TRACTEBEL ENGINEERING pvt. ltd.
Intec House
37, Institutional Area, Sector 44
Gurgaon 122 002 (Haryana) – INDIA
tel. +91 124 469 85 00 - fax +91 124 469 85 86
engineering-in@tractebel.engie.com
tractebel-engie.com

DPR – REVADANDA CREEK/KUNDALIKA RIVER (30.736KM) NW-85

Our ref.: **P.010257-W-10305-005**

Imputation: P.010257

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 – REVADANDA CREEK/ KUNDALIKA RIVER (30.736KM) NW-85**

Comments:

Revision No.	Date	Prepared / Revision By	Description
01	2019 05 07	Bidhan Chandra JHA	Final Submission

REV.	YY/MM/DD	STAT.	WRITTEN	VERIFIED	APPROVED	VALIDATED
01	19/05/07	Active	SARIKA KUMARI	ARUN KUMAR	N. SIVARAMAN	B.C.JHA

TRACTEBEL ENGINEERING pvt. ltd. - Registered office: A-3 (2nd Floor), Neeti Bagh - New Delhi - 110049 - INDIA
CIN: U74899DL2000PTC104134

ACKNOWLEDGEMENTS

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.

The consultants are grateful to Mr. S. K. Gangwar, Member (Technical), Mr. R. P. Khare (Ex. Member, Technical & Sr Consultant); Vice Admiral (Retd.) S. K. Jha (Sr. Advisor); Capt. Ashish Arya, (Hydrographic Chief) and Mr Rajeev Singhal (SHS) who provided their valuable guidance from time to time to make this report success.

(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 – 85 – Revadanda Creek / Kundalika River has been carried out for this assignment / analyzed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 06/12/2016 to 16/12/2016.

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

Terminal Land Survey was carried out on 27/04/2017.

Geotechnical Borehole was carried out from 23/06/2017 to 25/06/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

Proprietary rights of the information contained herein belong to "Inland Waterways Authority of India (IWAI)", Ministry of Shipping, Government of India. The information contained in this DPR is intended to be used for the mentioned purpose/project only, as permitted by IWAI. In case of misuse of information and any claim arising thereof, cost and consequence will be on the party misusing the information.

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)

Tractebel Engineering Pvt Ltd

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviations	Acronyms
BFL	Bombay Floating Light
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DMIC	Delhi Mumbai Industrial Corridor
DPR	Detailed Project Report
FSL	Full Supply Level
GAIL	Gas Authority of India Ltd.
HC	Horizontal Clearance
IO	Iron Ores
IOCL	Indian Oil Corporation Ltd.
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
KIOCL	Kudremukh Iron Ore Company Limited
KP	Km Points
LAD	Least Available Depth
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
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NMPT	New Mangalore Port Trust
NW	National Waterway
OMPT	Old Mangalore Port Trust
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
UPCL	Udupi Power Corporation Ltd
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

SALIENT FEATURES

#	Particulars	Details			
		REVADANDA (NW-85)			
A	**GENERAL**				
1	***Location***				
a	Cluster	Cluster-7			
b	State(s)	Maharashtra			
c	Co-ordinates& Name of Place	**Start**		**End**	
	Place	Anchorage / Salav Jetty		Roha	
	Latitude	18°32'16.7857"N		18° 26' 31.50"N	
	Longitude	72°55'33.4735"E		73° 07' 10.74"E	
B	**TECHNICAL**				
1	***Waterway***				
a	National Waterway Number	NW-85			
b	Class	IV (up to 26.00 km)			
c	Type (Tidal/Non-Tidal)	Fully Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		30.736km	30.736km	Nil	
d	Average Tidal Variation, if applicable	3.38m			
		Chainage (km)	Observed M. H.W.	Observed M. L.W.	Tidal variation (m)
		1.060	4.09	0.55	3.54
		10.610	4.04	0.68	3.36
		21.110	3.92	0.55	3.37
		30.355	3.96	0.72	3.24
e	Chart Datum				
	Description/Basis	Kude 18°29'38.9536"N 072°59'30.8202"E	Gophan 18°28'58.1257"N 073°02'48.3639"E	Roha 18°26'32.8232"N 073°07'00.6959"E	
	Value (from Zero of Gauge)	+ 0.159 m	+ 0.025m *	+ 0.210m *	
		* Chart Datum above zero of gauge			
f	LAD Status (w.r.t. CD)				
		Stretch-1	**Stretch-2**	**Stretch-3**	**Total**
	Stretch (From......To......)	0 – 10.00	10.00 -20 .00	20.00-30.736	
	Length with LAD < 1.2 m	0.000	0.000	7.486	7.486
	With LAD from 1.2-1.4 m	0.000	0.000	0.000	0.000
	With LAD from 1.5-1.7 m	0.150	0.000	0.000	0.150
	With LAD from 1.8-2.0 m	0.100	1.000	0.020	1.120
	With LAD > 2.0 m	9.750	9.000	3.230	21.980
g	Target Depth of Proposed Fairway (m)	2.00m			

#	Particulars	Details			
h	Conservancy Works Required				
	Type of Work	**Stretch-1**	**Stretch-2**	**Stretch-3**	**Total**
		0 - 10	10 - 20	(20 – 30.736)	
	Dredging Required	340.48	0	4,97,027.39	4,97,367.87
	Bandalling	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil
	River Training/Bank Protection (Km.)	Considered under Phase 2 at 8 locations 500 m each @ Ch. 14.92 km; Ch. 16.38 km; Ch. 17.73 km; Ch. 19.90 km; Ch. 23.81 km; Ch. 25.61 km and also between Ch. 21.00 km and Ch. 22.50 km (about 1000 m)			
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	15m to 50m	4.50m to 10.50m
	HT/Tele-communication lines	HT Lines	1	750m	12.30m
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil
2	***Traffic***				
a	Present IWT Operations (type of services)	At present Kundalika river is operational. Sanegaon Jetty & Salav Jetty are handling Coal & Iron Ore respectively.			
b	Major industries in the hinterland (i.e. within 25 km. on either side)	3 MIDC - Dhatav, Vile Bhagad & Usar and 2 industries in Salav – JSW & Welspun Maxsteel			
c	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Major roads - NH 66, Local roads along the Kundalika River on both sides. Major railway – Konkan railway line, 5 kms away from Roha (End point of River).			
d	Commodities	**In-bound**		**Out-bound**	
1	Coal	Import		n/a	
2	Iron Ore	Import		n/a	
e	Future Potential (MMT)				

	Name of Commodity	**5 years**	**10 years**	**15 years**	**20 years**	**25 years**
	Sanegaon Jetty					
1	Coal	2.44	2.75	3.00	3.00	3.00
	Salav Jetty					
1	Iron Ore	0.05	0.08	0.14	0.25	0.43
	Proposed IWAI Terminal on Kundalika River (Zolambe)					
1	Coal	0.00	0.00	0.12	0.57	1.12

#	Particulars	Details	
3	***Terminals/Jetties***		
a	Terminal/Jetty - 1	LO-LO	
	Location (Bank/city/district)	18° 27' 53" N & 73° 05' 09" E near Zolambe (V)	
	Type/Services	Handling of Bulk Cargo	
	Facilities	Cranes and Forklifts are provisioned	
	Approach	Road is available	
	Land Ownership		
	Area (ha.)	**Govt.**	**Private**
		NIL	4.2
4	***Design Vessel***		
a	Type	Pusher Tug & Dumb Barges	
b	No. & Size	2 PTs (30m to 40m x 12m to 14m) + 4 DBs (70m to 75m x 12m to 14m)	
c	Loaded Draft	PT 1.70 m / 2.0 m + DB 1.80 m / 2.0 m	
d	Capacity	Each DB of 1000 Tonne	
5	***Navigation Aids***		
a	Type	Beacon & Light (Phase 1) / Buoy & Light (Phase 2)	
b	Nos.	7 / 65	
b	Communication Facilities	No suggestion	
C	**FINANCIAL**		
1	***Project Cost***		
a	Capital Cost	Fairway (Ph 1 / Ph 2)	Lo-Lo
	Cost (INR)	14.24 cr / 64.34 cr	46.78 cr
b	O & M Cost	2.15 cr / 15.06 cr	15.42 cr
2	***User Charges***		
a	For IWAI	-	
b	For Operator	-	
3	***Financial Internal Rate of Return (%)***		
a	For IWAI	Non-existent	
b	Operator	-	
4	***Economic Internal Rate of Return (%)***	Fairway (Ph 1 / Ph 2)	Lo-Lo
		155% / 65%	7%
5	***Any other Important Feature***		

EXECUTIVE SUMMARY

Kundalika River is one of the waterways declared as National Waterway in March, 2016 as NW 85. Kundalika River originates in Western Ghats at an altitude of 820 masl and meets the Arabian Sea near Revedanda in Raigad district. Out of the total length, 31 km length of Revadanda Creek/ Kundalika River from Arabian Sea at Revadanda Lat 18°32'19.85"N, Long 72°55'32.80"E to Bridge on Roha-Astami Road near Roha Nagar Lat 18°26'31.50"N, Long 73° 7'10.74"E has been declared as new national waterway and proposed to undertake 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 30.736 Kms from Lat 18° 32' 16.7857" N, Long 72° 55' 33.4735" 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.

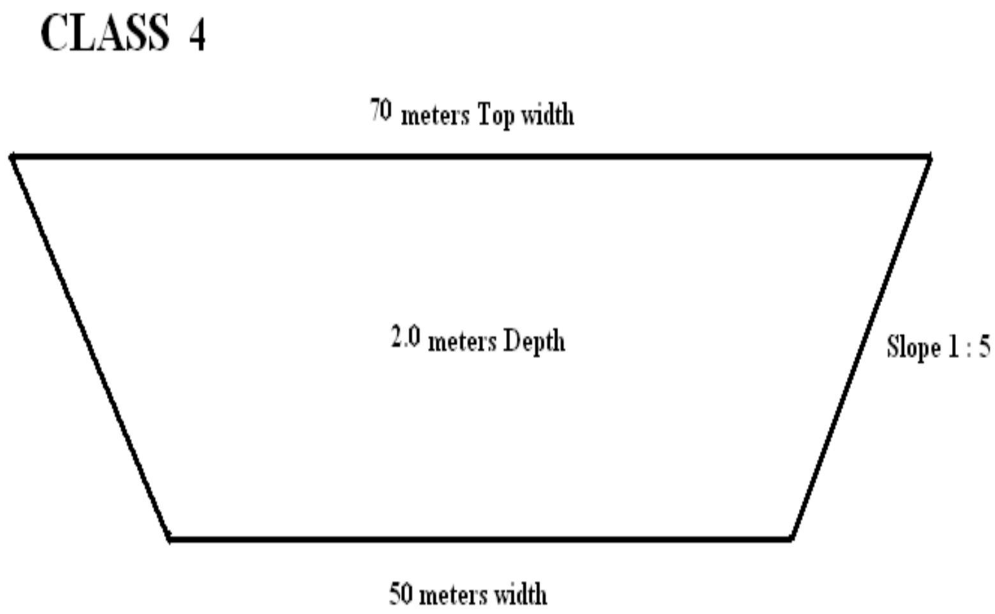
River Morphological analysis of the study stretch has been considered by analyzing the river regime of the past 15 to 20 years with 5 years span and the findings have been recorded. As such there is no major Regime disturbance in the study stretch. Based on the Hydrographic Survey inputs and other site data collected, it has been noticed that 3 Nos of Bridges are located. The Bridge at Ch. 0.805 Km is having sufficient Navigational clearances and the other two Bridges are located at the end of the stretch i.e., at Ch. 30.728 and 30.736, hence need not be considered for analysis. 1 No of HT Line is crossing the study area, which is having sufficient navigational clearances. No pipe line is crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 22 Nos. Bend locations have been identified in the study stretch.

Existing waterway of the study stretch is being used for mobility of the cargo of M/s JSW and M/s Indo Energy International Ltd., through their captive jetties located around Ch 20 Km and Ch 21 Km. The cargo for the captive jetty at Sanegaon is about 1.20 MMTPA in FY 16 and expected to increase to 3.00 MMTPA in FY 30 consisting of Coal. The increase is due to the plant capacity expansion and other increased planned activities in the hinterland. The Coal cargo in captive jetty of Sanegaon, on saturation, may have to be augmented with other terminal and to be developed by IWAI i.e., to meet the Coal cargo of 0.12 MMTPA in FY 30 and 1.12 MMTPA in FY 40. Accordingly, a Lo-Lo Terminal is proposed to be developed by IWAI.

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 20 kms stretch is having scattered shoals at 5 locations of 800 m and 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 10 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 26 km, it has been considered to develop Class IV waterway up to the IWAI proposed Terminal and Fairway is not suggested for any development beyond. However, the Terminal Design has been considered with Class VII vessel, keeping in view the Classification of NW 85 as Class VII, as per the revised notification.

In order to meet the mobility of 2000 T, the convoy system of Class IV has been concluded. Further, an alternative of mobility of Self Propelled Vessel with 70 m x 12 m x 1.8 m of 1000 T was thought of, but may not be economical in operation. Accordingly, the Dredging quantities have been worked out for the Indian class of Class IV convoy system for the subject study.



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	10					8.3	1.5	250	340.48
10	20	TIDAL ZONE				8.8	1.9	0	0
20	26					4.6	-0.9	3170	141943.1
							Total	3420	142283.6

The Development and Investment etc., are being proposed in TWO Phases i.e., in Phase 1, it is suggested to develop the Fairway stretch up to Ch. 26 Kms to provide safe mobility of IWT Traffic of M/s JSW and M/s Indo Energy International Ltd.,. Accordingly, the development is proposed for initial 3 years from the commencement. A period of 5 to 7 years is suggested for critical and Micro Level observation on the Growth Trend of Traffic. It is suggested to consider the Phase 2 only after the increase in Traffic volumes and keeping in view the possible growth. In Phase 2, the development period is suggested with the development ending in 2029 and the proposed developments are Fairway development with Bank Protection; Buoy / Light system along with Lo-Lo jetty.

In order to provide a safe navigable fairway, in Phase 1, dredging of about 1.48 Lakhs Cu. M in Soils and 0.17 Lakhs Cu. M in Hard Soils along with Beacon / Lights of 7 Nos. and the Institutional Requirements etc., have been recommended.

In the Phase 2, it has been proposed with the provision of 65 Nos. Of Buoy / Light system; Bank Protection at 8 Nos. Locations with 4000 m along with the Lo-Lo Terminal at identified location, only after having the justification of Phase 2 development.

The Terminal requirement has been considered with 1 Lift-on Lift-off (Lo-Lo) IWT Terminal along with handling facilities. Taking into the consideration of the origin and destination and fairway, the most probable location identified is at Ch 26 km, on the left side of the river with approx. Lat 18°27'53"N and Long 73°05'09"E. This location is having good accessibility to the road and on the opposite side of the Sanegaon area.

A tentative Land requirement has been worked out and arrived at with 31,000 Sq. M and the Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Zolambi Village; Roha Taluka; Raigarh District of Maharashtra state. Geotechnical Investigations have been carried out and the Preliminary designs have been worked out with these investigation Reports.

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 2 DBs of 75 m (say 80 m) each, the optimum length of Berth requirement has been taken as 120 m. In this length of 120 m, 2 cranes shall be made operational without any hindrance at any point of time. It is proposed to initially deploy 1 Rubber mounted crane capable of handling 125 TPH with 80 % efficiency, which will be increased to 2 Cranes. In the ultimate requirement, it will be considered as 1 Berth + 2 Cranes to meet the 1.12 MMTPA.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
LO LO	120	32

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

The Vessel Design has been discussed with international standards, as in vogue. To meet the mobility of the cargo in excess after attaining the saturation level by the infrastructure at captive Terminal locations, the following Vessel sizes are suggested and proposed for deployment. The convoy system only has been suggested. Costs are indicative. Deployment will be by Entrepreneurs.

Self Propelled Vessel: (2000 T) {Not Recommended} with Length – 86 m to 90 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 2.5 m / 3.0 m +; Cargo Capacity – 2000 T and Propulsion by Marine Diesel Engines of 2 x 625 Bhp is costing about **INR 1000 Lakhs each.**

Pusher Tug: with Length – 30 to 40 m; Breadth – 12 m to 14 m; Draft / Depth – 1.7 / 2.0 + 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 to 14 m; Loaded Draft / Depth – 1.8 m / 2.0 m +; Cargo Capacity – 1000 T is costing about **INR 500 Lakhs each.**

1 PT + 2 DBs may be required by 2029. {Construction from 2025 to 2029}
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. However, the system requirement with an indicative cost has been placed, which has not been taken into consideration, keeping in view the lower level cargo mobility.

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 fitted with Survey Instruments; Related Software; Laptop; 2 Nos. Tugs and 2 Nos. Inspection Boats (Speed Boats) etc,

As explained above, the development is suggested in TWO Phases. Cost estimates have been worked out for the above suggested 2 Phases.

Fairway in Phase 1 is working out to INR 14.24 Cr.
Fairway in Phase 2 is working out to INR 64.34 Cr.
Lo-Lo Terminal in Phase 2 is working out to INR 46.80 Cr.

All the capital assets will be provisioned in 36 months. Phase 2 is not recommended at this stage. Investment decision for Phase 2 may have to be considered in 2025 after observing the growth trend between 2020 and 2025.

The FIRR and EIRR have been worked out and the details are placed.

Project Modules	FIRR	EIRR
Fairway (Phase 1)	Non-existent	155 %
Fairway (Phase 2)		65 %
Lo-Lo Terminal		7%

It is recommended to develop the stretch of Kundalika River for about 26.00 Kms with Class IV convoy system of the NW standards, in phase 1, wherein the phase 2 investments in Fairway and Lo-Lo Terminal will be considered at later stage after having positive growth confirmations.

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 meagre 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 Bhubaneswar (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 Kundalika (NW 85) 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. Compliance of the ToT is placed at Annexure 1.2.

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 1.3, 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 Kundalika River – NW 85 for a distance of 30.736 kms from the Arabian Sea mouth to Upstream, in the state of Maharashtra.

TABLE 1-3: Description of Kundalika River (NW-10)

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Revadanda Creek/Kundalika River (NW-85)
2	State/ District through which river passes	The Revadanda Creek/Kundalika River passes through the Raigad district of Maharashtra State.
3	Length of the river / canal	Kundalika River originates in Western Ghats at an altitude of 820 masl and meets the Arabian Sea near Revedanda in Raigad district. Out of the total length, 31 km length of Revadanda Creek/Kundalika River from Arabian Sea at Revadanda Lat 18°32'19.85"N, Long 72°55'32.80"E to Bridge on Roha-Astami Road near Roha Nagar Lat 18°26'31.50"N, Long 73° 7'10.74"E have been declared as new national waterway and proposed to undertake the two stage DPR.
4	Map	The index map of Revadanda Creek/Kundalika River showing proposed waterway stretch, topographic features and road networks are shown in Figure1.2. The section of the Revadanda Creek/Kundalika River under feasibility study for inland waterway showing reconnaissance survey routes is presented in Drawing No. **P. 010257-W-20301-A05** (Sheet – 1 to 6).

Characteristic of River

Sl. No.	Introductory Consideration	Description of the River
5	River Course	Initially the River Kundalika flows in South West direction up to Patnus village and then turns to North-West till it joins the Arabian Sea. After covering a distance of about thirty two kilometres in westerly course, the river meets the tide at Roha, and for about thirty one kilometres more to the west and north-west, stretches a tidal inlet falling into the Arabian Sea at Revadanda. The general appearance of the channel in lower reaches shows meandering tendency. The meanders themselves introduce local channel variation, the width of channel increases considerably from upper reaches to lower reaches, where it meets the Arabian Sea.
6	Tributaries / Network of Rivers / Basin	The Revadanda Creek/Kundalika River receives two major streams during its course. About 5 kilometres at the upstream of Chaul village, one tributary meets at the right bank near Bhonang village. The other chief tributary is Achalbag, which after draining the hills near the Janjira border falls into the Kundalika about sixteen kilometres downstream of Roha.
7	Catchment Area	The total catchment area of Revadanda Creek/Kundalika River is 825 sq-km.

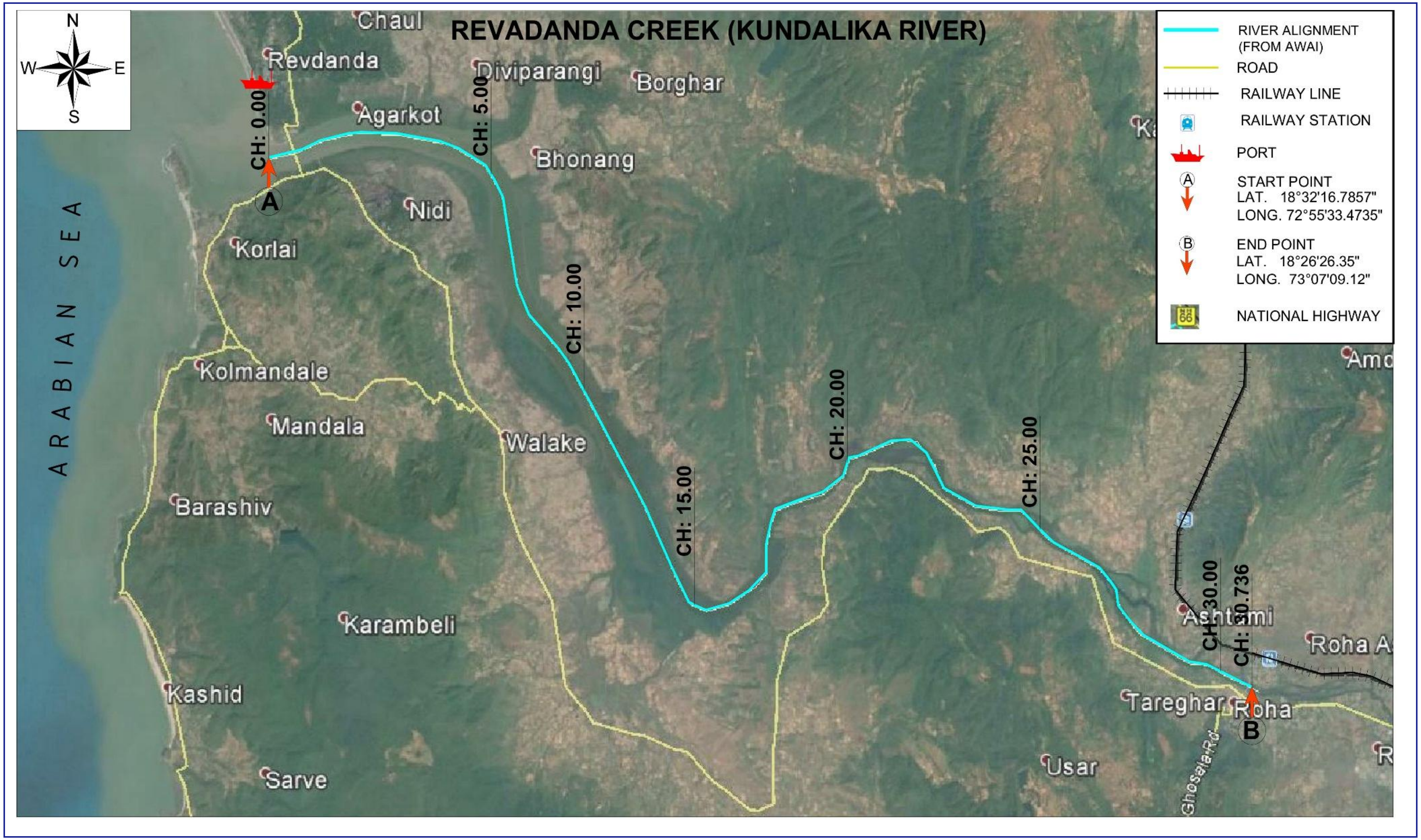


FIGURE 1.1 : INDEX MAP

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, harbours 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

The Kundalika River originates in Western Ghats from the Hills of Sahyadri at an altitude of 820m above mean sea level (AMSL) near Hirdewadi (Bhira), 150 km south east of Bombay (Mumbai) and meets the Arabian Sea near Revadanda in Raigad district of Maharashtra. Initially the river flows in South West direction up to Patnus village and then turns further in to North West and finally merge in to the Arabian Sea.

The Kundalika River is bounded by Roha, Tareghar, Kumboshi, Ashtami, Zolambe, Gophan and Wavekhar in the upper stretch, Shedsai, Mahalunge, Dapoli, Kapori, Kude and Walake in the middle stretch and Yesade, Mithekar, Talavali Tarf Umate, Nidi, Agarkot, Salav, Korlai and Revadanda in the lower stretch.

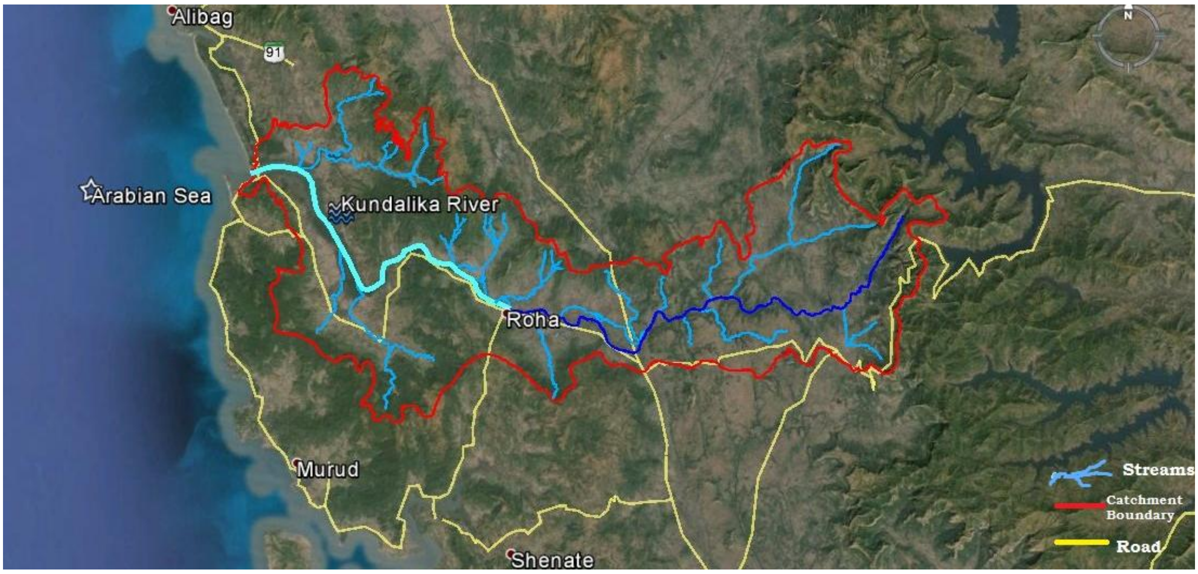


FIGURE 2.1: Catchment Area Map of Kundalika River (Source: Google Earth)

The river basin is bounded in north by Amba River catchment and in south by Savitri River basin, on east by Western Ghat and on west by Arabian Sea. The catchment receives an average annual rainfall of about 3143 mm. The total length of the river from origin to its outfall in the Arabian Sea is about 74.0 km. The present study focusses on 30.736 km.

A map showing Kundalika catchment basin is shown in Figure 2.1. Kundalika River has a relatively small catchment area; its tributaries are small tributaries and feeder local streams. Both the banks of Kundalika are characterized by clay deposit in lower reaches (Ref: Maharashtra water and Irrigation commission report, June, 1999). The important towns located on the banks of Kundalika are Kolad, Korlai, Chaul, Roha and Salav. 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. Given the size and terrain of the river, lower 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. March, April and May are the hottest months. The months of March, April and May, experience very high temperatures which are often accompanied by thunderstorms. Temperature varies between 22°C-39°C during summer season. Cool dry spell, with clear skies gentle breeze and pleasant weather prevails from November to February. Temperature varies between 12°C-34°C during winter season. During post monsoon time, the temperature varies between 23.1°C - 32.9°C. It is hot during the day time and cold during the night with humidity being very low.

The most important factor which influences the climate is the towering presence of the Western Ghats which block the monsoon bearing winds coming from the Arabian Sea and cause rainfall. The annual rainfall of the state can vary from 400 - 6000 mm and occurs for 3 - 4 months in a year. The months of March, April and May, experience very high temperatures which are often accompanied by thunderstorms. Rainfall starts normally in the first week of June. July is the wettest month in Maharashtra, while August too gets substantial rain. Monsoon starts its retreat with the coming of September from the state.

The soil status of Maharashtra is residual, derived from the underlying basalts. In the semidry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier. The higher plateau areas have pather soils, which contain more gravel.

For Kundalika River the soil texture has been observed during the reconnaissance survey. It is observed that that sandy clay soil is found in most part of the river under study stretch. Rock outcrops are visible at the banks in the end stretch beyond Ch 26.0km.

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.

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 slopes of this river indicate that the study stretch 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 Kundalika is influenced by tide.

Geomorphology

According to the classification of the waterway from class I to class VII, the maximum width required and maximum depth required 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.

Kundalika 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 (March, 2004, June, 2010, March, 2013 and October, 2016).

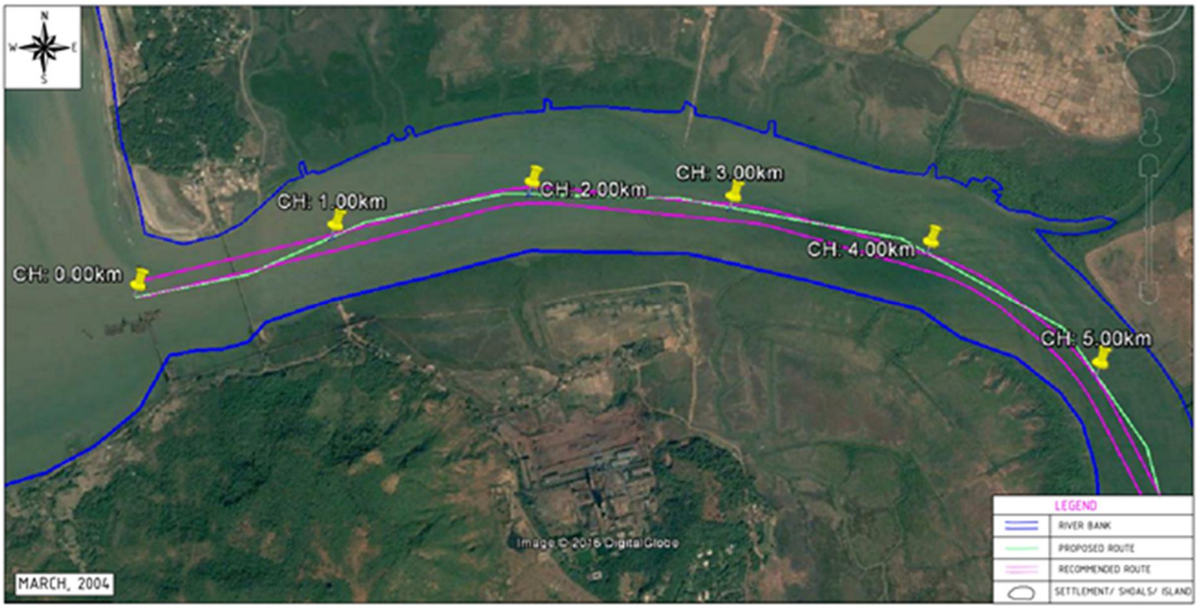


FIGURE 2.2: River stretch from Ch 0.00km to 5.00km in March, 2004 (Source: Google Earth)

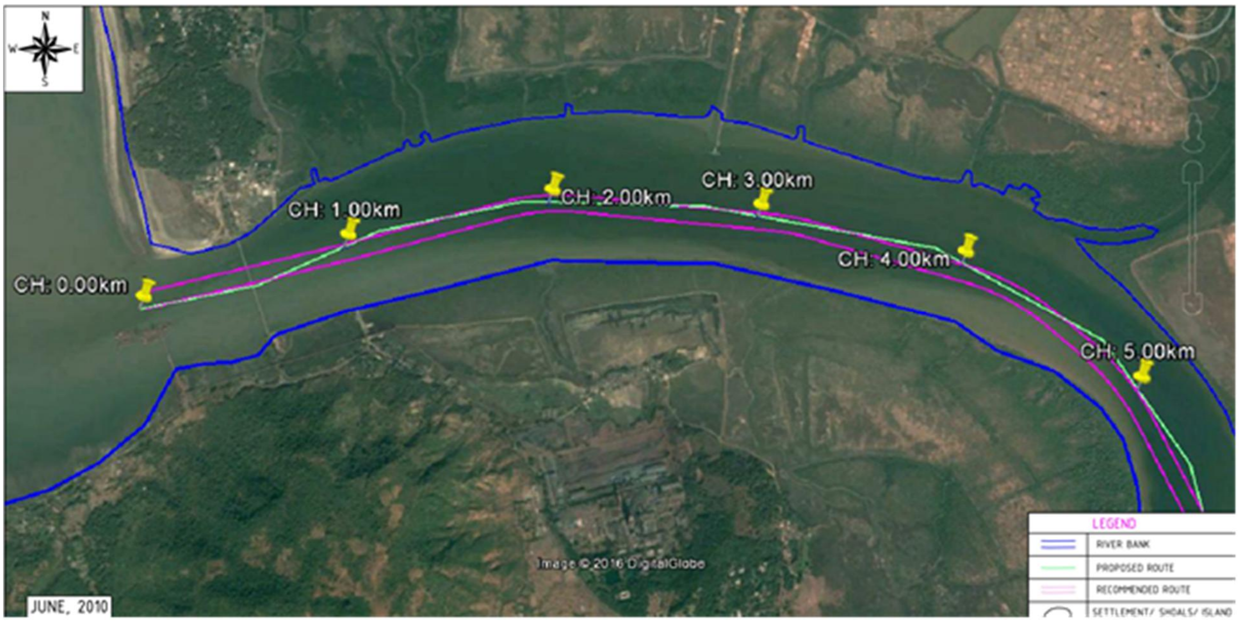


FIGURE 2.3 : River stretch from Ch 0.00km to 5.00km in March, 2004 (Source: Google Earth)

