		0.33	0.28	0.09		0.22		0.16	0.11	0.28	0.41
Iron & Steel	0.01											
Other Cargo		0.01										
Total	8.44	8.2	11.76	14.31	12.83	11.9	13.9	14.58	14.47	3.39	0.28	0.76

Source: Ministry of shipping

The above table clearly shows the drastic fall in the commodities handled at Panjim port.

Approximately 600 barges made 1,500 trips to Mormugao port and handled 3 mnT of bulk cargo in 2016. MPT Mooring Dolphin, MPT West of Breakwater were two main berths where these barges were handled. China,

Japan and Korea are the main destination countries where minerals are exported from Mormugao Port, out of which China accounts to more than 95% of mineral traffic. Japan and Korea require high quality of minerals with higher 'Fe' content. Iron Ore from Goa and Bellary – Hospet area are exported using Mormugao port.

MPT is also planning to expand its existing railway network by electronic interlocking of entire rail yard. At present rail yard of MPT is 13.25 km. Total 7 rail lines will be added. Four weigh bridges will also be added for weighing wagons. Overhead pipe conveyer system and silo would be installed at berth no. 5 and 6 for easy evacuation of coal.

Table 4-14 Shipper & Commodity wise historic traffic of Mormugao Port

(000' T)

Shipper	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Iron Ore										
Vedanta	3,407	5,581	7,304	7,495	7,028	6,712	1,377	-	-	1,709
Chowgule	2,298	2,261	2,145	2,687	2,081	2,353	-	-	-	-
Dempo	1,382	1,155	1,222	1,727	636	-	-	-	-	-
Fomento	-	-	136	144	2,628	1,345	1,139	-	71	323
Salgaonkar	834	1,262	1,246	2,040	2,278	1,308	-	-	-	-
Doddanavar	357	242	105	52	51	-	-	-	-	-
Bandekar	214	359	533	485	471	638	279	-	-	-
Bandodkar	75		49	-	99	51	-	-	-	-
MSPL	712	740	944	135	75	-	-	-	-	-
Magnum Minerals	-	-	73	169	326	431	51	-	-	-
Timblo	-	167	202	200	777	909	-	-	-	-
Others	4,807	5,039	8,386	13,103	13,344	6,801	2,365	-	413	1,060
Iron Ore Total	14,084	16,805	22,345	28,236	29,794	20,548	5,211	-	484	3,091
Coal										
Vedanta	52	265	168	133	367	317	203	387	303	429
Others	1	-	-	1	-	1	-	-	-	121
Coal Total	53	265	168	134	367	319	203	387	303	551
Coke										
Goa Carbon	-	16	-	-	-	-	-	-	-	-
Others	2		-	3	-	-	-	-	-	-
Coke Total	2	16	-	3	-	-	-	-	-	-
Other Bulk/Break bulk Cargo										

(000' T)

Shipper	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sesa	-	-	-	-	-	-	6	272	310	106
Vedanta	-	-	-	-	-	-	-	-	-	252
Others	13	0	-	-	-	0	12	3	-	-
Other Cargo Total	13	0	-	-	-	0	17	275	310	357
Total	**14,152**	**17,087**	**22,512**	**28,372**	**30,161**	**20,867**	**5,432**	**662**	**1,096**	**3,999**

It can be seen from the above table Table 4-14 Shipper & Commodity wise historic traffic of Mormugao Port that in the past few years total bulk commodities handled at Mormugao Port have decreased substantially. The reason of decreased cargo is ban on exports of iron ore. Vedanta, Chowgule, Fomento and Salgaonkar are the major iron ore exporters who use Mormugao Port's facility. Dempo Group has sold their iron ore extraction business to Vedanta and at present Vedanta is the major leading company in this sector. Vedanta does not have any mines in the catchment area of Mapusa river.

Table 4-15 Potential from major Iron ore mine owners to Mapusa river

Major Mine Owner	Location of Mine/Jetty	Mapusa River Potential	Reasoning
Vedanta	Surla, Bicholim	✗	Surla, Velguem, Amona, Cotombi do not come in the catchment area of Mapusa river. All these locations are located near Mandovi river. Mandovi river has fully developed & functional jetties for handling iron ore. Calvim jetty is located on Mapusa river. Assnora, Shirgao are within 5 km from river stretch, hence only these areas would provide opportunity for the waterway in Mapusa river.
Fomento	Calvim	✓	
Chowgule	Assnora, Shirgao	✓	
Salgaocar	Velguem, Surla, Amona	✗	
Bandodkar	Velguem	✗	
Bandekar	Cotombi	✗	

Source: Mantrana Maritime Advisory Pvt Ltd, Site visit

4.3 Commodity Composition

River transportation would be viable for movement of bulk commodities like minerals, Cement, Coal etc. Minerals and coal are major commodities handled at Mormugao Port. Though Mineral is a major commodity in the past few years due to Ban on mineral extraction, export of minerals has steadily declined. Fertilizer, POL and other minor dry bulk and break bulk cargo are handled at Port.

Table 4-16 Commodities transported by railway

Commodities	Origin	Destination	Consigner	Consignee	Rakes Demand (no.)	Opportunity	Reasoning
Container	Verna	BAT, ICPH, ICOD	CONCOR	CONCOR	10	✗	Verna industrial estate has close proximity with Mormugao port compared to Chapora/ Mapusa river. Container cargo is destined to Punjab & AP. This cargo's Origin-Destination is out of the catchment area of Mapusa river.
Coal	-	HACG	GCBL	HIL	1	✗	HACG siding is of Hindalco Ltd., which is in Jharkhand. It provides no scope for transportation through waterways. Goa Carbon plant is located in Salcete area in South Goa and Mapusa river is in north Goa. Hence, GCBL would not use waterways for cargo movement.

Source: FOIS, Consultant's analysis

Container and Coal both are not considered as potential commodity for Mapusa River. As discussed in the above table, container cargo is originated in South Goa and Mapusa River is in North Goa. Container cargo also gets destined in North and South India as per FOIS data. Mapusa River does not provide end to end connectivity, hence industry would need multi modal transportation. Multiple handling for short distance increases the cost of transportation. Using waterway would not be a commercially attractive option for the industries that at present using railway/roadway. Hence it would not provide any opportunity for Mapusa River.

Coal is also not considered as potential commodity for Mapusa River. Consigner and consignee location and trade route do not come in the stretch of Mapusa River. Thus, there does not exist any opportunity of shifting container or coal from railway to waterway.

4.3.1 Minerals

The mining belt of Goa covers approximately 700 sq. km and is mostly concentrated in four talukas namely, Bicholim of North Goa district and Salcete, Sanguem and Quepem of South Goa district. Part of Bicholim taluka (North West) could get attracted towards Mapusa River due to its close proximity. Others are located in South Goa and closer to Mandovi river; thereby limiting scope for this region.

Iron ore is the major mineral found in Goa. Other non-major minerals are Manganese Ore, Bauxite, Laterite, Basalt etc. Following table shows historic production of minerals in Goa. Chowgule has its own mines located near Sircaim and Assnora. Bandekar, Fomento are using Clavim jetty in Mapusa River for transporting iron ores to Mormugao port.

Table 4-17 Historic Production of Minerals in Goa

Production (mn T)

Mineral	2011	2012	2013	2014	2015
Iron Ore	207	169	137	152	129
Bauxite	13	14	17	22	22
Total	220	182	153	175	151

Following Table describes location and minerals found near Mapusa River. During site visit and interactions with mine owners, Laterite, Basalt etc. are used as building material and moved by trucks. Such minerals could not be transported by barges and hence presents no opportunity for the proposed waterway.

Iron Ore extraction in Goa is mostly done through open pit mining. Open pit mining of Goa operates below ground water level. Most of the iron ore mines of Goa are either partially or fully mechanized. They have processing facility at their loading point/ jetty.

Table 4-18 Location of mines in the catchment area of river

S. No.	Location	Mineral	Distance (Km)			Opportunity
			To river	River to Port	Direct Port (road)	
1	Aldona	Iron Ore	0.2	16	49	Mapusa river is used for iron ore transportation from past so many years. Now the movement
2	Sirsaim	Iron Ore	0.7	16	52	
3	Assonora	Iron Ore	6.0	16	54	
4	Tivim	Iron Ore & Laterite	4.9	16	48	
5	Ponolem	Basalt	1.2	16	47	

S. No.	Location	Mineral	Distance (Km)			Opportunity
6	Ucassaim	Murram	2.9	16	45	through river is nominal because of the ban. Upliftment of ban on the mines located in the vicinity of river could attract more iron ore traffic to river. There are jetties, which are not functional at the moment, would be revived soon after granted permission.

Source: Site visit, Consultant's analysis

There exists possibility of shift in traffic from Assnora and Shirgao mine area to Mapusa River. Calvim jetty is being used for iron ore transportation to Mormugao Port.

It has been observed that the North West side of mining area is located in vicinity of Mapusa River. The North-West region of mines is located at a distance of 3 km from Mapusa River, while Mandovi River is located at a distance of 11 km from the same location.

4.3.2 Iron Ore

Iron ore reserves in Goa are variously estimated to be around 1,000 million tonnes. Iron ore deposits in Goa are in fine form. Around 80% of the deposits are fines and the rest are in lump form. Iron ore mining in Goa is completely handled by private sector. The Iron ore deposits are distributed over the Northern, Southern and Central Blocks of Goa. The Northern Block deposits are richer both in terms of quality and quantity of the ore, as compared to the Southern and Central Blocks ores.

4.3.3 Bauxite

North Goa Bauxite deposits are found in the area of Chapora river, Mopa area, Pernem area, Morjim area, Dargalim, Ibrampur and Korgaon areas.

4.4 Originating & Terminating commodities

Following table summarises all the commodities handled at major port of Goa and its attractiveness to Mapusa River. There do not exist any such industries in the catchment area of river that consume unloaded cargo at Mormugao port. There exists no EXIM based industry near the catchment area of Mapusa River.

Table 4-19 Opportunities for river movement of commodities handled at Mormugao Port

Commodity	Volume (mn T)	Attractive	Reasoning
Liquid	0.71	✗	Indian Oil & Zuari Indian Oiltanking are two major industries located in the vicinity of Mormugao port area; they have dedicated pipeline. Indian oil is developing Berth no. 8 of port to increase liquid cargo traffic.
Iron Ore	0.76	✓	Sircaim/Shirigao, Assnora are potential area from where iron ore traffic could be shifted to Mapusa river. Calvim jetty in Mapusa river was also being used for iron ore transportation. Though the ban has been lifted from mines, traffic of iron ore has not increased substantially. There exists a possibility that iron ore transportation through Mapusa river could be increased but to a limited extent, due to limitation put by State Government.
Fertilizer	0.59	✗	Zuari Fertilizer is the only industry, which is located in the catchment area of Mormugao Port.
Coal	8.57	✗	Major coal handler at port is JSW for their Vijaynagar plant. There do not exist any other major steel or power plant in the catchment area. Vedanta which is a major mine owner handles coal cargo; however Vedanta it does not have iron ore mines in catchment area of Mapusa river.
Other Bulk	3.72	✗	Due to land constraint, no industry with big infrastructure could be set up in Goa, which further limits the scope of other cargo.
Container	0.31	✗	Container cargo requires higher draft and other infrastructure facility, which is not possible to develop around Mapusa river due to mangroves around river and area required. Major container cargo generates in South Goa.
Others	0.06	✗	Other cargo volume handled at port is not even crossing 1 million mark. Other cargo is fragmented cargo.
Total	14.72		

Source: IPA, Consultant's Analysis

There is no other cargo movement towards Maharashtra from Goa apart from container cargo. There is movement of container cargo from Verna Industrial Estate in South Goa to JNPT. From this industrial estate, about 200 containers move daily towards JNPT by road. Despite the short distance from Mormugao port, i.e. 21 km from this industrial estate, roadway is used for transporting containers. Mormugao port does not have facility to handle Mother vessels; hence existing containerized cargo moves via feeder vessels to JNPT. At present, Mormugao Port is planning to expand its facility & other infrastructure to handle Mother Vessels. The cost of transporting container from Verna Industrial Estate to Mumbai (JNPT) ranges from INR 30,000 to INR 40,000 per container. If Verna industrial container cargos are moved using MPT then per container cost reduces to INR 5,000 to INR 7,000.

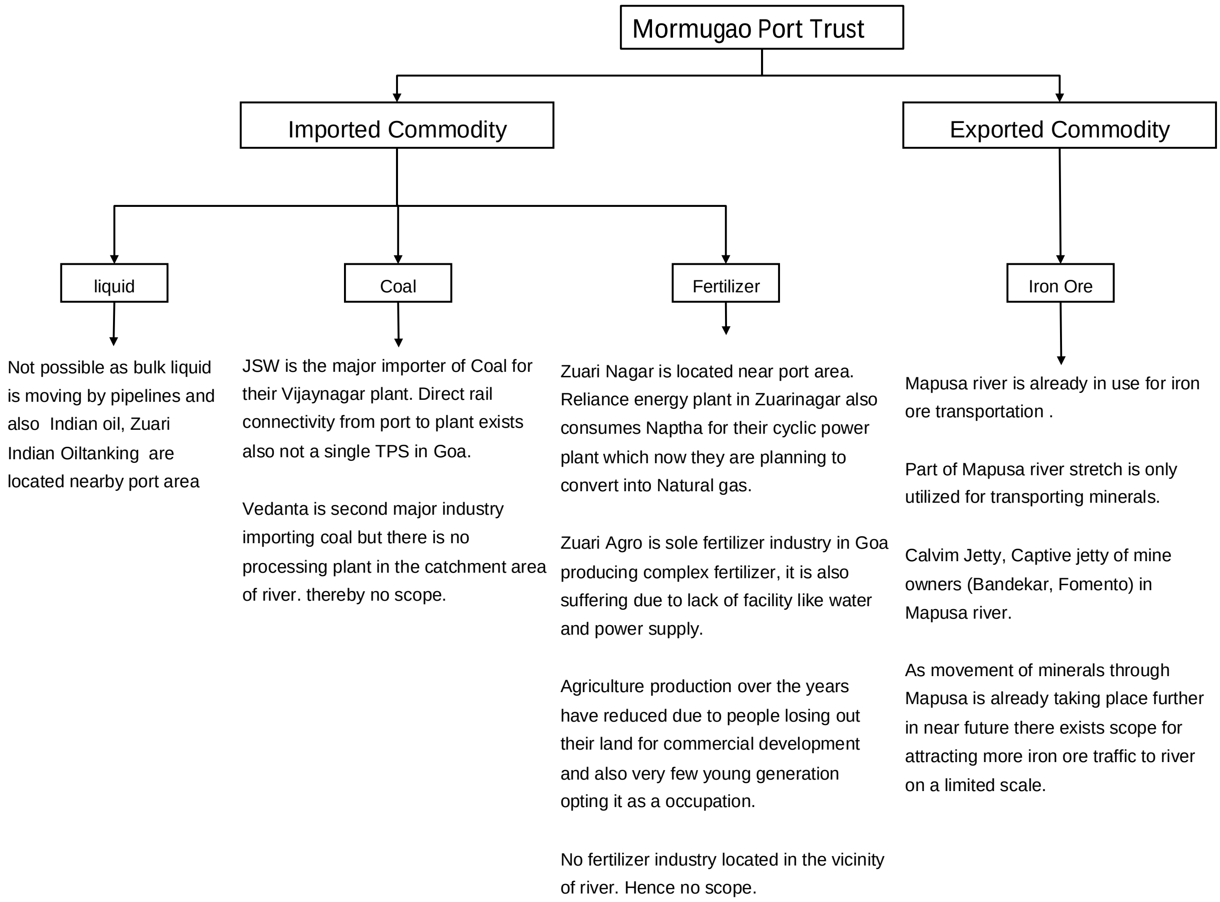
Volume of Iron ore mentioned in Table 4-19 is handled at Mormugao Port in the last financial year. Capacity or reserves for particular mine area is not available on public domain and was not disclosed by mine owners during personal interaction. All the projected traffic of iron ore is based on the inputs received during site visit, interaction with Barge Owner Association and mine operators. All the iron ore operators and the Association have confirmed that maximum extraction of iron ore from the catchment area of Mapusa would be limited to 1 mn T only. There are captive and non-captive defunct jetties on Mapusa River, which has capacity to handle 1 mnT of iron ore traffic. After the due permission from Government iron ore operators would revive them for handling iron ore.

Following table shows liquid cargo terminals facility & their distance from Port & river. It is clearly visible that Mormugao Port is located nearer to plant facility than Mapusa River.

Table 4-20 Liquid Cargo facility & scope for Mapusa river

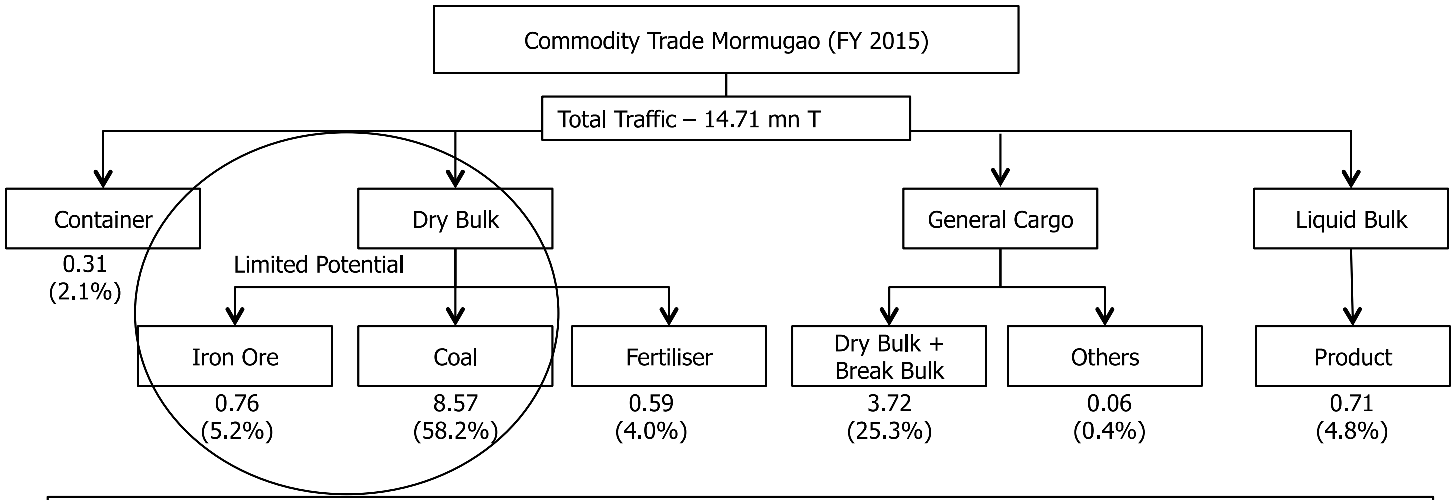
Industry	Location	Mormugao Port (km)	Mapusa River (Km)
Zuari Oiltanking	Zuarinagar	14	23
Hindustan Petroleum	Vasco	3	29
Indian Oil Corporation	Vasco	3	33

Source: Consultant Analysis



Source: Consultant Analysis

Figure 4-16 Overall Cargo scope for Mapusa



- Container being fast moving cargo and requires additional facilities for handling is not possible to create such terminal at Mapusa river.
- Only Bulk cargo like coal and iron ore could be handled through barges as barges require bigger volume to operate and Goa do not have any other major industry dealing in Bulk segment in the catchment area of Mapusa river.
- Pilgao, Amona, Assnora, Bicholim, Sattari. is where major iron ore mines are located. Pilgao and Amona is loctaed near Mandovi river and mines located in both of these areas are using Mandovi river. From Assnora, limited amount of iron ore traffic could get attracted for Mapusa river. Mapusa river do not have enough scale and other infra like Mandovi river due to which it would be hard to attract iron ore of bulk quantity to Mapusa river.
- Industrial areas like Tivim and Mapusa do not have any industry who is into bulk commodity category. thereby no scope for cargo from these industrial areas for Mapusa river.
- Pol and product consuming industries like Zuari Indian oiltanking, Bharat Petroleum, Hindustan Petroleum located nearby Mormugao port area and have dedicated berth/pipeline system connected to their facility.

Source: IPA, Consultant Analysis

Figure 4-17 Cargo opportunity for Mapusa

4.5 Passenger Traffic

Passenger traffic consists of Ro-Ro traffic and people visiting famous locations. In the recent years, number of domestic tourists visiting Goa increased compared to foreign tourists.

4.6 Tourism Traffic

At present tourism is the backbone of Goa's economy. It is traditionally known as a tourist paradise for its natural scenery, unique beaches and cultural diversity. It is bestowed with never-ending undisturbed beaches with palm and coconut trees. Paddy fields, ethnic temples, cashew and mango groves, gothic churches, ruins of forts and small charming villages enhance the experience of Goa's beauty. During the prime tourist season, the population doubles in Goa with the tourist population almost equaling to the local citizens. Goa's climate is pleasant throughout the year, which is a boon for tourism industry.

Many international festivals like international film festivals of India, which has been held since last year made Goa as an international hotspot in the world of Cinema. Domestic tourists of Goa comprise 80 percent of all tourists. International tourists who visit Goa have two sub-categories: backpackers and charter tourists. Domestic and international tourists also differ in terms of the areas they visit. For the domestic tourist, the beaches hold limited appeal, so domestic tourists remain away from the places frequented by the international tourists. The timing of visits are clearly different for the domestic and the international tourists.

Following table shows overall tourist traffic of Goa. It is clearly visible from below table that more domestic visitors are attracted towards Goa.

Table 4-21 Historic tourist traffic in Goa

Year	Domestic	Foreign	Total
2001	11,20,242	2,60,071	13,80,313
2002	13,25,296	2,71,645	15,96,941
2003	17,25,140	3,14,357	20,39,497
2004	20,85,729	3,63,230	24,48,959
2005	19,65,343	3,36,803	23,02,146
2006	20,98,654	3,80,414	24,79,068
2007	22,08,986	3,88,457	25,97,443
2008	20,20,416	3,51,123	23,71,539
2009	21,27,063	3,76,640	25,03,703
2010	22,01,752	4,41,053	26,44,805
2011	22,25,002	4,45,935	26,70,937

Year	Domestic	Foreign	Total
2012	23,37,499	4,50,530	27,88,029
2013	26,29,151	4,92,322	31,21,473
2014	35,44,634	5,13,592	40,58,226
2015	47,56,422	5,41,480	52,97,902
CAGR	**10.88%**	**5.38%**	**10.08%**

Source: Department of Tourism, Govt. of Goa

Following are some of the tourist places near Mapusa river and distance from river to that spot. All the tourist spots are located within 10 km from Mapusa river. There is possibility that people visiting these places could also come to Mapusa river for backwater sports activities etc. This would further increase the passenger traffic of Mapusa river.

Table 4-22 Existing tourist attractions near Mapusa river

Taluka	Tourist Spot	River	Distance (km)
Bardez	Candolim beach	Mapusa	9
	Museum of Goa	Mapusa	6
	Mae De Deus Church	Mapusa	6
	Viceroy's arch	Mapusa	7
	Coco beach	Mapusa	5
	Kegdole Beach	Mapusa	4
	St. Michael's Church	Mapusa	6
	Cheshire Cat Gallery	Mapusa	4
	Corjuem Fort	Mapusa	2
Bicholim	Shantadurga Temple	Mapusa	6

Source: Trip advisor

During the tourist season, seashore is always over crowded as many tourists come here from different parts of the world. Endless rows of beach chairs and umbrellas stretch out from one end of the beach to another.

4.6.1 Candolim Beach

Candolim beach is quite comfortable place for calm and relaxing vacations. Most of tourists come here to swim in tender seawaters, take relaxing sunbaths, try some traditional local cuisines and shopping. Candolim Beach is one of the most famous and well-known Goa resorts. This amazing paradise-type coastal resort is located in the northern part of Goa just 14 km away from the capital of Goa, Panajim. For 450 years Candolim was a Portuguese colony and was the first Goa state that proselyted into the Christianity. The territory of Candolim Beach stretches from the Fort Aguada to Calangute Beach, and is considered to be one of the longest beaches in Goa.

4.6.2 Mae de deus or Mother of God Church

The Mae de Deus or Mother of God Church is a breath-taking site. With its Gothic architecture and pristine white walls, it resembles a fairytale castle. It is the finest example of Neo-Gothic architecture in Goa. Situated in the Bardez taluka, this church was built in 1873. It is attractively illuminated at night. It houses the miraculous statue of Mae de Deus (Mother of God), which was brought from the ruins of the convent of Mae de Deus at Old Goa.

4.6.3 Corjuem Fort

Corjuem fort was built in 1550 and was originally the property of the Bhonsle rulers of Sawantwadi. However, in the time of Viceroy Caetano de Mello e Castro, the fort was annexed to the Portuguese administration of Goa. The colonists rebuilt the fort in 1705 to boost their defence of Panajim, which had by then become the capital city. Located in Corjuem, it lies across the Mapusa River from the village of Aldona. The river is spanned by a picturesque cable suspension bridge, which is also a tourist attraction. Like most of the other forts in Goa, Corjuem fort is constructed of laterite stone. The walls are wide and have multiple gun ports and/or murder holes.

4.6.4 Cheshire cat antique gallery

Cheshire Cat Antique Gallery is located in Historic Cameron Village in the original underground location of JC Penney. This place would provide a shopping adventure in 20,000-square foot multi-dealer mall. Cheshire Cat Antiques is Raleigh's oldest and largest antiques and collectibles mall.

Table 4-23 Taluka wise domestic tourists traffic

Year	Bardez	Bicholim	Total	% Increase over last yr.
2008-09	4,93,494	25,153	5,18,647	n/a
2009-10	5,07,196	27,943	5,35,139	3
2010-11	5,15,883	31,975	5,47,858	2
2011-12	6,53,801	2,447	6,56,248	17
2012-13	6,99,887	5,103	7,04,990	7
2013-14	8,01,455	5,803	8,07,258	13
CAGR (%)	**10.18**	**-25.42**	**n/a**	**n/a**

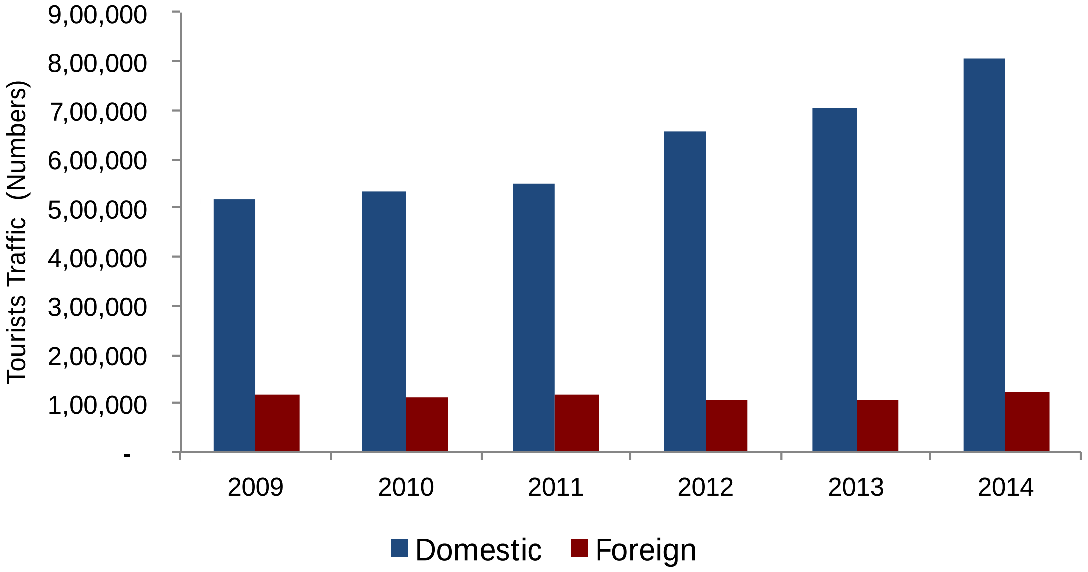
Source: Department of Tourism, Govt. of Goa

Table 4-24 Taluka wise foreign tourists traffic

Year	Bardez	Bicholim	Total	% Increase over last yr.
2008-09	1,16,716	135	1,16,851	n/a
2009-10	1,09,066	415	1,09,481	-7
2010-11	1,16,033	458	1,16,491	6
2011-12	1,04,975	1,707	1,06,682	-9
2012-13	1,05,881	1,801	1,07,682	1
2013-14	1,18,354	2,546	1,20,900	11
CAGR (%)	**0.28**	**79.93**	**n/a**	**n/a**

Source: Department of Tourism, Govt. of Goa, Statistical Handbook of Goa, Govt. of Goa

It is clearly visible from above tables that growth of domestic tourists is more compared to foreign tourists visiting Bardez and Bicholim. Following is the graphical representation of the same deduction.



Source: Department of Tourism, Govt. of Goa

Figure 4-18 Historic traffic of tourists in the catchment area of river

Above graph shows number of Domestic and Foreign tourists who visited Bardez and Bicholim talukas since 2009 to 2014. The flow of Domestic tourists has increased over the years. As per discussion with local people foreign tourists flow in Goa has declined in last few years.

4.7 Ro-Ro Traffic

At present there is only one Ro- Ro ferry plying on river Pomburpa to Chorao. It takes about 10 minutes to reach to the other end.

4.8 Growth Trend

4.8.1 Passenger & Tourism Growth

The stretch of Mapusa River is only 27 km. There exists one ferry terminal on the river. This river was used for iron ore transportation in past, therefore water of the river is very polluted at some places. This limits tourism activity in the entire river. Tourist activity is being carried out on very small scale only at the mouth of the river. At the mouth of the river near Chorao Island, there exist watersport activity and few jetties for tourism boating purpose. These jetties could be developed to attract more tourists. However number of tourists would remain constant due to cargo operation on the river. There exist two jetties on the river for iron ore transportation. Now the ban on mine extraction has also been lifted and Mapusa River would attract iron ore from nearby mines. This would further restrict growth in passenger & tourism traffic.

4.8.2 Cargo Growth

Though there are industries located in the catchment area of the river, their production & distribution volume is very low, thereby limiting industrial cargo scope for the river.

There are few mine areas located in the catchment area of the river. Iron ore from these mines could be transported to Mormugao port using barges. Shirgao/Sirciam and Assnora are potential mines nearby river. There exist two jetties on the river dedicated to handle iron ore traffic, Calvim jetty & captive jetty. Due to upliftment of ban on iron ore export, traffic is likely to increase.

4.8.3 Comparison of FSR & DPR study

Following table describes factors considered in FSR study and their current potential during DPR stage.

Table 4-25 Analysis of FSR Study

Commodity	Source	DPR Consideration	Potential	Reasoning
Iron Ore	-	✓	✓	Two potential mine areas in the catchment area of the river. Existing dedicated jetty for iron ore transportation
Laterite	-	✓	✗	Raw material for building material not moving through barges.
Basalt & Murram	-	✓	✗	
Other Industrial cargo	Mapusa & Tivim Industrial Estate	✓	✗	Small scale industries have low production volume
Fish	-	✓	✗	Inland fishing catch gets consumed locally.
Passenger	Pomburpa Chorao Ferry	✓	✗	People are demanding more bridge, roads than ferry. Existing ferry service traffic is stagnant. River stretch is less.
Tourism	-	✓	✗	There are watersports activities at the mouth of the river; these activities could be further developed by upgrading the existing infrastructure. Private cruise & Yachts are available for a backwater ride or for visiting Salim Ali Bird Sanctuary, which is at the mouth of Mapusa river. Some of the boat operators have permission to take boat inside the Sanctuary. These cruise operators have their own jetty/platform developed for berthing their boats, therefore it is unlikely that proposed IWT terminal would be used for handling tourist traffic. Distance between proposed IWT terminal and the river mouth is about 15 km. Also, extensive iron ore operations in Mapusa river could adversely affect tourism traffic for Mapusa river.

Source: Consultant's Analysis

4.9 Forecasting & Potential IWT Assumption

Mine area owned by mine operators in the catchment area and their export volume quantity. Interaction with Barge owner Operators and Iron Ore export association and Government policy on export of iron ore is taken into consideration for projecting future traffic. It is assumed that Calvim jetty i.e. existing jetty & captive jetty of mine owners would be used for transporting iron ore through barges. Iron ore could be handled at Mapusa River in the existing jetties. The jetties would revive once mining near Mapusa River commences. However, the maximum volume of 1 mn tonnes could only be handled due to fewer number of mines located near Mapusa River. There is no need for additional infrastructure or jetties in Mapusa for Iron Ore handling. Mapusa River was used for iron ore transportation and would be used in coming years as well.

Future Iron Ore export volume using Mapusa River would be around 1 mn T. Shirgao & Assnora iron ore mine areas near the river. From these mine area, potential iron ore traffic could be diverted to Mapusa River. Both the mine areas are very small compared to other big mines around Mandovi River. Mapusa river stretch is also smaller in length & width. There is a Government restriction on iron ore transportation for export purpose. All these factors restrict the volume of iron ore upto 1 mn T.

4.10 Terminal wise IWT Traffic analysis

Iron ore transportation on Mapusa river would be done by using Calvim jetty. There is need to develop these existing jetties on the river. These jetties were not used for any other cargo transportation when Government imposed ban on mining. If this terminal is developed and used there would not be any need to develop new terminal for handling iron ore traffic because the volume of iron ore extractions from nearby mines would not be on a large volume. On a restricted scale iron ore extractions would take place and existing jetties in the river would suffice the purpose.

At present there is no exisitng movement on Mapusa river. Existing jetties mentioned in below image are not functional at the moment. Among two existing jetties, one captive jetty is of Vedanta and other calvim jetty is a public jetty. Vedanta jetty has Iron ore loading facility whereas public jetty is abandoned.

Source: Google Earth

Figure 4-19 Proposed Terminal Location

As per Goa Minerals Ore Export Association, maximm annual production limit at smaller mines arround River Mapusa is upto 1 mnT. Close proximity of mines with Mandovi & Zuari Rivers restricts high volumes of iron ore movements through Mapusa. Many such industrialists opinion is captured in Minutes of Meeting (MOM) section.

Latest data of area and reserves of iron ore mines is not available on public domain. Mine owners did not share data about reserves & area etc. However, major mineral hub and operatinal areas were classified as big scale and small scale as per Stakeholders survery.

Table 4-26 Terminal & commodity wise projections

Name of the waterway: NW-71 (Mapusa/Moide River, 26.638 km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Original Terminal on NW**	**Final Destination**	**Destination Terminal on NW**	**Co-ordinates**	**Unit p.a**	**Fy-16**	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Existing Terminals on River (Presently Non Functional)														
1	Iron Ore	Bulk	Assnora/ Sircaim	Captive jetty/ Calim jetty	Mormugao Port		Existing terminal are capable to handle anticipated traffic so if they start handling iron ore after an upliftment of ban IWAI Terminal is not required							
Proposed Terminal Opportunity for IWAI														
1	Iron Ore	Bulk	Sircaim	Sircaim	Mormugao Port	n/a	15°36'57.02"N 73°52'51.56"E	(mn T)	0	0.1	0.5	0.5	0.6	0.9
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

Source: Consultant's Analysis

For handling tourists, there are few small jetties located at the mouth of the river near Porvorim village. To attract more tourist traffic further development or expansion of these jetties could be undertaken. However tourist traffic near mouth of the river could remain constant over the years once iron ore transportation resumes.

Existing terminals are capable to handle anticipated traffic so if they start handling iron ore after an upliftment of ban, IWAI Terminal is not required. It is a conditional requirement. If existing terminals does not handle the projected traffic only in that case IWAI terminal may require. Traffic proposed on Mapusa is purely based on site visit and interaction with stakeholders

Abbreviation	Full Form
IWAI	Inland Waterway Authority of India
IWT	Inland Water Transport
FDI	Foreign Direct Investment
CAGR	Compounded Annual Growth Rate
LED	Light Emitting Diode
Ro-Ro	Roll On- Roll Off
NH	National Highway
POL	Petroleum Oil & Lubricants
DAP	Diammonium Phosphate
NPK	Nitrogen Phosphorus Potassium
EXIM	Export Import
MOG	Ministry Of Goa
GOG	Government of Goa
STKYD	Stockyard
SEZ	Special Economic Zone
JSW	Jindal Steel Works
RCC	Reinforced Cement Concrete
MPT	Mormugao Port Trust
BAT	Batala Junction
ICPH	Inland Container Depot, Phillau
ICOD	Inland Container Depot
HACG	Hindalco Industries
HIL	Hindustan Insecticides
CONCOR	Container Corporation of India
EXIM	Export Import
GCBL	Goa Carbon Ltd.

CHAPTER 5 TERMINALS

5.1 General Review

Terminals act as a connecting center for shift of cargo and passengers from one mode to other mode. Inland Waterway Terminal (IWT) is a hub centre with a facility of connecting transport mode from / to the vessels on the water body to land provisioned with all the related infrastructure facilities like structure for berthing of vessels; facilities for loading / unloading of cargo; embarkation / disembarkation of passengers; storing / resting of cargo / passengers; connectivity to other modes of transport etc.,.

5.2 Identification and Site Location

Planning of the Inland Water Terminal location predominantly depends on the Traffic Origination and Traffic Destination criteria, which gives impetus to movement of traffic in inland waterways. Subsequent to the above, the site location in the vicinity can be considered duly taking into consideration of various influencing parameters, as below. In most of the cases the site location may not fulfil the idealistic scenario. However, the possibility of zeroing to a most suitable site may be possible based on certain basic parameters, as detailed.

Backup Land availability / Stability of Bank / Water Depth availability in Lean season / Velocity & Discharge both in Lean season and Flood season / Approach Road / Possibility of Rail connectivity / Nearness to City or Town / Availability of essential services / Impact of Social, Ecological & Environmental aspects etc.,.

In the morphological rivers, due to seasonal precipitation there are fluctuations in river flow and the rapid changes in water flow causes shift in the location of the deep channel and also results in erosion of banks and siltation. Accordingly, the basic requirement of an inland terminal is to ensure a permanent access to the navigational channel throughout the year. Keeping in view the above all, the terminal site location has been considered on Mapusa River.

Mapusa River is a right bank (North bank) tributary of River Mandovi. Nearest railway station is 4.5 km from Mapusa i.e. at Tivim. Tivim railway station is at a distance of 1.3 km on right bank from water way.

The river stretch (within a distance of 5 kms in the catchment of Mapusa / Moide River) is being utilised by two industrial estates viz., Mapusa and Tivim. Also, Sirigao Mining area is within 3kms to 5kms in reach of Mapusa / Moide River. The proposed terminal location on Mapusa River is very near to captive jetty of Vedanta.

Present IWT operations and ferry services along survey stretch of Mapusa River include navigational traffic as well as local boats for fishing and ferries.

The traffic, other than the captive terminal requirements, as identified, is of Bulk cargo of Iron Ore. The Iron Ore Bulk cargo is estimated to the extent of 0.1 MMTPA by the year 2020 and may increase to an extent of 0.9 MMTPA by the year 2040. These volumes are to be taken into consideration for IWAI Terminal development on Mapusa River.

Keeping in view the type of cargo, it has been identified that 1 Lift-on Lift-off (Lo-Lo) IWT Terminal with handling facilities are necessary for transhipment. Taking into the consideration of the origin and destination and fairway, the most probable location is near the Ch. 17 Km wherein the fairway development is under consideration for Class IV with approx. Lat 15°36'57.02"N and Long 73°52'51.56"E. This location is comparatively having lesser mangroves concentration.

A tentative Land requirement has been worked out before undertaking the Land Survey etc., duly considering the following requirements for the proposed Lo-Lo operation.

Sl. No.	Facility	Nos.	Size	Area (m2)
1	Open Storage Area	1	200 m x 100 m	20000
2	Covered Storage Godown	1	50m x 30m	1500
3	40' Container Stack Yard	1	20m x40 m	800
4	Parking for Handling equipments	1	30m x 15m	450
5	Main Parking Area	1	30m x 30m	900
6	Public Utility	1	6m x 4m	24
7	Weigh bridge	1	8m x 3m	24
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9
9	Area under internal Roads	1	7.5m x 351m	2632.5
10	Bank protection			
11	Administration building	1	12 m x 15 m	180
12	Business Area	1	10m x 3m	30
13	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
14	Staff Parking Area-2 wheelers	1	8m x 2m	16
15	Security shed for watch and ward	2	4m x 4m	32
16	Electrical facility	1	5m x 5m	25
17	Fuel Bunkers	1	10m x 5m	50
18	Water Supply Room	1	3m x 4m	12
19	Fire and Safety Room	1	3m x 4m	12
20	DGPS receiver & transmitter shed	1	8m x 4m	32
21	DG shed	1	5m x 5m	25
22	Canteen with Store	1	12m x 8m	96
23	Sewerage Treatment Plant (STP)	1	15m x 15m	225
24	Overhead Tank	1	10m dia	100
25	Green Area	1		1000
26	Future Requirement	1		2000
				30256

5.3 Terminal Layout / Master Planning including phases of development

The Terminal layout of the identified site based on the site land survey has been prepared and placed including the contours drawn at (Refer Volume-II **Drawing No.P.010257-W-20351-X02** for details). With regard to the Terminal Development, there is no need of consideration of any phased development, since the infrastructure is already available in the vicinity. Accordingly, IWT Terminal on Mapusa River is required only after the saturation of cargo handling in the present captive Terminal and the same is to be carefully watched before taking any activity. With regard to the Land, it is suggested to start the Acquisition in the proposed location at appropriate time after having the confirmations about development. The identified Terminal location is connected to the SH 01 near “Sircaim” village and the distance is about 1300 m, which may have to be taken up by the concerned agency.

Accordingly, a plan demarcating the infrastructure requirement is placed as Terminal Layout plan at (Refer Volume-II **Drawing No.P.010257-W-20311-A02** for details).

5.4 Land Details

TABLE 5-1: Terminal Land Details

Coordinates (UTM) N/E	**1726757.72**	**380042.60**
Coordinates (DMS) N/E	**15°36'57.02" N**	**73°52'51.56"E**
Village	Sircaim	
Taluka	Bardez	
District	North Goa	
State	Goa	
Nearest Town	Tivim	
Distance of town (km)	6	
Land use / Terrain	Mostly barren land with coconut trees	
Ownership	Private	
Water Distance	on edge of land	
Nearest Road	SH-1	
Road Distance (m)	1300 m	
Nearest Railhead	Tivim Rly stn	
Railhead Distance	3 km	
Nearby major Structure	unloading Jetties/staion of fleets for iron ore	
Soil/Subsurface strata	Mixed strata with variable colours	
Surveyed Area (Approx.)	7902 (m2) + 33375 (m2) = 41277 (m2)	

5.5 Geotechnical Investigations

Geotechnical investigation has been carried out at the proposed terminal location to find out the subsoil stratification in the project area and to collect data for deciding type of foundation and the design foundation. The scope of geotechnical investigation work consists of one bore hole at terminal of 20.5 m depth.

5.5.1 Regional Geology

The selected area/site is located on river Mandavi and is at a distance of 8Km from Mapusa (headquarters of Bardez Taluka) a town in North Goa. It is located near State Highway SH-1, near to village Sirsai in the town of Tivim. Geologically, Goa is dominantly covered by the rocks of Goa Group belonging to the Dharwar Supergroup of Archaean to lower Proterozoic age. A narrow strip of the area along the northeastern corner is occupied by Deccan Traps of Upper Cretaceous to Lower Eocene age. The Goa Group consisting of green schist facies of metamorphic rocks is divided into Barcem Formation, Sanvordem Formation, Bicholim- Rivona Formation and Vageri Formation and the part of Dharwar Supergroup.

The Barcem Formation comprises basic and acid volcanics with associated meta volcanics and metasediments. The Sanvordem Formation is made up of meta greywacke-argillite and conglomerate. The Bicholim-Rivomi Formation is represented by meta pyroclast and tuff with calcareous manganiferous and ferruginous chemical precipitates. The Vageri Formation consists of meta greywacke and metabasalt. Goa Group of rocks are intruded by layered mafic-ultramafic rocks, Chandranath, Dudhsagar and Canacona granite porphyry and later by gabbros/dolerites. Most of the rocks are draped with development of post-Paleocene laterites along with beach sands and alluvium. The rocks of the Goa Group record three phases of folding deformation. The project area is covered under Sanvordem formation which consists of Greywacke/Argellites of Archean age.

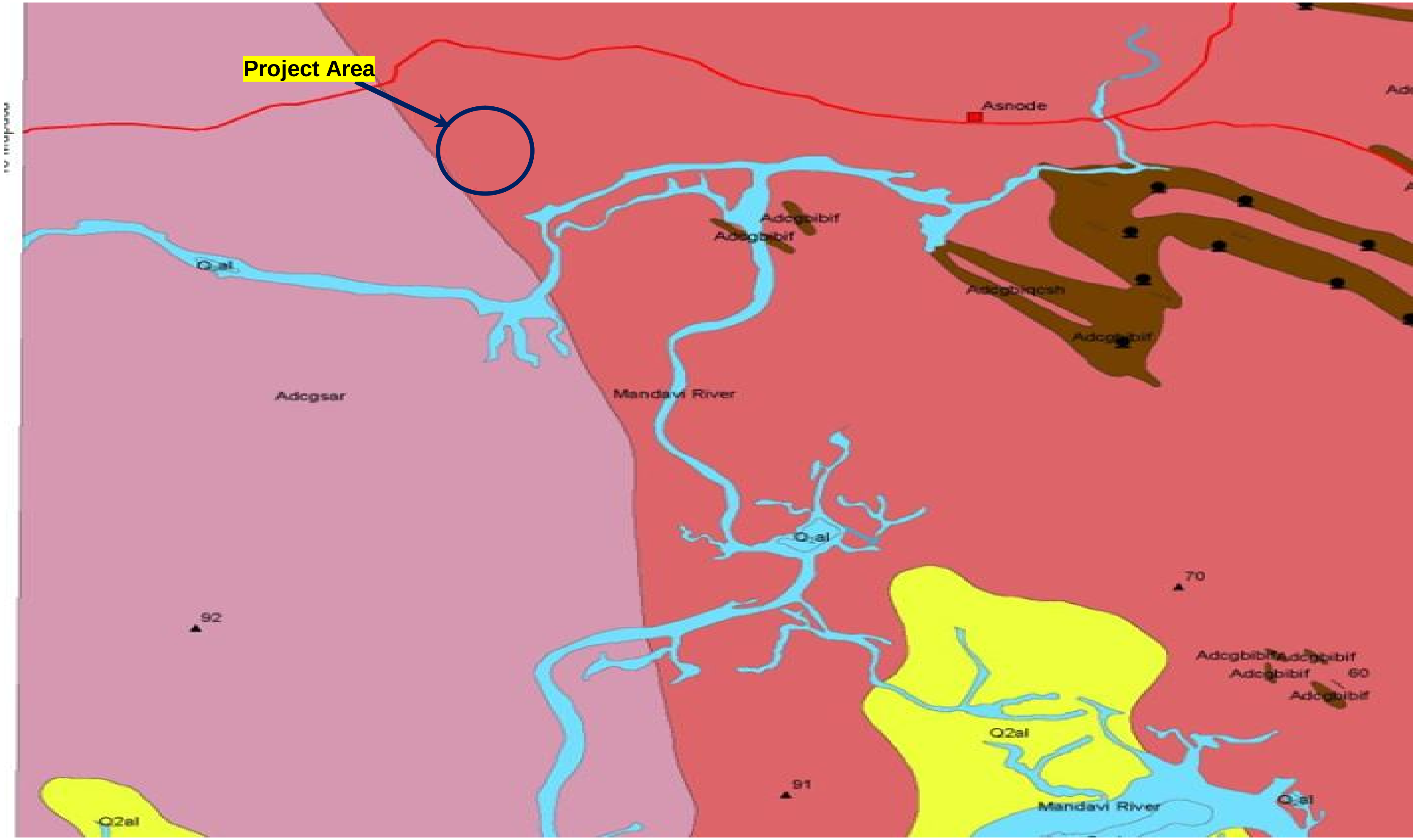


FIGURE 5-1: BLOWUP OF THE PROJECT AREA FROM GSI MAP

	LITHOLOGY	FORMATION	GROUP	SUPERGROUP	AGE
$\mathrm{Q_2al}$	Sand				Holocene
Czlal	Laterite- (aluminous)				Cainozoic
$\mathrm{\beta K_2Pg_1dsu}$	Basalt (undifferentiated flow)		Sahyadri		Palaeocene to Upper cretaceous
$\mathrm{\beta Pt_1d}$	Dolerite				Palaeoproterozoic
$\mathrm{\gamma Ap_1g}$	Granite (Chandranath)				
υAugb	Gabbro (Massive/ leuco)				
δAupy	Pyroxenite				
δAutcsh	Talc- chlorite- schist				
δAupu	Peridotite				
δAudu	Dunite with chromite				
Adcgvar	Greywacke / argillite	Vageri			
Adcgbimmph	Manganiferous phyllite				
Adcgbibif	Banded Iron Formation				Archaean
Adcgbils	Limestone	Bicholim			
Adcgbiar	Greywacke / argillite		Goa ≅ Chitradurga	Dharwar	
Adcgbiqcsh	Quartz chlorite schist				
Adcgsar	Greywacke / argillite	Sanvordem			
Adcgbmb	Metabasalt	Barcem			
Adcgbq	Quartzite				
$\mathrm{Ap_1ggn}$	Granite gneiss		PGC -I	Peninsular Gneissic Complex	

FIGURE 5-2: INDEX OF THE GSI MAP

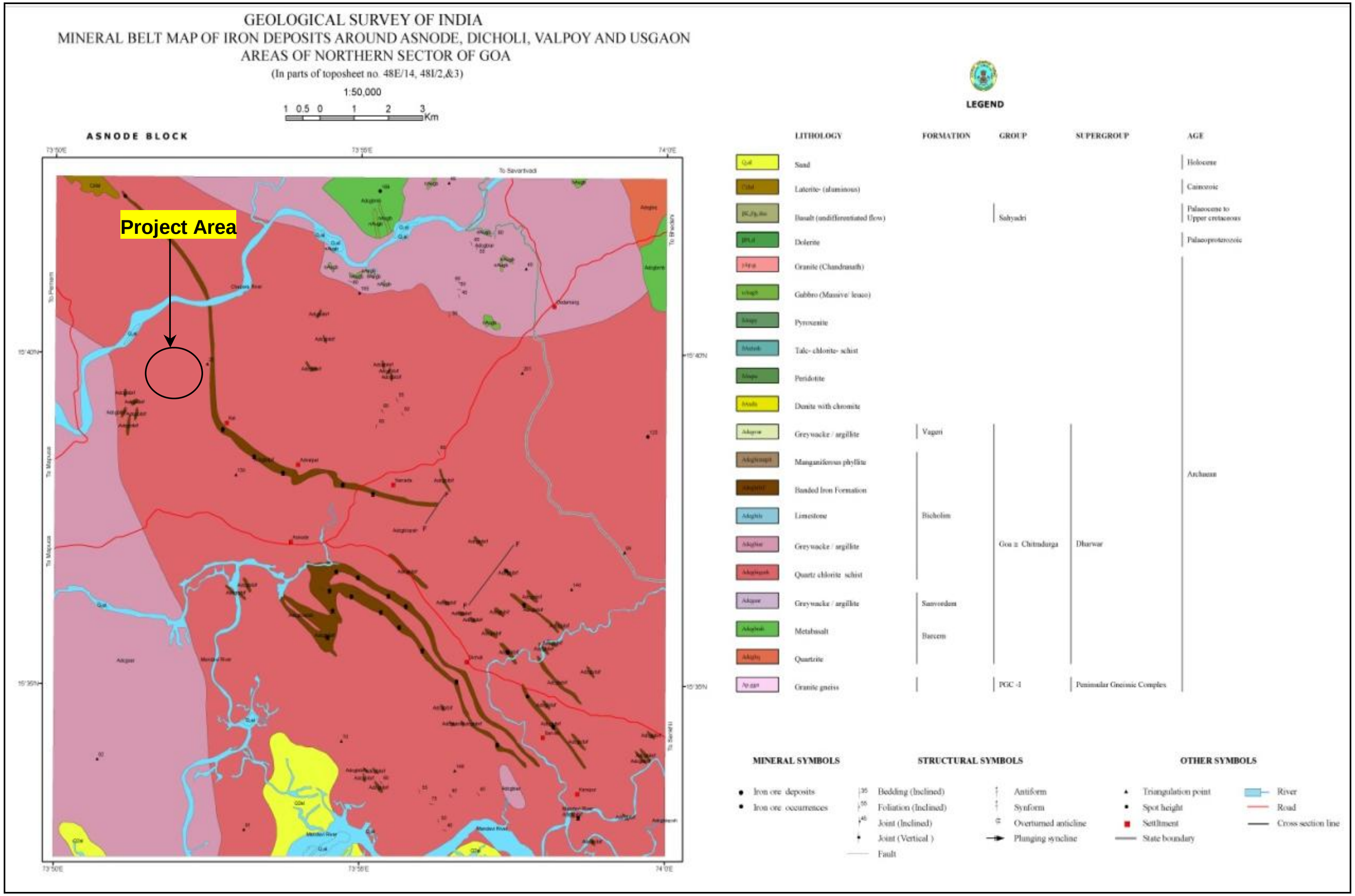


FIGURE 5-3: MINERAL BELT MAP OF IRON DEPOSITS AROUND ASNODE, DICHOLI, VALPOY AND USGAON AREAS OF NORTHERN SECTOR OF GOA SHOWING PROJECT AREA (SOURCE: GEOLOGICAL SURVEY OF INDIA)

5.5.2 Physical Condition and Drainage

The selected site/area majorly represents Coastal Geomorphologic features with Mandavi River as the main drainage in the area which flows in North-South direction. Presently the area near the river is occupied by agricultural fields/coconut farms/scrap and barren lands having yellowish silty sand as the top layer. The area represents a flat topography. However the area adjacent to the river represents mangrove swampy area with mud. The location of the selected site on Google earth is shown as Figure 4 while the enlarged view of the same is shown as Figure 5 while the figures showing the actual condition of the site is shown as Figure 6 & 7 respectively.

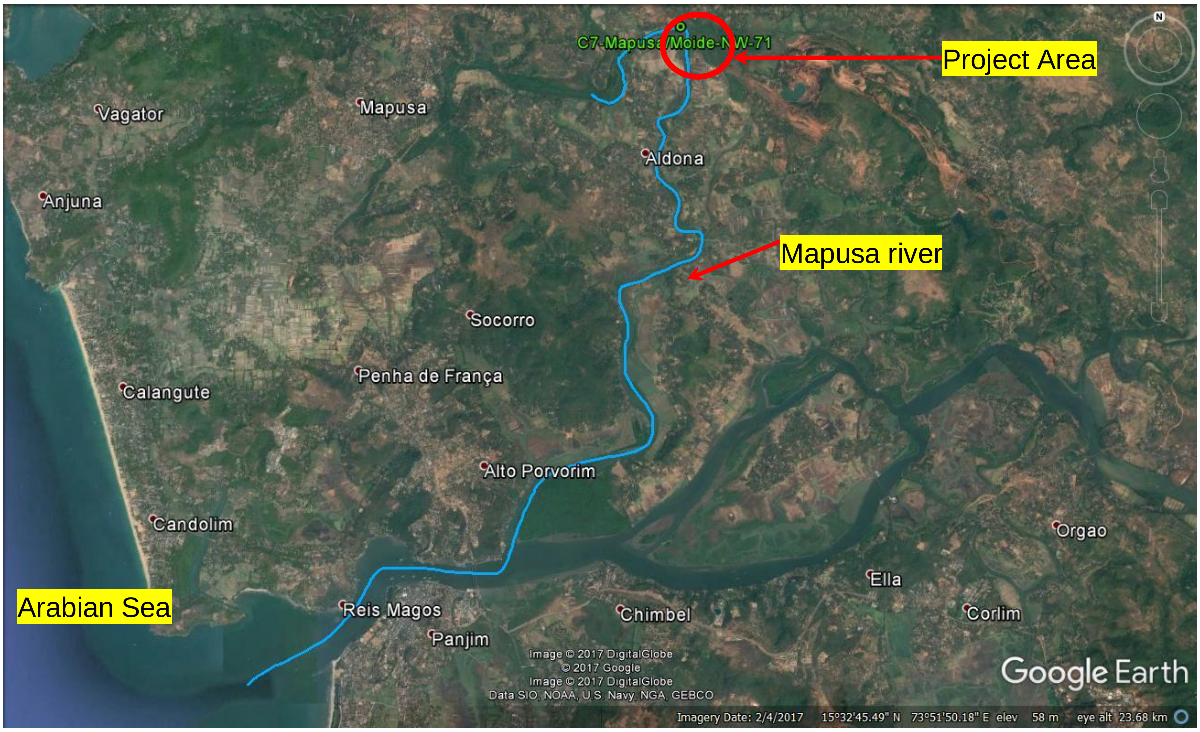


FIGURE 5-4: GOOGLE EARTH IMAGE SHOWING PROJECT AREA (IN CIRCLE)

FIGURE 5-5: ENLARGED VIEW OF GOOGLE EARTH IMAGE SHOWING PROJECT AREA (IN CIRCLE)

FIGURE 5-6: IMAGE SHOWING RIVER MAPUSA AND PART OF SELECT SITE

FIGURE 5-7: IMAGE SHOWING PART OF SELECTED SITE (WHILE SURVEYING)

5.5.3 General Geology and Stratigraphy

The selected site/area majorly represents Coastal Geomorphologic features with Mandavi River as the main drainage in the area. The coastal geo-environmental studies conducted have revealed the presence of both Quaternary and pre-Quaternary formations. The pre-Quaternary units represented in the form of structural, denudational and lateritic hills which are derived from the metavolcano sedimentary pile of Goa Group of rocks. Laterites at various levels viz., 8, 10, 20, 30, 40, 50, 60, 70, 80, 90, >100 m levels have been noticed. The vertical section of typical laterite in quality reveals from top to bottom, feriecrete, followed by lithomorgic clay and followed by parent rock. Stratigraphically and generally the area under consideration consists of the following units.

- **Quaternary units**: The Quaternary units are represented by (a) fluvial and (b) marine landforms.
- **Fluvial units**: The fluvial landform includes Zuari, Mandovi, Chapora/Mapusa and Terekhol estuaries. These estuaries are supported by tributary estuaries like Moide, Mapusa, Dicholi, Valas and Kalnas sub-estuaries, etc.

- **Lateral-channel bars, mud flats, mangroove swamps, complex channel bars**: The estuaries like Mandovi, Zuari, Terekhol and Chapora/ Mapusa are lined with mud flats with luxuriant growth of mangroove swamps on the mud flats. These estuaries are lined with lateral bars and sand bars. Along the estuaries at the centre there are channel bars which are essentially composed of sand and at some places chal111el bars are composed of both sand and mud.
- **River mouth bars**: These are formed by the deposition of sand at the mouth of Terekhol and Chapora estuaries joins the sea. They are composed of sand with heavy minerals.
- **Mangroove swamps**: It grows in sea water wherever there is mud. Their prop roots contain pores or lenticles called pneumatophores which help in respiration. Chapora/ Mapusa has 100 hectares of mangroves.

5.5.4 Sub-surface Investigations

The selected site has been investigated by one drill hole (BM-1) which has been drilled for depth of 20.50m. The detail of the drill hole is tabulated below.

TABLE 5-2: SUMMARY OF DRILL HOLE

S. No	Hole No.	Location	Drilled Depth (m)	Depth From (m)	Depth To (m)	Thickness (m)	Description of Strata	N-Value	Core Recovery (%)	RQD (%)
1.	BM-1	Centre of Terminal Area, RIGHT bank of Mandavi river	20.50	0	1.50	1.50	Back Filled			
				1.5	5.50	4.00	Reddish Medium Stiff to Stiff Sandy Clay	6, 13		
				5.50	9.00	4.50	Reddish Very Soft to Medium Stiff Silty Clay	2, 8		
				9.00	12.00	3.00	Reddish Very Stiff Silty Clay	28, 30		
				12.00	20.50	8.50	Completely Decomposed Rock to Highly Weather Laterite	Refusal	24 - 30	Nil

The description of the drill hole is as given below.

BM-1: Drill hole BM-1 has been drilled over the terminal location area on the left bank of Mandavi/Mapusa River. The drill hole has been drilled vertically down to the depth of 20.50m from EL.1.50m to EL. -19.00m. The drill hole has encountered filled up soil up to 1.5m depth followed by sandy clay till 5.50m depth thereafter, silty clay up to 9.00m depth after which completely decomposed rock occur till15.50m depth followed by Highly weathered Laterite up to the termination of drill hole.

The drill hole log and photographs of execution of drill hole and core box are appended in Volume IV-Geotechnical Investigation Report.

5.5.5 Geotechnical Results and Analysis

In-situ Test Results

Six Standard penetration test (SPT) has been carried out in accordance of IS 2131 in the drill hole to ascertain the consistency of the different soil strata. The depth wise N-values from the SPT are as tabulated.

TABLE 5-3: SUMMARY OF IN-SITU TEST RESULTS

Depth		Thickness (m)	Description of Strata	N-Value
From (m)	To (m)			
0	1.50	1.50	Back Filled	-
1.5	5.50	4.00	Reddish Medium Stiff to Stiff Sandy Clay	6,13
5.50	9.00	4.50	Reddish Very Soft to Medium Stiff Silty Clay	2,8
9.00	12.00	3.00	Reddish Very Stiff Silty Clay	28, 30
12.00	20.50	8.50	Completely Decomposed Rock to Highly Weather Laterite	Refusal

Laboratory Test Results

Testing on soil samples from SPT & Undisturbed Samples (UDS)

5 SPT & 2 UDS soil samples has been collected from the drill hole from different depths and has been tested in laboratory to know the engineering properties of sub-surface strata like Mechanical analysis, Consistency Limits (atterberg limits), Shear strength parameters, consolidation test, Natural Moisture content, Density, soil classification, specific gravity etc. The details of the soil sample collected and summary of results of the various tests are tabulated.

TABLE 5-4: SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Bore Hole	Depth in mtrs.		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistancy Limits				Soil Classification	Shear Strength Test			Consolid-ation		Specific Gravity	Remarks
				Wet	Dry		Gravel	Sand	Silt	Clay	Liquid	Plastic	Plasticity Index, Ip	Shrinkage SL		Type	Cohesion Cu	Degree	Comp. Index CcV (Lab)	Initial Void Ratio		
No.	From	To	UD/ SPT	gm/cm3		%	%	%	%	%	%	%	%	%	IS		kg/cm2	f	C c	e o	G	
BM-1	1.50	2.10	SPT	1.804	1.548	16.54	0	41	21	38	35	17	18	----	CI	----	----	----	----	----	2.63	
BM-1	3.00	3.60	SPT	1.815	1.540	17.82	0	34	36	30	39	23	16	----	CI	DS	----	----	----	----	2.61	
BM-1	4.00	4.50	UDS	1.637	1.222	34.00	0	37	33	30	31	19	21	----	CL	UU	0.182	17	0.427	1.338	2.64	
BM-1	6.00	6.60	SPT	1.839	1.596	15.21	3	15	35	47	41	19	21	----	CI	----	----	----	----	----	2.65	
BM-1	7.00	7.50	UDS	1.882	1.575	19.52	0	7	29	64	51	23	28	----	CH	UU	0.366	12	0.552	1.452	2.64	
BM-1	9.00	9.60	SPT	1.852	1.524	21.50	0	29	56	15	45	21	24	----	CI	DS	----	----	----	----	2.65	
BM-1	10.50	11.10	SPT	1.902	1.546	23.0	0	17	33	50	48	19	29	----	CI	DS	----	----	----	----	2.63	Clay Lumps
BM-1	15.00	15.05	SPT	2.102	1.866	12.7	55	33	12	--->	Non Plastic			----	GP	----	----	----	----	----	2.64	

Bearing Capacity Calculations

The bearing capacity and pile load capacity is worked out based on following soil parameters adopted for the analysis.