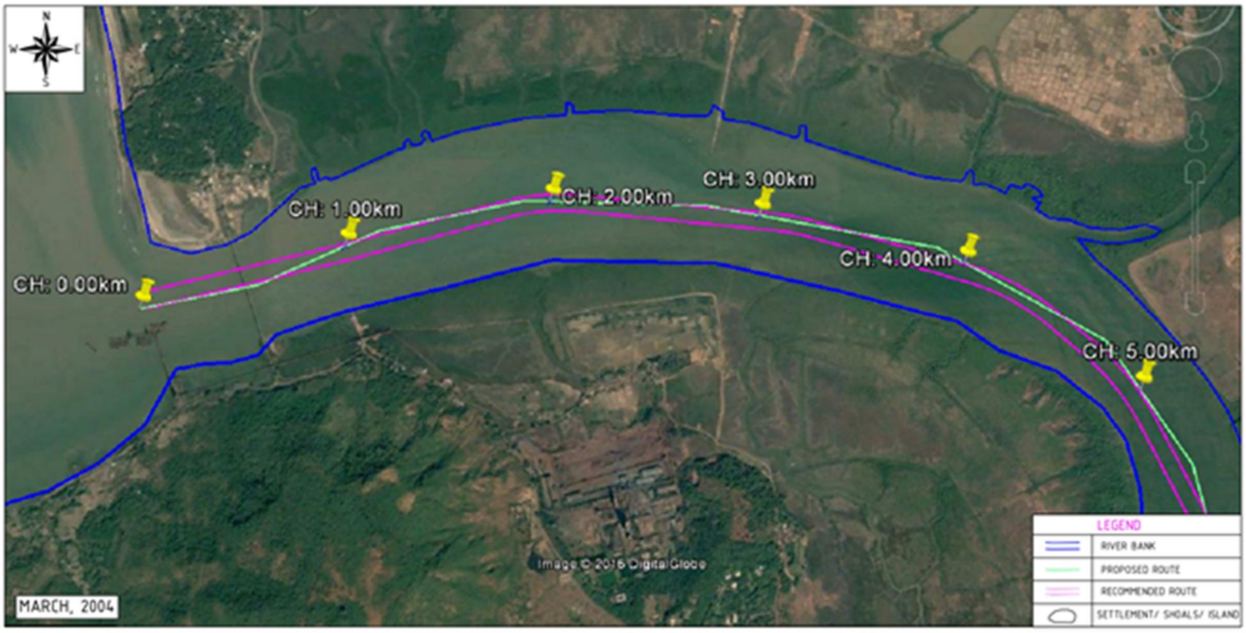


FIGURE 2.4 : River stretch from Ch 0.00km to 5.00km in June, 2010 (Source: Google Earth)

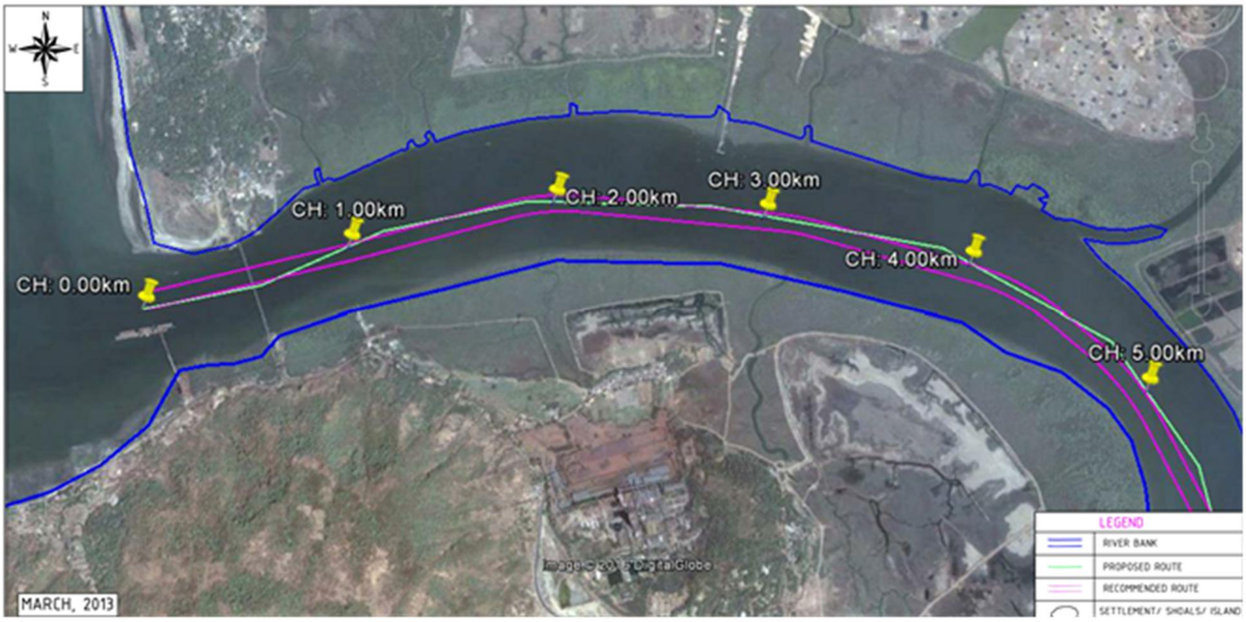


FIGURE 2.5 : River stretch from Ch 0.00km to 5.00km in March, 2013 (Source: Google Earth)

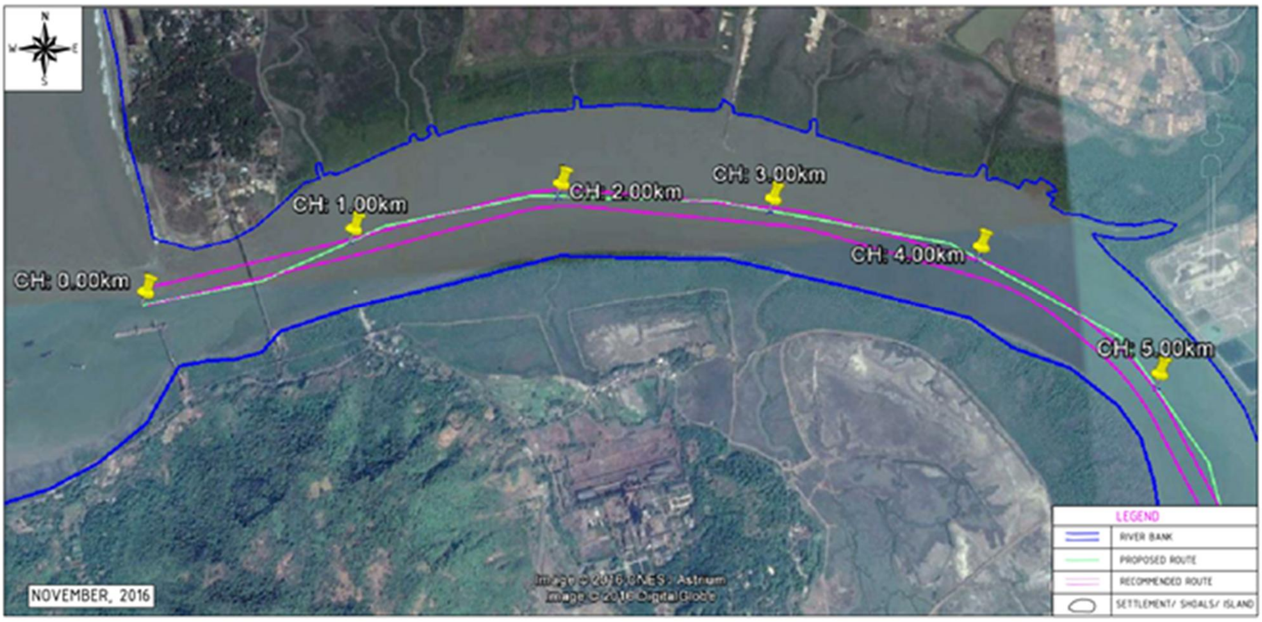


FIGURE 2.6 : River stretch from Ch 0.00km to 5.00km in November, 2016 (Source: Google Earth)

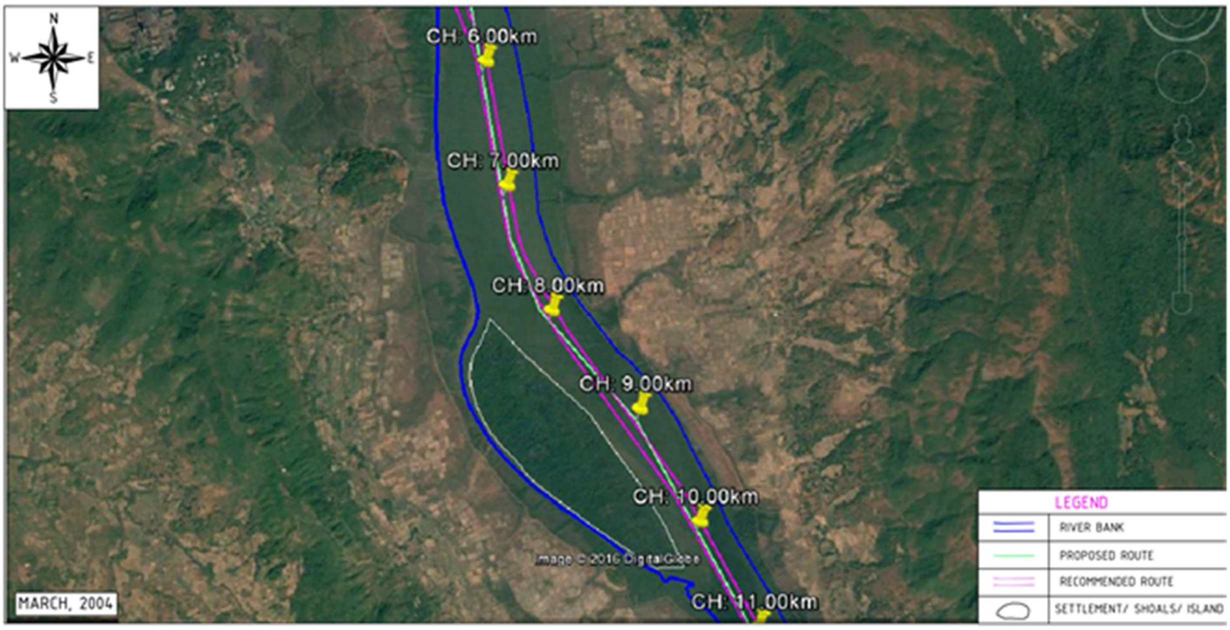


FIGURE 2.7 : River stretch from Ch 6.00km to 10.00km in March, 2004 (Source: Google Earth)

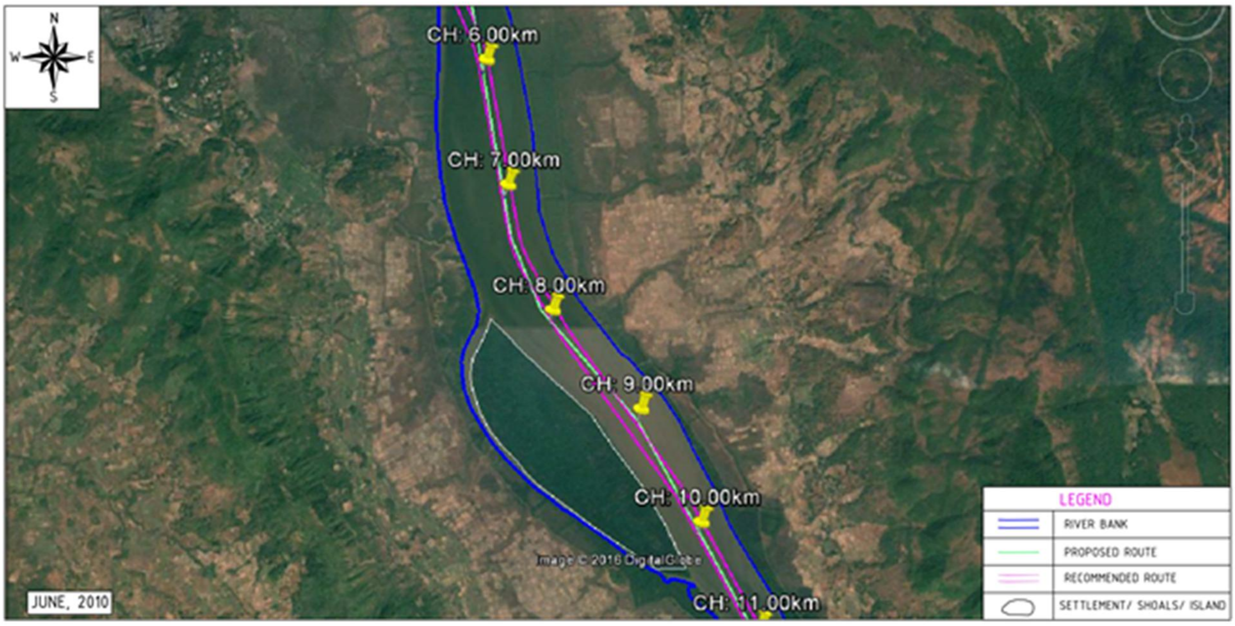


FIGURE 2.8 : River stretch from Ch 6.00km to 10.00km in June, 2010 (Source: Google Earth)

FIGURE 2.9 : River stretch from Ch 6.00km to 10.00km in March, 2013 (Source: Google Earth)

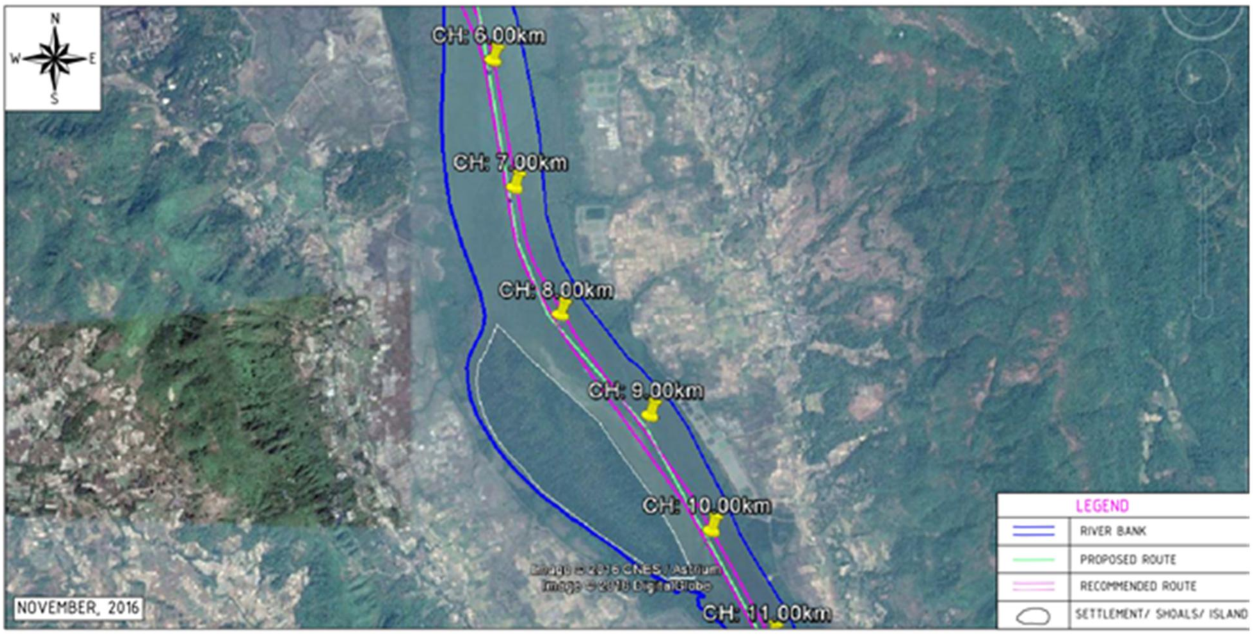


FIGURE 2.10 : River stretch from Ch 6.00km to 10.00km in November, 2016 (Source: Google Earth)

Prominent effect of accretion is noticed on the left bank up to Ch 5.00 km in June, 2010 which may have affected the depth of water. Comparing all the figures, it can be seen the right river bank near Ch 0.00 km has been eroded with time.

One tributary joins the right river bank between Ch 4.00 km and Ch 5.00 km and few smaller streams join both banks up to Ch 4.00 km.

One big shoal near the left bank is present between Ch 8.00 km and Ch 10.00 km. From all the figures, it is seen that there is negligible migration of the settlement of soil. It does not affect the waterway route.

A bridge in all the figures is noted between Ch 0.00 km and Ch 1.00 km.

Kundalika River (Ch 11.00 km - Ch 20.00 km)

The satellite image for the stretch of next 10 km for four time periods has been placed (March, 2004, June, 2010, March, 2013 and October, 2016).

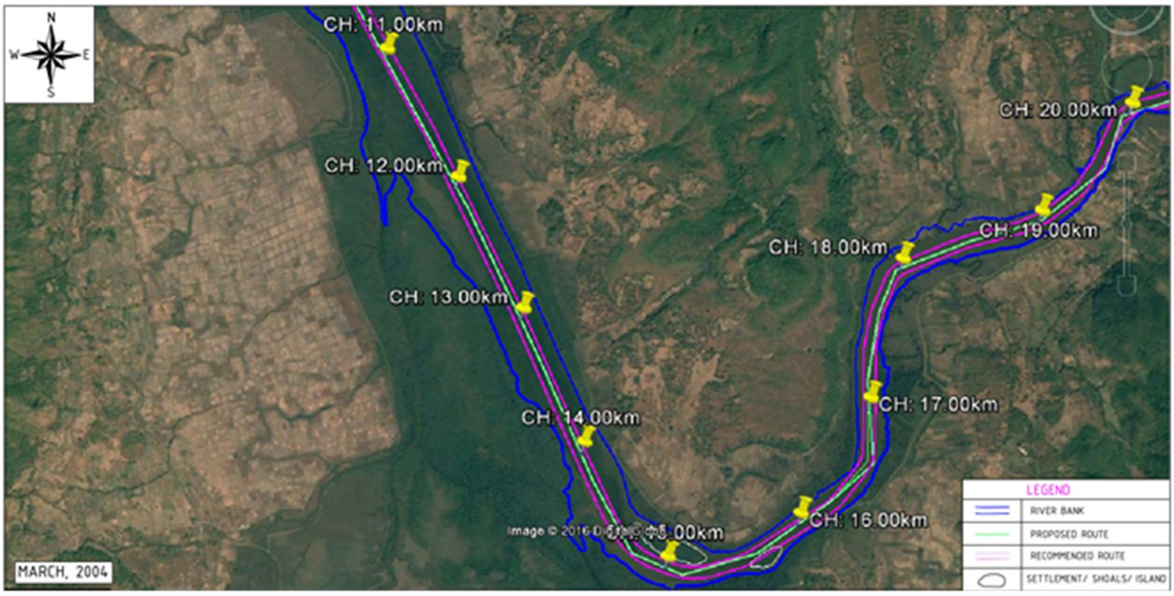


FIGURE 2.11 : River stretch from Ch 11.00km to 20.00km in March, 2004 (Source: Google Earth)

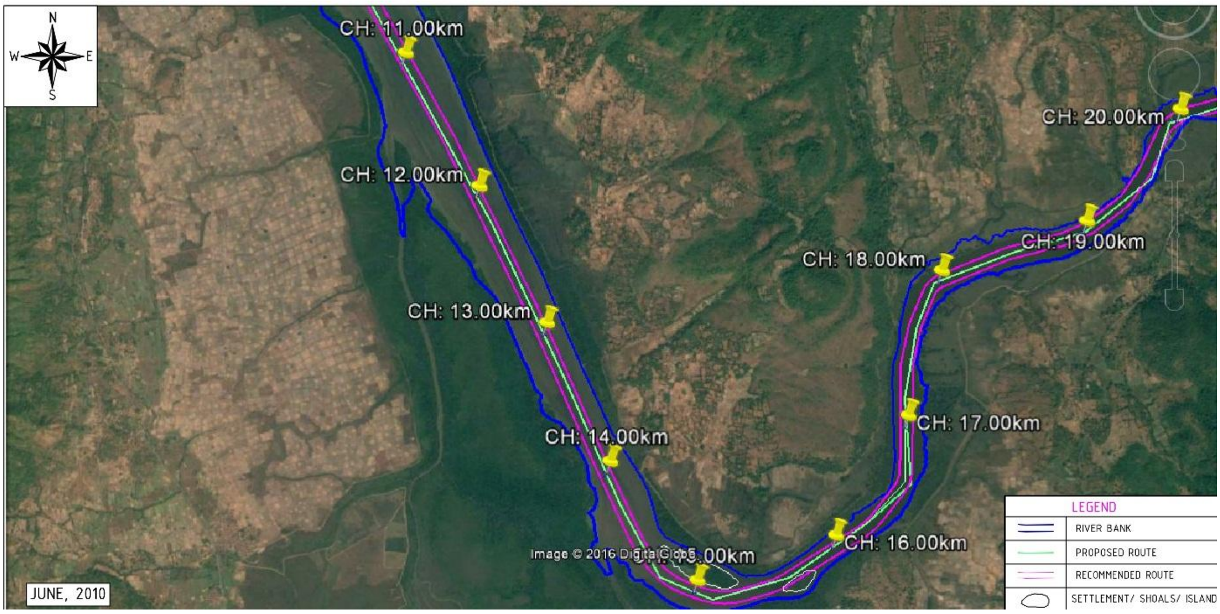


FIGURE 2.12 : River stretch from Ch 11.00km to 20.00km in June, 2010 (Source: Google Earth)

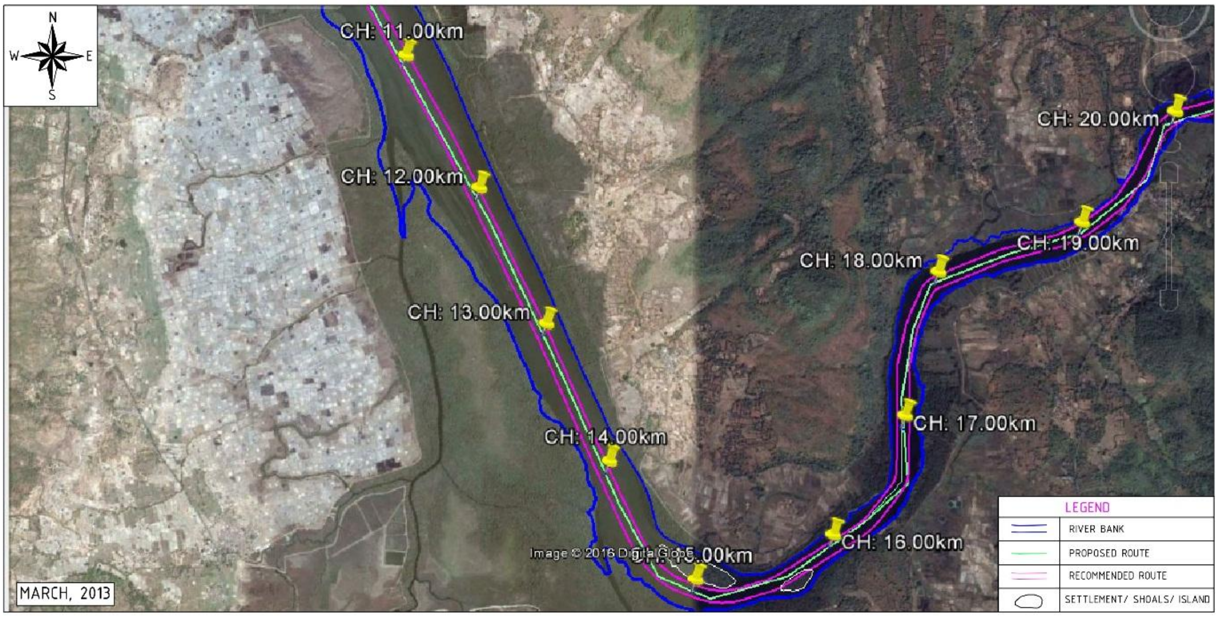


FIGURE 2.13: River stretch from Ch 11.00km to 20.00km in March, 2013 (Source: Google Earth)

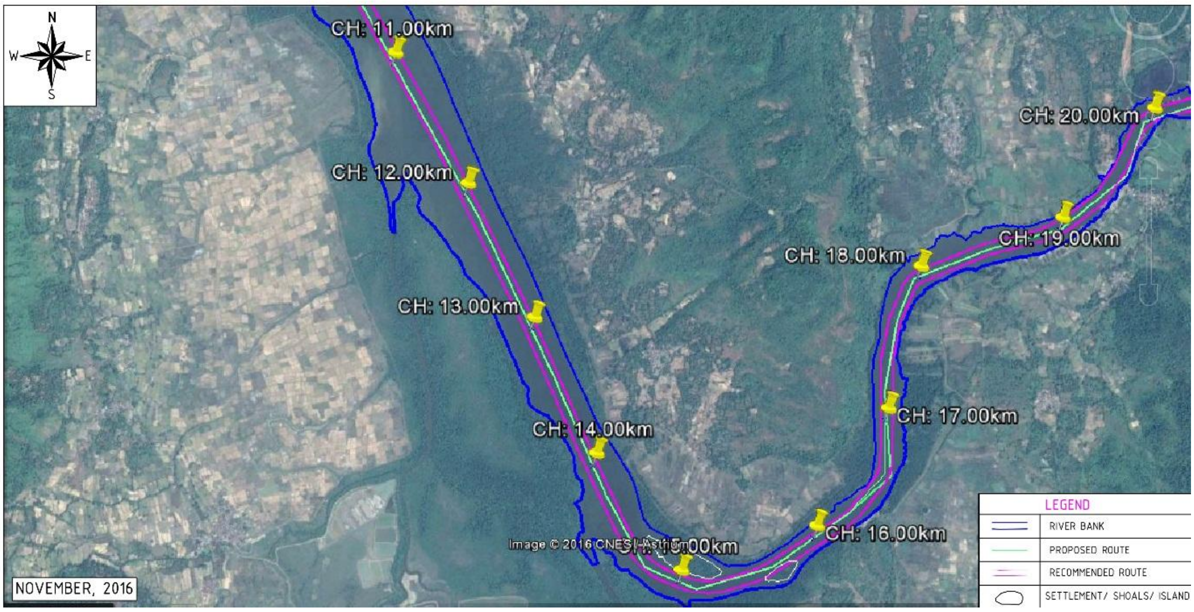


FIGURE 2.14 : River stretch from Ch 11.00km to 20.00km in October, 2016 (Source: Google Earth)

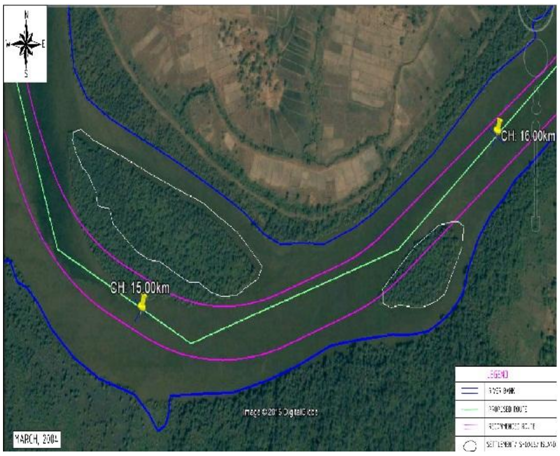


FIGURE 2.15 : River stretch near Ch 15.00km in March, 2004(Source: Google Earth)

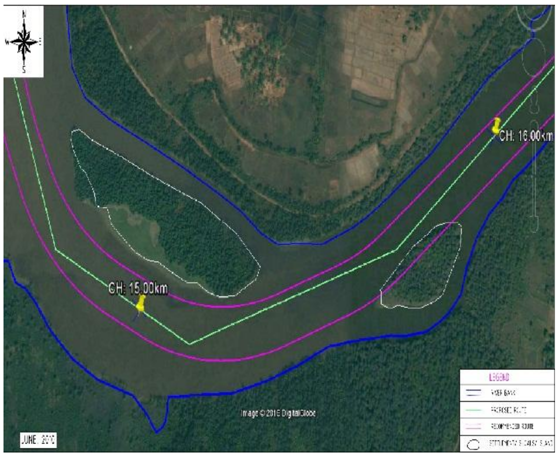


FIGURE 2.16 : : River stretch near Ch 15.00km in June, 2010 (Source: Google Earth)

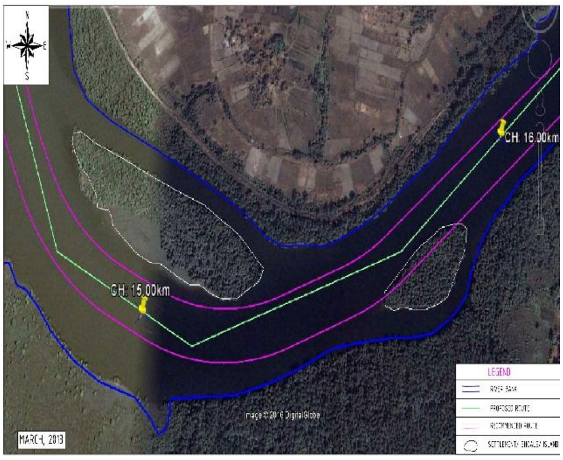


FIGURE 2.17 : River stretch near Ch 15.00km in March, 2013 (Source: Google Earth)

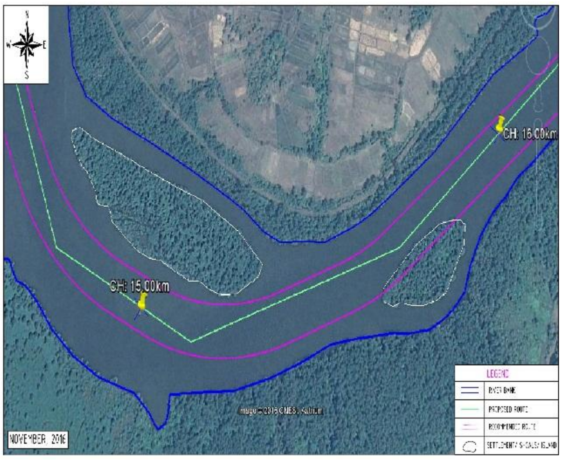


FIGURE 2.18 :River stretch near Ch 15.00km in November, 2016 (Source: Google Earth)

From the images of March 2004, June 2010, March 2013 and October 2016, it is observed that there is some change in the left river bank near Ch 12.00 km where a tributary joins the river. Another tributary joins the river at the left bank between Ch 14.00 km and Ch 15.00 km.

The river passes a bend with narrow strip at Ch 15.00 km. No significant variation is observed.

The right bank of the river changes in a minor way between Ch 18.00 km and Ch 19.00 km suggesting erosion.

There are two shoals present near Ch 15.00 km, one big and the other comparatively smaller. Comparing all the images, it is observed that the settlement of soil was bigger in size in 2004. However in 2010 and 2013 some portions of the landmass seem to be submerged. But from the image of 2016, it is seen that the settlement of soil re-emerged but still remain smaller in size in comparison to that in 2004. The settlement is covered with mangroves. Dredging of some portions of the settlement, i.e. approximately 63 cu.m, may be required for undisturbed route of waterway.

Kundalika River (Ch 21.00 km - Ch 30.736 km)

The satellite image for the stretch of last 10 km for four time periods has been (March, 2004, June, 2010, March, 2013 and October, 2016).