TABLE 5-5: SOIL PARAMETERS ADOPTED FOR THE ANALYSIS

Depth		Strata Type	Average N Value	Thickness (m)	Unit Weight (kN/m^3)	Cohesion (kN/m^2)	Angle of Internal Friction (Degrees)	Compression Index (Cc)	Initial void Ratio (e_0)
From (m)	To (m)								
0	1.5	Filled up Soil	-	1.5	16.0	-	-	-	-
1.5	5.5	Clay	10	4.0	17.52	18.2	17	0.427	1.338
5.5	9.0	Clay	5	3.5	18.60	36.6	12	0.552	1.452
9.0	10.5	Clay	30	1.5	18.77	95	0	-	-
10.5	12.0	Clay	28	1.5	18.77	90	0		
12.0	20.5	Rock	R	8.5	21.02	-	-	-	-

The bearing capacity is calculated for different size of isolated footing at different proposed depth. The details are given below. The sample calculations are given in **Annexure-1**.

TABLE 5-6: SUMMARY OF BEARING CAPACITY CALCULATIONS (KN/M2)

S. No	Size of Isolated Footing	Depth of Footing (m)			
		1.5	2.0	2.5	3.0
1.	1.5 m x 1.5 m	73	88	102	115
2.	2.0 m x 2.0 m	55	66	77	85
3.	2.5 m x 2.5 m	46	53	60	67
4.	3.0 m x 3.0 m	39	44	49	55

Pile Capacity Calculations

The pile capacity is calculated for different diameters of piles up to rock. The details are given below. The sample calculations are given in **Annexure-2**.

TABLE 5-7: SUMMARY OF PILE CAPACITY CALCULATIONS

S. No	Diameter of Pile (m)	Penetration Depth below NSL (m)	Capacity of Pile in compression (kN)	Uplift Capacity of Pile (kN)
1.	1.0	12	656	660
2.	1.3	12	860	950
3.	1.4	12	928	1056

5.6 Terminal Infrastructure including equipment

The land area identified is measuring to about 32000 Sq. m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities has been worked out to 30256 Sq. m, which can be accommodated within the Land proposed to be taken on Acquisition.

As mentioned earlier, there exist captive jetty and calvim jetty used by other mines on the river which was previously used for transporting iron ore to Mormugao Port for export purpose. Proposed terminal location on Mapusa River is very near to captive jetty. The other cargo comprising of Bulk / Break-Bulk cargo consisting of Iron, Steel and Coal shall be expected to be handled in a Terminal structure, preferably by a Lift-On and Lift-Off (LO LO) type of Inland Water Transport (IWT) Terminal along with crane facility.

As per the Class IV waterway classification, the maximum of 2000 T is to be mobilized in 2 x 1000 T barges with 12 m width and 1.8 m Loaded Draft / 2.0 m Depth in front of the Berthing Structure. Considering the vessel size of berthing of DB of 1000 T, the optimum length of Berth requirement shall be taken as 75 m. In this length of 75 m, 2 cranes shall be made operational at any point of time. Keeping in view the slow pace of cargo increase, it is proposed to initially deploy 2 Rubber mounted cranes capable of handling 125 TPH.

In order to evacuate the 3000 T per day i.e., 900,000 T with a working of 300 days, it is proposed to consider the deployment of 2 cranes with a capacity of 125 T per hour. One crane can handle 800 T in a day (1 shift operation of 8 Hrs.) with 80 % efficiency. The same will be 1600 T by Two Cranes. By increasing the working hours to 16 Hrs a day (2 shifts), it can evacuate the required level of cargo.

1 Berth x 2 Cranes x 300 Days in an year x 16 Hrs. a day x 125 TPH x 80 % efficiency = 0.96 MTPA.

Though the estimated requirement is of about 0.9 MTPA with an increase from 0.1 MTPA, this is to be observed carefully for optimum utilization of Terminal Structure and also for optimum utilization of the handling equipments. However, to attract the IWT cargo, the initial set up is most essential and the above LO-LO IWT Terminal with 2 Cranes are suggested / recommended.

Keeping this in view, the Lo-Lo berthing structure is being planned with 75 m Length.

There are many vendors available in the market for supply of the above specified cranes viz., TATA-HITACHI; Caterpillar; Kobelco etc. As enquired in the market, the crane is available at a cost INR 200 Lakhs each.

Note: The suggested Terminal details are only to the extent of Preliminary Engineering / Design. At this juncture, it is pertinent to mention that the Appropriate provisions and infrastructure are to be catered for “Disposal of Operational waste including the waste oil from vessels berthing at the terminal locations” and the related aspects are to be addressed to / attended to in accordance with the Gazette Notification vide No. 480 dt. 13/07/2016 of Ministry of Shipping {GSR No. 687 (E)} at the stage of Detailed Engineering / Design. In the similar way, the collection and disposal of Pollutants generated, on board vessel, also to be addressed during the Detailed Engineering / Design.

5.7 Berthing Structure

The berthing structures shall be designed such that they provide safe berthing of barges/vessels without damaging the barges/vessels as well as the structure. These structures shall also cater to the requirements of the various equipments to be used for loading /unloading of the vessels. The requirements of the berth differ depending on the nature of cargo being handled at the berth. The size of the structure shall depend on the largest vessel likely to use the berth and the type of the handling equipment to be used on the deck. The berth shall be designed for all possible loads that are likely to act on the structure as per BS 6349 & IS 4651. The total number of berths required for the proposed terminal shall be fixed based on the nature of cargo, traffic, and water level variation. The proposed berth under study is planned for handling 1 nos of barges/vessels of 1000 DWT at a time. The LOLO berth is designed taking into account crawler crane loading.

Deck Level

As per IS 4651 _IV, the deck level of the berthing structure shall be fixed considering the optimum position of the cargo transfer to cater for two extreme conditions viz the largest vessel in light displacement condition at highest water level and the smallest vessel fully laden at lowest water.

The deck level of LOLO is calculated taking a freeboard of 1 m above the highest water level.

Deck Dimensions

The dimensions of the berthing structure are decided on the basis of the dimensions of the largest vessel that are likely to use the terminal facilities as well as the function of the terminal.

TABLE 5-8: Salient Features of berth structure

Description	Length(m)	Width (m)
LO LO	75	32

The structural arrangement of the berth including the preliminary design has been explained in the chapter 6 (Refer Volume-II **Drawing No.P.010257-W-20341-E02** for details).

Note: The above Berthing structure has been considered based on the Preliminary Designs, as advised. Before taking up the work in the site, Detailed Engineering / Design are to be considered.

5.8 Terminal Costing

5.8.1 Capital Cost

The Capital Cost for the fairway has been considered in Chapter 11 along with the proposed development for LO-LO Terminal facilities at the defined location. The Capital Cost of terminal works out to INR 55.07 Crores.

5.8.2 O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined by IWAI, which have been analyzed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 6 PRELIMINARY ENGINEERING DESIGNS

6.1 River Training (including Barrages and Locks, if proposed)

River training covers those engineering works which are constructed on a river, so as to guide and confine the flow to the river channel. The river training works may serve the objectives as below:

To prevent the river from changing its course and to avoid outflanking of structures like, weirs, aqueducts, etc.

To protect the river banks by diverting the river away from the attacked banks.

To ensure effective disposal of sediment load.

To provide minimum water depth required for navigation.

Barrages are the structures to be constructed to channelize the flow condition duly building up the water depths and controlling the flow according to the requirements in the downstream. For safe navigation with controlled discharges in the waterways, this ideology is applicable. However, the problem of difference in the depth due to the pondage etc. shall be considered by constructing a lock structure for safe passage of the vessels in this zone. This type of “Barrages & Locks” combination is a comparatively costly proposal and such proposals may not be found viable in normal conditions. If such construction has other concurrent advantages, may be economical. Further in the inevitable situation of crossing the deep depth variation, such crossings may be recommended.

6.1.1 River Training through Spurs

Spurs or Groynes are constructed transverse to the river flow extending from the bank into the river. This form of river training works perform one or more functions which includes training the river along the desired course to reduce the concentration of flow at the point of attack by deflecting high velocity flow away from the vulnerable bank. Effectively designed spur-dikes encourage sediment deposition between the spurs and consequently the re-establishment of an eroded bank line. Spurs structures restrict the width of a river channel in low flows, thereby improving its navigability. Different types of spurs are shown in the below Figure.

Impermeable spurs do not permit appreciable flow through them whereas permeable ones permit restricted flow through them. Impermeable spurs are constructed of a core of sand or sand and gravel or soil as available in the river bed and protected on the sides and top by a strong armor of stone pitching or concrete blocks. Spur-dikes can be constructed from gabions mattresses which may be economical form of construction when the required stone sizes are available from the river bed.

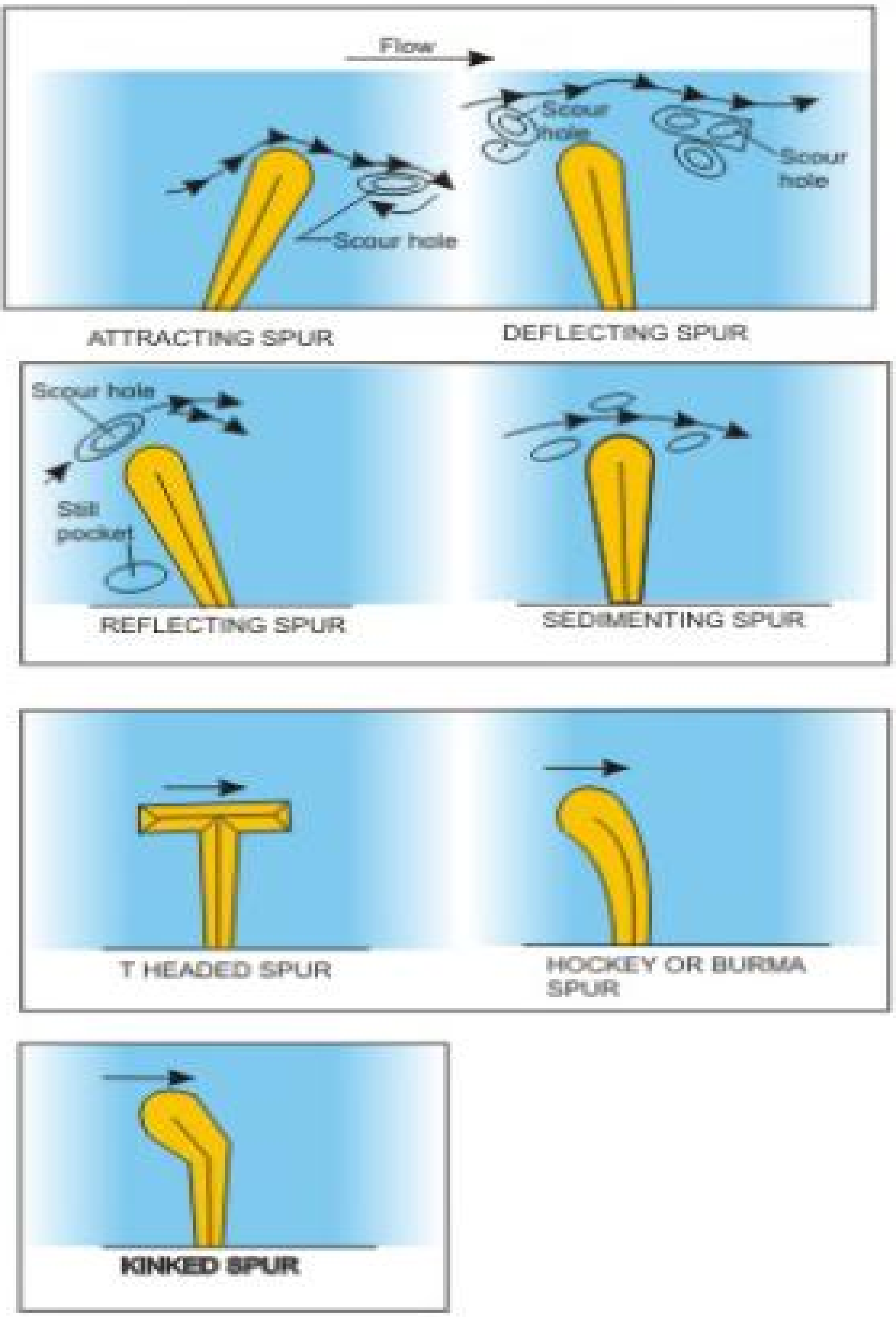


FIGURE 6.1: Different types of Spur

General Design Considerations

Layout of Spurs

Spurs are much more effective when constructed in series as they create a pool of nearly still water between them which resists the current and gradually accumulates silt forming a permanent bank line in course of time. In general, in the T-shaped spurs, greater length of the cross spurs projects upstream and a smaller portion downstream of the main spurs. Typical plan view of system of spur-dikes is shown in below Figure.

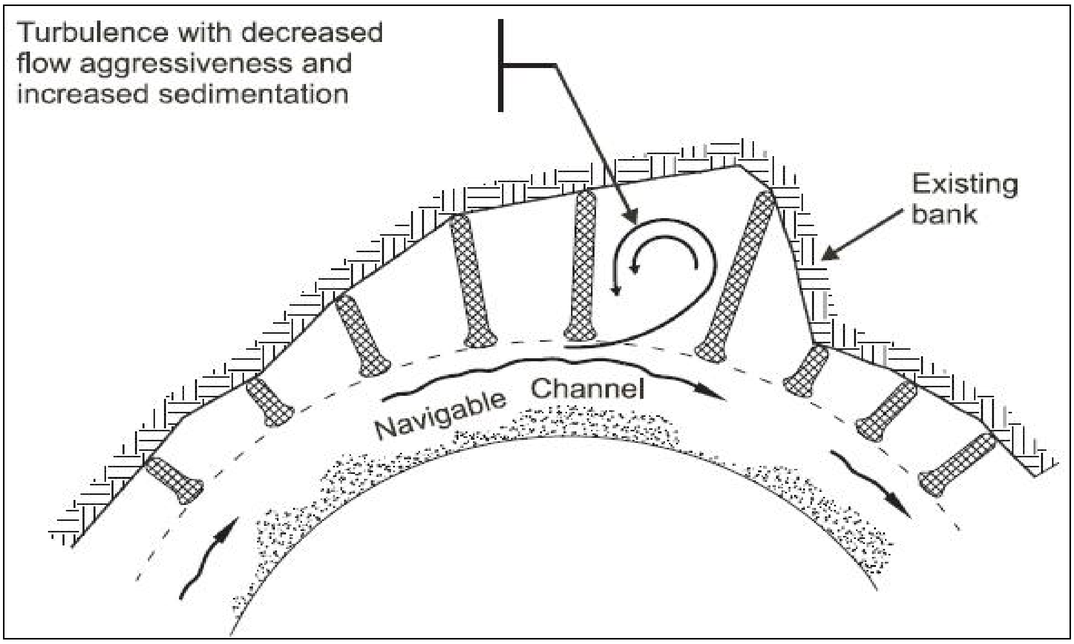


FIGURE 6.2: Plan view of system of spur-dikes constructed to control and stabilize the erosion of the outer band

Spacing

Each spurs protects only a certain length. The stability of eddies is govern by the non-dimensional spur ratio, $e_{sp.}$, which is ratio of the head loss in the river between two spurs, $U^2 S_{SP} / (C^2 h)$ (m), to the velocity head $U^2 / (2g)$ (m) of the river.

Where,

U = depth-averaged velocity (m/s)

S_{SP} = spacing between spur-dikes (m)

C = Chezy coefficient of the river ($m^{0.5}/s$)

h = cross-sectional average water depth of the river (m)

$e_{SP} = (2g S_{SP}) / (C^2 h)$,

e_{SP} should never exceed 1.

For the navigational requirement

$S_{SP} / B = 0.5$ to 2

Where B= width of the constricted river (m) as shown in Figure below.

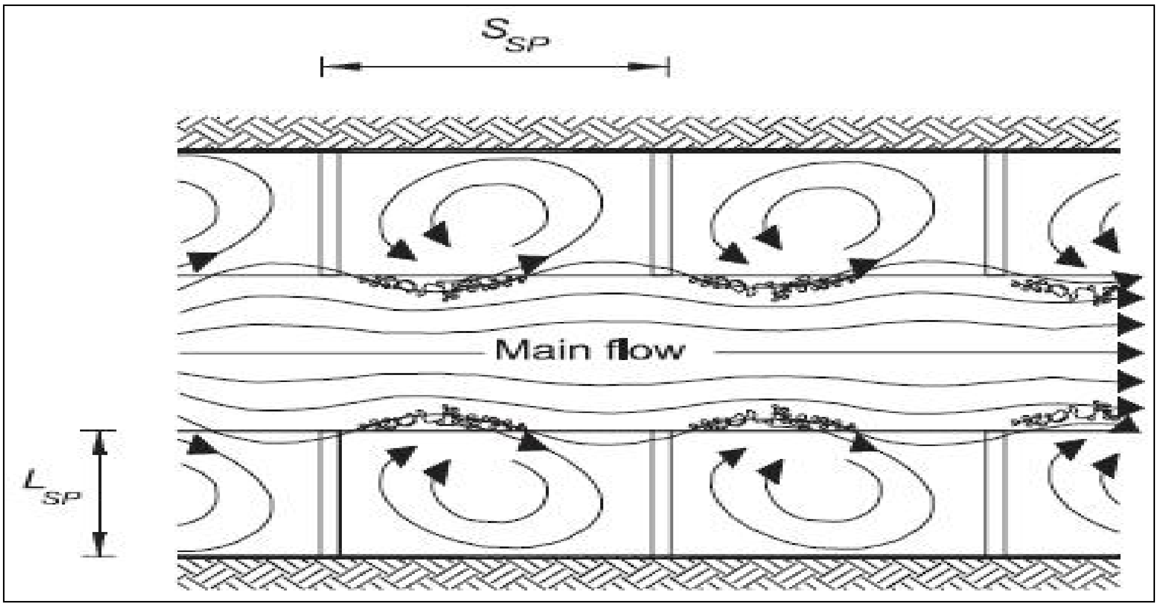


FIGURE 6.3: Diagram showing the length and spacing of the individual dikes with respect to the river width

In general, the prime factor for spur spacing between adjacent spurs is their lengths. Generally, spur spacing adopted = 2 to 2.5 time the length of spur at convex banks and Spur spacing = Length of spur at concave banks.

Length

The ratio of spacing of spur to its length (SSP / LSP) varies from 1 to 6.

Length of spurs depends upon the position of the original bank line and the designed normal line of the trained river channel. In erodible rivers, too long spurs may get damaged and cause failure. Hence, it is suggested / recommended to construct shorter ones in the beginning and extend them gradually, after due site observations.

Top width of spur

The top width of spur is kept as 3 to 6 m at formation level.

Free board

The top level of spur is kept with a free board of 1 to 1.5 m above the highest flood level for 1 in 500 years flood or anticipated highest flood level, whichever is more.

Side slope

Slope of upstream shank and nose is generally kept not steeper than 2:1. Downstream slope is kept which varies from 1.5:1 to 2:1.

Size of stone of pitching

Stones are placed over filters so that fines do not escape through the interstices of the pitching. For average velocity up to 2 m/s, burnt clay brick on edge are used as pitching material. For average velocity of 3.5m/s, pitching of stone weighing from 40 to 70 km (0.3 to 0.4 m in diameter) and for higher velocities, cement concrete blocks of depth equal to the thickness of pitching can be used.

Thickness of pitching

Thickness of pitching is determined from the formula,

T = 0.06 Q 1/3,

Where, Q = design discharge in Cumecs.

Thickness of stone need not be provided the same through-out the entire length of spur. It can be progressively reduced from the nose.

Provision of filters

In general, Filters are provided below the pitching at nose and on the upstream face for a length of 30m to 45m from the nose. The thickness of the same may be 20 cm to 30cm. The thickness for the next 30m to 45 m on the upstream face may be reduced to about 15cm and beyond that, it can be omitted. However, may also refer the codal provisions, if available.

A typical layout of a spur is shown in Figure.

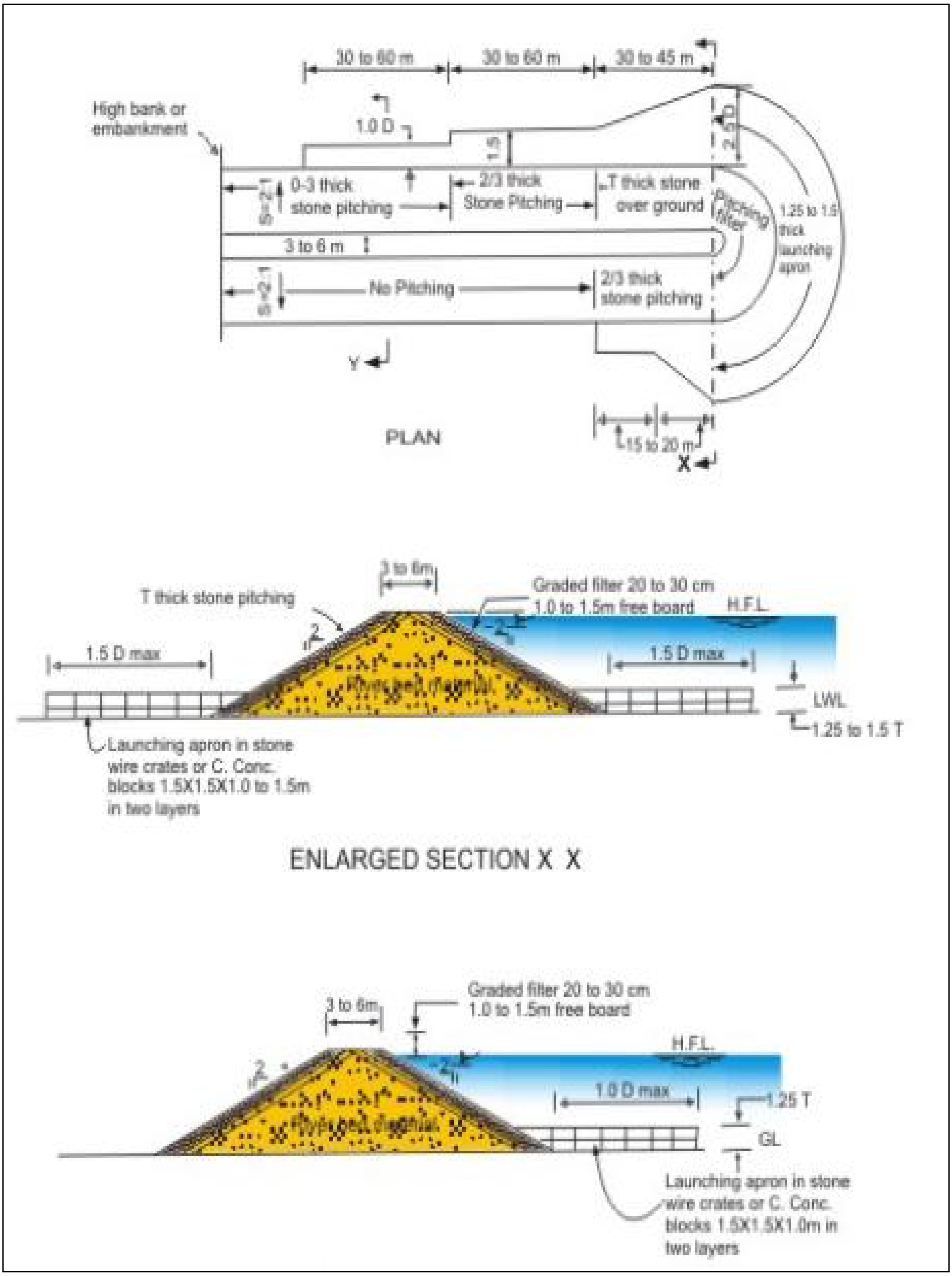
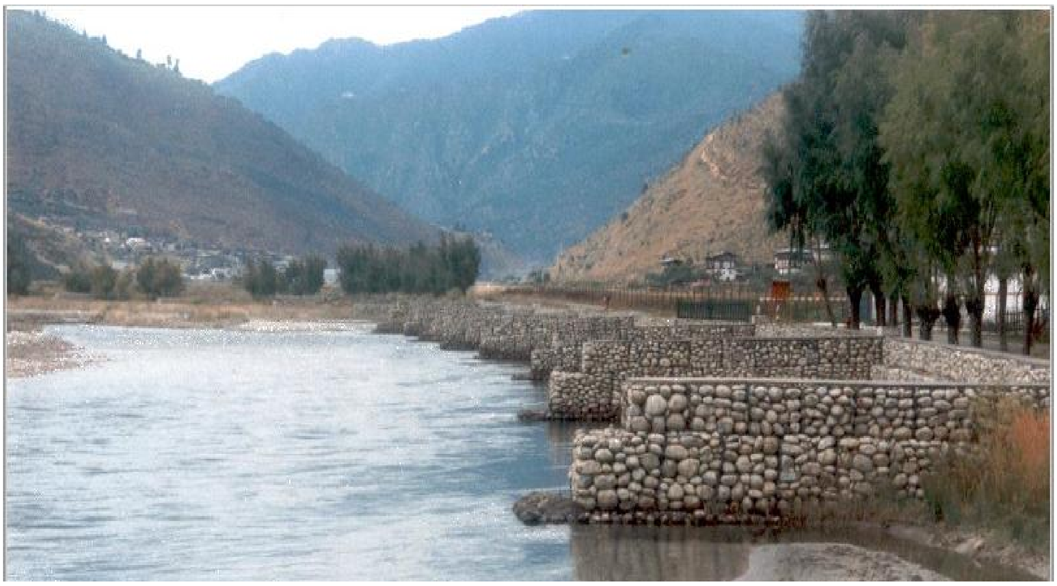


FIGURE 6.4: Typical layout and section of spur

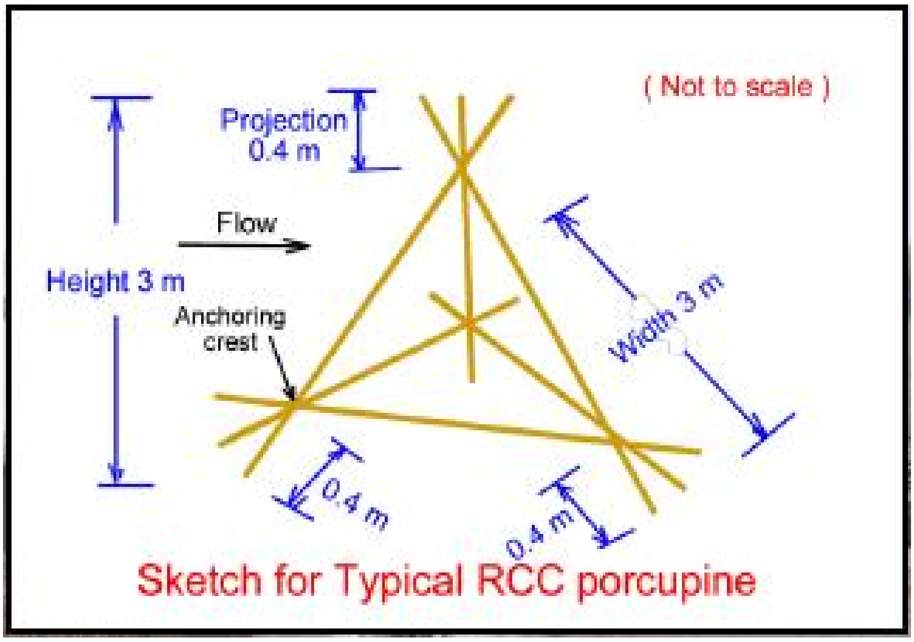
Impermeable spurs



Series of spurs

6.1.2 River Training through Porcupines

River Training through RCC Percupines are coming up nowadays and the same is under consideration on NW 1 for various activities including the Flood mitigation and taming of the river. Accordingly, the same also is under consideration for the study stretch, wherein the Design and Photos are placed herewith.



6.2 Bank Protection

6.2.1 Basis of Design

The following specifies design principles, criteria and requirements to be taken into account for the design of the Bank Protection / Revetments.

All the banks are within a floodplain and made up by sand, silt and clay. This soil type may present different failure modes, such as scour, loss of fines, erosion, piping, etc. A special attention is to be paid to overall and local geotechnical failures. It is suggested to consider the required investigations at site and Detailed Engineering Designs etc., based on the soil parameters at the site.

There are many materials available in the market to be used for revetments, i.e., box gabions, block stone, cabled concrete blocks, dense stone asphalt, gabion mattresses, grouted stone, hand-pitched stone, in-situ poured concrete, loose concrete blocks, precast concrete slabs, open stone asphalt, soil reinforcement systems, etc… The selection of the type of material is based on a trade-off between hydraulic/geotechnical performances, construction related aspects (availability and supply, equipment and labor, access and infrastructure, etc…) and costs

Gabion revetments at the site shall be considered in the present study stretch. As the gabions do not need special equipment nor high-skilled labour for execution, their maintenance is not cumbersome and further they are more durable and economical than geotubes or geobags.

A. Design Principles

Applicable Codes, Standards and Guidelines

The following national design guidelines shall be used while carrying out the design of the revetment and the embankment:

- IS1893 (Part1): 2002. Criteria for earthquakes resistant design of structures
- IS7894: 1975. Code of practice for stability analysis of earth dams
- IS8408:1992. Planning and design of groins in alluvial rivers
- IS10751:1994. Planning and design of guide banks for alluvial rivers
- IS12094:2000. Guidelines for planning and design of river embankments
- IS14262:1995. Planning and design of revetment guidelines
- IS11532:1995. Construction and maintenance of river embankments.
- Escarameia M. (1998). River and Channel revetments: a design manual. Thomas Telford Publications, London.
- Bezuijen A. and Vastenburg E.W. (2013). Geosystems: Design Rules and Applications. CRC Balkema.
- PIANC (2015). Guidelines for Protecting Berthing Structures from Scour Caused by Ships. Report no. 180.
- PIANC (2014). Harbour approach channels design guidelines. Report no. 121.
- CIRIA, CUR, CETMEF (2007). The Rock Manual. The use of rock in hydraulic engineering (2nd edition). C683, CIRIA, London.
- Pilarczyk, K.W. (2000). Geosynthetics and Geosystems in Hydraulic and Coastal Engineering. Taylor & Francis Group, London & New York.
- Lafleur, J. (1999). Selection of geotextiles to filter broadly graded cohesionless soils. Geotextiles and Geomembranes, 17(5), p. 299-312.

- BAW (1993). Code of practice - Use of geotextile filters on waterways. BAW, Karlsruhe.
- Craig, R.F. (1987). Soil mechanics. Chapman and hall, 4th edition.
- Maccaferri (2014). *Stone fill for gabions.*
- PIANC (1987) Guidelines for the design and construction of flexible revetments incorporating geotextiles for inland waterways.
- Gary E.F and J. Craig. (2000). Gabions for Streambank Erosion Control.
- EN 1997 Eurocode 7 – Geotechnical Design.
- BAW (2010). Principles for the Design of Bank and Bottom Protection for Inland Waterways (GBB).
- Blaauw H.G. & van de Kaa E.J. (1978). Erosion of bottom and sloping banks caused by the screw race of manoeuvring ships. Publication no. 202, July 1978. Delft Hydraulics Laboratory.
- Dash S.K., Dutta S., Sreedeep S. and Rao G.V. (2013). Design of a Bank Protection System on River Brahmaputra at Jamuguri. *The Masterbuilder*, October 2013.

B. Design Vessel

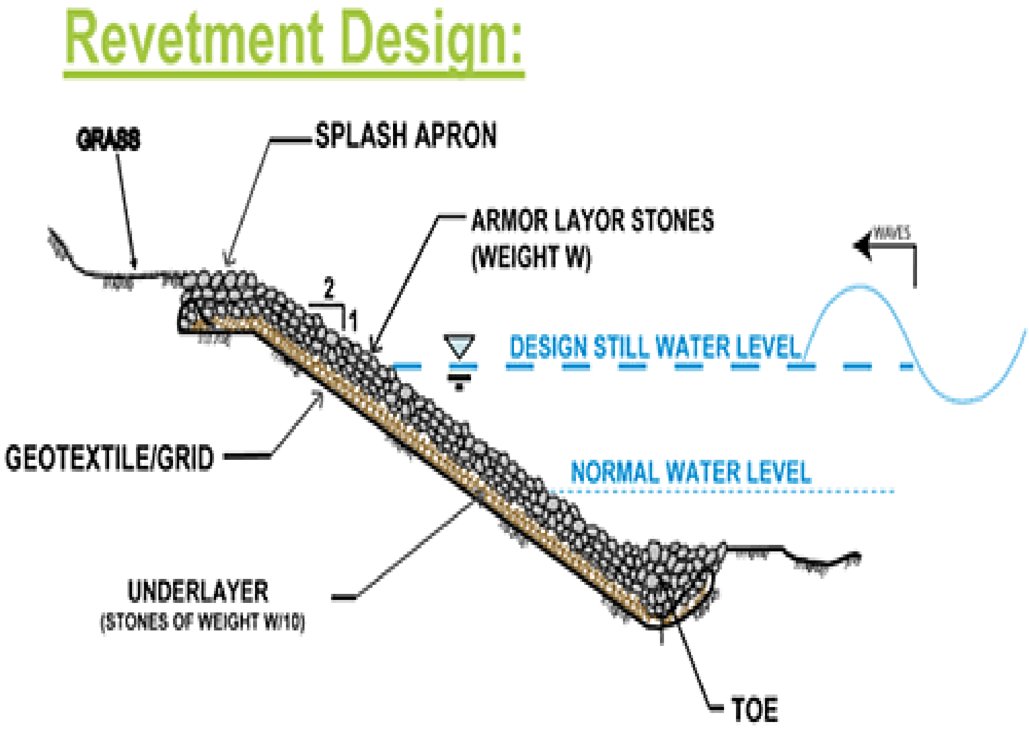
Vessel features are important in the design because moving vessels induce waves and currents in the river, which are a hydraulic load on the bank and river bed. These parameters will influence the design of the free board, the hydraulic stability of the structure and the size of the scour protection respectively for the revetments and the embankments.

C. Design requirements for Revetments

Gabions are wire mesh baskets filled with crushed rock. They are filled in situ, with locally available material and thus have a low capital cost. Because they are flexible and porous, they can absorb some wave and wind energy, thereby reducing the scour problems.

Gabions should be placed as sloping revetments with a preferable slope of 1:2.

Subdivided into equal sized cells, standard gabion baskets are of thickness 1, 1.5 and 3 feet and are available in lengths of 6, 9 and 12 feet.



D. Filter

A geotextile filter is required to prevent the underline sand being washed out through the gabions.

E. Toe protection

To prevent the sliding and failure of the revetment on the slope, a toe protection is required.

F. Anchoring

Proper anchoring is required for keeping the revetment in place. For this purpose the revetment will be extended both upstream and downstream.

Anchorage is required at the top of the submerged bank. It needs to be extended and anchored in the upper bank with a top key.

G. Hydraulic and Geotechnical Design

1) Revetment

a. Stone size

The minimum size of the stones should not be less than the ones specified in Figure. The figure is based on following assumptions:

· δ = friction angle between the geotextile bag surface and the subsoil, 20 degrees is recommended to be a conservative value;

- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made;
- The specific gravity of the stones is 2.65.

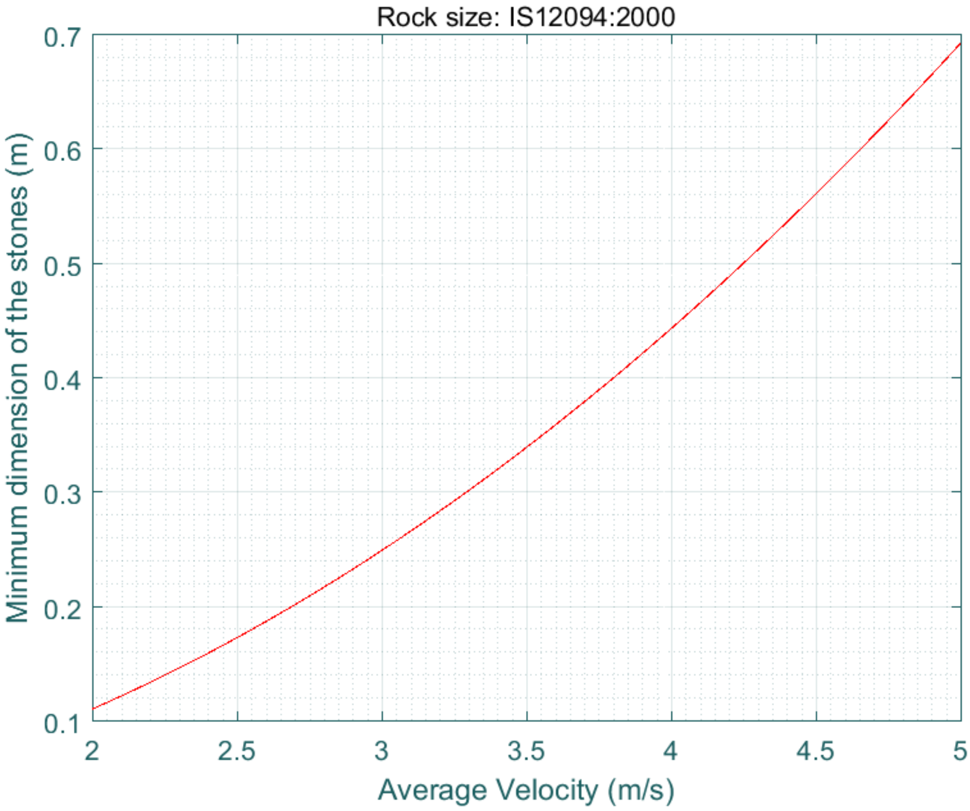


FIGURE 6.5: Minimum rock size according to the IS12094

From the above figure, it can be inferred that for average velocities higher than 3-4 m/s the rock size becomes very high. Under such circumstances small stones in crates or gabions are generally used. Therefore the use of gabions is proposed as alternative for the revetment.

b. Gabion size

The formulation of Pilarczyk allows to account for additional phenomena compared to the national codes (IS12094). This formulation is referred to standard guidelines such as PIANC. Therefore it is proposed to use that formula to perform a sensitivity analysis and to include more local effects (like the turbulence expected in the bends, difference between continuous layer and edges/transitions and influence of the propeller jet). It should be kept in mind that near the terminal the river current and the propeller can act together, for that case the formulation can be expressed as:

$$\Delta D = \phi_{sc} \frac{0.035}{\psi_{cr}} k_s^{-1} \frac{(k_{h1} k_{t,r}^2 V_h^2 + k_{h2} k_{t,p}^2 V_r^2)}{2g}$$

Where:

- D = characteristic dimension/ thickness [m];
- Δ = relative density of the system (=1.17). According to the IS12094 the porosity for gabions can be computed as follows:

$$\Delta_t = (1-e)\times\frac{\rho_s-\rho_w}{\rho_w}$$

$$e = 0.245 + \frac{0.086}{D_{50}^{0.21}}$$

- D_{50}= mean diameter of the stones (= 0.30)
- Sb = Specific gravity of the stones, 2.65
- V_h = Maximum velocity of the propeller jet at the bottom [m/s];
- V_r = Maximum velocity of the currents at the bottom [m/s]
- f = stability parameter, depending on the application (1, for gabions placed in edges or transitions and 0.75 for continuous top layer)
- ψ = Shields parameter (0.07, gabions)
- $k_{t,r}^2$= turbulence factor of the river current (1.5 higher turbulence at river bends)
- $k_{t,p}^2$= turbulence factor of the propeller yet (3-4, load to the water jet)
- K_s = factor related to the slope angle

$$K_s = \sqrt{1-\left(\frac{\sin\alpha}{\sin\delta}\right)^2}$$

- δ = friction angle between the gabion surface and the subsoil, 20 degrees is recommended to be a conservative value (for rip-rap is equal to 40 degrees)
- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made
- K_{h1} = factor related to the depth (1 for a very rough current). This factor translates the depth-averaged flow velocity into the flow velocity just above the bottom protection. The roughness of the gabion depends on the stone size and the height of the gabion, among other things. Therefore a value of 1 is chosen as a very conservative value to account for uncertainties in the vertical velocity field distribution and the roughness of the gabion.
- K_{h2} = factor related to the depth. For propeller jet PIANC (2016) recommends to use 1

In **Figure**, the minimum rock size for the gabions is shown. Assumptions have been taken for the calculation of the velocity and turbulence factors applied for the river currents.

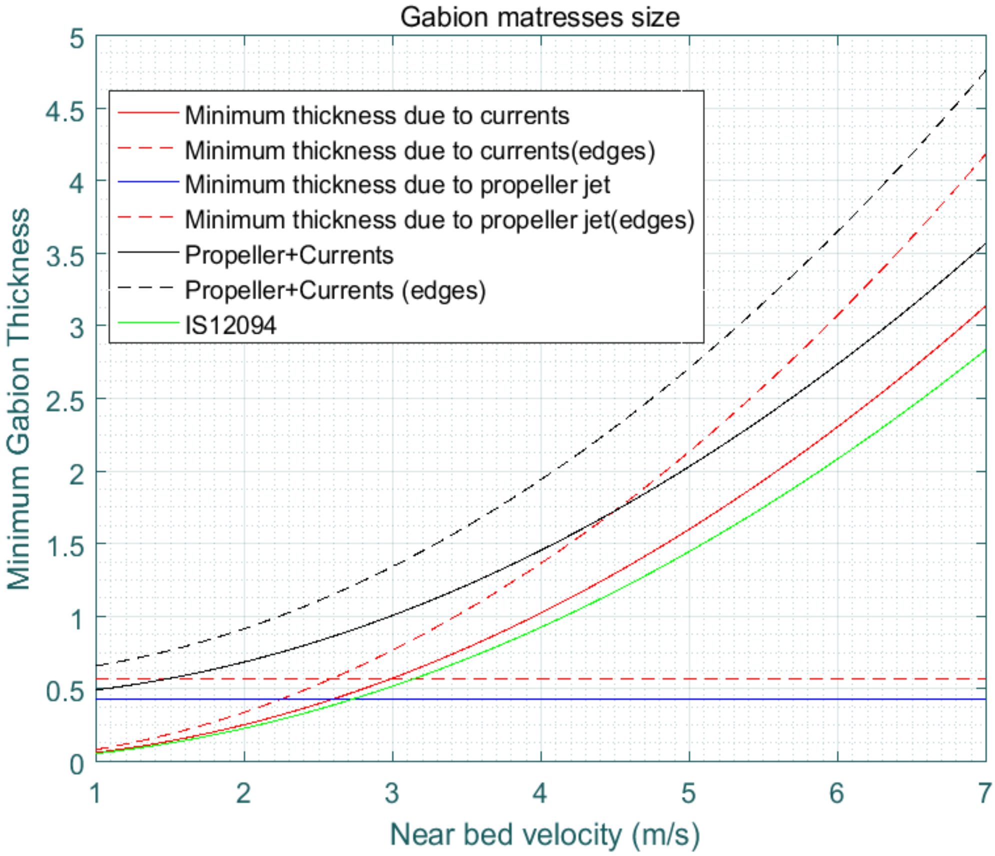


FIGURE 6.6: Minimum required thickness for revetment

The values given by Pilarczyk are chosen for the design since they allow for certain optimization. It should be noticed that, when changing slopes, the thickness of the gabion mattresses should be increased to account for the effects of the turbulence present on the transitions. The scour protection is considered as an edge of the revetment because high turbulence is also expected.

It is expected that the waves / currents calculated in section will not have any impact in the design. For revetments the required thickness to withstand wave / current loads can be worked out with next conservative formula (Klein & Pylarczyk, 1998):

$$\frac{H_s}{\Delta D} = \frac{9\cos(\alpha)}{\varepsilon_{op}^{2/3}}$$

- *D* = characteristic dimension/ thickness [m];
- Δ = relative density of the gabion
- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made
- ε_{op}= Breaking parameter

$$\varepsilon_{op} = \frac{\tan(\alpha)}{\sqrt{\frac{H_s}{1.56Tp^2}}}$$

For revetments, a very conservative approach will be to use the next formula:

$$\left(\frac{H_s}{\Delta D}\right)_{critical} = 8$$

Using the most restrict criteria, the minimum thickness of the gabion mattresses is 0.11 m for the design wave height. Therefore stability under longitudinal current is a more restrict criteria than wave stability for velocities higher than 1 m/s and the project wave loads.

c. Rock specifications

It is proposed to use a light grading which is appropriate for amour layers produced in bulk, usually by crusher opening. The size of the stone should be such that its length, width and thickness should be more or less the same. Round stones or very flat stones having small thickness should be avoided.

Standard grading should be used whenever possible. Determination of the gradation of the granular material is important for a number of reasons: 1) the packing and the volumetric layer porosity depend on the overall slope of the grading curve, 2) phenomena such as filtering and piping are governed by the gradation.

In Table 6.1 Some assumption for the rock grading are shown according to EN13383. Different rock layers are required to fill a determined gabion. In this sense the same table provides guidance on the amount of layers needed to fill a gabion.

TABLE 6-1: Typical Values for a grading of 10 to 60 Kg [1](following EN13383)

Grading (kg)	ELL	NLL	NUL	EUL	D_{n50}	D_{50}	Kt	nlayer	Ltmin
10-60	2	10	60	120	0.25	0.30	0.96	1	0.24
10-60	2	10	60	120	0.25	0.30	0.96	2	0.48
10-60	2	10	60	120	0.25	0.30	0.96	3	0.73
10-60	2	10	60	120	0.25	0.30	0.96	4	0.97
10-60	2	10	60	120	0.25	0.30	0.96	5	1.21
10-60	2	10	60	120	0.25	0.30	0.96	6	1.45

[1] G=Grading Denomination, ELL= the mass below which no more than 5 per cent passing by mass is permited, NLL= the mass below which no more than 10 per cent passing by mass is permited, NUL= the mass below which no more than 70 per cent passing by mass is permited, EUL= the mass below which no more than 97 per cent passing by mass is permited, Dn50=Maximum Foreseen medium nominal diameter, D50= mean stone diameter (D50=Dn50/0.84), Kt= Layer thickness coefficient, Lt= layer thickness

The major consideration in the design of gabion structures is the expected velocity at the gabion face. The gabion must be designed to withstand the force of the water in the stream. However the median stone size for gabion mattresses has to be in such a way that movement of the filler stone in the mattresses is prevented. This eliminates deformation that can occur when stone sizes are not large enough to withstand the forces of the water. The result of mattress deformation is stress on the basket wire and increases the resistance to flow and the likelihood of basket failure. A recommended value of a d_{50} in function of the water depth depends on manufacturer experiences; however some formulas are available in the literature (Gary E.F, J. Craig, 2000):

$$d_m = S_f C_s C_v d\left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{0.5} \frac{V}{\sqrt{gdK_1}}\right]^{2.5}$$

Where:

- C_s = Stability coefficient (= 0.1), C_v = Velocity coefficient (= 1.25), S_f = safety factor (= 1.1)
- d_m = average rock diameter in gabions
- d = local flow depth at V
- V = depth average velocity (= 4 m/s)
- γ_s = unit weight of stone (2650 kg/m^3)
- γ_w = unit weight of the water (1000 kg/m^3)
- K_1 = side slope factor (= 0.98 for a slope of 1:3)

Figure below shows that for a medium stone diameter of 0.3 m and for the design velocity of 2.5 m / sec, the grading 10-60 kg is suitable.

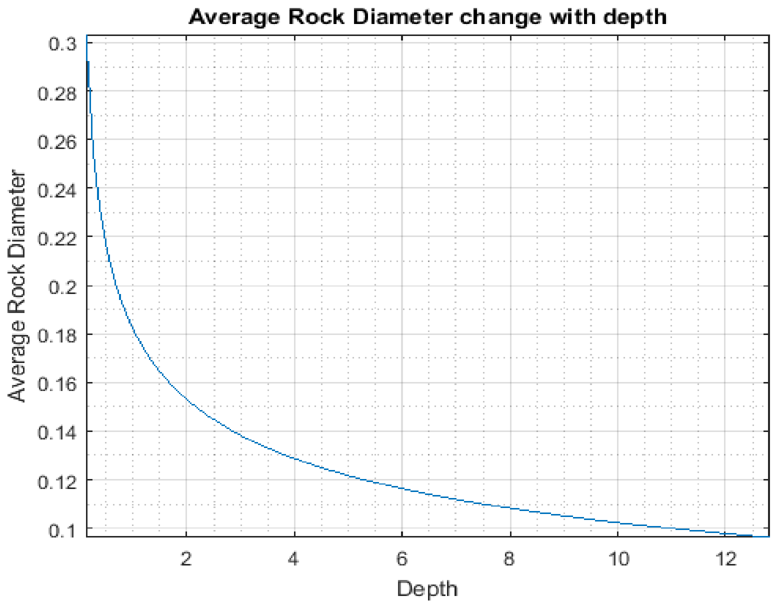


FIGURE 6.7: Minimum average rock diameter

The table below shows the properties from a well-known supplier (Maccaferri, 2014) for a durable stone fill for gabions:

TABLE 6-2: Technical specs for stone fill for gabions

Property	European standard references	Suggested requirements
Mechanical strength	Los Angeles, LA (EN 1097-2:1998) Fragmentability, FR (EN 1097-2:1998)	LA < 45 or LA > 45 and FR < 7
Resistance to attrition	Micro-Deval (EN 1097-1:1996) Fragmentability FR (EN 1097-2:1998)	MDE < 45 or MDE >45 and FR < 7
Resistance to freeze and thawing	EN 13383-1:2002	Category for FT_A (as assessed by loss of mass during testing): Loss of mass < 0.5%
Density of rock	EN 13383-2:2002	Apparent density > 2.2 t/m3
Amour stone grading	EN 13383-1:2002	CP90/180 or equivalent
Type of rock	Petrography	Calcareous, siliceous, metamorphic or igneous rock

d. Gabion specifications

The gabion basket is a double twisted wire mesh of variable sizes, uniformly partitioned in cells. A typical gabion has dimensions of 2 m length x 1 m width x 1 m height and comprises of a mesh type 80 mm x 100 mm. At the terminals, a mesh of 80 mm x 100 mm and a height of 1.4 m is proposed. A gabion mattress consists of gabions with relatively small height dimensions compared to length and width and would usually be of a smaller mesh type. A typical gabion mattress would have dimensions of 6 m length x 2 m width x 0.6 m in height and comprise mesh type 60 mm x 80 mm. At the terminals, a mesh of 60 mm x 80 mm and a height of 1-1.4 m is proposed.

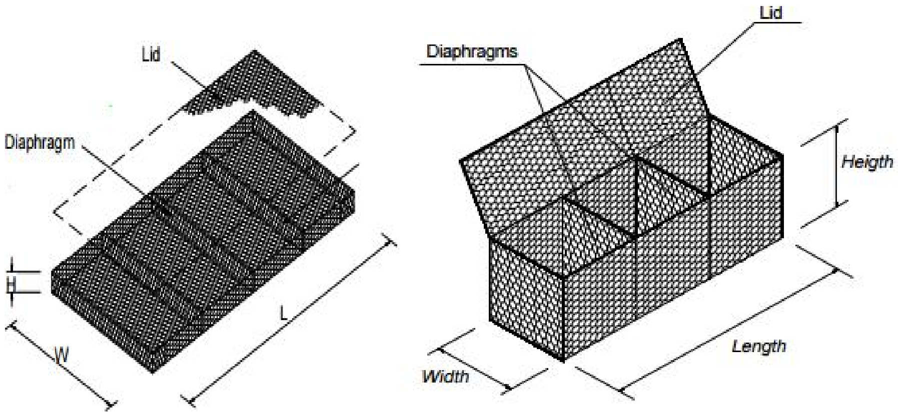


FIGURE 6.8: Example of a gabion mattress and gabion basket

According to IS14262:1995 gabions should be laid with the longer dimension along the slope of the bank. The size of the mesh of the crate should be smaller than the smallest stone in the crate. The mesh should be double knotted. Wire of minimum diameter of 4 mm should be used for crates. Crate units may be tied to each other by 5 mm wire.

A summary of the relevant European standards for gabions are given in table below, some suggestions are cited following the recommendations of the Rock Manual (CIRIA et al., 2007). Notice IS rules are more strict than EN for wire minimum diameter and those should be respected.

TABLE 6-3: European standards for the wire mesh

Wire Properties	European testing	Content
Steel wire composition	EN 10218-2:1997	Steel composition, strength
Steel mesh composition	EN 10223-3:1998	Mesh 60 mm x 80 mm wire: d = 2.2 or 2.4 mm Selvedge wire= 2.7 mm Mesh 80 mm x 100 mm wire: d = 2.7 mm Selvedge wire = 3.40 mm
Corrosion protection (galvanising)	EN 10244-1:2001 EN 1024402:2001	Thickness of the coating conforms to class A, mass of coating mc, depends on wire diameter: d = 2.2or 2.4 mm, mc = 23- g/m^2 d = 2.7 mm, mc = 245 g/m^2

Corrosion protection (polymer coating)	EN 10245-1:2001 EN 10245-2:2001 EN 10245-3:2001	Requirements for organic coating, PVC or PE, thickness, composition, strength, durability, flexibility
Tensile strength	EN 10223-3	60 mm x 80 mm: Tensile = 35 kN/m 80 mm x 100 mm: Tensile = 51 kN/m
Elongation	EN 10233-3	Elongation shall not be less than 10%

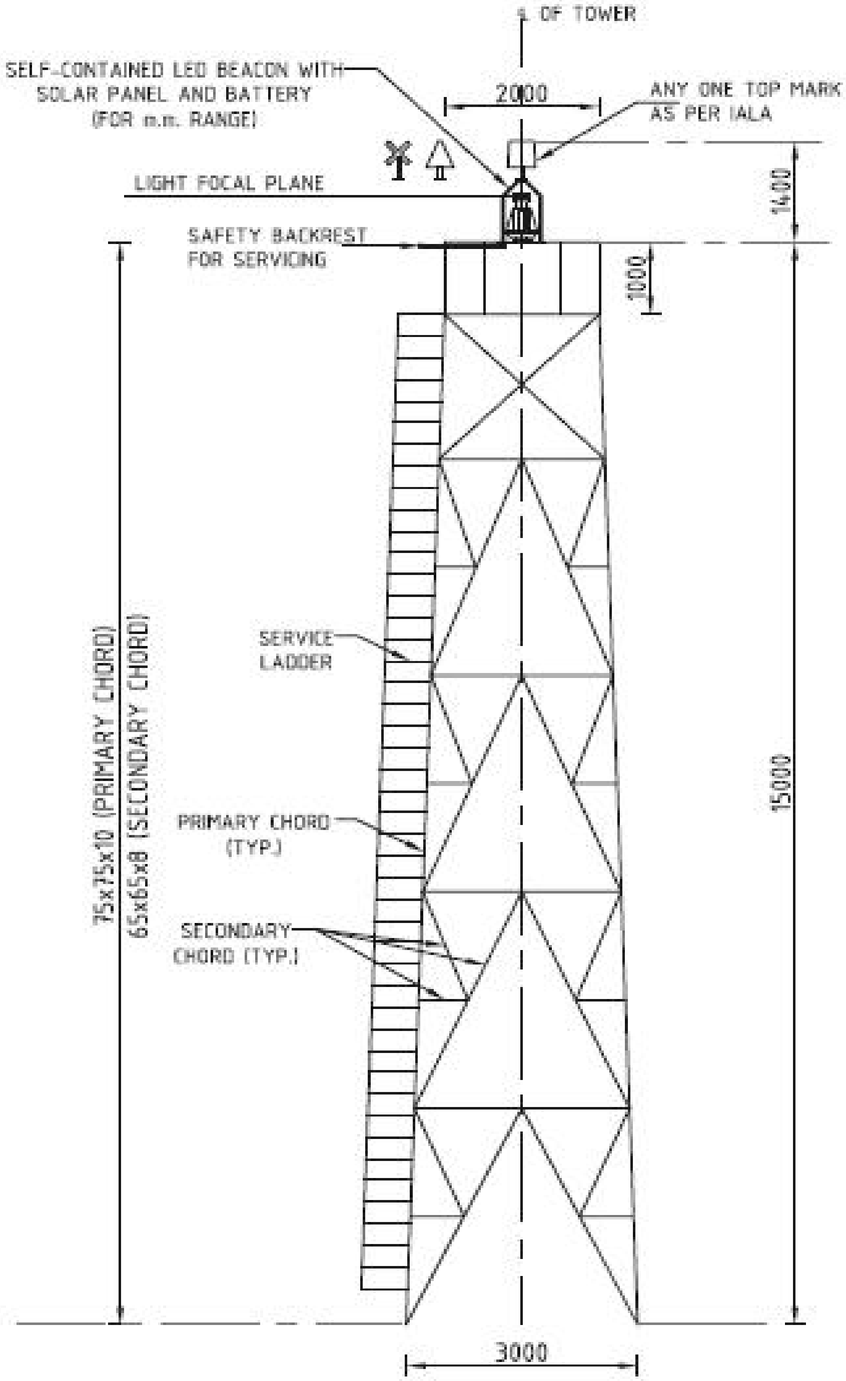
6.3 Navigation Aids

The Navigation system is of Two Types i.e., one is shore based and the other is water body based. The provision of Light is common in both the cases showing the Day / Night Marking system. The left / right marking during the day / night can be controlled through colour coding system. These aspects are being elaborated with guidelines by IALA at international level and are being followed in India also.

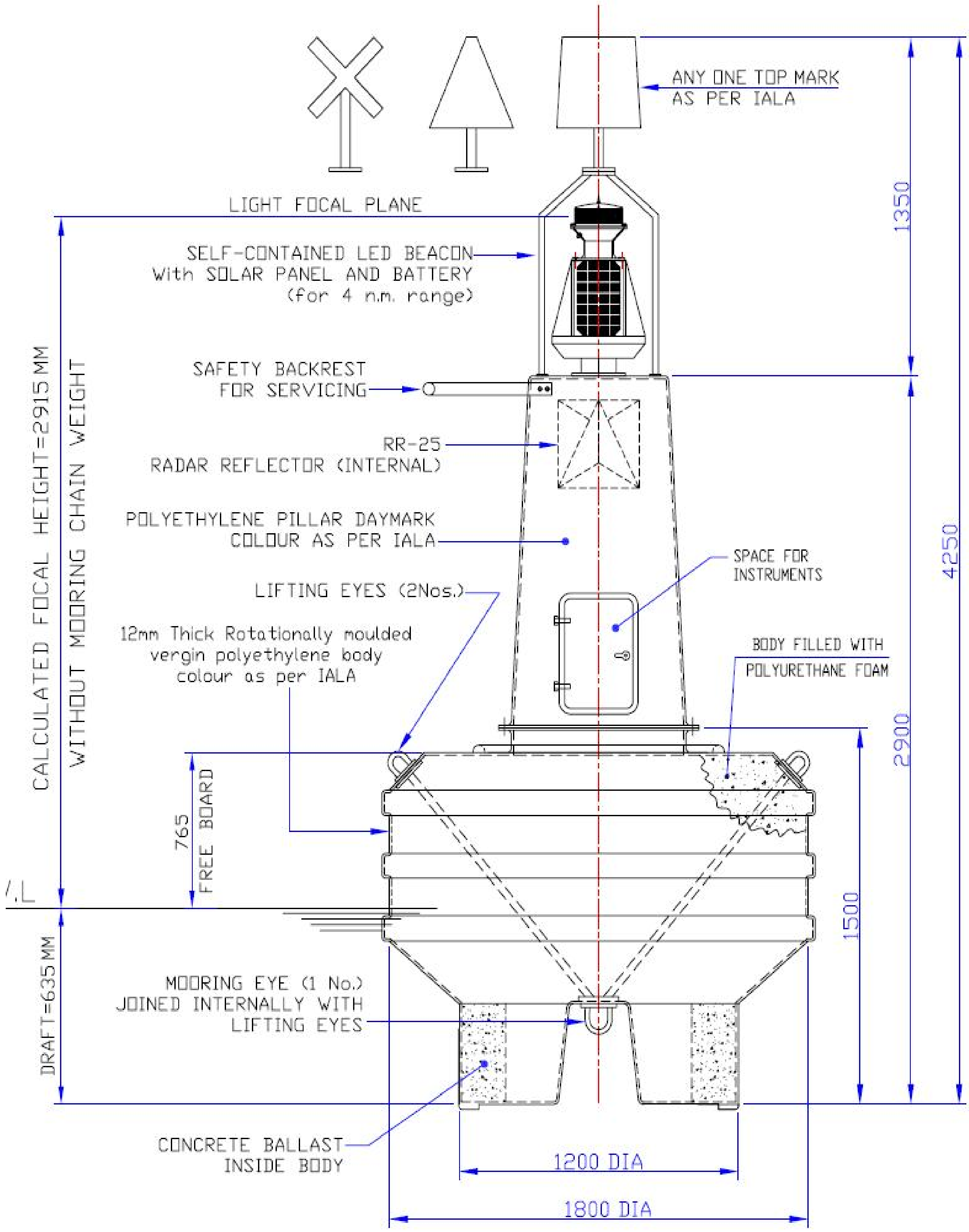
In the Shore based system, for the west flowing National Waterways of Cluster 7 and Cluster 6, it has been preferred to have a Beacon / Light system, wherein the Buoy / Light system has been preferred at later date.

The standard preliminary Design with drawing / along with specifications are placed hereunder.

BEACON WITH LIGHT SYSTEM:



BUOY WITH LIGHT SYSTEM:



<u>POLYETHYLELENE CHANNEL MARKING BUOYS: (PORT HAND) 1 No. - PEB/1 800 Polyethylene Buoys, each complete with Day mark, Top Mark and Radar Reflector. Main features are as given below:</u>

Body Diameter: 1800 mm / Wall Thickness : 12 mm thick body / Body Material : Rotationally moulded in low density UV-Stabilized virgin polyethylene / Foam : Body filled with Closed Cell Polyurethane Foam / Weight without Mooring : 645kg (approx.) / Focal Height : 29 15 mm / Draft : 635 mm / Free Board : 765 mm / Reserve buoyancy : 1893 kgs / Displacement : 26.0 kg./cm of immersion / Mooring Eyes : 1 No. of Steel / Lifting Eyes : 2Nos / Body Colour : As per IALA system, UV- stabilised colour pigments mixed thoroughly with polyethylene powder before moulding operation / Daymark : P E Module (as per IALA system) / Radar Reflector : RR - 25 as specified (25M2).

<u>1 Set - Mooring gear – Each set comprised of the following:</u>
1 No. - 3M x 26 mm dia open link chain with enlarged end links.
1 No. - 15M x 26 mm dia open link pendant chain with enlarged end links.
4 Nos. - 26 mm nom. dia forelock end shackles.
1 No. - 26 mm nom. dia swivel piece with end links.
1 No. - 250 kg. M.S. stockless Anchor.

<u>Note:</u> The chains shall be made as per 1S4692, shackles and swivel as per IS 4484 and stockless steel Anchor. The chain shackles and swivel shall carry proof load test certificate witnessed by the IRS. All the above shall be given one coat of coaltar paint.