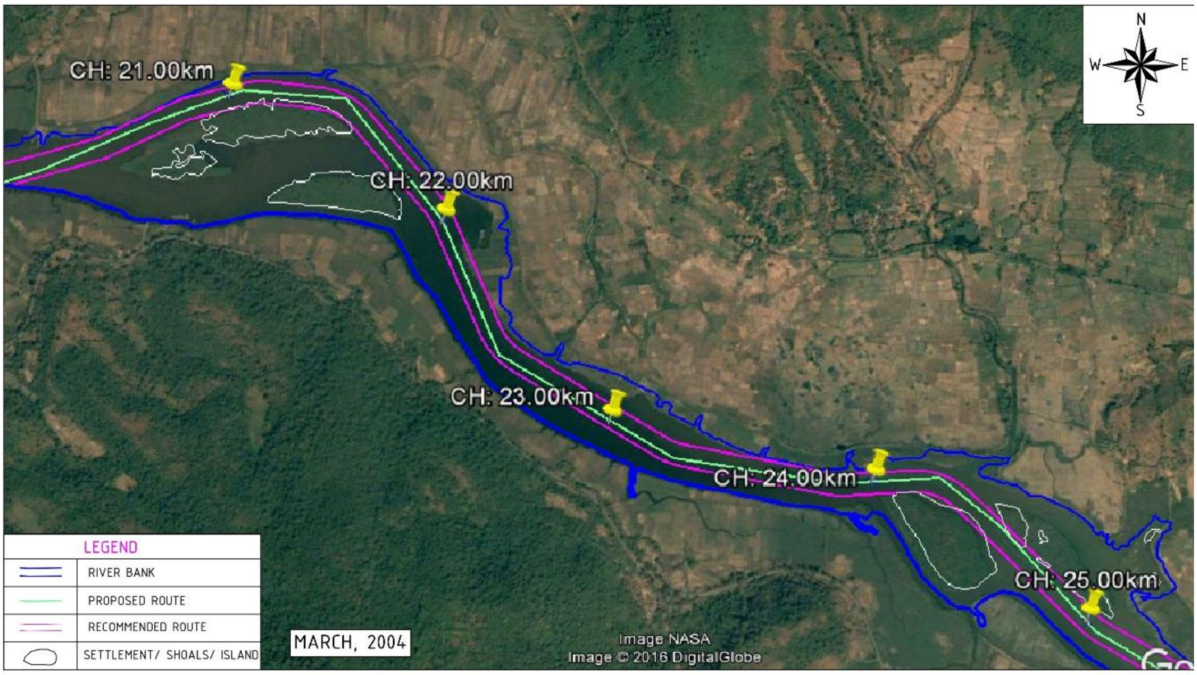


FIGURE 2.19 : River stretch from Ch 21.00km to 25.00km in March, 2004 (Source: Google Earth)

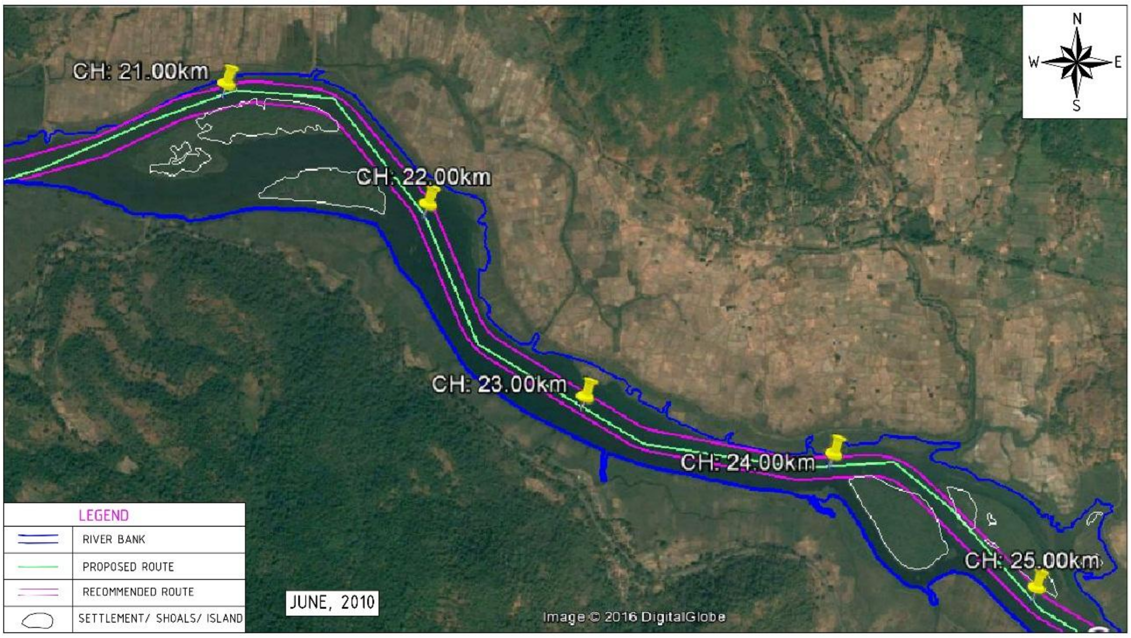


FIGURE 2.20 : River stretch from Ch 21.00km to 25.00km in June, 2010 (Source: Google Earth)

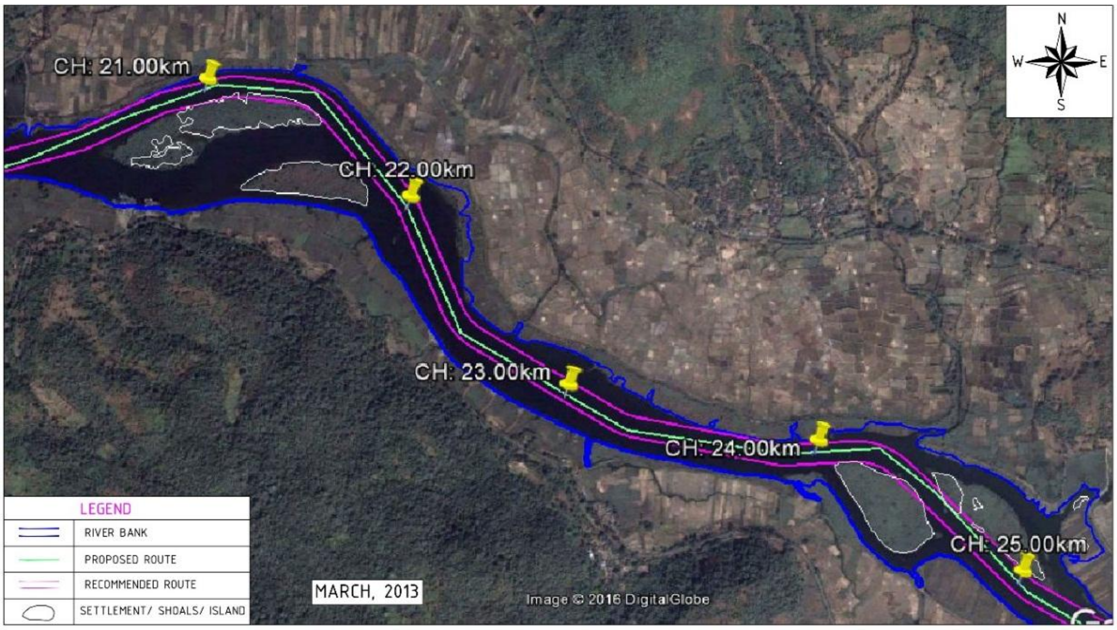


FIGURE 2.21 : River stretch from Ch 21.00km to 25.00km in March, 2013 (Source: Google Earth)

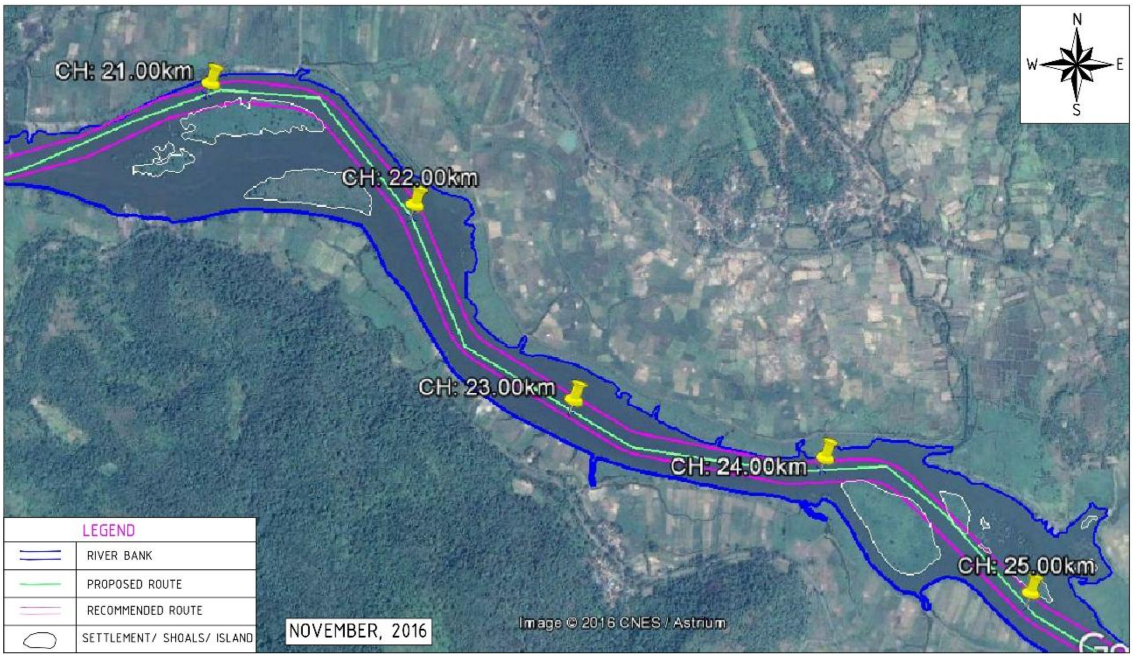


FIGURE 2.22 : River stretch from Ch 21.00km to 25.00km in November, 2016 (Source: Google Earth)

FIGURE 2.23 : River stretch from Ch 26.00km to 30.73km in March, 2004 (Source: Google Earth)

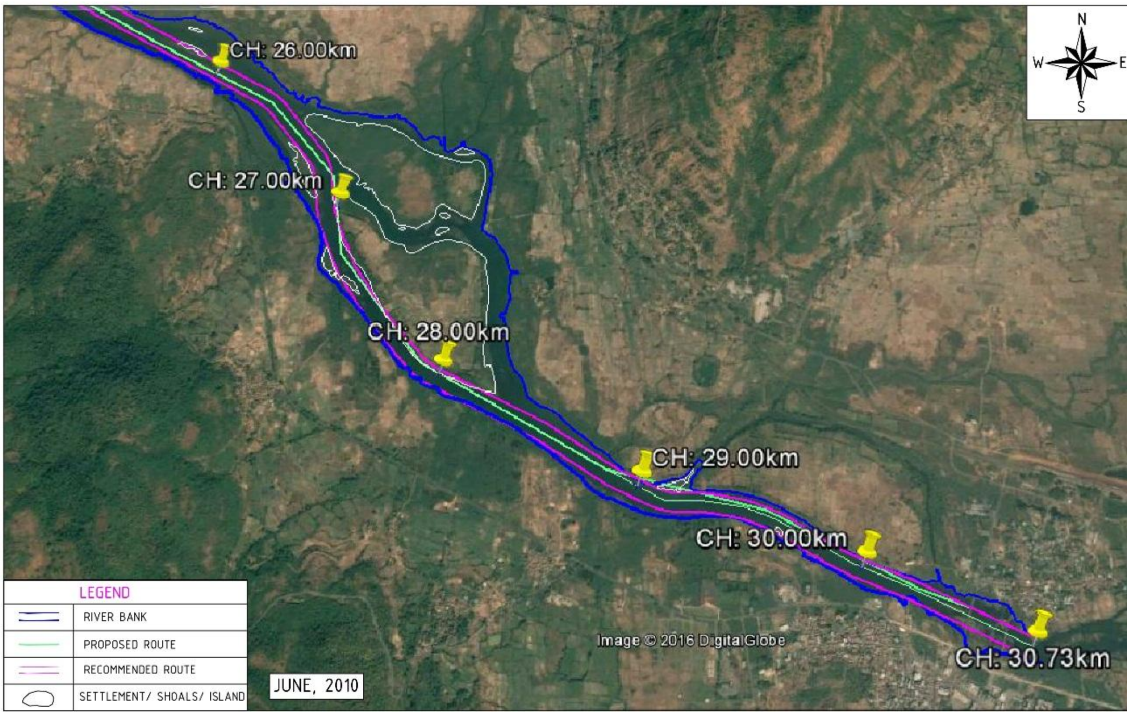


FIGURE 2.24 : River stretch from Ch 26.00km to 30.73km in June, 2010 (Source: Google Earth)

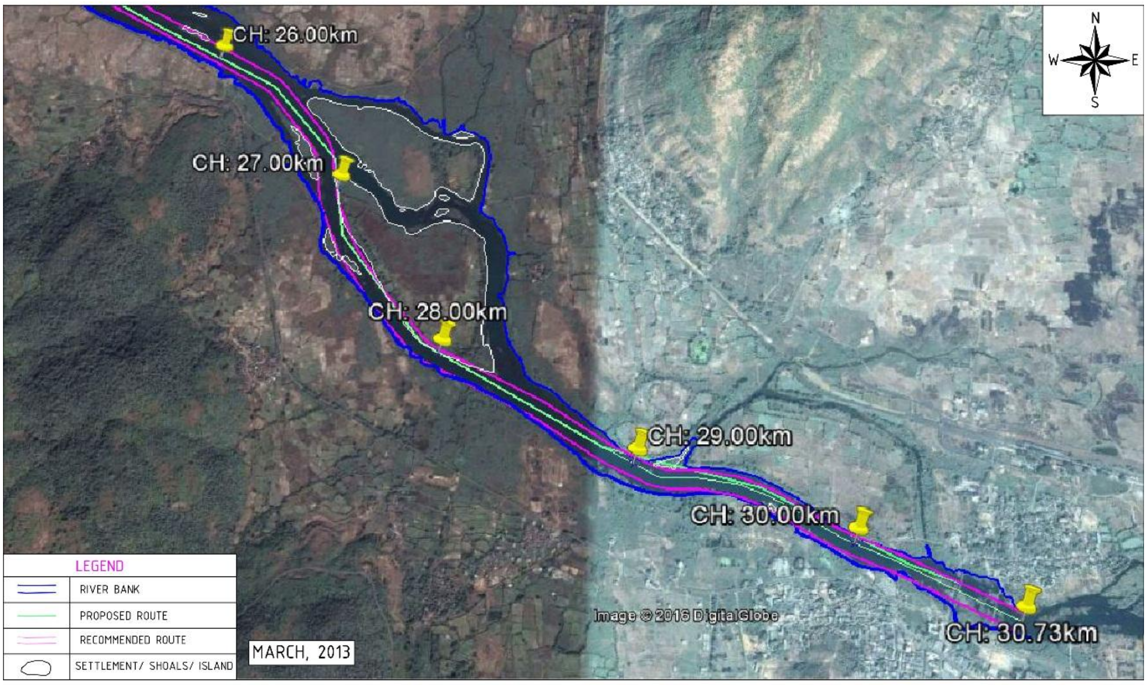


FIGURE 2.25 : River stretch from Ch 26.00km to 30.73km in March, 2013 (Source: Google Earth)

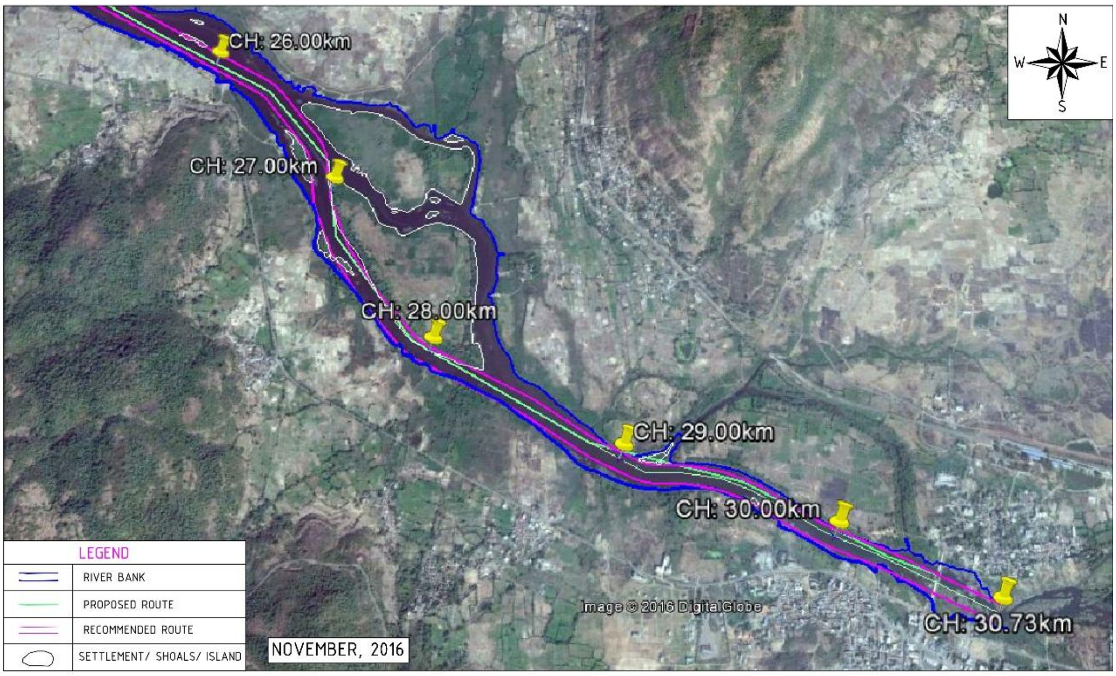


FIGURE 2.26 : River stretch from Ch 26.00km to 30.73km in November, 2016 (Source: Google Earth)

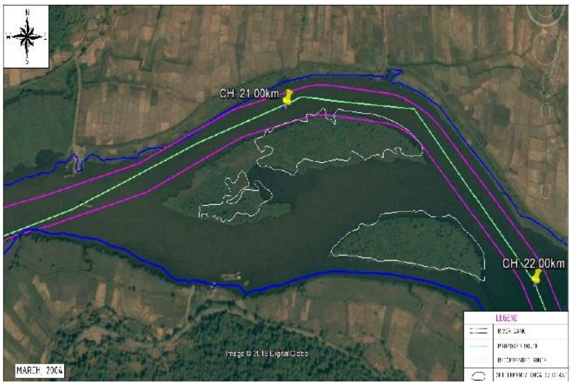


FIGURE 2.27 : River stretch near Ch 21.00km in March, 2004 (Source: Google Earth)

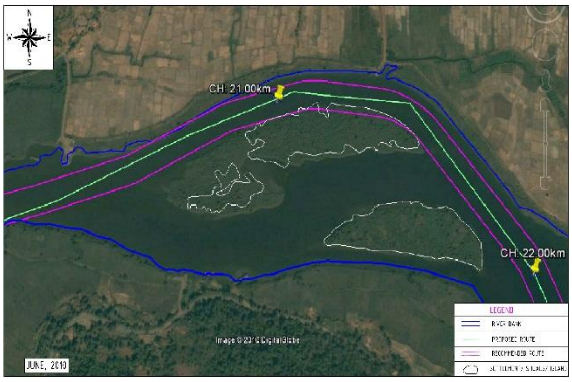


FIGURE 2.28 : River stretch near Ch 21.00km in June, 2010 (Source: Google Earth)

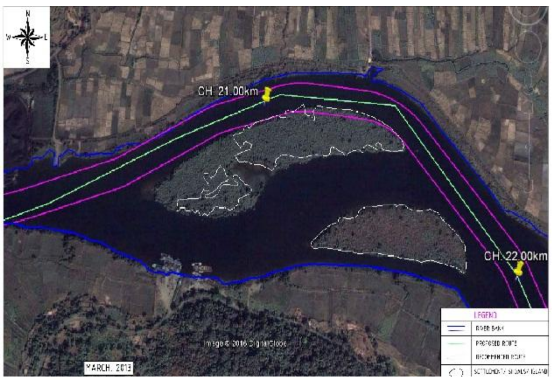


FIGURE 2.29 : River stretch near Ch 21.00km in March, 2013 (Source: Google Earth)

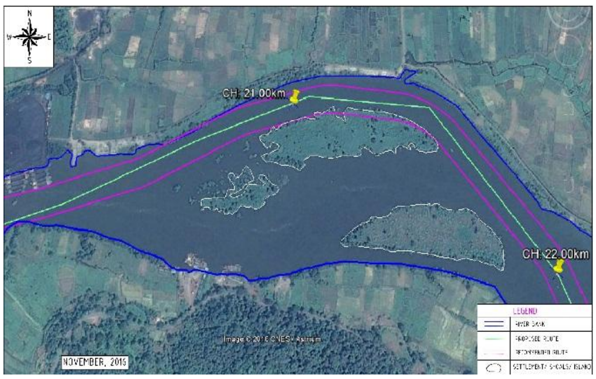


FIGURE 2.30 : River stretch near Ch 21.00km in November, 2016(Source: Google Earth)

FIGURE 2.31 : River stretch near Ch 21.00km in March, 2004 (Source: Google Earth)

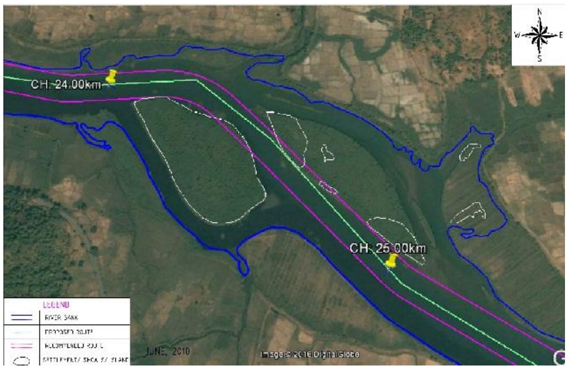


FIGURE 2.32 : River stretch near Ch 21.00km in June, 2010 (Source: Google Earth)

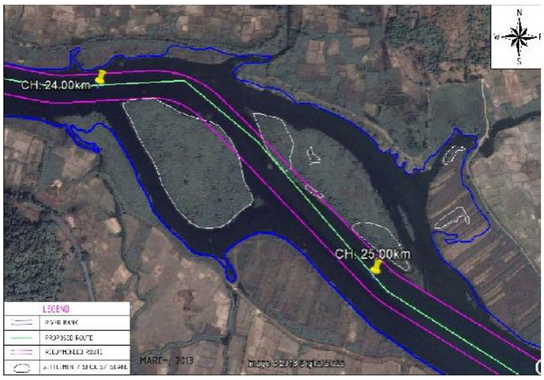


FIGURE 2.33 : River stretch near Ch 21.00km in March, 2013 (Source: Google Earth)

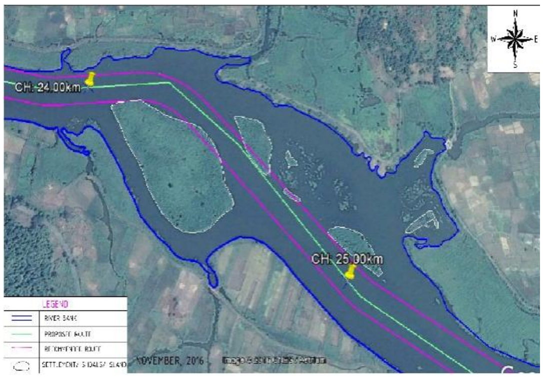


FIGURE 2.34 : River stretch near Ch 21.00km in November, 2016(Source: Google Earth)

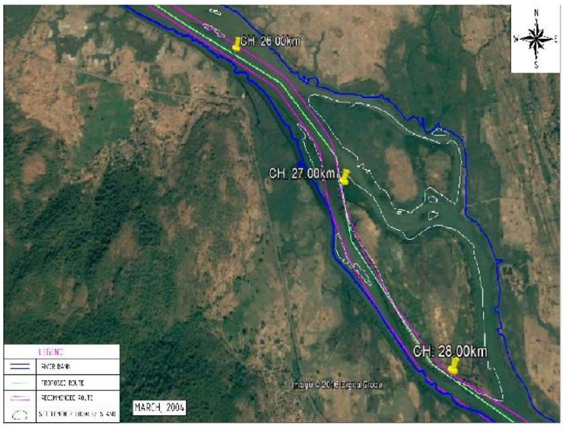


FIGURE 2.35 : River stretch near Ch 21.00km March, 2004 (Source: Google Earth)

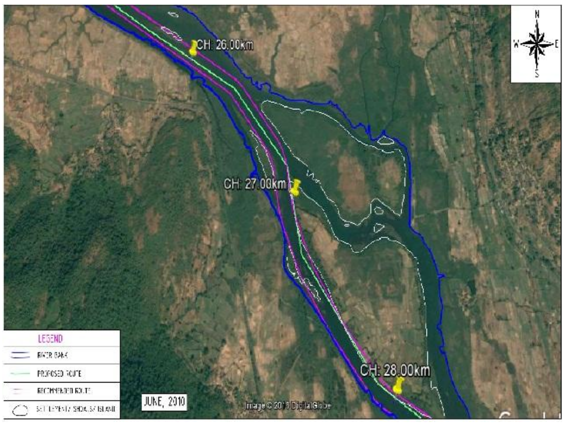


FIGURE 2.36 : River stretch near Ch 21.00km in June, 2010 (Source: Google Earth)

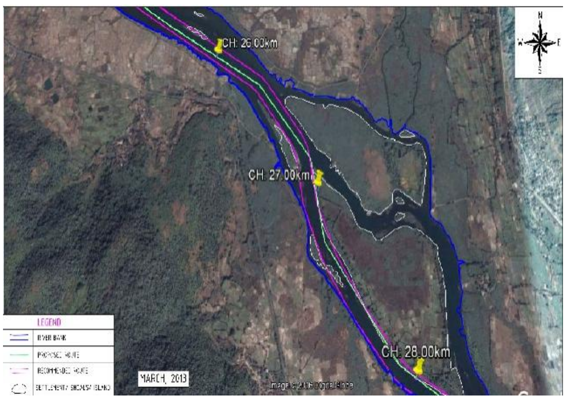


FIGURE 2.37 : River stretch near Ch 21.00km in March, 2013 (Source: Google Earth)

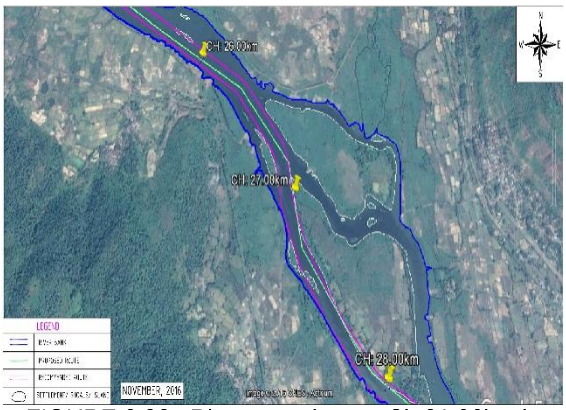


FIGURE 2.38 : River stretch near Ch 21.00km in November, 2016(Source: Google Earth)

From the figures of March 2004, June 2010, March 2013 and October 2016, it is clear that there is some change in the right river bank from Ch 22.00 km and in the left bank from Ch 24.00 km onwards. Comparing all the figures, it can be suggested that there has been erosion of the banks.

A bridge is present at the end of the stretch where width of the river decreases due to presence of small landmasses.

From the images shown it is observed that there are three shoals between Ch 21.00km and Ch 22.00km in November, 2016. But in March 2004, June 2010 and March 2013 there were two big shoals. Comparing all the figures, a conclusion can be drawn that the some portions of the bigger settlement of soil may have submerged, thus the exposing portions suggest two settlements as seen in figure from 2016. The relative positions of the settlement remain same throughout the time period.

From the images shown, two big shoals are observed between Ch 24.00km and Ch 25.00km in 2004, 2010 and 2013. But after 2013, one of the shoals gets submerged for major portion. Thus in the image from November, 2016 two smalls and two very small shoals can be seen in the place of the above shoal. The other shoal shows slight migration after 2004.

There are two big shoals and few small shoals present between Ch 26.00km and Ch 28.00km. The relative position of the settlement of soil remains negligible with slight movement between 2004 and 2010 towards upstream.

Conclusion

From Ch 0.00 km to Ch 30.736 km, a total of ten shoals were present, mostly of which were found to be immobile in the duration of recent six years, i.e., December, 2010 to December, 2016. As analysed, for maintaining Class IV fairway, the minimal dredging of approximately 509 Cu. M is required up to Ch 20.00 km, whereas for the stretch balance till Ch 30.736 (Ch 20.00 km – Ch 30.736 km), a huge quantity of 4.67 lakh Cu. M of dredging is required. Three tributaries are found in the study stretch.

From the satellite images of the above mentioned time periods, it is seen that river bank line experiences some shift during March, 2014 as compared to that in December, 2016. This shift is predominant in the upper stretch of the river i.e. Ch 20.00km onwards. A major change in the bank shape is observed between Ch 11.00km and Ch 13.00km on the left side.

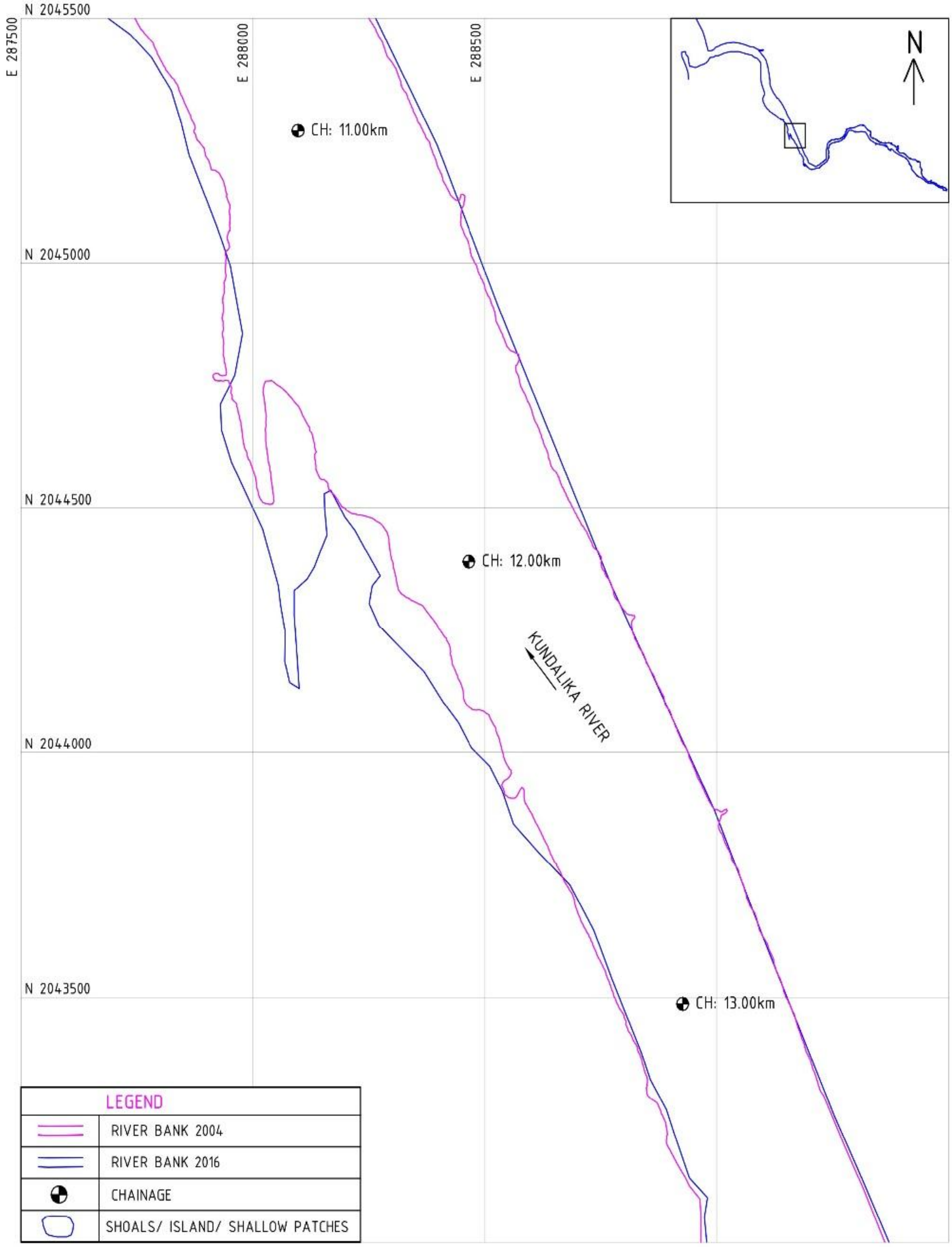


FIGURE 2.39: River bank in 2004 and 2016 in the middle stretch of the river

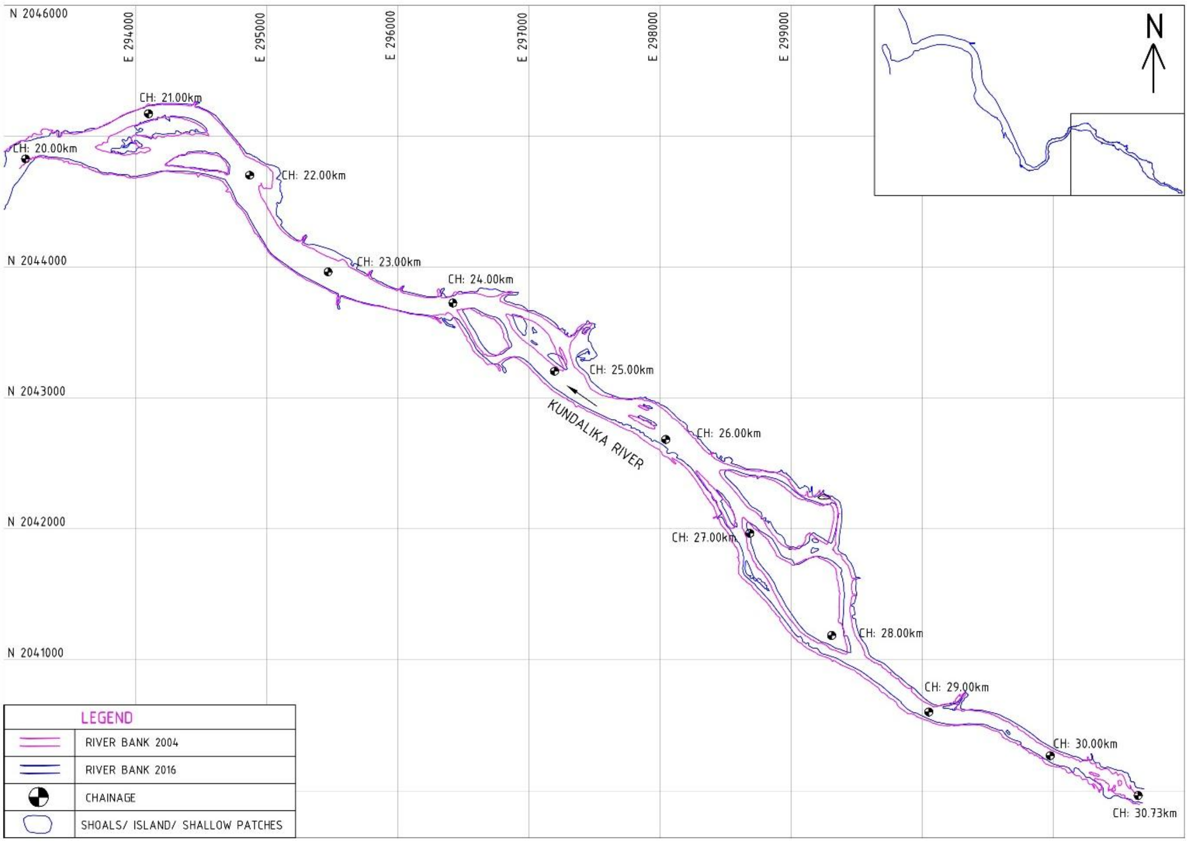


FIGURE 2.40: River bank in 2004 and 2016 in the upper stretch of the river

2.1.2. Existing Hydrological / Topographical Reference levels

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

Sl No	TBM	**Station**	Latitude (N) Longitude (E)	Easting Northing	Height above MSL (m)	Height above CD (m)
01	1.05	KUD -1	18°32'37.7319"N 072°55'51.8250"E	281619.909 E 2051607.081 N	3.007	5.232
02	10.605	KUD -2	18°29'32.5357"N 072°59'37.4343"E	288173.61 E 2045837.60 N	0.406	2.413
03	21.07	KUD -3	18°28'58.0783"N 073°02'48.2870"E	293761.327 E 2044716.707 N	3.456	4.742
04	30.345	KUD -4	18°26'32.9395"N 073°07'00.6545"E	301118.931E 2040175.499 N	2.489	3.085