<u>Solar Operated LED lighting 1 No. MLB-200-4 Self-contained LED beacon fitted with PLC-12 programmable LED controller. Specification of Each Light is as detailed below:</u>
Luminous range: 4 n. miles. (T 0.74) / Light Colour: as per IALA System. (Red) / Light Source : High intensity Light Emitting diodes (LEDs) with UEP to 60,000 hrs of burning life / Optical system : 200 mm dia clear polycarbonate UV stabilized diffuser lens / Lantern Body : High impact polystyrene / Cable entry : M l6 Cable glands fitted / Fixing : 4 fixings for Ml 0 bolts at 200 mm PCD / Lantern weight : 3.0 kg (approx.).

<u>1 No. - PLC 12 programmable microprocessor based LED controller (fitted in the base of the Lantern). Main description is given as below:</u>
Input Voltage: 12 V to 18 V d. c / Output Voltage: Switch-mode stabilized to suit LED operating current / LED load (max): upto 12 Amp. at 12 V d.c / Light Character : Any of the 256 IALA character can be selected / Solar charge regulator: Provided in the PLC-12 circuit / Light control : Automatic ON/ OFF by Photo diode / Protection : Against reverse polarity and excessive input voltage / Temperature range : -20°C to + 60°C.

SOLAR SUPPLY SYSTEM FOR MLB-200-4 LED Light: 1 Set — Solar supply system as detailed below:

4 Nos. - 12V 5 watt solar panel / 1 No. – 12 V 42 AH sealed, maintenance free battery / Autonomy period = 21 days Light Assembly : Lantern, Solar panel and battery are mounted on the GRP box, all assembled and wired as one self-contained unit, ready for fitting on top of buoy structure.

6.4 Cargo Terminals and River Ports

Design Criteria

All structures shall be designed using limit state design approach. 3-D structural analysis of the structure shall be carried out under all specified loads and load combinations as per Indian Standards as explained in this report using STAAD Pro software. The design shall be done manually using the results of the analysis obtained from STAAD.

Design Life

All permanent structures shall be designed for a design life of 50 years.

Material Properties

Density of reinforced concrete	25.0 kN/m3
Density of Steel	78.5 kN/m3
Density of plain concrete	24.0 kN/m3

Density of Backfill soil 18.0 kN/m3 (May vary based on soil fill proposed during detail design)

Structural Steel

Minimum yield stress: 250 N/mm²

However, higher grade of steel (310/355 Mpa) shall be used based on the availability during the detailed design stage and subject to owner's approval.

Reinforcing Steel (Corrosion Resistant)

The grade of steel to be used as reinforcement in the structural concrete members shall comply with IS 1786 and will have minimum strength and elongation as mentioned below.

Yield Strength	500 Mpa
Elongation	14.5%

However, use of higher grade steel in the detail design is subject to availability of higher grade steel meeting the ductility requirements (as per revised latest code).

Cover to Reinforcement

The clear cover to main reinforcement shall be as follows:

Piles	100 mm
Deck Slab	75 mm
Longitudinal beams:	75 mm
Columns:	75 mm
Cross Beams	75 mm

Concrete Grades

Grade of RCC members	M40 for Piles
	M40 for Beams and Slab
	M40 for all precast elements
Grade of reinforcement	Fe500 confirming to IS 1786

Overall Deflection Criteria

The criteria for deflection shall be so limited that it shall not produce difficulties in serviceability conditions nor shall it cause damage to the structures and its components.

Deflection limits

Pile deflection at the deck level is normally considered as H/350 under extreme condition, where H is the distance from the point of fixity of piles to the top elevation of deck.

Crack Control

The crack width criteria shall comply with the provisions of IS: 4651(Part 4).

However the assessed surface width of cracks (for service load combinations only) at points nearest to the main reinforcement will be restricted to 0.004 times the cover to the main reinforcement.

Corrosion Protection Painting

All steel surfaces in the splash zone and atmospheric zone shall be painted in accordance with the painting specifications. Areas and joints that are inaccessible for maintenance and thereby susceptible to corrosion shall be suitably sealed by methods such as boxing with plates.

All appurtenances such as walkway bridges shall be painted as per technical specifications of corrosion resistance suitable for the environment.

Classification of Loads

A. General Loading

The Self weight of the structure shall be calculated using the following

Density of reinforced concrete	25.0 kN/m3
Density of Steel	78.5 kN/m3
Density of plain concrete	24.0 kN/m3

Density of Backfill soil 18.0 kN/m³ (May vary based on soil fill proposed during detail design)

In addition superimposed dead load and live load shall be considered

The various loads acting on the berthing structure are classified as:

1. Loads from the River Side:

The loads from the river side include the horizontal forces caused by the river currents and the forces caused by berthing and vessel's pull from bollard. The forces caused by the berthing of the vessels are determined from the velocity and angle of approach of the vessels.

2. Loads from Deck

The important loads from the deck are the vertical loads caused by self-weight of the deck and the superimposed loads from handling equipments. Also horizontal loads due to wind and seismic forces are considered.

3. Loads from Shore

Seismic loading

Earthquake loads shall be adopted as applicable for the site as per IS 1893 – 2002. The river fall under Zone III, as per the seismic map of India shown in IS 1893-2002. Design horizontal seismic coefficient shall be evaluated as per procedure detailed in IS 1893-2002.

The horizontal seismic coefficients are as follows:

TABLE 6-4: Seismic Loading

Seismic zone	III
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.16
Importance factor, I	1.5
Response Reduction Factor, R	3 (for ordinary RC moment resisting frame)
Average response acceleration coefficient Sa/g	Depending on time period of structure

Time period of specified structures shall be evaluated by STAAD analysis considering Dead Load + 50% Live load.

Scour

Scour depth is considered in calculating the total length of the pile.

$R = 0.473 (Q/f)^{1/3}$

Where R = depth of scour below HFL

Q = discharge m^3/s

f = silt factor (=1) Max scour around piers = 2 R. Hence, scour length of 10 m has been considered from the HFL/ MHWS.

However since as per geotechnical investigations pile Length required is 15 m +5*Dia of pile socketed into rock (The depth of pile being computed from G.L (+1.5 m) at exploratory Bore hole (BM-1) location) therefore the total length of pile provided below deck is 25 m including a socket length of 6.5m .

Loads & Load Combinations

All the structural members shall be designed to sustain safely the effect of the combination of various loads/forces and stresses that can possibly co-exist. The load combinations shall comply with the requirements of Indian reference standards both for limit state of collapse & serviceability.

Structural Design of Berthing Structure

Structural Arrangement

The LO-LO berthing structure shall consist of a concrete deck supported on piles. I.e. the sub structure shall comprise of piles at 7.5 m c/c in transverse direction, whereas the super structure shall comprise of the pile caps and concrete deck precast planks supported on longitudinal beams and cross beams. The pile caps span in the transverse direction with the longitudinal beams resting on the pile caps.

The structure shall be designed for its self-weight and also for forces arising due to wind / seismic loads, current forces, vehicular loads etc. as explained below. (Refer Volume-II **Drawing No.P.010257-W-20341-E02** for details).

For LO-LO the deck has been considered at approx. 1 m above HFL/ MHWS. Expansion loops has been provided along the stretch at almost 30 m

A staged construction approach is assumed in the design viz:

- Piles,
- Precast pile caps and placement of cross head beams,
- Placement of precast longitudinal beams with precast planks for slab
- Placement of concrete for cast-in-situ ties between beams and deck slab.

The LO-LO berthing structures considered in design have salient features as below:

TABLE 6-5: Salient Features of Ro-Ro and Lo-Lo

Sl. No	Type	Length	Total Width
1	LO-LO	75m	32 m

Design Loads on Berthing Structures

a) Dead Load

The dead load comprise of the weight of all components of the structure as well as the weight of all permanent connections.

For LO LO berthing structures, the member load has been defined directly by STAAD Pro using the self-weight command. The weight of concrete slab & precast panels has been applied in STAAD Pro software using floor load command.

b) Live Load

The vertical live loads comprise of loads from vehicular traffic of all kinds including trucks/ trailers/track and cranes, and other mechanical handling equipments and also, surcharges due to stored and stacked materials such bulk .The vertical live loads as defined in IS 4651 (III) shall be considered in the analysis and design of the berthing structure.

TABLE 1 TRUCK LOADING AND UNIFORM LOADING

Function of Berth (1)	Truck Loading (IRC Class) (2)	Uniform Vertical Live Loading T/m² (3)
Passenger berth	B	1·0
Bulk unloading and loading berth	A	1 to 1·5
Container berth	A or AA or 70 R	3 to 5
Cargo berth	A or AA or 70 R	2·5 to 3·5
Heavy cargo berth	A or AA or 70 R	5 or more
Small boat berth	B	0·5
Fishing berth	B	1·0

Note — The relevant Indian Road Congress (IRC) codes may be referred for axle load. The spacing of the loads may be changed to suit individual design requirements.

For LO LO berthing structure, uniform loading corresponding to container berth of 30 KN/m2 has been considered in the analysis. However, no additional surcharges because of stored and stacking of material have been considered.

c) Seismic Forces

The river is in zone III as per IS 1893:2002(part I). Dynamic analysis has been done to calculate the time period of the structure. The spectral acceleration is calculated based on the time period of the structure obtained for its mode as per IS 1893:2002 for rocky soils types.

The maximum mass participation is observed for mode 1 in X direction and for mode 2 in Z direction.

The time period obtained is of the order of 3 sec in X direction and 3 sec in Z direction Hence based on the acceleration value the horizontal seismic coefficient is worked out as

Ah = (Z/2) x (I/R) x (Sa/g).

Z = zone factor =0.16

I= importance factor =1.5

R = reduction factor =3

Sa/g= spectral acceleration based on time period

50 % Live load is considered for the dynamic analysis of the structure.

Thus Ah = 0.05 (in X direction) and Ah = 0.05 (in Z direction)

d) Wind Forces

Wind loads on the structure shall be applied according to IS: 875 (Part 3) -1987

Wind Pressure   Pz = 0.6 Vz^2

Where

Pz = Design Wind Pressure in N/m2 at height Z

Vz = Design wind speed at any height in m/s

Vb = Basic wind speed at any height in m/s

K1 = Probability factor (risk coeff)

K2= Terrain height and structure size factor

K3 = Topographic factor

Pz is calculated as 1.5 KN/m2 taking Vb as 44 m/s

The wind force is applied on piers in both X and Z direction in STAAD Pro software.

e) Berthing Load

Berthing forces on the structure are applied according to IS 4561 (III). When an approaching vessel impacts on the berth, horizontal forces act on the berth. The magnitude of this force depends on the kinetic energy that can be absorbed by the fender system. When the berthing takes place, the fenders absorb the kinetic energy and convert into strain energy and in that process, passes on the reaction force to the structure, for which the berth is designed. The kinetic energy, E, imparted to a fender system by a vessel moving with velocity V is given by E = (Wd x V^2 x Cm x Ce x Cs) / (2x g)

Where,

E = Berthing Energy (Tm)

Wd= Displacement Tonnage of the Vessel (T)

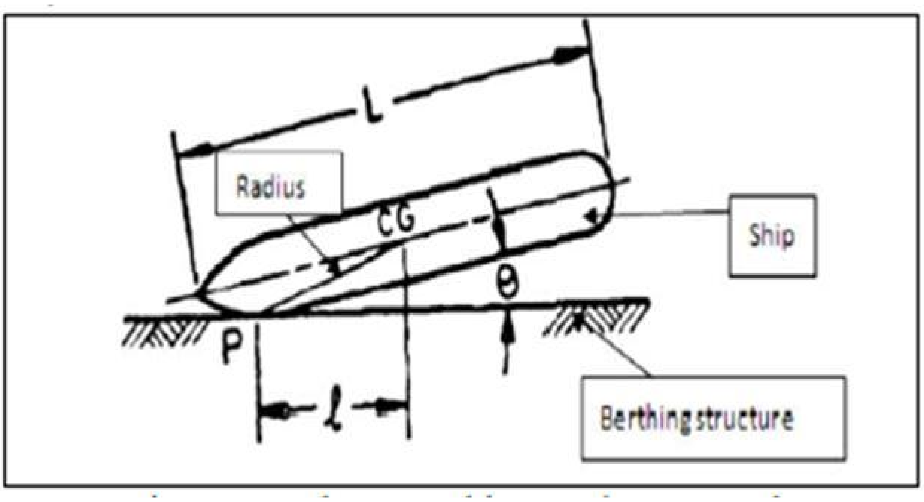
V= Berthing Velocity in m/s

Cm = Mass co –efficient

Ce = Eccentricity co-efficient

Cs = Softness co-efficient

G = Acceleration due to gravity (m/s2)



Mass Co-efficient

Taking   Wd = 4000 DWT

Cm = 1+ (pi (). D^2. L.w/Wd)

D= draught of vessel =1.7 m

L = length of vessel =75 m

W= unit weight of water

Cm =1.042

Eccentricity Co-efficient

Let the vessel berth at angle O = 15 deg

Ce= 1 + (l/r)^2 sin^{2}O / (1+ (l/r)^2)

Taking l= L/2

r = L/4

Ce =0.26

Softness Co-efficient

Cs = 0.95 (Is 4651 –III)

IS : 4651 (Part III) - 1974

TABLE 2 NORMAL VELOCITIES OF VESSELS

(*Clause* 5.2.1.1)

Sl No.	Site Condition	Berthing Condition	Berthing Velocity Normal to Berth in m/s			
			Up to 5 000 DT	Up to 10 000 DT	Up to 100 000 DT	More than 100 000 DT
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Strong wind and swells	Difficult	0·75	0·55	0·40	0·20
ii)	Strong wind and swells	Favourable	0·60	0·45	0·30	0·20
iii)	Moderate wind and swells	Moderate	0·45	0·35	0·20	0·15
iv)	Sheltered	Difficult	0·25	0·20	0·15	0·10
v)	Sheltered	Favourable	0·20	0·15	0·10	0·10

Velocity of Vessel normal to berth = 0.45 m/s

E = 106.2 kNm

f) Mooring Load

The Mooring loads are the lateral loads caused by the mooring lines when the vessel is pulled into or along the deck or hold it against the forces of wind or current. The maximum mooring forces are due to wind force on exposed area, on the port side of the vessel.

IS 4651_III, gives Bollard Pulls of vessel as below

For 4000DWT Line pull = 200 kN

TABLE 4 BOLLARD PULLS

(*Clauses* 5.3.4 *and* 6.1)

Displacement (Tons)	Line Pull (Tonnes)
(1)	(2)
2 000	10
10 000	30
20 000	60
50 000	80
100 000	100
200 000	150
Greater than 200 000	200

Note 1 — For ships of displacement tonnage 50 000 and over the value of line pulls given above should be increased by 25 percent at quays and berths where there is a strong current.

Note 2 — Main bollards at the ends of individual large vessel berths at river structures should be designed for a line pull of 250 tons for ships up to 100 000 tons displacement and for double the values given above for larger ships.

g) Current Forces

As per IS 4651 III, pressure due to current is applied to the area of vessel below the water line when fully loaded.

Current force $F = w\,v^2/2g$ per m^2

Where v = velocity =2.5 m/s

W= 10 kN/m^2

F = 3.185 kN/m^2

Load Combinations

The load combinations as per IS 4651(IV): General Design Considerations are considered in design of structure. Suitable partial safety factors as per IS: 4651 - 1989 applied to the loads for limit state design are considered.

All operational load combinations will be checked to satisfy the serviceability criteria.

TABLE 6-6: Partial Safety Factors for Loads in Limit State Design

Loading	Partial Safety Factor					
	Limit State Serviceability		Limit State of Collapse			
Dead load [4.1(a)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Vertical live load [4.1(b)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Earth Pressure [4.1(f)]	1.0	1.0	1.0	1.0	1.0	1.0
Hydrostatic and hydrodynamic forces [4.1(g)]	1.0	1.0	1.0	1.2	1.0	1.0
Berthing and mooring forces [4.1(h) and 4.1(j)]	-	1.0	1.5	-	-	-
Secondary stresses [4.1(m)]	1.0	-	-	-	-	-
Wind forces [4.1(k)]	-	-	-	-	1.5	-
Seismic forces [4.1(p)]	-	-	-	-	-	1.5

NOTE: For the limit states of serviceability, the values given in the table are applicable for short terms effects. While assessing the long term effects due to creep, the dead load and the part of the live load, likely to be permanent, may only be considered.

Structural Analysis and Design of Berthing Structures

Based on the structural arrangement and loadings described above, a 3-D model was developed in Staad Pro software for LO-LO Berthing structures. The structure is modelled with its deck (long & cross beams) along with piles at every 7.5 m in transverse direction.

Linear elastic analysis has been carried out using the Staad model for estimating the actual forces in structural length of the pile for all loads considered. The design is carried out the most critical load combination.

RCC members are designed manually considering limit state design approach as per latest available Indian standards.

A one-third increase in permissible stresses shall be allowed in seismic case as per clause 6.3.5.1 of IS 1893 part-1 2002.

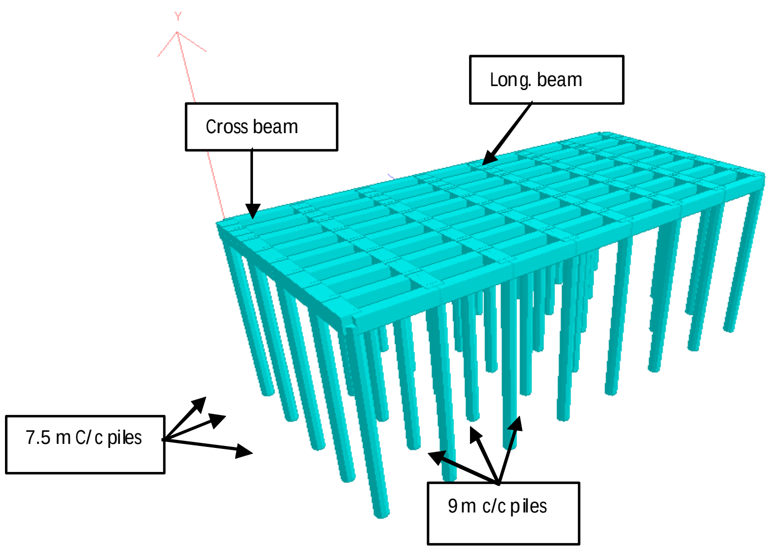


FIGURE 6.9: Perspective view of 3 dimensional model prepared in STAAD for LO-LO

SIZING OF LO-LO

Member Description	Length(m)	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	7.5	1.8	1.8		Concrete
Longitudinal Beams	9	1.0	1. 25		Concrete
Cast In situ Slab				0.15	Concrete
Pile Diameter, OD		1.3	25*		Concrete

* Including socket length of 6.5 m

It is evident from the bore hole log and flood data that the soil of 3 m approx. above the rock bed shall be scoured during HFL condition. Therefore the axial capacity of the pile proposed for the Ro-Ro structure would be computed combining the frictional resistance of soil & rock below scour level (-7.7m) and end bearing resistance at the bottom of the pile socket. Considering competent rock for socketing at EL. -14 m socket length and corresponding axial capacity of the pile has been calculated as follows:

TABLE 6-7: CALCULATION OF SOCKETED PILE CAPACITY- MAPUSA LO-LO

	Rock Socketed Pile : MAPUSA LO-LO				
1.	METHOD 2 : UCS < 10 MPa, IRC 78-2014				
1.1.	Input				
	Rock Quality Designation, RQD		=	0	%
	Core recovery, CR		=	30	%
	Uniaxial Compressive Strength (UCS), qc		=	7.3	MPa
	N-Value below base		=	110	
	Average shear strength below base of pile (based on N-value), Cub		=	0.8	MPa
	N-Value along Socket		=	80	
	Ultimate shear strength along pile socket (based on N-value), Cus		=	0.6	MPa
	Coefficient, Nc		=	9.0	
	Dia of Pile		=	1.3	m

	Area of base, Ab	Pi* $d^2/4$	=	1.33	m^2
	Length of Socket		=	3	m
	Area of socket, As	Pi*d*L	=	12.25	m^2
	Load on Pile		=	5000	KN
	Scour Depth		=	10	m
1.2.	Pile Capacity				
	Ultimate end bearing capacity of socketed pile, Re	Cub*Nc*Ab	=	9795.64	KN
	Ultimate side socket shear, Raf	As* Cus	=	6739	KN
			=		
	Ultimate capacity of socketed pile, Qu	Re + Raf	=	16534.36	KN
	Allowable capacity of socketed pile, Qallow	Re/3 + Raf/6	=	4388.33	KN
	Frictional resistance from intact soil & rock below scour level		=	1480.00	KN
	Total Allowable capacity of the pile		=	5868.33	KN

6.5 Construction Schedule

Construction schedules of different structures will be discussed and elaborated as a part of the implementation schedule in the appropriate chapter.

CHAPTER 7 VESSEL DESIGN

7.1 General Review

The design of a vessel is dependent on various factors viz., Waterway / Fairway structure; Flow pattern in the Fairway for different seasons; Waterway morphological behaviour in different seasons; Cross structures across the fairway; Navigational constraints (Presence of Locks); Cargo volumes to be handled; Type of cargo to be handled; Cargo handling facilities available at Origin and destination; Turnaround time; Capacity of the fairway.

In the above, the predominant factors are Fairway and Cargo i.e., the Fairway availability and Cargo Volumes to be transported. The Fairway details have been discussed in Chapter 03 and the IWT Cargo scenario has been discussed in Chapter 04. Further the present status on the vessels plying in the study stretch also have been collected and placed in subsequent chapters, which will also have bearing in the vessel deployment.

There are not many countries internationally in which IWT is a significant industry, so skills and techniques in IWT vessel research and development are globally scarce. The countries that have significant IWT industries can therefore gain by learning from each other. Vessel design, including vessel loading/unloading methods, is expected to be a fruitful area for USA, EU and China to utilize international experience, particularly in newer, more specialized vessel types.

7.2 Design Basis

The design waterway channel width / depth is usually determined according to the following information: Design Width / depth = f {vessel size, vessel steering characteristics, traffic density, vessel speed, water depth, channel type, flow currents, waves and winds}

Further, the determination of the vessels will be based on traffic / freight projection. The higher the amount of traffic / volumes and lesser the freight cost, the more transport capacity can be foreseen, either in the form of larger vessels or by using more vessels.

7.2.1 Vessel Classification adopted in Indian Inland Waterway

Ministry of Shipping, Road Transport and Highways (Inland Waterways Authority of India) has classified the Inland waterways into seven categories for rivers and canals for safe plying of self-propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in Push Tug + 4 barges units of carrying capacity up to 8000 tonne (Ref: IWAI, Gazette Notification 2006).

The classification criteria of waterways are mentioned in **Table 7.1** for Rivers and in **Table 7.2** for canals.

TABLE 7-1: Classification of Inland Waterways for Rivers

Class of Waterways	Rivers				
	Minimum Depth (m)	**Bottom Width (m)**	**Bend Radius (m)**	**Vertical Clearance (m)**	**Horizontal Clearance (m)**
I	1.2	30	300	4	30
II	1.4	40	500	5	40
III	1.7	50	700	7	50
IV	2.0	50	800	10	50
V	2.0	80	800	10	80
VI	2.75	80	900	10	80
VII	2.75	100	900	10	100

TABLE 7-2: Classification of Inland Waterways for Rivers

Class of Waterways	Canals				
	Minimum Depth (m)	**Bottom Width (m)**	**Bend Radius (m)**	**Vertical Clearance (m)**	**Horizontal Clearance (m)**
I	**1.5**	**20**	**300**	**4**	**20**
II	**1.8**	**30**	**500**	**5**	**30**
III	**2.2**	**40**	**700**	**7**	**40**
IV	**2.5**	**50**	**800**	**10**	**50**
V	-	-	-	-	-
VI	**3.5**	**60**	**900**	**10**	**60**
VII	-	-	-	-	-

Vertical clearance for power cables or telephone lines or cables for any transmission purpose for all the classes of waterways mentioned shall be as follows:

i) Low voltage transmission lines including telephone lines -16.5 metres

ii) High voltage transmission lines, not exceeding 110 kilo volt-19.0 metres

iii) High voltage transmission line, exceeding 110 kilovolt- 19.0 metres + 1centimetres extra for each additional kilovolt.

The vessel sizes for self-propelled or tug and barge combination for different classes of waterways are described in **Table 7.3**.

TABLE 7-3: Classification of Vessel Size

Class of waterways	Self-Propelled Vessel Tonnage (Size, L x B x Draft in m)	Tug and Barges Combination Tonnage (Size, L x B x Draft in m)
I	100 (32 x 5 x 1)	200 (80 x 5 x 10)
II	300 (45 x 8 x 1.2)	600 (110 x 8 x 1.2)
III	500 (58 x 9 x 1.5)	1000 (141 x 9 x 1.5)
IV	1000 (70 x 12 x 1.8)	2000 (170 x 12 x 1.8)
V	1000 (70 x 12 x 1.8)	4000 (170 x 24 x 1.8)
VI	2000 (86 x 14 x 2.5)	4000 (210 x 14 x 2.5)
VII	2000 (86 x 14 x 2.5)	8000 (210 x 28 x 2.5)

In general, total weight of the vessel considered to be 1.4 X DWT. Refer Figure 7.1 below for proposed dimensions of one way navigation channel.

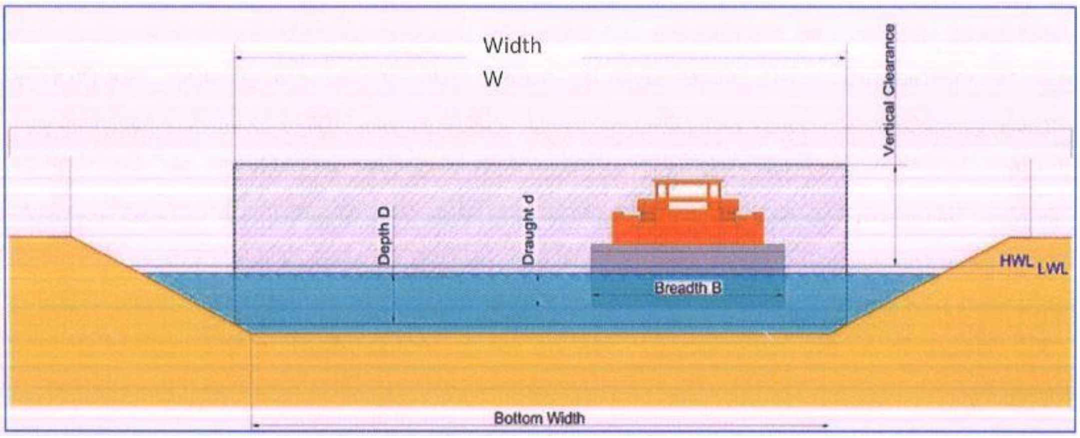


FIGURE 7.1: Dimensions – one way navigation Channel

Proposed dimensions of two ways navigation channel has been shown in **Figure 7.2** below.

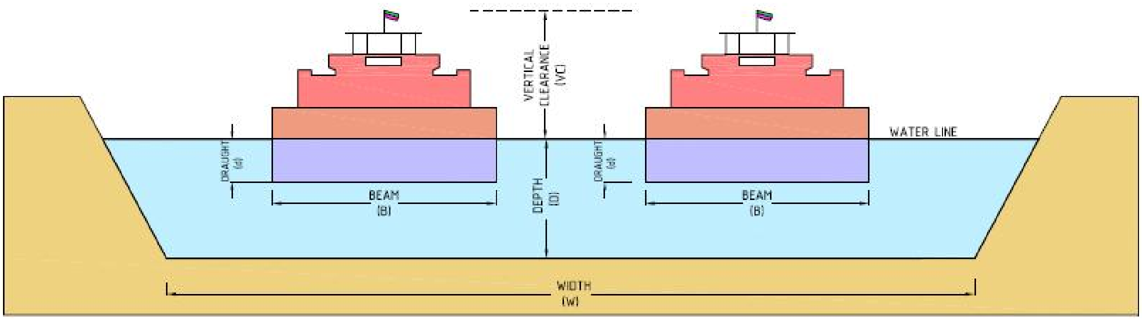


FIGURE 7.2: Dimensions – Two way navigation Channel

7.2.2 Vessel Classification of USA Inland Waterway

As per American Association of State Highway and Transportation Officials (AASTHO) standards, vessels with following dimensions referred in **Figure 7.3** below is under consideration with the characteristics as given in **Table 7.4** and **Table 7.5**.

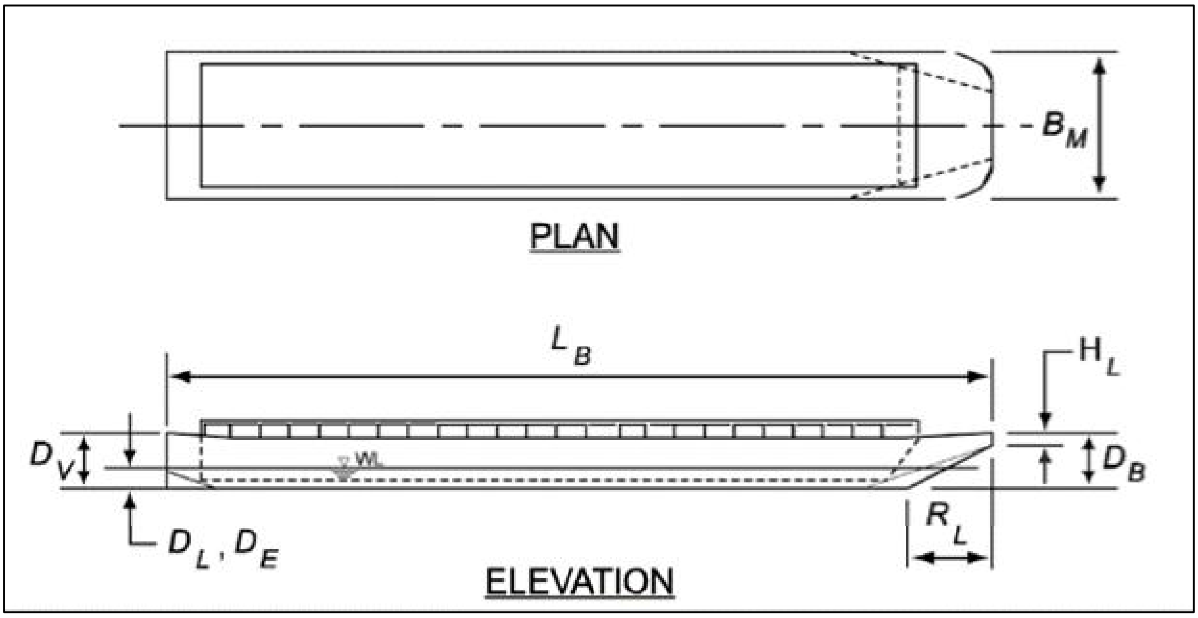


FIGURE 7.3: Plan and Elevation of vessel

TABLE 7-4: Typical Barge Tow Characteristics

Particulars	Symbol	Unit	Jumbo Hopper	Oversize Tank	Special Deck
Width	BM	ft/m	35 / 10.67	53 / 16.15	72 / 21.95
Length	LB	ft/m	195 / 59.44	290 / 88.39	250 / 76.20
Head log Height	HL	ft/m	2-3 / 0.61-0.91	2-3 / 0.61-0.91	3-5 / 0.91-1.52
Depth of Vessel	DV	ft/m	12 / 3.66	12 / 3.66	17 / 5.18
Depth of Bow	DB	ft/m	13 / 3.96	13 / 3.96	18 / 5.49
Bow rake length	RL	ft/m	20 / 6.10	25 / 6.10	30 / 9.14
Loaded Draft	DL	ft/m	8.7 / 2.65	8.7 / 2.65	12.5 / 3.81
Empty (light) draft	DE	ft/m	1.7 / 0.52	1.7 / 0.52	2.5 / 0.76
Cargo Capacity	CC	tons	1700	3700	5000
Empty Displacement	WE	tons	200	600	1300
Loaded Displacement	WL	tons	1900	4300	6300

TABLE 7-5: Typical Characteristics of Barges on the Inland Waterways System

Barge Type	Size	Length (ft/m)	Width (ft/m)	Draft (ft/m)	Capacity (tons)
Open Hopper	**Small**	**120 / 36.58**	**30 / 9.14**	**7 / 2.13**	**630**
Open Hopper	**Standard**	**175 / 53.34**	**26 / 7.92**	**9 / 2.74**	**1060**
Open Hopper	**Jumbo**	**195 / 59.44**	**35 / 10.67**	**9 / 2.74**	**1700**
Open Hopper	**Oversize**	**245 / 74.68**	**35 / 10.67**	**10 / 3.05**	**2400**
Covered Hopper	**Jumbo**	**195 / 59.44**	**35 / 10.67**	**9 / 2.74**	**1700**
Deck Barge	**Small**	**100/150 ------- 30.48/45.72**	**26/32 ------- 7.92/9.75**	**6 / 1.83**	**350/600**
Deck Barge	**Jumbo**	**195 / 59.44**	**35 / 10.67**	**9 / 2.74**	**1700**
Deck Barge	**Oversize**	**200 / 60.96**	**50 / 15.24**	**9 / 2.74**	**2050**
Tank Barge	**Small**	**135 / 41.15**	**40 / 12.19**	**9 / 2.74**	**1300**
Tank Barge	**Jumbo**	**195 / 59.44**	**35 / 10.67**	**9 / 2.74**	**1700**
Tank Barge	**Oversize**	**185/290 ------- 56.39/88.39**	**53 / 16.15**	**9 / 2.74**	**2530/3740**

7.2.3 Vessel Classification of European Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7.6** (Ref: SMART Rivers 2015-PIANC).

TABLE 7-6: Classification of European Inland Waterways-1992

Type of Inland Waterways		Classes of Navigable waterways	Motor Vessels and barges – Type of Vessels Characteristics: Designation	Maximum Length	Maximum Beam	Draught	Tonnage	Pushed Convoys – Type of convoys: General Characteristics	Length	Beam	Draught	Tonnage	Minimum Height under Bridges
				L (m)	B (m)	d (m)	T (t)		L (m)	B (m)	d (m)	T (t)	H (m)
1		2	3	4	5	6	7	8	9	10	11	12	13
Of Regional Importance	To West of Elbe	I	Barge	38.5	5.05	1.80-2.2	250-400						4.0
		II	Campine barge	50-55	6.6	2.50	400-650						4.0-5.0
		III	Gustav Koeings	67-80	8.2	2.50	650-1000						4.0-5.0
	To East of Elbe	I	Gross Finow	41	4.7	1.40	180						3.0
		II	BM-500	57	7.5-9.0	1.60	500-600						3.0
		III		67-70	8.2-9.0	1.60-2.00	470-700		118-132	8.2-9.0	1.6-2.0	1000-1200	4.0
Of International Importance		IV	Johann Welker	80-85	9.5	2.50	1000-1500		85	9.5	2.5-2.8	1250-1450	5.25 or 7.0
		Va	large Rhine Vessels	95-110	11.4	2.50-2.80	1500-3000		95-110	11.4	2.5-4.5	1600-3000	5.25 or 7.0 or 9.1
		Vb							172-185	11.4	2.5-4.5	3200-6000	
		VIa							95-110	22.8	2.5-4.5	3200-6000	7.0 or 9.1
		VIb		140	15.0	3.90			185-195	22.8	2.5-4.5	6400-12000	7.0 or 9.1

7.2.4 Vessel Classification of China Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7.7.** (Ref: SMART Rivers 2015-PIANC)

TABLE 7-7: Characteristics of Reference Motor cargo Vessels- Chinese Classification

Class	Type of vessel: General Characteristics					Type of convoy : General Characteristics				
		Length	Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage
		m	m	m	T	Push tows	m	m	m	T
II	Barge	75	14	2.6	2000	1) 2P. barge -2 rows *1 columns	180	14	2.6	4000
		65	15.8	2.6-2.9		2) 2P. barge -2 rows *1 columns	160	15.8	2.6-2.9	
	Motor Vessel	90	15.4	2.6		3)1 motor vessel	90	15.4	2.6	2000
		65	13	2.6-2.9		3)1 motor vessel	65	13	2.6-2.9	
III	Barge	65	10.8	1.9-2.2	1000	1) 2 P. barge -2 rows *1 columns	160	10.8	1.9-2.2	2000
		55	10.8	2.5		2) 6 T. barges	357	10.8	2.5	6000
	Motor Vessel	68	10.8	2.6		3) 1 motor vessel	68	10.8	2.6	1000
IV	Barge	42	9.2	1.9	500	1) 2 P. barge -2 rows *1 columns	108	9.2	1.9	1000
		42	8.2	1.9-2.1		2) 7 T. barges	320	8.2	1.9-2.1	3500
	Motor Vessel	52	9.6	2.2		3) 1 motor vessel	52	9.8	2.2	500
V	Barge	30	8	1.8-1.9	300	1) 2 P. barge -2 rows *1 columns	82	8	1.9	600
		35	6.8	1.7-2.0		2) 8 T. barges	303	6.8	1.7-2.0	2400
	Motor Vessel	42	8.2	1.8-2.2		3) 1 motor vessel	42	8.2	1.8-2.2	300

After having elaborate analysis over the important ratios, the following comparison has been found as an apt requirement to arrive at the Channel vessel relationship and the same has been compared with the present Classification of IWT vessels considered by IWAI.

TABLE 7-8: Waterway Ratios of different Countries

Relative Waterway Dimensions from Guidelines for different Countries

Location	Ship	Two-lane			One-lane		Driving Quality
	(B x L x D)	F/B	D/d	n	F/B	D/d	category
China Cannel	Average (Class III-VII)	4.4	1.3	7	-	-	A-B
China Cannel	Average (Class II-VII)	4.4	1.4	6-7	-	-	A-B
China River	Average (Class I-VII)	4.4	1.2	-	2.3	1.2	A-B
Dutch normal	11.45 x 185 x 3.5	4.0	1.4	8.7	2	1.3	A-B
Dutch narrow	11.45 x 185 x 2.8	3.0	1.3	6.7	-	-	B-C
France	11.45 x 105 x 2.5	3.1	1.4	5.8	-	-	B-C
Germany	11.45 x 185 x 2.8	3.3	1.4	5.6	1.8	1.4	B-C
Russia	16.5 x 135 x 3.5	2.6	1.3	-	1.5	1.3	C
US River	10.7 x 59.5 x 2.7	3.3	1.3	4.9	2.2	1.3	B-C

TABLE 7-9: Waterway Ratios of Indian IWT (Rivers)

Relative Waterway Dimensions (in Rivers) from Guidelines in vogue in India

Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d Waterway F x D
	F/B	D/d	n	F/B	D/d	
Class I	6.00	1.20	7.20	6.00	1.20	32 x 5 x 1.0 / 80 x 5 x 1.0 30 x 1.2
Class II	5.00	1.17	5.83	5.00	1.17	45 x 8 x 1.2 / 110 x 8 x 1.2 40 x 1.4
Class III	5.56	1.13	6.30	5.56	1.13	58 x 9 x 1.5 / 141 x 9 x 1.5 50 x 1.7
Class IV	4.17	1.11	4.63	4.17	1.11	70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.0
Class V	6.67	1.11	7.41	3.33	1.11	70 x 12 x 1.8 / 170 x 24 x 1.8 80 x 2.0
Class VI	5.71	1.10	6.29	5.71	1.10	86 x 14 x 2.5 / 210 x 14 x 2.5 80 x 2.75
Class VII	7.14	1.10	7.86	3.57	1.10	86 x 14 x 2.5 / 210 x 28 x 2.5 100 x 2.75

TABLE 7-10: Waterway Ratios of Indian IWT (Canals)

Relative Waterway Dimensions (in Canals) from Guidelines in vogue in India

Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d Waterway F x D
	F/B	D/d	n	F/B	D/d	
Class I	4.00	1.50	6.00	4.00	1.50	32 x 5 x 1.0 / 80 x 5 x 1.0 20 x 1.5
Class II	3.75	1.50	5.63	3.75	1.50	45 x 8 x 1.2 / 110 x 8 x 1.2 30 x 1.8
Class III	4.44	1.47	6.52	4.44	1.47	58 x 9 x 1.5 / 141 x 9 x 1.5 40 x 2.2
Class IV	4.17	1.39	5.79	4.17	1.39	70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.5
Class V	--	--	--	--	--	70 x 12 x 1.8 / 170 x 24 x 1.8 --
Class VI	4.29	1.40	6.00	4.29	1.40	86 x 14 x 2.5 / 210 x 14 x 2.5 60 x 3.5
Class VII	--	--	--	--	--	86 x 14 x 2.5 / 210 x 28 x 2.5 --

The parameters of Horizontal clearance and Vertical clearance considered in the Indian Waterway classification guidelines are related to the Cross Structures in the particular waterway. These aspects can be modified for the requirement of Vessel / Waterway size, on need basis.

Further, the Bend Radius criterion is related to the terrain, which can be taken care by Cutting / Protection in the curves.

Hence, the basic Vessel design criteria is related to the Cross Section of the Waterway and accordingly, the factors on Breadth (F / B); Depth (D / d) and Cross Section Area (n), which is now being considered for comparison i.e., the Indian IWT classification with the Waterway classifications of other countries, with reference to the Tables above.

The Range variation on the Factors – Width F / B; Depth D / d and N have been tabulated herewith for an overview.

TABLE 7-11: Range Variation of the Factors

Factor on Width "F / B"

Indian classification – Rivers – SPV / Single Channel	4.17 to 7.14
Indian classification – Canals – SPV / Single Channel	3.75 to 4.44
Others – Waterways – SPV / Single Channel	1.50 to 2.30
Indian classification – Rivers – Convoy	3.33 to 6.00
Indian classification – Canals – Convoy	3.75 to 4.44
Others – Waterways – Convoy	2.60 to 4.44

Factor on Depth "D / d"	
Indian classification – Rivers – SPV / Single Channel	1.10 to 1.20
Indian classification – Canals – SPV / Single Channel	1.39 to 1.50
Others – Waterways – SPV / Single Channel	1.20 to 1.40
Indian classification – Rivers – Convoy	1.10 to 1.20
Indian classification – Canals – Convoy	1.39 to 1.50
Others – Waterways – Convoy	1.20 to 1.40
Factor on Cross Section Area "n"	
Indian classification – Waterways – SPV / Single Channel	4.63 to 7.86
Indian classification – Canals – SPV / Single Channel	5.63 to 6.00
Others – Waterways – Convoy	4.90 to 8.70

Note: Other Waterways, only Chinese waterways are having the segregation available between Rivers and canals. However, the same has not been taken into consideration.

Indian IWT classification has not been provided with "n" value for convoy system, which is essential.

Other Waterways has not been provided with "n" value for SPV / Single Channel.

In the above, the range of Indian IWT Classification on Width factor "F/B" and Cross Section area factor "n" are well within the safer range. Whereas, the Depth factor "D/d" may have to be relooked into and this will have larger implication on the West flowing rivers i.e., the present study stretch areas.

7.3 Type of proposed Vessels

The most suitable river vessel is to be considered based on the following aspects viz., Fairway availability; Availability of Day / Night navigation system; Obstructions enroute like Locks; Navigational clearances free cross structures; Haulage distance; Type and Nature of Cargo; Terminal facilities etc.,.

In brief, the study stretch of river Mapusa has been limited to Class IV in the proposed stretch up to Ch 17 km, keeping in view the cargo mobility etc.,.

Vessel Requirement for a waterway can be segregated mainly into two parts i.e., Waterway maintenance vessels and Cargo vessels. There are many vessels required for maintenance of waterway viz., Dredgers; Tugs; Survey vessels; Navigational Equipment maintenance vessels; Patrol Boats; Pilot Boats; Inspection Vessels etc.,. The said abundant types of vessels may not be required for the proposed stretch and neither suggested nor recommended. However, 2 Nos of Survey Vessels / 2 Nos. of Buoy Layiong Vessels / 2 Nos. of Inspection Boats have been provisioned for the entire Cluster of 6 waterways and projected as a part of the Institutional requirement in Chapter 10. The apportioned cost for river "Mapusa" has been considered, as a part of development of this waterway. Hence, the present discussions are being concentrated only on Cargo Vessels.

The river Mapusa is being proposed for the mobility of 1 SPV of 1000 T or 2 x 1000 T Barges with 1 Pusher Tug (PT). These vessels will ply also by taking tidal advantage for smooth uninterrupted mobility. The estimated IWT Traffic volume may reach to a max of 1 MMTPA.

Keeping in view the traffic growth and also keeping in view the classification standards of India in vogue, the maximum standard that can be considered as 2000 T mobility with 2 Barges (Dumb Barges – DB) of 1000 T with 1 Pusher Tug (PT) combination, for the stretch up to the Vedanta IWT Port. The same combination may be sufficient for usage by other operators and up to the proposed Terminal of IWAI @ Ch. 17 km.

For the above scenario, the most suitable vessel size has already been defined in Class IV of the classification. The configuration of 170 m x 12 m x 1.8 m for 1 PT + 2 DBs with the channel requirement of 50 m x 2.0 m for two ways Navigation will be required, if traffic volumes increase. In general, there will be a saving in the power of about 20 % in "Push Towing" for comparable Loads. Further, keeping in view the operational safety considerations in the river navigation, the "Pull Towing" is avoidable and hence only the "Push Towing" is recommended.

7.4 Proposed Vessel Size and Specifications

In line with the above derivations, the vessel size and specifications are placed herewith.

Self-Propelled Vessel: (1000 T) INR 800 Lakhs each. {Not Recommended}

Length: 75 m

Breadth: 14 m

Loaded Draft / Depth: 1.8 m / 2.5 m +

Cargo Capacity: 1000 T

Propulsion: Marine Diesel Engines of 2 x 625 Bhp

Tug Barge Combination: (1 P. T + 2 DBs of 1000 T each – 2000 T)

Pusher Tug **INR 900 Lakhs each**

Length: 30 m to 40 m

Breadth: 12 m to 14 m

Draft / Depth: 1.7 m / 2.0 m +

Cargo Capacity: - -

Propulsion: Marine Diesel Engines of 3 x 800 Bhp

Speed (with Load): 16 kmph to 20 kmph in D/s and 12 kmph to 16 kmph in U/s

Dumb Barge	**INR 500 Lakhs each**
Length:	70 m to 75 m
Breadth:	12 m
Loaded Draft / Depth:	1.8 m / 2.0 m +
Cargo Capacity:	1000 T

Note: Depth + is an indication for provision of increased depth for the vessel mobility as a coaster.

Keeping in view the type of cargo as Bulk / Break Bulk, the SPV and the DBs will be considered as a Hold type. The structural designs of vessels are to be considered as per the Inland Vessels Act and as per the rules of Indian Register of Shipping. Further, the vessels now proposed are to maneour in the west flowing rivers like Mapusa-Moide and also through Arabian Sea. Accordingly, the concerned applicable rules and acts are also to be consulted while constructing such vessels. The Tugs / Work Boats are to be capable of maintaining a good speed of about 16 kmph to 20 kmph with load in down stream mobility and 12 kmph to 16 kmph with load in up stream mobility. The relative trial tests are also essential to be conducted, as per the guidelines. The mobility through captive terminals will be considered by the stake holders. However, with the commencement of operation through IWAI Terminal in 2030, the vessel requirement will be as detailed.

1 PT + 2 DBs may be required by 2033. {Construction from 2030 to 2033}

1 PT + 2 DBs may be required by 2038. {Construction from 2035 to 2038}

7.5 Turn around Time

Turn Around Time (TAT) for the Inland Navigation is a most critical analysis, involving many practical issues, linked with the Fairway constraints; Terminal Operational Constraints; Availability of Day / Night Navigation system; Vessel speed etc.,.

The requirement for the project from the IWAI may be only the provision of “Fairway” with proper Navigational channel dimensions and a safe Day / Night Navigation system, to facilitate the existing stakeholder’s mobility.

Hence, the working of TAT may be essential only to cater to the requirement of other traffic proposed / expected to be handled in the IWAI Lo-Lo Terminal to handle the Iron Ore cargo of max 0.9 MMTPA in FY 40.

Bulk / Break Bulk Cargo:
In the proposed IWAI Terminal location, maximum designed propositions are catered with 1 Berth of 75 m length to accommodate 1 Barge at any point of operation and considering

2 cranes (Each Crane of 125 TPH with 80 % efficiency) with 16 Hrs of operation, it can clear about 0.9 MMTPA.

The Bulk / Break Bulk cargo is to be moved from Anchorage to IWAI Berth i.e., for a distance of about 40 Km. (Marmuagoa is about 23 Km from Mapusa confluence with Mandovi + Distance in the river upto IWAI Terminal is about 17 Km). Keeping in view the average speed of the vessel as 20 Kmph, the journey Time is 2 Hrs.

The TAT will be as detailed:
Loading at IWT Terminal 16 Hrs + Onward Journey 2 Hrs + Unloading at Port 4 Hrs + Return Journey 2 Hrs = Total 24 Hrs.

7.6 Number of Vessels Required

In order to handle Iron Ore cargo, 1 PT + 2 DBs - 2000 T with TAT with 20 Hrs round trip can carry 2000 T. Accordingly, in 300 days, it can handle about 0.6 MMTPA, wherein 2 units with 2 SPVs can handle about 1.2 MMTPA, which may be sufficient to handle the estimated cargo.

As above, it is proposed to be enhanced to 2 units after 5 years, on need basis. Besides, this proposal is only after the capacity saturation, which may take some time to settle i.e., up to 2030.

1 PT + 2 DBs may be required by 2033. {Construction from 2030 to 2033}

1 PT + 2 DBs may be required by 2038. {Construction from 2035 to 2038}

7.7 Vessel Repair facilities

Vessel Repair facility in close proximity always will have added advantage for ease and timely operation of IWT Vessels. On board Minor repairs can be considered, while the vessel under mobility, wherein the Major repairs and Dry Dock repairs may have to be attended only in the Ship Yards. There is no repair yard in the study stretch of Mapusa River, which is in North Goa. (also a tributary to Mandovi).

However, the state of Goa had glorious days till recently on IWT activity, especially in mobilizing the Iron Ore export cargo, through Mandovi River, Zuari River and other inter related Waterways. The same has retarded with the reduction in the volumes based on the policy issues. Revamping is on, but may take longer time. During the jubiliant days of IWT mobility, many repair yards flourished in Goa and waiting for the revamp of this sector. Certain notable shipyards in the vicinity are tabulated and placed.

Sl. No.	Shipyard	Promoter	Approx Location
1	Goa	Western India Shipyard	South Goa
2	Goa	Goa Shipyard	South Goa
3	Mandovi Drydock	-	South Goa
4	Chicalim, Goa	Waterways Shipyard	South Goa
5	Dempo Shipbuilding & Engineering	Dempo	North Goa
6	Chowgule shipyard	Chowgule Group	South Goa
7	Vijai Marine Shipyard	Vijai Marine Services	South Goa
8	West Coast & Nigel Shipyard	-	South Goa
9	Timblo Drydocks	Timblo	South Goa

7.8 Vessel Costing

7.8.1 Capital Cost

At the outset, it is to place that the Capital Cost of the vessel may not form part of the Financial / Cost analysis, since the deployment of vessels will be considered by the Vessel Owners, who will deploy the required type of vessel. It has been noted that the Capital Vessel Building Subsidy is under consideration by IWAI / Administrative Ministry of Shipping, which is being recommended herewith to give boost to this sector.

Hence, the indicative cost, as ascertained from the Market, is being furnished herewith.

Self Propelled Vessel: (1000 T) {Not Recommended} with Length – 75 m; Breadth – 14 m; Loaded Draft / Depth – 1.8 m / 2.5 m +; Cargo Capacity – 1000 T and Propulsion by Marine Diesel Engines of 2 x 625 Bhp is costing about INR 800 Lakhs each.

Pusher Tug: with Length – 30 to 40 m; Breadth – 12 to 14 m; Draft / Depth – 1.7 m / 2.0 m + and Propulsion by Marine Diesel Engines of 3 x 800 Bhp is costing about INR 900 Lakhs each.

Dumb Barge: with Length – 70 m to 75 m; Breadth – 12 m; Loaded Draft / Depth: 1.8 m / 2.0 m + with Cargo Capacity of 1000 T is costing about INR 500 Lakhs each.

Note: Depth + is an indication for provision of increased depth for the vessel mobility as a coaster.

7.8.2 O&M Cost

The Operation & Maintenance cost (O & M Cost) for the Vessels being considered in the IWT project, in general, consists of Running Cost of the vessels; Crew Cost; Repair Cost; Depreciation Cost; Insurance factor and Interest Factor. The vessel mobility is under consideration of 1 Unit as 1 PT + 2 DBs, for which the indicative O & M Costs have been worked out.

1 PT + 2 DBs (For 1 Year)

· 1 PT Running cost for 300 days operation with 24 Hrs turnaround (300 Cycles) of which 4 Hrs mobility in a cycle, cost per annum will be as detailed. No Running cost of DB.

· 300 cycles x 4 Hrs x {0.1 Liter per hour x 3 Engines x 800 Bhp} x INR 70 per Liter = **INR 201.60 Lakhs Per Annum** per Unit.

· No Running cost for Barges.

· 8 Nos. Crew on 1 PT + 2 Nos. Crew on each DB, totalling to 12 Nos. @ INR 0.50 Lakhs per month.

· Crew cost for 12 months will be 12 x 12 x 0.5 = **INR 72 Lakhs Per Annum** per Unit.

· Repair Cost is @ 2 % P. A of CAPEX i.e., 0.02 {1 x 900 + 2 x 500} = **INR 38 Lakhs Per Annum.**

· Depreciation is proposed by considering the life of vessels as 20 Yrs.

· Interest factor is proposed as per the industry norms.

· Insurance factor is proposed as per the industry norms.

CHAPTER 8 NAVIGATION AND COMMUNICATION SYSTEM

8.1 General Requirements

A full proof communication system in the River Navigation is a most important requirement in order to maintain the safety of the entire system. Safety is one of the important parameters that have to be considered for the development of the inland navigation along with the protection of the environment and efficiency. In order to have undisturbed and uninterrupted development and maintenance of Inland navigation System, safe communication is most important.

Safety implies that navigation risks on the waterway stretch need to be at an acceptable level. In particular, the risks of:

- Ship-to-ship collisions;
- Ship-bridge collisions;
- Groundings;

Need to be minimised, rather to be nullified. Accordingly, to accomplish, an adequate visual marking of the fairway have to be done. Even if more advanced and potentially more accurate systems are deployed, visual fairway markings are used to verify proper navigation and are also a necessary backup in case of system failures.

8.1.1 VHF / HF

Communication is essential for navigation in Inland Waterways. Due to the VHF the captains of the vessel can communicate with each other. The VHF communication can be recorded if the system will be equipped with VHF-transceiver. The recordings of the VHF can be used to investigate incidents or near-incidents to prevent future incidents.

8.1.2 GPS

The DGPS system provides the RIS-system with a correction value. This correction value increases the accuracy of the AIS transponders on-board of the vessels. The AIS base station transmits the correction signal through the designated AIS message or DGPS correction.

8.1.3 RIS / AIS / Radar / VTMS

RIS is a concept for harmonised information services which supports traffic and transport management in inland navigation, including interfaces to other transport modes.

The general technical solution is depicted in Figure below.

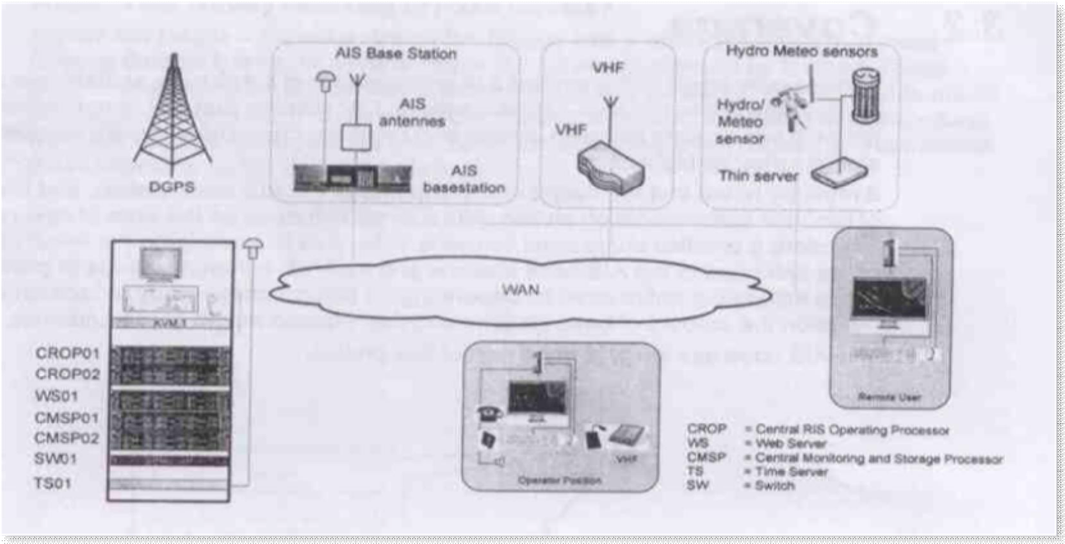
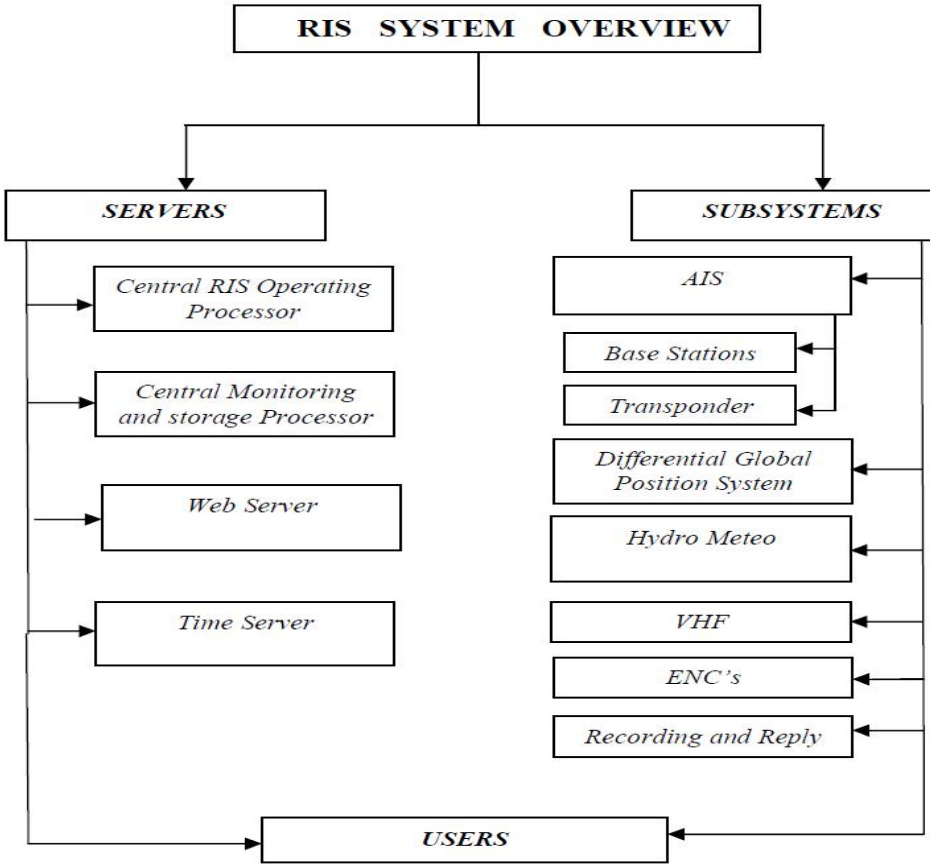


Fig 8.1 Main components of the RIS system are given below in flowchart:



River Information Service (RIS) system is one among the latest technology introduced in Inland Water Transport sector, which is in nascent stage in India. It has been ascertained that the system is suitably designed keeping in view the PIANC and IALA guidelines for setting up of RIS.

In the RIS system, a group of base stations is connected by LAN through lease line. Each of the stations is located at 50-60Kms intervals. These base stations will have 30 Kms (approx) radial coverage and two way communication between vessels plying in their region and management authority. The goal of safe and efficient transportation can be achieved by avoiding navigational risks like ship to ship collision, ship to bridge collisions and vessel groundings. In addition, RIS system provides fairway information, traffic information, calamity abatement support etc. Efficiency of this system gets greatly increased when there are multiple users of the waterway with different type of vessels and different types of cargo.

Components of RIS systems: The River Information Services (RIS) System consists of (a) base stations, (b) control stations and (c) Mobile /user stations.

a. Base station: Deploy series of sensors for exchange of electronic data between the control station and the vessels. Two porta cabin at each stations are equipped with latest version of the sophisticated electronic equipment's transmit the waterway information namely navigable depth in their jurisdiction, channel limits with virtual buoys, terminal facilities, port clearance etc. The AIS and VHF antennae and meteorological sensors are installed on the mono pole tower of 30 meter height at each station to provide update weather information. The basis of height calculation will be considered based on the geographical position including the Antenna height and the vessel Antenna elevation.

The list of equipment's include

- Automatic Identification Systems (AIS) equipment
- Meteorological equipment.
- VHF equipment's with Tx/Rx installed on 30 mtr mono pole.
- Gen Set 10 KVA with UPS 5 KVA for 2 hours backup.

b. Control station: The control station is responsible for situational awareness of waterway for undertaking coordinated actions to ensure safe passage of vessels through the waterway. The control station has been set up along with any one of the base station suitability near to the Regional Office. As the name indicates, control station carry out all standing orders and collect the data of cargo/vessel movement and keep back up for analysis and further improvement of efficiency. The control centers include 2x control Centers Servers for AIS data record and display, WEB Servers which provide traffic situation presentation via Web interface. This also includes Operator Workstations. Operator have comprehensive tabular information about traffic, wide variety of navigational alarms, traffic management tools like zones, reporting lines, routes, traffic prediction tools, control of AIS base stations. Tools such as Playback are available for each Operator. All above mentioned system components interact between each other via TCP/IP protocol i.e. proposed system is completely IP based. The control station consists of the following computer hardware:-

- Central RIS Operating Processor
- Central Monitoring and Storage Processor
- Web Server & Time Server
- Workstation
- Operator Display 52" LED wide Screen+ with operator display
- RIS software

c. Mobile/user station;- The state of art equipment installed on board each vessel for her safe navigation and smooth sailing for 24x7 in clock.

- AIS Transponder Inland Class – A

- VHF Sets with Antenna
- Echo Sounder
- DGPS Receiver
- Short Range Radar
- Laptop (Tough Book) - 14” with 5 KVA UPS
- MFD Multi-Function Display 19” size

d. Manpower: Each of the base stations and control station are manned 24x7 round the clock by 3 operators and 3 security personnel. Accommodation facilities have been provided in the porta cabins. The manpower deployments are covered under Operation and Maintenance of RIS system.

As ascertained, IWAI has already initiated the implementation of RIS system in phased manner.

Observations:

1. AIS receiver is must on board the vessels utilizing the Waterway.
2. Preferred to provide the RADARs installed at selected locations, for easy tracking of vessels.
3. Trained Operators can effectively be utilized for ensuring proper running of RIS system.

8.1.4 Vessel / Hydrographic Survey equipment

The RIS-system also requires that certain systems are available and working on the used vessels. The system should be connected and integrated with each other. The required systems are:

- AIS transponder
- VHF
- Radar
- Hydro and meteo sensors
- Echo sounder
- Electronic chart display capable of displaying virtual buoys

8.2 Existing System

IWAI is already having the communication system on NW 1 / NW 2 along with Day / Night Navigation system which have been developed considering the AIS and DGPS stations. Further, the adaptable Digitized charts are already being used linked with Survey Equipments viz., Echo-sounders and GPS with a provision for updating the charts. Provision also is under consideration to link up with the Day / Night Navigation Buoys.