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

Sl.No.	**Location**	**Latitude**	**Longitude**	**Z0*(m)**
1	Revdanda	18°32'36”	72°55'56”	-2.225

*- *Below Mean Sea Level*

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 Gauge = 13.12.2016, 1700hrs												
	Position of Established Gauge		Lat	18°32'37.6706"N			Position of Established Gauge		Lat	18°29'38.9536"N		
			Long	072°55'51.4585"E					Long	072°59'30.8202"E		
			Name	REVADANDA JETTY, TP-1					Name	KUDE, TP-2		
	At Established Gauge @ 1.060m						At New Gauge 10.610m					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.04	x	1		0.04	-	0.100	x	1		0.10
b	4.271	-	x	1	4.27		4.340	-	x	1	4.34	
c	-	1.098	x	3		3.29	-	0.979	x	3		2.94
d	3.813	-	x	2	7.63		3.740	-	x	2	7.48	
e	-	0.026	x	3		0.08	-	0.395	x	3		1.19
f	4.475	-	x	1	4.48		4.361	-	x	1	4.361	
g	-	1.020	x	1		1.02	-	1.255	x	1		1.26
	Sum of Contribution				16.37	4.43	Sum of Contribution				16.181	5.48
	Observed M. H.W.				4.09		Observed M.H.W.				4.04525	
	Observed M.L.W.					0.55	Observed M.L.W.					0.68
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	3.54	Observed Mean Range = r				=	3.360625
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.32	Observed Mean Level = m'				=	2.364938
	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 Gauge											
	(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 of Zero of Gauge				SD =	0.159	m above Zero of Gauge			

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 Gauge = 13.12.2016, 1700hrs												
	Position of Established Gauge		Lat	18°32'37.6706"N			Position of Established Gauge		Lat	18°28'58.1257"N		
			Long	072°55'51.4585"E					Long	073°02'48.3639"E		
			Name	REVADANDA JETTY, TP-1					Name	GOPHAN, TP-3		
	At Established Gauge @ 1.060m						At New Gauge @ 21.110					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
A	-	0.04	x	1		0.04	-	0.340	x	1		0.34
B	4.271	-	x	1	4.27		4.150	-	x	1	4.15	
C	-	1.098	x	3		3.29	-	0.626	x	3		1.88
D	3.813	-	x	2	7.63		3.700	-	x	2	7.4	
E	-	0.026	x	3		0.08	-	0.467	x	3		1.40
F	4.475	-	x	1	4.48		4.140	-	x	1	4.14	
G	-	1.020	x	1		1.02	-	0.800	x	1		0.80
	Sum of Contribution				16.37	4.43	Sum of Contribution				15.69	4.42
	Observed M. H.W.				4.09		Observed M.H.W.				3.9225	
	Observed M.L.W.					0.55	Observed M.L.W.					0.55
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R R = M.H.W. - M.L.W.				=	3.54	Observed Mean Range = r r = M.H.W. - M.L.W.				=	3.370125
	Observed Mean Level = M' M' = (M.H.W +M.L.W.)/2				=	2.32	Observed Mean Level = m' m' = (M.H.W.+M.L.W.)/2				=	2.237438
	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 Gauge											
	(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 Gauge						SD = 0.025 m above Zero of Gauge					

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 Gauge = 13.12.2016, 1700hrs

Position of Established Gauge	Lat	18°32'37.6706"N	Lat	18°26'32.8232"N
	Long	072°55'51.4585"E	Long	073°07'00.6959"E
	Name	REVADANDA JETTY, TP-1	Name	ROHA, TP-4

At Established Gauge @ 1.060m — At New Gauge @ 30.355m

Sl. No.	Height Above CD HW	Height Above CD LW	Factor		Contribution for HW	Contribution for LW	Height Above CD HW	Height Above CD LW	Factor		Contribution for HW	Contribution for LW
a	-	0.04	x	1		0.04	-	0.110	x	1		0.11
b	4.271	-	x	1	4.27		4.010	-	x	1	4.01	
c	-	1.098	x	3		3.29	-	1.008	x	3		3.02
d	3.813	-	x	2	7.63		3.770	-	x	2	7.54	
e	-	0.026	x	3		0.08	-	0.520	x	3		1.56
f	4.475	-	x	1	4.48		4.290	-	x	1	4.29	
g	-	1.020	x	1		1.02	-	1.050	x	1		1.05
	Sum of Contribution				16.37	4.43	Sum of Contribution				15.84	5.74
	Observed M. H.W.				4.09		Observed M.H.W.				3.96	
	Observed M.L.W.					0.55	Observed M.L.W.					0.72

Note : Observed MHW = Sum of Contribution of HW / 4

Observed MLW = Sum of Contribution of LW / 8

Observed Mean Range = R R = M.H.W. - M.L.W.	=	3.54	Observed Mean Range = r r = M.H.W. - M.L.W.	=	3.242
Observed Mean Level = M' M' = (M.H.W +M.L.W.)/2	=	2.32	Observed Mean Level = m' m' = (M.H.W.+M.L.W.)/2	=	2.339

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 Gauge

(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 Gauge	SD =	0.210	m above Zero of Gauge

2.2. Existing Waterway Structures

2.2.1. Bridges

The details of Bridges crossing the Kundalika River are given in the Table below. The vertical clearance at Revadanda Road Bridge at Ch 0.805km is sufficient for all Class. The last two bridges are beyond study stretch.

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) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	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
1	Revdanda Road Bridge	0.810	RCC	Revadanda	Left Bank: 18°32' 31.13"N 72°55' 46.75"E Right Bank: 18°32'15.57"N 72°55'53.16"E	Left Bank: 2051405.78N 281468.73 E Right Bank: 2050925.15 N 281651.24 E	560	5	11	50	10.5	complete
2	Roha Bridge	30.723	RCC	Roha	Left Bank: 18°26'34.19"N 73° 7'11.48"E Right Bank: 18°26'26.63"N 73° 7'8.66"E	Left Bank: 2040210.65N 301437.00 E Right Bank: 2039979.06 N 301351.84 E	250	10	16	15	5	Under Construction
3	Roha Old Bridge	30.732	Stone	Roha	Left Bank: 18°26'33.96"N 73° 7'11.69"E Right Bank: 18°26'26.94"N 73° 7'9.18"E	Left Bank 2040203.51 N 301443.09 E Right Bank: 2039988.43 N 301367.20 E	250	8	16	15	4.5	complete

MHWS (4.42m from Mumbai port)

2.2.2. Electric Lines / Communication Lines

The details of Electric lines/ Communication lines crossing the Kundalika River are given in the Table below. The vertical clearance required for power cables or telephone lines is 19 m. From the below table it is seen that the HT line at Ch 29.2km near Roha may need modification. The support base of these HT line will have to be raised by 6.7m to get the required clearance.

TABLE 2-7: Details of High Tension Lines

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				Left Bank Right Bank	Left Bank Right Bank				
1	HTL	29.2	Roha	Left Bank: 18°26'59.7596"N 073°06'23.4113"E	Left Bank: 300034.66E 2041011.54N	2	750	12.3	Complete
				Right Bank: 18°26'35.3635"N 73°06'24.1541"E	Right Bank: 300048.61E 2040261.20N				

2.2.3. Pipe Lines / Cables

There are no Pipe lines, under water cables present in the entire survey stretch of Kundalika River.

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

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

2.3. Bends

On the proposed waterway route, there are many bends in Kundalika River, which are given in the Table below. River bend radius as given below is sufficient for Class –V vessel.

TABLE 2-8: River Bend Radius in Kundalika River

Sr. No.	Chainage (Km)	Radius
1	1.86	3850
2	4.45	1550
3	7.42	1600
4	9.13	5080
5	14.92	630

Sr. No.	Chainage (Km)	Radius
6	16.38	520
7	17.73	460
8	18.68	1600
9	19.36	1040
10	19.90	450
11	21.32	740
12	22.30	740
13	23.35	940
14	23.81	490
15	25.61	460
16	27.41	670
17	28.33	1440
18	28.67	470
19	29.00	570
20	29.81	640
21	30.03	560
22	30.29	770

2.4. Velocity and Discharge Details

The details of Velocity and Discharge in the Kundalika 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)
1	1.06	18°32'27.6936"N 072°55'55.3928"E	281721.01 E 2051297.20 N	3.6	1.8	0.916	2126.99	1948.32
2	10.61	18°29'36.4467"N 072°59'23.6365"E	287770.15 E 2045962.36 N	2.7	1.35	0.683	1532.70	1046.83
3	20.830	18°29'04.5476"N 073°02'46.5439"E	293712.34 E 2044916.18 N	3.2	1.6	0.750	696.54	522.41
4	30.075	18°26'34.3026"N 073°07'00.8819"E	301126.04 E 2040217.34 N	0.6	0.3	0.417	44.27	18.46

The period of survey is November-December, which is a normal flow condition. As per the statistics collected, the maximum velocity is 0.916 m/s and discharge is 1948.25 m^3/s at the gauging station i.e., at Ch 1.06km near the confluence of the river with the Arabian Sea.

2.5. Waterway description

Kundalika River (Ch 0.00km – Ch 10.00km)

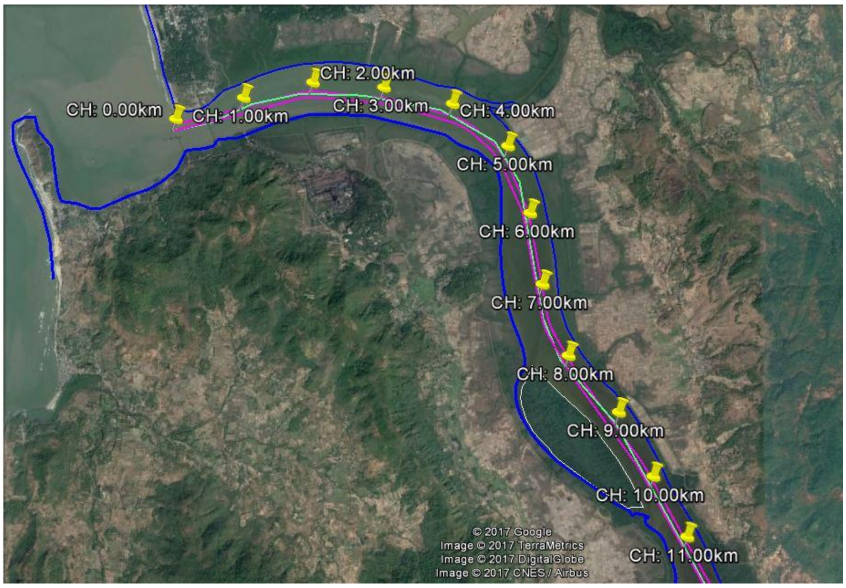


FIGURE 2.41: Kundalika River from Ch 0.00km to Ch 10.00km

TABLE 2-10: Reduced depth from Ch 0.00km to Ch 10.00km

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty.(cu.m)	Cumulative Qty.(cu.m)
		Max	Min			
0	1	8.3	4.9	0	0	0
1	2	6.3	3.8	0	0	0
2	3	4.4	3.4	0	0	0
3	4	4.7	3.9	0	0	0
4	5	6.1	4.5	0	0	0
5	6	5.5	3.3	0	0	0
6	7	6.6	1.8	50	0.57	0.57
7	8	4.9	1.9	50	0.57	1.14
8	9	4.1	2.8	0	0	1.14
9	10	3.5	1.5	150	339.34	340.48

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). There is one bridge at Ch 0.805km. The total length of shoal is 250m. Mangroves are observed on either side of the river. As observed from the charts, the bed slope is 1: 0.00072 in this stretch. The stretch is bounded by places like Agarkot, Salav, Nidi, Bhonang, Yesade and Kude. From the obtained information, it can be concluded that the stretch has potential for navigation some dredging requirement.

Kundalika River (Ch 10.00km – Ch 20.00km)

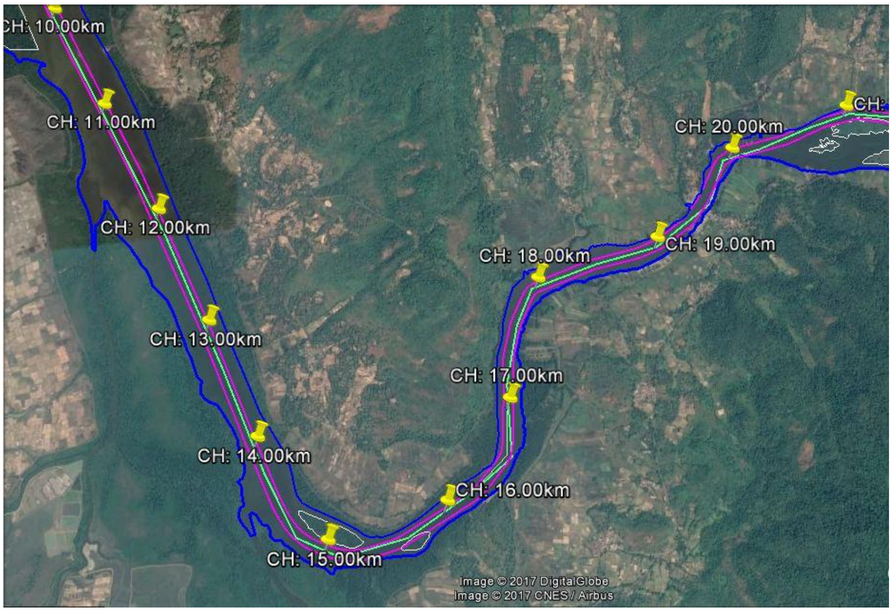


FIGURE 2.42: Kundalika River from Ch 10.00km to Ch 20.00km

TABLE 2-11: Reduced depth from Ch 10.00km to Ch 20.00km

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty.(cu.m)	Cumulative Qty.(cu.m)
		Max	Min			
10	11	4.2	3.0	0.0	0	0
11	12	4.5	3.0	0	0	0
12	13	5.4	2.3	0	0	0
13	14	4.8	2.8	0	0	0
14	15	4.8	1.9	0	0	0
15	16	8.1	3.8	0	0	0
16	17	8.8	2.0	0	0	0
17	18	7.5	3.0	0	0	0
18	19	7.9	2.1	0	0	0
19	20	7.9	2.4	0	0	0

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). There are no cross structures. The total length of shoal is NIL. Mangroves are observed on either side of the river beyond which there are open fields. As observed from the charts, the bed slope is 1:0.00106 in this stretch. The stretch is bounded by places like Satirde, Savroli, Mahalunge, Shedsai and Wavekhar. From the obtained information it can be concluded that the stretch has potential for navigation some dredging requirement.

Kundalika River (Ch 20.00km – Ch 30.736km)

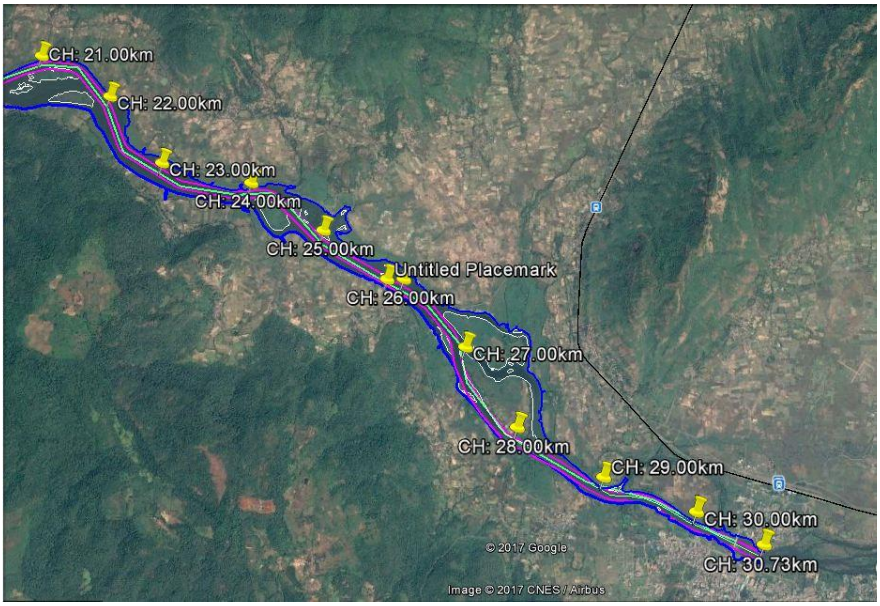


FIGURE 2.43: Kundalika River from Ch 20.00km to Ch 30.736km

TABLE 2-12: Reduced depth from Ch 20.00km to Ch 30.736km

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty.(cu.m)	Cumulative Qty.(cu.m)
		Max	Min			
20	21	4.4	1.8	20	44.18	44.18
21	22	4.5	1.1	250	1845.19	1889.37
22	23	4.6	0.9	350	6767.19	8656.56
23	24	2.4	0.1	850	44589.93	53246.49
24	25	3.0	-0.2	800	41562.41	94808.9
25	26	2.8	-0.9	900	47134.22	141943.12
26	27	3.6	-0.2	900	29231.9	171175.02
27	28	2.4	-0.2	900	49654.03	220829.05

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty.(cu.m)	Cumulative Qty.(cu.m)
		Max	Min			
28	29	1.3	-0.6	900	86355.85	307184.9
29	30	0.7	-0.3	900	109409.97	416594.87
30	30.736	0.3	-0.3	736	80432.52	497027.39

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). One HT line passes the river at Ch 29.2km. The total length of shoal present in this stretch is 7506m. Open fields are observed on either side of the river. As observed from the charts, the bed slope is 1:0.00075 in this stretch. The stretch is bounded by places like Gophan, Dongari, Zolambe, Ashtami and Roha. From the obtained information it can be concluded that the stretch has potential for navigation with some dredging requirement.

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
KUD-1	Revadanda	281721.01 E	2051297.20 N	326	7.36
KUD-2	Kude	287770.15 E	2045962.36 N	517	7.28
KUD-3	Gophan	293713.24 E	2044916.18 N	423	7.41
KUD-4	Roha	301126.04 E	2040217.34 N	602	7.31

The river water is slightly basic in nature with average pH being 7.34

TABLE 2-14: Soil sample results

SAMPLE NO.	LOCATION	Easting	Northing	Specific Gravity	Grain Size Analysis (%)				Cu	Cc
					Gravel	Sand	Silt	Clay		
KUD-1	Revadanda	281721.01 E	2051297.20 N	2.64	0	5	73	22	-	-
KUD-2	Kude	287770.15 E	2045962.36 N	2.59	29	63	8	8	13.684	0.506
KUD-3	Gophan	293713.24 E	2044916.18 N	2.55	0	92	8	8	4.300	1.823
KUD-4	Roha	301126.04 E	2040217.34 N	2.60	46	74	20	6	1060.0	1.348

The river bed is silt loam at Revadanda, sandy loam at Kude and Gophan and Loam at Roha. Thus the river bed can be concluded to be Loamy at most parts with clay sand 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 stretch i.e., up to Ch 20km from the Fairway point of view.

As per the IWT traffic data, the river Kundalika is already being used by JSW Steel plant in this area and Indo Energy International through their captive jetties at Salav and Sanegaon on the right side of the river near the Ch 21km. 3000 T vessels are plying in this stretch by using the tidal advantage. The cargo is of Iron Ore / related and Coal. Hence, the fairway improvements will facilitate the increase in volumes and may facilitate the planned expansion. The Day / Night navigation may be a boost for such operations with quick turn around time etc.

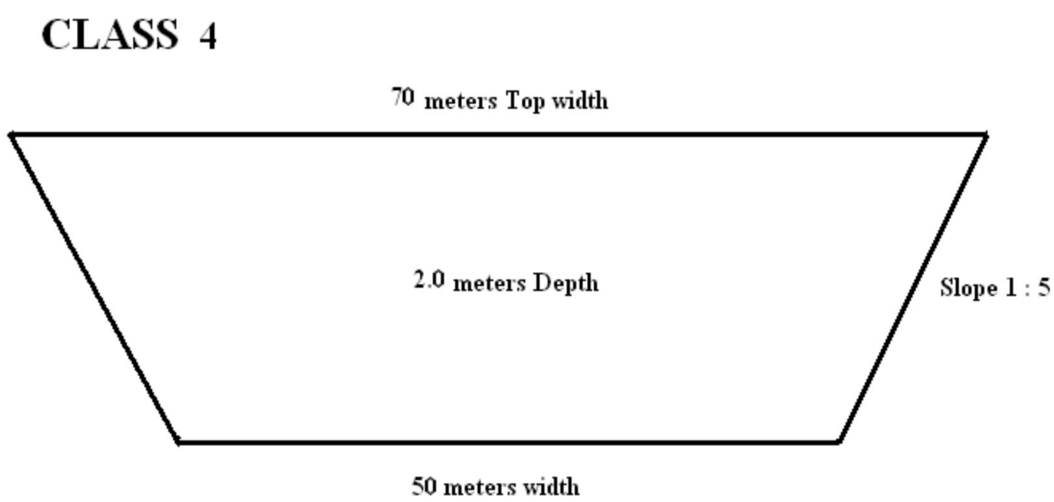
Initial stretch from Ch 0.00km to Ch 21.00km: According to the requirement of the existing stake holders of the region i.e., M/s JSW and M/s Indo Energy International Ltd., and keeping in view the fairway condition, 2000 T vessel mobility with 2 m depth and with Day / Night navigation facilities, uninterrupted 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. 21.00 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 10 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 Sanegaon Jetty area, one Bridge is existing with 50 m HC and 10.5 VC, which is within the Class IV standards. No HTL / LTL are observed up to Sanegaon area.

Stretch up to Ch 26km: There are 2 (Two) Bridges on the waterway at the end of the study stretch, which need not be taken into consideration, since the existing / proposed cargo operation is within the operational area. One HTL is at Ch. 29.20 km having 750 m HC and 12.30 m VC. It is proposed to develop a Terminal of IWAI on the opposite side of Sanegaon near the Ch. 26 km and the development, since restricted up to Ch 26 km, the HTL also need not be taken into consideration. The location at Ch 26 has been considered for development of IWT Terminal of IWAI, so as to provide the infrastructure and upliftment of this area. Further the stretch up stream of this location is having lesser depth and rock out crop have been noticed. Accordingly, the development of Revadanda Creek / Kundalika River has been restricted up to Ch 26 km with ***Class IV*** waterway.

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 80 m Bottom width with 2.5 m depth. The same is not amenable from the fairway development point of view. Accordingly, the Dredging quantities have been worked out for the convoy system as per Indian class of Class IV for the subject study.



Observed						Reduced w. r. t. Sounding Datum			
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.) Per km drg	Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.) Per km drg
From	To	Max.	Min.			Max.	Min.		
0	10					8.3	1.5	250	340.48
10	20	TIDAL ZONE				8.8	1.9	0	0
20	26					4.6	-0.9	3170	141943.1
							Total	3420	142283.6

Accordingly, the shoal length is of 3,420 m and the respective Dredging quantity has been taken as 1.43 Lakhs Cu. M. Considering about 15 % addition for variation, the same is working out to 1.65 Lakhs Cu. M. 10 % of this quantity is being considered as hard strata.

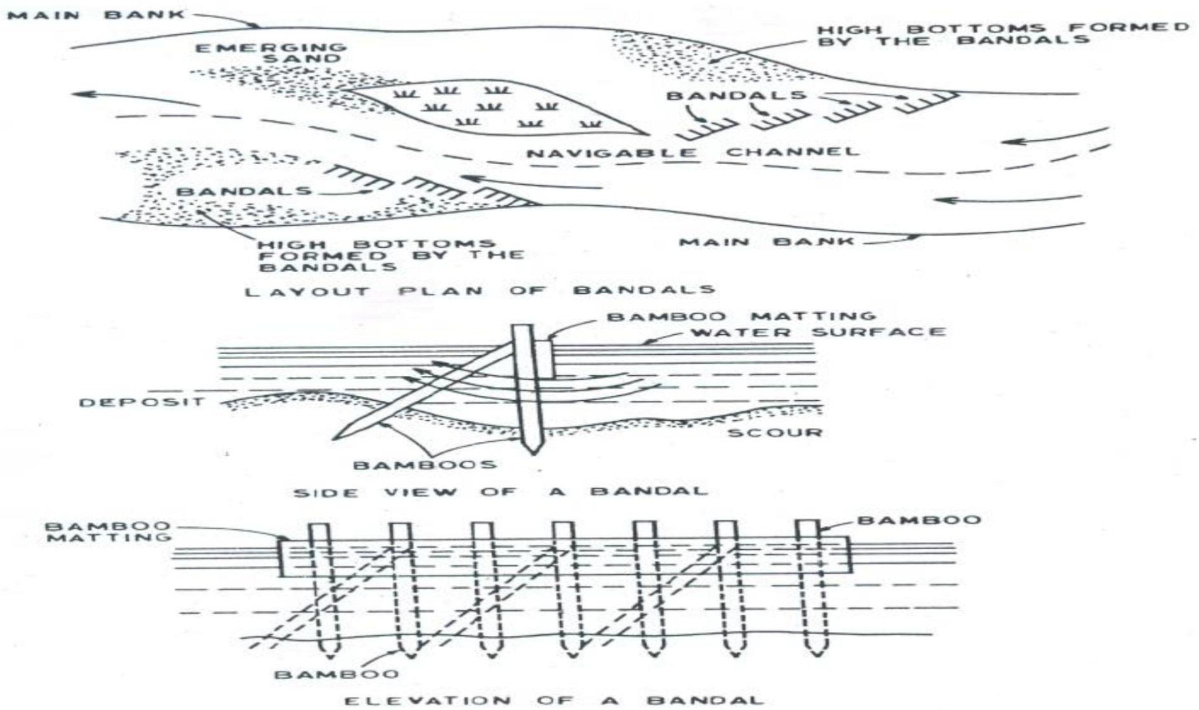
3.3. Proposed Conservancy Activities

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 stretch, up to Ch 26 km, no major divided discharge locations have been observed and hence there is no need of implementation of Bandalling in this stretch.

3.3.2. Dredging

“Dredging” is the removal of sediments and debris from the bottom of lakes, rivers, harbours, 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 harbours). 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 26 km, there is a need of dredging the shoal length of about 3,420 m with an estimated quantity of 1.48 Lakhs Cu. M of general soil which may have to be taken up through CSD. Hard soil Dredging, estimated to be of 17,000 Cu. M, will be considered according to the site requirement at the point of dredging.

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.

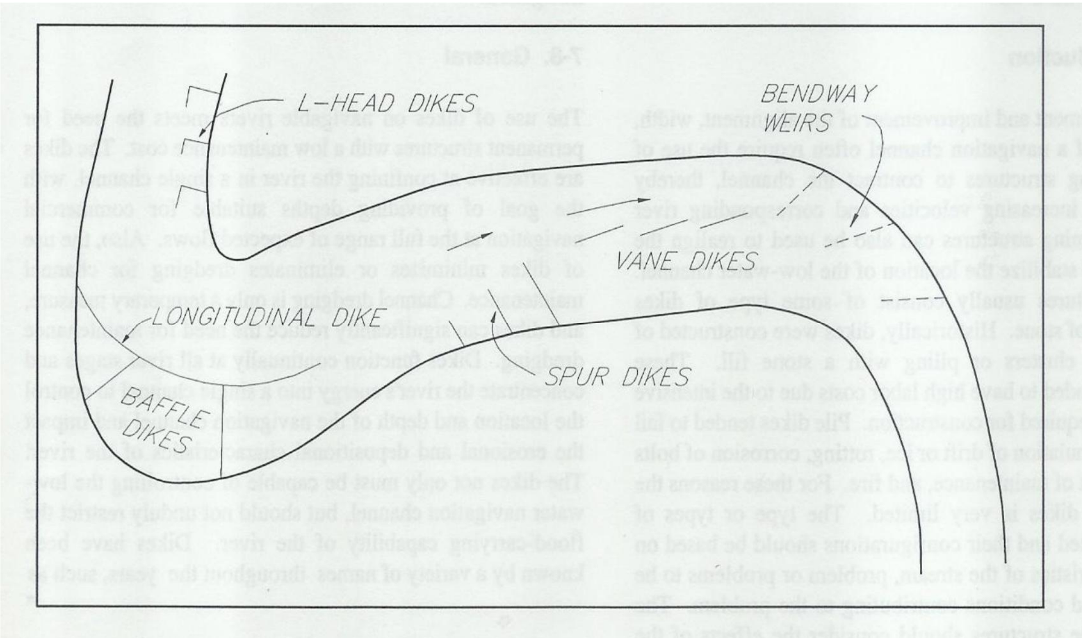


FIGURE 3.1: Types of dike structures

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 Maharashtra, 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.

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.

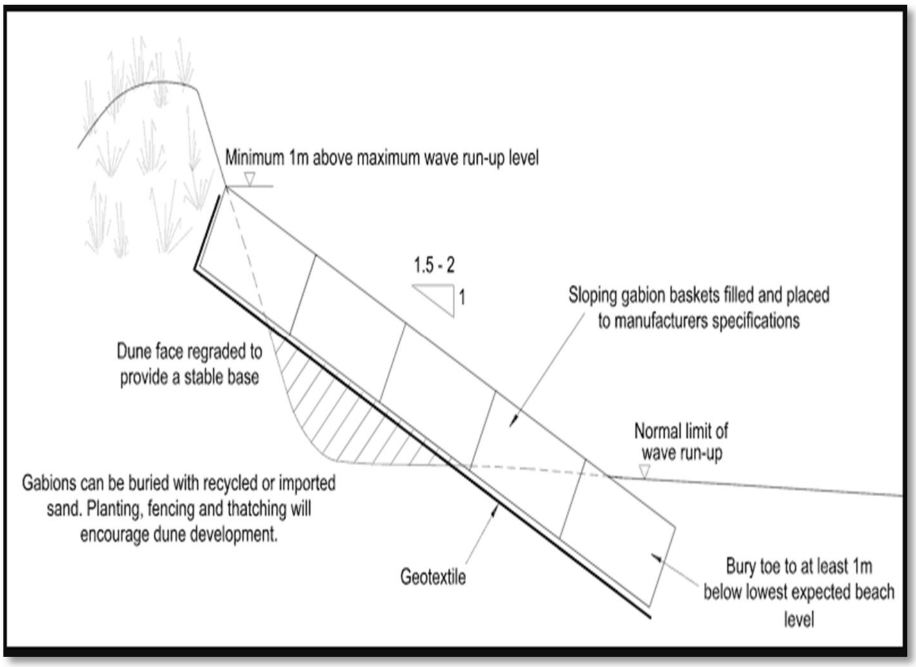
In the study stretch, there is no such location with any River Training requirements.

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 26.00 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, a nominal provision of 4000 m (8 locations @ 500 m at each location) Bank Protection is suggested. The protection work is proposed with the Gabions filled with rocks. The proposed Bank Protection works (each of about 500 m) length are to meet the vulnerable Bend locations at Ch. 14.92 km; Ch. 16.38 km; Ch. 17.73 km; Ch. 19.90 km; Ch. 23.81 km; Ch. 25.61 km and also between Ch. 21 Ch. 22.50 km (about 1000 m). However, this Bank Protection work is suggested for execution only in Phase 2 after observing the river morphological condition, Bank condition at these locations and preferably after the completion of Dredging.

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 with specification, which are placed at Chapter 6, appropriately. 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 Kundalika River, it is only suggested to consider the Beacon Light system, in phase 1. 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 5000 m. Hence, it is proposed to work out the requirement with 5000 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. 26 ~ 30 kms {30000 / 5000 + 10 % approx.} 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. Considering the interval of 500 m, the requirement has been worked to 65 Nos. {30000 / 500 + Bends + 5 % approx.}. A provision of Tug – cum – Buoy laying vessel has been considered, which will act as a multi-purpose vessel. Hence the 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 26 km, the Bridge at Ch. 0.805 Km is having adequate clearance for the proposed Class IV. Hence there is no need of any Bridge modification.

In the stretch, up to Ch 26 km, there is no presence of Power Cable.

No cross structures viz., Dams / Barrages & Locks / Weirs / Anicuts / Aqueducts are observed in the present stretch, up to Ch 26 km. Hence, modification doesn’t arise.

It was understood that a Gas Pipeline is passing across the Creek and informed by one of the stakeholder’s at Ch. 4.5 km between Nidhi – Devparangi in a depth range of about 3.5 m – 4 m. This may have to be dealt appropriately, while carrying out the Dredging duly considering the possibilities of Deep Trenching / Rerouting. However, the depth for deepening cannot be concluded at this DPR forum, since such proposals are to be dealt with by keeping in view the interlinked stake holders holistic requirements and also with due consideration of the mobility of the deep draft vessels.

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

As narrated, the Kundalika River is extensively being used by M/s Indo Rama and M/s Jindal etc. The IWT operations by these major stake holders are having their own captive terminals with handling system at Sanegaon area (Ch. 21 km). Further, M/s Jindal is having an expansion plan for increased cargo mobility. Hence, the development has been segregated into 2 Phases i.e., Phase 1 for fairway development and Phase 2 to meet the hinterland cargo mobility.

Further, the IWAI Terminal development is proposed for the increase in cargo volumes after the saturation of cargo with the existing infrastructure and suggested in Phase 2. The Phase 2 implementation or otherwise will be decided in due course of time.

Accordingly, the Capital Cost for the fairway has been considered for 1.48 Lakhs Cu. M of Dredging in soils + 0.17 Lakhs Cu. M of Dredging in hard strata (INR 4.44 Cr + 1.53 Cr) and 7 Nos. of Beacons with Light (INR 1.38 Cr). Cost estimates are placed with details in Chapter 11 and its Annexures.

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

Kundalika River originates from Sahyadri hills and flows through talukas of Sudhagarh, Roha and Murud in Raigarh district of Maharashtra and merges with Arabian Sea through Revadanda creek at Revadanda. Important towns located on the banks of Kundalika are Chaul, Salav, Roha and Kolad. Kundalika River is fed by the excess water from Tata Power's Mulshi Dam Project on to a series of hydroelectric projects and dams, including Ravalje followed by Bhira and then Dholvan, where the water is released into the River. The navigable length of the River/ Creek is about 31 km from Arabian Sea at Revadanda to the bridge on Roha- Astami Road near Roha Nagar.