8.3 Additional requirement

The communication system technology is rapidly changing with Technology change. Accordingly, within a short gap of time, the existing system is leading to an obsolete scenario. Hence, development of a sustainable system is very difficult. However, an attempt has been made and a workable rather reliable system has been worked out and placed as Annexure 8.1. This is only indicative. A map indicating the Radar station is also placed for reference at Annexure 8.2.

Further to the above, an attempt has been made to ascertain the details on the alternative real time ship tracking system viz., Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed.

Subsequent to the discussions with the stakeholders' viz., Maharashtra Maritime Board and Mumbai Port Trust, it was noticed that the Ministry of Shipping, Govt. Of India has already initiated the working about feasibility and implementation of "National Coastal Grid of VTMS", in which a considerable distance of the Rivers joining the sea also is under consideration. This proposal is from the strategic safety point of view and is expected to take some more time. It is suggested to have a dialogue at later date by IWAI for a full proof communication / navigation system in the National Waterways joining the sea in both West / East coast.

Regarding the RIS on "Mapusa River", there is no mobility to substantiate the provision of RIS. Further, the river Mapusa is only a tributary to Mandovi and the RIS initially is to be developed in the main river. However, the cost details are provisioned for taking up the same, at later date, if the need is judicious.

8.4 Specifications of certain equipment's of the system

The following indicative specifications on various equipment's proposed for developing the RIS unit are placed. A system context Diagram is placed at the end.

VHF sets with Antenna

- Channel Capacity minimum - 100
- Frequencies 156.00 - 161.50 Mhz (Marine Universal frequency band)
- Rx @ Rated Audio 2 A max
- Tx @ Rated Audio 14.5 A max
- Power Supply 12 VDC to 24 VDC
- Channel Spacing :- 12.5 kHz/ 25 kHz
- Audio Response:- + 1, -3 dB

- Adjacent Channel Selectivity:- 60 dB @ 12.5 kHz 70 dB @ 25 kHz

<u>Metrological Equipment's (Anemometer, Barometer, Relative Humidity)</u>

Wind Speed

- Range: 0 to 60 m/s
- response time 250 ms
- accuracy : 0 to 35 m/s: $\underline{+}$0.3 m/s or $\underline{+}$3%, whichever is greater
- Output resolution and unit: 0.01m/s
- Protection IP66
- Serial Output:RS232/485

Wind Direction

- Azimuth: 0 to 360°
- Response time: 250 ms
- Accuracy: $\underline{+}$3°
- Output resolution and unit: 1°
- Protection IP66
- Serial Output:RS232/485

Air temperature

- Range: - 50 3 to +60 °C
- Accuracy for sensor at +20 °C: $\underline{+}$0.3 °C
- Output resolution and unit: 0.1 °C

Barometric pressure

- Range: 600 to 1100 hPa
- Temp: -50 to +60 °C
- Accuracy: $\underline{+}$0.5% of analog pressure range, digital accuracy 0.2 hPa (25°C)
- Output resolution: 0.2hPa

Relative humidity

- Range: 0 to 100 %RH
- Accuracy: $\underline{+}$3 %RH within 0 to 90 %RH $\underline{+}$5 %RH within 90 to 100 %RH

Output resolution and unit: 0.1 % RH

<u>Control Station Servers (CROP / CMSP / WS / TS)</u>

<u>Central RIS Operating Processor (Application cum Data base Server)</u>

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 2TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- 52" LED Display. The Operator console should be minimum 21" size.

<u>Central Monitoring and Storage Processor (Web Server / GIS Software)</u>

- Processor Intel Xeon – 4 core

- RAM 64 GB
- HDD 10TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition

Web Server & Time Server (Application cum Data base Server)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 4TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- Concurrent 50 web users

Operator Console

· Processor :-	Intel® Core™ Xeon Processor or
· Operating	Latest Windows operating system 64
· Display :-	24. 0" (min)
· Memory :-	16 GB RAM (min)
· Hard Drive :-	2.0 TB SATA Hard Drive (min)
· Optical Drive	DVD +/- RW
· USB Ports	4 Ports minimum
· Memory card	Standard Memory Card Reader slots
· Warranty :-	3 Year Complete Cover Accidental

Operator Display

- 52” LED Display wide Screen

General Features for RIS Software/ Application

1. Provide the situational awareness and Traffic overview of channel to the Traffic Operators in the Control centre.

2. Facilitate planning of the river Channel activities on a ‘Time-line’ view of the Traffic Display.

- The GUI (Graphical User Interface) should be capable of displaying the arrival and departure information of vessels entering and exiting the Channel with date and time indicators.
- List all important activities being undertaken in the Channel
- Should Display various important activities being undertaken in the Channel, which includes activities of the ‘previous Operator Watch’, ‘current Watch’ and the activities being planned for the ‘next Watch’.
- It must be possible to define start and end-point of the time line
- It must be possible to choose the waterway for the time line.

3. Facilitate the Operator to ‘Define’ the conditions for generating Alerts / Warnings by the system and automatic generation of Alerts / Warnings in the event of any abnormality

4. Facilitate escalation of the alerts / warnings to all important stakeholders using SMS / email.

5. Undertake Incident management during emergencies

6. Receive AIS messages from Base stations and store important AIS messages. Data storage facilities should be able to store data for a period of one year. AIS messages received by multiple stations shall be stored only once.

7. Send out AIS messages broadcast and individual to Vessels in the river channel

8. Disseminate met data on case to case basis to vessels in the system.

9. Facilitate communications between the Traffic operator and captains of the vessels using VHF.

10. Provide the situational awareness and Traffic overview of the river channel to important stakeholders over the web using web access. Web Access shall be planned for minimum 50 stakeholders which shall be scalable at later date.

11. Application should be web based and available on PC, tablet and smartphone (Android and IoS). Application must be available as App for Android Users.

12. BITE facility to provide system status to the Operators to detect any abnormality in the functioning of the sensors integrated with the system.

13. Support integration with other Command and Control systems of security agencies of Police, Navy / Coastguard etc. for building up a collaborative contingency plan in case of emergencies.

14. Should facilitate Storing of important information being received from the sensors such as:-

- Storing of display scenarios
- AIS messages
- VHF data
- Warning / Alerts

Minimum one year data shall be stored.

15. Facilitate automatic detection of the abnormal behaviors of Vessels such as over speeding, vessel entering or leaving demarcated non-entry area, Anchor watch etc. This automatic detection shall be done based on AIS data in the system.

16. Should be able to Zoom, and navigate to any geographical area in the Channel.

17. Should be possible to switch between ENC and Google Maps presentation.

18. Should have the facility for inserting temporary charts (such as plotting point, lines, circle etc.) on the map.

19. Should be able to search any vessel on the geographical location at the given instant.

20. Should have tools to calculate "Closest Point of Approach, TCPA, Range & Bearing Line, ETA, Distance between 2 Vessels or points" etc. in the Channel.

21. Facilitate geo fencing.

22. Capability to provide Virtual Buoys / Aids to Navigation inputs. This according international standard for ATON via AIS.

Based on the market survey, the cost implications are placed herewith,

8.5 Costing

8.5.1 Capital Cost / O & M Cost

Provision of RIS is not suggested, at this point of time. However, cost implications are placed.

COST FOR RIS SYSTEM ON "MAPUSA RIVER (NW-71)"

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
A.	**CAPITAL COST**			
1	AIS Base Station (Hot standby for 2 locations)	2	30,00,000	60,00,000
2	RADAR	2	50,00,000	100,00,000
3	Meteo Sensor	2	8,00,000	16,00,000
4	ATG	2	11,90,000	23,80,000
5	VHF	2	5,00,000	10,00,000
6	DG Set 10 KVA	2	7,00,000	14,00,000
7	UPS	2	5,00,000	10,00,000
8	RIS Software	2	65,00,000	130,00,000
9	RIS Hardware	1	120,00,000	120,00,000
10	Installation Testing & Commissioning	2	20,00,000	40,00,000
11	Porta cabin	4	12,00,000	48,00,000

COST FOR RIS SYSTEM ON "MAPUSA RIVER (NW-71)"

Sl. No .	Equipment	Qty	Unit Price (in INR)	Total (in INR)
12	Trestle Tower	2	10,00,000	20,00,000
13	Land Cost	-	Lump Sum	34,20,000
14	Buildings etc.,	-	Lump Sum	74,00,000
			Total	**7,00,00,000**
B.	**MANPOWER COST**			
	1^{ST} YEAR			
	1 Engineer * 1 NW * 12 months p. a	12	35,000	4,20,000
	3 Operators * 2 Sites * 12 months p. a	72	20,000	14,40,000
	3 Security * 2 Sites * 12 months p. a	72	15,000	10,80,000
	Total for 1^{st} year			**29,40,000**
	Total for 2^{nd} year (7 % on the previous year)			**3,145,800**
	Total for 3^{rd} year (7 % on the previous year)			**3,366,006**
	Total for 4^{th} year (7 % on the previous year)			**3,601,626**
D.	**CAMC for 4 years**			
	1^{st} year			**-Nil-**
	2^{nd} year (10 % on the Capital Cost)			**70,00,000**
	3^{rd} year (+ 10 % on the previous year Cost)			**77,00,000**
	4^{th} year (+ 10 % on the previous year Cost)			**84,70,000**
D.	**LICENSE COST (per annum)**			
	Wireless etc.,			33,00,000
	VHF	3	5,000	15,000
	Other Miscellaneous		Lump Sum	85,000
			Total	**34,00,000**

A. Equipment Cost has been ascertained from the Market, in consultation with IWAI.
B. Man Power Cost has been worked out as per the reuirement and only indicative.
C. Cumulative Annual Maintenance Cost is indicative.
D. The Annual License Cost may vary acoording to the policy of the Licensing Authority.
E. The above cost is not being considered for any cost analysis, since it is only optional.
F. If RIS is planned for implementation, additional cost of INR 0.5 Lakhs / Buoy may have to be added.

An Indicative Module of River Vessel Tracking Information System has been placed at Annexure 8.1.

Further, the following indicative Figures / Diagrams are placed herewith.

1. ***Typical Automatic Identification System (AIS) on Mapusa River and its connectivity to Control Centre***

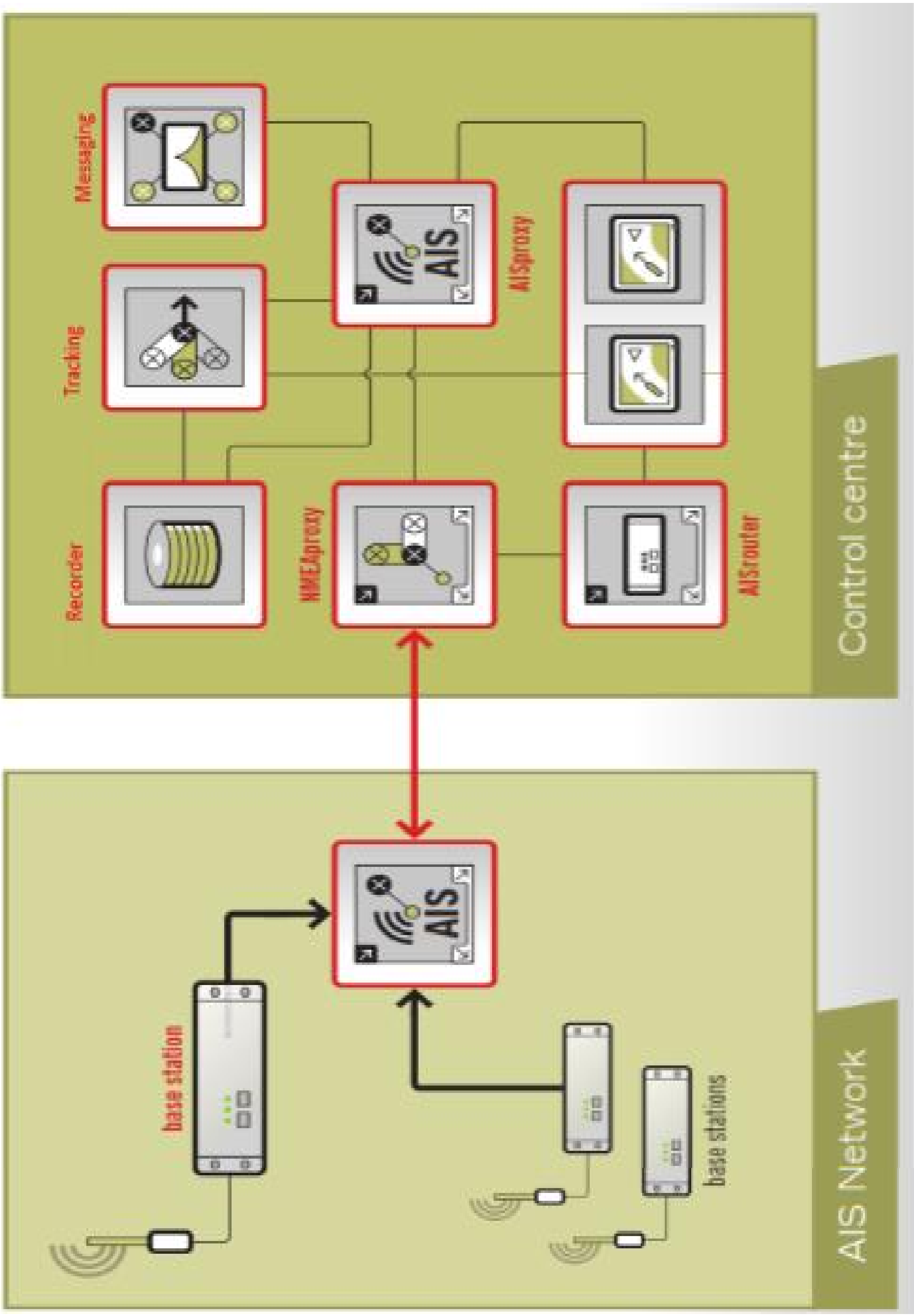
2. ***Diagram indicating the existing Centres (MR) along the coast and Proposed Centres (RR) along the National Waterway***

3. ***Typical line diagram showing the interface of other systems with the Radar system are placed herewith.***

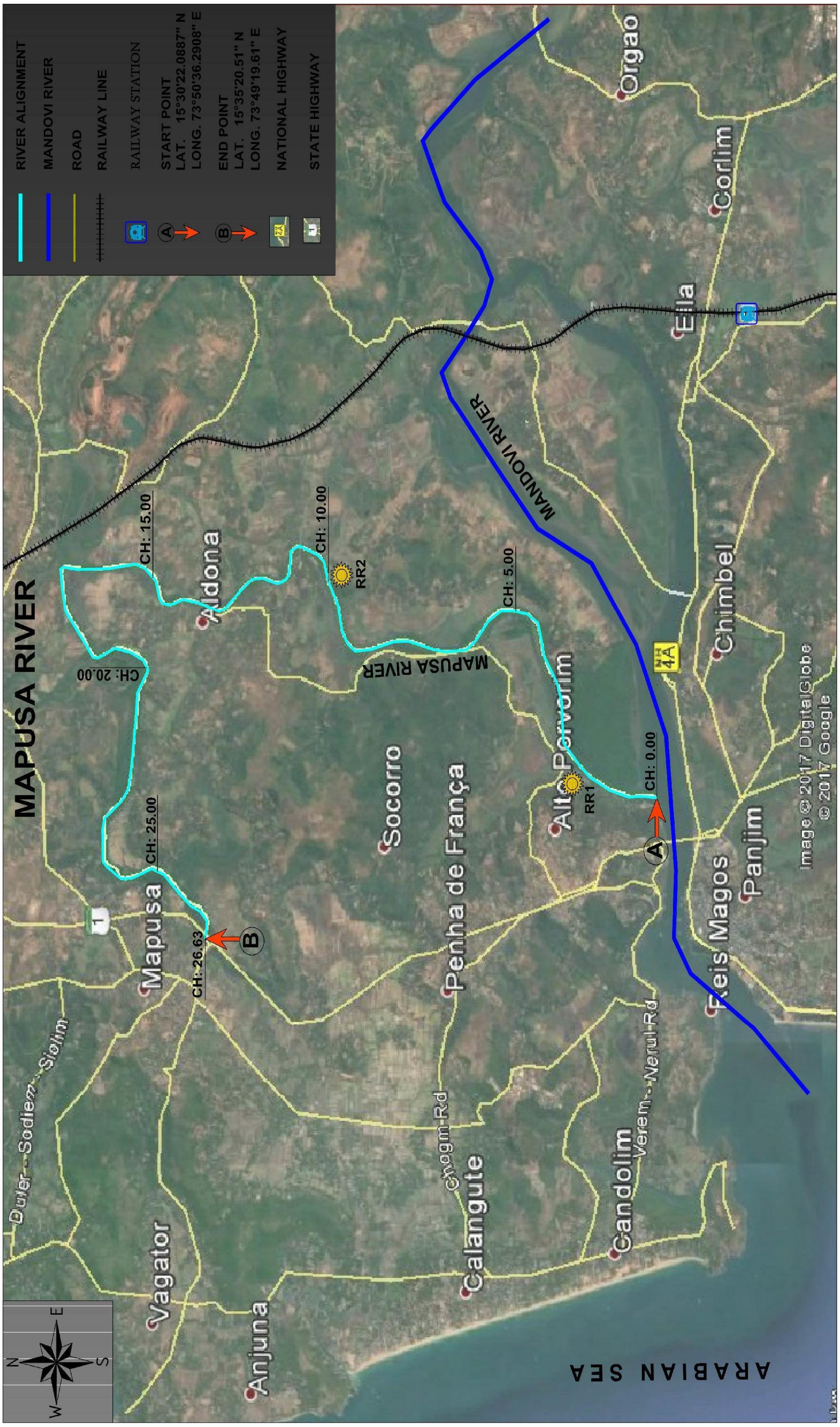
AIS (Automatic Identification System)

Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

The AIS Base Stations installed in VTS will receives ships information and send to data processing for process and display on Display Terminals



AIS (Automatic Identification System)


MAPUSA RIVER
RIVER ALIGNMENT
MANDOVI RIVER
ROAD
RAILWAY LINE
RAILWAY STATION
START POINT
LAT. 15°30'22.0887" N
LONG. 73°50'36.2908" E
END POINT
LAT. 15°35'20.51" N
LONG. 73°49'19.61" E
NATIONAL HIGHWAY
STATE HIGHWAY
CH: 0.00
CH: 5.00
CH: 10.00
CH: 15.00
CH: 20.00
CH: 25.00
CH: 26.63
A
B
RR1
RR2
MAPUSA RIVER
MANDOVI RIVER
Mapusa
Aldona
Socorro
Penha de França
Alto Porvorim
Reis Magos
Panjim
Chimbel
Ella
Corlim
Orgao
Candolim
Calangute
Vagator
Anjuna
ARABIAN SEA
4A
Image © 2017 DigitalGlobe
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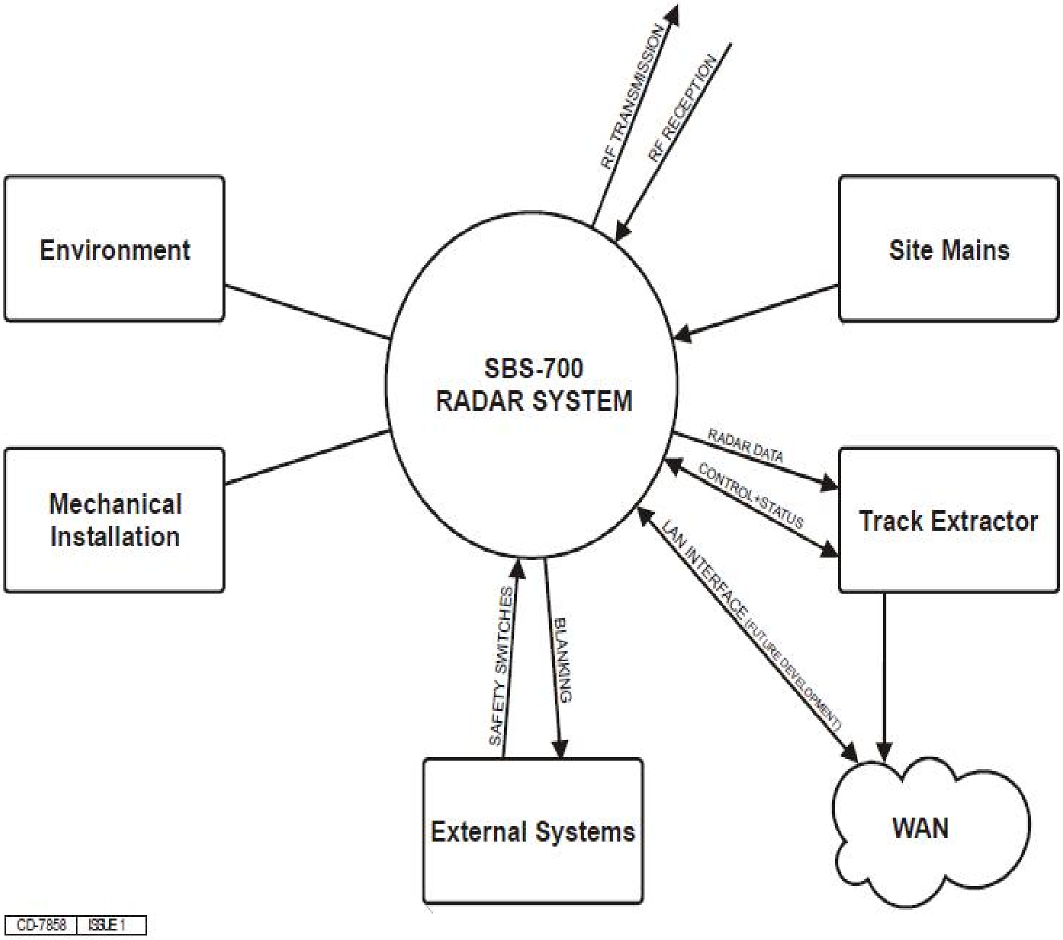

RF TRANSMISSION
RF RECEPTION
Environment
Site Mains
SBS-700
RADAR SYSTEM
RADAR DATA
CONTROL+STATUS
Mechanical
Installation
Track Extractor
LAN INTERFACE (FUTURE DEVELOPMENT)
SAFETY SWITCHES
BLANKING
External Systems
WAN
CD-7858
ISSUE 1

CHAPTER 9 ENVIRONMENTAL & SOCIAL ASPECTS

9.1. Objective of Environmental and Social Studies

The objective of the environmental and social studies is to assess the environmental and social impacts due to the proposed development works and suggest a suitable environmental management plan (EMP) to mitigate adverse impacts, if any, including its cost. In addition, Consultant has to identify the authorities who will give the clearance for EIA / EMP.

9.2. Environmental Setting in the Project Area

The proposed project is designated as national waterway no. 71 under the National Waterways Act 2016 and is located on Mapusa River in the North Goa district of Goa State. A 26.638 km stretch of the Mapusa river beginning from the confluence point of Mapusa and Mandovi rivers at Porvorim Lat 15°30'20.01"N, Long 73°50'42.09"E to the Bridge on National Highway # 17 at Mapusa Lat 15°35'20.79"N, Long 73°49'17.20"E has been declared as new national waterway no. 71 under the National Waterways Act 2016.

The environmental setting in the project area is described in the sections that follow.

9.2.1. Physiography

North Goa district, where NW 71 is located, lies in the northern part of Goa state. The geographical area of the district is 1,736 sq km, and is situated between north latitudes 15º 16' 30" & 15º 48' 15" and between east longitudes 73º 40' 30" & 74º 17' 15". The district is bounded by Sindhudurg district of Maharashtra in the north, Belgaum district of Karnataka in the north–east, Uttara Kannada district of Karnataka in the east, South Goa district in the south and by the Arabian Sea in the west.

Physiographically, North Goa district can be broadly divided into the following four distinct morphological units from west to east:

i. coastal plain with marine land forms on the west,
ii. vast stretch of plains adjoining the coastal plain,
iii. low dissected denudational hills & tablelands towards the east, and
iv. deeply dissected high Western Ghats denudational hills along the eastern most part of the district.

Principal rivers draining through the district include the perennial rivers Terekhol, Chapora, Mandovi & Zuari and the non – perennial (seasonal) river Baga. The river basin of all these west flowing short rivers originate from Western Ghats and drain in the Arabian Sea in the west under estuarine environment.

Primarily, the underlying rocks govern the drainage system in the area. The drainage pattern is generally dendritic type. The major river Zuari follows the major NW synclinal axis. The river valleys are 'V' shaped in the western high hill ranges, but broaden in central midlands and become 'U' shaped in the low lands and coastal plains.

(Source: Ground Water Information Booklet, North Goa District, Goa State, Central Ground Water Board, Ministry Of Water Resources, Government of India, June 2010)

Mapusa River, which is also known as Moide River, is a right bank tributary of Mandovi River. The river originates from the jungles of Dumacem and Amthane, meanders eastward and then southward before draining into the Mandovi River at Penha de France (Bardez) in North Goa district.

The total length of the river is about 31 km before joining the sea. The river is under tidal effect of the Arabian Sea (backwater effect) up to Mapusa about 27 km from the river confluence with River Mandovi. The entire 27 km stretch of the river designated as NW - 71 is under tidal effect of the Arabian Sea.

Mapusa River has a relatively small catchment area and its tributaries are small feeder streams and canals. The total catchment area of Mapusa River basin is 190 sq. km.

9.2.2. Geology and Seismicity

North Goa district is dominantly covered by the formation of Goa Group belonging to Dharwar Super Group of Archaean to Proterozoic age. Deccan Trap of Upper Cretaceous occupies a narrow strip along the north-eastern corner to Lower Eocene age.

The Goa Group comprises of metamorphic rocks of greenschist facies, and is divided into Barcem, Sanvordem, Bicholim and Vageri formation in the ascending order of superposition. The Goa Group of rocks has been intruded by granite gneiss, feldspathic gneiss, hornblende gneiss and porphyritic granite, followed by basic intrusive.

During the Sub – Recent and Recent times, the rocks have been subjected to lateritisation of varying thickness. Thus, laterite occurs extensively covering almost all the formations in North Goa district.

Coastal alluvium occurring along the coastal plains consists of fine to coarse sands with intercalations of sandy loam, silt and clay.

The Goa group of rocks is disposed in a general NW – SE direction. The rock types indicate three cycles of folding. The straight coastline suggests the major fault along the west coast. Associated with this fault a number of weak planes have developed. Along these weak planes Terekhol, Chapora, Mandovi and Zuari rivers flow to meet the Arabian Sea.

Western Ghats, which extends in NS to NNW – SSE direction represent a prominent fault zone. Even though the rock types of Goa Group have suffered considerable faulting, all the faults are not exposed on surface owing to the extensive cover of laterite.

(Source: Ground Water Information Booklet, North Goa District, Goa State, Central Ground Water Board, Ministry Of Water Resources, Government of India, June 2010)

Goa forms part of the moderate seismic zone in the country, namely, Zone IV of seismic zoning map of India.

Although Goa has not witnessed earthquakes directly, the tremors of the devastating earthquakes with magnitude 5.0 or more that hitted “Koyana” and “Latur” in Maharashtra in the year 1967 and 1993 respectively, affected the routine life of the people in Goa as many of the residential as well as public structures, infrastructures were damaged severely, although no casualties were taken place.

(Source: http://nidm.gov.in/pdf/dp/Goa.pdf).

9.2.3. Climate

Due to maritime influence, the diurnal range of temperature during the day is not large. The diurnal range is the least being 4 to 6°C during monsoon season and increases to the maximum of 10 to 20°C during December & January.

May is the hottest month when the mean daily temperature increases to 30°C. January is the coolest with mean daily temperature of about 23°C.

The temperature is highest (around 33ºC) in pre – monsoon months of April & May and again in post monsoon months of November & January. The day temperature is the lowest in monsoon months of July and August and not in the cool winter months of December and January.

Due to proximity to the Arabian Sea, humidity throughout the year is more than 60% with range from 80 to 90% during monsoon period.

As a result of orographic influence, rainfall increases towards the Western Ghats, with average annual rainfall varying between (1971 – 2001) 2828.70 mm (in Bardez taluk) to 3948.30 mm (in Satari taluk). Over 90% of annual rainfall occurs during monsoon months of June to September. About 32% of the annual rainfall is received during July.

(Source: Ground Water Information Booklet, North Goa District, Goa State, Central Ground Water Board, Ministry Of Water Resources, Government of India, June 2010).

9.2.4. Soils

Soils of the district can be classified into the following three types:

(i) Laterite soil

(ii) Saline soil and

(iii) Alluvial soil

Lateritic soil is the major soil type in the district. It is highly porous & permeable, slightly acidic with low pH values, low in organic matter, Calcium and Phosphorus.

Saline soil in the district occurs in the flood plains of Zuari and Mandovi rivers in Tiswadi, Bardez and Ponda taluks. It also occurs in Pernem taluk. The soil is deep, poorly drained and less permeable. It is saline, high in pH and contains humus and organic matter.

Alluvial soil occurs as very thin strip along the coastline towards western part of the district. It is reddish brown to yellowish, coarse grained and confined to narrow valleys of rivers. It is well drained, acidic with low pH and organic content.

(Source: Ground Water Information Booklet, North Goa District, Goa State, Central Ground Water Board, Ministry Of Water Resources, Government of India, June 2010)

Clayey sand soil is present in most part of the river under NW -71 stretch.

9.2.5. Land Use Pattern

Land use is the surface utilization of all developed and vacant lands on a specific space at a given time. Lands are used for forest, pastures, transportation, settlements, industrial and commercial purposes, whereas, uncultivable waste land, barren and fallow land are unused lands.

The project area is characterized by mixed land use comprising mangrove forests, agricultural land, settlements, some big industries, fishing and ferry jetties managed by local operators and roads.

Table 9-1: Land Utilization Pattern in Goa

S. No.	Item	Area in Hectares	% age of total reported area
1.	Total reported area according to village papers for land utilization	361113	100.00
2.	Area under forest	125473	34.75
3.	Land not available for cultivation	37137	10.28
4.	Other uncultivated land (i) Permanent pastures & other grazing land	1305	0.36
	(ii) Land under miscellaneous tree crops and groves not included in net area sown	580	0.16
	(iii) Cultivable waste including fallow land and current fallow	64796	17.95
5.	Net area sown	131822	36.50
6.	Area sown more than once	32169	--
7.	Gross cropped area	163991	--

Source: Statistical Handbook of Goa, Government of Goa, 2011-12.

9.2.6. Ambient Air and Noise Quality

The overall ambient air quality in the project area is found to be of acceptable standards. The impact on the existing ambient air and noise quality is largely limited to the emissions due to vehicular movement. The project area has settlements and some industries with emission norms regulated by the SPCB.

As per a Central Pollution Control Board (CPCB) Report based on monitoring of ambient air quality and noise levels carried out during Deepawali festival in 2015, ambient air quality monitoring was carried out by the Goa State Pollution Control Board, Panaji, at five cities and noise monitoring was carried out at four cities.

As per this report, The normal day, PM10 level ranged between 30 and 287 µg/m^3 , while same on the festival day ranged between 55 and 239 µg/m^3 . The maximum PM10 value 239 µg/m^3 was reported at Vasco on the festival day.

The normal day noise level ranged between 61 and 67 Leq.dB (A), while the same on the festival day ranged between 63 and 71 Leq.dB (A). The maximum noise level value 71 Leq.dB (A) was reported at Vasco (C) on the festival day.

(Source: Ambient Air Quality and Noise Levels: Deepawali Festival Monitoring Report 2015, Central Pollution Control Board, Ministry of Environment, Forest & Climate Change, February 2016)

Primary data on ambient air quality monitoring in the project area may be collected at a later stage as part of the EIA study to be carried out for the project by IWAI.

9.2.7. Ambient Water Quality

The entire river stretch coming under NW-71 is tidal and sea water is mixed with the river water. There are two industrial clusters located close to the proposed waterway stretch namely Mapusa & Tivim. The waterway stretch is dotted with several fishing jetties. Ferry services run from Pomburpa to Chorao. In addition, a number of mining sites are located in the catchment of Mapusa River. These sites are located in Bardez & Bicholim Talukas.

The river is, therefore, likely to be used for discharge of effluents. However, discharge of effluents by the industries and by the fishing and ferry vessels is to be regulated by the Goa State Pollution Control Board.

Water quality samples have been collected and tested for three sample locations along the NW-71 stretch as part of the hydrographic survey carried out for preparation of the present DPR. The sample locations include Britona Jetty, Aidona and Quitla and the pH value of the water samples at these three locations was 7.74, 7.82 and 6.9 respectively, which indicates that water in the project area is largely alkaline in nature.

The Central Pollution Control Board (CPCB) has established a network of monitoring locations on aquatic resources across the country. The present network operated under Global Environmental Monitoring System (GEMS) and Monitoring of Indian National Aquatic Resources System (MINARS) covers 445 rivers in 29 States and 6 Union territories having 1275 locations.

Based on an analysis of the water quality data for the years 2009-2012, CPCB published a report in February 2015 titled 'River Stretches for Restoration of Water Quality' (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15).

In the said report, the rivers have been prioritized based on the concentration of BOD in five classes from Priority I to V. The criteria of each priority are elaborated indicating the concentration range of BOD in mg/l. The degree of violation is with respect to water quality criteria for drinking water source with conventional treatment with respect to BOD. The polluted locations in a continuous sequence are defined as polluted river stretches.

Criteria for Priority I

Monitoring locations exceeding BOD concentration 30 mg/l.

Criteria for Priority II

Monitoring locations having BOD between 20-30 mg/l.

Criteria for Priority III

Monitoring locations having BOD between 10-20 mg/l.

Criteria for Priority IV

Monitoring locations having BOD between 6-10 mg/l.

Criteria for Priority V

Monitoring locations having BOD between 3-6 mg/l.

According to this report, water quality of rivers in Goa is measured at 28 locations on 16 rivers. Among these, 11 locations are non-complying to the Water Quality Criteria with respect to BOD. These 11 locations are on 8 rivers. The names of 8 polluted rivers are: Mandovi, Assanora, Bicholim, Chapora, Khandepar, **Mapusa**, Sal and Valvant. These rivers are classified in Priority Class – III, IV and V based on the leve of BOD.

The details of the polluted river stretches in Goa are provided in Table 9-2.

Table 9-2: Details of Polluted River Stretches in Goa

Sl. No.	River Name	Stretch Identified	Towns Identified	Approx. Length of the Stretch (in Km)	BOD Range / Max. Value	Priority Class
1.	Mandovi	Marcela to Volvoi	Marcela, Volvoi	10	3.9	V
2.	Assonora	Assonora to Sirsaim	Assonora	5	7.0	IV
3.	Bicholim	Bicholim to Kurchirem	Bicholim	6	3.9	V
4.	Chapora	Pernem to Morjim	Chikhli, Siolim	18	5.0	V
5.	Khandepar	Ponda to Opa	Ponda	10	3.9	V
6.	**Mapusa**	**Mapusa to Britona**	**Mapusa**	**16**	**6.2**	**IV**
7.	Sal	Khareband to Mobor	Margao	14	3.2-10.6	III
8.	Valvant	Sankli-Bicholim to Poriem	Bicholim	5	3.1	V

The identified polluted stretch of 16 km of Mapusa River, which runs from Mapusa to Britona, falls within the proposed NW-71 strech. However, as can be noted from the data provided in Table 9-2 above, with a maximum BOD value of 6.2 the river stretch under consideration is amongst the less polluted river stretches and falls under Priority Class IV.

9.2.8. Susceptibility to Natural Hazards

Two types of disasters are experienced by the State: 1) Natural Disaster like Earthquake, Floods / Heavy rains, Cyclones, Landslides, Tsunami and 2) Manmade Disaster like Oil spill in the Sea / Land, Gas leakage, Explosives, Mine collapse, etc.

Although Goa has not witnessed earthquakes directly, the tremors of the earthquakes with magnitude 5.0 or more that hit “Koyana” and “Latur” in Maharashtra in the year 1967 and 1993 respectively, affected the Goa as many of the residential as well as public structures, infrastructures were damaged severely, although no casualties took place. Goa falls in seismic zone IV that indicates that Goa has high probability for occurrence of earthquakes. Goa forms part of the moderate seismic zone in the country, namely, Zone IV of seismic zoning map of India.

A number of large and small river systems drain the district and the gradient and topography of the region combined with heavy monsoons and high tide conditions have caused flooding and water logging in the past in quite a few places. The occurrence of cyclones / floods, however, is restricted to the monsoons only.

The North Goa district has not experienced any major floods in past, except in 2000 at Bicholim; in 2005 at Mala, Panaji and Bicholim and in 2007 also in Bicholim due to overflowing of rivulet, causing no major casualties but causing heavy damages to the properties.

The whole of North Goa is vulnerable to cyclones. The impact of cyclonic winds is felt towards the onset of the monsoons in April end and May and again towards the flag and around September/October. Cyclone ‘Phyan’ that hit the coasts of Maharashtra, Goa and Gujarat in 2009 caused damage to crops and properties in Goa. If cyclonic winds are accompanied by heavy rainfall then there is possibility of flooding in low lying areas in Goa.

Incidences of landslide that have occurred in Tiswadi, Bardez and Pernem Taulkas of Goa in past have been generally of low severity. However, the landslide that took place on Mapusa – Panaji NH-17 during the monsoon of 2007 was of high severity as the vehicular traffic on this road was obstructed almost for a month.

As far as the North Goa District is concerned, the coastal belt has not witnessed any Tsunami in the past.

(Source: National Disaster Risk Reduction Portal: Goa, National Institute of Disaster Management)

9.2.9. Estuary and Coastal Zone

The coastal zone of Goa is characterized by sandy stretches and an intricate network of water bodies across lowlands. The sea front is marked by a combination of beaches, rocky shores and headlands. Out of 105km long coast, more than 70 km comprise linear and wide sandy beaches all backed by 1 to 10 meters high dunes; sandy pockets and secluded coves backed by rocky cliff are also found. The coastal plain, 20 to 35 km in width, consists of lowlands traversed by seven major and four minor river systems that experience tides. Small islands, shoals and mangrove swamps are observed within water bodies.

(Source: Technical Report of the Project on Consultancy Services and to Conduct Survey and Enquiry in CRZ III of Goa Coast, Remote Sensing Instruments, Hyderabad, 2008)

The entire National Waterway 71 project area falls under the inter-tidal zone.

The Ministry of Environment and Forests, Govt. of India, under the provision of Environment (Protection) Act, 1986, had issued a notification in February, 1991, declaring an area of 500 m. from the high tide line along the sea coast, bays and estuaries and up to 100 m from the rivers and creeks as a Coastal Regulation Zone. The developments within this zone are required to be regulated in accordance with the provisions of the notification and the Coastal Zone Management Plan which the State Govt. is required to prepare for the area.

The CRZ Notification 1991 was later amended and a new Notification was issued in 2011 namely CRZ Notification, 2011. The notification imposes certain restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ.

As per the Goa State Coastal Zone Management Plan as approved and notified by the Government of India (vide no. J-17011/12/92/IA-III dated: 27/09/1996), along the rivers namely Tiracol, Chapora, Mandovi, Zuari, Sal, Talpona and Creeks and back waters in Goa influenced by tidal action, the extent of CRZ will be 100m or width of the river or creek or backwater whichever is less, up to the point the tidal affects are experienced towards land.

According to Goa Coastal Zone Management Plan approved on September 27, 1996 by the Ministry Of Environment and Forests, Government of India, tidal influence in Mapusa river is felt up to Mapusa, Tivim and Mulgao.

Mapusa River passes through Bardez and Bicholim Talukas. The Goa CZMP identifies the following areas in Bardez Taluka as CRZ area.

i. In Anjuna village, Chapora Fort is classified as CRZ-I and the rest of the area is classified as CRZ-III.

ii. Calangute area is classified as CRZ-III except sand dunes which are classified as CRZ-I.

iii. Candolim is classified as CRZ-III except sand dunes and forts which are classified as CRZ-I.

The CRZ Notification, 2011 makes a special mention of the State of Goa as follows:

CRZ of Goa:

In view of the peculiar circumstances of the State Goa including past history and other developments, the specific activities shall be regulated and various measures shall be undertaken as follows:

(i) the Government of Goa shall notify the fishing villages wherein all foreshore facilities required for fishing and fishery allied activities such as traditional fish processing yards, boat building or repair yards, net mending yards, ice plants, ice storage, auction hall, jetties may be permitted by Grama Panchayat in the CRZ area;

(ii) reconstruction, repair works of the structures of local communities including fishermen community shall be permissible in CRZ;

(iii) purely temporary and seasonal structures customarily put up between the months of September to May;

(iv) the eco sensitive low lying areas which are influenced by tidal action known as khazan lands shall be mapped;

(v) the mangroves along such as khazan land shall be protected and a management plan for the khazan land prepared and no developmental activities shall be permitted in the khazan land;

(vi) sand dunes, beach stretches along the bays and creeks shall be surveyed and mapped. No activity shall be permitted on such sand dune areas;

(vii) the beaches such as Mandrem, Morjim, Galgiba and Agonda have been designated as turtle nesting sites and protected under the Wildlife Protection Act, 1972 and these areas shall be surveyed and management plan prepared for protection of these turtle nesting sites;

(viii) no development activities shall be permitted in the turtle breeding areas referred to in sub-paragraph (vii).

As per the CRZ categorization provided in the CRZ Notification, 2011, the NW-71 project area falls in CRZ – I. Accordingly, the proposed project will require clearance under the CRZ Notification 2011.

9.2.10. Archaeological and Heritage Locations

No structures of archaeological, cultural or historical importance will be impacted due to the proposed project.

As per the CRZ Notification, 2011, areas or structures of archaeological importance and heritage sites on land and underwater are categorized as CRZ I areas. There are several structures of religious / historical / archaeological significance located on the banks of river Mapusa in the stretch identified as NW-71. However, the proposed project does not interfere in any manner with the said structures.

As per the information available on the website of Archaeological Survey of India (http://asi.nic.in/asi_protected_monu_goa.asp) and the website of Directorate of Archives and Archaeology, Government of Goa (http://daa.goa.gov.in/monuments_details.php), there area total of 51 Protected Monuments in Goa.

As has been mentioned earlier, some of these protected monuments are located close to Mapusa River stretch falling under NW-71. However, **no construction activities are proposed inside the prohibited or regulated areas of these protected monuments. Therefore, no clearance requirement is envisaged with respect to these structures.**

Prohibited and Regulated Areas are defined in the Ancient Monuments and Archeological Sites and Remains (Amendment and Validation) Act, 2010, and the definition of the two terms is as follows:

Prohibited Area: Every area, beginning at the limit of the protected area or the protected monument, as the case may be, and extending to a distance of one hundred meters in all directions shall be the prohibited area in respect of such protected area or protected monument.

Regulated Area: Every area, beginning at the limit of prohibited area in respect of every ancient monument and archaeological sites and remains, declared as of national importance and extending to a distance of two hundred meters in all directions shall be regulated area in respect of every ancient monument and archeological site and remains.

A list of the protected monuments located along the NW-71 stretch of Mapusa River, along with their distance from the proposed waterway as measured on Google Map, is provided in Table 9-3 below.

Table 9-3: Protected Monuments Located Along NW-71 Stretch

Sl.No	Name of Structure	Taluka	River Bank (Mapusa)	Shortest Distance from NW-71 (km)
1	Chapora Fort	Bardez	Left	9.12
2	Fortress of Colvale	Bardez	Left	3.20
3	Church of Reis Magos	Bardez	Right	3.95
4	Fort of Khorjuve / Corjuem	Bardez	Left	1.2
5	Auguda Fortress, Candlim	Bardez	Right	7.54
6	Caves at Naroa	Bicholim	Left	14.93
7	Temple of Saptakoteshwar,	Bicholim	Left	6.95
8	Site of Gujir, Kudnem	Bicholim	Left	15.65
9	Fort of Sanquelim	Bicholim	-	-
10	Namazgah	Bicholim	Left	6.5

In addition to the protected monuments mentioned above in Table 9-3, there are several other structures of religious / cultural significance located close to the NW -71 stretch along Mapusa River. The NW-71 waterway project is not likely to interfere with any of these structures. A list of these structures is provided in Table 9-4 below.

Table 9-4: Other Structures of Cultural / Historical / Significance Located Close to NW-71

Sl.No	Name of Structure	Taluka	River Bank (Mapusa)	Shortest Distance From NW-71 (km)
1	Mae De Deus Church	Bardez	Right	6
2	St. Michael's Church	Bardez	Right	6
3	Viceroy's Arch	Bardez	Left	7
4	Museum of Goa	Bardez	Right	6
5	Candloim Beach	Bardez	Right	9
6	Coco Beach	Bardez	Right	5
7	Kegdole Beach	Bardez	Right	4

Note: These are structures of historical / cultural importance but are not listed as Protected Monuments either by the Centre or by the State.

9.2.11. Flora and Fauna

Flora

In Goa, mangroves are present on the Mandovi and Zuari estuaries and Cumbarjua Canal. In addition, mangrove vegetation is also found on other parts of Galgibag, Talpona, Sal, Chapora and Terekhol river mouths and in Khazan lands. Goa has 16 true mangrove species belonging to 13 genera and 7 families. Mandovi River supports luxuriant mangrove forests with maximum species diversity in Goa. *Avicennia marina* grows in the estuarine mouth, *Aegiceras corniculatum, Kandelia candel, Rhizophora apiculata, Rhizophora mucronata and Sonneratia alba* in the upstream region and *Acrostichum aureum, Acanthus ilicifolius, Derris heterophylla* and *Excoecaria agallocha* in the mid-estuarine region. *Avicennia officinalis* is the dominant mangroves species. (Source: Carrying Capacity of Beaches of Goa for providing Shacks and Other Temporary Seasonal Structures in Private Areas, National Centre for Sustainable Coastal Management, Ministry of Environment, Forest and Climate Change, Government of India).

Table 9-5: Mangrove Species in Goa

Sl. No.	Scientific Name	Common Name
1	*Acanthus ilicifolius*	Sea Holly
2	*Acrostichum aureum*	Leather Fern
3	*Aegiceras corniculatum*	Black Mangrove / River Mangrove / Khalsi
4	*Avicennia marina*	Grey Mangrove / White Mangrove
5	*Avicennia officinalis*	Indian Mangrove
6	*Bruguiera cylindrica*	White Burma Mnagrove
7	*Bruguiera gymnorrhiza*	Black Mangrove
8	*Ceriops tagal*	Yellow Mangrove
9	*Derris heterophylla*	Panlata
10	*Excoecaria agallocha*	Blinding Tree
11	*Kandelia candel*	Narrow-Leaved Kandelia
12	*Lumnitzera racemosa*	White-flowered Black Mangrove
13	*Rhizophora apiculata*	Tall-stilt Mangrove
14	*Rhizophora mucronata*	Kandal
15	*Sonneratia alba*	Mangrove Apple
16	*Sonneratia caseolaris*	Mangrove Apple

Source: http://www.forest.goa.gov.in/mgr/

As per the hydrological survey carried out for the present DPR, mangroves are found to be located on both banks of the Mapusa River along the proposed waterway stretch. The Coastal Regulation Zone Notification (2011) under the Environmental Protection Act (1986) recognizes the mangrove areas as ecologically sensitive and categorizes them as CRZ-I which implies that these areas are afforded protection of the highest order.

Table 9-6: List of Flora Commonly Found in the Forest Areas of North Goa Forest Division

Sl. No.	Scientific Name	Common Name
Trees		
1	*Acacia catechu*	Khair
2	*Adina cordifolia*	Hed
3	*Agele marmelos*	Bel
4	*Albizia lebbak*	Shiras
5	*Albizzia odoratissima*	Kaloshiras
6	*Alstonia scholaris*	Satvan
7	*Amoora lawii*	Burumbi
8	*Anacardium occidentale*	Kaju
9	*Anogeissus latifolia*	Dhaoda
10	*Aporusa lindleyana*	Salai
11	*Artocarpus integrifolia*	Phanas
12	*Artocarpus lakoocha*	Otamb
13	*Azadirachta indica*	Nimb
14	*Barringtonia acutangula*	Men kumbyo
15	*Bauhinia racemosa*	Apto
16	*Bauhinia wahilli*	Mavli
17	*Bombax ceiba*	Savar
18	*Bridelia retusa*	Khatem Asan
19	*Buchnania lanzan*	Chara
20	*Butea monospermum*	Palas
21	*Callicarpa tomentosa*	Phalyo
22	*Callophylum inophyllum*	Undi.
23	*Calycopteris floribunda*	Uski.
24	*Carallia brachiata*	Panshi, Makad bhiran
25	*Careya arborea*	Kumbyo
26	*Caryota urens*	Birlo mad
27	*Cassia fistula*	Bayo, Balo
28	*Ceiba pentandra*	Savar
29	*Cinnamomum zeylanicum*	Tikhi
30	*Corypha umbraculifera*	Karetel
31	*Dalbergia latifolia*	Shisham

Sl. No.	Scientific Name	Common Name
32	*Derris scandens*	Kanranj
33	*Dillenia pentagyna*	Karmal
34	*Diospyros Montana*	Goiunda, Govimelu
35	*Diospyros paniculata*	Kuri.
36	*Ficus glomerata*	Rumad
37	*Ficus Hispida*	Kalaumbar
38	*Ficus religiosa*	Pipal
39	*Ficus tsiela*	Basri
40	*Flacourtia jangomonas*	Jangli Jagam
41	*Flacourtia montanna*	Chafra
42	*Garcinia gummigutta*	Dhar ambo.
43	*Garcinia indica*	Bhiran
44	*Gmelina arborea*	Shivan
45.	*Grewia tillifolia*	Dhaman
46	*Helicters isora*	Kivan
47	*Holarrhena antidysentrica*	Kudo
48	*Holigarnia arnottiana*	Bibo
49	*Holoptelia integrifolia*	Vamolo
50	*Hopea wightiana*	Pav
51	*Hydnocarpus laurifolia*	Khast, Kavat
52	*Lagerstroemia lanceolata*	Nano
53	*Lagerstroemia parviflora*	Taman
54	*Lannea coromandalica*	Moi
55	*Leea indica*	Jino
56	*Luta graveolens*	Arod
57	*Macaranga peltata*	Chandado.
58	*Mallotus phillipinensis*	Bems, Sendri.
59	*Mangifera indica*	Ambo
60	*Manilkara hexandra*	Kirni
61	*Melia azedarach*	Firnage nimb.
62	*Mesua ferrea*	Nagchampho
63	*Mimusops elengi*	Onval
64	*Mitragyna parvifolia*	Kalamb
65	*Murraya koenigii*	Karphil, Karipatha

Sl. No.	Scientific Name	Common Name
66	*Myristica fragrans*	Jayphal
67	*Myristica malabarica*	Kayphal
68	*Polyalthia fragrans*	Miryo, Mirio
69	*Pterocarpus marsupium*	Asan
70	*Radermachera xylocarpa*	Kharshing
71	*Randia deumatorum*	Gel
72	*Sapium insigne*	Uro
73	*Saracca indica*	Ashoka
74	*Schleichera oleosa*	Kasamb
75	*Semecarpus anacardium*	Biboi
76	*Spondeas acuminata*	Ran Ambado
77	*Spondeas mangifera*	Ambado
78	*Sterculia foetida*	Nagin
79	*Sterculia guttata*	Kulinder
80	*Sterculia urens*	Dhavoruk, Pandruk
81	*Sterculia villosa*	Aployo suplo
82	*Stereospermum suaveolens*	Kusgo
83	*Strychnos nux-vomica*	Kajro, Karo
84	*Sygizium caryophyallatum*	Bhedas
85	*Sygizium cumini*	Jambul
86	*Tabernamontana heyneana*	Kudo
87	*Tamarindus indicus*	Chinch
88	*Tectona grandis*	Saylo
89	*Terminalia arjuna*	Arjun
90	*Terminalia bellerica*	Goting
91	*Terminalia paniculata*	Kindal
92	*Terminalia tomentosa*	Marat
93	*Terminlia chebula*	Hirda, Huradi
94	*Tetrmeles nudiflora*	Zarmal
95	*Thespesia populnea*	Bhendi
96	*Trewia nudiflora*	Bomovaro petari
97	*Vitex altissima*	Bavalgi
98	*Xylia xylocarpa*	Zambo
99	*Zanthoxylum retsa*	Tirphal

Sl. No.	Scientific Name	Common Name
Shrubs		
1	*Adathoda vasica*	Aduso
2	*Bridelia stipularis*	Phatrphala
3	*Calotrophis giagantea*	Rui
4	*Calycopteris floribunda*	Uski
5	*Carissa caronda*	Karvanda, Kanda
6	*Cassia tora*	Taykhilo
7	*Clerodendrum indicum*	Bharmgi
8	*Ixora coccinea*	Pitkoli
9	*Lobelia nicotianaefolia*	Baknal
10	*Microcos paniculata*	Asale, chivara
11	*Moullava spicata*	Wagati, vakeri
12	*Pothos scandens*	Bemdarli
13	*Vitex negundo*	Nimgud
14	*Zizhuphus oenoplia*	Kanera
15	*Zizhuphus rugosa*	Churna
Herbs		
1	*Achyranthes aspera*	Aghado
2	*Amorphophallus campanulatus*	Suran
3	*Asparagus racemosus*	Shatavari
4	*Bambusa arundinacea*	Velu
5	*Boerhavia diffusa*	Punarnava
6	*Centella asiatica*	Gundhurichi bhaji
7	*Cynodon dactylon*	Haryali
8	*Dendrocalamus strictus*	Maango
9	*Eclipta alba*	Mako
10	*Gloriosa superba*	Wagchampho
11	*Hemidesmus indicus*	Dudhshiri
12	*Leucas aspera*	Tumbo
13	*Mentha arvensis*	Ortelamv
14	*Ocimum omericanum*	Ramtulas
15	*Ocimum sanctum*	Tulas
16	*Rauvolfia serpentina*	Atki

Sl. No.	Scientific Name	Common Name
17	*Smilax zeylanica*	Ghot vel or Kaval kamti
18	*Themeda cymbaria*	Karad
19	*Themeda triandra*	Karad

Source: http://www.forest.goa.gov.in/pdf/ffnorth.pdf

Fauna

A list of important faunal species found in the North Goa Forest Division is provided below.

Mammals: Important species of mammals found in the Division are given below in Table 9-7.

Table 9-7: List of Mammals Found in the Forest Areas of North Goa Forest Division

Sl. No.	Scientific Name	Common Name
1	*Axis axis*	Spotted deer
2	*Bandicota indica*	Bandicoot rat
3	*Bos gaurus*	Gaur or Indian bison
4	*Canis aureaus*	Jackal
5	*Cervus unicolor*	Sambar
6	*Cuon alpinus*	Wild dog
7	*Cynopterus brachyotis*	Indian fulvous fruit bat
8	*Delphinus tropicalis linn*	Common Dolphin
9	*Felis bengalensis*	Leopard cat
10	*Felis chaus*	Jungle cat
11	*Funambulus palmarum*	Three striped palm squirrel
12	*Herpestes edwardsii*	Common grey mongoose
13	*Hyaena hyaena*	Striped hyaena
14	*Hysterix indica*	Porcupine
15	*Lepus nigricollis*	Black napped Hare
16	*Loris tardigradus*	Slender loris
17	*Lutra lutra*	Common Otter
18	*Lutra perspicillata*	Smooth coated Otter
19	*Macaca radiata*	Bonnet macaque
20	*Manis crassicaudata*	Indian pangolin
21	*Megaderma spasma*	Indian false vampire bat
22	*Melursus ursinus*	Sloth bear

Sl. No.	Scientific Name	Common Name
23	*Muntiacus muntjak*	Barking deer
24	*Mus booduga*	Indian field mouse
25	*Otompos wronghtoni*	Wronghton's freetailed bat
26	*Panthera pardus*	Leopard
27	*Panthera tigris*	Tiger
28	*Paradoxurus hermaphorditus*	Palm civet cat
29	*Petaurista petarauista*	Common flying squirrel
30	*Phocoena phoecoena*	Porpoise
31	*Pipistrellus dormeri*	Dormers bat
32	*Presbytis entellus*	Common Langur
33	*Pteropus giganteus*	Flying Fox
34	*Rattus rattus*	House Rat
35	*Ratufa macroura*	Malabar Giant Squirrel
36	*Rhinolophus luctus*	Horse shoe bat
37	*Suncus murinus (Linnaeus)*	House shrew
38	*Sus scrofa*	Wild Boar
39	*Tatera indica*	Indian Gerbille
40	*Tragulus meminna*	Mouse deer
41	*Tursiops aduncus*	Indian bottlenose dolphin
42	*Viverricula indica*	Small Indian civet cat

Source: http://www.forest.goa.gov.in/pdf/ffnorth.pdf

Birds: Important birds found in the Division are given in the Table 9-8 below.

Table 9-8: List of Birds Found in the Forest Areas of North Goa Forest Division

Sl. No.	Scientific Name	Common Name
1.	*Accipiter badius*	Shikra
2	*Acridotheres fuscus*	Jungle Myna
3	*Acrocephalus aedon*	Thick billed Warbler
4	*Acrocephalus agricola*	Paddyfield Warbler
5	*Aegithina tiphia*	Common Iora
6	*Alcedo atthis*	Common Kingfisher
7	*Amaurornis phoenicurus*	White-breasted Waterhen
8	*Anas acuta*	Northern Pintail

Sl. No.	Scientific Name	Common Name
9	*Anas clypeata*	Northern Shoveler
10	*Anas crecca*	Common Teal
11	*Anas poecilorhyncha*	Spot-billed
12	*Anas querquedula*	Garganey
13	*Anastomus oscitans*	Asian Openbill
14	*Anhinga melanogaster*	Oriental Darter
15	*Anthus richardi*	Richards Pipit
16	*Apus pacificus*	Large White Rumped Swift
17	*Aquila pomarina*	Lesser Spotted Eagle
18	*Ardea cinerea*	Grey Heron
19	*Ardea purpurea*	Purple Heron
20	*Ardeola grayii*	Indian Pond-Heron
21	*Bubulcus ibis*	Cattle Egret
22	*Cacomantis passerinus*	Grey-bellied Cuckoo
23	*Calandrella brachydactyla*	Greater Short-toed Lark
24	*Calidris temminckii*	Temminck's Stint
25	*Celeus brachyyurus*	Rufous woodpecker
26	*Centropus sinensis*	Greater Coucal
27	*Ceryle rudis*	Pied Kingfisher
28	*Chalcophaps indica*	Emerald Dove
29	*Charadrius alexandrinus*	Kentish plover
30	*Charadrius dubius*	Little ringed plover
31	*Chloropsis aurifrons*	Gold fronted chloropsis
32	*Circaetus gallicus*	Short-toed Snake-Eagle
33	*Circus aeruginosus*	Western Marsh Harrier
34	*Columba elphinstonii*	Nilgiri Wood-Pigeon
35	*Columba livia*	Rock Pigeon
36	*Copsychus malabaricus*	White-rumped Shama

Sl. No.	Scientific Name	Common Name
37	*Copsychus saularis*	Magpie robin
38	*Coracina mealnoptera*	Black headed cuckoo shrike
39	*Corvus macrorhynchos*	Jungle crow
40	*Corvus splendens*	House Crow
41	*Cuculus varius*	Common Hawk-Cuckoo
42	*Cyornis tickelliae*	Tickell's blue flycatcher
43	*Cypsirus Parvus*	Palm Swift
44	*Dendrocitta vagabunda*	Indian tree pie
45	*Dendrocopos mahrattensis*	Yellow-crowned Woodpecker
46	*Dendrocopus mahrattensis*	Yellow fronted pied woodpecker
47	*Dendrocygna javanica*	Lesser Whistling teal
48	*Dicaeum agile*	Thick billed Flowerpecker
49	*Dicaeum erythrorhynchos*	Tickell's Flowerpecker
50	*Dicrurus aeneus*	Bronzed Drongo
51	*Dicrurus caerulescens*	White bellied Drongo
52	*Dicrurus hottentottus*	Hair crested Drongo
53	*Dicrurus macrocercus*	Black Drongo
54	*Dicrurus paradiseus*	Greater racket tailed drongo
55	*Dinopium benghalense*	Lesser golden back woodpecker
56	*Dryocopus javensis*	White-bellied Woodpecker
57	*Ducula badia*	Mountain Imperial-Pigeon
58	*Dumetia hyperythra*	White throated Babbler
59	*Egretta gularis*	Western Reef-Egret
60	*Elanus caeruleus*	Black-winged Kite
61	*Eremopterix grisea*	Ashy-crowned Sparrow-Lark
62	*Eumyias thalassina*	Verditer flycatcher
63	*Fulica atra*	Common Coot

Sl. No.	Scientific Name	Common Name
64	*Gallicrex cinerea*	Watercock
65	*Gallinula chloropus*	Common Moorhen
66	*Galloperdix spadicea*	Red Spurfowl
67	*Gallus sonneratii*	Grey Junglefowl
68	*Glareola lactea*	Small Pratincole
69	*Gorsachius melanolophus*	Malayan Night Heron
70	*Halcyon pileata*	Black-capped Kingfisher
71	*Halcyon smyrnensis*	White-throated Kingfisher
72	*Haliaeetus leucogaster*	White-bellied Fish-Eagle
73	*Haliastur indus*	Brahminy Kite
74	*Hemicircus canente*	Heart-spotted Woodpecker
75	*Hemiprocene longipennis*	Crested tree swift
76	*Hemipus picatus*	Pied flycatchcher shrike
77	*Himantopus himantopus*	Black-winged Stilt
78	*Hirundo concolor*	Dusky Crag Martin
79	*Hirundo daurica*	Red rumped Swallow
80	*Hirundo smithii*	Wire tailed Swallow
81	*Hypothymis azurea*	Black-naped Monarch
82	*Iole indica*	Yellow-browed Bulbul
83	*Irena puella*	Asian Fairy-bluebird
84	*Lanius schach*	Rufous back Shrike
85	*Leptoptilos javanicus*	Lesser Adjutant
86	*Lonchura malacca*	Black headed Munia
87	*Lonchura striata*	White backed Munia
88	*Megalaima haemacephala*	Crimson breasted Barbet
89	*Megalaima viridis*	Small Green Barbet

Sl. No.	Scientific Name	Common Name
90	*Merops leschenaulti*	Chestnut headed bee-eater
91	*Merops orientalis*	Little Green Bee-eater
92	*Merops philippinus*	Blue-tailed Bee-eater
93	*Mesophoyx intermedia*	Intermediate Egret
94	*Milvus migrans*	Black Kite
95	*Motacilla citreola*	Citrine Wagtail
96	*Motacilla madaraspatensis*	Large Pied wagtail
97	*Muscicapa dauurica*	Asian Brown Flycatcher
98	*Mycteria leucocephala*	Painted Stork
99	*Myiophonus horsfieldii*	Malabar Whistling-Thrush
100	*Nectarinia asiatica*	Purple Sunbird
101	*Nectarinia lotenia*	Loten's Sunbird
102	*Nectarinia zeylonica*	Purple rumped Sunbird
103	*Nycticorax nycticorax*	Black-crowned Night-Heron
104	*Nyctyornis athertoni*	Blue bearded bee-eater
105	*Oriole oriolus*	Golden oriole
106	*Oriolus xanthornus*	Black headed oriole
107	*Orthotomus sutorius*	Common Tailor bird
108	*Oxylophus jacobinus*	Pied Cuckoo
109	*Pandion haliaetus*	Osprey
110	*Passer domesticus*	House Sparrow
111	*Pavo cristatus*	Indian Peafowl
112	*Pelargopsis capensis*	Stork-billed Kingfisher
113	*Pellorneum ruficeps*	Spotted Babbler
114	*Perdicula asiatica*	Jungle Bush-Quail
115	*Pericrocotus cinnamomeus*	Small minivet

Sl. No.	Scientific Name	Common Name
116	*Pericrocotus cinnamomeus*	Small Minivet
117	*Pericrocotus flammeus*	Scarlet Minivet
118	*Picumnus innominatus*	Speckled Piculet
119	*Pitta brachyura*	Indian Pitta
120	*Ploceus philippinus*	Indian Baya
121	*Pomatorhinus horsfieldii*	Indian Scimitar-Babbler
122	*Porphyrio porphyrio*	Purple Swamphen
123	*Porzana fusca*	Ruddy-breasted Crake
124	*Prinia hodgsonii*	Grey-breasted Prinia
125	*Prinia inornata*	Plain Prinia
126	*Prinia socialis*	Ashy Prinia
127	*Psittacula krameri*	Rose ringed parakeet
128	*Psittacula kyanocephala*	Blossom headed parakeet
129	*Pycnonotus cafer*	Red vented Bulbul
130	*Pycnonotus jocosus*	Red whiskered Bulbul
131	*Pycnonotus luteolus*	White browed Bulbul
132	*Rhipidura albicollis*	White throated fantail flycatcher
133	*Saxicola caprata*	Pied bush chat
134	*Saxicoloides fulicata*	Indian Robin
135	*Sitta frontalis*	Velvet-fronted Nuthatch
136	*Spilornis cheela*	Crested Serpent-Eagle
137	*Spizaetus cirrhatus*	Changeable Hawk-Eagle
138	*Sterna aurantia*	River Tern
139	*Sterna bengalensis*	Lesser Crested-Tern
140	*Sterna nilotica*	Gull-billed Tern
141	*Streptopelia chinensis*	Spotted Dove
142	*Sturnus pagodarum*	Brahminy Myna

Sl. No.	Scientific Name	Common Name
143	*Sturnus roseus*	Rosy Starling
144	*Tachybaptus ruficollis*	Little Grebe
145	*Terpsihone paradisi*	Paradise flycatcher
146	*Treron pompadora*	Pompadour Green-Pigeon
147	*Tringa cinerea*	Terek Sandpiper
148	*Tringa erythropus*	Spotted Redshank
149	*Tringa glareola*	Wood Sandpiper
150	*Tringa hypoleucos*	Common Sandpiper
151	*Tringa nebularia*	Common Greenshank
152	*Turdoides striatus*	Jungle Babbler
153	*Turdus merula*	Eurasian Blackbird
154	*Upupa epops*	Hoopoe
155	*Vanellus indicus*	Red-wattled Lapwing
156	*Vanellus malabaricus*	Yellow-wattled Lapwing

Source: http://www.forest.goa.gov.in/pdf/ffnorth.pdf

Reptiles: Important reptiles found in the Division are mentioned in the Table 9-9 below.