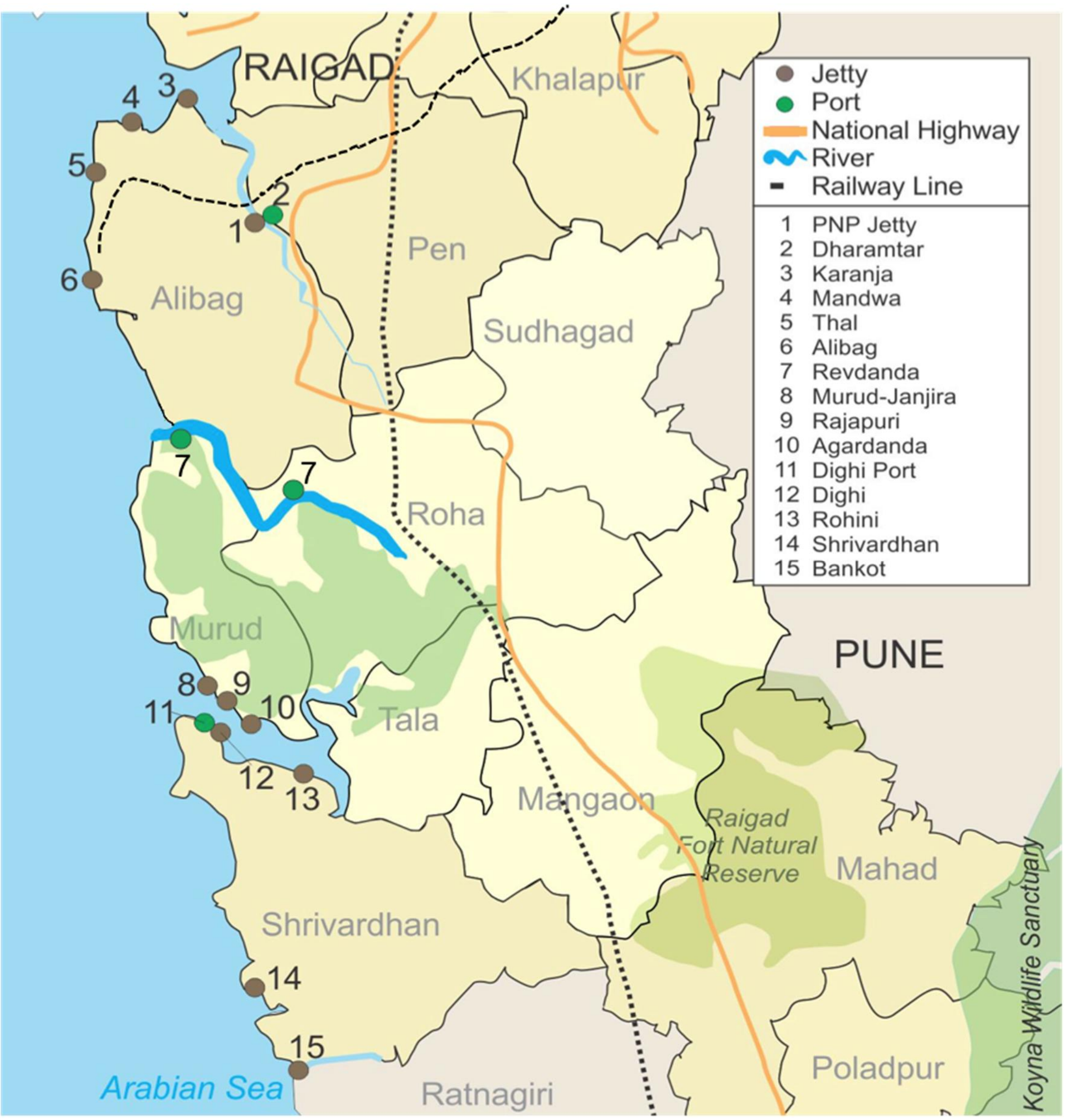


Figure 4-1 Kundalika River Overview

Traffic Study for Kundalika river catchment area constitutes analysis for existing and potential waterway traffic for cargo and passenger, their existing trends of flow between origin and destination and the feasibility of diversion from existing mode of transportation to waterways.

4.2. Hinterland Analysis

The Primary catchment area of Kundalika River that stretches from Roha, which is the end point of the navigable length of the river till Revdanda Port, covers an area of 25 km around the river. The primary catchment area for Kundalika River covers whole of Alibaug taluka on the north side and whole of Murud taluka on south side. Rest of the stretch of the river covers southern part of Pen till Dharamtar Port, whole of Sudhagad, Roha, Tala and central region of Mangaon. Amba River is located on north side of Kundalika River, which is just 10 km away and Savitri River in south within 40 km distance. Kundalika River shares its hinterland with both these rivers. Northern primary catchment area of Kundalika River, which includes Alibaug, Pen & Sudhagad, is also shared by Amba River. Primary catchment area of both Amba & Kundalika river covers major industries, like JSW Steel & Cement plant, Nagothane MIDC, industries located in Pen, one non-major port, i.e. Dharamtar Port & PNP jetty. Though the primary catchment area is shared by both Amba & Kundalika river, but the shared area would prefer Amba River for water transportation because it is already operational for Cargo Movement. Amba River would attract more industrial cargo than Kundalika River. Industries which are located closer to Amba River are already considered in the DPR of Amba River; hence these industries would not be studied for Kundalika River.

In upper secondary catchment area, there exist two major ports, Mumbai Port Trust (MbPT) & JNPT; which are located farther than 50 km from Revdanda Port which is located at the mouth of Kundalika River. These ports & industries located in the nearby region are not taken into consideration for this study because industries are closer to JNPT/MbPT port compared to Revdanda port thereby limiting scope from these regions.

Lower secondary catchment area is spread from Southern region of Mangaon, whole of Shrivardhan, Mahad, Mhasla & north of Ratnagiri. But all these talukas come under primary catchment area of Savitri River. Amba River in North & Savitri River in South of Kundalika River restrict the catchment area of Kundalika. Primary hinterland in North & whole of secondary hinterland of Kundalika River do not hold any market potential.

Murud, Roha, Tala & Mangao which are talukas of Raigad district, come under the hinterland of Kundalika River. There exist two operational jetties namely Sanegaon & Salav jetty for cargo handling on Kundalika River. There also exists one non-major port i.e. Dighi port.

Raigad district is in close proximity to Mumbai. Natural resources like soil, water are favorable for agriculture and horticulture in the district. There is good road connectivity in the district, but not all villages and rural areas are connected via good road or state highway.

4.2.1. Demography Profile of Hinterland

In the primary catchment area of Kundalika River, Roha & Mangao are densely populated areas compared to Murud & Tala. Mangaon is the central position for 3 MIDCs namely Vile-Bhagad MIDC, Mahad-Birwadi MIDC & Roha- Dhaatav MIDC. It is the biggest industrial area after Roha, amongst all 4 talukas considered in the catchment area of Kundalika River. It is also the major junction for all nearby tourist places like Harihareshwar, Shrivardhan etc. Mangaon is going to be developed as the major city in the region due to the impact of Raigad's development plans.

Table 4-1 Taluka wise population around Kundalika river

Taluka	Population	Area in Sq. km	No. of villages
Mangaon	1,59,613	683	187
Murud	74,207	231	74
Roha	1,67,110	643	162
Tala	40,619	250	61

Source: Census, 2011

The above table clearly shows that Mangaon has the biggest land area among other talukas and highest number of villages. The reason is abundance of industrial units and beaches in and around Alibaug, which attract large population in the region. Sudagarh has the least number of villages and population. There exists Sudhagad fort, which is 2,000 feet above the sea level. There exists medium to low opportunity for people living in these talukas due to availability of various types of industries and MIDCs.

4.2.2. Economic profile of Maharashtra

There has been many developments in Navi Mumbai in past few years, which have helped to boost the economy of Raigad district. Petrochemical, Iron & Steel industries of Raigad have helped in urbanization of the district. GSDP of Maharashtra in FY 16 was the highest among all other states of India. Maharashtra contributed 13% to GSDP of India; GSDP in FY 16 was US $300.51 billion. Mumbai & Pune are the two major cities, whose contribution to GSDP is comparatively higher in the state. Due to dominating existence of many small-scale industries, Maharashtra is considered as an industrialised state. Following table shows Gross State Domestic Product prices of Maharashtra.

Table 4-2 Historic GSDP of Maharashtra

Year	Primary	Secondary	Tertiary	GSDP
2005	48,418	1,19,531	2,47,531	4,15,480
2009	81,001	2,30,921	4,42,048	7,53,970
2010	93,988	2,49,698	5,12,065	8,55,751
2011	1,34,356	3,06,571	6,08,223	10,49,150
2012	1,40,314	3,25,096	7,04,711	11,70,121
2013	1,48,710	3,67,979	8,05,534	13,22,222
2014	1,76,016	4,05,002	9,29,115	15,10,132

Source: GOG, Directorate of planning, statistics, evaluation

The table below shows sector wise annual growth rates of GSDP. In Fy 15, Primary sector has witnessed major decrease. Secondary and Tertiary sector in Fy 15 have also decreased compared to GSDP of Fy 14.

Table 4-3 Sector wise annual growth rates of GSDP

(%)

Sector	2013	2014	2015
Primary	0.5	7.7	-8.5
Secondary	9.2	4.5	4
Tertiary	8.1	8.6	8.1

Source: DES, GoM

The below chart shows primary, secondary & tertiary sectors of Economy of Maharashtra.

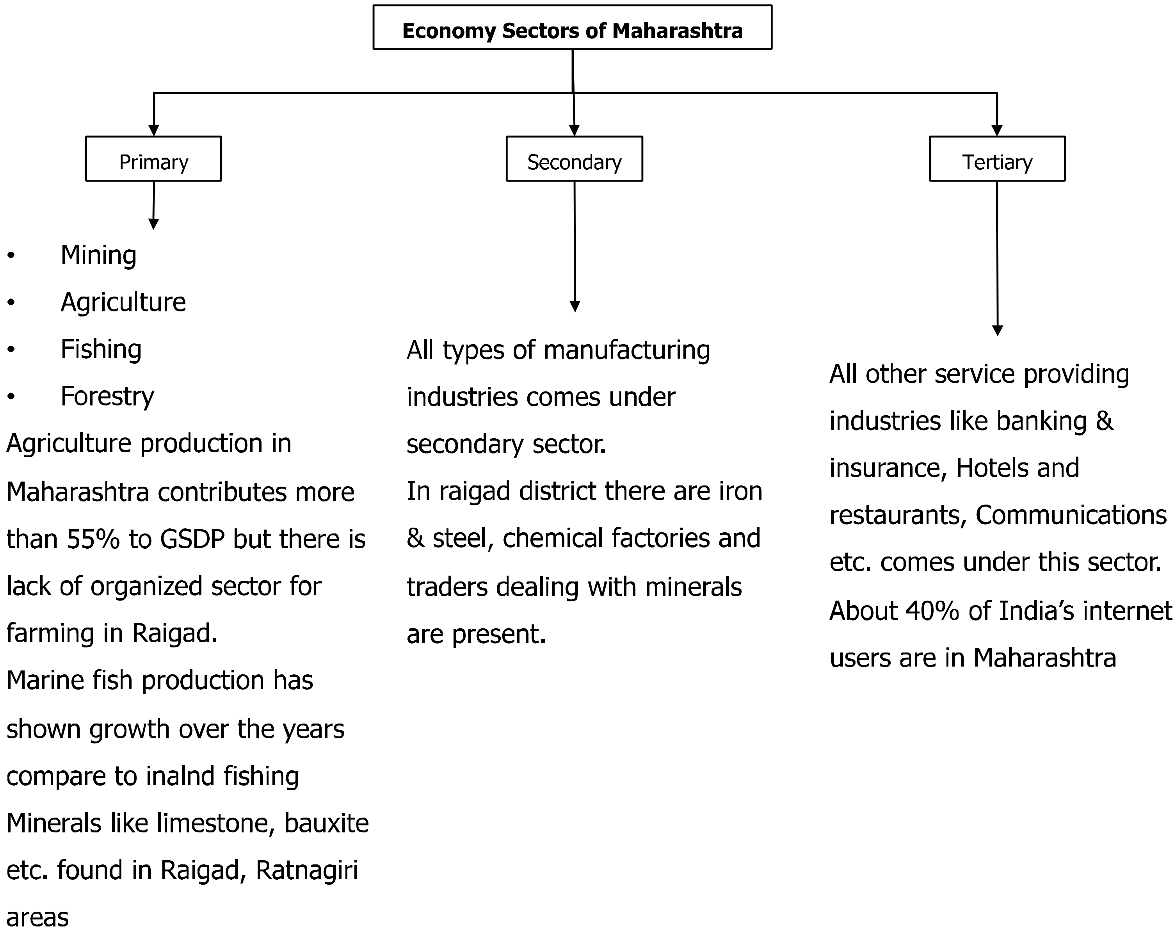


Figure 4-2 Sectors of Maharashtra

4.2.2.1 PRIMARY SECTOR

Primary sector consists of Agriculture, Forestry, Fishing and Mining. The table shows that whereas Agriculture, Forestry and Fishing sections witness growth, Mining segment has witnessed decrease since Fy 13.

Table 4-4 Historic growth in Primary sector of Maharashtra

(Cr.)

Primary Sector	2009	2010	2011	2012	2013	2014
Agriculture	41,549	43,286	54,016	51,633	51,282	55,441
Forestry	10,775	9,610	10,227	10,862	11,508	12,258
Fishing	1,484	1,461	1,504	1,570	1,594	1,613
Mining	3,571	3,760	3,897	4,135	4,161	3,799

Source: Directorate of Economics & Statistics, MH

a. Agriculture

Agriculture sector contributes as a prominent sector to the economy of Raigad district. Mango and Cashew are two major commercial crops of Raigad district. There are two regions in the agriculture sector- Sea Shore region in Roha & Murud and Hill Top region in Mangaon & Tala.

Following table describes major agriculture productions in the catchment area of Kundalika River.

Table 4-5 Agriculture production in the catchment area of Kundalika river

Taluka	Rice		Nachni		Tur Pulse		Total
	Area (Ha)	Production (MT)	Area (Ha)	Area (Ha)	Area (Ha)	Production (MT)	Production (MT)
Roha	10,304	30,912	519	467	101	81	31,460
Murud	3,115	9.345	20	18	240	192	9,555

Source: FSR Study

Agriculture is the most significant sector providing employment opportunity to about 56% people. However, its contribution to economy of Maharashtra is declining over time because of unfavorable climatic condition and growth of other sectors, especially service sector.

b. Fishing

There are more than 90% traditional fishermen operating in whole Maharashtra. It is observed that inland fishing activity in Kundalika River takes place in a very small scale. Local people of villages located on the bank of river mostly depend on coastal fishing.

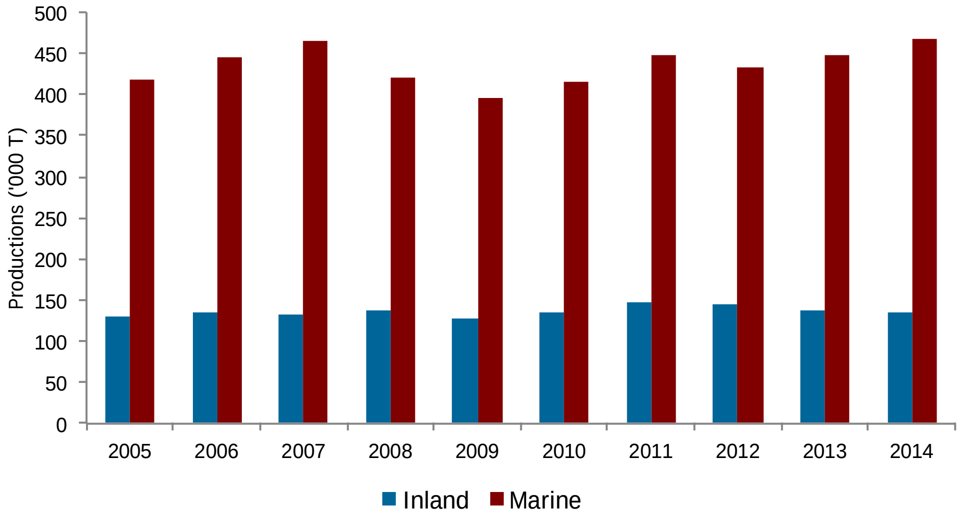


Figure 4-3 Fish production in Maharashtra

The above graph represents fish production in whole Maharashtra. It is clearly visible that marine fish production is more than inland fish production. As Kundalika River is used for cargo handling purpose, encouraging fishing activity may not prove fruitful.

At present no fishing activity in large scale is found in Kundalika River. However, in the catchment area of the river, there are few fish landing points where fishing is carried out. Following table depicts total fish production in Raigad district. Only Revdanda & Murud talukas have fish production in the catchment area of Kundalika River.

Table 4-6 Historic fish production in the hinterland of Kundalika river

(Tonnes)

Location	2005	2006	2007	2008	2009
Revdanda	4,507	4,719	5,381	4,414	6,707
Murud	6,703	7,476	6,108	5,107	5,134
Total	**11,210**	**12,195**	**11,489**	**9,521**	**11,841**

Source: Department of Fisheries, MH

It can be seen from the above table that Murud is the major fish production center and contributes about 17% to entire Raigad district's total fish catch. Revdanda is located near the mouth of Kundalika River and contributes 11% of total fish catch. The volume of fish catch in Kundalika River and its catchment area is very less; hence fishing sector would not provide any opportunity for the proposed waterway in Kundalika River. There is limited scope for development of fish related activity in the river.

c. Forestry

Total forest area of Raigad district is 1,725 sq. km., out of which 1,465 sq. km. forest is reserved, 135 sq. km is protected and 125 sq. km. of forest is unorganised. Dense forest is spread over an area of 566 sq. km. In Raigad district, there exist Phansad Wildlife Sanctuary and Karnala Bird Sanctuary.

4.2.2.2 SECONDARY SECTOR

Manufacturing industries, Electricity, Gas, Water supply providing and construction companies come under secondary sector. There are iron & Steel, Chemical manufacturing industries in Raigad region. The table below presents GSDP of various types of industries that come under Secondary sector in the catchment of Kundalika River.

Table 4-7 GSDP by industry of origin

(Cr.)

Secondary Sector	2009	2010	2011	2012	2013	2014
Industry	2,36,089	2,55,108	3,11,591	3,31,343	3,74,219	4,10,789
Registered Manufacturing	1,20,748	1,28,812	1,61,529	1,67,853	1,95,185	1,98,919
Unregistered Manufacturing	46,437	51,147	59,312	60,414	63,174	74,312
Construction	52,512	55,658	68,368	79,277	85,553	94,878
Other	11,224	14,081	17,363	17,552	24,067	36,893
Total	**4,67,010**	**5,04,806**	**6,18,163**	**6,56,439**	**7,42,198**	**8,15,791**

Source: Directorate of Economics & Statistics, MH

4.2.2.3 TERTIARY SECTOR

Hotels, Restaurants, Transport, storage and other communication industries, Banking & insurance, Public administration etc. come under tertiary sector. Tertiary sector has grown steadily over the years. Growth in service sector affects the overall development of the state's economy.

4.2.2.4 INFRASTRUCTURE ANALYSIS

Infrastructure is crucial in the development of a region. It is also essential to understand various types of existing and upcoming infrastructure around Kundalika River, as they would provide support and connectivity for waterway with other modes of transportation. It becomes backbone for any new development.

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.

a. Roadway

National Highway 66 is the major and only national highway that passes through Roha, Pen and Mangaon talukas. It connects the cities of Mumbai – Madgaon – Mangaluru – Kochi, covering the states like Maharashtra, Goa, Karnataka and Kerala along the Indian west coast. NH 66, which stretches between Mumbai and Goa, is being converted to four-lane highway from the existing two lanes and also being concretised. The construction work is expected to be completed by June 2018. The state highways SH 88, SH 89, SH 91, SH 99 and SH 104 cover Pen, Alibaug and Mangaon talukas, providing inter taluka connectivity. The district roads in the talukas also provide adequate connectivity.

b. Railway

There are 10 stations of Konkan Railway in the catchment area of Kundalika River, with the major stations being Pen, Nagothane, Roha and Kolad. The Konkan Railway operates its highly successful and one of its kind Ro-Ro service, wherein loaded goods trucks are mounted on rail wagons and transported. These loaded trucks, then get down at their respective drop off points on the Konkan rail route. The Konkan Railway operates two freight routes from Kolad, one is between Kolad & Verna and the other is between Kolad & Surathkal. Verna and Surathkal are the drop off points for these freight routes. On an average, 50 trucks are loaded per rake and 3 rakes are loaded per day. The Konkan Railway operates the Ro-Ro about 2-3 times per week on its rail route.

c. Airport

Maharashtra state has both international & domestic airports. Two international airports serve the catchment area of Kundalika River, Chhatrapati Shivaji International Airport in Mumbai and Goa International Airport in Dabolim, Goa. Chhatrapati Shivaji International Airport is 75 km away from Kundalika River and Goa International Airport in Dabolim, Goa is 435 km away from the river. There exists one domestic airport in Pune, which is 115 km away from the river.

4.2.2.6 EXISTING INFRASTRUCTURE

Figure 4-4 shows the existing infrastructure on Kundalika River. The below 2 images show the ongoing fishing activity at the mouth of the river with small fishing boats. Fish catch is very less in volume, which is locally consumed. The lower left image shows the coal handling activity at Sanegaon Jetty. This jetty imports coal from other countries and further distributes to the industries in nearby regions. Lower right image shows the bridge, crossing over Kundalika near Revdanda.

Figure 4-4 Infrastructure in the catchment area of Kundalika River

Source: Consultant's Site Visit

Following table summarizes existing landing points for passenger, fish and cargo on the catchment area of Kundalika River.

Table 4-8 Type of jetties in the catchment area of Kundalika River

Name	Passenger	Fishing	Natural Landing Point	Cargo	Total
Revdanda	2	13	14	2	31
Borli Mandala	-	1	1	-	2
Nadgaon	-	1	7	-	8
Murud	1	1	3	-	5
Rajpuri	4	2	-	1	7
Mandad	-	7	4	-	11
Dighi	2	4	2	2	10
Total	**9**	**29**	**31**	**5**	**74**

Source: MMB

a. Sanegaon Jetty

Indo Energy International Limited (IEIL) owns Sanegaon jetty. The 200 m existing jetty is 21 km upstream and has 5 hectare backup area for storage, handling and dispatch of coal. The clearance between intermediate bridge piers is 36 m. IEIL currently trades coal using the lighterage facility on the right bank of Kundalika River at Sanegaon. The following table shows volume of imported coal, handled at Sanegaon jetty.

Table 4-9 Coal imported at Sanegaon Jetty

Year	Coal Import (MT)
Fy 11	304,542
Fy 12	340,557
Fy 13	736,378
Fy 14	523,285
Fy 15	744,997
Fy 16	1,201,514

Source: IEIL

Existing facilities at Kundalika River includes anchorage handling and barging to Sanegaon Terminal. Coal gets imported from Africa, Indonesia & Australia to the terminal and further moved to railhead at Roha to be transported to the industries, located in Khopoli & nearby regions. In Fy 16, Indo Energy imported 1.2 mn T of coal at this jetty, which is further distributed to Khopoli industrial area and other small industries in the nearby MIDC's. (List of these small units is not available in any source, as it is kept confidential by Port.)

Coal would provide good opportunity for the proposed waterway in Kundalika, as demand for coal is likely to increase in future for power generation. Apart from small units, in future River Kundalika could also attract the major coal importers like Uttam Galva, Coastal Energy, Turian Iron & Steel, Gupta Coal, Mercator Lines, etc. These are some of the prominent industries that used to handle coal at MbPT before the ban imposition i.e. 2017. Aforementioned industries would have either shifted to Dharamtar Port or Revdanda Port to continue their operations.

b. Salav Jetty

JSW Steel operates the Jetty at Revdanda creek in Salav village near Korlai. Located at the mouth of Kundalika River, beside the Revdanda-Murud Bridge, Salav jetty is a captive facility. Operation at Salav was temporarily suspended since August 2015, due to the shutdown of Dolvi plant (because of capacity expansion). JSW Salav resumed its operation in March 2016.

This captive jetty, with its existing length of 235 m, handles 3.0 MT cargo of JSW Pallet and DRI plant. Barges of 3,000 DWT size handle the cargo at this existing jetty. Iron Ore Fines, Iron Ore Lumpy & Iron Pallet are majorly handled at the jetty.

4.2.2.7 UPCOMING INFRASTRUCTURE

a. **Expansion of Sanegaon Jetty**

The proposed expansion plan of Sanegaon Jetty includes capacity expansion at the Inland Water Facility by upgrading the existing equipment and having year round operations at the Jetty.

b. **Expansion of Salav Jetty**

JSW Salav has proposed to construct a new jetty, adjacent to the existing Salav jetty. After the completion of the construction, the existing jetty would be demolished and reconstructed for capacity expansion. The MOU has already been signed and Maharashtra Maritime Board has issued authorization for 500 m water expansion of port facility. The jetty expansion plan intends to serve the current facility and its expansion at Salav, which includes supply of raw material for the new setup of 3 MTPA Coke Oven plant and 5 MTPA Steel plant. The development of new jetty at the current site with expanded capacity will have the ability to handle 21 MT of raw material for 10 MT of finished goods.

c. **Korlai Port**

IEIL's proposed plans include development of Deep Water Facility at Korlai Village in Raigad district, on the left bank of Kundalika river along with the expansion of existing Inland Water Jetty facility at Sanegaon village in Raigad district on the right bank of Kundalika River. Location for the development of proposed Deep Water Facility is at north east of Rat Island. The plan is to develop facility for Panamax size vessels as a direct berthing port.

4.2.3. Existing & Proposed Industries

Many industries are setting up plants in Raigad district, away from Mumbai's city life and road congestion problem. More people are attracted to industrial sector for employment opportunities, which leads to shortage of labour for farming related activities. The table below shows Large, Medium and Small types of Industries in Raigad district.

Table 4-10 Industrial Profile of Raigad District

Large	Medium	Small
Food Processing	Horticulture	Rice mill
Repairs of Agri Implements	Bamboo, Bricks	Packing material
Idol making for festival	Auto parts	Rubber, Plastic product
Fish and products	Electrical equipment	Stone blasting

Source: Industrial State Profile of MH

The following table shows the type of industries in the catchment of Kundalika River and their distance from the existing ports and Kundalika River.

TABLE 4-11: Existing Industries in the catchment of Kundalika River

Location	Industries	Category	Distance to Port		Opportunity	Reasoning
			Via River	Road		
MIDC, Dhatav	Excel Industries	Chemicals	71	42	✗	Industries located in Roha industrial area provide no scope for the proposed waterway. This area is well connected with roadways. Industries in Roha have good connectivity to Dighi Port by roadways, so they would not use waterway.
	PepsiCo India Pvt. Holdings India	Food & Beverages	77	45	✗	
	Maharashtra Seamless	Pipes	109	61	✗	
	BEC Chemicals	Pharmaceutical	78	45	✗	
MIDC, Vile Bhagad	Pioneer Gas Power Ltd	Gas	140	78	✗	The MIDC is located 40 km away from river. The distance through waterway is higher than roadway. Dighi port is nearer by roadways rather than through waterway; hence using Kundalika river is out of scope.
	Posco Maharashtra Steel	Steel	144	73	✗	
MIDC, Usar	GAIL	LPG Recovery Plant	52	51	✗	These industries do not use Dighi Port for trading; hence they would not provide any opportunity for Kundalika river.
	HPCL	Bottling Plant	55	52	✗	
Salav	JSW Steel, Salav	Steel	40	42	✗	Both the plants are situated on the coastal region of Kundalika river. They are located within 5 km from the river. These industries have their own infrastructure for cargo handling, on the bank of the river. Cargo is directly handled at jetty from/to the plant; hence these plants would not provide opportunity for the proposed waterway.
	Welspun Maxsteel	Sponge Iron	43	42	✗	

Source: Consultant's Analysis

Industrial clusters in the catchment area of Kundalika river are shown in the below map Figure 4-5. Salav, Usar, Dhatav and Roha are the clusters, located within the hinterland of Kundalika River. These industrial clusters are located within 25 km from the river. Vile Bhagad MIDC comes in the secondary catchment area, as it is located 30 km away from the river. At present none of the clusters is using Kundalika rive for cargo transportation.

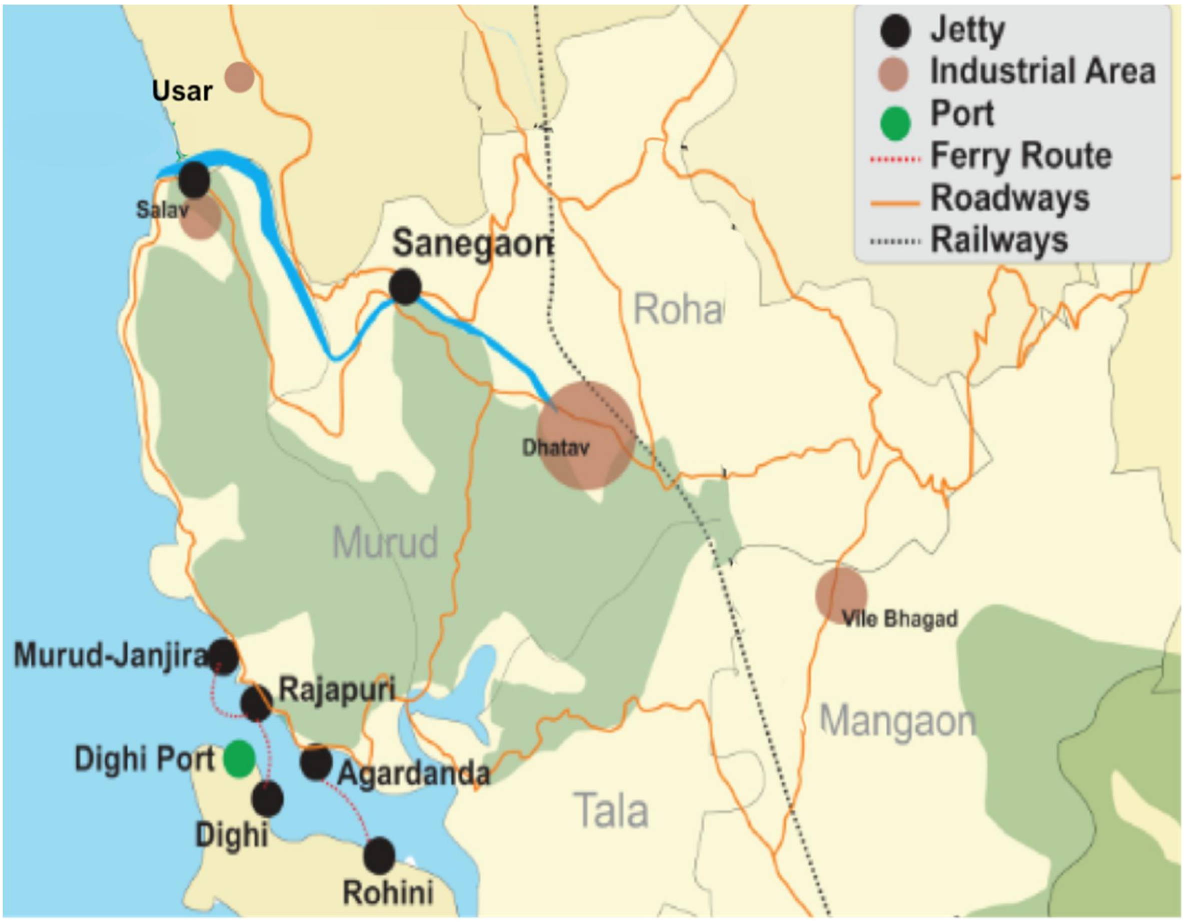


Figure 4-5 Infrastructure in the catchment area of Kundalika River

4.2.3.1 VILE BHAGAD MIDC

MIDC, Vile Bhagad area is well connected by roads, State highway 97 and MIDC road. Delhi Mumbai Industrial Corridor Development Corporation is planning to set up a power plant in Vile Bhagad. The Dhabhol- Dahej Pipe line of GAIL Gas is at a distance of only 8 km from Kundalika River. The close proximity provides power consumers the ease of complete power evacuation within 4 km.

(PGPL) incorporated as a Public Limited Company, is setting up a 388 MW Gas Based Combined Cycle Power Plant (CCPP) at Vile Bhagad, in Mangaon Taluka. The site is located near Mumbai-Goa National highway (NH-17).

POSCO Maharashtra Steel is located in Vile-Bhagad Industrial Area, in Mangaon Taluka. It provides high quality Galvanized and Galva annealed steel that are applicable to all types of industries, such as construction, home appliance, and automotive industries.

4.2.3.2 DHATAV MIDC

This huge industrial set up is declared as chemical industry zone by Maharashtra Industrial Development Corporation. It has many industrial units; majority are chemical process industries. Located at a distance of 5 km from Roha, these industries are connected through rail by Roha railway station. The nearby town connected via road is Murud. Murud has good rail/road connectivity.

BEC Chemicals Private Limited is located in Roha. Its present capacity of handling powder products is around 300 MT/year. There is an adequate provision for further expansion. It is well connected with Road, Rail and airways. The nearest airport is in Mumbai. BEC is specialized in manufacturing of Active pharmaceutical Ingredients (API's) and Intermediates.

Excel Industries is one of India's first domestic chemical manufacturers. The plant is located in Roha, which is fully certified for quality and EHS and is an important member of the local community. The plant is in process of constructing a facility for production of Organophosphorous (OP) Insecticide on campaign basis. The industry's Roha plant is the hub for producing a number of phosphorus based products. It handles high quantity of yellow phosphorus in India. Roha plant manufactures a wide range of chemical inputs along with key polymer additives and specialty chemicals.

Excel industries is also planning to undertake civil and structural work for a multi-purpose plant during Fy 17. Excel industries also have a plant in Lote, Chiplun; for which the company has plans to add a new API production facility. This is to aid the commercial launch of new APIs and expand their API product range.

4.2.3.3 USAR MIDC

At present there are only two industries operational in production segment, namely GAIL India & HPCL. GAIL India Ltd has a LPG recovery plant and Hindustan Petroleum Corporation has a bottling plant in Usar with daily capacity of 30,000 CYL. This area is well connected by road. The nearest road is state highway 91. There is no railway station within 10 km proximity.

4.2.3.4 SALAV

JSW steel is a manufacturer of basic Iron and Steel. It is engaged in manufacture of value added steel products, which mainly consists of Galvanized and Galvalume coils/sheets and Color Coated coils/sheets. JSW Steel Coated caters to both domestic and international markets. JSW has expansion plans for Dolvi & Salav. It has plans to set up a steel unit with a capacity of 3 million TPA at Salav, near Kundalika River. The expansion plan of Dolvi plant is to increase its capacity from 3.3 MTPA to 5 MTPA, which includes commissioning of 2.5 MTPA new Sinter Plant.

4.2.3.5 INDO ENERGY INTERNATIONAL LTD.

Indo Energy International Ltd. is an unlisted non-governmental Public company, which is involved in Inland water transport. It is a sister concern of Esquire Shipping and Private Ltd and provides all shipping related services. The company owns a multi-purpose 200 m port facility (jetty) at Sanegaon village of Roha taluka, since 2009. The company is in international trading through sea transportation. It handles export/import of bulk cargoes like Steam Coal, Iron Ore, Bauxite, Limestone, Sulphur etc. It also offers survey and consultancy services as well as port infrastructure development.

Diversion from Industries

Many industries are located in the catchment of Kundalika River. Kundalika River is surrounded by Usar MIDC, Dhatav MIDC, Vile Bhagad MIDC & Salav industrial areas, but very few of them use Ports of Revdanda to export/import their cargo. The below listed companies use Ports of Revdanda and the table presents the potential for diversion cargo of these companies from existing mode of transportation to waterways.

Table 4-12 Industries around Kundalika River using Revdanda Port

(Production in MT)

Company	Commodity	Fy 15	FY 16	Potential	Reasoning
Welspun Maxsteel	I O Lumpy	265,862	-	✗	The company is located at the mouth of Kundalika river and has its own captive jetty, which is located just 3 km from the industry.
	I O Fine	80,300	33,431	✗	
	I O Pellets	216,690	2,301	✗	
Indo Energy International (IEIL)	Coal	239,981		✓	IEIL has its own captive jetty at Sanegaon for handling imported
	Coal in bulk	341,326	1,292,619	✓	

Company	Commodity	Fy 15	FY 16	Potential	Reasoning
					coal. Mother vessels are handled at the Anchorage of Revdanda and through lighterage operation coal is further moved to Sanegaon Jetty. Khopoli Industrial area and some nearby small industrial units are the final destination of imported coal at Sanegaon Jetty. Kundalika river is already operational for cargo movement i.e. coal and in future its volume is likely increase. This creates good potential for any new development on the defined stretch.
	Rock Phosphate	-	16,111	✗	Volume is too low to be diverted to the waterway; hence provides no opportunity.

Company	Commodity	Fy 15	FY 16	Potential	Reasoning
Total		**1,053,829**	**1,144,160**		

Source: Consultant's Analysis

4.2.4. Traffic from Major & Non Major Ports

The decline in the traffic of major ports has been a boon to the non-major ports of the state. These ports recorded a cumulative growth of 17% per annum in the last five years. This has been due to large investment in the port sector by the government and the private companies. Raw material requirement for major industries have boosted the growth of the non-major ports of Maharashtra. Coal and iron ore have recorded a substantial share in the overall traffic. There is still a large gap between demand and supply in container and fertilizer segment.

4.2.4.1. NON MAJOR PORTS

The state has developed several private ports and captive ports. These ports have put a large investment on the infrastructural development and have evolved as an option to industries located far off from the major ports, such as Mumbai Port Trust and JNPT. Non-Major ports have experienced boost in traffic only in the last 5 years; they have grown at a rate of 29%. The traffic increase was majorly due to increase in import, which was more than 15 mn tonnes from overseas in last five years. This increase in import is more than double the growth rate in last 10 years.

Three non-major ports exist in the primary catchment area of Kundalika River, namely Dharamtar, Revdanda & Dighi. Out of these three, only Dighi & Revdanda are considered for traffic analysis in this report. Dharamtar Port is located on Amba River and would not provide any potential for Kundalika River. This port is already analysed for the study of Amba River. The following table shows the existing infrastructure at Revdanda & Dighi port.

Table 4-13 Infrastructure at the Existing Ports

Port	Volume ('000 mn T)	Draft (m)	Berth (No.)	Type	DWT ('000 T)	Commodities
Dighi	785	12.5	2	Greenfield Port	155	Bauxite, Coal & Steel
Revdanda	1,344	4	2 Jetty	Anchorage Port	-	Iron Ores & Coal

Source: IPA

Revdanda Port is an anchorage port that is located at the mouth of Kundalika River. Welspun Maxsteel & Indo Energy operates lighterage facilities at Revdanda port for their captive jetty at Salav and Sanegaon respectively. Traffic handled by both the jetties makes the total volume handled by Revdanda Port. Major commodities handled at the port are Iron Ore, Coal & Minerals.

Dighi Port is located at the bank of Rajpuri Creek, which is just 40 km away from the mouth of Kundalika River. The ideal location of this port helps to serve coastal & International shipping routes. All the chemical industries in the catchment area of Kundalika River use Dighi Port for Import/Export. Dighi port handles Chemicals, Minerals, Coal and other steel products. Below tables Table 4-14 and Table 4-15 show the Import Export trade of Dighi and Revdanda ports.

Table 4-14 Historic Import Trade of Non Major Ports of MH

('000 T)

Ports	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Dighi	-	5	6,697	5,938	161	-	20	67	9,551	10,139	653	595
Revdanda	128	883	832	666	655	988	1,526	1,145	1,251	1,001	1,059	1,311
Others	9,338	8,588	2,856	3,010	4,079	9,773	10,724	15,087	9,587	10,756	21,238	22,568
Total	9,466	9,476	10,385	9,614	4,895	10,761	12,270	16,299	20,389	21,896	22,950	24,474

Source: IPA

Table 4-15 Historic Export Trade of Non Major Ports of MH

('000 T)

Ports	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Dighi	366	15	104	384	67	156	277	400	172	40	219	190
Revdanda	1,144	84	185	173	374	241	146	165	102	53	85	33
Others	1,147	1,587	886	1,442	5,080	1,353	2,182	3,084	3,535	2,675	4,041	4,152
Total	2,657	1,686	1,175	1,999	5,521	1,750	2,605	3,649	3,809	2,768	4,345	4,375

Source: IPA

Import has surged at a cumulative rate (CAGR) of 29% in the last five years, but the export grew only with a rate of 13%. This trade deficit is because the major import of raw material for the industries is in bulk form and is done through ports. A major share of the finished cargo is transported by roadways. In FY 15, the total trade at MMB ports grew approximately to 19 mn tonnes, out of which the share of import accounts for more than 85%.

Development of infrastructure at non-major ports in Maharashtra boosted the overseas traffic at these ports. These non-major ports have been able to successfully acquire a big chunk of share of major ports. Coal has been a prime commodity of import at these ports. However, it has not seen significant growth in the coastal trade. Road traffic has still managed to retain its share. The reason is that non-major ports do not have a customised infrastructure, which could compete with roadways in cost effectiveness. The below table shows commodity wise historic traffic handled at non-major ports, i.e. Dighi and Revdanda port.

Table 4-16 Commodity wise historic traffic of Non-Major Ports

('000 T)

Ports	Commodities	2012	2013	2014	2015	2016
Dighi	Chemical	-	-	26	-	18
	Coal	-	-	286	467	237
	Mineral	456	244	171	213	187
	Others	-	-	-	-	10
	Steel & Product	11	-	119	191	333
	Total	**467**	**244**	**602**	**872**	**785**
Revdanda	Coal	191	-	523	581	1,293
	Iron Ore & Products	1,118	1353	531	563	36
	Mineral	-	-	-	-	16
	Total	**1,310**	**1,353**	**1,054**	**1,144**	**1,344**
Total Traffic of Non-Major Ports		**20,064**	**24,198**	**24,774**	**27,338**	**29,080**

Source: MMB

In FY'16, total coal traffic handled in Kundalika at both the jetties, i.e. Salav and Sanegaon, was 1.29 mn T. Salav is a captive jetty and it handled approx. 0.1 mn T coal in FY'16. Sanegaon Jetty handles major share of coal traffic of Kundalika. It caters the coal demand of local industries of Khopoli, and it has shown 32% of compounded growth rate for the period of 5 years, i.e. FY'11 to FY'16. Coal traffic handled at Sanegaon Jetty in FY'16 increased by 61%, i.e. 1.2 mn T as compared to previous year, i.e. 0.7 mn T in FY'15. The main reason behind the traffic growth in FY'16 is expansion of local industries and shift of MbPT's coal traffic to other ports of Maharashtra due to environment concerns. Imported coal traffic of MbPT has gradually increased between FY'06 to FY'15. In FY'06, the port handled 1.8 mn T, which increased to 4.3 mn T in FY'15, but with intermittent fall. Due to clean cargo policy, traffic has started to fall after FY'15. Clean cargo policy of MbPT is the major reason behind increase of coal traffic on Kundalika after FY'15.

Korlai Port (Proposed)

Indo Energy International Ltd. plans to develop a Deep Water facility at Korlai village in Raigad District. The Proposed port is located on the left bank of Kundalika River to the north east of Rat Island. The direct berthing Port facility would be developed on the 525 meter waterfront, leased by Maharashtra Maritime Board. The developed facility would be able to handle cement, HR coils and slag for export cargo and Edible oil, Bauxite, dolomite, limestone, clinker, iron ore, coal, Iron and Steel, Container for import cargo. These cargoes would be handled by fully mechanised equipments. The berthing facility is intended to serve Panamax vessels (105,000 DWT vessels) in its initial operations and on completion would be able to berth the Cape size vessels (180,000 DWT vessels). Presently there is a channel for lighterage operation.

The proposed port will be developed in 3 phases at Korlai -

- Phase I - 7.5 million MT
- Phase II - l7 million MT
- Phase III - 22 million MT

The proposed port requires 125 acres of land to create the storage backup for jetty. The dredged material of the shallow area itself would be used for land reclamation near the shore regions. The proposed jetty would be provided with the fully mechanised equipments and best dust suppression system. There would also be provision for storage and reclamation state of the art facilities. The turnaround time would be 48 hours for Panamax vessel and 36 hours for Cape size vessel (Handymax) on completion.

The road connectivity would be developed by a four lanes road from the port to Alibaug-Revdanda Road and Revdanda-Murud road; this would further strengthen the existing connectivity. National Highway 66 is the nearest highway, which is about 12 km from the site of Korlai Port, while the nearest railway station would be Roha on the Konkan Railway route, which is about 40 km from the site. The nearest airport is Chhatrapati Shivaji International Airport, which is 130 km away from the site of the port. Korlai and Salav are the nearby villages which are approximately 2 km from the site while Alibaug town is 15 km away and Revdanda town is 2.8 km away from the site. Revdanda Fishing Jetty is the nearest fishing jetty, while Korlai is a fishing Hamlet with no nearby landing facility available. JNPT is the nearest seaport located at a distance of 45 km from the site. Presently there exists an operational barge facility, 1 km upstream and 21 km inside Kundalika River.

4.2.4.2. MAJOR PORTS

JNPT & MbPT are the two Major Ports of Maharashtra. These ports are located farther than 45 km from Kundalika River. As both these ports do not come under the primary catchment area, i.e. within 25 km from Kundalika River; so they are not considered for the study.

4.3. Commodity Composition

Table 4-17 shows the possibility of cargo diversion from Revdanda & Dighi Port. Commodities, destined or originated towards port mostly use Roadways. Some of the commodities from the above detailed traffic breakup, refer Table 4-16, could be diverted to the proposed waterway, if industries find the proposed multi modal route beneficial in every aspect.

Table 4-17: Traffic Diversification from Port

Commodities	Traffic	Diversion	Reasoning
Coal	1,530	✓	Around 90% of total coal traffic in catchment area of Kundalika is handled by Revdanda Port. Huge potential exists for coal movement through the waterway; a portion of coal traffic is already moving on waterways at present.
Chemicals	18	✗	Very less volume; hence no opportunity for the waterway.
Iron Ores	36	✗	Iron Ore handling has decreased around the river; hence it would not provide future potential.
Minerals	203	✗	Very less volume; hence no opportunity for the waterway.
Iron & Steel Products	333	✗	Dighi Port handles 90% of total traffic. Iron & steel products have no volume generation near Kundalika river. Diversion to the waterway is not possible.
Others	10	✗	Very less volume to get diverted to the waterway.
Total	**3,331**	-	-

Source: Consultant's Analysis

4.4. Originating & Terminating commodities

Due to the two existing jetties Sanegaon & Salav, Industries would prefer using these infrastructures only. Industries in the primary catchment area are already using existing terminal i.e. Sanegaon. Industries in the secondary catchment area are using Dharamtar port due to close proximity. 3 MIDCs in the catchment area would not give any opportunity for the river movement, as volume traded is negligible. The table below depicts potential commodities and opportunity they would provide to the proposed waterway, along with suitable reasoning.

Table 4-18 Opportunity from commodities to the proposed waterway

Cargo	Traffic Source	Traffic ('000 T)	Potential	Reasoning
Coal	Handled at Ports of Revdanda	2,491	✓	MbPT's coal handling operation has come to halt. Currently, no coal handling activity takes place at Haji bunder as ban is imposed on coal operation on land but not on shore. However there is no ban on coal handling at Tata power jetty in Trombay, Mumbai. JNPT does not handle coal cargo. This coal could get diverted to nearby non-major ports i.e. Dharamtar and Revdanda Port. Mumbai anchorage would be used for ligtherage and then through barges it could move in IWT route to destined port. Dharamtar Port which is handling 3.2 mn T of coal at present, would attract major share of diverted coal and rest would be handled by Revdanda Port at Sanegaon Jetty. In near future, possibility of power plants of Maharashtra to use non-major ports for coal import exists. This future traffic creates the opportunity for coal handling at proposed terminal.
Iron Ore	Handled by Welspun Maxsteel	36	✗	There is major decline in Iron Ore handling at Salav Jetty in Revdanda Port. It is very unlikely that cargo traffic would increase in future; hence Iron Ore would not provide any opportunity for the river.
Minerals	-	16	✗	Negligible volume of Minerals is handled at Dighi Port. River movement is not viable for such small shipments. Hence, mineral handling would not provide potential for the river.
Chemical	Roha Industrial Area	NA	✗	MIDC has declared Roha as chemical cluster, which is located at the start point of Kundalika river. Though number of chemical units is more, volume generated is too low to be shifted to the waterway.

Cargo	Traffic Source	Traffic ('000 T)	Potential	Reasoning
Container	-	NA	✗	There is no container-based industry in the catchment area of the river.
Others	-	NA	✗	For handling other miscellaneous cargoes, which are small in volume, there might be a need for terminal on the river.
Total		**2,543**		-

Source: Consultant's Analysis

4.5. Passenger Traffic

Passenger traffic consists of Ro-Ro & Tourism traffic. However as 50% stretch of Kundalika river is used for cargo operation, there does not exist much opportunity to develop any infrastructure to attract passenger traffic on the river.

4.6. Tourism Traffic

The talukas of Murud and Alibaug lie in the Konkan Region on the west coast of Maharashtra. These talukas offer diverse scenic spots to attract tourists, like pristine beaches, temples and historic forts. Beaches include Kashid beach, Alibaug and Kihim beach. The beaches of Alibaug like Varsoli Beach, Akshi beach and Nagaon beach offers comfortable homestays for tourists. Famous forts in the region are Janjira Fort, Korlai Fort and Kolaba Fort. There also exists a historic place, Nawab Palace. Religious places include famous Birla Temple.

Murud and Kolad are the famous tourist destinations near Kundalika River. The table below Table 4-19 shows a list of famous tourist places in the catchment of Kundalika River and their distance from the river.

Table 4-19 Famous Tourist Spots around Kundalika River

Location	Distance from the river (km)
Birla Temple	2
Janjira Fort	36
Korlai Fort	4
Garambi Falls	31
Nawab Palace	28
Kashid Beach	14
Alibaug Beach	19
Kolaba Fort	19
Kihim Beach	27
Kolad	11

Source: Consultant's Analysis

Sanegaon Jetty is located at a distance of 20 km from the mouth of Kundalika River. The Jetty is used to handle coal. After Sanegaon till the end of the identified river stretch; i.e. Roha, there is no cargo activity. Half of the river stretch is used by vessels, carrying cargoes, mainly coal i.e. dirty cargo. Hence, it could be difficult to start tourism related activities in the entire river stretch.

Some of the famous tourist places in the catchment of Kundalika River are discussed below.

4.6.1. Birla Temple

Located 2 km away from Kundalika River, the temple is situated in Salav village. The main deity worshipped in the temple is Lord Ganesha. There are small temples of 'Radha-Krishna', 'Shiv-Parvati' and 'Suryadeva' inside Birla Temple. Aarti starts at Birla Temple at 9.00 am and 7.00 pm everyday. The temple is built of pure milk white marble and its dome can be seen from a long distance. The temple can be reached by road or by taking steps to the temple. The best way to reach this temple is via road through ST buses.

4.6.2. Janjira Fort

It is a tourist hotspot as it is an island fort, situated 3 km from the coastal town of Murud. It is also known as Janjira Jal-durg. Located in a small town named Murud, it was built by Malik Ambar. Recognized as one of the major monuments in India, it is frequented by thousands of tourists from all over the country. One can easily get to Janjira Fort by any mode of transportation. The nearest airport is at Mumbai, while Roha is the nearest railway station. One needs to take a boat ride to reach the fort.

4.6.3. Korlai Fort

Located about 15 km from Kashid, the fort is located almost midway between Kashid and Alibaug. Built by the Portugese, Korlai Fort guarding the Revdanda creek, offers a panoramic view of the sea as well as Revdanda fort and Kundalika River from its eastern side. There is a lighthouse on the western side of the fort.

Within the fort there are three inscriptions. Over one of the inscriptions surmounted by a cross, is a coat of arms with a shield and the Portuguese star in the center, surrounded by seven castles. People visit this fort more to get a magnificent view of the sea.

4.6.4. Garambi Falls

The Garambi Falls, which is at a height of 100 ft. is situated in the forest and its beauty is at its peak during monsoon season. One can reach this destination via Tala- Murud Road.

4.6.5. Nawab Palace

It is also known as Ahmedganj Palace, and was constructed in 1885. It is owned by the descendants of the Nawabs. Covering an area of about 45 acres, it has a beautiful mosque and tombs within its premises. The palace depicts Gothic and Mughal architectural styles. The Arabian Sea and the Murud village can be seen from the palace, constructed on the edge of the cliff.

4.6.6. Kashid Beach

Kashid Beach in Murud is located at a distance of 125 km from Mumbai and 170 km from Pune. Buses ply on a regular basis to and from Pune, Thane, Mumbai and other nearby places. The closest railway station is Roha railway station, which is located at a distance of 45 km. It offers camping as well as some water sports for its visitors along with its twin Murud beach. Kashid also offers parasailing activity.

4.6.7. Alibaug Beach

Located in Alibaug town, the beach is well connected by state highway. It is easily accessible from Pune and Mumbai. The nearest railway station is Pen, which is around 30 km from Alibaug. Being a famous tourist spot and district headquarter, there are many resorts and lodging facilities in Alibaug. There are beachside food stalls also at the beach. The peak season of tourism in the beach is November and December. Around 50,000 to 60,000 people visit this beach during peak season. Tourists visit this place for leisure. Most of the tourists come from within Maharashtra, predominantly from Mumbai.

4.6.8. Kolaba Fort

Located at a distance of around 2 km from Alibaug beach, it is a tourist hotspot. Maratha warrior, Shivaji Maharaj constructed this sea fort in 1680, which has 25 feet high, 350 feet wide and 900 feet long walls. The fort dates back to around 300 years. The entrance arch of the fort has numerous carvings of elephants, peacocks and tigers. An interesting feature of this fort is that it has freshwater wells in its premises. One can reach this fort by boat from Alibaug beach.

4.6.9. Kihim Beach

Kihim Beach is situated 12 km away from Alibaug. The beach lies to the north of the city and is surrounded by various trees with colorful butterflies, coconut trees and wild flowers. Beautiful migratory and resident birds are found in abundance at the beach, which attract tourists in large number. The beach retains its natural beauty, as it is an undiscovered land.

4.6.10. Kolad

Kolad lies in Roha taluka of Raigad district. This village is surrounded by Sahyadri mountain range, which has rugged topography. Kolad is famous for waterfalls and trekking, especially during monsoon season. Kolad is famous for its one of its kind white water river rafting. The water leaving the dam during the winter season ensures speed of the water in the river. Apart from white water river rafting, other well-known adventure activities in Kolad are kayaking, boating, river crossing and paragliding. Jungle camping is also available at Kolad. Moreover, Kolad Railway Station is the first railway station, built on the Konkan Railway Line. It is also considered to be the starting point of Ro-Ro service (Roll-On Roll-Off service) on Konkan Railways. Kolad Bus Station is directly connected with Mumbai, Pune and other cities of Maharashtra.

4.6.11. Phansad Wildlife Sanctuary

This Sanctuary offers a glimpse of the wildlife of the Western Ghats and is spread across Murud and Roha talukas. The sanctuary has over 720 species of flora and 279 species of fauna that include mammals, birds and butterflies. Phansad is a paradise for bird watchers and lepidopterists (people who study or collect butterflies and moths). Phansad claims to be home to over 90 species of butterflies. A trek in Phansad Wildlife Sanctuary attracts nature lovers. The Sanctuary is well connected by Revdanda-Murud Road.

All the tourism places around Kundalika River are located more than 10 km away, thereby it is very unlikely that people would use river to reach these tourist spots. It is more convenient to go by roadways due to direct accessibility; hence the tourist places in the catchment area would not provide much opportunity for the proposed waterway in Kundalika River.

4.7. Passenger Ferry Terminal

Table 4-20 shows the existing passenger terminals in catchment area of Kundalika River. All the terminals are located near Dighi Port and this port would not provide any opportunity for Kundalika River, as there is no potential to divert the port's traffic to Kundalika River.

Table 4-20 Existing Passenger ferry terminals and historic passenger traffic

(in '000)

Terminals	2012	2013	2014	2015	2016
Agardanda to Rohini (Ro-Ro)	-	-	-	-	18
Dighi	229	220	203	198	77
Dighi to Agardanda	-	-	-	-	103
Dighi to Agardanda (Ro-Ro)	-	-	-	-	96
Dighi to Janjira Killa	-	-	-	-	23
Murud	1	24	34	57	49
Nandgaon	9	15	15	14	3
Rajpuri	649	620	633	558	219
Rajpuri Motor Launch	-	-	-	-	64
Rajpuri to Dighi	-	-	-	-	44
Rajpuri to Killa	-	-	-	-	234
Revdanda	8	7	8	11	8
Total	**964**	**976**	**958**	**888**	**955**

Source: MMB

As depicted in the above table, it is evident that Fy 16 has witnessed overall growth in passenger traffic, but there is a fall in traffic in Dighi, Murud, Nandgaon, Rajpuri and Revdanda terminals, which have been handling passengers from many years. In Fy 16, major passenger traffic is handled at Rajpuri to Killa ferry terminal.

4.8. Growth Trend

Commodities considered in previous study that is Feasibility Study Report are also been analysed. The commodities, which are considered in FSR and are also considered as potential commodity in DPR are listed with suitable reasoning. Those commodities, which are considered in FSR but during DPR stage, it was found that these commodities do not provide potential for Kundalika River, they are also presented below with proper reasoning.

Table 4-21 Analysis of FSR Study

Commodity	Source	Considered in DPR	Potential	Reasoning
Thermal Coal	Sanegaon Jetty	✓	✓	Coal requirement for Khopoli industrial areas and small industrial in the region is likely to increase in coming years. Once coal-handling capacity of Sanegaon Jetty

Commodity	Source	Considered in DPR	Potential	Reasoning
				is fully utilized then additional cargo could be diverted on the identified terminal at the river in future.
Iron Ore	Vile Bhagad MIDC	✓	✗	Vile Bhagad MIDC is located 40 km away from the tail of the identified stretch of the river. Diversion from this MIDC would not be possible as Dighi Port is closer than Revdanda port & Dighi port has good connectivity.
Steel	Vile Bhagad	✓	✗	
POL	BPCL & HPCL	✓	✗	-
Fertilizers & Chemicals	RCF & DFCL	✓	✗	RCF does not look after logistics/distribution of fertilizers. It has its own rail siding. Deepak Fertilizer plant is located too far from the river and does not come in the primary catchment area. Hence, no potential from fertilizers.
Food Grains	Locally produced	✓	✗	The volume of food grains is very less and is locally consumed; hence no opportunity for the waterway.
Container Traffic	from Ratnagiri to Mumbai	✓	✗	Container handling requires huge storage facilities & draft. Industries would not be ready to shift their container traffic to Kundalika river because of double handling cost & increase in time required. Hence, river movement for containers would not be viable.

Source: Consultant's Analysis

4.8.1. Passenger & Tourism Growth for Kundalika River

There is no growth potential for passenger and tourism traffic for Kundalika River. Due to existing dirty cargo operation on the river, people are reluctant to use waterway in Kundalika River for passenger & tourism purpose. In future, there is high possibility of growth in cargo handling through Kundalika River, which would restrict further development on passenger & tourism handling facilities.

4.8.2. Cargo Growth for Kundalika River

There exists cargo growth potential for Kundalika River. At present, 1.2 mn T of coal is transported through the river. This traffic is handled at Sanegaon Jetty; the jetty has future plans for expansion, which would attract more cargo. This development is likely to increase future cargo traffic of Kundalika River. There is one more jetty on Kundalika River in Salav village. Salav jetty also has expansion plans, which would create opportunity for Kundalika River as there would be growth in cargo handling.

4.9. Forecasting & Potential IWT Assumptions

The table below shows the overall potential for the proposed waterway from Cargo, fishing, passenger and tourism traffic.

Table 4-22 Overall River Attractiveness

Traffic	Attractiveness	Reasoning
Cargo (Industrial & Commodities)	✓	Two existing jetties (Salav & Sanegaon) on the river are operational; thereby cargo handling would increase in the river in near future.
Fishing	✗	Dirty cargo is being handled at the existing Ports of Revdanda, covering half of the river stretch in utilization for cargo operation. This limits the scope for fishing and tourism activity. Polluted river & good road connectivity in the region also limit the scope for Ro-Ro operation.
Passenger	✗	
Tourism	✗	

Source: Consultant's Analysis

Potential for cargo movement in Kundalika River exists only for coal movement. At present 1.2 mn T coal is being transported using the river at Sanegaon jetty. Coal is further distributed to the industries, located in Khopoli. MbPT, a major port of Maharashtra used to handle coal at a very large scale, but now it has been restricted on the orders of High Court & Pollution Control Board. However coal would get handled at shore not on land. This coal would get diverted to non-major ports of Maharashtra through barges. Majority of this diversion would get shifted to Amba River, towards Dharamtar Port and rest would be diverted to Kundalika River. At present Sanegaon Jetty handles sufficient traffic as per its capacity. It is assumed that in coming future when traffic will increase, then the additional traffic could be diverted towards the identified terminal on Kundalika River. The below Table 4-23 shows the traffic projection for the identified terminal at Zolambe that is just 5 km away from the existing jetty.

Table 4-23 Traffic projection of Coal in Kundalika River

(mn T)

Commodity	Fy 16	Fy 20	Fy 25	Fy 30	Fy 35	Fy 40	Fy 45
Coal	0.00	0.00	0.00	0.12	0.57	1.12	1.78

*Note: Traffic projection is done, considering Coal handling capacity of Sanegaon Jetty as constant i.e. 3 mn T.
Source: Consultant's Analysis

Table 4-24 Traffic projection of Coal at Sanegaon Jetty

(mn T)

Jetties	Commodities	Fy 16	Fy 20	Fy 25	Fy 30	Fy 35	Fy 40	Fy 45

Sanegaon	Coal	1.2	2.4	2.7	3	3	3	3
Salav	Iron Ore	0.04	0.05	0.08	0.14	0.25	0.43	0.77

Source: Consultant's Analysis

The above table shows the projected traffic of existing jetties on Kundalika River. Traffic Projection is done on the basis of current scenario and future expansion plans. 4% growth rate is considered, based on the industrial growth of the region, till the time proposed plans (infrastructure/ facilities) gets operational and after that when capacity gets increased, there will be growth in traffic by 12% year on year for Salav Jetty. 12% growth rate is based on the expansion plans of the jetty.

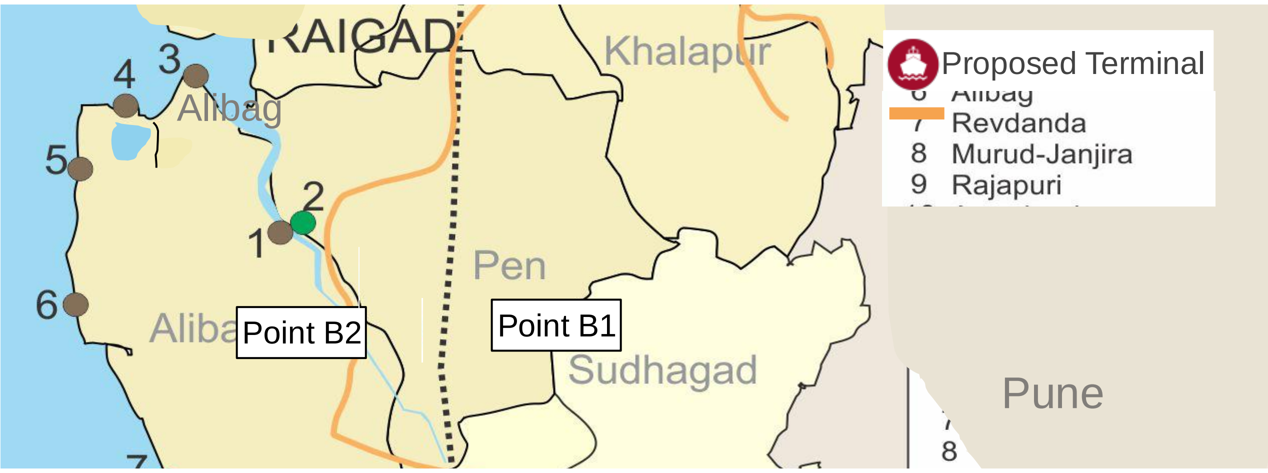
For Sanegaon Jetty, 4% traffic growth rate is considered based on the industrial growth rate of the region, till the capacity reaches to 3 mn T, beyond that it is assumed that its traffic handling capacity would be constant at 3 mn T only. Annual growth rate of Secondary sector (Industries) decreased by 4.7% from Fy 13 to Fy 14 and thereafter it remained constant, i.e. 4%.

4.10. Terminal wise IWT Traffic Analysis

At present, Kundalika River has two operational terminals, namely Salav & Sanegaon. Many expansion plans are planned for the development of these jetties in future. One additional terminal, i.e. Korlai Port is going to be developed next to Salav, on the mouth of the river.

Salav Jetty is captive and used by its own industry, while Sanegaon is a multipurpose port, serving Khopoli and other interior parts of Maharashtra. The below map depicts the two terminals identified on Kundalika river and road/railway connectivity around them.

Figure 4-6 Identified terminals on Kundalika River



The table below shows the location of two identified terminals on Kundalika River. The table also describes traffic potential of both the proposed terminal locations, supported by suitable reasoning.

Table 4-25: Traffic Potential for Identified Terminal Locations

Sr. No	Identified Location	Coordinates	Traffic Potential	Reasoning
1	Zolambe (Point B2)	18°27'53"N, 73°05'09"E	✓	Zolambe is only 5 km away from the existing terminal at Sanegaon. Though there is no industry near Zolambe, the proposed terminal could be benefitted with the fully operational and developed river stretch between Sanegaon and Zolambe. Sanegaon jetty provides all types of facilities and infrastructure required by industries. River near the jetty is navigable and fully functional. Hence, at Zolambe it would be cost effective to develop a terminal. There would not be any need to dredge the river here. Also, there is a road, which runs parallel to the river; this road would help in cargo evacuation.
2	Wali, Roha (Point B1)	18°26'32"N, 73°07'00"E	✗	Terminal identified at Roha is 10 km away from the existing terminal at Sanegaon and 5 km from the proposed terminal location at Zolambe. Industries in the catchment area of Kundalika river are mostly located near Roha; hence it would be commercially viable to develop a terminal here. However, there are technical obstacles at this location. Riverbed is rocky near Roha and dredging would be required for navigability. Dredging is expensive and would increase the cost of the project. Hence, it is not advised to develop a terminal at Roha. Cargo to/from Roha could easily be moved to Zolambe terminal by using roadways.

Source: Consultant's Analysis

As per detailed analysis of each terminal, it is advised to develop IWT terminal at Zolambe (Point B2) and not Wali, Roha (Point B1). There exists no industry near Zolambe; however it has advantage of location. The identified terminal location at Zolambe is around 5 km away from Sanegaon jetty. As there already exists a developed jetty at Sanegaon, there would not be any requirement for dredging for the IWT terminal at Zolambe. Sanegaon jetty provides all types of facilities and infrastructure required by industries. The already developed infrastructure of Sanegaon jetty and the navigability of river stretch near Sanegaon, makes it easier to develop IWT terminal at Zolambe. This would reduce the cost of developing terminal. A road runs parallel from this location, which could be used to move cargo from Roha to this terminal. This road would help in cargo evacuation.

On the other hand, developing a terminal at Roha, which is around 6 km away from Zolambe, would be technically challenging and very expensive. At Roha, the riverbed is rocky and there is very less draft; hence it is necessary to dredge the river for developing a terminal here. Dredging and navigability at this part of the river would be expensive. To reduce the cost, it is advised that IWT terminal would be developed at Zolambe near Sanegaon jetty.

Table 4-26: Traffic Summary

Sl. No.	Name of Cargo	Type of Cargo*	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Co ordinates	Unit p.a	Volume's (mn Tonnes)					
									Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Captive Jetty - JSW Salav														
1	Iron Ores	Bulk	Import	n/a	Salav Plant	JSW Salav jetty	n/a	mn T	0.04	0.05	0.08	0.14	0.25	0.43
Existing Private Jetty - Sanegaon Jetty (Jetty has a capacity of 3mn Tonnes Coal and 2 mn Tonnes Multipurpose)														
1	Coal	Bulk	Import	n/a	Khopoli	Sanegaon	n/a	mn T	1.20	2.44	2.75	3.00	3.00	3.00
Proposed Terminal Opportunity for IWAI														
1	Coal	Bulk	Import	n/a	Nearby Coal based industries in MH	Zolambe (IWAI)	18°27'53"N, 73°05'09"E	mn T	0.00	0.00	0.00	0.12	0.57	1.12
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.														