Table 9-9: Reptiles Found in the Forest Areas of North Goa Forest Division

Sl. No.	Scientific Name	Common Name
Snakes		
1	*Ahaetulla nasutus*	Vine Snake
2	*Amphiesma stolatum*	Buff striped keelback
3	*Boiga forsteni*	Forsten's Cat Snake.
4	*Boiga trigonata*	Common Indian Cat Snake.
5	*Bungarus caeruleus*	Common Indian Krait
6	*Calliophis nigrescens*	Coral Snake
7	*Cerberus rhynchops*	Dogfaced water Snake
8	*Chrysopelea ornata*	Golden back tree Snake

Sl. No.	Scientific Name	Common Name
9	*Coelognathus helena*	Trinket Snake
10	*Dendrelaphis tristis*	Bronzeback tree Snake
11	*Echis carinatus*	Saw scaled Viper
12	*Enhydrina schistosa*	Hook-nosed Sea Snake
13	*Eryx johnii*	Johns sand boa
14	*Gongylophis conicus*	Common Sand Boa
15	*Grypotyphlops acutus*	Beaked worm snake
16	*Lycodon aulicus*	Common Wolf snake
17	*Macropisthodon plumbicolor*	Green keelback.
18	*Naja naja*	Indian Spectacled Cobra.
19	*Oligodon arnensis*	Common Kukri snake
20	*Oligodon taeniolatus*	Variegated Kukri Snake
21	*Ophiophagus hannah*	King Cobra
22	*Ptyas mucosa*	Indian Rat Snake
23	*Python molurus*	Indian Rock Python
24	*Ramphotyphlops braminus*	Brahminy worm snake
25	*Trimeresurus malabaricus*	Malabar Pit Viper
26	*Trimeresurus gramineus*	Bamboo Pit Viper
27	*Uropeltis macrolepis macrolepis*	Bombay shield tail
28	*Vipera russelii*	Russels Viper
29	*Xenochropis piscator*	Checkered keelback
Crocodiles		
1	*Crocodylus palustris*	Mugger or Marsh crocodile
Turtles (Sea Turtle & Fresh Water Turtle)		
1	*Lepidochelyes olivacea*	Olive ridley turtle
2	*Lissemys punctata*	Indian flapshell turtle
3	*Melanochelys trijuga*	Indian black turtle
Lizards, Skinks		
1	*Calotes rouxii*	Rouxii lizard
2	*Calotes versicolor*	Indian garden lizard
3	*Chamaeleo zeylanicus*	Indian chameleon
4	*Draco dussumieri*	Flying lizard
5	*Mabuya macularia*	Bronze skink

Sl. No.	Scientific Name	Common Name
Amphibians		
1	*Duttaphrynus melanostictus (schnieder)*	Indian toad
2	*Hoplobatrachus tigerinus*	Indian bull frog
3	*Euphlyctis cyanophlyctis*	Indian skipper frog
4	*Sphaerotheca breviceps*	Indian burrowing frog
5	*Rhacophorus malabaricus*	Malabar gliding frog
6	*Rana malabarica*	Fungoid frog

Source: http://www.forest.goa.gov.in/pdf/ffnorth.pdf

Large number of species of fishes are found in Arabian Sea and creeks such as Silver Pomfret (*Stromateus argenteus*), Sea Bass (*Lates calcarifer*), Gold Spotted Anchovy (*Coilia dussumieri*), Mackrel (*Rastrelliger kanagurta*), Bombay Duck (*Harpadon nehereus*), Little Tuna (*Euthynnus affinis*), Ribbon Fish (*Lepturacanthus savala*), Dhoma (*Sciaena dussumieri*), Seer Fish (*Scomberomorus guttatus*), Silver bar (*Chirocentrus dorab*), Sepia (*Sepia officinalis*), Mud Crab (*Scylla serrata*), Prawns (*Penaeus monodon*) etc and bulk of the catch is sent to local market and Mumbai market.

In Goa, coral reefs are confined only to the Grand Island (15°21‟3.696”; 73°47‟ 4.102”). Live coral cover in Grand Island accounts for 50.8% of the benthic substrate. The reef diversity comprises 15 species of corals, 196 species of fishes including commercial and ornamental fishes, 108 species of molluscs, 68 species of crustaceans, 4 species of mammals, 5 species of reptiles and major flora such as seagrasses (2 species) and seaweeds (143 species). *Favites sp., Turbinaria mesenterina, Dendrophyllia sp. and Turbinaria peltata* are the dominant coral species observed in Goa.

(Source: Carrying Capacity of Beaches of Goa for Providing Shacks and Other Temporary Seasonal Structures in Private Areas, National Centre for Sustainable Coastal Management, Ministry of Environment, Forest and Climate Change, Government of India).

As per the hydrographic survey report prepared as part of the DPR for NW-71, presence of crocodiles has been observed in the river between Ch 14.00 km to Ch 17.50 km.

9.2.12. National Parks, Forests, Wildlife Sanctuaries and Reserves

The recorded forest area in the State is 1254. 73 sq km, this constitutes 34.75% of the total geographical area of the State. As per the India State of Forest Report, 2015 published by the Forest Survey of India, Goa has a total forest cover of 2224 sq km, which is 60.08% of the total geographical area of the State. In terms of forest canopy density classes, the State has 542 sq km very dense forest, 580 sq km of moderately dense forest and 1102 sq km of open forest.

North Goa District, where the project is located, is fairly rich in forest areas. The district has a forest cover of 924 sq km constituting 53.23% of its total geographical area of 1736 sq km.

As per the hydrological survey carried out for the present DPR, mangroves are found to be present on both banks of the Mapusa River along the proposed waterway stretch. The Coastal Regulation Zone Notification (2011) under the Environmental Protection Act (1986) recognizes the mangrove areas as ecologically sensitive and categorizes them as CRZ-I which implies that these areas are afforded protection of the highest order.

Chorao Island Wildlife Sanctuary is the only marine protected area in Goa with a total area of 1.78 sq km. This Sanctuary is crisscrossed with a network of water channels. The "Mangrove Scrub" type of vegetation that is found here occurs in small isolated areas along the banks of Mandovi and Mapusa rivers.

(Source: Carrying Capacity of Beaches of Goa for Providing Shacks and Other Temporary Seasonal Structures in Private Areas, National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest and Climate Change, Government of India)

Olive Ridley turtle (*Lepidochelys olivacea*) is the major nesting species of sea turtle found in Goa. Sporadic nesting of Olive Ridley and Leatherback turtles has been recorded all along the coast of Goa (Bhaskar, 1984, Das, 1985) but recent nesting records are only of Olive Ridley (Giri and Chaturvedi, 2001). Nesting takes place between October and March each year (Dongre and Shambhu 2008, Giri, 2001; Kurian, 2013).

Considering the rapid decline in the turtle populations, sea turtles found in India were included in Schedule I of the Wildlife Protection Act, 1972. Turtles are listed in Appendix I of the Red Data Book of IUCN (International Union for the Conservation of Nature and Natural Resources) and also in Appendix I of CITES (Convention on

International Trade in Endangered Species of Wild Flora and Fauna). India is a signatory to both the afore-mentioned Conventions. (Source: http://goaenvis.nic.in/marineturtle.htm).

Morjim in North Goa, Galgibag and Agonda in South Goa are the three main nesting sites of the Olive Ridleys in Goa. All sites are protected by the Forest Department with the help of local people. Morjim beach, which is about 2.0 km in length in Pernem Taluka, has a good sandy shore with well-developed dune system. A long strip, which terminates at the mouth of river Chapora, is marked by extensive rows of sand dunes with dune vegetation being more pronounced in the southern part. In 1996, the Goa Forest Department deployed Forest Guards and volunteers to protect the turtles and their nests. During 1997-98, only 5 nests were located and protected on part of the Morjim beach. This number increased to 8 in 1998-99 and resulted in extension of the protected area of the beach. Consistent efforts have resulted in increased nesting with number reaching 32 nests in 2000-01. (Source: http://goaenvis.nic.in/marineturtle.htm).

The CRZ Notification, 2011 recognizes beaches such as Mandrem, Morjim, Galgibaga and Agonda as designated turtle nesting sites (Source: CRZ Notification 2011). NW-71 on Mapusa River is not located close to any of these beaches.

The State has one National Park (Mollem) and six Wildlife Sanctuaries covering an area of 107 sq km and 648 sq km respectively. Thus a total of 755 sq km constituting 20.4% of the geographical area of the State is under protected area network.

A list of the protected areas in Goa is provided in Table 9-10 below.

Table 9-10: Protected Areas in Goa

S.No.	Protected Areas	Year of Estbl.	Area (sq km)	District (s)	Taluka
1	Bhagwan Mahavir (Mollem) NP	1992	107.00	North Goa	Sanguem and Dharbandora
1	Bhagwan Mahavir (Mollem) WLS	1967	133.00	North Goa	Sanguem and Dharbandora
2	Cotigaon WLS	1968	85.65	South	Canacona
3	Bondla WLS	1969	7.95	North Goa	Ponda, Sattari and Dharbandora

S.No.	Protected Areas	Year of Estbl.	Area (sq km)	District (s)	Taluka
4	Dr. Salim Ali Bird (Chorao Island) WLS	1988	1.78	North Goa	Tiswadi
5	Madei WLS	1999	208.48	North	Sattari
6	Netravali WLS	1999	211.05	South Goa	Sanguem

Note: NP = National Park; WLS= Wildlife Sanctuary

A brief description of these protected areas is provided below. (Source: Report of the Committee on Six Protected Areas in Goa in relation to establishment of eco-sensitive zones, Office Memorandum dated 24th October 2013, Ministry of Environment and Forests, Government of India).

Bhagwan Mahavir Wildlife Sanctuary and National Park: This protected area is located on the Eastern part of the State, with an area of 240 sq km. Initially, it was notified as a Sanctuary (Molem Wildlife Sanctuary) in 1967. Subsequently an area of 107 sq km of the said Sanctuary was notified as the Molem National Park in 1978. Later, the name was changed to Bhagwan Mahaveer Wildlife Sanctuary and National Park (Wildlife Sanctuary 133 sq km, National Park 107 sq km).

Cotigao Wildlife Sanctuary: This was notified in 1968 with a total area of 85.65 sq km. The Cotigao Wildlife Sanctuary is largely low lying and contiguous to the Netravali Wildlife Sanctuary.

Bondla Wildlife Sanctuary: This was notified in 1969 on ridge top with an area of 7.98 sq km.

Dr. Salim Ali Wildlife Sanctuary: This is a small protected area of approximately 1.78 sq km, notified on acquired agricultural land (1998), presently supporting mangroves. It is bounded on three sides (North, West and South) by rivers (Mandovi and Mapusa), with a village (Chorao) located towards its Eastern side. The area between the protected area boundary and the adjoining village, also supporting mangroves, which forms part of the area proposed as eco-sensitive zone by the State, is with the State's Fisheries Department. The river is used for transportation. The protected area is rich in bird life, crocodiles, leopards etc.

Madei Wildlife Sanctuary: This was notified in 1999 with an area of 208.48 sq km. The Sanctuary has tiger presence. Tiger presence has been reported in the said protected area since 2001.

Netravali Wildlife Sanctuary: This Sanctuary was notified in 1999 with a total area of 211.05 sq km.

A Map of the National Park and the Wildlife Sanctuaries in the State of Goa, as available on the website of the Forest Deaprtment of Goa, is provided below as Figure 9.1.

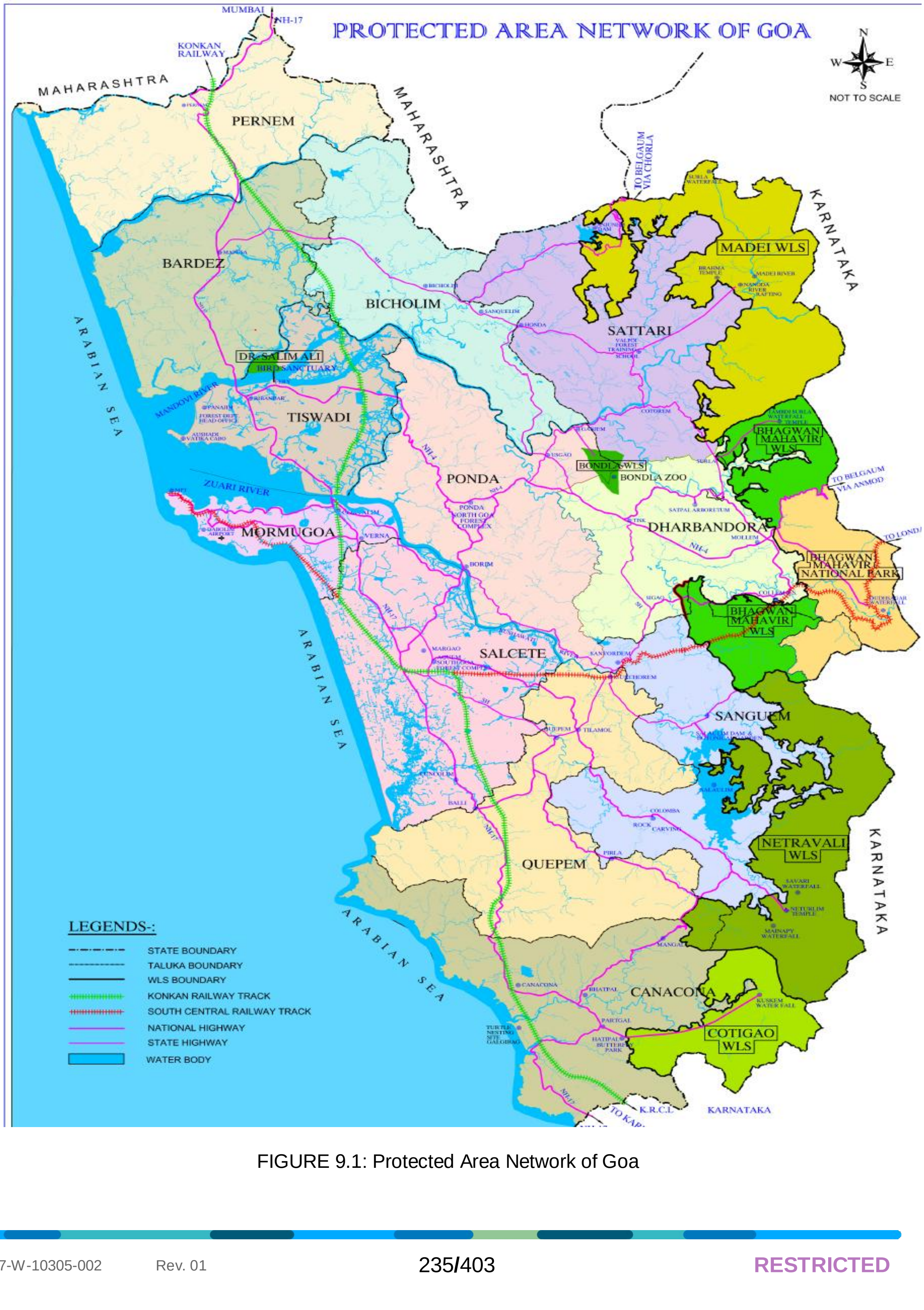


FIGURE 9.1: Protected Area Network of Goa

Source: Website of Forest Department of Goa: http://www.forest.goa.gov.in/wp-content/uploads/2015/08/fmap.jpg

Chorao Island Wildlife Sanctuary, which is also known as Dr. Salim Ali Wildlife Sanctuary, is the only marine protected area in Goa with a total area of 1.78 sq km. This Sanctuary is crisscrossed with a network of water channels. The "Mangrove Scrub" type of vegetation that is found here occurs in small isolated areas along the banks of Mandovi and Mapusa rivers. (Source: Carrying Capacity of Beaches of Goa for Providing Shacks and Other Temporary Seasonal structures in Private Areas, Submitted to Government of Goa and Prepared by National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest and Climate Change, Government of India available at http://www.dstegoa.gov.in/Beach%20Carrying%20Capacity%20Report.pdf)

As per the Office Memorandum dated 24th October 2013 issued by the Ministry of Environment and Forests, Government of India, Dr. Salim Ali Wildlife Sanctuary is bounded on three sides (North, West and South) by rivers (Mandovi and Mapusa), with a village named Chorao located towards its Eastern side. Thus, in case of this protected area, the rivers serve as natural boundary on three sides. The protected area is rich in bird life, crocodiles, leopards etc.

As can be seen from Figure 9-1, the project area is not located close to any of the protected areas in the State except Dr. Salim Ali Wildlife Sanctuary at Chorao village.

Approximately four kilometres of the initial stretch of NW-71 (between Ch 1.0 km to Ch 5.0 km) on Mapusa river lies along the boundary of the Dr. Salim Ali Wildlife Sanctuary. A fishing jetty already exists in this stretch along the boundary of the wildlife sanctuary.

As per the MoEFCC Notification dated 24th February 2015, the extent of Eco-Sensitive Zone around Dr. Salim Ali Wildlife Sanctuary in Goa shall be upto the river bank abutting the sanctuary on three sides of the Wildlife Sanctuary and to the extent of 100 metres on the eastern side towards Chorao village.

A study of the boundary of Dr. Salim Ali Wildlife Sanctuary and the extent of Eco-Sensitive Zones around it, as notified by the Government of India, confirms that the NW-71 project lies clearly outside of the Protected Area as well as outside the Eco-Sensitive Zone around it.

Olive Ridley turtle (*Lepidochelys olivacea*) is the major nesting species of sea turtle found in Goa. Sporadic nesting of Olive Ridley and Leatherback turtles has been recorded all along the coast of Goa (Bhaskar, 1984, Das, 1985) but recent nesting records are only of Olive Ridley (Giri and Chaturvedi, 2001). Nesting takes place between October and March each year (Dongre and Shambhu 2008, Giri, 2001; Kurian, 2013).

Considering the rapid decline in the turtle populations, sea turtles found in India were included in Schedule I of the Wildlife Protection Act, 1972. Turtles are listed in Appendix I of the Red Data Book of IUCN (International Union for the Conservation of Nature and Natural Resources) and also in Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna). India is a signatory to both the afore-mentioned Conventions. (Source: http://goaenvis.nic.in/marineturtle.htm).

Morjim in North Goa, Galgibag and Agonda in South Goa are the three main nesting sites of the Olive Ridleys in Goa. All sites are protected by the Forest Department with the help of local people. (Source: http://goaenvis.nic.in/marineturtle.htm). The CRZ Notification, 2011 recognizes beaches such as Mandrem, Morjim and Galgibaga and Agonda as designated turtle nesting sites (Source: CRZ Notification 2011). **NW-71 project is not located close to any of these nesting sites.**

9.2.13. Socio-economic Profile

With the Arabian Sea on the west of its 105 km coastline, the State of Goa today stretches over an area of 3,702 sq km comprising 1,736 sq km in North Goa and 1,966 sq km in South Goa. Goa served as a transit point for trade from the east during the Portuguese colonisation because of its strategic location on the west coast of India.

After its liberation from the Portuguese rule in December 1961, Goa was a district of the then Union Territory of Goa, Daman and Diu until May, 30, 1987 when Goa attained Statehood. Consequent upon the formation of new State of Goa, it was divided into two districts viz. North Goa and South Goa with their headquarter as Panaji and Margao respectively.

The Northern part of Goa has been named as North Goa District. North Goa District comprises six talukas under four sub–divisions as listed in Table 9-11 below.

Table 9-11: Sub-divisions and Talukas in North Goa District

Name of Sub-divisions	Name of Talukas
Mapusa	Bardez
	Pernem
Panaji	Tiswadi
Bicholim	Bicholim
	Satari
Ponda	Ponda

The Southern part of Goa has been named as South Goa District which comprises the remaining five talukas of Goa State.

For the purpose of revenue administration each taluka is in charge of a Mamlatdar. Further, for developmental activities, each taluka constitutes a separate Community Development (C.D.) Block under a Block Development Officer. Thus, in North Goa District there are four Subdivisions, six Talukas and six Community Development Blocks. The Taluka and C.D. Block boundaries are coterminous excluding the Statutory Towns in North Goa.

There are 188 inhabited villages and 47 towns in North Goa as per the 2011 Census. There are two uninhabited villages in Satari Taluka, 4 villages in this taluka are submerged due to the construction of Anjunem dam. Among the 47 towns, seven are Municipal Towns two in Bicholim, one each in five taluka and the remaining 40 are Census Towns with civic status of a Village Panchayat. At District level there is one Zilla Panchayat and 120 Village Panchayats in North Goa, a Panchayat comprising of one village or a group of villages.

District Highlights – 2011 Census

North Goa is smaller than South Goa District in terms of size and but is larger in population than South Goa.

About 60.28 per cent of its population of North Goa lives in urban areas.

It has a population density of 471 persons per sq km.

North Goa has a sex ratio of 963 females per thousand males compared to a sex ratio of 973 for the State.

Siroda (Ponda Taluka) is the most populated village (14,041) and Codvol (Satari Taluka) is the least populated village (5) in the district.

Satari Taluka is having the highest number of villages (77) in the district and the lowest numbers of villages are found in Bicholim Taluka, Tiswadi Taluka and Ponda Taluka (22) in the district.

Siroda village (Ponda Taluka) has the largest area (3,691 hectares) and Ambarim village (Tiswadi Taluka) has the smallest area (14 hectares) among the villages in the district.

North Goa is famous for historical temples, churches, forts and world famous beaches.

Source: District Census Handbook: North Goa, Census of India -Series-31, Part XII-B, Directorate Of Census Operations, Goa, 2011.

Agriculture is one of the important economic activities in the district. Rice is the staple food and paddy is the principal agricultural crop. Other crops grown are cereals, millets, pulses & oil seeds, sugarcane, coconut, arecanut and cashew nut.

Fishing has traditionally been one of the chief occupations and the source of livelihood of the people living in the coastal areas of Goa. The marine and fresh water fishery contributes significantly to the State's economy.

Goa is one of the most favoured tourism destinations in India. Tourism has contributed to the growth and development of many sectors in the State such as infrastructure, hotels, transport, housing, banking, travel agencies and tour operators. Presently, tourism contributes to over one-third of the State Gross Domestic Product, providing employment to a significant proportion of the total workforce. Tourism is generally focused on the coastal areas of Goa, with moderately low tourist activity inland.

Goa is the smallest State in India by area and the fourth smallest by population. It is bordered by Karnataka to the east and south, Maharashtra to the North and the Arabian Sea to its west. The State ranks 4th in the country with regard to literacy rate as per the 2011 census and has the highest per capita income.

9.3. Potential Environmental and Social Impacts of the Project

Based on the DPR study, the NW-71 project is proposed to be developed in two phases – Phase 1 and Phase 2.

Phase 1 involves development of the waterway for a stretch of 17 km with the installation of navigational aids only.

The DPR study recommends development of Phase 1 at present. Development of **Phase 2** may be taken up in future if required. Development of Phase 2 shall also be for a stretch of 17 km only.

Potential Environmental and Social Impacts in Phase 1

The construction activities as proposed for Phase 1 development are as follows:

i. Construction of terminal buildings - No

ii. Construction of access roads - No

iii. Bank protection works - No

iv. Dredging of the river in the proposed waterway stretch – No

v. Installation of Navigational Lights - Yes

No dredging, terminal construction, approach road construction or bank protection works are proposed for development of Phase 1.

Impacts on aquatic ecology during operation of the project need to be established as part of the EIA study to be commissioned for the project separately by IWAI.

The project does not involve any dislocation of population.

The positive impacts of the project will include improved waterway facilities and other allied infrastructure facilities for the local population. It will also generate some employment and small business opportunities for the local population.

Thus no significant adverse impacts are anticipated on account of development of Phase 1.

Potential Environmental and Social Impacts in Phase 2

The construction activities as proposed for Phase 2 development are as follows:

i. Construction of terminal buildings – Yes, one terminal at village Sircaim (Ch 17.00 km).

ii. Construction of access roads – Yes, 7.5 wide road for a length of 1300 m.

iii. Bank protection works – Yes, at 6 locations comprising a total length of approximately 3 km.

iv. Dredging of the river in the proposed waterway stretch – Yes.

v. Installation of navigational lights – Yes.

Phase 2, thus, envisages construction of a terminal facility, approach road development, bank protection works, dredging for creation of a navigable channel and installation of beacon lights.

As has been mentioned above, one terminal is proposed to be constructed as part of Phase 2 development. The proposed terminal is located at village Sircaim (Bardez Taluka) on the right bank of Mapusa at Ch 17.00 km (Lat. 15° 36' 57.02" N, Long. 73° 52 '51.56" E). A total of 3.2 ha of land will be required for terminal construction. No structures are present over the land identified for construction of terminal or related project components. Therefore, the project does not involve any dislocation of population. The land identified for the construction of terminal is entirely privately owned, which is mostly barren land with some coconut trees on it. Therefore, limited land use change is anticipated due to the construction of the terminal for operation of the proposed waterway.

For Phase 2, construction of 7.5 m wide road for 1300 m length shall be required for connectivity to the proposed terminal.

Bank protection works envisaged for the project are also to be carried out in Phase 2 of the project. The cumulative length for which the bank protection works shall be required is 3.0 km covering six locations.

Development of Phase 2 envisages dredging for creation of a navigable channel. The estimated quantity of dredged material for NW-71 is 1.0 lakh cu m. limited dredging will be required in the first 7 km of the navigation channel (approx. 53 cu m). Major dredging is envisaged for the stretch between Ch 8 to Ch 17 km. All the dredged material is proposed to be disposed of within the flood banks of the river. As such there is no impact on the land environment due to disposal of dredged material.

Impacts on aquatic ecology due to dredging and disposal of the dredged material within the river banks need to be established as part of the EIA study to be commissioned for the project separately by IWAI.

In general, the construction phase will involve mobilization of manpower and equipment at site, movement of vehicles, use of existing water resources and use of DG sets for construction power.

Impacts on air and noise, arising out of vehicular movement and fugitive dust emission, will be largely limited to the construction period.

Potential impacts on water quality of the river can be suitably mitigated by constructing the labour camps away from the river banks and by not allowing any debris to be thrown into the river during the construction and operation phases.

No structures are present over the land identified for construction of terminal or related project components. Therefore, the project does not involve any dislocation of population.

Taking into consideration the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices.

The positive impacts on the project will include improved waterway facilities and other allied infrastructure facilities the local population. It will also generate some employment and small business opportunities for the local population.

9.4. EMP and Mitigation of Environmental Effects

As already stated most of the potential impacts will be limited to the construction period of Phase 2 development.

The management measures required to mitigate the potential impacts of the project on the ambient air quality during construction period include suppression of fugitive dust by water sprinkling, transportation of construction debris in covered vehicles, maintaining the specified stack height of DG sets under use and ensuring that the vehicles and equipment used during the construction period are in well maintained condition. To ensure that the ambient air quality remains within the prescribed standards by the Central Pollution Control Board (CPCB), periodic monitoring of ambient air quality should be undertaken through an accredited laboratory. Suitable corrective measures should be implemented if the ambient air quality is found to exceed the prescribed limits.

The measures to ensure that there is no adverse impact on the water quality on account of the project during the construction period would include setting up of labour camps at a safe distance from the river banks. In addition, no construction debris / untreated effluents should be allowed to flow or be thrown into the river. The batching pants and concrete mixing plants should be located away from the river banks and these should be set up and operated strictly in accordance with the conditions stipulated by the SPCB.

To mitigate land, air and water contamination by the construction workers, adequate fuel, water and sanitation facilities should be provided to the construction workers. Hunting or poaching of wildlife should be strictly prohibited by any of the construction workers or employees. Also, it should be ensured that no unauthorized tree / forest cutting is undertaken by anyone engaged on the project.

Minimum required land should be acquired for the project. The private land owners, whose land is to be acquired for the project, should be compensated adequately in accordance with law.

The project authorities will need to ensure that the traditional fishing rights of the local population are not impacted adversely in any manner on account of the proposed waterway development. Adequate consultation with the local population shall need to be undertaken as required.

The project authorities should ensure that the Contractors engaged on the project have an approved environment management plan in place and that this management plan forms a part of the Contract document so as to ensure its effective implementation by the Contractors.

9.5. Applicable Legal and Regulatory Framework

The Goa State Pollution Control Board (GSPCB) acts as the nodal agency for environmental management, prevention & control of pollution and for the enforcement of following important acts & rules:

- Water (Prevention & Control of Pollution) Act, 1974
- Water (Prevention & Control of Pollution) Cess Act, 1977
- Air (Prevention & Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Notifications issued under Environment (Protection) Act, 1986
- Noise Pollution (Regulation & Control) Rules, 2000

Key legal and regulatory provisions as applicable to the project are described below.

Consent to Establish and Consent to Operate

The project will require obtaining the Consent to Establish from the SPCB under the Air and Water Acts prior to commencement of construction. Prior to commencement of operation, it shall require obtaining the Consent to Operate from the SPCB under the same Acts.

CRZ Clearance

The Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India, under the provision of Environment (Protection) Act, 1986, had issued a notification in February, 1991, declaring an area of 500 m from the high tide line along the sea coast, bays and estuaries and up to 100 m from the rivers and creeks as a Coastal Regulation Zone. The developments within this zone are required to be regulated in accordance with the provisions of the notification and the Coastal Zone Management Plan which the State Govt. is required to prepare for the area.

The CRZ Notification 1991 was later amended and a new Notification was issued in 2011 namely CRZ Notification 2011.

The CRZ Notification, 2011 declares the following areas as CRZ:

i. the land area from High Tide Line (HTL) to 500 mts on the landward side along the sea front.

ii. the land area between HTL to 100 mts or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance up to which development along such tidal influenced water bodies is to be regulated shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans (hereinafter referred to as the CZMPs).

    Explanation - For the purposes of this sub-paragraph the expression tidal influenced water bodies means the water bodies influenced by tidal effects from sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like.

iii. the land area falling between the hazard line and 500mts from HTL on the landward side, in case of seafront and between the hazard line and 100mts line in case of tidal influenced water body the word ‘hazard line’ denotes the line demarcated by Ministry of Environment and Forests (MoEF) through the Survey of India (SoI) taking into account tides, waves, sea level rise and shoreline changes.

iv. the land area between HTL and Low Tide Line (LTL) which will be termed as the intertidal zone.

v. the water and the bed area between the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies.

The coastal zone is categorized for the purposes of regulation in the following categories:

(i) CRZ-I,–

A. The areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast,-

(a) Mangroves, in case mangrove area is more than 1000 sq mts, a buffer of 50 meters along the mangroves shall be provided;

(b) Corals and coral reefs and associated biodiversity;

(c) Sand Dunes;

(d) Mudflats which are biologically active;

(e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves;

(f) Salt Marshes;

(g) Turtle nesting grounds;

(h) Horse shoe crabs habitats;

(i) Sea grass beds;

(j) Nesting grounds of birds;

(k) Areas or structures of archaeological importance and heritage sites.

B. The area between Low Tide Line and High Tide Line;

(ii) CRZ-II,-

The areas that have been developed up to or close to the shoreline.

Explanation.- For the purposes of the expression “developed area” is referred to as that area within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains;

(iii) CRZ-III,-

Areas that are relatively undisturbed and those do not belong to either CRZ-I or II which include coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up.

(iv.) CRZ-IV,-

A. the water area from the Low Tide Line to twelve nautical miles on the seaward side;

B. shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year.

(v) **Areas requiring special consideration** for the purpose of protecting the critical coastal environment and difficulties faced by local communities -

A. (i) CRZ area falling within municipal limits of Greater Mumbai;

(ii) the CRZ areas of Kerala including the backwaters and backwater islands;

(iii) **CRZ areas of Goa**.

B. Critically Vulnerable Coastal Areas (CVCA) such as Sunderbans region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 and managed with the involvement of coastal communities including fisherfolk.

The development or construction activities in different categories of CRZ are regulated by the concerned Coastal Zone Management Authority (CZMA) in accordance with the norms as defined under the CRZ Notification 2011.

The entire NW-71 project area falls under the tidal zone.

Mangroves are found to be located on both banks of the Mapusa River along the proposed waterway stretch. The Coastal Regulation Zone Notification (2011) under the Environmental Protection Act (1986) recognizes the mangrove areas as ecologically sensitive and categorizes them as CRZ-I.

Based on the categorization provided in CRZ Notification, 2011, the NW-71 project shall fall under CRZ – I. Accordingly, the project shall require obtaining clearance under the CRZ Notification 2011.

Forest Clearance

Even though mangroves are present on both banks of the Mapusa River along the NW-71 stretch, no Forest Clearance on this account is required to be obtained for development of the project as suggested.

9.5.1. Need for Environmental Clearance

Inland waterways are not listed as an activity that requires prior environmental clearance under the EIA Notification 2006. The Notification, as amended in 2009, includes 'Dredging' as an activity for which prior environmental clearance is required. However, **as per the MoEFCC letter dated 21 December 2017, National Waterway projects are exempt from the requirement of prior Environmental Clearance on account of maintenance dredging for creation of navigational channel.** The project, therefore, does not need to obtain Environmental Clearance from the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The MoEFCC letter to this effect is enclosed as Annexure 9.1 of the DPR.

The project shall, however, have to comply with the conditions stipulated in the said letter.

9.5.2. Other Major Clearances / Approvals / Permits Applicable to the Project

Other clearances required for the project shall include those that need to be obtained by the Contractors such as the Certificate of Registration from the Labour Department under various applicable labour laws, permission from SPCB for setting up of batching plants, license for storing petroleum / diesel etc.

No wildlife clearance is envisaged for the proposed waterway.

Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

A summary of major clearances / approvals / permits and their applicability to the project is provided in Table 9-12 below.

Table 9-12: Major Clearances / Approvals / Permits and their Applicability to the Project

Sl. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
1.	Environmental Clearance	No	EIA Notification 2006	Exempted by MoEFCC vide its letter dated 21 December 2017.
2.	Forest Clearance	No	Forest Conservation Act,	No clearance of mangrove vegetation or diversion of

Sl. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
			1980	any forest land for any other purposes is involved in the development of NW-71 as recommended.
3.	Wildlife Clearance	No	Wildlife Protection Act, 1972	No part of the project falls within the boundary of any of the protected areas or within their eco-sensitive zones.
4.	CRZ Clearance	Yes	CRZ Notification 2011	The entire project falls in CRZ I.

9.6. Cost Implications

As per the scope of services for further environmental and social impact assessment (EIA & SIA) studies and requirement of obtaining all mandatory statutory clearances for the project approximately 1 to 1.5 year is adequate period for consultancy services (1 year for non-CRZ and 1.5 year for CRZ waterways) related to EIA & SIA studies. In this regard, the project authority may engage to QCI/NABET accredited EIA consultant for Category – A projects, who shall conduct rapid EIA & SIA studies and shall prepare a stand-alone EMMP (EMP & EMoP) for inclusion in the contractor bid documents. The generation of environmental baseline data at pre-construction stage along with environmental monitoring during construction and operation stages shall be carried out by the NABL/MoEF&CC approved laboratory to assess the project performance during entire project cycle.

The estimated cost for conducting EIA-EMP & SIA studies along with obtaining all mandatory statutory clearances at pre-construction stage and timely and effective implementation of EMMP (EMP & EMoP) during construction and operation stages have been described in the following sections.

9.6.1. Estimated Cost at Pre-Construction Stage

The statutory fee shall be paid by the project authority for obtaining all mandatory statutory clearances. The estimated environmental and social budget for EIA-EMP & SIA studies have been summarized below:

Table 9-13: Summarized Estimated Cost for Consultancy Services

Sl. No.	Particulars of Estimated Budget	Amount (in Rs. Lakh)	Remark (if any)
1.	Salary of 12 Professionals/Domain Experts on intermittent based input (as per QCI/NABET scheme)	40	Lump-sum cost on intermittent basis
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	3.20	To be done for one season **(Table – 9-14).**
3.	Public Consultation Meeting (PCM)	4	Lump-sum cost
4.	Reports / Document Printing	1	Lump-sum cost without break-up
5.	Travelling Cost for Site Visits (Bus, Taxi, Boat *etc.*)	5	Lump-sum cost
6.	Lodging & Boarding Cost	5	Lump-sum cost
7.	Cost for collection of metrological data and other information like Maps *etc.*	5	Lump-sum cost
	Grand Total (Rs)	**63.20**	

***In words: (i)** Rs. Sixty Three Lakhs Twenty Thousand only*

Note: No. of Key Experts: 12 as per QCI/NABET Scheme on intermittent basis. Which may increase or decrease by the project proponent as per actual scope of work.

(i) Above consultancy Fee is without Service Tax.

(ii) The breakup of Sl. No. 2 is given in Tables 9-14.

Table 9-14: Estimated Sub-Cost for One Time Baseline Data Generation at Pre-Construction Stage

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per Sample with various parameters	4	20,000	80,000
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per Sample with various parameters	4	15,000	60,000
3.	Noise Quality monitoring	Day & Time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	4	10,000	40,000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per Sample with various parameters	4	10,000	40,000

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.	-	4	25,000	100,000
	Sub-Total (Baseline Environmental Data Generation Cost)						**320,000**
	In Words: *Rs. Three Lakh Twenty Thousand only.*						

Note: 1 monitoring station @ 8 Km/station = tentatively 4 locations shall be monitored.

9.6.2. Estimated Cost at Construction Stage

The civil work contractor during construction stage shall depute a well experience environmental & safety Officer (ESO), who shall conduct Environmental Monitoring at Construction Stage as per stipulated conditions in the contractor documents. He shall also prepare environmental monitoring report that to be submitted timely to the project proponent and statutory authorities as per project requirement.

Table 9-15: Estimated Cost for Environment Management during Construction

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Construction Stage once in a year	9.60	Shall be carried on half yearly basis for entire construction period (**Table 9-14)**
2.	Greenbelt Development nearby terminal Premises by Contractor	6	Lump-sum cost
3.	Solid Waste Management	6	Lump-sum cost
4.	Sanitary facilities at labour camps	6	Lump-sum cost
5.	Disaster Management Plan	5	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**34.60**	

Table 9-16: Environmental Monitoring Cost for Construction Stage

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per sample with various parameters	4X3 = 12	20,000	240,000
2.	Water Quality	***Physical Properties:***	Surface and ground	Per sample with	4X3 = 12	15,000	180,000

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
	monitoring	pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	water to be monitored separately	various parameters			
3.	Noise Quality monitoring	Day & Time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per sample location with various parameters	4X3 = 12	10,000	120,000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per sample with various parameters	4X3 = 12	10,000	120,000

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.		4X3 = 12	25,000	300,000
Total (Rs)							**960,000**

9.6.3. Estimated Cost at Operation Stage

Like preconstruction stage, the environmental monitoring and supervision to be done by the project proponent.

Table 9-17: Estimated Environment Management Cost during Operation

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Operational Stage once in a year.	3.20	Shall be carried for one season as per Table 9-7 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
3.	Solid Waste Management	2	Lump-sum cost
4.	Sanitary facilities nearby terminals	2	Lump-sum cost
5.	Disaster Management Plan (if applicable)	2	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**13.20**	Per Year

9.6.4. Summary of Estimated Environmental & Social Budget

This covers the consultancy fee at pre-construction stage along with implementation of EMMP (EMP & EMoP) during construction and operational stages of the project. The statutory fee along with the cost of private and government land acquisition shall be borne by the project proponent. This has been summarized in Table 9-18 given below:

Table 9-18: Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (Rs.)	Remark
1.	Pre-Construction Stage	63.20	Lump-sum
2.	Construction Stage	34.60	
3.	Operational Stage	13.20	
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		111.00	

In Words: Tentative estimated cost is Rs. 111.00 Lakhs.

The above proposed expenditure may have to be considered against the allocated provisions under the head of Fairway Development and Terminal Development.

CHAPTER 10 INSTITUTIONAL REQUIREMENTS

10.1 Organizational Set up / Establishment

The Inland Waterways Authority of India (IWAI) has been carved out duly taking over the responsibilities etc., of the erstwhile Inland Water Transport (IWT) directorate under Ministry of Surface Transport / Ministry of Shipping with a vision of more thrust on the IWT sector along with more Autonomy, by an Act of Parliament (IWAI Act 82 of 1985). Accordingly, IWAI is vested with the functions / duties and responsibilities connected to the safe navigation in the National Waterways and in the interconnected waterways, where IWT is considered for development. The Para 14 of IWAI ACT 82 of 1985 is provisioned with the Functions and Powers of authority, as detailed, which is self-explanatory.

Functions and Powers of the authority:

14. (1) The Authority may-

(a) carry out surveys and investigations for the development, maintenance and better utilization of the national waterways and the appurtenant land for shipping and navigation and prepare schemes in this behalf; (b) provide or permit setting up of infrastructural facilities for national waterways;

(c) carry out conservancy measures and training works and do all other acts necessary for the safety and convenience of shipping and navigation and improvement of the national waterways;

(d) control activities such as throwing rubbish, dumping or removal of material, in or from the bed of the national waterways and appurtenant land, in so far as they may affect safe and efficient, shipping and navigation, maintenance of navigable channels, river training and conservancy measures;

(e) remove or alter any obstruction or impediment in the national waterways and the appurtenant land which may impede the safe navigation or endanger safety of infrastructural facilities or conservancy measures where such obstruction or impediment has been lawfully made or has become lawful by reason of long continuance of such obstruction or impediment or otherwise, after making compensation to person suffering damage by such removal or alteration;

(f) provide for the regulation of navigation and traffic (including the rule of the road) on national waterways; (g) regulate the construction or alteration of structures on across or under the national waterways;

(h) disseminate navigational meteorological information about national waterways;

(i) ensure co-ordination of inland water transport on national waterways with other modes of transport; and (j) establish and maintain pilotage on national waterways;

(k) enter into joint ventures concerning inland shipping by way of equity participation.

14. (2) The Authority may also-

(a) advise the Central Government on matters relating to inland water transport;

(b) study the transport requirement with a view to co-coordinating inland water transport with other modes of transport;

(c) carry out hydrographic surveys and publish river charts;

(d) assist, on such terms and conditions as may be mutually agreed upon, any State Government in formulation and implementation of scheme for inland water transport development;

(e) develop consultancy services and provide such services, on such terms and conditions as may be mutually agreed upon, in India and abroad in relation to planning and development of waterways for shipping and navigation or any facility thereat;

(f) conduct research in matters relating to inland water transport including development of craft design mechanization of country crafts, technique of towage, landing and terminal facilities, port installations and survey techniques;

(g) lay down standards for classification of inland waterways;

(h) arrange programme of technical training for inland water transport personnel within and outside the country; and

(i) perform such other functions as may be necessary to carry out the provisions of this Act.

14. (3) Any dispute arising out of or concerning the compensation referred to in clause(e) of subsection(1) shall be determined according to the law relating to like disputes in the case of land required for public purposes.

14. (4) Every scheme, prepared by the Authority to carry out functions under sub-sections(1) and (2), involving capital expenditure exceeding the amount as may be prescribed, shall be submitted to the Central Government for approval.

14. (5) The Central Government may either approve the scheme submitted to it under sub-section (4) without modification or with such modifications as it may consider necessary or reject the scheme with directions to the Authority to prepare a fresh scheme according to such directions.

In order to consider a planned and systematic implementation with the assigned functions of the authority, a strong Institutional mechanism is required.

If we keenly observe the Institutional systems of similar administrations / establishment globally and the parallel administrations / establishments nationally, the key factor emerging out of the same is only the Policy and procedure of implementation of the assigned responsibilities. It is yet a debatable aspect i.e., whether to have a full pledged organization so as to undertake the works through contractual agencies or to have a mechanism of Out Sourcing the work along with supervision to different contractual agencies (Out Sourcing the work to an agency and the Project Management to other agency).

10.2 Man Power Requirement

It is suggested that the Outsourcing the work to a contractual agency is the best alternative for the subject study and accordingly, the Manpower requirement is under consideration

As ascertained, IWAI is having an Institution Mechanism consisting of a Board along with Functional Manpower having the inverted conical organization pattern. The major functional aspects have already been segregated as Project; Planning; Survey; Marine; Traffic; Finance and Administration. Hence, dislocation of the existing system is not suggested. The present requirement within the study stretch should be unique, which should be amenable to the existing system in the office of Policy making with Control.

Accordingly, the Controlling office (at NOIDA) has been depicted in the pictorial form and will have 1 Chief Engineer to look after the Central part of the country (Hyderabad) to deal with the Waterways / National Waterways in the states of Maharashtra; Goa; Karnataka; Orissa; Telangana; Andhra Pradesh; Tamilnadu & Kerala (including NW 3). Refer the Annexure 10.1.

The present study stretch of Cluster 7 having 6 National Waterways will be looked after by a Directorate (suggested / recommended) with an office within the Geographical zone, preferably accessible to all the Waterways / National Waterways. The Organizational requirement has been depicted in Annexure 10.2. A skeleton staff requirement of 3 Nos. also has been projected as a support requirement in the Chief Engineer's office.

10.3 Training Requirement / Capacity Building

IWAI is having various disciplines within the organization viz., Civil Engineering; Mech. Marine Engineering; Hydrographic Survey; Traffic; Administration / Establishment; Finance etc.,.

It is suggested and recommended to have an intra discipline and inter discipline training for all the employees of the IWAI at entry level i.e., at Technical Assistant / Assistant Director; Junior Hydrographic Surveyor / Assistant Hydrographic Surveyor; Junior Accounts Officer / Accounts Officer; Section Officer / Assistant Secretary etc.,. The National Inland Navigation Institute (NINI) of IWAI at Patna premises can be used for such training. It is preferred to have such Trainings as onsite training, while the works are under progress.

10.4 Infrastructure

The Infrastructure for the Institution will not have much implication, except the Land for the Office premises, if at all to have the own building of IWAI. However, the infrastructure for functional aspects may be essential within the accessibility of the site controlling office viz., the office of the Director.

The functional requirement can be identified as Survey Vessels; Survey Instruments in order to carry out the mandatory periodical Survey works on the National Waterways. Likewise, to maintain the Night Navigation system, there should be a powerful Tug – cum – Buoy maintenance vessel should be available within the bounds of the office. Further, to have quick inspections and also to have periodical visits, Speed Boats are to be available as an Infrastructure within the controlling office.

Accordingly, 2 Nos. of Survey Vessels; 2 units of Survey Instruments with Software; 2 Nos. of Tug – cum – Buoy maintenance vessel; 2 Nos. of Speed Boats are suggested / Recommended for each Directorate office to look after approximately 6 Nos. of the National Waterways within its jurisdiction.

10.4.1 Immovable

The immovable asset, Land is not suggested at this point of time. In the Long run, even if identified the need of having own office, this will be considered at one of the Terminal Locations, amenable with ease approach. Hence there is no suggestion / recommendation of Land / immovable asset under Institution.

10.4.2 Movable

As discussed above, the asset requirement for attending the functions and responsibilities catered will be considered for procurement. The details have been tabulated directly as a financial Implication with segregation of Capital Cost Implication and Monthly Cost Implication, including the Manpower monthly implication in the forth coming Paras. Keeping in view the Organization requirement, as derived, the implication has been worked out duly taking into consideration of the 7th Pay commission Pay system, so as to have an implementable approach.

10.5 Cost Implications

The cost implication for the apportioned project has been worked out and placed herewith.

TABLE 10-1: Manpower financial implication per month

Sl. No	Name of the Post	Nos. of the Post	Basic Pay (INR)	Implication per month @ 95 % extra (INR)	Remarks
1.	Director	1	78800	153,660	Annexure 10.2 may be referred.
2.	Asst. Director Civil / Mechanical	3	56100	328,185	
3.	Asst. Hy. Surveyor	1	56100	109,395	
4.	Junior Hy. Surveyor	1	47600	92,820	
5.	Junior Accounts Officer	1	47600	92,820	
6.	Supervisor	3	35400	207,090	
7.	Steno / P. A	1	35400	69,030	
8.	Upper Divisional Clerk	1	25500	49,725	25 % extra for statutory allowances and 20 % extra for perks have been taken into
9.	Data Entry Operator	6	21700	253,890	
10.	Driver	1	21700	42, 315	
11.	Attendant	6	21700	253,890	
	Total	25		1,652,820	

Sl. No	Name of the Post	Nos. of the Post	Basic Pay (INR)	Implication per month @ 95 % extra (INR)	Remarks
	Chief Engineer's Office Component				consideration.
1.	Deputy Director	1	67600	131,820	
2.	Technical Assistant	1	47600	92,820	
3.	Data Entry Operator	1	21700	42,315	
	Total	3		266,955	
	Grand Total	28		1,919,775	

TABLE 10-2: Financial implication – Capital and Maintenance

Sl. No	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
1.	Office premises	*	75,000	* In the initial stages, office will function on rented premises only
2.	Furniture etc.,	1,000,000	--	L. S.
3.	Pay and Allowances for 28 Nos.	--	1,919,775	As per the Table 10.1
4.	Vehicle 1 No.	500,000	--	
5.	Running & Maintenance of the Vehicle	--	50,000	
6.	Computer Systems including UPS etc., 6 Nos. @ 1 lakh each	600,000	60,000	
7.	Printers 4 Nos. @ 0.5 lakhs each	200,000	*	* Taken into General Office maintenance
8.	Laptops 6 Nos. @ 1 lakh each	600,000	*	* Taken into General Office maintenance
9.	Drawing Printer 1 No. @ 5 lakhs each	500,000	*	* Taken into General Office maintenance
10.	High Speed Printer 1 No. @ 3 lakhs each	300,000	*	* Taken into General Office maintenance
11.	Alternate Uninterrupted Power Supply with D. G set 1 No @ 10 Lakhs per no.	1,000,000	50,000	
12.	2 Nos. Survey Vessels (2 engines of 175 Bhp each) @ 350 lakhs each	70,000,000	1,000,000	Inclusive of Staff charges, on board.

Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
13.	2 Units of Survey Instruments (9.5 lakhs each) + Software (6.5 lakhs each) + Laptop (1 lakh each) etc.,	3,400,000	200,000	Maintenance is inclusive of Survey Stationery and Consumables.
14.	2 Nos. Tug – cum – Buoy Maintenance vessel (2 engines of 375 Bhp) @ 750 lakhs each	150,000,000	1,200,000	Inclusive of Staff charges, on board.
15.	2 Nos. Speed Boats (2 engines of 75 Bhp @ 75 Lakhs each	15,000,000	150,000	Inclusive of Staff charges, on board.
16.	Other General Office maintenance including stationery, consumables etc.,	--	500,000	
	Total	**243,100,000**	**5,204,775**	

+ The Cost implications for segregated functions like Fairway Development Cost; Terminal Development Cost; Vessel maintenance Cost; Navigation and Communication system implementation cost etc., have been taken into consideration at the appropriate heads, whereas the item Nos. 12 to 15 above are being provisioned for undertaking the requisite functions under the Institution requirements.

+ The above expenditure may have to be considered for 6 National Waterways and accordingly the apportioned cost for River Mapusa-Moide i.e., Capital cost will be INR 405.00 Lakhs {2431 Lakhs / 6} and maintenance cost per month will be INR 8.70 Lakhs. {52.05 Lakhs / 6} say 9 Lakhs per month.

+ It is also suggested to have the Limited Manpower of 1 Asst. Director (AD) + 1 Supervisor + 1 Junior Accounts Officer (JAO) + 1 Data Entry Operator (DEO) + 1 Attendnat as a skeleton staff and the deployment is recommended at initial stages duly meeting the cost from the suggested provisions. It can be reviwed from time to time based on the volume of work requirement.

CHAPTER 11 PROJECT COSTING

11.1 General and Financial assumptions

Project Costing is an important aspect, which is to be worked out rationally to assess the apt requirement of the project with a reasonable costing structure so as to ascertain the end result of returns and also will play a vital role in decision making on the implementation of various project components.

It is also essential to define certain financial requirements, in terms of assumptions for the project, which are to be rational i.e., not to be irrational.

In this context, certain parameters, as defined by IWAI, have been analyzed and considered in the cost working and Return working. The circulated data has been placed at Annexure 11.1. However, the same may not suffice the requirements in working out the cost / returns and hence some more assumptions have been considered appropriately, wherever required.

11.2 Basis of Costing

In general, the costing used to be worked out based on the quantity requirements along with rate per unit quantity. The quantities for the subject project have been arrived at based on the actual item wise requirements. The estimated costs have been worked out based on the DSR / relevant Schedule of Rates (SoR) of the concerned region / state. Rates for the non-available items have been proposed based on the Market Rates or based on the realistic budgetary quotations, to the extent possible.

11.3 Development Cost

Based on the utility, the Mapusa River was earlier used for the mobility of Mining Ore through Mandovi River to Port. In this process, Infrastructure was developed / mobilized. However, with the stoppage of Mining due to the complaints / cases, the matter has gone to the level of Supreme Court. With the recent decisions of the Supreme Court, mining is under revival in the catchment area of Mandovi River. However, the pace of revival is very slow. Hence, the period up to 2030 has been taken as observation period with a nominal investment of INR 6.80 Crores (Phase1).

The Fairway development will be considered depending on the observed growth for IWT traffic. The fairway investment is estimated as INR 51.80 Crores for investment from FY 2030 to FY 2033.

Since the infrastructure is in existence for cargo handling, IWAI's investment is not required. However, if the provisional of Terminal is essential (based on the requirement at that point of time), a judicious decision can be taken for the investment of INR 55.10 Crores between FY 2030 & 2033.existing infrastructure.

11.4 Capital Expenditure

As explained above, the Fairway related development cost has been worked out and placed herewith.

TABLE 11-1: Abstract of Cost for Mapusa Fairway Development (Phase I)

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	0.00	
(ii)	Hard Soil	0.00	
2	Low Cost River Structures		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	0.00	
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	0.00	
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	137.58	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**137.58**	
B	**Modification of Structures**		

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
(i)	Bridges	0.00	
(ii)	Cables	0.00	
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	
	Sub-total (C)	**0.00**	
D	**Institutional Requirement**		
(i)	Office Development Cost	405.00	
	Sub-total (D)	**405.00**	
	Sub-total (A)+(B)+(C)+(D)	**542.58**	
E	Environmental Management Plan Cost@5% of Prime cost	27.13	
F	Project Management & consultancy Charges @10% of Prime cost	54.26	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	54.26	
	Project total Hard Cost	**678.23**	
		6.78 cr	

TABLE 11-2: Abstract of Cost for Mapusa Fairway Development (Phase II)

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	300.00	11.2
(ii)	Hard Soil	0.00	
2	Low Cost River Structures		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	3696.49	11.3
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	151.31	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**4147.80**	
B	**Modification of Structures**		
(i)	Bridges	0.00	
(ii)	Cables	0.00	
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
	Sub-total (C)	**0.00**	
D	**Institutional Requirement**		
(i)	Office Development Cost	0.00	
	Sub-total (D)	**0.00**	
	Sub-total (A)+(B)+(C)+(D)	**4147.80**	
E	Environmental Management Plan Cost@5% of Prime cost	207.39	
F	Project Management & consultancy Charges @10% of Prime cost	414.78	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	414.78	
	Project total Hard Cost	**5184.75**	
		51.85 cr	

The Lo-Lo facility requirement has been worked out and placed herewith.

TABLE 11-3: Abstract of Cost for Mapusa LOLO Facility

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Terminals**		
(i)	Land	722.29	11.5
(ii)	Riverine Components	902.97	11.6
(iii)	Infrastructure Components including internal roads	1821.57	11.7
(iv)	Approach Road Cost	29.30	11.8
(v)	Bank Protection Works for terminal	423.43	11.9
	Sub-total (A)	**3899.57**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Cargo Handling Equipments**		

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
(i)	Ambulance - 1 no.	10	
(ii)	Dumper Trucks 16 T Capacity - 0 no.	0	
(iii)	Cranes with 125 T Capacity - 2 no.	400	
(iv)	Fork lift trucks 20 T Capacity - 2 no.	96	
	Sub-total (C)	**506.00**	
	Sub-total (A)+(B)+(C)	**4405.57**	
D	Environmental Management Plan Cost@5% of Prime cost	220.28	
E	Project Management & consultancy Charges @10% of Prime cost	440.56	
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	440.56	
	Project total Hard Cost	**5506.96**	
		55.07 cr	

11.5 Operational and Maintenance Expenditure

The operation & Maintenance expenditure has been considered as at Annexure 11.1 and as per the industrial standards.

11.6 Phasing of Expenditure

The project will be under observation during the period up to 2030 with nominal investment of INR 6.80 Crores (Phase1), in the initial 12 months.

The Fairway development will be considered depending on the observed growth for IWT traffic. The fairway investment is estimated as INR 51.80 Crores for investment from FY 2030 to FY 2033. (36 months).

The Lo-Lo Terminal development will be taken up with a judicious decision for the investment of INR 55.10 Crores between FY 2030 & 2033. (36 months).

CHAPTER 12 IMPLEMENTATION SCHEDULE

12.1 Time Frame

The Time Frame for the development of river Mapusa is being considered for observation of Traffic Growth till FY 2030 with nominal investment of INR 6.80 Crores.

In order to facilitate the ongoing IWT Traffic of from Vedanta captive Terminal, the module of Fairway development, the activities of Dredging; River Training works; Day / Night Navigation facilities; Communication System; Institutional Requirements along with Environmental Management Plan (EMP) have been proposed. With the development of fairway, the revenue collection can be considered for the traffic with possible expandable traffic. The Implementation Schedule in Pictorial form is placed at Annexure 12.1.

Further to the above, to meet the cargo growth beyond the saturation of the existing captive Terminals, it is proposed to develop 1 Lo-Lo Jetty Terminal to facilitate the mobility of the identified IWT divertible Traffic, which is proposed to be developed in phased manner. The Implementation Schedule in Pictorial form is placed at Annexure 12.2.

12.2 Phasing

Observation period till FY 2030 with nominal investment of INR 6.80 Crores (Phase1), in the initial 12 months.

The Fairway development is estimated as INR 51.80 Crores for investment from FY 2030 to FY 2033. (36 months).

The Lo-Lo Terminal development is estimated as INR 55.10 Crores between FY 2030 & 2033. (36 months).

12.3 Suggested Implementation Mechanism

The implementation will be considered through the Project Management Consultancy, as provisioned. However, it is suggested that the overall supervision will be under the control of the IWAI supervision mechanism.

CHAPTER 13 ECONOMIC AND FINANCIAL ANALYSIS

13.1 Introduction

Mapusa River development has been distinguished across two development modules. This is depicted in the following Table 13 1:

TABLE 13-1: Mapusa River Development– Case 1

	Sub-sector	FY19	FY30	FY31	FY32	FY33	FY40
With Development	Fairway	Phase 1					
				Development			
						Phase 2	
Without Development	Fairway	Operational					

Mapusa River Development– Case 2

	Sub-sector	FY19	FY30	FY31	FY32	FY33	FY40
With Development	Fairway	Phase 1					
				Development			
						Phase 2	
	Lo-Lo			Construction			
						Phase 2	
Without Development	Fairway	Operational					

Sircaim is the proposed location where Lo-Lo terminal is to be developed. At this identified location, there already exists few jetties only for iron-ore handling i.e. a captive jetty, Calvim jetty, etc., presently these jetties are not operational because of the ban imposed on mining. However, now policies are relaxed and ban has been removed partially, it is likely that these jetties come into operation soon.

The plan is to develop the fairway in two phases and Lo-Lo terminal in one phase. Lo-Lo terminal will be developed only post an observation period scheduled from 2019 to 2030. The earliest possible year when the terminal will handle any traffic is 2033. With due consideration of 3 years for construction period of the terminal, construction work towards setting up the terminal should start by 2031 and finish by 2033. By 2033, the Lo-Lo terminal can become operational and start handling the projected traffic. The second phase of development for the fairway should also commence at the same time, thus coinciding with the development of Lo-Lo terminal.

Two cases are designed for this financial analysis. Case 1 - If above said, existing jetties restarts, happens then there would be no need for developing any new terminal, as existing jetties have sufficient capacity to handle the available traffic in the region. Only fairway will be developed till FY40 if observation period gives good outcomes. Case 2 - But in case, these jetties does not come into operation, then there exists opportunity for development of IWAI terminal. Traffic study indicates that the proposed Lo-Lo terminal at Sircaim is likely to observe traffic only if the existing jetties will not be functional. The observation period between 2019 and 2030 will be used to evaluate the market and to arrive at the decision of going ahead with Phase 2 development of the fairway. In the event the market is not conducive for fairway expansion, Phase 1 operational status quo will be maintained without any further development of fairway and terminal, this factor will be same in both the cases.

Operations at each of these sub-sector projects are expected to commence in the last year of its construction period. So, fairway should start generating revenue from FY20 in Phase 1 and FY33 in Phase 2. Similarly, Lo-Lo terminal will also commence operation by FY33.

13.2 Input Sheet

The following table lists all the assumptions and input values used in the financial modeling of Mapusa River. This includes financial analysis for the navigation infrastructure (fairways), and terminal operations (Lo-Lo):

TABLE 13-2: Input Sheet for Mapusa River project

Description	Unit	Fairway	Lo-Lo
Loan Tenure	Years	10	10
Moratorium Period (Years Construction)	Years	3	3
Rate of Interest	Annual	11%	11%
Corporate Tax	Annual	30%	30%
Royalty to MMB	INR/Tonne		20
Annual Lease Rental Increase	Annual	2%	2%
Cargo Revenue Escalation	Annual	6%	6%
Other Revenue Escalation	Annual		6%
Administrative Cost	of Revenue	3%	2%
Manpower Cost Escalation	Annual	5%	5%
Cargo Costs Escalation	Annual	5%	
Other Costs Escalation	Annual		6%
Fairway Chainage	km	17.3	
Chainage (Lo-Lo – Mormugao Port)	Km		31.8
Tariff for Revenue Calculation			
Various Revenue Sources	**Unit**	**Fairway**	**Lo-Lo**
Fairway Cost			
Movement of vessel	GRT/km	0.5	
Charges of Handling ores			
Vessel Berthing Charges	Per GRT		10
Vehicle Unloading Charges	Per tonne		100
Revenue prospects from Ancillary Activity			
Truck Parking Charges	Per Day		50
Weigh Bridge Charges	Per Day		75
Leasing Space Coffee Shops	Per Day		500
Lease space for Rest/Retiring	Rs/Day/Truck		25
Operation & Maintenance			
Description	**Unit**	**Fairway**	**Lo-Lo**
Civil Infrastructure	Cost		1%
Dredging	Cost	10%	
Ship Operating Cost	Cost		
Utilities	Cost	5%	5%
Machinery Infrastructure	Cost		5%
IT & Other Soft Factors	Cost	5%	5%
Insurance Cost	Capex Mechanical	2%	2%
Description	**Unit**	**Fairway**	**Lo-Lo**
Total Engine Power	KW		
Fuel Consumption	KL/Day		
Fuel Price	INR/L		
Cargo Handling at Jetty	INR/ Tonne		40
Storage	INR/T		0
Evacuation	INR/T		

Assumptions for EIRR			
Parameters	**Unit**	**Value**	**Reference**
Economic loss due to Road Accidents	of GDP	3%	Tractebel
GDP of India@ Current Prices	Rs Lakhs Crores	125.41	
Value of economic loss due to road accidents	Rs Lakhs Crores	3.7623	
Total Road network in India	Lakh KM	0.4865	
Safety Index (IWT as base)	times safer than road	50	
	times safer than rail	5	
Accidental Loss			
Road	Rs Lakhs/KM	7.73	Tractebel
Rail	Rs Lakhs/KM	0.77	
IWT	Rs Lakhs/KM	0.15	
Fuel Cost (1 liter of fuel moves)			
Road	t-km	24.00	Tractebel
Rail	t-km	85.00	
IWT	t-km	105.00	
Total Cargo	Million Ton	16.48	
Total Distance	KM	Fairway – 2 X 17.3; Lo-Lo – 2 X 31.8	
Fuel price	Rs/Litre	60.00	
Vehicular Operating Cost (VOC)			
Road	Rs/t-km	2.58	Tractebel
Rail	Rs/t-km	1.41	
IWT	Rs/t-km	1.06	
Direct Employment Creation			
Road	Per Million t-km	20	Tractebel
Rail	Per Million t-km	2	
IWT	Per Million t-km	0.5	
Employment cost	Rs Lakhs per Annum	2.5	
Emission Reduction			
Road	g CO_2/t-km	60	Tractebel
Rail	g CO_2/t-km	13.3	
IWT	g CO_2/t-km	6	
Shadow Factor			
CAPEX/O&M Cost- To convert financial cost to economic cost		0.85	Tractebel
O&M Cost escalation	p.a.	5%	
Carbon Credits Factors			
Carbon Shadow price	$/Tonne	20	Tractebel
Exchange rate	Rs/USD	67	

Source: Consultant, Market standards

All the necessary assumptions for financial modeling are either market driven or provided by IWAI. Fairway and terminal tariff have been taken from IWAI. The vessel parcel size is estimated at 90% of the rated DWT, and GRT is estimated at 75% of the rated DWT. The chainage of 17.3 km is from the mouth of the River to a location where the Lo-Lo operations will terminate. The Phase 2 will come into the picture when IWAI decides to carry out further development on the fairway, and set up a fully-fledged Lo-Lo Terminal to attract the industries. This will be on the back of viability of Phase 1. In case of fairway and Lo-Lo revenue calculations, traffic originates from the mines located in the nearby region of proposed IWAI terminal location and destined to Mormugao port across the considered chainage of 17.3 km for development covering total distance of 31.8 from Terminal location to Mormugao Port. In EIRR, round-trip distance is considered in each of the sub-sector's economic viability evaluation.

Keeping in line with the "with development" and "without development" model, all the subsequent sections will include financial analysis accordingly.

13.3 Revenue

Revenue for the cumulative stretch of Mapusa River will be generated from the core operations, which include utilization of the fairways by the potential users from nearby mining areas, and operation at the Lo-Lo terminal. Secondary revenues sources, labeled "Ancillary Revenue", will be generated from sources like vehicle parking, weighbridge, land leasing for commercial operations (tea-stall, coffee shops, inn, etc.), and leased resting area for bus operators. The revenue break-up and total revenue for IWAI on Mapusa River are presented in the table below:

TABLE 13-3: Revenue for Mapusa (INR Lakhs)

`	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)	-	7.6	51.2	68.5	-	-
Fairway (Phase 2)	-	-	-		54.6	109.6
Lo-Lo Terminal	-	-	-		79.1	157.2
Without Development						
Fairway	-	7.6	51.2	68.5	110.0	220.5

As mentioned earlier, the Phase 1 period will end in FY30, if this comes not viable then same will be continued with nominal investment till FY40. This is why revenue generated from FY19 to FY30 for both "with development" and "without development" fairway model will be the same, on account of the same chainage of 17.3 km. The lack of any considerable investment bodes well for returns in case of fairway utilization. Even in case of development post Phase 1, the high traffic volume will continue to favourably impact the revenue prospects. FY19 has been reserved for laying the necessary groundwork to initiate the Phase 1 campaign. So, FY20 is the year when the estimated traffic will start moving the fairway.

13.4 Costs

This section presents the total project cost, and equity-debt distribution in phased manner. The following table shows these cost-heads for both the core business operations:

TABLE 13-4: Project Cost

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
With Development				
Fairway (Phase 1)				
Fairway	137.6	137.6	-	-
Institutional Requirement	405.0	405.0	-	-
Environmental Management Plan Cost@5% of Prime cost	27.1	27.1	-	-
Project Management & consultancy Charges @10% of Prime cost	54.3	54.3	-	-
Contingencies and Unforeseen Items of Works@10% of Prime cost	54.3	54.3	-	-
Total Project Cost	**678.2**	**678.2**	-	-
Fairway (Phase 2)				
Fairway	4,147.8	1,659.1	1,244.3	1,244.3
Environmental Management Plan Cost@5% of Prime cost	207.4	62.2	62.2	83.0
Project Management & consultancy Charges @10% of Prime cost	414.8	124.4	124.4	165.9
Contingencies and Unforeseen Items of Works@10% of Prime cost	414.8	124.4	124.4	165.9
Total Project Cost	**5,184.8**	**1,970.2**	**1,555.4**	**1,659.1**
Lo-Lo Terminal				
Terminal	3,899.6	1,559.8	1,169.9	1,169.9
Cargo Handling Equipment	506.0	101.2	202.4	202.4
Environmental Management Plan Cost@5% of Prime cost	220.3	66.1	66.1	88.1
Project Management & consultancy Charges @10% of Prime cost	440.6	132.2	132.2	176.2
Contingencies and Unforeseen Items of Works@10% of Prime cost	440.6	132.2	132.2	176.2
Total Project Cost	**5,507.0**	**1,991.4**	**1,702.7**	**1,812.8**
Without Development				
Fairway				
Fairway	137.6	137.6	-	-
Institutional Requirement	405.0	405.0	-	-

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
Environmental Management Plan Cost@5% of Prime cost	27.1	27.1	-	-
Project Management & consultancy Charges @10% of Prime cost	54.3	54.3	-	-
Contingencies and Unforeseen Items of Works@10% of Prime cost	54.3	54.3	-	-
Total Project Cost	**678.2**	**678.2**	-	-

The only cost fairway utilization (with and without development) will entail is for shore marking with lattice bridge and for lighting equipment. Cost for dredging activity and bank protection works will be incurred only during the “with development” period.

This just theoretical calculation to assists viability of this project, 1PT+2DBs would be required till FY40. The onus of these vessel acquisitions lies with the private operator and not IWAI. Hence, these costs will not be factored in to develop model for the Lo-Lo Terminal. Capital and O&M costs associated with these vessel acquisitions and operations are indicated in the table below:

TABLE 13-5: Cost associated with vessel acquisition and operation

Parameters	Unit	1 Lo-Lo
Vessel Cost (1PT + 2DBs)	Lakhs	1,900
Running Cost	Lakh/annum	173
Crew	No.	12
Crew Wages	Lakh/annum	6
Crew Cost	Lakh/annum	72
Repair Cost (@2% Capex)	Lakh/annum	38

13.5 Financial Analysis / FIRR

The financial indicators dictating FIRR for individual ventures, viz. fairways development and terminal operations have been presented in Table 13.8. These indicators help measure the financial return on investment, which will enable IWAI in taking an informed decision in regard to implementing the project. However, before presenting FIRR for the project, some major components such as Salary, Depreciation, Project Cashflow, and P&L statement are provided in the following four tables, respectively:

TABLE 13-6: Employment schedule and salary expenditure (INR Lakh)

Parameter	No.	CTC p.a. / person (INR Lakh)	FY19	FY20	FY25	FY30	FY35	FY40
With Development								
Fairway (Phase 1)								
Manpower Expenditure								
Fiber Boat for Inspection	2	2	-	4.2	5.4	6.8	-	-
Hydrographer	1	8	-	25.2	32.2	41.0	-	-
Executives	2	3	-	18.9	24.1	30.8	-	-
Engineer	1	4	-	12.6	16.1	20.5	-	-
Total Salary (INR Lakh)	**-**	-	**-**	**60.9**	**77.7**	**99.2**	**-**	**-**
Fairway (Phase 2)								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	-	-	-	4.9	6.2
Hydrographer	1	8	-	-	-	-	29.2	37.2
Executives	2	3	-	-	-	-	21.9	27.9
Engineer	1	4	-	-	-	-	14.6	18.6
Total Salary (INR Lakh)			-	-	-	-	70.5	90.0
Lo-Lo Terminal								
Manpower Expenditure								
Cranes	1	3	-	-	-	-	10.9	14.0
Forklift	2	3	-	-	-	-	21.9	27.9
Manager Cargo Handling	1	6	-	-	-	-	21.9	27.9
Security Guards	2	2	-	-	-	-	13.1	16.8
Executives for billing and commercial	1	3	-	-	-	-	10.9	14.0
Weigh Bridge	1	2	-	-	-	-	7.3	9.3
Total Salary (INR Lakh)			-	-	-	-	**86.1**	**109.8**
Without Development								
Fairway								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	4.2	5.4	6.8	8.7	11.1
Hydrographer	1	8	-	25.2	32.2	41.0	52.4	66.9
Executives	2	3	-	18.9	24.1	30.8	39.3	50.1
Engineer	1	4	-	12.6	16.1	20.5	26.2	33.4
Total Salary (INR Lakh)	**-**	**-**	**-**	**60.9**	**77.7**	**99.2**	**126.6**	**161.6**

Manpower cost has been considered in Total Project Cost under "Institutional Requirement". However, this investment component toward manpower will accommodate expenses only for the initial years, covering construction period. Manpower expenses in case of the Lo-Lo terminal aren't necessarily directed towards IWAI. It will be borne by whosoever operates the terminal. IWAI can either own and operate the infrastructure, or lease it to a private third party on a suitable PPP model.

TABLE 13-7: Depreciation (Using SLM Method) (INR Lakh)

Depreciation & Amortization	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Gross Block	678.2	678.2	678.2	678.2	-	-
Depreciation & Amortization	-	55.1	27.9	27.9	-	-
Cumulative Depreciation & Amortization	-	55.1	303.3	443.1	-	-
Net Block	678.2	623.1	374.9	235.2	-	-
Fairway (Phase 2)						
Gross Block	-	-	-		5,184.8	5,184.8
Depreciation & Amortization	-	-	-		469.9	262.6
Cumulative Depreciation & Amortization	-	-	-		1,718.1	3,321.2
Net Block	-	-	-		3,466.7	1,863.6
Lo-Lo Terminal						
Gross Block	-	-	-		5,507.0	5,507.0
Depreciation & Amortization	-	-	-		491.2	270.9
Cumulative Depreciation & Amortization	-	-	-		1,792.8	3,455.6
Net Block	-	-	-		3,714.1	2,051.3
Without Development						
Fairway						
Gross Block	678.2	678.2	678.2	678.2	678.2	678.2
Depreciation & Amortization	-	55.1	27.9	27.9	26.2	19.2
Cumulative Depreciation & Amortization	-	55.1	303.3	443.1	581.0	677.2
Net Block	678.2	623.1	374.9	235.2	97.2	1.0

Depreciation has been calculated using the Straight Line Method (SLM). Under this method, cost of asset is evenly distributed across its useful life. Gross Block in each case is sum of total hard cost and pre-operative expenses, which includes environmental management plan @ 5% of the Capex.

TABLE 13-8: P&L Statement (INR Lakh)

Parameter	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
PBDIT	-23.9	-78.1	-56.7	-66.5	-	-
Depreciation	-	55.1	27.9	27.9	-	-
Interest	48.5	43.1	16.2	-	-	-
PBT	-72.4	-176.3	-100.8	-94.4	-	-
Tax	-	-	-	-	-	-
PAT	**-72.4**	**-176.3**	**-100.8**	**-94.4**	-	-
Fairway (Phase 2)						
PBDIT	-	-	-		-599.4	-704.9
Depreciation	-	-	-		469.9	262.6
Interest	-	-	-		276.3	40.3
PBT	-	-	-		-1,345.7	-1,007.7
Tax	-	-	-		-	-
PAT	-	-	-		**-1,345.7**	**-1,007.7**
Lo-Lo Terminal						
PBDIT	-	-	-		-783.5	-1,301.6
Depreciation	-	-	-		491.2	270.9
Interest	-	-	-		293.8	44.0
PBT	-	-	-		-1,568.5	-1,616.5
Tax	-	-	-		-	-
PAT	-	-	-		**-1,568.5**	**-1,616.5**
With Development						
Fairway						
PBDIT	-23.9	-78.1	-56.7	-66.5	-60.2	3.8
Depreciation	-	55.1	27.9	27.9	26.2	19.2
Interest	48.5	43.1	16.2	-	-	-
PBT	-72.4	-176.3	-100.8	-94.4	-86.3	-15.4
Tax	-	-	-	-	-	-
PAT	**-72.4**	**-176.3**	**-100.8**	**-94.4**	**-86.3**	**-15.4**

TABLE 13-9: O & M Costs for Mapusa River (INR Lakh)

Parameter	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	14	14	18	24	-	-
Total Cost	14	14	18	24	-	-
Fairway (Phase 2)						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	-	-	-	-	504	643
Total Cost	-	-	-	-	504	643
Lo-Lo Terminal						
Direct Operating Costs	-	-	-	-	583	1,117
Maintenance and Other Cost	-	-	-	-	108	145
Total Cost	-	-	-	-	722	1,262
With Development						
Fairway						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	14	14	18	24	30	38
Total Cost	14	14	18	24	30	38

None of the project or its sub sectors is generating positive returns on investment. The project is commercially not viable. The following table is the ultimate assessment of the viability of the individual projects planned under the development of the Mapusa River:

TABLE 13-10: FIRR for Mapusa River (INR Lakh)

Parameter	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Project Cash flow(Pre-tax)	-702.2	-78.1	-56.7	-66.5	-	-
Project IRR(Pre-tax)	**Non-existent**					
Project Cash flow(Post-tax)	-702.2	-78.1	-56.7	-66.5	-	-
Project IRR(Post-tax)	**Non-existent**					
Fairway (Phase 2)						
Project Cash flow(Pre-tax)	-	-	-	-	-599.4	-704.9

Parameter	FY19	FY20	FY25	FY30	FY35	FY40
Project IRR(Pre-tax)	**Non-existent**					
Project Cash flow(Post-tax)	-	-	-		-599.4	-704.9
Project IRR(Post-tax)	**Non-existent**					
Lo-Lo Terminal						
Project Cash flow(Pre-tax)	-	-	-		-783.5	-1,301.6
Project IRR(Pre-tax)	**Non-existent**					
Project Cash flow(Post-tax)	-	-	-		-783.5	-1,301.6
Project IRR(Post-tax)	**Non-existent**					
Without Development						
Fairway						
Project Cash flow(Pre-tax)	-702.2	-78.1	-56.7	-66.5	-60.2	3.8
Project IRR(Pre-tax)	**Non-existent**					
Project Cash flow(Post-tax)	-702.2	-78.1	-56.7	-66.5	-60.2	3.8
Project IRR(Post-tax)	**Non-existent**					

Revenue prospect for fairway and Lo-Lo in with and without development generates no rate of returns. It's because of very low traffic and high cost of project. Both Lo-Lo and navigational infrastructure are likely to be a loss-making venture. Based on the EIRR, Viability Gap Funding (VGF) can be sought.

In contrast to the above project component-wise FIRR, the following table provides FIRR for the project as a whole:

TABLE 13-11: FIRR for Mapusa River – Whole Project (INR Lakh)

Parameter	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Whole Project						
Project Cash flow (Pre-tax)	-678.2	-13.8	11.4	42.2	-937.1	-1,564.8
Project IRR (Pre-tax)	**Non-existent**					
Project Cash flow(Post-tax)	-678.2	-13.8	11.4	37.9	-937.1	-1,564.8
Project IRR (Post-tax)	**Non-existent**					

Source: Consultant

13.6 Economic Analysis / EIRR

Economic Internal Rate of Return (EIRR) includes all the financial benefits of a project as well as the non-financial benefits of that project. Non-financial benefits would include reduction in CO2 emission, decreased health care interventions, reduced traffic, and other quantified benefits that a project can have on a region considered for a project. The EIRR looks at any investment decision from the perspective of improving the welfare of the society in general.

Lo-Lo and Fairway development in Phase-2 would require financial intervention from the government. A strong EIRR could warrant capital inflow from state and/or central government in the form of Viability Gap Funding (VGF). Estimated EIRR for each of these sub-sectors is presented in the table below:

TABLE 13-12: Project EIRR (INR Crores)

Parameters	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Economic Cash Outflow	-0.1	2.0	5.0	4.9	-	-
Net Cash Flow to Project	-6.9	2.0	5.0	4.9	-	-
Project EIRR	**40%**					
Fairway (Phase 2)						
Economic Cash Outflow	-	-	-		1.0	1.6
Net Cash Flow to Project	-	-	-		1.0	1.6
Project EIRR	**Non-existent**					
Lo-Lo Terminal						
Economic Cash Outflow	-	-	-		4.9	4.1
Net Cash Flow to Project	-	-	-		4.9	4.1
Project EIRR	**-14%**					
Without Development						
Fairway						
Economic Cash Outflow	-0.1	2.0	5.0	4.9	5.6	7.7
Net Cash Flow to Project	-6.9	2.0	5.0	4.9	5.6	7.7
Project EIRR	**41%**					

Only fairway development without any investments exhibits positive impact on the local economy, and invariably, the economy of the state and the nation.

Similar to calculating EIRR of the whole project, the following table shows the EIRR of the whole project:

TABLE 13-13: Project EIRR – Whole Project (INR Crores)

Parameters	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Whole Project						
Economic Cash Outflow	-0.2	1.6	9.5	14.4	20.0	27.2
Net Cash Flow to Project	-7.0	1.6	9.5	14.4	20.0	27.2
Project EIRR	**15%**					

The project as a whole produces a positive EIRR, but the quantum of impact it may have on the overall region's development is similar as of individual project component.

13.7 Sensitivity Analysis

Variations in tariff rates and project cost (+/- 10%) have been applied to measure the overall impact these could have on the project's earnings and profitability. Sensitivity Analysis for each of the sub-sectors is shown in the table below:

TABLE 13-14: Sensitivity Analysis (+10% Project Cost, +10% Revenue)

Revenue Source	FY19	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Revenue	-	8.4	56.3	75.3	-	-
PAT	-79.7	-187.8	-103.1	-94.0	-	-
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Fairway (Phase 2)						
Revenue	-	-	-		60.1	120.6
PAT	-	-	-		-1,473.2	-1,099.5
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Lo-Lo Terminal						
Revenue	-	-	-		87.0	173.0
PAT	-	-	-		-1,655.4	-1,651.0
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

Without Development						
Fairway						
Revenue	-	8.4	56.3	75.3	121.0	242.6
PAT	-79.7	-187.8	-103.1	-94.0	-82.3	-0.8
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

TABLE 13-15: Sensitivity Analysis (+10% Project Cost, -10% Revenue)

Revenue Source	**FY18**	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Revenue	-	8.4	56.3	75.3	-	-
PAT	-65.2	-163.3	-88.6	-81.6	-	-
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Fairway (Phase 2)						
Revenue	-	-	-		87.0	173.0
PAT	-	-	-		-1,466.2	-1,551.5
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Lo-Lo Terminal						
Revenue	-	-	-		14	24
PAT	-	-	-		(372)	(194)
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	-	8.4	56.3	75.3	121.0	242.6
PAT	-65.2	-163.3	-88.6	-81.6	-69.0	8.9
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

TABLE 13-16: Sensitivity Analysis (-10% Project Cost, +10% Revenue)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Revenue	-	6.9	46.1	61.6	-	-
PAT	-79.7	-189.3	-113.1	-107.2	-	-
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Fairway (Phase 2)						
Revenue	-	-	-		49.2	98.6
PAT	-	-	-		-1,483.8	-1,120.7
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Lo-Lo Terminal						
Revenue	-	-	-		71.2	141.5
PAT	-	-	-		-1,670.7	-1,681.5
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	-	6.9	46.1	61.6	99.0	198.5
PAT	-79.7	-189.3	-113.1	-107.2	-103.6	-43.6
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

TABLE 13-17: Sensitivity Analysis (-10% Project Cost, -10% Revenue)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway (Phase 1)						
Revenue	-	6.9	46.1	61.6	-	-
PAT	-65.2	-164.7	-98.5	-94.9	-	-
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Fairway (Phase 2)						
Revenue	-	-	-		49.2	98.6
PAT	-	-	-		-1,218.2	-915.9
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
Lo-Lo Terminal						
Revenue	-	-	-		71.2	141.5
PAT	-	-	-		-1,481.6	-1,582.0
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	-	6.9	46.1	61.6	99.0	198.5
PAT	-65.2	-164.7	-98.5	-94.9	-90.4	-30.0
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					

Under no scenario does the Lo-Lo and Fairway both project produce positive FIRR. This means that even in imaginable optimistic conditions of higher revenue and lower cost, Lo-Lo terminal is highly unlikely to generate positive returns in the projected period up to FY40. Prima facie, this indicates that Lo-Lo Terminal and navigational infrastructure both are not a sound investment to make.

13.8 Risk Factors & Mitigation

The project has not been found commercially viable. The projected traffic volumes are very low. The financial analysis undertaken for the project shows very high negative IRR or non-existent IRR. Hence, there is no need to develop this project.

The following Table 13 17 enumerates risks identified in executing the Project, the rationale behind it, and the potential mitigation or management measures:

TABLE 13-18: Risk Factors & Mitigation measures

Risk	Description	Likelihood	Impact	Risk Rank	Mitigation / Management
Project delay	The cause could either be due to delay in acquiring necessary permissions and clearances, meeting environmental regulations and guidelines, delay in procurement of necessary equipment, local resistance, natural disaster, etc. Or, the delay could be the result of any combination of above determinants.	2	3	6	• Project Insurance • Increased lending to bridge gap due to cost overruns
Uncertain Future traffic	It is anticipated that Calvim Jetty will start its operation again in near future. If that happens then the traffic for proposed terminal would come down, as the Calvim jetty would capture this revived volume	4	4	16	· Explore other cargo options · Derive business opportunities from other sources like boating, tourism, etc.
Opportunity loss	It is assumed that in future due to the growth in traffic the capacity of Calvim jetty would reach to its optimum utilization, the additional traffic which it could not handle would get shifted to proposed IWAI terminal. But, if Calvim jetty expands its capacity & infrastructure, then the opportunity for proposed terminal for handling additional traffic would be lost.	3	3	9	· Provide better infrastructure &facilities to attract surplus cargo volume · Competitive Cost
Project delay	The cause could either be due to delay in acquiring necessary permissions and clearances, meeting environmental regulations and guidelines, delay in procurement of necessary equipment, local resistance, natural disaster, etc. Or, the delay could be the result of any combination of above determinants.	2	3	6	· Project Insurance · Increased lending to bridge gap due to cost overruns

13.9 Necessity of Govt. Support (VGF / PPP)

Difficulty in securing funds aside, some projects are not even considered to be financially viable, although they might be economically justified and indispensable. To take care of such projects and to carry them towards their successful completion, the government has designed Viability Gap Funding (VGF). Viability Gap Funding is the grant provided by the government towards financing projects that are termed financially unviable but are economically justified. The Ministry of Finance monitors the scheme and the projects, and amount is allocated through annual budget. The usual grant given by the government is 20% of the total capital cost of the project, which can be supplemented by the state government through an additional 20% grant.

Lo-Lo Terminal and fairway both the projects are commercially as well as economically unviable. So both are not eligible for VGF. A broad analysis is undertaken in the following table to test if use of VGF will have any bearing on the return of the Lo-Lo Terminal:

TABLE 13-19: Probable impact of VGF on project returns

Reduction in Project Cost	Lo-Lo Terminal - With Development		Fairway – With Development	
	-20%	-40%	-20%	-40%
Project IRR (Pre Tax)	Non-existent	Non-existent	Non-existent	Non-existent
Project IRR (Post Tax)	Non-existent	Non-existent	Non-existent	Non-existent
Project EIRR	-3%	4%	-11%	-1%

Even with significant financial support from the government, Lo-Lo terminal may fail to produce the desired positive returns.

13.10 Conclusion

The following table gives a snapshot of the project cost and viability indicators for all the sub-sector developments under Mapusa River:

TABLE 13-20: Critical indicators for the Mapusa River Project

Parameter	Unit	With Development			Without Development	With Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal	Fairway	Whole Project
Project Cost	INR Cr.	6.8	51.85	55.07	6.8	113.7
Revenue (FY40)	INR Cr.	0.69 (Fy'30)	1.1	1.57	2.21	2.7
FIRR	%	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
EIRR	%	40%	Non-existent	-14%	41%	15%

As per the outcome of traffic study, there is no need for IWT terminal development because existing infrastructure are sufficient enough to handle current as well as future traffic of iron ores. It is anticipated that the terminals located nearby, which are currently non-operational due to the ban on iron ore extraction, will start their operations soon after the relaxation of policies for ban removal. It is recommended to IWAI to follow Case-2 i.e. after the observation period, IWAI should invest in development of navigational infrastructure while developing IWT terminal should be neglected.

CHAPTER 14 CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Mapusa - Moide River (NW 71) in the stretch of 26.638 Kms from Lat 15° 30' 22.0887" N, Long 73° 50'36.2908" E has been carried out as per the Terms of Reference (ToR) and the details of the study are given in the preceding chapters.

A summary of the recommendations and conclusions as a result of the study is placed herewith:

- Based on the Detailed Hydrographic Survey carried out / Site data collected and subsequent to the Morphological analysis etc., the required developments in the Fairway along with inter related activities have been identified.
- The National Waterway (NW 71) “Mapusa - Moide River” is having a 2.0 m depth (w. r. to CD) up to about initial 10 kms and having a shoal of about 3700 m for class IV waterway up to Ch. 17 Kms.
- Existing waterway of the study stretch was effectively used for transportation of Mining ores from the nearby catchment area, which was stopped with the complaints / cases. The same has been taken up to the Supreme Court and the Mining is under revival with the improvised policies / guidelines, however in slow pace. The estimated Traffic is about 0.9 MTPA by FY 2040.
- The Traffic growth will be observed up to FY 2030 and any development is suggested only beyond FY 2030, based on the positive observation. Prior to FY 2030, only a nominal investment of INR 6.8 Crores is suggested, as Phase 1.
- Accordingly, the fairway development is suggested with Class IV standard of Waterway with 50 m Bottom Width of fairway and 2.0 m Depth of fairway with a vessel / convoy requirement for Class IV as 170 m (Length) x 12 m (Breadth) x 1.8 m (Draft), only up to Ch. 17 km, beyond FY 2030. No development is suggested beyond this chainage.
- Investment has been suggested (nominal investment) for development of 7 Nos of Lattice Bridge with Lighting and L. S provisions have been worked out for INR 6.8 Cr in Phase 1.
- No development is suggested till a critical and micro level analysis with observation of increase in Cargo potential and after establishing the need of development / investment, then the Phase 2 can be considered in FY 30.
- As a part of Phase 2 development, in order to provide a class IV safe navigable channel, Dredging of 1 Lakh Cu. M in Soils; 3000 m of Bank Protection; 45 Nos of Buoy / Light etc., have been suggested.

- Ø Also suggested the development of Lo-Lo Terminal in Phase 2. The most probable location for Lo-Lo Terminal has been identified adjacent to the existing infrastructure (adjacent to the present jetties of M/s Vedanta) on the Left side of the river and with approx. Lat 15°36'57.02" N and Long 73°52'51.56" E. This location is having good accessibility to the road.
- Ø The tentative Land requirement has been arrived at with 30,256 Sq. M and the Land Survey was considered accordingly.
- Ø Details of the location has been firmed up and the same is in the in the Sircaim Village; Bardez Taluka; North Goa District in the state of Goa.
- Ø Terminal Infrastructure has been considered to suit to the Lo-Lo operation with the length of the Berthing structure as 75 m and width as 32 m.
- Ø In order to facilitate the Iron Ore mobility, the following Vessel type and size have been considered i.e., 1 PT + 2 DB of 1000 T each – Convoy mobility of 2000 T wherein the PT is of LOA – 30 m to 40 m; Breadth – 12 m to 14 m; Draft / Depth – 1.7 m / 2.0 m +; Propulsion with Marine Diesel Engines of 3 x 800 Bhp. The indicative cost is about INR 900 Lakhs. 1 DB of 1000 T capacity is of LOA – 70 m to 75 m; Breadth – 12 m; Loaded Draft / Depth – 1.8 m / 2.0 m +. The indicative cost is about INR 500 Lakhs.
- Ø The cost estimates have been worked out and segregated into Phase 1 with a capital cost of 6.8 Cr. Phase 2 Fairway at a cost of 51.85 Cr. The cost of Lo-Lo jetty at a capital cost of 55.07 Cr. is suggested, on need basis. Implementation of phase 1 is 12 months, on immediate basis and phase 2 is 36 months commencing 2030.
- Ø The FIRR and EIRR have been worked out and the details are placed, with an alternative of investment only for Fairway and fairway + Terminal.

Parameter	Unit	With Development			Without Development	With Development
		Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal	Fairway	Whole Project
Project Cost	INR Cr.	6.8	51.85	55.07	6.8	113.7
Revenue (FY40)	INR Cr.	0.69 (Fy'30)	1.1	1.57	2.21	2.7
FIRR	%	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
EIRR	%	40%	Non-existent	-14%	41%	15%

- Ø Not recommended any investment till the confirmations of the traffic, except a nominal infra creation at a cost of INR 6.8 Cr. Development / Investment is recommended after considering a critical analysis before FY 30. If there is no much increase in cargo volumes by FY 30, there is no need of any investment / development.

CHAPTER 15 TEMPLATES

15.1 Environmental & Social Screening Template

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site			
a) National Park		ü	
b) Wildlife/ Bird Sanctuary		ü	Nearly four kilometers of the waterway is located along the boundary of Dr. Salim Ali Wildlife Sanctuary, but the NW-71 project lies outside the boundary of this Wildlife Sanctuary and its Eco-sensitive Zone.
c) Tiger or Elephant Reserve		ü	
d) Biosphere Reserve		ü	
e) Reserved / Protected Forest		ü	
f) Wetland		ü	
g) Important Bird Areas		ü	Part of the project is located close to Dr. Salim Ali Wildlife Sanctuary which is an important bird area but no part of the project is either located within the boundary of the Wild Sanctuary or its Eco-sensitive Zone.
h) Mangroves Areas	ü		Mangroves are present on both banks of Mapusa river in the NW-71 stretch, but the development of NW-71 project does not involve clearing of any mangrove vegetation.
i) Estuary with Mangroves		ü	
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	ü		Dr. Salim Ali Wildlife Sanctuary is rich in birds, leopards and crocodiles. The CRZ Notification, 2011 recognizes beaches such as Mandrem, Morjim and Galgibaga and Agonda as designated turtle nesting sites. Morjim beach, which is turtle nesting sites in North Goa, is located at a safe distance from NW-71.

Screening Question	Yes	No	Details / Remarks
k) World Heritage Sites		ü	
l) Archeological monuments/ sites (under ASI"s Central / State list)		ü	
2. Is the project located in whole or part in / near any Critically Polluted Areas identified by CPCB?		ü	
3. Is, there any defense installations near the project site?		ü	
4. Whether there is any Government Order/ Policy relevant / relating to the site?	ü		Discussed in Section 9.5 of the DPR.
5. Is the project involved clearance of existing land, vegetation and buildings?		ü	Clearance of vegetation shall be required if and when Phase 2 is taken up for development in future. The present DPR recommends development of Phase 1 only.
6. Is the project involved dredging?		ü	Not required for development of Phase 1 as recommended. Dredging is envisaged as part of Phase 2 development. The present DPR recommends development of Phase 1 only.
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)		ü	
8. Is the project located in whole or part within the Coastal Regulation Zone?	ü		The entire project falls in CRZ I.
9. Is the project involved any demolition of existing structure?		ü	
10. Is the project activity require acquisition of private land?		ü	Land will be required for terminal construction only if Phase 2 is taken up for development in future. The present DPR recommends development

Screening Question	Yes	No	Details / Remarks
			of Phase 1 only which does not involve any land acquisition.
11. Is the proposed project activity result in loss of direct livelihood / employment?		ü	The present DPR recommends development of Phase 1 only which does involve any loss of livelihood / employment.
12. Is the proposed project activity affect schedule tribe/ caste communities?		ü	

S. N.	Result of Screening Exercise	(Yes / No)
1.	Environment Impact Assessment is Required	Yes
2.	CRZ Clearance is Required	Yes
3.	Environmental Clearance is Required	No
4.	Forest Clearance is required	No
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	Only as part of EIA study
8.	Abbreviated RAP is required	No
9.	Full RAP is required	No
10.	Any other clearance is required	Other clearances required include those that are to be obtained by the Contractors during the construction period such as the Certificate of Registration under

S. N.	Result of Screening Exercise	(Yes / No)
		Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, licenses / permits under other applicable labour laws, permission from SPCB for setting up of batching plants and for use of DG sets etc.

15.2 Traffic Template

15.2.1 Catchment Baseline

- Local economic geography – Mapusa River is a part of Mandovi River. Coastal region along Mapusa River has less elevated region (25-30 meter). East side of the river near Sattari taluka has hilly areas and high elevation about 500 meter.
- Catchment area – Bicholim & Bardez taluka of North Goa.
- Population – As per census 2011, total population of both talukas is 1,30,096. Majority of population is residing in Thivim.
- Economic activities –Agriculture activities, Mining, Goa is the major exporter of iron ore. Marine & Inland Fishing, Marine fishing productions in Goa is more compare to inland fishing, industrial activities, tourism related activities. Tertiary sector contribution to state economy is much higher compare to primary & secondary sector of the state.
- Major industries - Chowgule, Fomento (Iron ore mine owners)
- Connectivity

ü Major roads - NH 66 is major highway passing nearby Mapusa River.

ü Major railway – Konkan railway line is the only line near to Mapusa River. Karamli & Thivim are the two nearby railway stations.

- Specific Developments

  No specific developments regards to Mapusa River. However there are other developments plans in Goa proposed by Government like 16 SEZ for IT sector, upcoming Mopa airport etc.
- Catchment area Map

15.2.2 Navigation Baseline

- Existing Waterway Usage
  - At present there is only one passenger Ro- Ro ferry plying on river Pomburpa to Chorao. It takes about 10 minutes to reach to the other end. Mostly local people residing on the both side of river use this ferry service.
  - Other boats for watersport activities like Kayaking etc. take place nearby Chorao Island where Bird sanctuary is located.
  - Not all bridges on river give standard vertical clearance at all places. Corjuem and Poira bridge on Mapusa river is openable bridge that was used in past to give way to barges. This bridge is not in use at present due to ban on mining. There are houses built nearby bridge at present.
  - About 1,000 to 1,100 tons of barges ply on Mapusa River.
  - Mapusa river stretch is also smaller in length & width. After dredging, the present draft in Mapusa River is in the range of 2.7 meter to 3 meter as per mine owner's opinion.
  - There is one captive jetty and non-captive jetty called as Calvim jetty on the river.
  - Mapusa river water is dirty and mangroves have grown on the banks of the river.

- There are few small jetties located at the mouth of the river near Porvorim village for tourism/other activities.

15.2.3 Market Baseline

- Potential Market
- Bulk & Semi bulk commodities – Iron Ore

Commodity	Source	Reasoning
Iron Ore	Sircaim/ Assnora iron ore mines	Two potential mine areas in the catchment area of the river. Existing dedicated jetty for iron ore transportation already exist on river. Both the mine areas are very small compared to other big mines around Mandovi river. Maximum iron ore that could get handled in Mapusa river is not beyond 1 mn T

15.2.4 Forecasting Years

- IWT Share

If existing jetties/ terminals on river become functional then IWT share in traffic would become zero. However if these terminal still remains non-operational in near future 100% traffic share would come to IWT terminal

Name of the waterway: NW-71 (Mapusa/Moide River,26.638 km)

Sr. No	Name of Cargo	Type of Cargo	Origin	Original Terminal on Nw	Final Destination	Destination Terminal on NW	Co-ordinates	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (Presently Non Functional)														
1	Iron Ore	Bulk	Assnora/ Sircaim	Captive jetty/ Calim jetty	Mormugao Port		Existing terminal are capable to handle anticipated traffic so if they start handling iron ore after an upliftment of ban IWAI Terminal is not required							
Proposed Terminal Opportunity for IWAI														
1	Iron Ore	Bulk	Sircaim	Sircaim	Mormugao Port	n/a	15°36'57.02"N 73°52'51.56"E	(mn T)	0	0.1	0.5	0.5	0.6	0.9

* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..

15.2.5 Presentation of Forecast

Sr. No	Name of Cargo	Type of Cargo	Origin	Final Destination	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (Presently Non Functional)											
1	Iron Ore	Bulk	Assnora/ Sircaim	Mormugao Port	Existing terminal are capable to handle anticipated traffic so if they start handling iron ore after an upliftment of ban IWAI Terminal is not required						
Proposed Terminal Opportunity for IWAI											
1	Iron Ore	Bulk	Sircaim	Mormugao Port	mn T - Km	0	3.5	18	18	21	32

15.2.6 Market Success Factors

The market success factor regarding the development of the Mapusa – Moide River is the present fairway availability with abundant required navigational channel parameters which is presently being utilized in advantageous manner by various stake holders mobilizing the Iron Ore Cargo. Additional factor is the Iron Ore mines in the hinterland of the river. The fairway development will ease and increase the traffic. In order to meet the excess capacity, if IWAI develops a Lo-Lo jetty, it will have larger implication. Since the cargo is destined for export, the market success will be in terms of Foreign Trade.

15.2.7 Forecasting Methodology

Mine area owned by mine operators in the catchment area and their export volume quantity. Interaction with Barge owner Operators and Iron Ore export association and Government policy on export of iron ore is taken into consideration for projecting future traffic.

15.3 Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	· Land, compensation and resettlement : No · Capital dredging: 1.0 lakhs cu.m Ordinary soil – 3.0cr · River training/bank protection: 6 Nos-3000m – 36.9cr · Locks: No · Barrages: No · Channel marks / · Night navigation: 7 Nos–1.38 cr (Phase 1: Beacon & Lights); 45–1.51cr (Phase 2: Buoy & Lights) · Other: Communication system – No
Terminal Infrastructure		Lo-Lo facility · Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) – Considered

Cost type	Cost categories	Components to be itemized
		· Loading/uploading and other equipment (itemized) · Buildings : Considered in infrastructure · Other : --
Operation and maintenance (O & M) costs	Waterways	· Maintenance dredging · Markings and nav.-aids Considered as per standard · Bank maintenance · Other
	Terminals	· Terminal operations · Terminal maintenance Considered as per standard · Other
	Vessel: (NB vessel operating costs/tons-km fall sharply with larger capacity vessel, when there is sufficient traffic to utilize them)	· Crew · Fuel · Maintenance · Registration & insurance · Fees and charges Considered as per standard · Vessel capital amortization (or leasing cost equivalent) · Total costs · (Cost/tons-km for use in evaluation)
Recurrent costs		Periodic major capital costs that may occur over life of assets : Considered as per standard
Price levels		All costs to be expressed in mid-2014 price levels. Costs derived from other years to be indexed to 2014

Cost type	Cost categories	Components to be itemized
		price levels : Considered accordingly
Value engineering		Not all investments will be necessary in all projects. Value engineering should be applied to project scoping and specification to avoid „gold-plating‟ of costs and undermining viability of project: --
Cost verification		Costs that are estimated on a „bottom-up‟ basis should be verified or tested for reasonableness against actual costs for such activities evidenced in the market place: Considered as per standard

15.4 Economic Evaluation Template

Item	Requirements
Objective	To assess economic internal rates of return (EIRR) on a consistent basis between different river projects.
Economic evaluation approach	Economic evaluation of each river upgrading project may include: ▪ **Capital Cost:** *i) With Development* (a) Navigation infrastructure(FY19-FY30) – INR 6.8crore (b)Navigation infrastructure (FY31-FY40) – INR 51.85crore (c) Terminal Ro-Ro Cost -INR 55.07 crore *ii) Without Development* (a) Navigation infrastructure (FY19-FY40) – INR 6.8crore ▪ **O & M costs:** *i) With Development* (a) Navigation infrastructure (FY19-FY30) – INR 0.24crore (b)Navigation infrastructure (FY31-FY40) – INR 6.43crore (c) Terminal Ro-Ro Cost -INR 12.62 crore

Item	Requirements
	ii) Without Development (a) Navigation infrastructure (FY19-FY40) – INR 0.38crore Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel:** *i) With Development* (a) Navigation infrastructure (FY19-FY30) – INR 1.8crore (b)Navigation infrastructure (FY31-FY40) – INR 3.2crore (c) Terminal Ro-Ro Cost -INR 5.9 crore *ii) Without Development* (a) Navigation infrastructure (FY19-FY40) – INR 3.2crore **Saving on Vehicle Operating Cost:** *i) With Development* (a) Navigation infrastructure (FY19-FY30) – INR 1.6crore (b)Navigation infrastructure (FY31-FY40) – INR 2.91crore (c) Terminal Ro-Ro Cost -INR 5.4 crore *ii) Without Development* (a) Navigation infrastructure (FY19-FY40) – INR 2.9crore · **Savings in road/rail accident costs:** *i) With Development* (a) Navigation infrastructure (FY19-FY30) – INR 1.4crore (b)Navigation infrastructure (FY31-FY40) – INR 1.4crore (c) Terminal Ro-Ro Cost -INR 2.6 crore *ii) Without Development*

Item	Requirements
	(a) Navigation infrastructure (FY19-FY40) – INR 1.4 cr. · **Saving in carbon emissions:** *i) With Development* (a) Navigation infrastructure (FY19-FY30) – INR 0.1crore (b)Navigation infrastructure (FY31-FY40) – INR 0.1crore (c) Terminal Ro-Ro Cost -INR 0.2 crore *ii) Without Development* (a) Navigation infrastructure (FY19-FY40) – INR 0.1crore
Standard values	To ensure consistency between evaluations of different waterways the following has been used: Vehicle operating Cost · Road : INR 1.5/tons-km · Rail : INR 0.8/tons-km · IWT: INR.1.0/tons-km · Road accident Loss: INR 5 Lakhs/km · Rail accident Loss: INR 0.5 Lakhs/km · Carbon shadow price : 30 dollars/tons
Other benefits	Other significant economic benefits such as direct employment creation has also been considered in the evaluation. Employment cost has been taken as INR 2.5 Lakhs per annum.
Cash flows in real terms	Economic cost has been considered as 85% of actual values without any escalation.
Resource cost adjustments	Market prices has been taken on 2017 price level as equivalent to resource costs for the purposes of the economic evaluation.
Evaluation period	The Phase 1 for waterway utilization is assumed to start from FY19, whereby no development is required. On the back of market response at the end of Phase 1 in FY30, future development decisions will be made. Under pessimistic conditions, no development will be required, and the entire fairway operation will be relegated to the 17.3 km chainage. A development period of 3 years (FY31 – FY33) has been allotted in case the market respond well, and further fairway

Item	Requirements
	development is necessary to further increase the waterway transport's leverage.
EIRR	The EIRR for fairway (without development) is positive, rest all the individual projects under development of the Mapusa River are negative. However, of all the sub-segment projects, Fairway with development is not commercially viable, because of the non-existent FIRR. Development of Mapusa as an alternate mode for transportation for bulk cargo handling is likely to generate employment. The waterway would decongest the roads by traffic diversion and likely to save fuel used in road transportation along with reduction in environment pollution. The reduction of vehicular operating cost due to use of Mapusa is also likely to generate overall benefits to the project. Economic IRR of Navigational Structure during phase 1 is 40%, EIRR does not exists during Phase 2 between FY31 and FY40, and 41% when there's no development to be carried out for the fairway. For the Lo-Lo Terminal, the EIRR comes at -14%.
Checking and Replicability	Systematic checks of spreadsheets and logic trail have been done keeping in mind the input data, assumptions and calculations.

15.5 Financial Evaluation Template

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
Objective	To assess financial internal rates of return and financial payback periods of Mapusa River
Financial evaluation approach	Financial evaluation of each river upgrading project should estimate and present actual cash flows (cost and revenues) at market prices within the inland waterway sector consisting of the two sub-segments: (a) navigation infrastructure; (b) terminal operation. **Returns for Navigation infrastructure (With Development) are:**

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	i) Phase 1 (FY19 – FY30) Total Revenue: INR 0.69 cr. in FY30 O&M Cost: INR 0.24 cr. in FY30 Tax: INR 0.0 cr. In FY30 (@ 30% on EBITDA) EBIDA: INR -0.67 cr. In FY30 Project Capital Cost (with escalation): INR 6.78 cr. Net Cash Flow: INR -0.66 cr. In FY30 *ii) Phase 2 - Official Deployment Period (FY31 – FY40)* Total Revenue: INR 1.10 cr. in FY40 O&M Cost: INR 6.43 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -7.05 cr. In FY40 Project Capital Cost (with escalation): INR 51.85 cr. Net Cash Flow: INR -11.74 cr In FY40 **Returns for Navigation infrastructure (Without Development) are:** Total Revenue: INR 2.21 cr. in FY40 O&M Cost: INR 0.38 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR 0.04 cr. In FY40 Project Capital Cost (with escalation): INR 6.78 cr. Net Cash Flow: INR 0.04 cr In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 1.57 cr. in FY40 O&M Cost: INR 12.62 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -13.02 cr. In FY40 Project Capital Cost (with escalation): INR 55.07 cr. Net Cash Flow: INR -18.00 cr. In FY40
Disaggregation	Cash flow streams and FIRRs have been attached as annexures in Financial Evaluation chapter-13 for Navigation Structure and terminals separately. It is not considered as a whole. Payback is also considered separately for all 2 facilities.

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	Returns for Navigation infrastructure (With Development) are: *i) Phase 1 (FY19 – FY30)* Total Revenue: INR 0.68 cr. in FY30 O&M Cost: INR 0.24 cr. in FY30 Tax: INR 0.0 cr. In FY30 (@ 30% on EBITDA) EBIDA: INR -0.67 cr. In FY30 Project Capital Cost (with escalation): INR 6.78 cr. Net Cash Flow: INR -0.66 cr. In FY30 *ii) Phase 2 - Official Deployment Period (FY31 – FY40)* Total Revenue: INR 1.09 cr. in FY40 O&M Cost: INR 6.43 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -7.05 cr. In FY40 Project Capital Cost (with escalation): INR 51.85 cr. Net Cash Flow: INR -11.74 cr In FY40 **Returns for Navigation infrastructure (Without Development) are:** Total Revenue: INR 2.21 cr. in FY40 O&M Cost: INR 0.38 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR 0.04 cr. In FY40 Project Capital Cost (with escalation): INR 6.78 cr. Net Cash Flow: INR 0.04 cr In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 1.57 cr. in FY40 O&M Cost: INR 12.62 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -13.02 cr. In FY40 Project Capital Cost (with escalation): INR 55.07 cr. Net Cash Flow: INR -18.00 cr. In FY40
Evaluation period	The Phase 1 for waterway utilization is assumed to start from FY19, whereby no development is required. On the back of market response at the

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	end of Phase 1, future development decisions will be made. Under pessimistic conditions, no development will be done, and the entire fairway operation will be relegated to the 17.3 km chainage. A development period of 3 years (FY31 – FY33) has been allotted in case the market respond well, and further fairway development is necessary to further increase the waterway transport's leverage. Traffic across the fairway will commence from FY33, the last year of development.
FIRR and payback period	Estimate both FIRR (sector and sub-sectors) and overall sector payback period, the latter being the year in which the cumulative sector each flows becomes non-existence. : Described in financial evaluation
Ramp-up period	Unless good reasons otherwise, assume 4 years ramp-up period from first operational year to long-term trend levels of traffic: 5 years ramp up period considered
Commentary on FIRR	Explain overall sector FIRR results and distribution between sub-sectors. Identify main drivers of the results and sensitivity to assumptions: All the sub-projects under the development of Mapusa River do not have positive returns (FIRR). Factors influencing the lack of positive project returns are: • Extremely low estimated traffic volume of iron ore, coupled with relatively high project cost. • Availability of competing infrastructure in the event iron ore movement resumes on the River, and even if the volume increases over historical levels.
Risks to financial out-turn	Identify main risks to the estimated project out-turn or viability and their underlying causes e.g. market risks (traffic, tariffs, and competition), hydrology risks, engineering risks, operational risks etc.: • Future traffic is uncertain. If Calvim Jetty starts operating then the traffic at proposed terminal would come down by shifting back to Calvim.

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	Hence, there would be no requirement for a new jetty. • It is evident that the proposed terminal would only attract the surplus volume from mining at Assnora and Shirigao. However, Calvim jetty can expands its capacity to cater to the increased cargo volume. In this case, diversion of surplus cargo to the Lo-Lo Terminal is highly improbable.
Checking and Replicability	Systematic checks of spreadsheets and logic trail have been done keeping in mind the input data, assumptions and calculations.

ANNEXURES

ANNEXURE 1.1 – TOR OF THE 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 Athirampuzha market Lat 9°40'04"N, Lon 76°31'54"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.

1.2.1.4 <u>CURRENT VELOCITY AND DISCHARGE MEASUREMENT</u>

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.

2.0 PERIOD OF SERVICES

Consultant may associate with sub Consultant(s) to enhance their expertise. The applicant shall submit a Memorandum of Understanding (MOU) with the Sub Consultant regarding the role and responsibilities of the Associate Company along with the proposal.

2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:

(a) The time of completion of various sub-stages of the assignment will be as given below:

			Cluster -2	Cluster -3	Cluster -4	Cluster -5	Cluster -6	Cluster -7	Cluster -8
	Sl. No	**Activity**	**Time in weeks****						
Stage-I	a)	Mobilization of the Team and submission of Inception Report (2 copies)	6	9	10	11	8	8	15
	b)	Submission of Draft Feasibility Report (3 copies)	9	12	13	14	11	11	18
	c)	Comments from IWAI	11	14	15	16	13	13	20
	d)	Presentation and Submission of Final Pre-feasibility Report (3 copies)	13	16	17	18	15	15	22
Stage-II	a)	Acceptance of Stage-I report and go ahead for Stage-II by IWAI	15	18	19	20	17	17	24
	b)	Submission of Hydrographic Survey Charts and report (3 copies)	23	30	29	31	24	26	38
	c)	Submission of Draft Detailed Project Report (3 copies)	31	38	37	39	32	34	46
	d)	Receipt of comments of IWAI on Draft DPR.	33	40	39	41	34	36	48
	e)	Submission of Final Detailed Project Report (10 copies) after incorporating final comments of IWAI.	39	46	45	47	40	42	54
****reckoned from the date of signing of Contract or 15 days from the date of issuance of work order, whichever is earlier.**									

NOTE: - The consultants are required to submit the following outputs in Stage-II for all the clusters in the enclosed standard templates:-

vi) Traffic Template: at Annex-IV
vii) Project Costing Template: at Annex-V
viii) Financial Evaluation Template: at Annex-VI
ix) Economic Evaluation Template: at Annex-VII
x) Environmental & Social Screening Template: at Annex-VIII

3.0 Minimum Qualification of Key Professionals

Sl. No	Key Professionals	Qualification Criteria
1.	**Waterway Expert (Team Leader)**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Higher professional qualification in Port and Harbor Engineering/Structural Engineering/Geo-technical Engineering will be preferred. **Professional Qualification:** • Minimum 15 years' experience in planning, design, construction, preparing Feasibility Report/Detailed Project Report for various waterway/port/river front development/river training works, terminals, trade facilitations and other infrastructures in different natural and operational conditions with at least 5 years in a reputed firm of consultants.
2.	**Port planning & Infrastructure Specialist**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Postgraduate training/ studies in Port & Harbor Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in Port planning, Port infrastructure Planning and development of physical facilities for port operations. Should be well conversant with different types of port structures and other physical facilities required for the provision of various port services efficiently. Should preferably have experience/ exposure of constructing several modern ports.
3.	**Remote Sensing/GIS Expert**	**Educational Qualification:** • Should be Graduate in Engineering/Geology. Higher professional qualification in Remote Sensing/ Geoinformatics will be preferred. **Professional Qualification:** • Minimum 10 years' experience in waterway/port/river mapping and a demonstrated proficiency in using the GIS software. Working knowledge of spatial data formats and related metadata issues. Working knowledge of web mapping applications, such as Google Earth/Bhuvan.
4.	**Floodplain Specialist**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher professional qualification in Floodplain Management/ Hydrology/Water Resource Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in Floodplain Management. Working

Sl. No	Key Professionals	Qualification Criteria
		knowledge of water and/or wastewater modeling is desirable.
5.	**Hydrographic Expert**	**Educational Qualification:** • Should be ITI in Survey/Diploma in Civil Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 8 years' experience in conducting hydrographic surveys, investigations and measurements, bathymetric surveys/Topographic Survey in a variety of geographical locations and natural.
6.	**Soil Engineer/ Foundation Engineer**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher qualification in Marine Structure/Geotechnical Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of the soil investigation, reclamation work, soil improvement and will be associated in foundation design. He will also be responsible for preparation of cost estimates/BOQ.
7.	**Traffic Surveyor**	**Educational Qualification:** • Should be Graduate in Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of traffic survey of waterways/river/canal or similar facilities.
8.	**Transport Economist**	**Educational Qualification:** • Should be Graduate in transport planning management, transport economics, transport/road/rail/Civil engineering/MBA or equivalent qualifications. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of estimating transport investments and implementing transport programs.

NOTE 1:- If the Key Personnel proposed in the CV does not fulfill the minimum academic qualification, the overall score of his CV will be evaluated as zero. All such Key Personnel (whose CV scores less than 75% or who does not fulfill the minimum qualification) will have to be replaced by the firm. H-1 firm will be intimated for replacement of such personnel and work will be awarded after receipt of CV's fulfilling the tender criteria.

Note 2:- IWAI may call each key personnel of the preferred Consultant at the time of award of work, at the cost of Consultant.

Note 3: - In case during interaction with the key personnel, it is found that the key personnel proposed is un-suitable for the assignment position, his replacement by equivalent or better shall be provided by the consultant. The key personnel with such un-suitable CV shall not be considered in any future bids for that position for two years. No deduction for such replacement, who are not found suitable during interaction shall be made.

Note 4:- Since two clusters only will be awarded to one bidder, the same CVs cannot be proposed for at least two clusters. The same CV's can be proposed if the bidder is bidding for more than two Clusters.

Note 5:- Role and responsibilities of the Key Professional shall be as per the requirement of the project and Terms of Reference of the tender document and the same has to be access by prospective bidder.

ANNEXURE 1.2 – COMPLIANCE ON TOR OF THE AGREEMENT

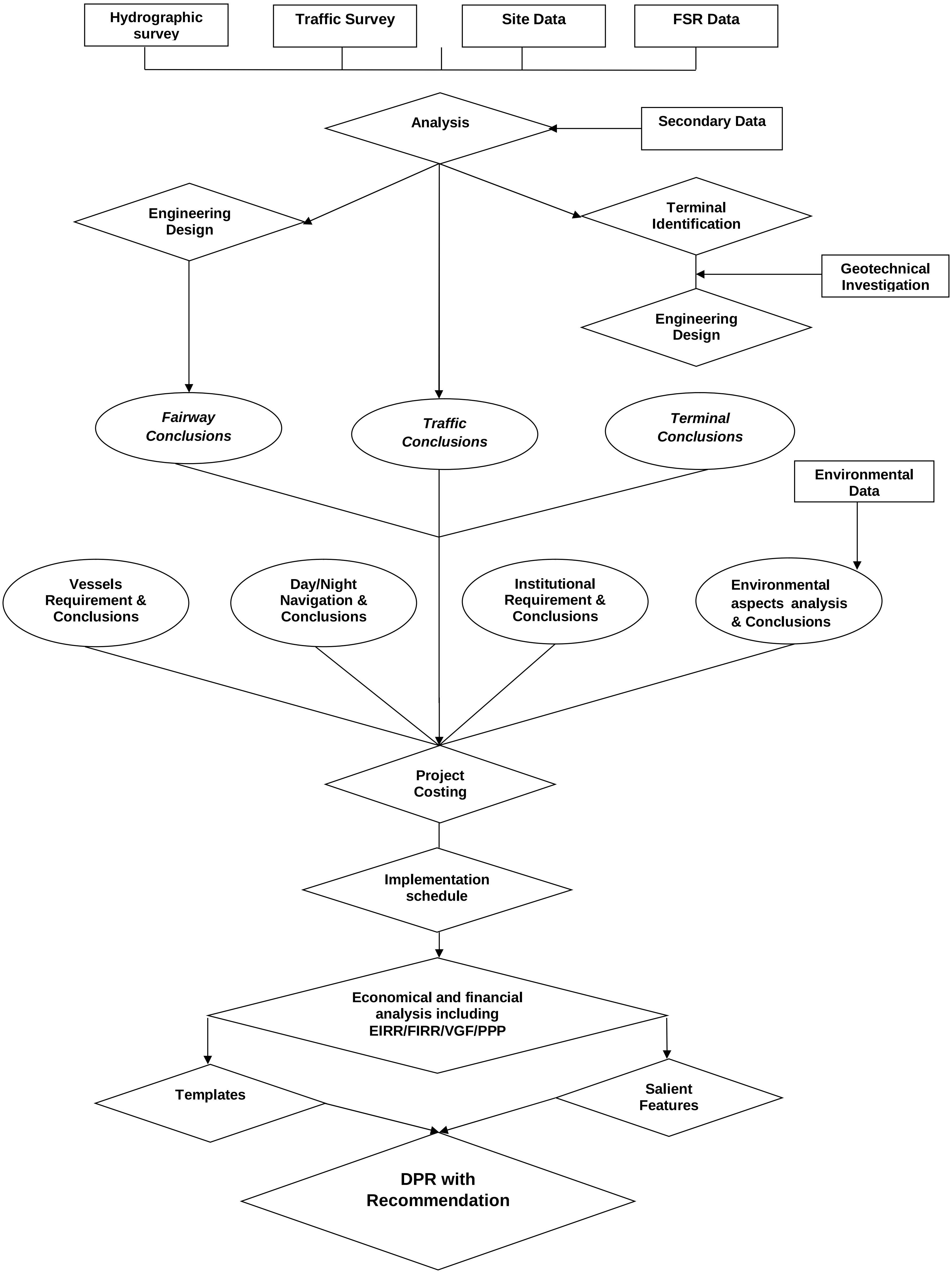
COMPLIANCE ON THE TERMS OF REFERENCE

MAPUSA RIVER (NW 71)

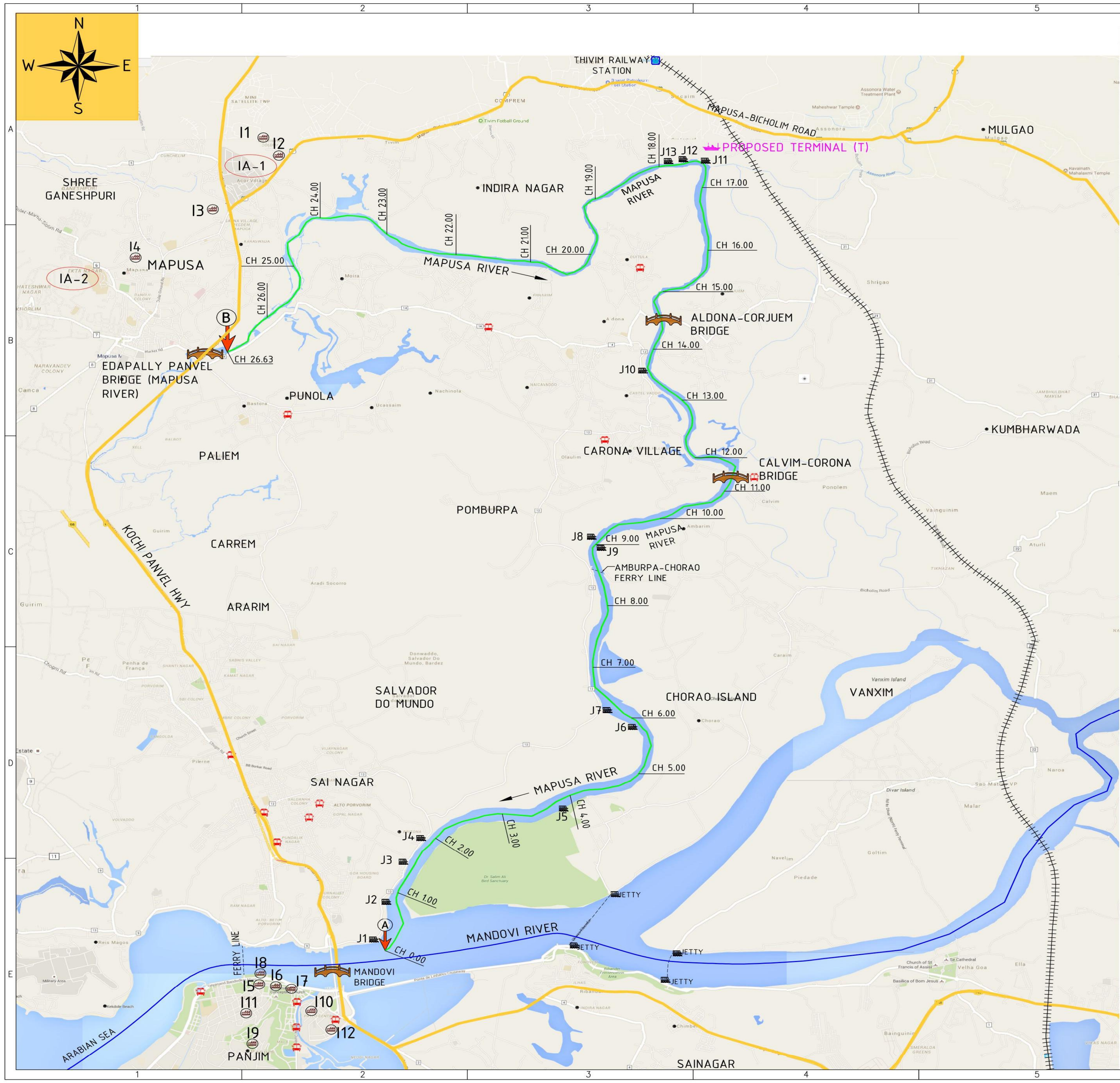
Brief of ToR	**Compliance**
1.0 OBJECTIVE OF THE STUDY: The study would consist of 2 stages: Stage-1 &Stage-2	
1.1 STAGE-1 1.1.1 Reconnaissance Survey – i) to xii) 1.1.2 Collection and Review of Available Data 1.1.3 Feasibility Report 1. Introductory considerations: 2. Analysis of present state of affairs: 3. Market Analysis: 4. Reconnaissance Survey:	Stage I has been completed and based on the same, Stage II Work Order was provided by IWAI.
1.2 STAGE-2 1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY (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	Detailed Hydrographic Survey was completed and the data compiled / analysed (including the Charts) have been submitted under Volume III of the report. Further, the analysed data have been taken into Volume I and Volume II of the Report appropriately.
1.2.1.1 <u>BENCH MARK PILLARS – a)</u>	-do-
1.2.1.2 <u>WATER LEVEL GAUGES i) & ii)</u>	-do-
1.2.1.3 <u>BATHYMETRIC AND TOPOGRAPHICAL SURVEY – a) to k)</u>	-do-
1.2.1.4 <u>CURRENT VELOCITY AND DISCHARGE MEASUREMENT – a) to e)</u>	-do-
1.2.1.5 <u>WATER AND BOTTOM SAMPLES – a) – i) to vi)</u>	-do-
<u>COLLECTION OF TOPOGRAPHICAL FEATURES – a) to j)</u>	-do-
1.2.1.6 <u>SURVEY CHART PREPARATION – a) to n)</u>	-do-

Brief of ToR	**Compliance**
1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY	Submitted in Chapter 4 and in the inter related chapters
1.2.3 DETAILED PROJECT REPORT The scope of works is as follows: in paras a) to k)	Submitted the Volume I of the DPR.
2.0 PERIOD OF SERVICES	
2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:	Delay observed, as narrated from time to time.
NOTE: - The consultants are required to submit the following outputs in Stage-II i) Traffic Template: at Annex-IV ii) Project Costing Template: at Annex-V iii) Financial Evaluation Template: at Annex-VI iv) Economic Evaluation Template: at Annex-VII v) Environmental & Social Screening Template: at Annex-VIII	Submitted at Chapter 15 – Templates in the DPR Volume I.