Source: Consultant's Analysis

4.10.1. Existing Terminal on Kundalika River

Salav & Sanegaon are the two operational jetties in Kundalika River. Salav Jetty is operated by JSW, where Iron ores & other Raw materials are imported from other countries for the steel plant. Another jetty at Sanegaon is operated by IEIL; it handles imported coal for the industries, located in interiors of Maharashtra. Many expansion plans are lined up for future for these jetties.

4.10.2. Proposed Terminal on Kundalika River

The proposed location at Wali Village in Roha is commercially viable; however at this part of the river dredging is required which would be expensive. Also, the riverbed is rocky at this location.

The location at Zolambe is suitable to develop IWT terminal because it is close to Sanegaon jetty and river at this part is already navigable. There is no need for dredging at Zolambe, which would keep the cost of developing IWT terminal under control. Sanegaon jetty is a fully operational and developed jetty with day navigation facility. At Zolambe, IWT could develop night navigation also for better movement. Cargo evacuation from this terminal could be done by a nearby road, which runs parallel to the river towards Roha. Cargo from Roha could reach Zolambe through this road.

The projections for Coal traffic on Kundalika river has been influenced by following;

- Shifting of Coal traffic from Mumbai Port Trust due to regulatory and Court ruling
- Coal requirements from Khopoli industrial areas and small industries in the hinterland is likely to increase in coming years
- Future expansion plans of two existing jetties, Salav and Sanegaon, would attract more cargo on the river.

In 2017, MbPT's coal handling operation has come to halt, due to ban imposed on coal operation on land. This coal traffic could get diverted to nearby non-major ports i.e. Dharamtar and Revdanda Port. As per the previous year, maximum share of MbPT's coal traffic was diverted towards Dharamtar Port. Based on this traffic flow and nearby industrial scenario, it has been assumed that Dharamtar would attract 70% of the diverted traffic, while remaining would come to Revdanda i.e. 30%. This is a subjective assumption taken based on following factors

- Close proximity to MbPT – River Amba is closer to MbPT than Kundalika.
- Observed shift – Coal traffic handled in Kundalika is distributed to the nearby small industries, while Amba serves the thermal power plants of Maharashtra. Amba has shown higher growth in traffic after FY'15 as compared to Kundalika.
- Coal handling infrastructure – Amba has far better facilities and infrastructure to handle coal than Kundalika.
- The prominent assumptions for traffic of Coal in Kundalika river are as follows

- The traffic at Salav Jetty on Kundalika will be linked to the captive demand for coal. The company has already provisioned for expansion to match the Coal demand.
- The non-captive coal demand of the region would be handled at existing Sanegaon jetty or the additional terminal proposed by IWAI at Kundalika.
- Current expansion plan of Sanegaon jetty includes upgradation of equipment and throughout the year operation.
- It has been assumed that after Sanegaon Jetty's capacity is exhausted, there would be a need to develop an additional terminal to handle any surplus traffic. IWAI could develop a terminal to target this traffic.
- Till FY'30, Sanegaon jetty has sufficient capacity to handle increase in existing traffic, along with additional coal shifted from MbPT (commencing from FY'20). Hence, there is no need to develop another terminal till FY'30.
- After FY'30, if coal demand outpaces Sanegaon jetty's capacity and promoters do not decide to augment the jetty's capacity, IWAI would develop a new terminal. This proposed IWAI terminal would attract only that traffic, which Sanegaon would not be able to handle due to its capacity constraint.
- The traffic growth has been assumed at a moderate growth rate of 4%. This has been linked to industrial growth rate. Annual growth rate of Secondary sector decreased by 4.7% from FY'13 to FY'14 and thereafter it remained constant, i.e. 4%.
- 4% traffic growth is considered till the coal handling capacity reaches 3 mn T in Sanegaon Jetty and further it is assumed that capacity would be constant at 3 mn T only.
- The entire surplus coal traffic generated beyond 3 mn T would have to be handled at the proposed terminal of IWAI.

However, if promoters expand its capacity, there would not be any need for IWAI to develop a new jetty to absorb the said surplus traffic. Hence, development of IWAI jetty on River Kundalika is conditional and subjected to non-expansion of Sangean jetty's capacity.

Abbreviations	Full form
MIDC	Maharashtra Industrial development Corporation
JSW	Jindal Steel Works
JNPT	Jawaharlal Nehru Port Trust
GSDP	Gross State Domestic Product
FY	Financial Year
Ro-Ro	Roll On Roll Off
S.H.	State Highway
MH	Maharashtra
DRI	Direct Reduced Iron
MOU	Memorandum Of Understanding
GAIL	Gas India Limited
PGPL	Pioneer Gas Power Limited
SEZ	Special Economic Zone
HPCL	Hindustan Petroleum Corporation Limited
MT	Metric Tonne
CAGR	Compounded Annual Growth Rate
DWT	Dead Weight Tonnage
IWT	Inland Water Terminal

CHAPTER 5: TERMINALS

5.1. General Review

Terminals act as a connecting centre 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 Kundalika River.

Kundalika River is being utilized by M/s Kolai Kolivada Jetty for the import of raw material and M/s Salav Jetty (JSW). These stakeholders are having their own captive terminals.

Sanegaon Jetty in Kundalika River waterway is a multipurpose terminal and has a capacity of handling, storing and dispatching of Bulk cargo. Iron ore and thermal coal being the main import item. Hence, there is no need of development of any terminal infrastructure for loading / unloading of their traffic volumes. Accordingly, the fairway development suiting to their traffic volume mobility is essential, which has already been considered as a part of Fairway development.

Agrav Jetty in Kundalika River waterway is being utilised for recreational activity. Every year sailboat race takes place on the very next day of Gudi Padwa (Beginning of the Maharashtrian calendar). The race begins in a creek from Agrav with participating boats coming from Revdanda, Chaul, Korlai and other neighbouring villages

The traffic other than the captive terminal requirements, as identified are of Bulk / Break-Bulk mobility. The Bulk / Break-Bulk cargo are estimated to the extent of 1.12 MMTPA by the year 2040, but may be required after the saturation of the existing infrastructure i.e., may be from 2030.

Keeping in view the type of cargo, it has been identified that 1 Lift-on Lift-off (Lo-Lo) IWT Terminal with handling facilities and IWT Terminal are necessary for transhipment. Taking into the consideration of the origin and destination and fairway, the most probable location is with approx. Lat 18°27'53"N and Long 73°05'09"E.

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.

S.No.	Facility	Nos.	Size	Area (m2)
1	Open Storage Area	1	200 m x 100 m	20000
2	Covered Storage Godown	1	100m x 30m	3000
3	Ro-Ro Truck Parking			0
4	40' Container Stack Yard			0
5	Parking for Handling equipments	1	30m x 15m	450
6	Main Parking Area	1	30m x 30m	900
7	Public Utility	1	6m x 4m	24
8	Weigh bridge	1	8m x 3m	24
9	Utility Room (Near Weigh Bridge)	1	3m X3m	9
10	Area under internal Roads	1	7.5m x 267m	2002.5
11	Bank protection with Geotextile Bags			
12	Administration building	1	12 m x 15 m	180
13	Business Area	1	10m x 3m	30
14	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
15	Staff Parking Area-2 wheelers	1	8m x 2m	16

S.No.	Facility	Nos.	Size	Area (m2)
16	Security shed for watch and ward	2	4m x 4m	32
17	Electrical facility	1	5m x 5m	25
18	Fuel Bunkers	1	10m x 5m	50
19	Water Supply Room	1	3m x 4m	12
20	Fire and Safety Room	1	3m x 4m	12
21	DGPS receiver & transmitter shed	1	8m x 4m	32
22	DG shed	1	5m x 5m	25
23	Canteen with Store	1	12m x 8m	96
24	Sewerage Treatment Plant (STP)	1	15m x 15m	225
25	Overhead Tank	1	10m dia	78.5
26	Green Area	1		1000
27	Future Requirement	1		2000
				30304 say 31000

5.3. Terminal Layout / Master Planning including phases of development

The Terminal layout of the identified site based on the site land survey data available has been prepared. (Refer Volume-II **Drawing No.P.010257-W-20351-X05** for details). The Land Acquisition etc., can be planned at appropriate time, after having the cargo volume increase and confirming the Terminal development. he Terminal location is connected to the Revadanda – Chanera – Roha Road near "Zolambe" village and the distance is only of 80 m (Estimated cost of 7.5 Lakhs), which may have to be taken up by the concerned agency.

Keeping in view the Classification of NW 85 as Class VII waterway, the Terminal design etc., have been considered with the Class VII Vessel size. The fairway and other activities can be developed at later date, whereas Terminal development may be difficult with expansion, if any, in furture.

Accordingly, a Terminal Layout plan demarcating the infrastructure requirement has been prepared. (Refer Volume-II **Drawing No.P.**010257**-W-20311-A05** for details).

5.4. Land Details

TABLE 5-1: Terminal Land Details

Coordinates (UTM) N/E	**2042671.52**	**297868.47**
Coordinates (DMS) N/E	**18°27'53"N**	**73°05'09"E**
Village	Zolambe	
Taluka	Roha	
District	Raigarh	
State	Maharashtra	
Nearest Town	Roha	
Distance of town (km)	5	
Land use	Agriculture land	
Ownership	Private	
Water Distance	on edge of road 5-10m	
Nearest Road	Roha-Revdanda road	
Road Distance (m)	80	
Nearest Railhead	Roha	
Railhead Distance	6km	
Nearby major Structure	None	
Terrain	Mostly Agriculture land	
Soil/Subsurface strata	Thick yellowish sticky soil	
Surveyed Area (Approx.)	42205 (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 m depth or 3 m into the bed rock whichever is earlier.

5.5.1. Regional Geology

Geologically, the project area lies in the Konkan area where lowlands are a platform of marine denudation raised to form a narrow plain. The geology of the entire Raigarh district (Project area) consists of dark colored volcanic lava flows and laterities which date back to the Mesozoic Era. These are spread out in the form of horizontal sheets or beds and have innumerable spurs, hills, ridges, peaks and plateau, the lava are termed as plateau basalts. Since these basaltic lava flows cover an extensive region in the Deccan and frequently present step like appearance to the hills and ridges, they are commonly known as “Deccan trap”. The Deccan traps generally lack minerals of economic importance but being hard, dense and durable, are most suitable as building materials.

The project area is covered under Geological Quadrangle map sheet No 47F prepared by Geological Survey of India (GSI). The project area on this map is shown in **Figure 5.3** while the blow up from the same map with project area is shown as **Figure 5.1** with index as **Figure 5.2**. This map reveals that the project area is occupied by alluvium deposits overlain by basaltic flows of Karla formation of Deccan Traps.

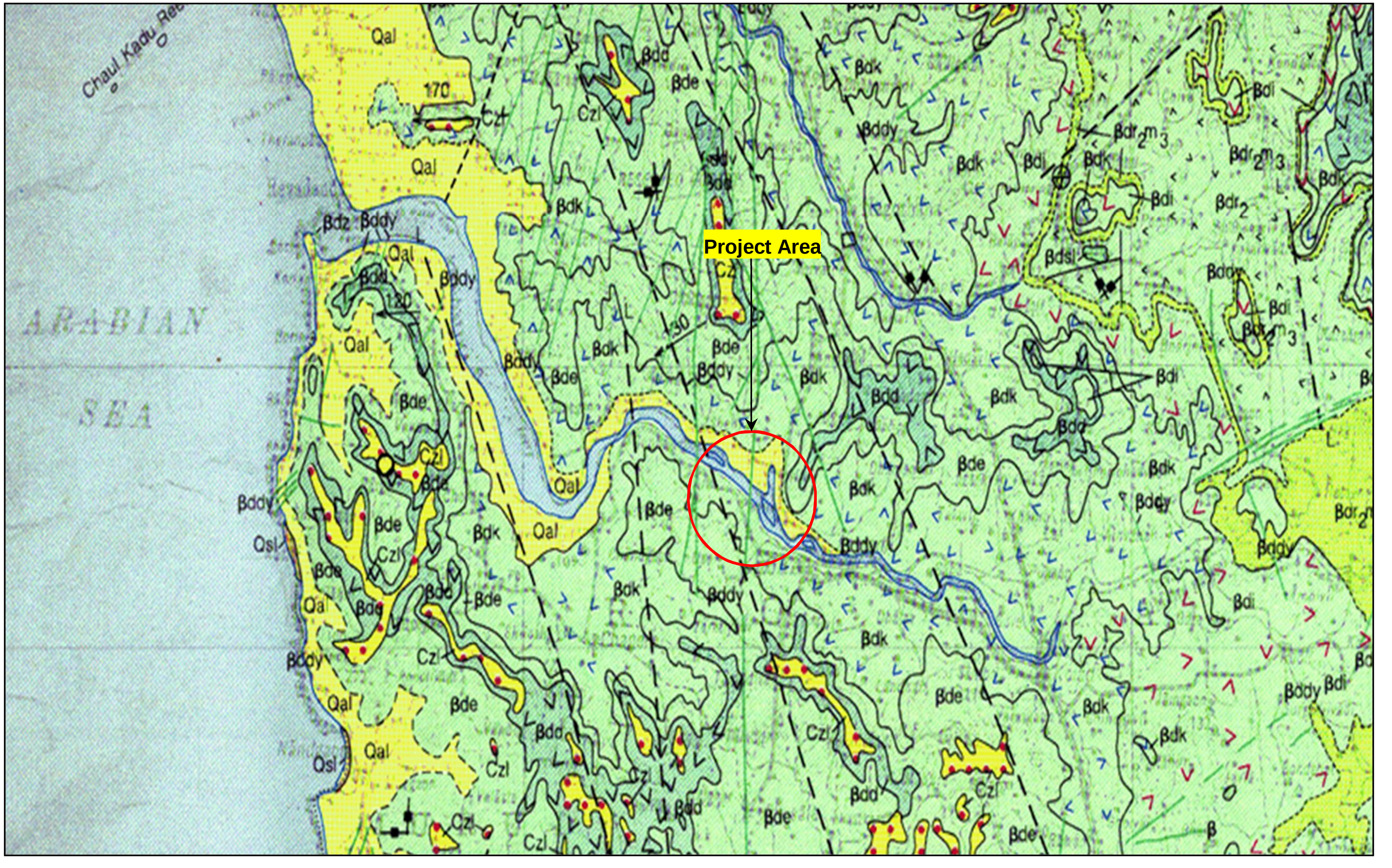


FIGURE 5.1: Blow up of the Project area from geological quadrangle map (Figure 1.3)

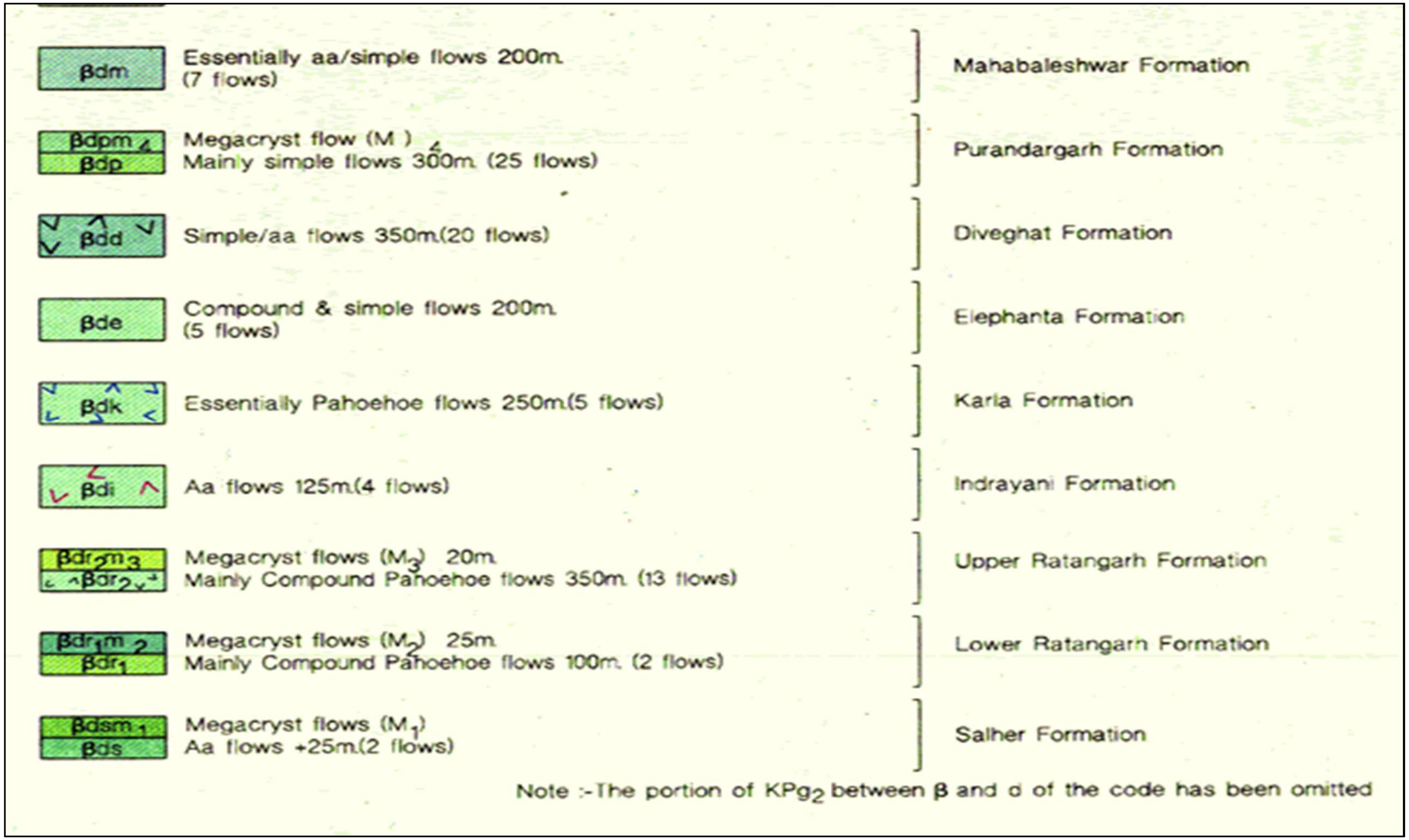


FIGURE 5.2: Index of the geological quadrangle map (47F)

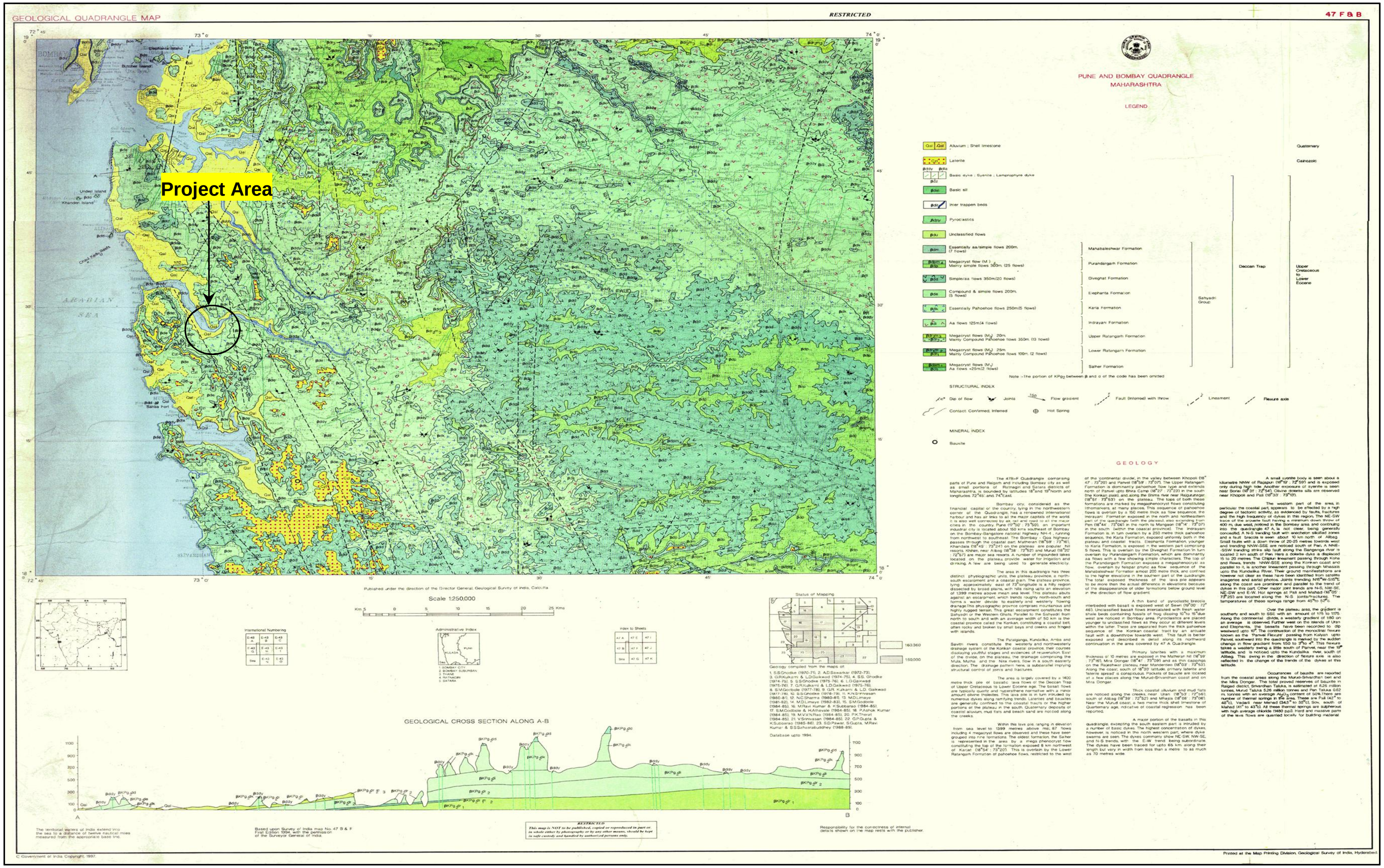


FIGURE 5.3: Geological Quadrangle map (47F) showing Project area (Source: Geological Survey of India)

5.5.2. Physical Condition and Drainage

Raigad district forms a part of Maharashtra littoral, the micro level divisions of coastal plain. It is slightly elongated in the north-south direction. Raigad has a long indented coastline. The length of the coastline is about 240 kms, with a number of creeks and inlets, suggesting submergence confirmed by the submerged khair forest in Thane creek and Mumbai harbor. Though the districts form an important part of the traditional "Konkan Plain", ruggedness and uneven topography form the governing theme in its physical features. The Sahyadri (Western Ghats) in the east send several transverse numbers of subsidiary hills westwards denying the plains of a uniform level and continuous character. On the basis of variation in local relief, the district can be classified into six groups viz Sahyadri Hills, Konkan Forested Hills, Sudhagad Plateau, Ulhas Basin, Kal-Savitri Valley & Raigad Coast. The selected project location/site falls in the zone of Konkan forested hills which is described below.

Konkan Forested Hills

The Konkan forested hills are situated at the centre of the district comprising parts of Panvel, Khalapur, Alibag, Pen, Roha, Mangaon, Tala, Murud, Mhasla and Shrivardhan tehsils and a small part of Karjat tehsil. These hills are basically an extension of the Sahyadri hills formed by the offshoots of the Sahyadri, which runs parallel to the drainage pattern of the district. The hill in general attains height above 200 meters. The spot heights of 791 meters at the northern boundary of the district at Malang gad and 766 meters near Matheran are recorded. During the rainy season, the west flowing rivers erode mountains and deposit rich and fertile soils at the coastal area.

The district is drained by short westwards flowing parallel streams, which originate in the Sahyadri hills in the east and flow into the Arabian Sea. These streams are swift and erode material and deposit on the shoreline. Besides the general parallel pattern of the rivers, the tributary pattern tends, at places, to be rectangular suggesting the adaptation of stream to the local rock structure. The Kundalika is a small river flowing from the Hills of Sahyadri to the Arabian Sea. This river originates at a small town called Bhira in the Indian State of Maharashtra, 150 km south east of Mumbai. Roha is located on the banks of Kundalika. The Kundlika or Roha River drains a narrow central belt into the Chaul creek.

The location of the selected site on Google earth is shown as **Figure 5.4** while the enlarged view of the same is shown is **Figure 5.5**.

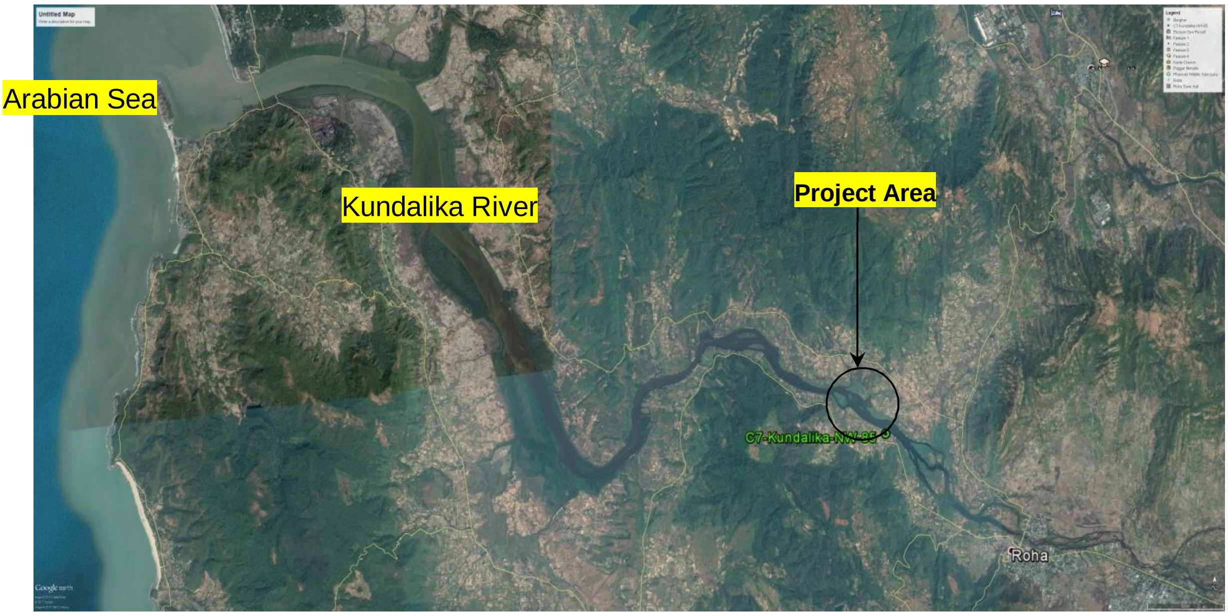


FIGURE 5.4: Google earth image showing Project area (in Circle)

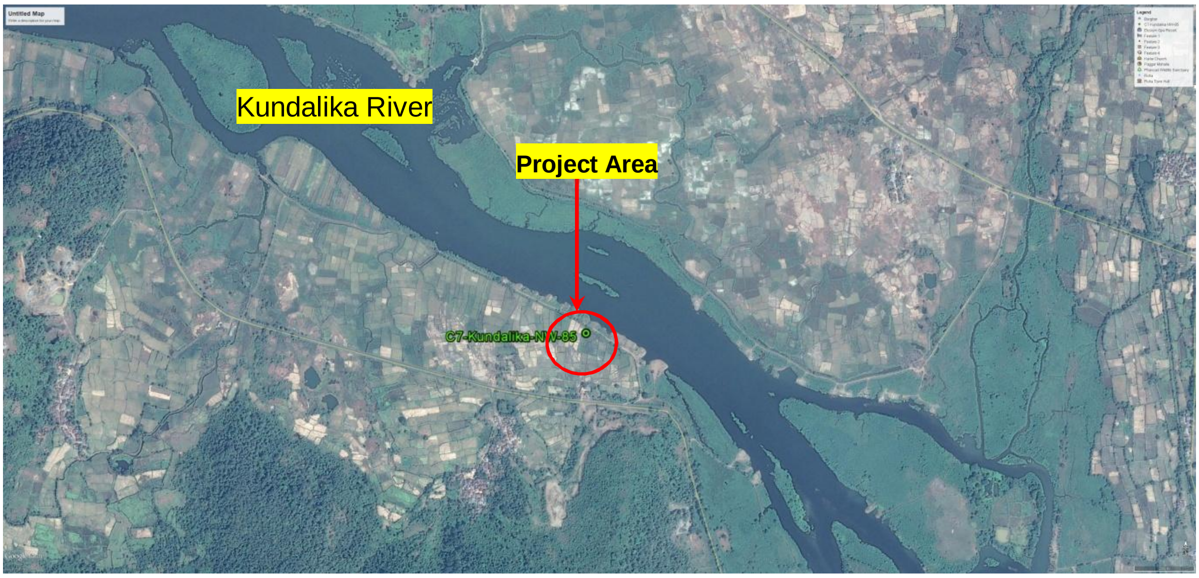


FIGURE 5.5: Enlarged view of Google earth image showing Project area (in Circle)

5.5.3. General Geology and Stratigraphy

Generally the area is occupied by thick patches of alluvium which are seen deposited along the banks Amba river. These deposits extend ever large areas and are comprised of loose grit, fine silt and marshy and swampy patches of sand bars particularly along the course of river.

Stratigraphically, the Deccan basalt pile exposed in the area which has a cumulative thickness of about 980m as noticed between the elevations of 20 m and 575 m above msl. Within this pile, 13 individual flows had been recognised in the area, and numbered serially as I to XIII, with number I being the lower most flow. There are two groups of aa flows that are identified within the flow No. V and VII and are further numbered as capital Aa, Aa2, Aa3, and small aa1, aa2, aa3, respectively. Megascopically, depending on the abundance of phenocrysts, these flows could be categorised from non-porphyritic to moderately porphyritic to highly porphyritic varieties.

Sequence of basalt flows

Based on the field observations, following sequence of flows comprising the basaltic pile and other formations, encountered in the area is given below:-

Table 5-2: Geological Stratigraphy

		Thickness in mts		**Age**
	Alluvium, beach sand, Basic dykes and granites Basalt flows	Gravel		Recent Post trappean flows
XIII	Kankeshwar aa	porphyritic flow	40+	Upper cretaceous to lower eocene
XII	Kankeshwar pahoehoe	Non-porphyritic vesicular flows	80	
XI	Kankeshwar aa	porphyritic flow	80	
X	Chora pahoehoe	Porphyritic to sparsely porphyritic, vesicular flow some with olivine	180	
IX	Mira dongar aa	porphyritic flow	40	
VIII	Chandipatt. Compound pahoehoe	Moderately porphyritic to nonporphyritic flows.	220	
VII	Simal aa	Group of thin porphyritic aa flows	45	
VI	Manickghad pahoehoe	Sparsely porphyritic to nonporphyritic vesicular flows.	60	
V	Thakurvadi aa	Group of porphyritic aa flows -------------RB--------	55	

		Thickness in mts		Age
IV	Megacryst pahoehoe	Non-porphyritic to moderately porphyritic flows with megacryst unit	60	
III	Ambivali aa	Porphyritic flow	45	
II	Parkhande pahoehoe	Non porpnyritic to sparsely porphyritic flow	55	
I	Koynanayar aa	Porphyritic flow	20	

5.5.4. Sub-surface Investigations

The selected site has been investigated by one drill hole (BR-1) which has been drilled for depth of 10.50m. The detail of the drill hole is tabulated below in **Table 1-2**.

Table 5-3: Summary of Drill hole

Sl. No	Hole No.	Location	Total Drilled Depth (m)	Depth		Thickness (m)	Description of Strata	N-Value	Core Recovery	RQD	Remarks
				From (m)	To (m)				%	%	
1.	BR-1	Centre of Terminal Area, left bank of Kundalika river	10.50	0	3.45	3.45	Reddish /Brownish Gravelly Silty Hard Clay	31-62			1.35m below GL
				3.45	10.5	7.05	Brownish /Greyish Highly to Moderately Weathered Basalt	R			R stands for Refusal

The description of the drill hole is as given below.

BR-1: Drill hole BR-1 has been drilled over the terminal location area on the left bank of Kundalika River. The drill hole has been drilled vertically down to the depth of 10.50m from EL.1.23m to EL. -6.79m. The drill hole has encountered 3.45 thick Reddish /Brownish Gravelly Silty Hard Clay followed by highly to moderately weathered basalt up to the termination depth. The core recovery in the bed rock varies from 33.00%-91.00% and RQD ranges from 0.00%-89.00%.

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

Four 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 for soil strata are as tabulated in **Table 5-4**.

Table 5-4: Summary of In-Situ Test Results

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Reddish /Brownish Gravelly Silty Hard Clay	1.5	2.1	31
		3	3.45	62

Laboratory Test Results

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

2 SPT 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 in **Table 5-5**.

TABLE 5-5: Summary of Laboratory Test Results on Soil Samples

Bore Hole	Strata Description	Depth		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistency Limits				IS Soil Classification	Shear Strength			Consolidation		Specific Gravity
					Wet	Dry		Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index, I_p	Shrinkage, S_L		Type	Cohesion	Friction	Compression Index	Initial Void Ratio	
		From	To		Kg/cm^3		%	%	%	%	%	%	%	%	%			Kg/cm^2	degree	C_C	e_0	G
BR-1	Reddish /Brownish Gravelly Silty Hard Clay	1.5	2.1	SPT	1.721	1.409	22.14	0	7	52	41	58	30	28		CH						2.64
		3.0	3.45	SPT	1.715	1.349	27.15	24	8	45	23	52	27	25		CH						2.63

For further details please refer Geotechnical Investigation Report provided in Volume-IV.

Three core samples of bed rock recovered from the drilling has been tested in laboratory to know the engineering parameters of the bed rock like crushing load, Point load index, UCS, Water absorption, porosity, Dry density & rock type. The details of the rock sample collected and results of the various tests are tabulated in **Table 5-6**.