ANNEXURE 1.3 – SEQUENTIAL APPROACH TO THE PROJECT IN SCHEMATIC FORM



ANNEXURE 4.1 – LAYOUT MAP SHOWING EXISTING JETTIES AND INDUSTRIES IN THE VICINITY OF MAPUSA-MOIDE RIVER



LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	BOAT JETTY	J1
2	BOAT JETTY	J2
3	FLOATING JETTY	J3
4	FLOATING JETTY	J4
5	FISHING JETTY	J5
6	BOAT JETTY	J6
7	FISHING JETTY	J7
8	FERRY JETTY - POMBURPA	J8
9	FERRY JETTY - CHORAO	J9
10	FERRY JETTY - ALDONA	J10
11	OLD JETTY IN SHIPYARD	J11
12	NEW JETTY IN SHIPYARD	J12
13	SHIP YARD JETTY	J13

LIST OF EXISTING INDUSTRY

SL.	DESCRIPTION	SYMB.
1	GOA HYDRAULICS	I1
2	DIEBOLD INDIA PRIVATE LIMITED	I2
3	ALPHA INDUSTRIES	I3
4	RISHABH INDUSTRIES	I4
5	DEPARTMENT OF MINES & GEOLOGY	I5
6	DEPARTMENT OF FISHERIES	I6
7	GOA MINERAL ORE EXPORT ASSOCIATION	I7
8	CAPTAIN OF PORTS	I8
9	DEMPO GROUP	I9
10	VEDANTA GROUP	I10
11	D B BANDOKAR & SONS	I11
12	MANDOVI DRY DOCK	I12

LIST OF EXISTING INDUSTRIAL AREAS

SL.	DESCRIPTION	SYMB.
1	TIVIM INDUSTRIAL AREA	IA-1
2	MAPUSA INDUSTRIAL AREA	IA-2

LEGEND

- BUS STOP
- PROPOSED TERMINAL (T)
- INDUSTRY
- RAILWAY STATION
- PLACE NAME
- JETTY
- ROAD BRIDGE
- NATIONAL HIGHWAY (Hwy)
- ROAD
- NALA/SUB CREEK/SMALL RIVER
- FERRY LINE
- STUDY STRETCH
- RAILWAY LINE
- (A) START POINT AT CONFLUENCE POINT OF MAPUSA & MANDOVI RIVER — LAT. 15°30'22.0887" N, LONG. 73°50'36.2908" E
- (B) END POINT NEAR BRIDGE ON NH17 AT MAPUSA — LAT. 15°35'20.51" N, LONG. 73°49'19.61" E

PROPOSED WATERWAY LENGTH 26.63Km

SCALE 0 — 1.20 — 3.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

TITLE	LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF MAPUSA/MOIDE RIVER
CLIENT	INLAND WATERWAYS AUTHORITY OF INDIA, MINISTRY OF SHIPPING
PROJECT	CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -7 OF NATIONAL WATERWAYS
PROJECT NO.	P.0010257
	TRACTEBEL ENGIE — ANNEXURE - 4.1

ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

- During site visit and interaction with major industries it was found that all the mine locations are nearby Mandovi and Zuari and very few mines nearby Mapusa River.
- Iron ore in bulk quantity could not be transported through Mapusa River, as most of the mines are located nearby Mandovi River. 95% of iron ore is transported through Mandovi River to port. Hence, there exists limited scope for iron ore transportation through Mapusa River.
- Imported cargo could not be handled at Mapusa River as the industries that consume imported cargo are located near Mormugao port and Mandovi River.
- Very few industries are located near Mapusa River and the production of these industries is very low in volume. Hence, it is not commercially viable to transport those cargos through river to some other places. These industries are small and would not contribute in bulk cargo segment.
- Fishing activities around river is carried out by local fishermen. Fish catch from these areas are consumed locally and volume is also low thereby do not hold export potential.
- Tourism activities on smaller scale take place near Mapusa River.

Sr. No.	Name of the Industry	Name of the Person	Designation
1	Mormugao Port	Jerome Clement	Sr. Dy. Traffic Manager
		Vipin R Menoth	Traffic Manager
2	Department of Mines & Geology	Neha A. N Panvelkar	Assistant Director of Mines and Geology
3	Goa Tourism Development Corporation	Gavin Dias	Dy. GM
4	Department of Fisheries	Chandresh Haldankar	Superintendent of fisheries
5	Goa Mineral Ore Export Association	Glen	Secretary of GMOEA
6	Captain of Ports	Capt. Premal Sirsaiker	Dy. Captain of Ports
7	Chowgule & Company	Sumant L Kirloskar	GM (Exports)
8	Dempo Group	Vaman Gaitonde	-
9	V M Salgaocar & Bro	Ze Lucas A Braganca	GM (Exports)
10	Vedanta Group	Vishal Sharma	VP (HOD)
11	D B Bandodkar & Sons	Sumant V Bhende	Manager, Logistics
12	Mandovi Dry Dock	Lington	Mech. Engineer
13	Barge owner association	Raymond	President

Site Visit and Local Inputs about Mapusa river development

- Apart from existing Pomburpa ferry there is Sarmanas ferry that connects Pilgao to Amona in Mandovi River. Pilgao and Amona have iron ore mines and jetty infrastructure for handling minerals.
- There are lots of mangroves around the river.
- River water at most of the places is very polluted and dirty due to barge operation on river.
- There are many landing points on river underutilized due to bridges.
- Not all bridges on river give standard vertical clearance at all places.
- People have built platform on river for Ganesh Visarjan, where lot of lotus flowers could be seen.
- There exist two jetties for mineral handling around catchment area of river near Pilgao on Mandovi River.
- Old Chowgule Shipyard near Poira – the old structure is yet to be demolished.

Chowgule and Company Pvt. Ltd.

Name: Sumant L Kirloskar

Designation: GM (Exports)

Chowgule are carrying out mineral activities in Goa from last 50 to 60 years.

General Mineral scenario of Goa

GOG put bans on mineral companies for 3 years due to illegal issues with mine owners. Government's regulations related to mines were old and was in the process of updating these regulations. At present, in Goa not all mines have received permission for mineral extraction; some are in the process of obtaining license of operation.

- Mandovi and Zuari River are the main rivers, used for mineral and other bulk cargo transportation. Company has its own captive jetty in Mandovi, Zuari River and in Mapusa River also.
- Chowgule has their mines located at Asnoda and Shirgao. Both these places are located in North Goa. From Shirgao mines, per day about 2,500 - 3,000 Tons minerals are transported to Mormugao Port. The mines operate for 24 hrs. and there are 25 working days in a month.
- Calvim Jetty of Mapusa River is being used for transporting minerals to Mormugao Port through barges. Another jetty is at Palem, in Bardez Taluka near Bicholim. 1,000 Tons – 1,100 Tons of barges ply on Mapusa River. It is the maximum limit of barges that could be moved in the river. The length of Chowgule jetty is about 16-20 meter (small projection into water).

- Land area around Mapusa River has a strong base. Generally truck goes backward on road and then direct tipping into barges takes place. At a time 2 trucks could do these activities at the jetty.
- Mooring Dolphin of Mormugao, Mormugao Port Berth No. 9 and West of Breakwater of Mormugao Port are the locations where minerals are unloaded into mother vessels or where transhipment takes place.
- Chowgule exports minerals to China and Japan.
- 15th September to 15th of May is considered as generalized season for mineral activities in Goa. At the starting of season (15th September) dredging activities are carried out in the Mapusa River.
- Present draft in Mapusa River is in the range of 2.7 meter to 3 meter (after dredging) and in Mandovi River, it is about 3.2 meter.
- Increase in number of ferries on Mapusa River could create problem for smooth operation of barges.
- Mapusa River could be more developed from cargo carrying point of view as Chowgule, Bandodkar & Sons have their jetty in Mapusa River and Tourism activity to be developed on Chapora River.

Mormugao Port Trust

Name: Jerome Clement; Designation: Sr. Dy. Traffic Manager

Name: Shri Vipin R Menoth; Designation: Traffic Manager

- Mormugao Port has given Berth No. 09 on PPP basis to Vedanta Limited to handle Iron Ore also Six Panamax vessels handled at Dolphins, West Breakwater are areas where minerals are handled.
- Panajim Port is just opposite to Mormugao Port on water area. It is also called as imaginary port mainly used for transshipment.
- Dedicated Berth for Navy and Coast Guard – Project cost 395 Cr. To be awarded by March 2017
- Mormugao Port is also in the process of developing jetty at Savarde, Goa. in Mandovi river.
- Expansion Project of Port:
- General Cargo Berth
- Handling capacity - 2 mn T pa. Project cost of developing this is 210 Cr. Project to be awarded by 2018
- General Cargo Berth at Vasco Bay

- Handling Capacity – 5mn T pa. Project cost of developing this berth is about 300 Cr. Project to be awarded by March 2017

Dempo Group

Name: Vaman Gaitonde

- Dempo Group has sold its mines business to Vedanta Limited. At present it's operating into Shipbuilding sector and Coal handling/ processing. (Goa Carbon Ltd.)
- Goa Carbon plant is located in Panajim area. Goa carbon import Coke and exports calcined pet coke using Mormugao Port. They do not have any plant or carry any other activities nearby Chapora or Mapusa River thereby these river development for handling cargo is not beneficial for this company.
- Government of Goa is planning to develop electronic city at Tuem that is in the catchment area of Chapora River. Electronic items transportation volume would not be as much as of minerals to transport it through barges to Mormugao Port.
- Though there is lift of ban on minerals extraction there still exist certain limitation to it as per Government order.
- Chapora River could be developed as tourism and for ferry services and Mapusa River could be developed for handling cargo.

V M Salgaocar & Bro Pvt Ltd

Name: Ze Lucas A Braganca

Designation: GM (Exports)

At present 2,500 Tons of minerals is being transported in barges through Mandovi River. (16m/ 96m)

Only local people residing in nearby villages use ferry terminals. Most tourists use roadways/ new bridges to go to other side of river.

Location of Mines - Velgeum, Surla and Amona. From Velgum 2,400 tons of barges go to Mormugao Port and from Amona 600-700 Tons of Barges goes to Port. About 3lac tons p.m. is the export volume which goes to Mormugao Port. At the time of low tide barges wait and when high tide comes they move ahead. Empty barges can easily roam around the river without waiting period.

Salgaocar has minerals processing plant nearby mines only. They extract process and then transport via barges to port. Infrastructure like cranes etc. are required for unloading minerals into mother vessels but at the time of loading into barges no such supporting infra is required as these jetties are above water and directly through truck minerals are loaded into barge.

Some of the mine owners were using old licenses and from Government side also some pending issues were there related to mines and clearances so ban was put on mines. Even though on some of mines the ban has been lifted there will still be a gap of 20 mnT in the total mineral traffic in future, as Government has put restrictions that only 30 to 37 mnT p.a minerals would be handled at port. Due to this reason there does not exist any scope of further increase in minerals volume in coming future.

Mines which are in working condition now have advance permit of operation once that gets over it would again go into pending status. Many mineral companies have minerals into stockyard, which they are further processing and then exporting.

Vedanta exports pig iron and limestone and imports coal at Mormugao port. Dempo has given mines on lease basis in Maharashtra, Sawantwadi area.

Panajim Port is just opposite to Mormugao Port. Panajim port generally handles 1 to 2 mnT of traffic p.a. only once it handled around 14mnT of minerals when the transhipment was done by Salgaocar, jointly with Dempo. Now Dempo's mineral business has been taken over by Vedanta. Panajim Port is operational but small scale of volume of cargo are being handled at present. Panajim Port also lack infrastructure facility and Mormugao Port also reduced their handling charges which was previously very high and also offered various facilities like bunkering at their berth etc. that captured Panajim Port's traffic.
Salgaocar exports minerals to Japan, Korea, China etc. Japanese have higher standards in terms of Fe content of Iron ore. They demand premium quality of minerals. There is a restriction of export duty of 58%. Average mineral grades in Goa ranges from 50-53 to 56-57.

- JSW cranes and it's operation at Mormugao Port
- JSW imports coal at Mormugao Port also for their Vijaynagar Plant in Ballery district. There exist good railway connectivity from Mormugao Port to their plant. For JSW this is cheaper route compare to handling coal at New Mangalore Port.
- Indian Oil is developing berth No 8 at Mormugao Port.
- Ferry Scenario in Goa

Earlier when Mandovi bridge collapsed at that time Britona ferry was used to go to Panajim. After new bridges on Chapora River, some of earlier ferries are closed down. Only local people are using ferries these days, compared to tourists.

Vedanta Group

Name: Vishal Sharma

Designation: VP (HOD)

- Vedanta is using Zuari and Mandovi River for mineral transportation. They have mines at Bicholim, Surla etc.
- Vedanta have their own fleet of barges. They own 33 barges having capacity of 1,600 Tons to 2,500 Tons. About 30,000 Tons of minerals every day are being transported through these mines.
- Mandovi River has 3.4 meter draft. In Goa there do not exist constant tidal situation. So barges wait for high tide and then pass through river. Minimum 3.3 meter draft is required to ply these barges on river. Mapusa River hardly have 3meter draft. It is also Small River in stretch.
- 90% of minerals go to China and rest goes to Japan and Korea.
- For cargo handling there is not much scope for these Mapusa and Chapora River, for tourism it holds great potential. There do exist some tourist spot around Chapora River that could be developed. Half to one meter draft is also sometimes sufficient to carry out water sports and other tourism related activities on river. Goa Rivers are tidal rivers they don't dry up completely in any season.
- Only bulk cargo like cement, Minerals, Coal etc. Holds potential for using barges and for using inland waterway as they can be weigh in tons/kg. Whereas light goods like electronic items are in small parts. Packed items also do not hold any potential for transporting it through barges on river. There are very less industries who deals in bulk cargo in Goa.
- For developing container terminal, river needs more draft to handle bigger vessels, which is not possible in case of Chapora and Mapusa. So these rivers could be developed for tourism and for sightseeing etc.
- Ferry potential for river

Ferry operates in it's own particular timing, Vehicles have to wait for ferry also ferries operates in daytime only between 6am to 8 pm. Whereas bridges are open 24/7. In monsoon period ferries do not operate due to high current. Developing ferries on river is not a good option for passenger due to waiting period. It could only be considered as temporary solution. There exist need for more bridges on river.

D B Bandodkar & Sons

Name: Sumant V Bhende

Designation: Manager, Logistics

Bandodkar has jetty at Kotambi and Kishe, which has outsourced to Chowgule. Bandodkar has mines in Velguem, North Goa. Their mines are not in working condition at present due to environment issue. Previously they have exported only 5 lac tons per year due to environment limit. As per Supreme Court order only 2 to 2.5 lac tons per year is allowed. Around 20 mn T of minerals would be exported from Goa. There is restriction to amount of mineral traffic handled in future too so limited scope for handling minerals. For tourism purpose these river holds potential.

Goa Minerals Ore Export Association

Name: Glen

Designation: Secretary of GMOEA

- No iron ore mines are located nearby Chapora River. Chapora River do not have any scope related to barge operations. Mapusa River to limited extent is being used from past years for iron ore transportation. For Iron Ore operations through barges Mandovi, Zuari are major rivers. 95% of iron ore moves through these rivers. Hardly 5% of iron ore is being transported through Mapusa. On a broader or outer scope around 1 mn T to 1.5 mn T is transported through Mapusa River.
- Calvim Jetty and North of Calvim is the only portion from where iron ore handling takes place. Bandekar, Fomento have their captive jetty in Mapusa River.
- Mapusa river stretch is very limited which is used for barge operations. For import of cargo there is zero scope in Mapusa River. Only limited export of iron ore could take place. Only iron ore and coal commodity would move through barges.
- Part of Iron ore traffic from Assnora could be attracted to Mapusa River. Even though some of the mines located at Sattari and Bicholim are in the catchment area of Mapusa River but they are also nearby Mandovi River thereby bulk of iron ore minerals would be moved by Mandovi River and not Chapora or Mapusa.
- AT present 20 mnT p.a. is the limit set by Government for exporting iron ore and 30 mn T is proposed to be exported in the Supreme Court. If court approves then only quantity of export would reach 30 mn T maximum and could be extended to 37 mn T in near future.

Barge Owner Association

Name: Raymond

Designation: President

Total barges available with association are 70 to 80 but very few are operational due to ban on exports. They ply barges on North Goa & South Goa. North – Mandovi River & South – Zuari River. Association is handling more business from North Goa compared to South Goa. Draft of Mandovi River is also good in North Goa. There are four commodities transported in barges, Coal, Iron ore, slag and Gypsum. Coal for Vedanta for their pig iron plant & to Delta is distributed through rail wagon. Sircaim & Alcon jetty in North Goa is used for bulk commodity transportation. Verna industrial estate has 11 units of Cipla. Verna is closer to Mormugao port (21 km) than any river in North Goa. Container traffic to Mormugao port is generated from this Verna Industrial Estate.

Existing Mandovi Dry Dock nearby Mapusa River

Name: Lington

Designation: Mech. Engineer

- Mandovi Drydock is nearby Pilgao, which is in the catchment area of Mapusa River. Their core activity is Barge making. Their barges mainly ply on Mandovi and Zuari River.
- At present, there are around 400-500 workers working at dock.
- Goa market is coming down. They are not getting any new order from domestic market though ban on mining business is lifted. Mainly they are getting new order from other states like West Bengal, Andhra Pradesh and from foreign markets like Dubai etc.
- At present they are constructing Aluminum Cruise for Dubai client and also in process of making world's biggest barge of about 80 to 85 meter with 750hp engine for Kolkata client. Generally normal barge require 350 hp engine.
- Apart from bulk cargo no other cargo has scope of transporting it through barges using inland waterways. Not many industries that deal in bulk cargo are situated in the catchment area of river.
- Lot of dredging would be required in Mapusa River.

Goa Tourism Development Corporation

Name: Gavin Dias

Designation: Dy. GM. Hotels, Marketing

- At present river cruise business is at stagnant stage. There are 10-20 big operators. Total 50 cruise operators having passenger capacity of 150-600. There is single window system at cruise jetty that is going to be redeveloped.
- Multi car parking development along side cruise point on revenue model would be developed. Government would provide only land and private party will invest it and develop it. At present there is Backwater cruises, Dinner cruises operating on Mandovi River to Bay area. Coastal Darshan scheme at Goa has been approved which will soon start its operation.

- For developing floaters platform on river LOA has been issued. Kerala is famous for backwater tourism similar way on a smaller scale GTDC plans to develop it on inland waterways of Goa.
- Continuous barge operation on river disturbs tourism activities on river that is why river tourism was not considered previously but now there is ban on mines, which has slowed down barge operations on few rivers that could be developed for tourism purpose. There parking areas could be developed nearby jetty. Water sports could be also be developed. GTDC also wants to reduce tourist traffic on road and explore tourism potential for river.
- Any new tourism development is always welcome in Goa. GTDC have considered Chapora and Mapusa River in their development plans. For this new technical and site survey visit is yet to be done.

Department of Fisheries

Name: Shri Chandresh Haldankar
Designation: Superintendent of fisheries

Pomburpa, Britona, Aldona are major places where fishing activity takes place in Chapora river. Fishing in the river is scattered all over. There is no major landing point for fish in these rivers. Only traditional fishermen are carrying out this activity. Minimum 2meter draft is also sufficient for fishing activity. All the fish gets consumed locally no export from these areas.

Goa Minerals Ore Export Association
Name: Glen
Designation: Secretary of GMOEA

- No iron ore mines are located nearby Chapora River. Chapora River do not have any scope related to barge operations.
- Mapusa River to limited extent is being used from past years for iron ore transportation. For Iron Ore operations through barges Mandovi, Zuari are major rivers. 95% of iron ore moves through both of these rivers. Hardly 5% of iron ore is being transported through Mapusa. On a broader or outer scope around 1 mn T to 1.5 mn T is transported through Mapusa River.
- Calvim Jetty and North of Calvim is the only portion from where iron ore is handling takes place. Bandekar, Fomento have their captive jetty in Mapusa River.
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- Only iron ore and coal commodity would move through barges.

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- AT present 20 mnT p.a. is the limit set by Government for exporting iron ore and 30 mn T is proposed to be exported in the Supreme Court. If court approves then only quantity of export would reach 30 mn T maximum and could be extended to 37 mn T in near future.

Industrial Unit in Mapusa Industrial Estate

Sr. No.	Unit Name	Product
1	O M Enterprises	Cutting Of Natural Stone
2	Ashok Eng. Works	Steel furniture and fabrication
3	Goa Instrument Indus	Thermometers
4	Bal Bandhoo	Wrist watches, wall clocks
5	Centaur Pharmaceuticals	Protein Hydrolysat
6	Cenzor Industries	Assembly of qurtz/ wrist watches and calculators
7	Siddesh Engineering	Steel grills, Centering materials
8	Sai Service Station	Repairs Of Vehicals
9	Goa Horological Industries	Electronic quartz analogues, Wall clock, time pieces
10	Goa Telecommunication & Systems	Electronic instrumentation
11	Cosme Cost & Sons	Plastic bags
12	Gull Chem Industries	Digital Watches
13	Hi-Tech Caps	Pilfer proof caps
14	Le Grand Engineering	Painting of vehicles & fabrication
15	Lokmanya Soap Works	Wax candles, washing soaps
16	Manohar Packaging	Manufacture of paper label, card boards, cartoons
17	Modern Cosmetics Industries	Toilet detergent & shaving soaps
18	Nitin Metal Packs	Metal caps out of M. S. & aluminum sheets
19	Shree Gajantlaxmi work	Aluminum Doors, Windows
20	Rashmi Powertronics	Assembling of D. G. Sets, electrical panels and distribution boards
21	Shivraj Metal Works	Trunks and buckets
22	Speciality Caps	Pilfer proof caps
23	Alpana Frozen foods	Frozen foods
24	Agarwal Industries.	Injection Molding
25	Hoysala Coach Builders	Servicing & repairs of Vehicles & Body Building

Industrial Unit in Tivim Industrial Estate

Sr. No.	Unit Name	Product
1	Arvind Organics	Paints, primer
2	Atul International	Automobile seat covers, shopping bags
3	Blossom Pharmaceuticals	Cream lotion, ointment
4	Centaur Pharmaceuticals	Drugs & pharmaceuticals formulation
5	Chodankar Brothers	Garage & repair jobs
6	Crompton Greaves	Electric motors & generators
7	Dudeshwar Steel Furniture	Steel furniture & fabrication
8	Dyanaquip Engineers	Die casting machines accessories
9	Dynaquip Machines	Pressure Die Castings
10	Epoxy Coats Industries	Printing & Painting on metal glass
11	G. K. Enterprises	Automobile components
12	Geno Pharmaceuticals	Pharmaceuticals products
13	GKB Hi- Tech Lenses	Ophthalmic Lenses from blanks
14	GKB Ophthalmic	Ophthalmic Lenses
15	Goa Hydraulics	Machines Tools, Accessories
16	Goa Optolab	Ophthalmic Lenses,
17	Goa Wire & Allied Products	Wire Products such as hooks, bolts
18	Goan Liquor Products	Blending & bottling (IMFL)
19	Gomantak Cables	Wire and cables
20	House of Furniture	Wooden furniture
21	HYD Air Engg. Works	Hydraulic Fittings& Valves
22	Hydropack Industries	Hydraulic Cylinders, Pumps
23	Laxmi Coach Builders	Repair and servicing of vehicles
24	Living Room Life Style	Wooden furniture
25	M. R. Engineering	Single arm david and life boats fittings
26	Magic Wash Industries	Washing machines, sheet metal components
27	Mahalsa Packers	Corrugated boxes
28	Manerkar Industries	Blouse hooks
29	Mardolkar Marine Engineers	Spares of marine engines, Earth moving machinery
30	Midwest Instruments	Instrumentation / Apparatus Systems for measuring
31	Minco (India)	Pressure Vaccum gauges
32	Modern India Detergents	Soap detergents
33	Navtara Fabricators	Fabrication
34	Nevgi Fastners	Barbed wire, Nails, rivets
35	Nirupa Fishnet Industries	Fish nets

Sr. No.	Unit Name	Product
36	Patel Closures	Plastic closures
37	Patel Flexiprint Goa	LDPE Films, Bags
38	Phil Corporation	Motion picture, sound & projection
39	Phil Enterprise	Projectors, photographic products
40	Phil System	Photographic projectors, Films
41	Prakash Enterprises	Motor shaft component, cylindrical grinding
42	Prestige Industries	Hawai chappals
43	Prestige Furniture	M. S. Furniture, Partition & storage rack
44	Ram Industries	Sewing machines cabinets
45	Raut Roadways & Vehicles Repairs	Motor vehicles repairs
46	Rotoflex Filmpack Industries	Polythene bags
47	Satpurush Industries	Steel cupboards
48	Shidore Microsys Electronics	Power electronics equipment UPS
49	Siddarth Engineering	Fabrication
50	Sigma Laboratories	Tablets, liquid injection
51	Sonoo Garage	Maruti cars repairs
52	Standard Pack & Print	Corrugated boxes
53	Structures India	Wooden and steel furniture
54	Sunprint Ink Industries	Printing ink
55	Sunshine Electric Company	Electric control panels
56	Tata InfoTech	Mini computers, documents encoders, readers
57	Tivim Pharmaceuticals	Pharmaceuticals Products
58	Top Brass Mfg.	Lock latches
59	J. & J Prescission Industries	Watch Cases & quartz analog watch assembly
60	Sai Extrusion	HDPE, Twines and robs
61	Anand Engineers	Barbed wire
62	Dyna Plast Tech	Plastics Injection molding
63	Weld Tech Engineers	M. S. Grills
64	J. J. Precision Industries	Digital Electronics Watches & Watch straps
65	Mangurish Engg. Works	Fabrication & Machinery works
66	Atul Udyog	Concrete mixer, loaders
67	S. N. Industries	Metal lamp caps for Auto & other lamps
68	Shakti Industrial	Concrete Mixers, Concrete batch plant
69	Supreme Furniture	Fabrication
70	Arden Enterprises	Ice cream, Fruit Juice and Cold storage operation

Sr. No.	Unit Name	Product
71	Suyash Enterprises	Pollution prevention equipment, waste water treatment system, incinerators, oil filtration systems,
72	Suyash Equipment	Oil skimmers, oil spill booms spray systems & electrostatic precipitators
73	Nilma Twines & Ropes	HDPE Twines & Ropes
74	Parle Exports	PVC comp[und & plastic items
75	Gurukrupa Powder Coating & Plating	Powder coating
76	Nilima Nets	Fishnet
77	Print Master	Printing and Binding
78	Shriram Glass Ampoules	Glass ampoules
79	Excel Prints & Packs	Printing of labels bags, stickers
80	Nanora Distilleries	Blending & bottling (IMFL)
81	National Industrial	IMFL
82	Mantravadi Industries	Powder coating
83	Tivim Instruments	Components for gauges
84	S. N. Industries	Metal Lamo caps for auto & other lamps

ANNEXURE 5.1– CALCULATION OF SAFE BEARING CAPACITY

Calculation of Safe Bearing capacity as per IS 6403 - 1981

Width of Footing/Raft (B)	=	**1.50**	m	
Length of Footing/Raft (L)	=	**1.50**	m	
Cohesion (C)	=	**18.2**	KN/m^3	For BM-1
Angle of Internal Friction (ϕ)	=	**17.0**	degree	For BM-1
Bulk Unit weight (γ)	=	**16.4**	KN/m^3	For BM-1
Unit weight of water (γ_w)	=	**10**	KN/m^3	
Submerged Unit Weight	=	**6.4**	KN/m^3	
Type of Failure	=	**Local Shear Failure**		
Depth of foundation (Df)	=	**3.0**	m	
Factor of Safety	=	**2.5**		
Shape of Footing / Raft	=	Rectangle		
L/B	=	1		
Shape factor (sc)	=	1.2	(Table 2 of IS 6403)	
Shape factor (sq)	=	1.2	(Table 2 of IS 6403)	
Shape factor (sγ)	=	0.6	(Table 2 of IS 6403)	
Nϕ	=	1.825	(cl. 3 of IS 6403)	
Depth factor (dc)	=	1.54	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dq)	=	1.27	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dγ)	=	1.27	(cl. 5.1.2.2 of IS 6403)	
Inclination of load to vertical (α)	=	**0**	degree	
Inclination factors (ic)	=	1	(cl. 5.1.2.3 of IS 6403)	
Inclination factors (iq)	=	1	(cl. 5.1.2.3 of IS 6403)	
Inclination factors (iγ)	=	1	(cl. 5.1.2.3 of IS 6403)	

From Table 1 of IS 6403

ϕ' for local shear failure (*Φ*'=*Φ**2/3) =		11.52	degree
Bearing capacity factor (Nc')	=	**9.16**	For Punching Shear Failure
Bearing capacity factor (Nq')	=	**2.91**	For Punching Shear Failure
Bearing capacity factor (Nγ')	=	**1.66**	For Punching Shear Failure

q = Effective surcharge at the base level of foundation = γ*Df
qa = Net pressure for a specified settlement of 50 mm
R = Relative density of soil
W' = Correction factor for Water Table = **1.00** (cl. 5.1.2.4 of IS 6403)

Qu' (Local shear failure) = 1/F(2/3*c* Nc' *sc*dc*ic + γ*Df*(Nq' -1) *sq*dq*iq + 0.5*γ*B*Nγ' *sγ*dγ*iγ*W')
146.0 KN/m^2

Load at 50 mm Settlement = 115.0 kN/m^2 (As per Calcula

Safe Bearing Capacity = 115.0 kN/m^2

Calculation of Settlement as per IS 8009 (Part I) - 1976

Proposed Depth of foundation =		3.0	m		
Total depth of Borehole =		20.5	m		
Depth of bed rock =		15.5	m		
Proposed Length of Footing (L) =		1.5	m		
Proposed Width of Footing (B) =		1.5	m		
Depth of effective zone = 1.5B =		2.25	m		
Bottom level of Influence zone =		5.25	m		
Effective thickness of Layer-2 for Settlement =		2.25	m		
Effective thickness of Layer-3 for Settlement =		0.0	m		

Available Soil properties at different depths are given below;

	Layer-1	Layer-2		Layer-3	
Start Level (EL) of Layer =	**0**	**1.5**	m	**5.5**	m
End Level (EL) of Layer =	**1.5**	**5.5**	m	**9.0**	m
Average Unit Weight =	16.00	17.52	kN/m^3	18.605	kN/m^3
Cohesion (C) =		18.2	kN/m^2	36.6	kN/m^2
Angle of Internal Friction (ϕ) =		17	degree	12	degree
Compression Index (Cc) =		0.427		0.552	
Initial void Ratio (e_0) =		1.338		1.452	
				Two layers	

Initial pressure at the center of Layer-2 Below Foundation Level (σ_0) =	69.99	kN/m^2
Initial pressure at the center of Layer-3 below Foundation Level (σ_0) =	0.00	kN/m^3
Assumed Pressure increment at the base of footing =	**200**	kN/m^2
Pattern of pressure distribution below based of footing =	2	V:1H
=	0.5	H:1V
Total Load at the base of the footing=	450	kN

Calculation of settlement for Layer-2

Length of load dispersion at top of Layer-2 (L) =	1.5	m
Width of load dispersion at top of Layer-2 (W) =	1.5	m
Pressure increment at top of Layer-2 =	**200.00**	**kN/m^2**
Length of load dispersion at middle of Layer-2 (L) =	2.625	m
Width of load dispersion at middle of Layer-2 (W) =	2.625	m
Pressure increment at middle of Layer-2 =	**65.31**	**kN/m^2**
Length of load dispersion at top of Layer-2 (L) =	3.75	m
Width of load dispersion at top of Layer-2 (W) =	3.75	m
Pressure increment at top of Layer-2 =	**32.00**	**kN/m^2**
Average pressure increment for Layer-2 (as per Simpson's rule) =	**82.20**	**kN/m^2**
Total Settlemt of Layer-2 (Sf) =	0.1386	m
	138.63	**mm**

Calculation of settlement for Layer-3

Length of load dispersion at top of Layer-3 (L) =	3.75	m
Width of load dispersion at top of Layer-3 (W) =	3.75	m
Pressure increment at top of Layer-3 =	**32.00**	**kN/m^2**

Length of load dispersion at middle of Layer-3 (L) =	3.75	m
Width of load dispersion at middle of Layer-3 (W) =	3.75	m
Pressure increment at middle of Layer-3 =	**32.00**	**kN/m^2**
Length of load dispersion at top of Layer-3 (L) =	3.8	m
Width of load dispersion at top of Layer-3 (W) =	3.8	m
Pressure increment at top of Layer-3 =	**32.00**	**kN/m^2**
Average pressure increment for Layer-3 (as per Simpson's rule) =	**32.00**	**kN/m^2**
Total Settlemt of Layer-3 (Sf) =	0.0000	m
	0.00	**mm**

Calculation of Immediate Settlement

(Clause 9.2.3.2 of IS 8009 Part 1 - 1976)

The immediate settlement beneath the center or corner of the flexible loaded area is given by

$Si = p*B*(1-\mu^2)/E*I$

p = Effective Pressure at foundation level =	50.28	kN/m^2
μ = Poisson's Ratio =	0.5	For Saturated clay
I = Influence Factor (L/B) = 1 =	1.12	For Flexible Loaded Area
(Table 2 of IS 8009 Part 1)	0.896	For rigid loaded area (0.82 for rigi
Young's Modulus of Elasticity (E) =	300	kg/cm^2 (Assumed)
	30000	kN/m^2
Width of footing (B) =	1.50	m
Immediate Settlement (Si) =	0.002112	m
	2.11176	mm
Total Settlement including immediate settlement =	**140.74**	**mm**
Value of D/sqrt(L*B) =	2.00	
Value of sqrt(L*B)/D =	0.50	
Correction Factor for Depth of foundation =	0.62	(Fig 12 of IS 8009_Part 1)
Correction Factor for Rigidity of Foundation =	1.00	(Clause 9.5.2 of IS 8009_Part 1) (C
Settlement after Corrections =	87.26	mm
Allowable Settlement for Isolated footing =	50	mm (Table -1 of IS 1904-1986)
Load at 50 mm Settlement =	**115.00**	**kN/m^2**

ANNEXURE 5.2– CALCULATION OF PILE CAPACITY

TRACTEBEL engie

Working Pile - Vertical Capacity in Soil (Both Friction and End Bearing as per IS 2911-1-2 : 2010) i.e. Bored Cast in situ Pile of BM-1

Dia of Pile (D) =	1.00 m		0 to 1.5 m	1.5 to 5.5 m	5.5 to 9.0 m
Ground Level =	0.0 m	Saturated Unit Weight (kN/m^3) =	16.00	17.52	18.605
Pile Cutoff Level (Assumed) =	0.0 m				
Maximum Scour Level	0 m	Overburden Pressure Correction Factor CN = 0.77*log10(2000/σ0)			
FoS (Bearing and Friction)	2.5	Ultimate Shaft Resistance = S ((Ks*Pdi*tanδ)*Asi + a*C(As))			
Effective Length of Pile = 15D =	15 m (-1.5 to -13.75	Ki = Earth Pressure Coefficient	**Value**	**ϕ (Degree)**	**Factor**
Length of Pile below Scour level =	12 m		1	30	
Unit Weight of Reinforced Concrete	25 kN/m^3		1.5	40	0.05

Depth below NSL (m)	**EL (m)**	**Friction angle (ϕ) as per Fig-1 (IS 6403)**	**Cohesion (C) kN/m^2**	**Wall Friction Angle δ (Degree)**	**Earth Pressure Coefficient (Ki)**	**Adhesion Factor (α)**	**Overburden Pressure at bottom of the**	**al Area of Pile Shaft (Asi) (m^2)**	**Ultimate Shaft Friction (kN)**
0	0.0	0	0	0	0.00	0.00	0	0.00	0.0
1.5	-1.5	30	0	30	1.00	1.00	24.00	4.71	32.6
3	-3	17	18.2	17	1.00	1.00	50.28	4.71	139.3
4.5	-4.5	17	18.2	17	1.00	1.00	76.56	4.71	177.1
5.5	-5.5	17	18.2	17	1.00	1.00	94.08	3.14	139.1
7.5	-7.5	12	36.6	12	1.00	1.00	131.29	6.28	380.5
9	-9	12	36.6	12	1.00	1.00	159.20	4.71	318.0
10.5	-10.5	0	95	0	1.00	0.45	187.35	4.71	201.5
12	-12	0	90	0	1.00	0.48	215.51	4.71	203.6

Total Ultimate Skin Friction Resistance, Qst (kN) = 1591.63
Total Allowable Skin Friction Resistance, Qst (kN) = 636.65

Note : Effective Length of Pile = 15D. Effective Overburden pressure will not increase after effective length of Pile.

End Bearing (T) = Ap*(Nc*Cp+0.5*D*γ*Nγ+Pd*Nq)

Cohesion (C) =	90	kN/m^2
Depth of Pile Tip (Pile Bottom) from Ground Level =	12	m
Effective Overburden Pressure at Pile Tip =	215.5075	kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	0	degree
Bearing Capacity Factor (Nc)	9	
Bearing Capacity Factor (Nq)	0.000	(As per IS 2911 Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	0.000	(As per IS 6403 -1981)

End Bearing (T) =	636.17	kN
Allowable End Bearing Capacity of Pile =	**254.47**	**kN**
Self Weight of Pile =	235.62	kN
Net Bearing Capacity of Pile =	**656.0**	**kN**

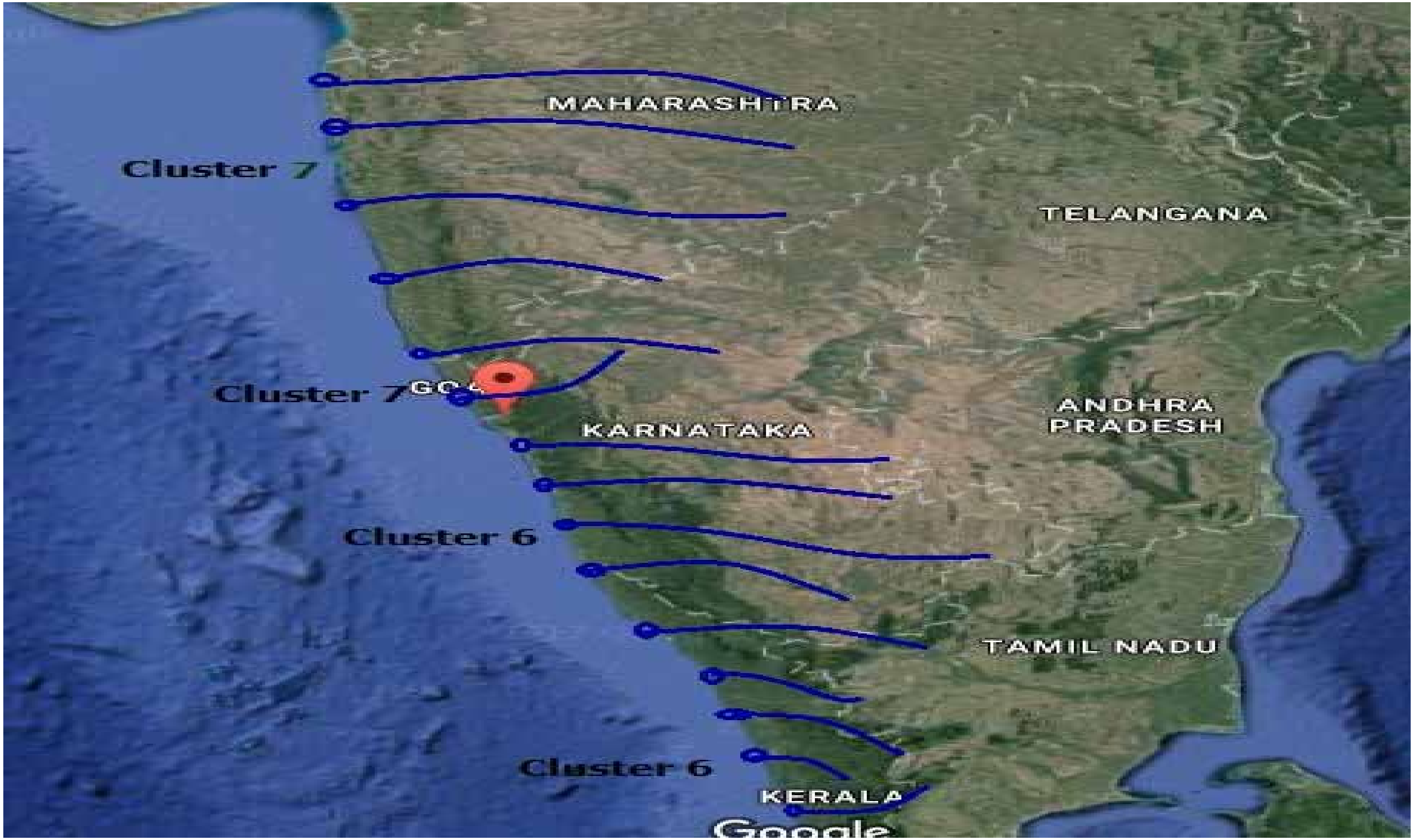
Uplift Capacity of Pile

Safe Uplift Capacity of Pile = 2/3*Frictional Resistance =	424.43	
Safe Uplift Capacity (Including Weight of Pile)=	**660.0**	**kN**

ANNEXURE 8.1– RIS / AIS

RIVER VESSEL TRACKING INFORMATION SYSTEM

- RIS Objective
- Proposed AIS Base Station
- RIS Key Technologies
  - (a) Vessel Tracking & Tracking
  - (b) Onshore Facilities
- AIS Base Station Set up
- AIS Station Tower Design
- AIS Station VHF Range
- AIS Onboard Device
- Onboard ECDIS Interface
- RIS Centre
- Communication Segments
- Bill of Material


MAHARASHTRA
Cluster 7
TELANGANA
Cluster 7
KARNATAKA
ANDHRA PRADESH
Cluster 6
TAMIL NADU
Cluster 6
KERALA
Google

Services for skippers

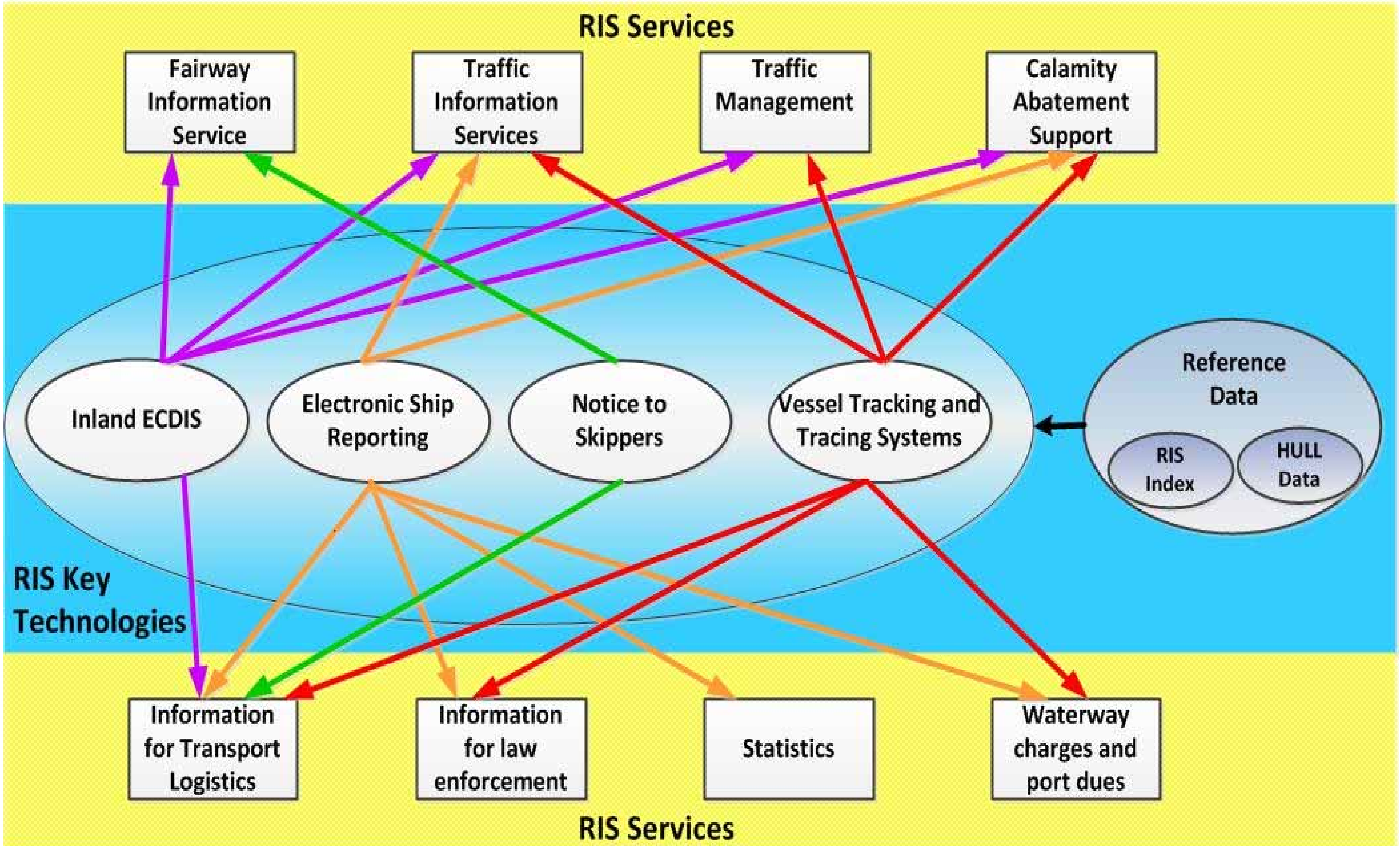
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

Services for authorities

- Real time traffic monitoring (tracking and tracing)
- Analysis of accidents
- Exchange of safety related messages
- Electronic vessel register
- Electronic lock management
- Reception of electronic cargo reports
- Border surveillance

Services for logistic users

- Electronic cargo documents
- Data for fleet management
- Data for voyage planning
- Fairway conditions
- Water level forecast
- Availability of locks
- Calculations of arrival times

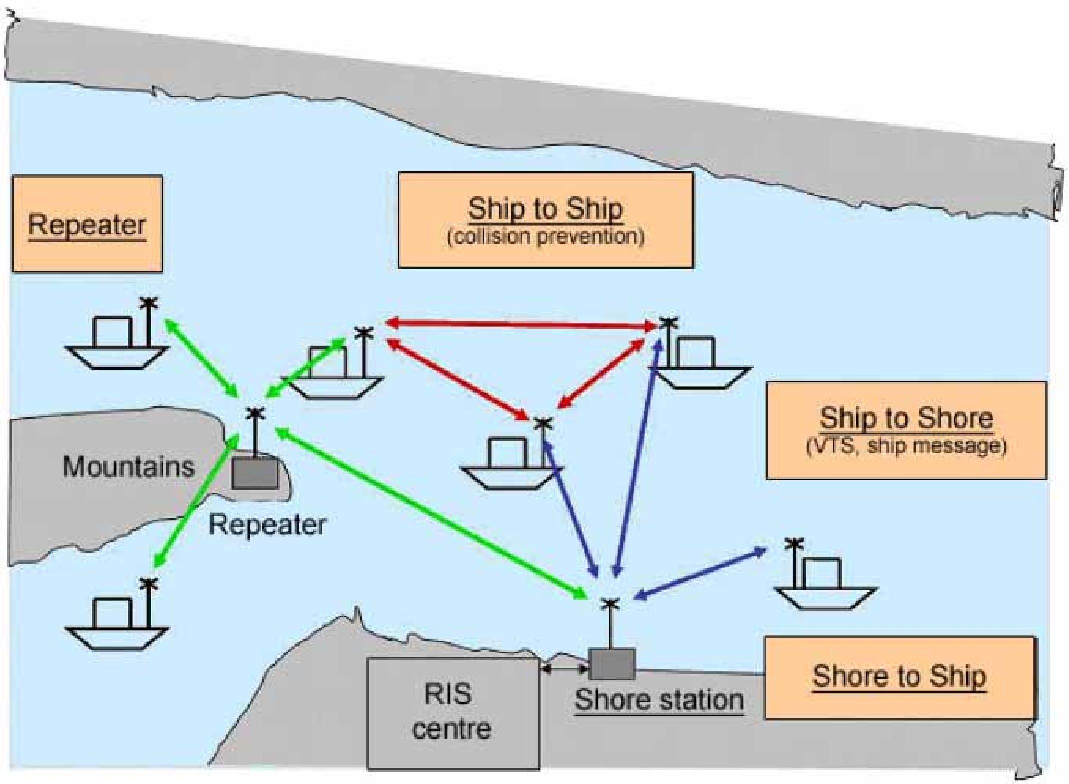

RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notice to Skippers
Vessel Tracking and Tracing Systems
Reference Data
RIS Index
HULL Data
RIS Key Technologies
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services

The key technologies of RIS are

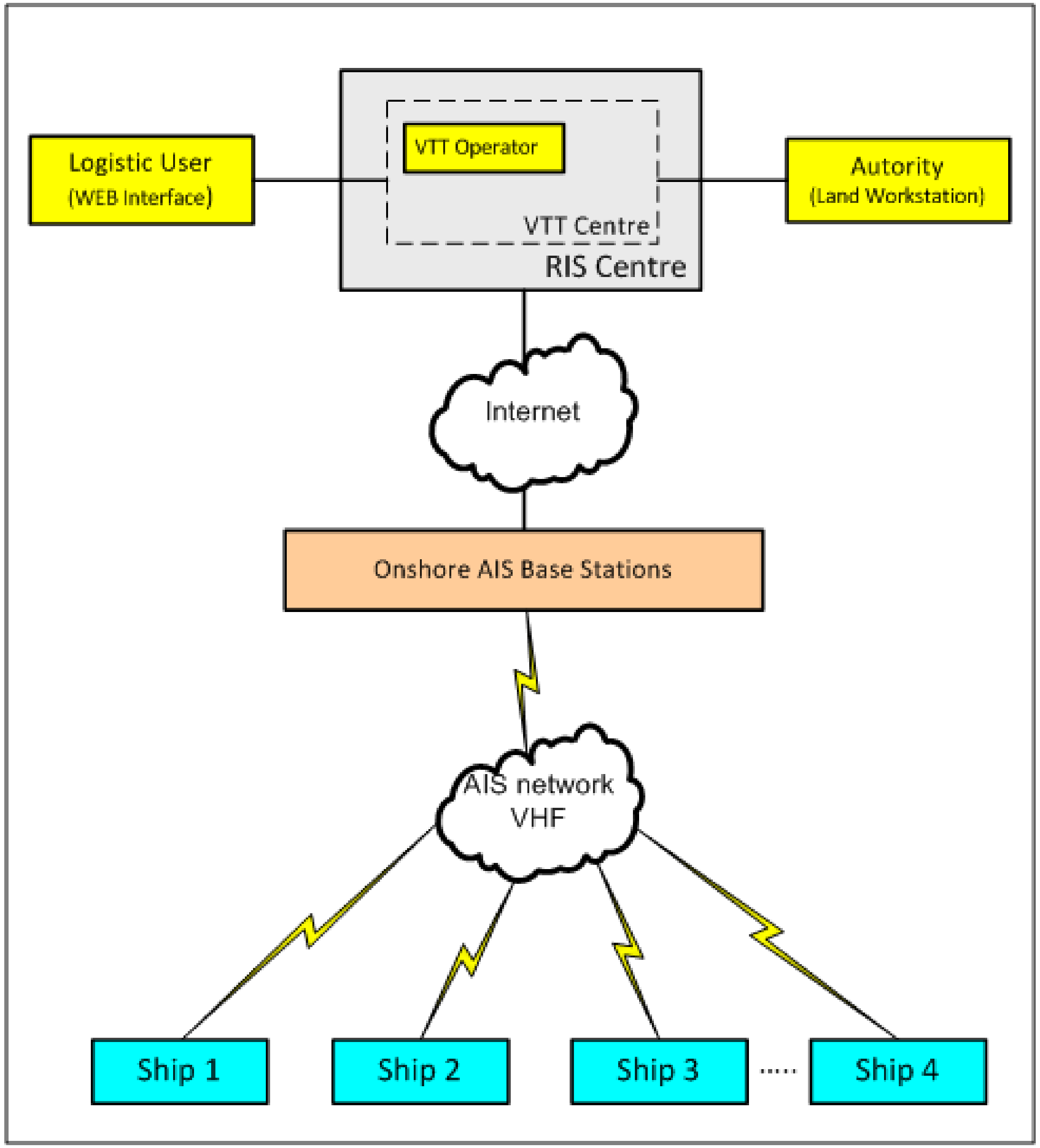
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

Some technologies needs to be adapted to the local laws and operating procedures.

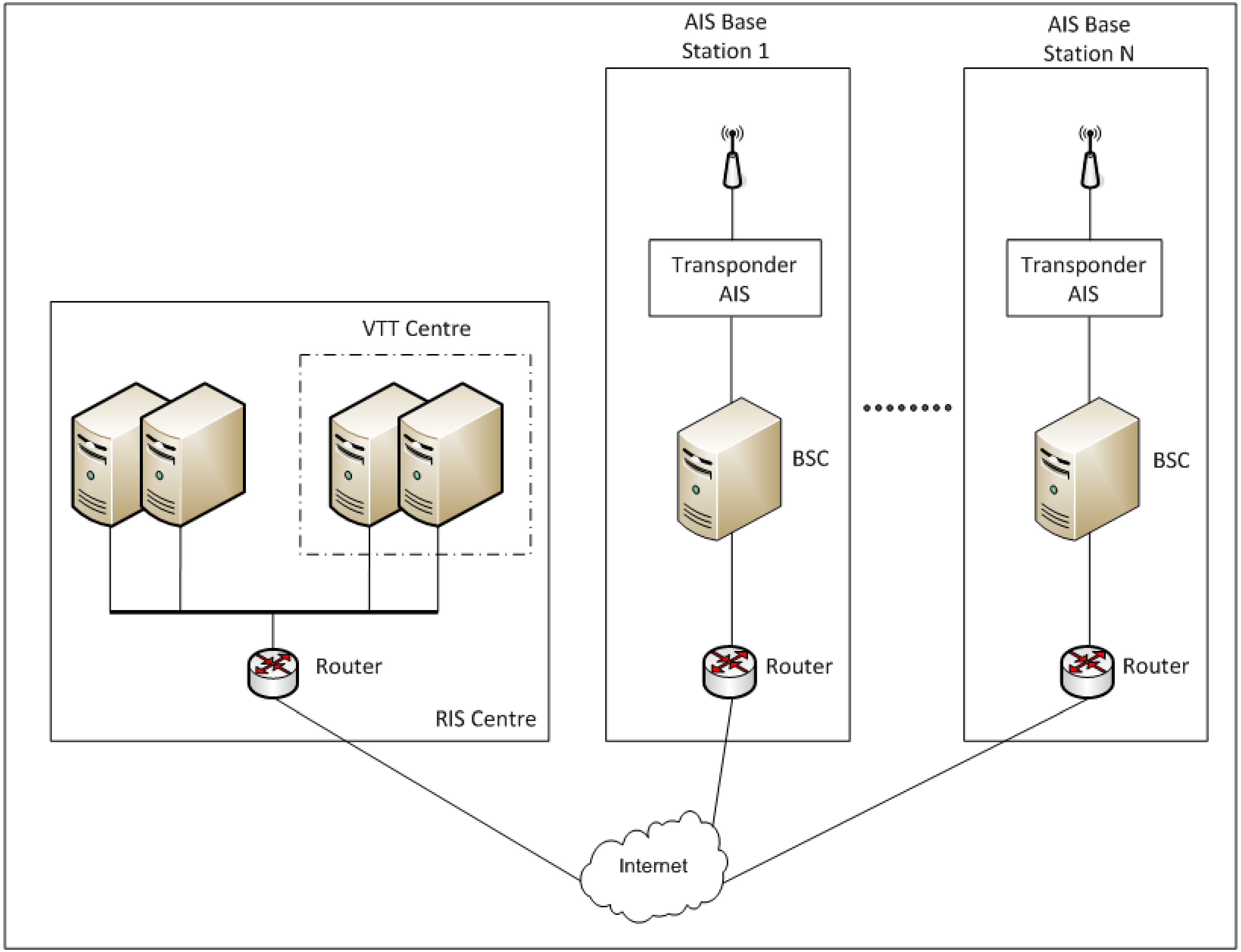
System to get a Strategic and Tactical Traffic Image using AIS technology with INLAND extension



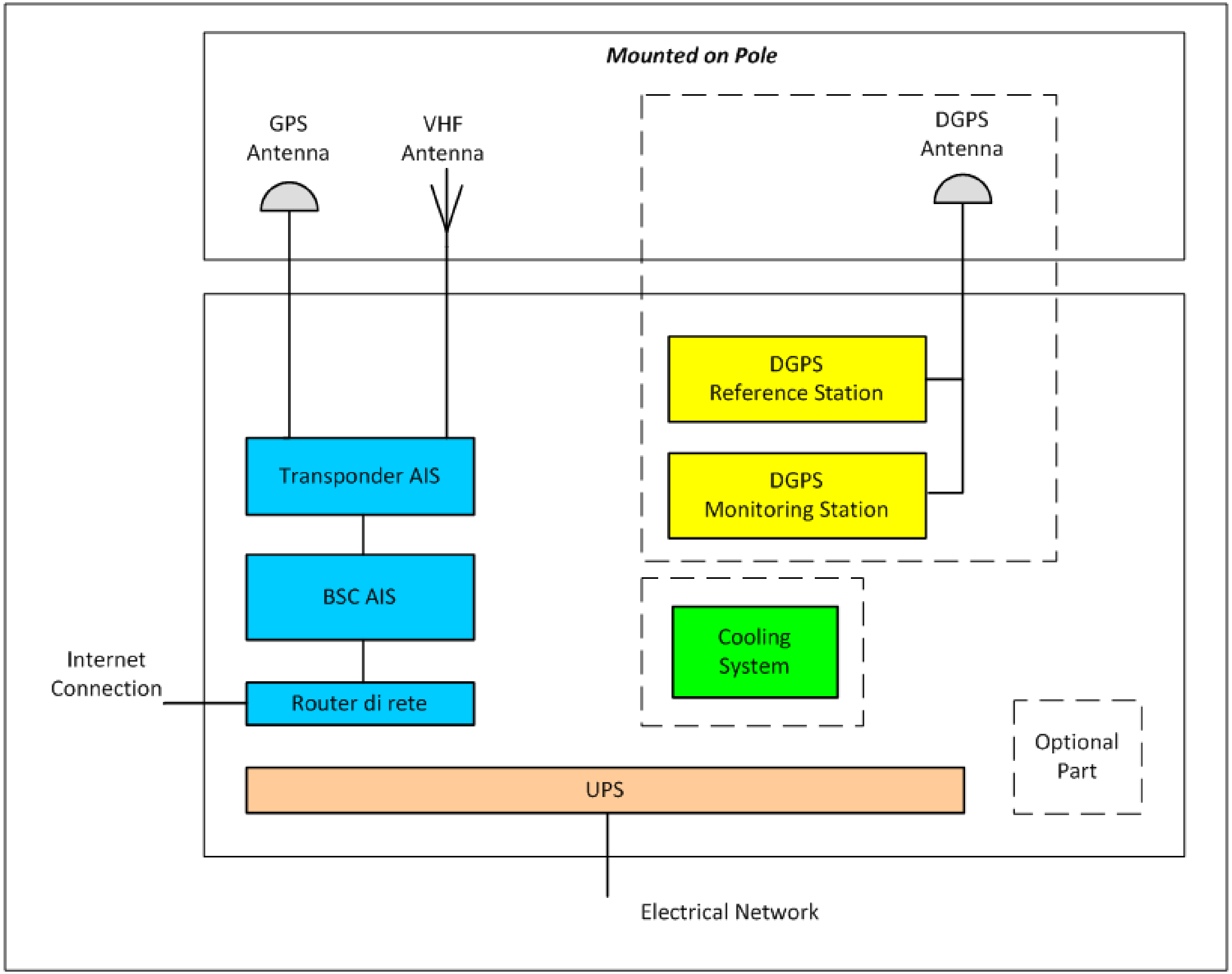
Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS display. AIS systems are meant to boost the safety of navigation by use from vessel-to-vessel alongside onshore Vessel Traffic Services (VTS) to trace and track vessels and to assist in calamity abatement.


Logistic User
(WEB Interface)
VTT Operator
VTT Centre
RIS Centre
Autority
(Land Workstation)
Internet
Onshore AIS Base Stations
AIS network
VHF
Ship 1
Ship 2
Ship 3
.....
Ship 4

AIS BASE STATION & RIS CENTRE
ONSHORE FACILITIES



AIS BASE STATION



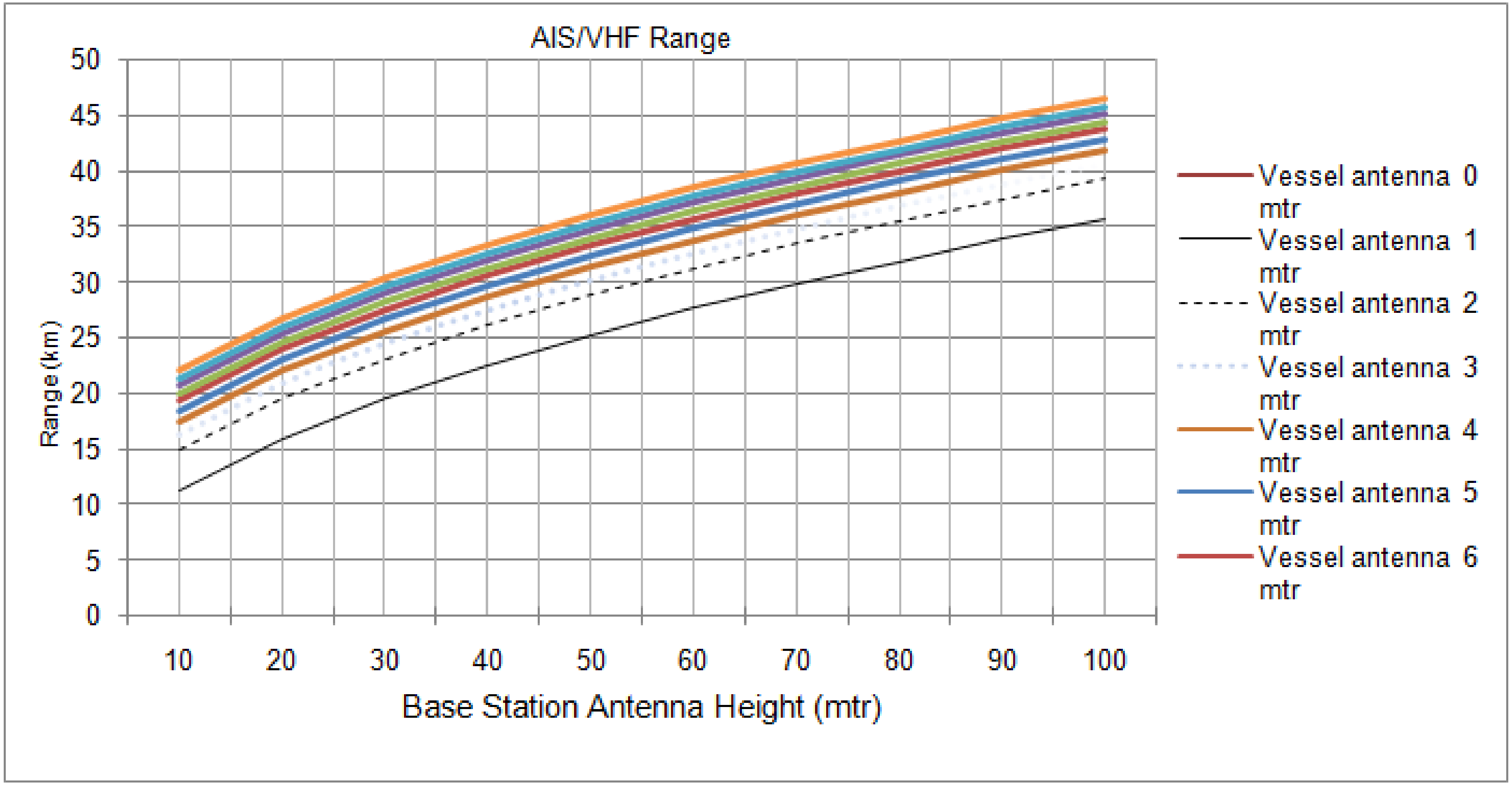
AIS STATION TOWER DESIGN

The type of tower depends upon the environment & also capable to carry Radar. Some of the examples are shown in the pictures

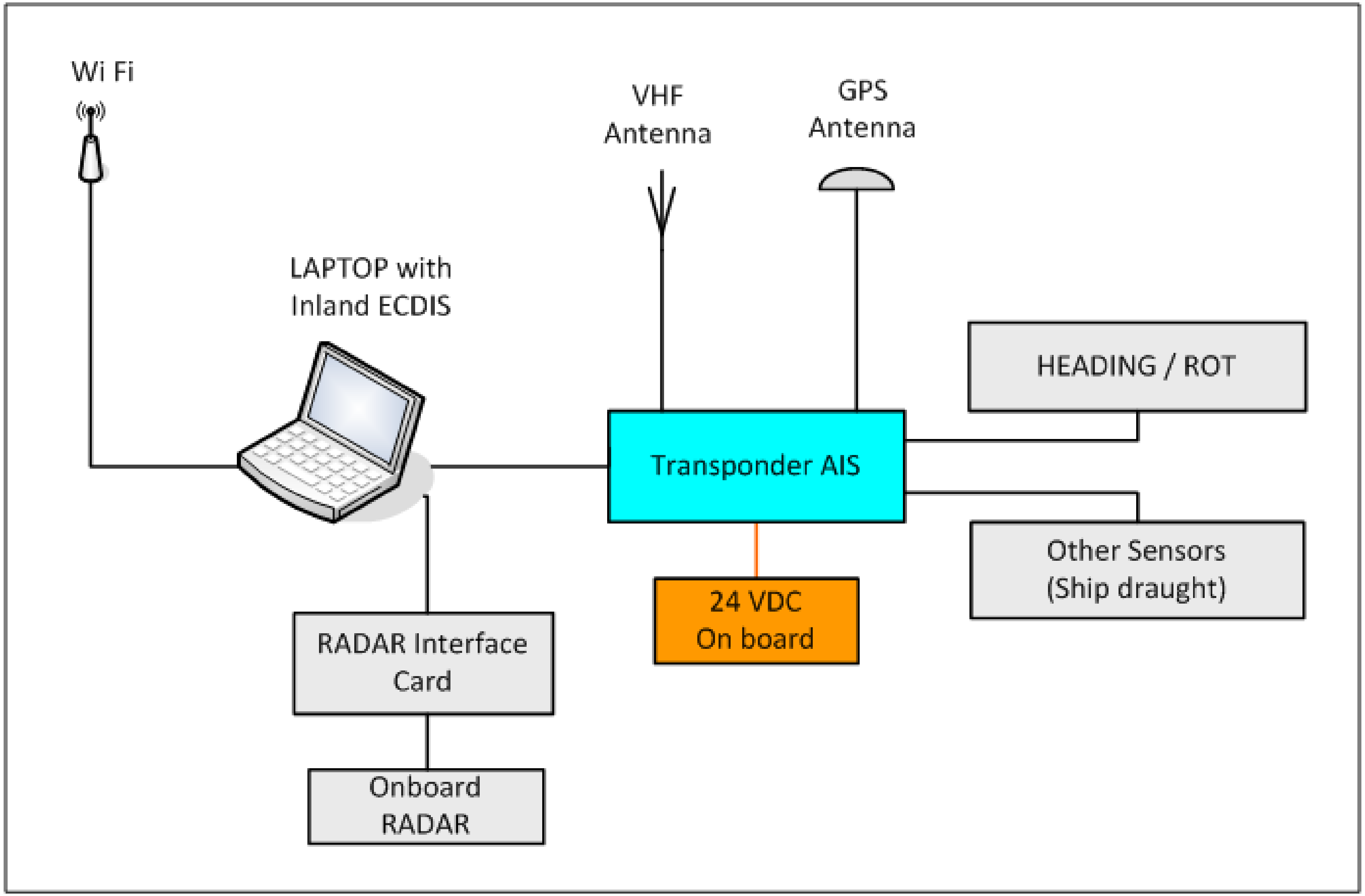
AIS STATION VHF RANGE

AIS/VHF Range												
Base Station antenna Height (mtr.)	Vessel Antenna Height	0	1	2	3	4	5	6	7	8	9	10
10		11.3	14.9	16.3	17.5	18.4	19.3	20	20.7	21.4	22	22.6
20		16	19.5	21	22.1	23.1	23.9	24.7	25.4	26.1	26.7	27.3
30		19.6	23.1	24.6	25.7	26.7	27.5	28.3	29	29.7	30.3	30.8
40		22.6	26.1	27.6	28.8	29.7	30.6	31.3	32	32.7	33.3	33.9
50	Range (km)	25.2	28.8	30.3	31.4	32.4	33.2	34	34.7	35.3	36	36.5
60		27.7	31.2	32.7	33.8	34.8	35.6	36.4	37.1	37.8	38.4	38.9
70		29.9	33.4	34.9	36.1	37	37.9	38.6	39.3	40	40.6	41.2
80		31.9	35.5	37	38.1	39.1	39.9	40.7	41.4	42	42.6	43.2
90		33.9	37.4	38.9	40.1	41	41.9	42.6	43.3	44	44.6	45.2
100		35.7	39.3	40.8	41.9	42.8	43.7	44.4	45.1	45.8	46.4	47

AIS STATION VHF RANGE

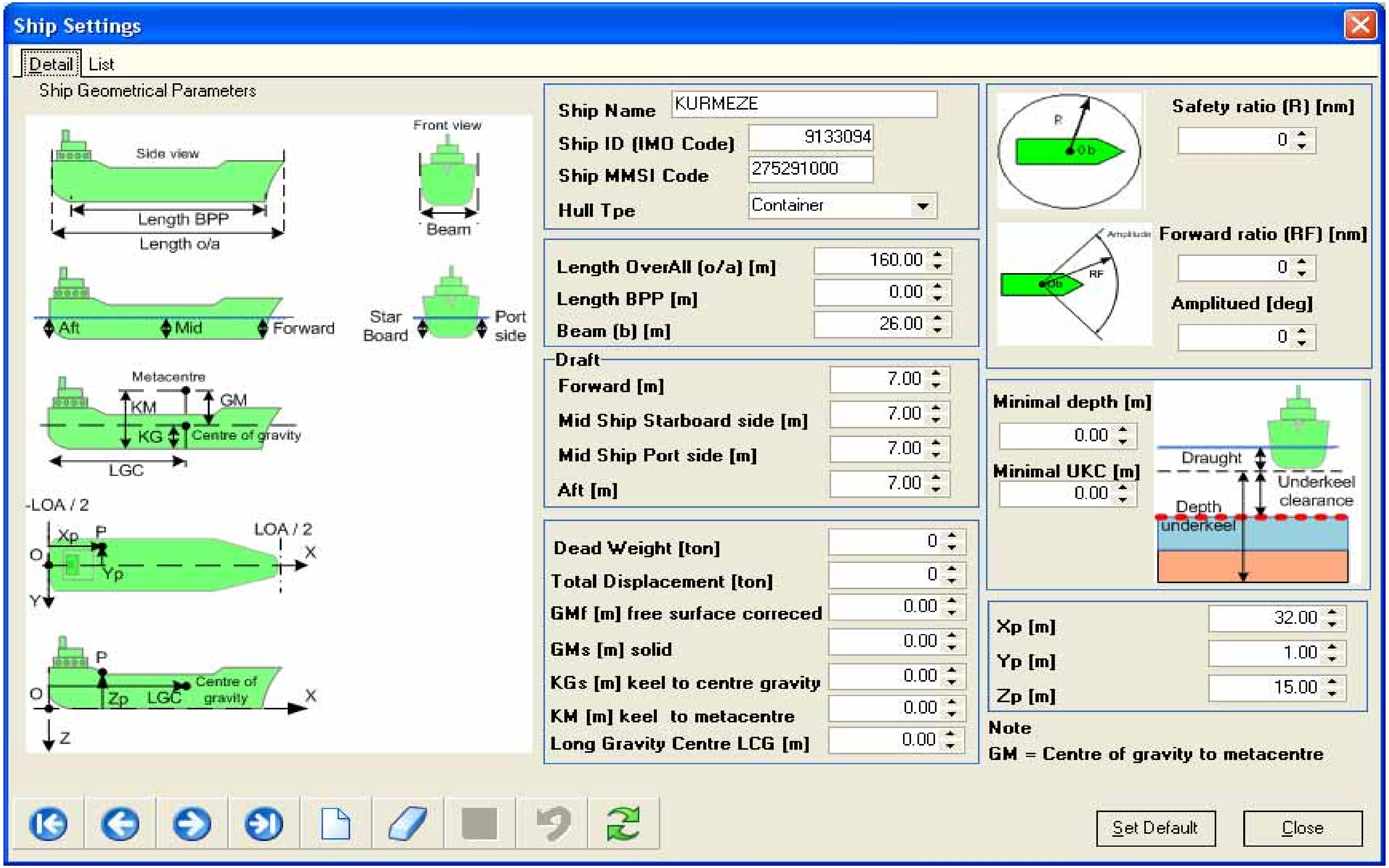


AIS ON BOARD DEVICE

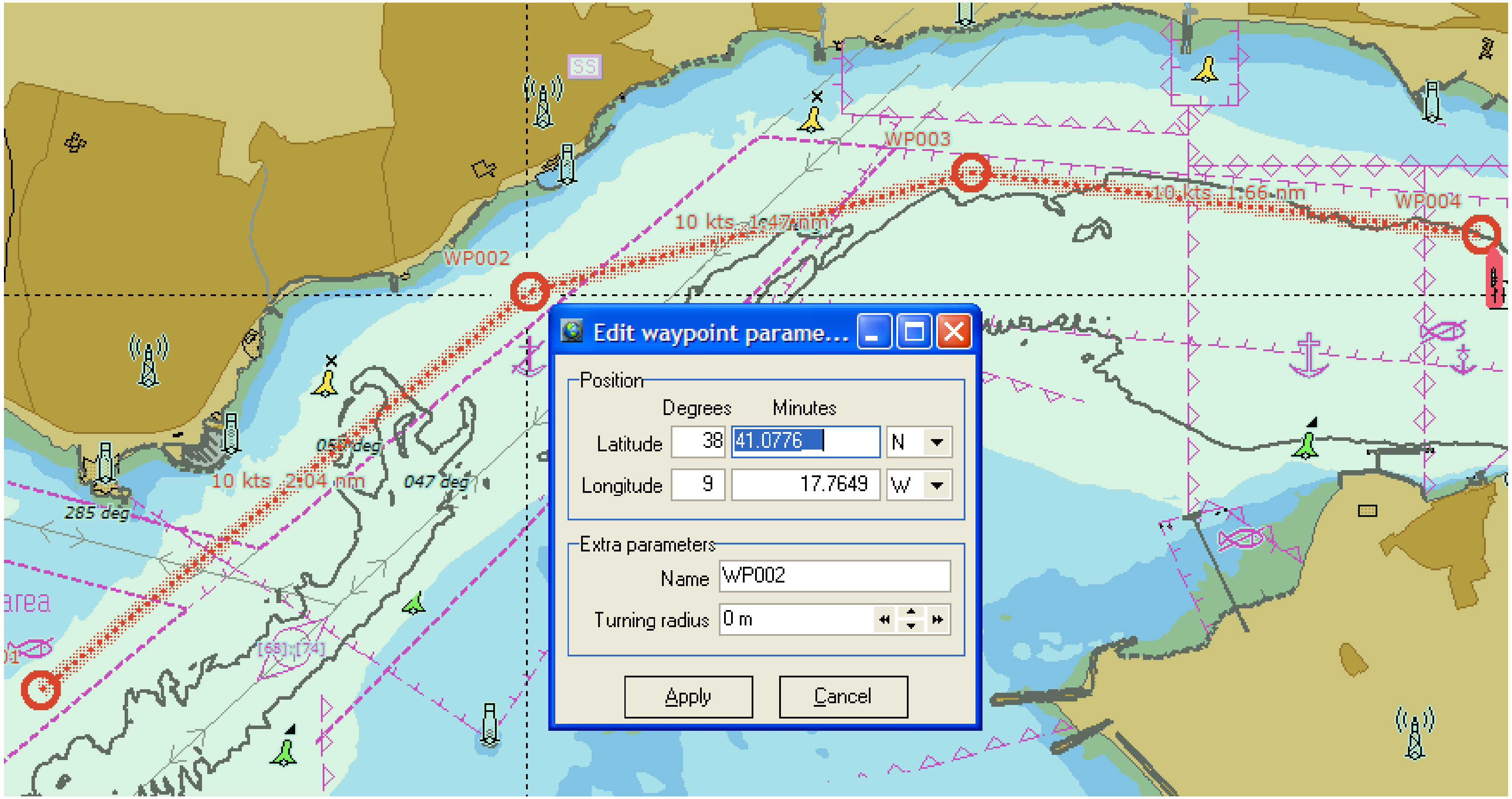


ONBOARD ECDIS INTERFACE

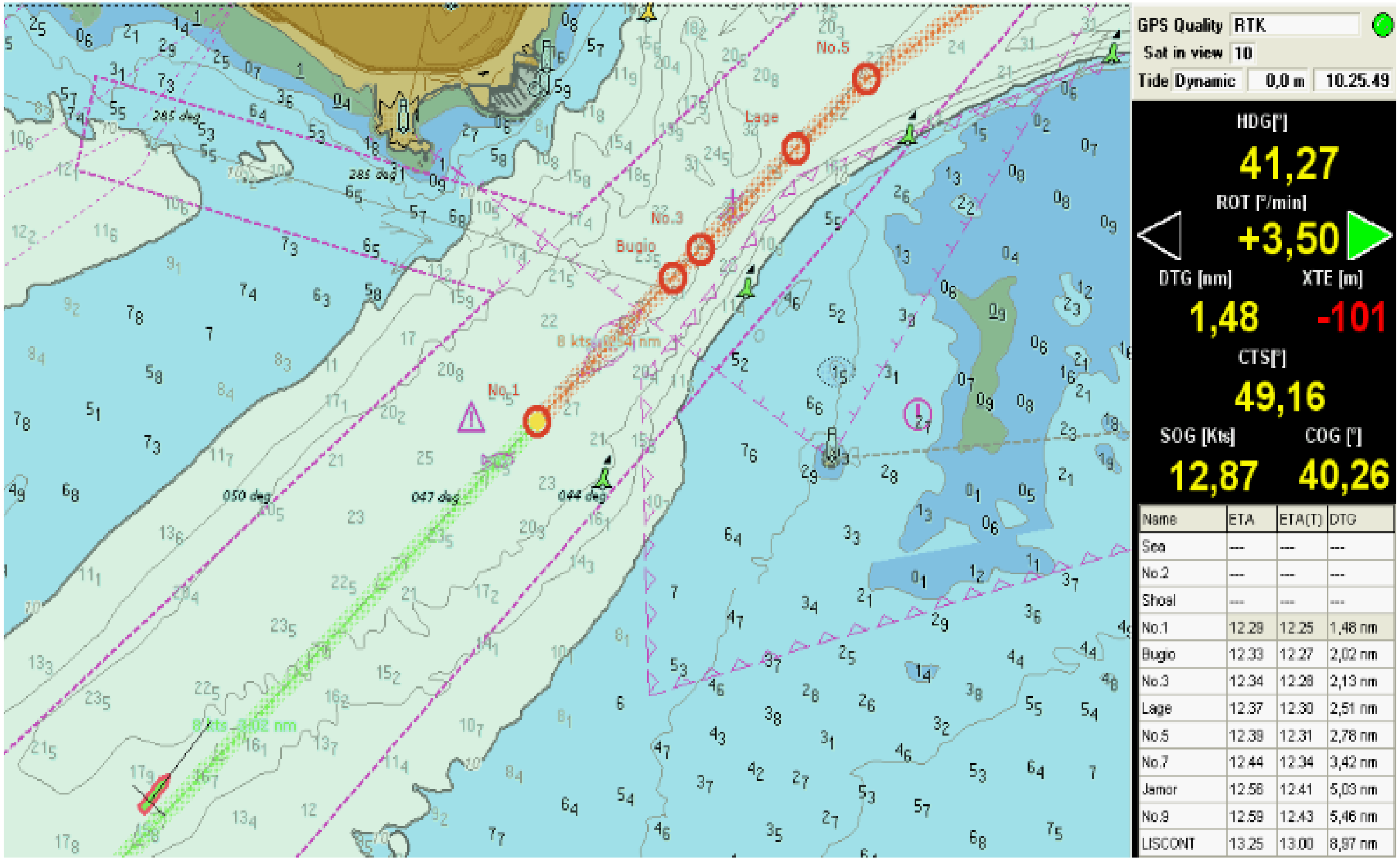
Interface to insert ship data



Interface to for voyage planning

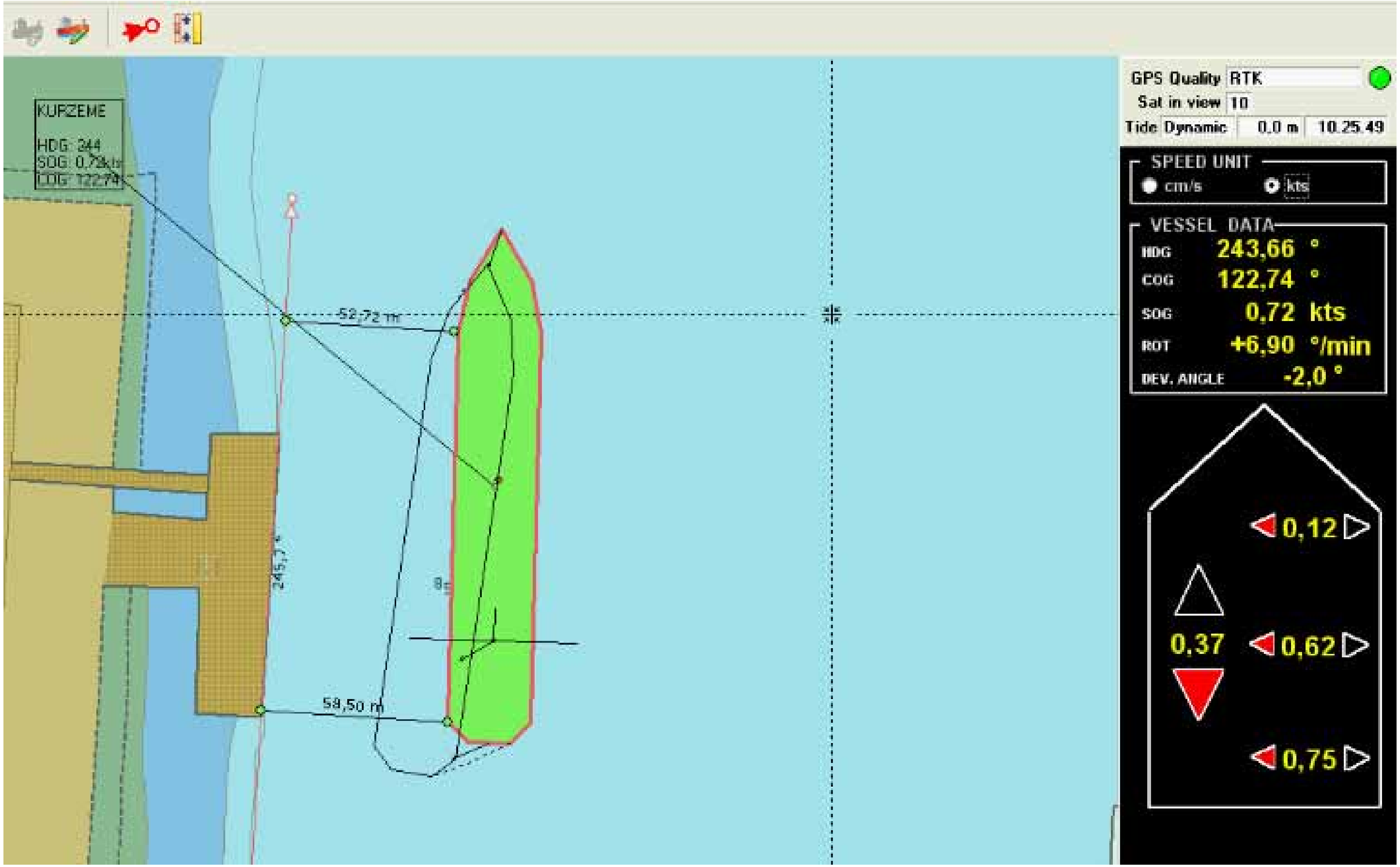


Interface in navigation mode

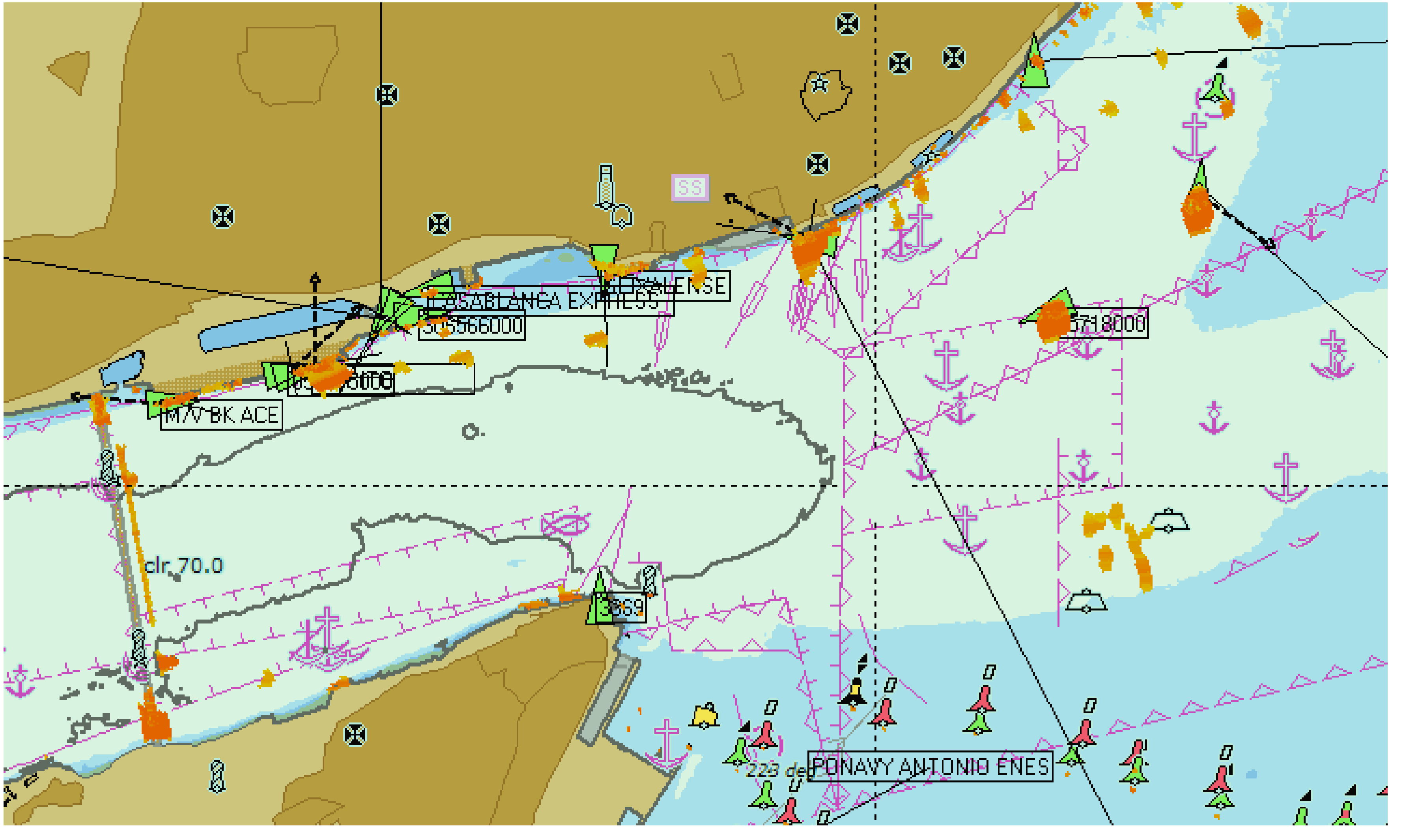


ONBOARD INTERFACE

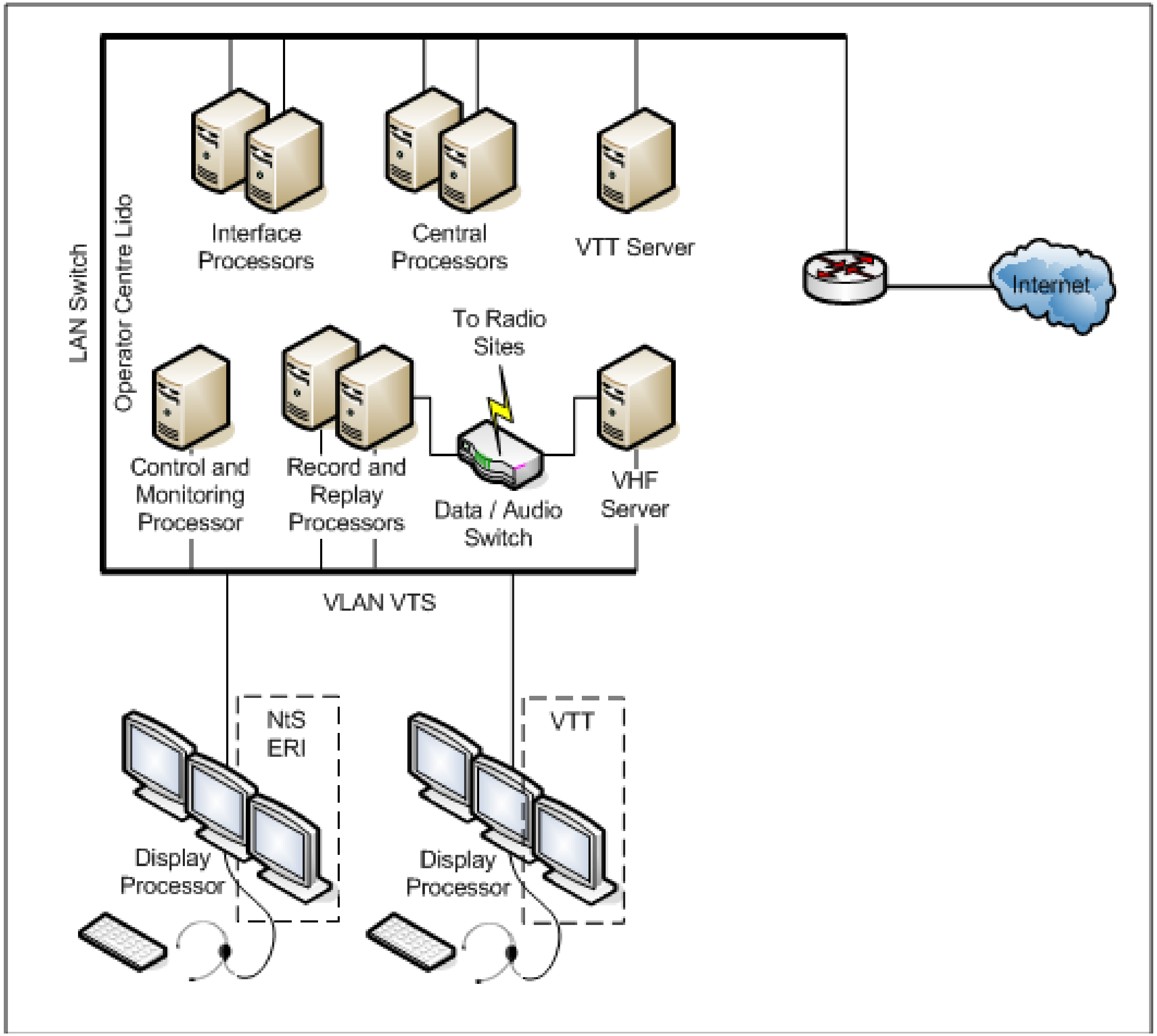
Interface for docking



Tactical Traffic Image + RADAR

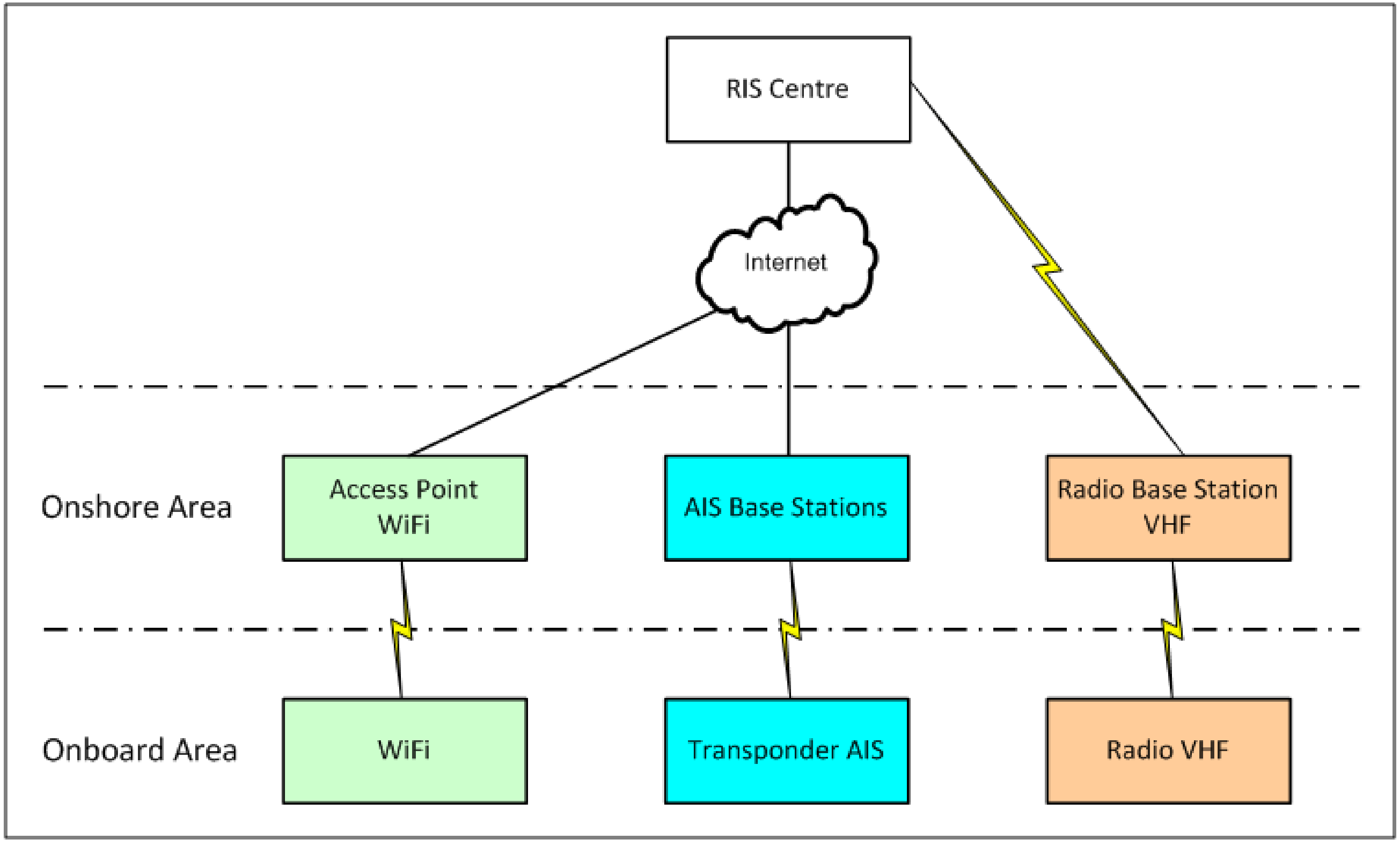


RIS CENTRE


Interface Processors
Central Processors
VTT Server
Internet
LAN Switch
Operator Centre Lido
To Radio Sites
Control and Monitoring Processor
Record and Replay Processors
Data / Audio Switch
VHF Server
VLAN VTS
NtS ERI
VTT
Display Processor
Display Processor

COMMUNICATION SEGMENTS

- **Voice**
- **AIS**
- **WiFi for Charts Update and WEB Interface**



MAIN ACTIVITIES

- VHF/WiFi Coverage Study of the Inland Area
- Identification of Location for WiFi Access Point
- Identification of Location of VHF voice base stations
- Detailed definition of Main VTT Functionalities
- Notice To Skipper for River Levels
- Instrumentation with Inland AIS class A of each ship
- Creation of Inland ECDIS-S57 Chart
- DGPG integration in AIS Base Stations for 10cm precision in ships location (RTCM via AIS Msg. 17)
- Integration with Local Level and Meteo Monitoring Systems ?
- Lock/Bridge/Terminal Management ?

BILL OF MATERIAL

Onboard Vessel composed of

- AIS Transponder+ VHF

Onshore Area composed of

- AIS Base Stations + Controller + radio base VHF (voice)

1 RIS Centre Composed of

- Workstations with Data management software

ANNEXURE 9.1– LETTER OF MoEFCC

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

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

Dated: 21st December, 2017.

OFFICE MEMORANDUM

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

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

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

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

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

21/12/17

Sharath Kumar Pallerla
Director

To

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

ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Operate' shall be obtained from State Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.

ii. The project authority shall ensure that no rivers or tributaries are blocked due to any activities at the project site and free flow of water is maintained.

iii. Shoreline shall not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary.

iv. Dredging shall not be carried out during the fish/turtle breeding seasons.

v. All vessels used in the river will be fitted with noise control and animal exclusion devices so that aquatic life is not unduly disturbed.

vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.

vii. Construction waste including debris shall be disposed safely in the designated areas and in no case shall be disposed in the aquatic environment.

viii. Vessels shall not discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil

ix. The project authority shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.

x. All vessels will also have to comply with 'zero discharge' standards to prevent solid or liquid waste from flowing into the river and affecting its biodiversity.

xi. The dredging shall be carried by integrated and systematic planning by selective grid method by allowing migratory movement of Benthic fauna.

xii. All required Noise and vibration control measures are to be adopted in Dredgers. Cutter section Dredgers should be avoided as much as possible which produces more noise and vibration. No Drilling and Blasting is to be carried out.

xiii. Pre geo-tectonic studies has to be completed and the strata to be dredged is predetermined with complete data pertaining to hardness, compressive and tensile strengths.

xiv. Dredger type and other strata loosening methods shall be preconceived.

xv. Staggered dredging shall be carried based on turbidity monitoring to minimise the impact of turbidity.

xvi. Threshold level of turbidity, which has a minimal effect on fauna, has to be predetermined and Dredging planned accordingly.

xvii. Further silt screens needs to be used for minimising the spread of Turbidity.

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

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

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

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

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

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

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

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

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

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

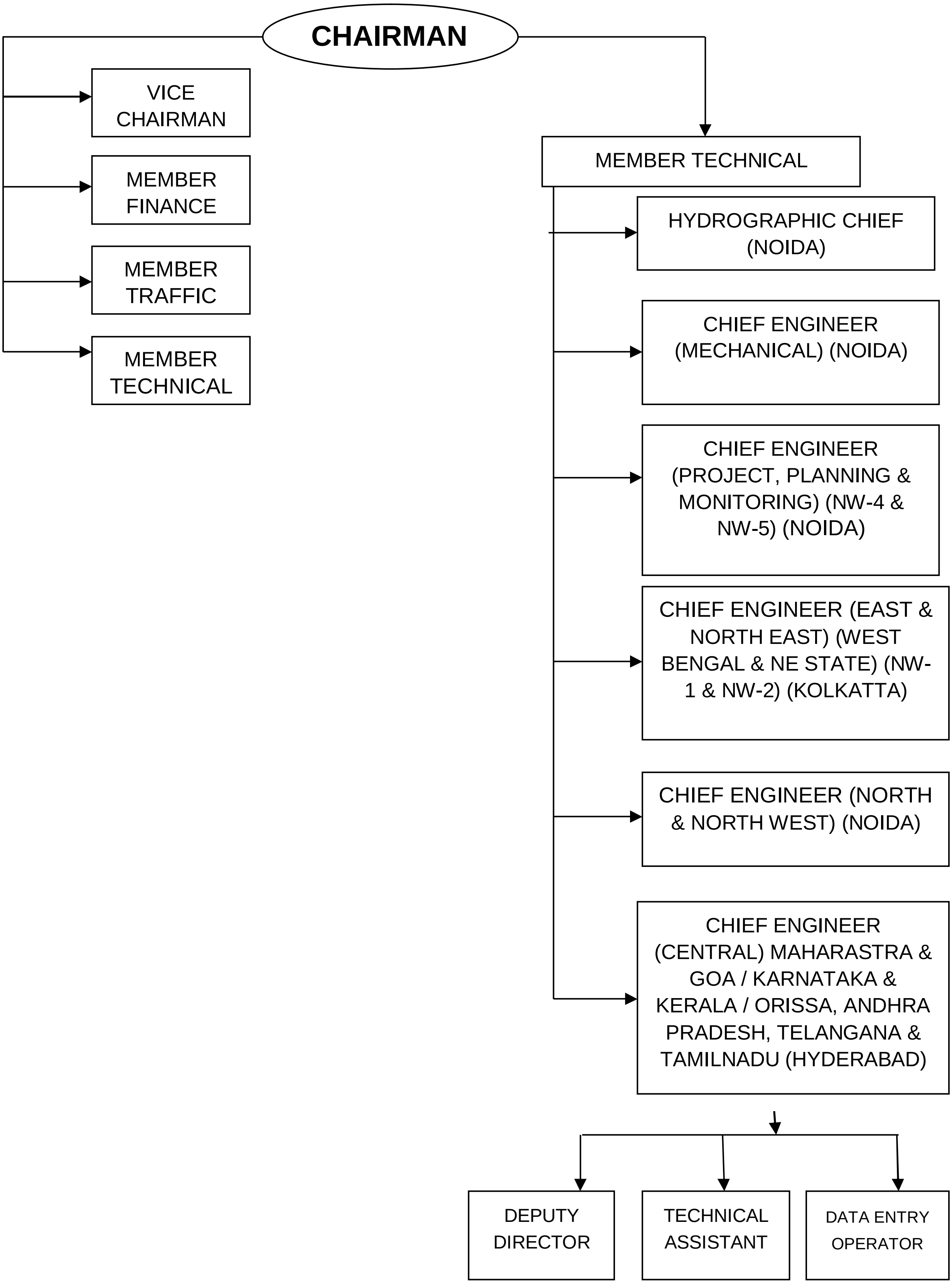
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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

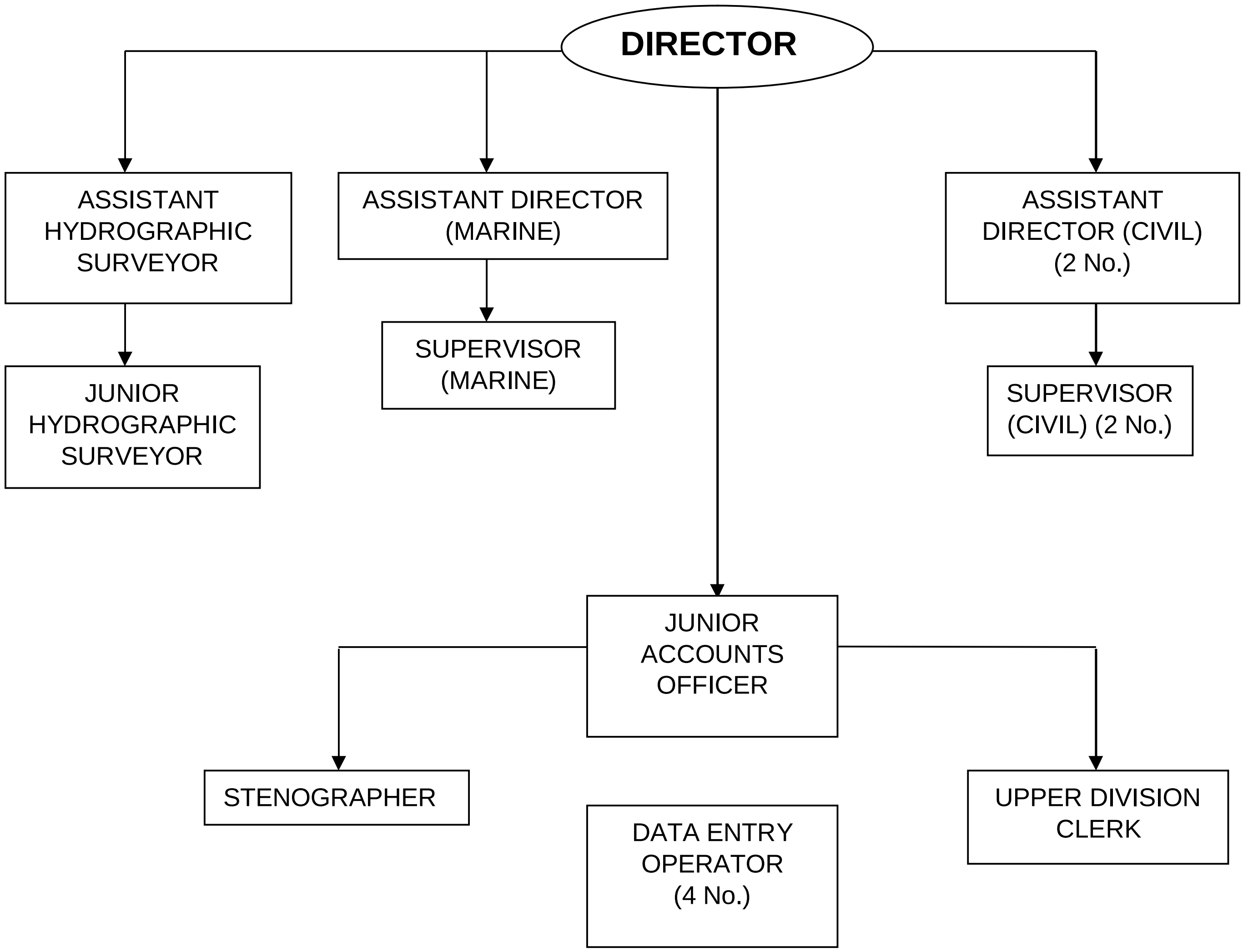
21/12/17

Sharath Kumar Pallerla
Director

ANNEXURE 10.1– INSTITUTIONAL REQUIREMENT HEAD OFFICE COMPONENTS



ANNEXURE 10.2– INSTITUTIONAL REQUIREMENT IN MAHARASTRA AND GOA



ANNEXURE 11.1 – COSTING/FINANCIAL ASSUMPTIONS

FINANCIAL ANALYSIS

Broad Assumptions

Based on Financial Analysis as per DPR of NW5

Abstract

Broadly identified assumptions in order to facilitate financial analysis of Category II shortlisted waterways development

Inland Waterways Authority of India

FINANCIAL ANALYSIS BROAD ASSUMPTIONS[1]:

<u>Capital Expenditure:</u>

Elements to be covered (based on planned infrastructure requirement for respective rivers)

Suitable assumptions with relevant justification shall be made for any missing items.

CAPEX HEAD	TOTAL COST (INR CRORE)
Land Acquisition	Cost initially to be considered for acquisition of land for land side development of floating jetty
Dredging	**<u>Normal Condition</u>** Standard dredging rate of Rs. 200/cum to be considered. Suitable adjustments shall be made (with proper justification) for change in quality of dredge material/any special requirement for disposal of dredge material
Barrages with Navigational Locks	Based on requirement standard charges as per Planned Infrastructure of respective rivers.
Raising Banks	
Protection Measures	
Environmental Monitoring	
Navigational Aids	
Bridges	
Cross Drainage Works	
Facilities to Local People	
Terminals	Initially while calculating CAPEX terminal cost shall include cost for development of required numbers of floating jetty along respective waterways, cost of equipment, manpower required for terminal operation
Total Capital Expenditure	**Sum of all parameters mentioned above**
DC, PMC, IE Services, Loan Fees	10% of Total CAPEX
Overall Contingency	3% of Total CAPEX
Escalation	1.5% of Total CAPEX
Total Hard Capex	
Interest During Construction	
Total Project Cost	

<u>Operations & Maintenance Expenditure:</u>

(Pick up the cost items relevant to your study and planned infrastructure components)

Suitable assumptions with relevant justification shall be made for any missing items.

Annual Escalation shall be assumed @ 5.0%.

[1] These assumptions are to facilitate consultants in giving a sense of direction in which they shall move to make the reporting of final outcome consistent. Any missing information shall be assumed suitably (with valid justification) by the consultants in order to provide desired end result.

Cost Items	% of CAPEX
Dredging	5%
Cross Drainage	2%
Locks	2%
Bridges	1%
Terminals	2%
Navigation Aids	2%
Protection Measures	2%
Raising Banks	2%
Facility to Local People for Ferry Services	2%
Environmental Monitoring	2%
Cost of Barrages with Navigation Locks	2%
Total Waterway O&M Costs	

Revenue Estimation:

For estimating the revenue, the tariff structure proposed by IWAI (Levy & Collection of fees and charges) Regulations, 2011 shall be used as a reference.

Existing Tariff Structure & Charges by IWAI (Shall be verified from the latest published Tariffs)

Suitable assumptions with relevant justification shall be made for any missing items.

Tariff Heads	Charge unit	Charges (INR)
(A) Usage Charges		
Movement of Vessels	GRT/km	0.02
(B) Vessel related charges		
Berthing charges	Vessel	1000.00
Towage	Vessel/hour	600.00
Pilotage	Day	750.00
(C) Cargo related charges		
(i) Terminal Charges		
Dry Cargo	Ton (or part thereof)	1.00
Liquid Cargo	Ton (or part thereof)	1.00
Containerised Cargo	TEU	50.00
(ii) Transit shed charges		
First 3 days	MT per day	
First 7 days	MT per day	
7-21 days	MT per day	5.00
22-35 days	MT per day	10.00
After 35 days	MT per day	40.00
(iii) Open storage charges		
Hard Stand		
First 3 days	MT per day	
First 7 days	MT per day	0.00
7-21 days	MT per day	2.00
22-35 days	MT per day	4.00
After 35 days	MT per day	16.00
On Open Area		
First 3 days	MT per day	

Tariff Heads	Charge unit	Charges (INR)
First 7 days	MT per day	0.00
7-21 days	MT per day	1.00
22-35 days	MT per day	2.00
After 35 days	MT per day	8.00
(D) Composite Charges		
Movement of Over Dimensional Cargo	Per MT per km	1.50
Customs clearance convenience charges	Per MT	40.00
(E) Miscellaneous charges		
Crane, fork lift, bunkering of fuel, water supply, etc.	Of total revenue	
Crane (including Pontoon crane)		
5 MT capacity Crane	Per shift of 8 hrs	800.00
20 MT capacity Crane	Per shift of 8 hrs	2000.00
>20 MT capacity Crane	Per shift of 8 hrs	2500.00
Container Crane	Per hr	1100.00
Fork Lift (3MT capacity)	Per shift of 8 hrs	600.00
Electricity supply to Vessels		As per Electricity Board
Bunkering of fuel/ Petroleum Oil Lubricants		As per Market Rates
Water Supply	Per km	300.00
Sewage Disposal	Per km	100.00
Weighing scale	Per MT	5.00

In order to estimate the effective charge that the end users are expected to face, it is assumed that the margin charged by barge operators is Rs. 1.20 per MT per km.

FINANCING

The financing parameters considered for the study are as follows:

Suitable assumptions with relevant justification shall be made for any missing items.

Item	Unit	Value
Leverage Ratio	% Debt	70%
Moratorium	Quarters	2
Door-to-door Tenor	Years	15
Interest Rate	%	8%
Debt Drawal Start Quarter	No.	1
Debt Repayment Start Quarter	No.	22
Debt Repayment End Quarter	No.	60
Discount Rate (For NPV calculations)	%	16%

OTHER ASSUMPTIONS

Suitable assumptions with relevant justification shall be made for any missing items.

Tax Rate Assumptions

Type of Tax	Rate
Corporate Income Tax Rate	34.61%
Minimum Alternate Tax Rate	21.34%

Final IRR Reporting:

The consultant shall report the Project FIRR & EIRR considering different scenarios. Broadly the sensitivity shall include (but not limited to) following parameters as variable:

- Traffic (15-20% ± of projected divertible cargo, as at this stage the divertible cargo potential)
- Development Cost (15-20% ± of planned cost)
- Leverage Ratio (70:30 in base case, 10-15% ± in optimistic & pessimistic scenarios)

ANNEXURE 11.2 –COST OF DREDGING

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	100,000	300	300.00
2	Dredging in Hard Soil	Cum	0	900	0.00
	Total Cost of Dredging				**300.00**

INR 200/ per Cu. M + 20 % for escalation + 30 % for Managing the disposal
Considered 3 times over the General Soil, keeping in view the hardness observed in the site.

ANNEXURE 11.3 –COST OF BANK PROTECTION WORKS AT RIVER

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	17400	3231.30	562.25	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	11380	354.44	40.34	DSR 2016, Cl.no. 22.20 15% reduction in rate due to market rate status
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	500	2700.00	13.50	Market Rate
	Cost of Bank Protection Works for 500 m				616.08	
	Cost of Bank Protection Works for 1 m				1.23	
	Cost of Bank Protection Works for 3000 m for 6 locations				**3696.49**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.4 –COST OF NIGHT NAVIGATION WORKS

Phase I: Beacon & Lights

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Land Area Cost	Sq.m	25	1,120	0.28
2	Lattice bridge structure	No.	1	865,000	8.65
3	Lattice bridge structure Foundation)				
3-a	RCC (Cement) 3.5 m x 3.5 m x 2.5 m	Cu. M	31	7,949	2.43
3-b	RCC (Steel) @ 3.3 Kg / Cu. M	Kg	101	7,850	7.93
4	Lighting equipment	No.	1	35,500	0.36
					19.65
	Cost of Night Navigation Works		**7**		**137.58**

Phase II: Buoy & Lights

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	45	336,250	151.31
	Cost of Night Navigation Works				**151.31**

Rates based on Quotation / Market Rates

ANNEXURE 11.5 –COST OF LAND FOR LO-LO

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Land Area Cost				
(i)	Land inside the terminal area	m2	32000.00	1120.00	358.40
(ii)	Land required for Road Extension or construction of external approach road	m2	9750.00	1120.00	109.20
(iii)	area under Mangrooves clearance	m2	8000.00	1120.00	89.60
(iv)	Boundary wall 250 mm thk brick masonary (1:6) surrounding the entire terminal on 3 sides except RORO and LOLO side	m2	640.00	1120.00	7.17
2	Filling & compaction Cost	m3	80000.00	197.40	157.92
	Total Cost of Land				**722.29**

Rate As Rs.39 lakh per Acre.

1 Acre = 4047 m2

1120.00 Rs. Amount for 1 m2 land

ANNEXURE 11.6 –COST OF RIVERRINE STRUCTURES AT MAPUSA-MOIDE RIVER LO-LO FACILITY

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1.0	**RCC Concrete Works (M40 grade concrete)**					
	CONCRETE - Reinforced Cement Concrete of specified Grade M40 in different structural members above pile cut-off level.					
1.1	Providing and laying Vertical M40 Grade Concrete Piles of 1.3 m diameter					
	Vertical Piles					
	Grid A	No	9			
	Grid B	No	9			
	Grid C	No	9			
	Grid D	No	9			
	Grid E	No	9			
	Total Piles	cu.m	1,493			
1.2	Pile Caps (1800x1800x1000)	cu.m	145.80			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	93.75			
	Grid A1	cu.m	93.75			
	Grid B	cu.m	93.75			
	Grid B1	cu.m	93.75			
	Grid C	cu.m	93.75			
	Grid C1	cu.m	93.75			
	Grid D	cu.m	93.75			
	Grid D1	cu.m	93.75			
	Grid E	cu.m	93.75			
1.4	Cross Beams (1800x1800)					
	grid 1 to 9	cu.m	785.86			
1.5	Deck Slab	Cu.m	840.00			

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
	Total Concrete	**Cu. m**	**4108.65**	7948.89	326.59	DSR 2016, Cl.no. 5.33.1 & 5.34.3
2.0	**Steel Reinforcement**					
	REINFORCEMENT - High yield strength deformed bars Reinforcement Grade Fe500 in reinforcing cage including ring bars as detailed on the drawings					
2.1	Piles 1.3 dia	MT	223.99			
2.2	Pile Caps (1800x1800x1000)	MT	11.66			
2.3	Longitudinal Beams (1000x1250)					
	Grid A	MT	16.88			
	Grid A1	MT	16.88			
	Grid B	MT	16.88			
	Grid B1	MT	16.88			
	Grid C	MT	16.88			
	GridC1	MT	16.88			
	Grid D	MT	16.88			
	Grid D1	MT	16.88			
	Grid E	MT	16.88			
2.4	Cross Beams (18000x1800)					
	grid 1 to 9	MT	141.46			
2.5	Deck Slab	MT	100.80			
	Total Reinforcement	**MT**	**630**	70350.83	443.06	DSR 2016, Cl.no.5.22.4
3.0	**Structural Steel works**					
3.1	Structural Steel hand rail with steel grade Fy=240 Mpa	MT	120	66,000	79.20	DSR 2016, Cl.no.10.2
4.0	**Bollards**					

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
	Supply and fix in position cast steel bollards of working loads capacity of 40 ton, twin horn type of approved make, including galvanized holding down bolts, nuts, washers (80microns zinc coating) and painting as per specification and drawings complete.	MT	5	82,500	4.13	As per Market rate
5.0	**Fenders**					
	Supply and fix in position fender system in the rear side of jetty structure from an approved manufacturer meeting the berthing energy absorption and reaction forces requirements given in technical specification and drawings for the following type of fenders. The rate include design, supply, installation, testing and commissioning of fenders and necessary fixtures such as chains, U bolts, fasteners etc., complete.	LS			50.00	
	Total cost of Mapusa Riverrine Structures at LOLO Terminal				**903**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.7 –COST OF STRUCTURES AT TERMINAL

S.No.	Facility	Nos.	Size	Area (in m2)	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Open Storage Area	1	200m x 100m	20000	5,934	1,186.75
2	Covered Storage Godown (Nominal)**	1	50m x 30m	1500	17,801	267.02
3	40' Container Stack Yard		40mx20m	800	8,901	71.21
4	Parking for Handling equipments	1	30m x 15m	450	1,333	6.00
5	Main Parking Area	1	30m x 30m	900	1,010	9.09
6	Public Utility	1	6m x 4m	24	29441.54	7.07
7	Weigh bridge	1	8m x 3m	24	250000	60.00
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9	29441.54	2.65
9	Bank Protection					
10	Area under internal Roads	1	7.5m x 351m	2632.5	15000	52.65
11	Administration building	1	12 m x 15 m	180	37860.29	68.15
12	Business Area	1	10m x 3m	30	37860.29	11.36
13	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1332.65	1.08
14	Staff Parking Area-2 wheelers	1	8m x 2m	16	1446.50	0.23
15	Security shed for watch and ward	2	4m x 4m	32	4029	1.29
16	Electrical facility	1	5m x 5m	25	14087	3.52
17	Fuel Bunkers	1	10m x 5m	50	5555.56	2.78
18	Water Supply Room	1	3m x 4m	12	14,170	1.70
19	Fire and Safety Room	1	3m x 4m	12	18337	2.20
20	DGPS receiver & transmitter shed	1	8m x 4m	32	6824.75	2.18
21	DG shed	1	5m x 5m	25	6643.5	1.66
22	Canteen with Store	1	12m x 8m	96	13629.69	13.08
23	Sewerage Treatment Plant (STP)	1	15m x 15m	225	12437	27.98
24	Overhead Tank	1	10m dia	100	1923.08	1.92
25	Green Area	1		1000	800	8.00
26	Future Requirement	1		2000	600	12.00
	Total cost of Other Components					**1,821.57**

* Rates worked out based on the DSR rates duly considering related items.
Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

** The requirement is to be critically examined, in detail at implementation stage and provisioned accordingly.

ANNEXURE 11.8 –COST OF APPROACH (EXTERNAL) ROADS

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	External Roads				
(i)	Pacca Road (7.5m wide road)	m	1300.00	1985	25.80
2	Pipe Culvert on External Road			LS	3.50
	Total Cost of Approach (External) Roads				**29.30**

Unit cost for the apportioned portion has been considered.

* Rates worked out based on the DSR rates duly considering related items.

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.9 –COST OF BANK PROTECTION WORKS AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	11880	3231.30	383.88	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	7560	358.94	27.14	DSR 2016, Cl.no. 22.20, 15% reduction in rate due to market rate status
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	460	2700.00	12.42	Market Rate
	Cost of Bank Protection Works				**423.43**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

MAPUSA RIVER

Sl.No.	Items	Phase 1 (12 Months)																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils (Approval & Tendering)																																				
	Ordinary Soils																																				
	1.b) Dredging																																				
	Hard Soils (Approval & Tendering)																																				
	Hard Soils																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (NIL)																																				
	4. Night Navigation																																				
	Beacon/ Lights (Approval & Tendering)																																				
	Beacon / Lights (7 Nos)																																				
	5. Land Acquisition (No land acquisition for fairway)																																				
B	**Modification of Structures (NIL)**																																				
C	**Communication System (NIL)**																																				
D	**Institutional Requirement**																																				
	Office / Manpower (Establishment & Recruittment)																																				
	Office / Manpower (Deployment)																																				
	Vessels (Approvals & Tendering)																																				
	Vessels (Procurement & Deployment of 2 SLs; 2 Tugs; 2 IBs)																																				
E	**Environmental Management Plan**																																				
		Phase 2 (36 Months Commencing 2030)																																			
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils (Approvals & Tendering)																																				
	Ordinary Soils (Execution of 1,00,000 Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils (Approvals & Tendering)																																				
	Hard Soils																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Approval & Tendering)																																				
	River Training Works/ Bank Protection (3000 m @ 5 Locations)																																				
	4. Night Navigation																																				
	Buoy/ Lights (Approval & Tendering)																																				
	Buoy / Lights (45 Nos)																																				

*Phase 2 implementation will be from 2030 (36 months) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for immediate implementation.

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE LO-LO

MAPUSA RIVER

Sl.No.	Items	Phase 2 (36 Months Commencing 2030)																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	**Lo - Lo Terminal (Phase 2)***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
	Infrastructure Components internal roads (Execution)																																				
	Approach Road Cost																																				
	Bank Protection Works for terminal (Approvals & Tendering)																																				
	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	1 No. Ambulance																																				
	2 Nos. Cranes with 125 T Capacity																																				
	2 Nos. Fork lift trucks 20 T Capacity																																				
	Environmental Management Plan																																				
	Vessels																																				
B	**Ro - Ro Terminal (Phase 2)***																																				
	Land Acuisition (Should be completed by 2030)																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
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	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	Ambulance - 0 no.																																				
	Cranes with 125 T Capacity - 0 no.																																				
	Fork lift trucks 20 T Capacity - 0 no.																																				
	Environmental Management Plan																																				
	Vessels																																				
	4. Night Navigation																																				

*Phase 2 implementation will be from 2030 (36 month) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for immediate implementation.

LIST OF DRAWINGS

Sl.No	DRAWING NAME	DRAWING NUMBER
1.	LAYOUT PLAN OF MAPUSA-MOIDE RIVER (3 SHEETS)	P.010257-W-20301-A02
2.	TERMINAL LOCATION MAP OF MAPUSA-MOIDE RIVER (1 SHEET)	P.010257-W-20351-X02
3.	TERMINAL LAYOUT PLAN (WITH PROPOSED INFRASTRUCTURE FACILITY (1 SHEET)	P.010257-W-20311-A02
4.	LO-LO TERMINAL PLAN (1 SHEET)	P.010257-W-20341-E02
5.	BANK PROTECTION TYPICAL SECTION (1 SHEET)	P.010257-W-20303-X02

LIST OF VOLUMES

VOLUME-I MAIN REPORT

VOLUME-II DRAWINGS

VOLUME-IIIA HYDROGRAPHIC SURVEY REPORT

VOLUME-IIIB HYDROGRAPHIC SURVEY CHARTS

VOLUME-IV GEO-TECHNICAL INVESTIGATION REPORT