Table 5-6: Summary of Laboratory Test Results on Rock Samples

Bore Hole	Strata Description	Depth		Crushing Load	Point load Index	Uniaxial Compressive Strength	Modulus of Elasticity	Poisson's Ratio	Water Absorption	Porosity	Dry Density
		From	To	Kg	Kg/cm^2	Kg/cm^2	Kg/cm^2		%	%	gm/cm^3
BR-1	Greyish Brownish highly Weathered disintegrated rock	4.5	4.55	160	5.16	113.46					
	Greyish Basalt	6.0	7.5	15500		656.33	2.04E+05	0.19	0.79	1.14	2.67
		9	10.5	10000		424.32	1.16E+05	0.17	0.36	0.85	2.35

Geotechnical Analysis

Bearing Capacity Calculations

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

TABLE 5-7: 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	2.1	Clay	31	2.1	17.2	200	0	0.432	0.96
2.1	3.45	Clay	62	1.35	17.1	200	0	0.378	1.06
3.45	5.00	Sand / Weathered rock	-	1.55	-	-	-	-	-

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 5-8: 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	76	109	165	332
2.	2.0 m x 2.0 m	65	93	143	290
3.	2.5 m x 2.5 m	57	83	129	265
4.	3.0 m x 3.0 m	53	77	118	246

Pile Capacity Calculations

The pile capacity is calculated for different diameter of piles up to rock level. The details are given below. The sample calculations are given in **Annexure-5.2**.

TABLE 5-9: SUMMARY OF PILE CAPACITY CALCULATIONS

S. No	Diameter of Pile (m)	Depth of Pile below NSL (m)	Capacity of Pile in compression (kN)	Uplift Capacity of Pile (kN)
1.	1.0 m	5	766	277
2.	1.3 m	5	1217	399
3.	1.4 m	5	1393	443

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 31000 Sq. m approx., which can be accommodated within the Land proposed to be taken on Acquisition.

As mentioned earlier, the cargo of JSW and Kolai Kolivada are being handled in their own captive jetties. The other cargo of 1.12 MMTPA estimated in FY 40, comprising of Bulk / Break-Bulk cargo 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 / 2.00 m Depth in front of the Berthing Structure. Considering the vessel size of berthing of 2 SPVs of 86 m (say 90 m) each, the optimum length of Berth requirement shall be taken as 120 m. This has been considered keeping in view the SPV of 2000 T capacity. However, the same has not been recommended. In this length of 120 m, 4 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 1 Rubber mounted crane capable of handling 125 TPH.

In order to evacuate the 2000 T vessel, it is proposed to consider the deployment of 1 crane with a capacity of 125 T per hour. One crane can handle 1000 T in a day (10 Hrs operations) with 80 % efficiency. The same will be 2000 T with 20 Hrs operations.

1 Berth x 1 Crane x 300 Days in an year x 20 Hrs a day x 125 TPH x 80 % efficiency = 0.6 MTPA

Though the estimated requirement is of about 0.57 MTPA in FY35 with an increase to 1.12 MTPA in FY 40, 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 1 Crane is suggested / recommended at the initial phase. The following iterations of improvement are also suggested / recommended with the estimated traffic improvement.

1 Berth x 1 Crane x 300 Days in an year x 10 Hrs a day x 125 TPH x 80 % efficiency = 0.3 MTPA

1 Berth x 1 Crane x 300 Days in an year x 20 Hrs a day x 125 TPH x 80 % efficiency = 0.6 MTPA

1 Berth x 2 Cranes x 300 Days in an year x 20 Hrs a day x 125 TPH x 80 % efficiency = 1.2 MTPA

Keeping the above all in view, the Lo-Lo berthing structure is being planned in FY 30.

Regarding the Cranes, 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 2 nos of barges/vessels of 2000 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 LO-LO 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.

The LO-LO berthing structures are kept at a minimum distance of 2x vessel length apart for safe and efficient handling and operation.

TABLE 5-10: Salient Features of berth structure

Description	Length(m)	Width (m)
LO-LO	120	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-E05** 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

Development of 1 Lo-Lo Terminal is proposed after attaining the saturation of the existing infrastructure and also after observing the growth trend in cargo. The Capital Cost for the Lo-Lo Terminal is of INR 46.78 Cr. The detailed cost estimates have been placed in Chapter 11 and its Annexures.

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 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.

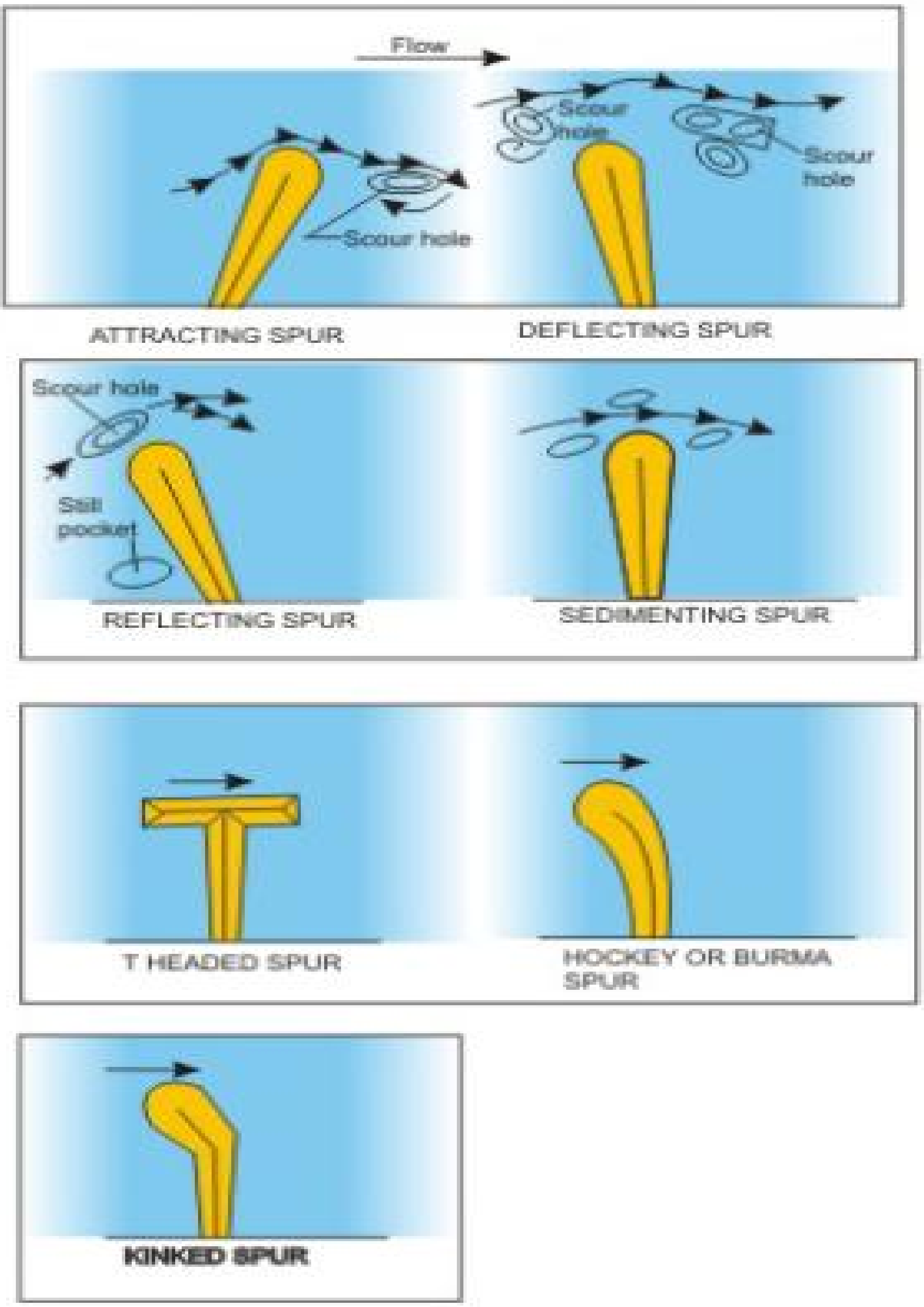


FIGURE 6.1: Different types of Spur

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.

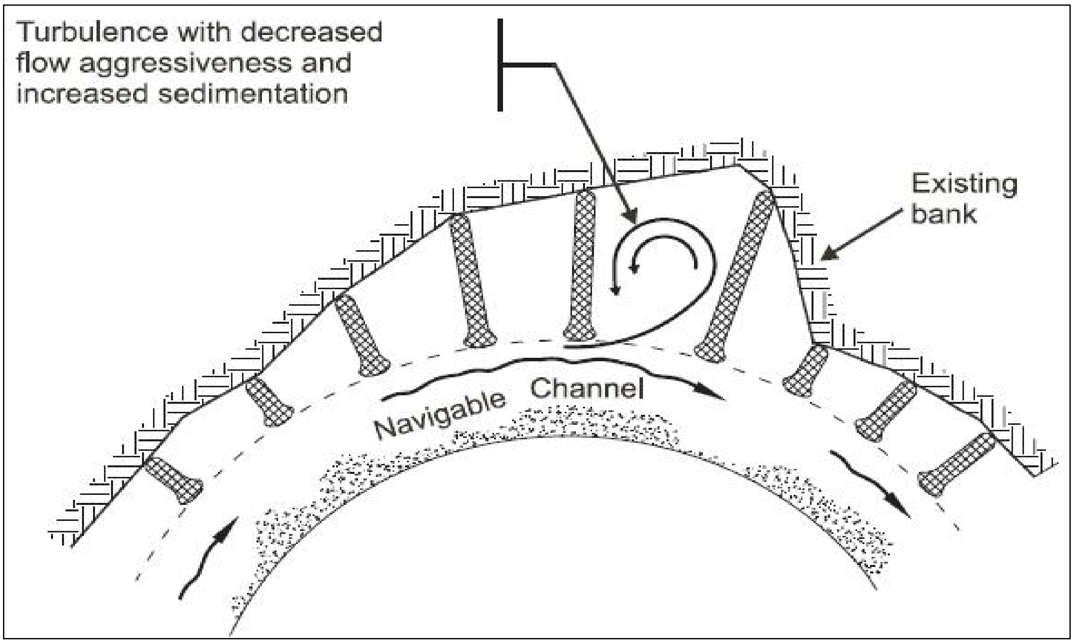


FIGURE 6.2: Plan view of system of spur-dikes constructed to control and stabilize the erosion of the outer band

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.

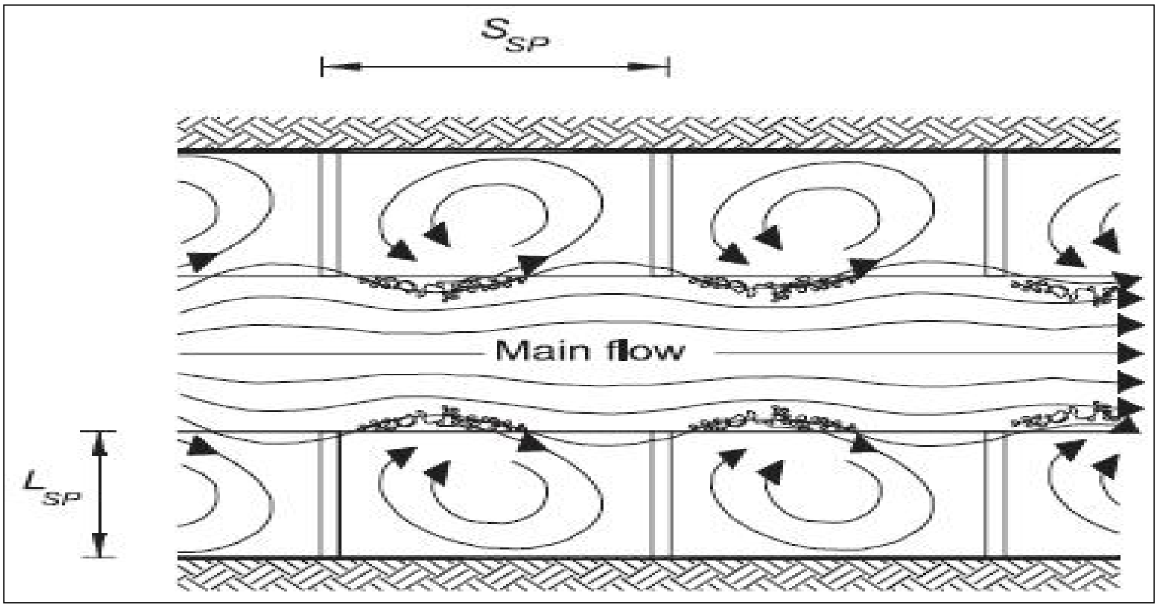


FIGURE 6.3: Diagram showing the length and spacing of the individual dikes with respect to the river width

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.

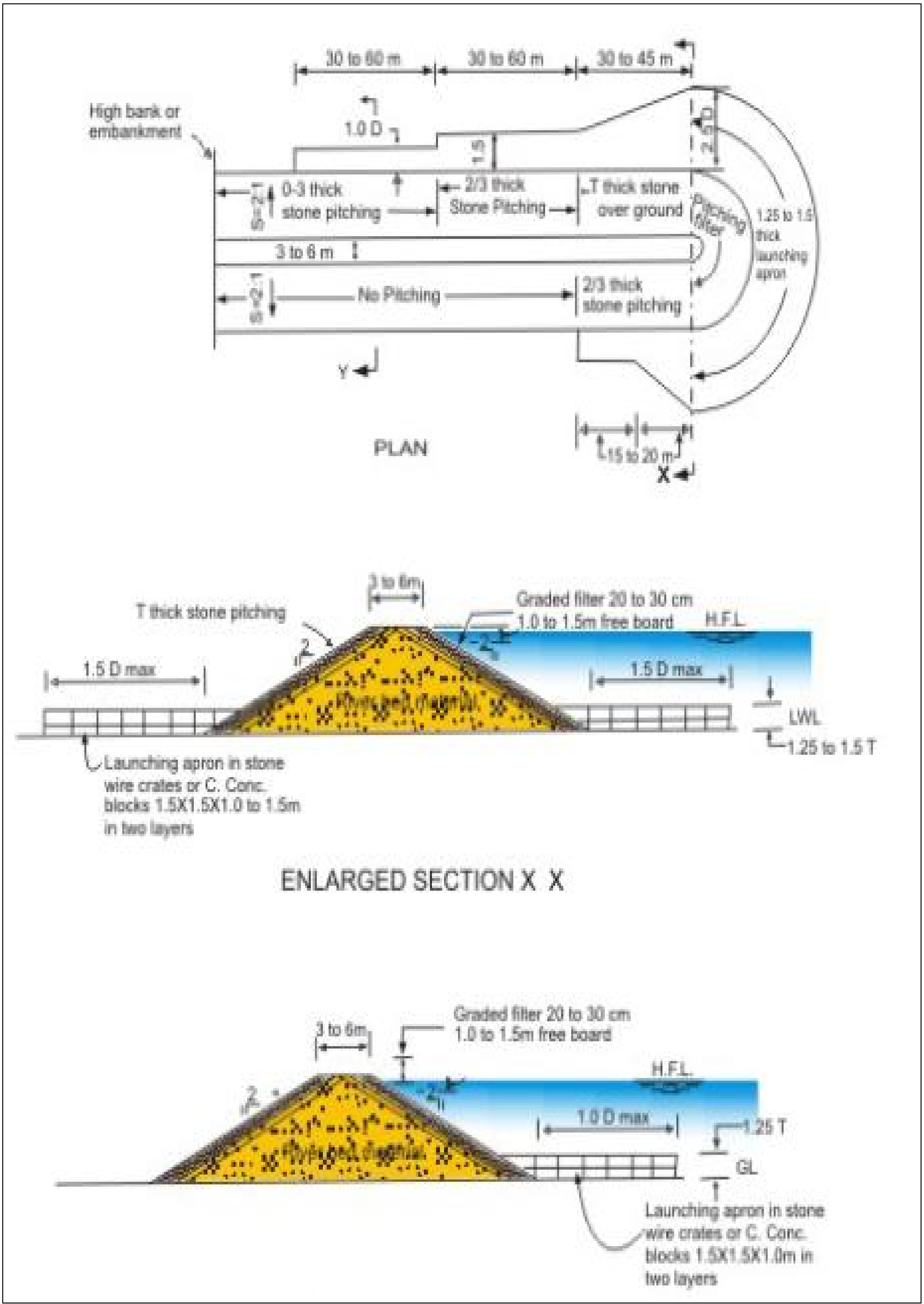
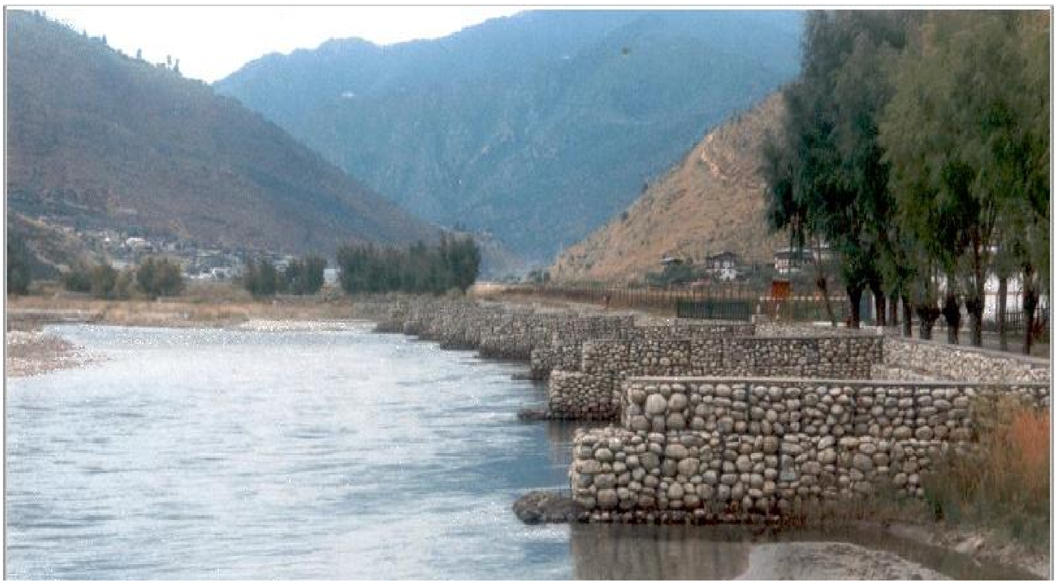


FIGURE 6.4: Typical layout and section of spur

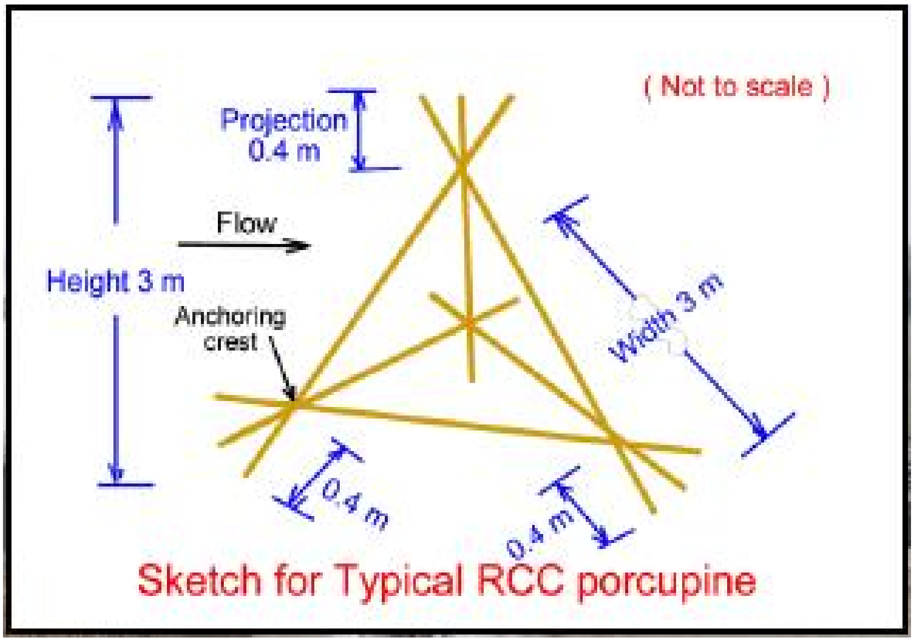
Impermeable spurs



Series of spurs

6.1.2. River Training through Porcupines

River Training through RCC Porcupines 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 labour, 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.

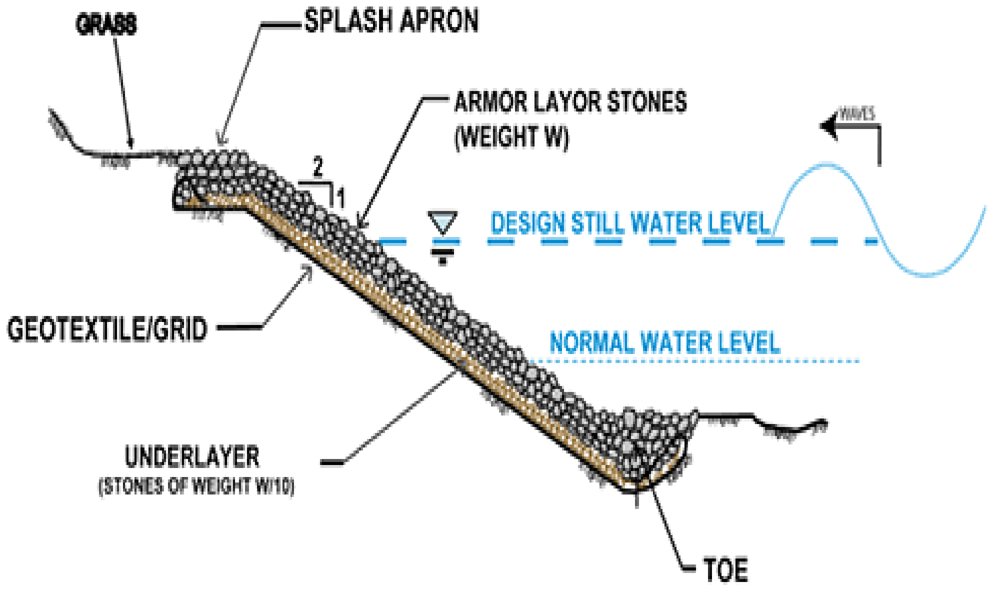
C. Design requirements for Revetments

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. (Refer Volume-II **Drawing No.P.010257-W-20303-X05** for details).

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.

Revetment Design:



Filter

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

D. Toe protection

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

E. 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.

F. 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.

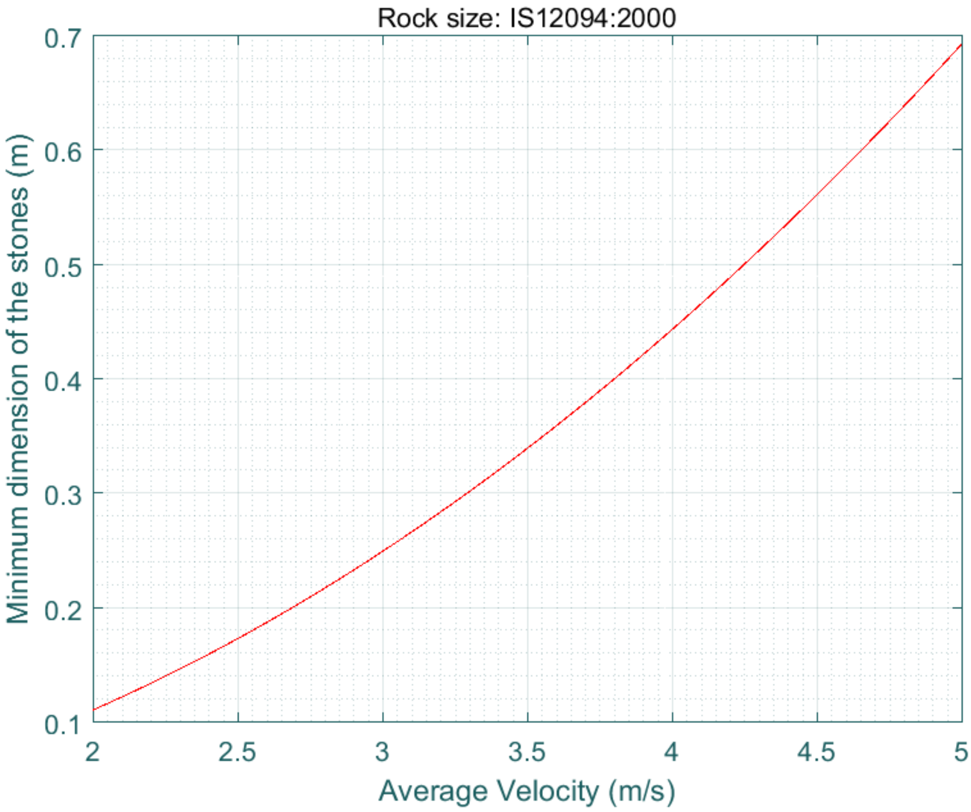


FIGURE 6.5: Minimum rock size according to the IS12094

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 a 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.

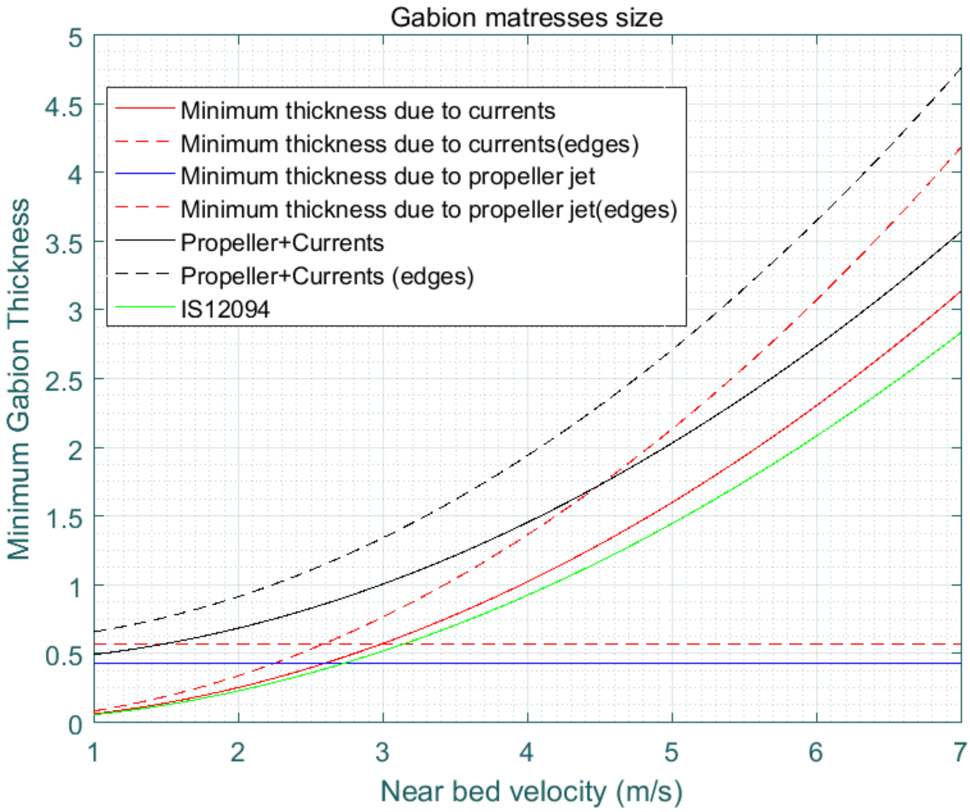


FIGURE 6.6: Minimum required thickness for revetment

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

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

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

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

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

- 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.

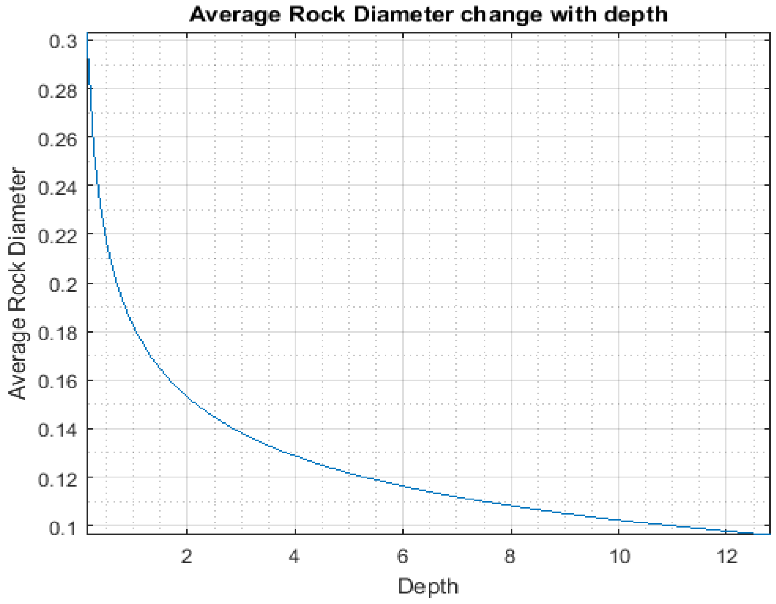


FIGURE 6.7: Minimum average rock diameter

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.

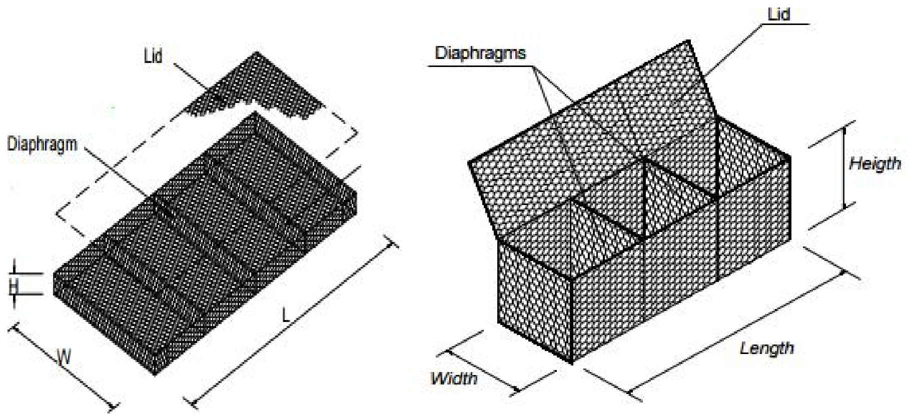


FIGURE 6.8: Example of a gabion mattress and gabion basket

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

Wire Properties	European testing	Content
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%

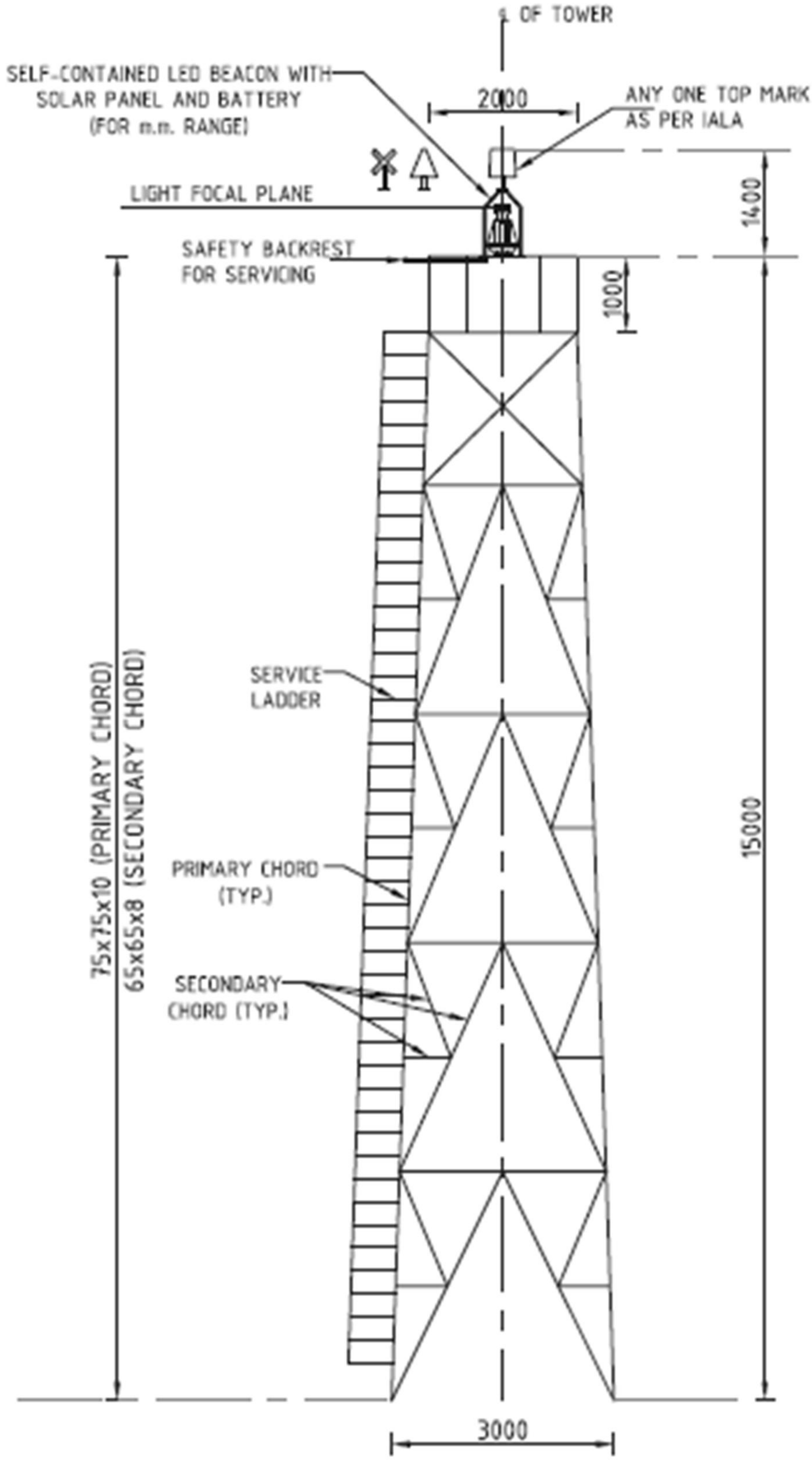
6.3. Navigation Aids

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.

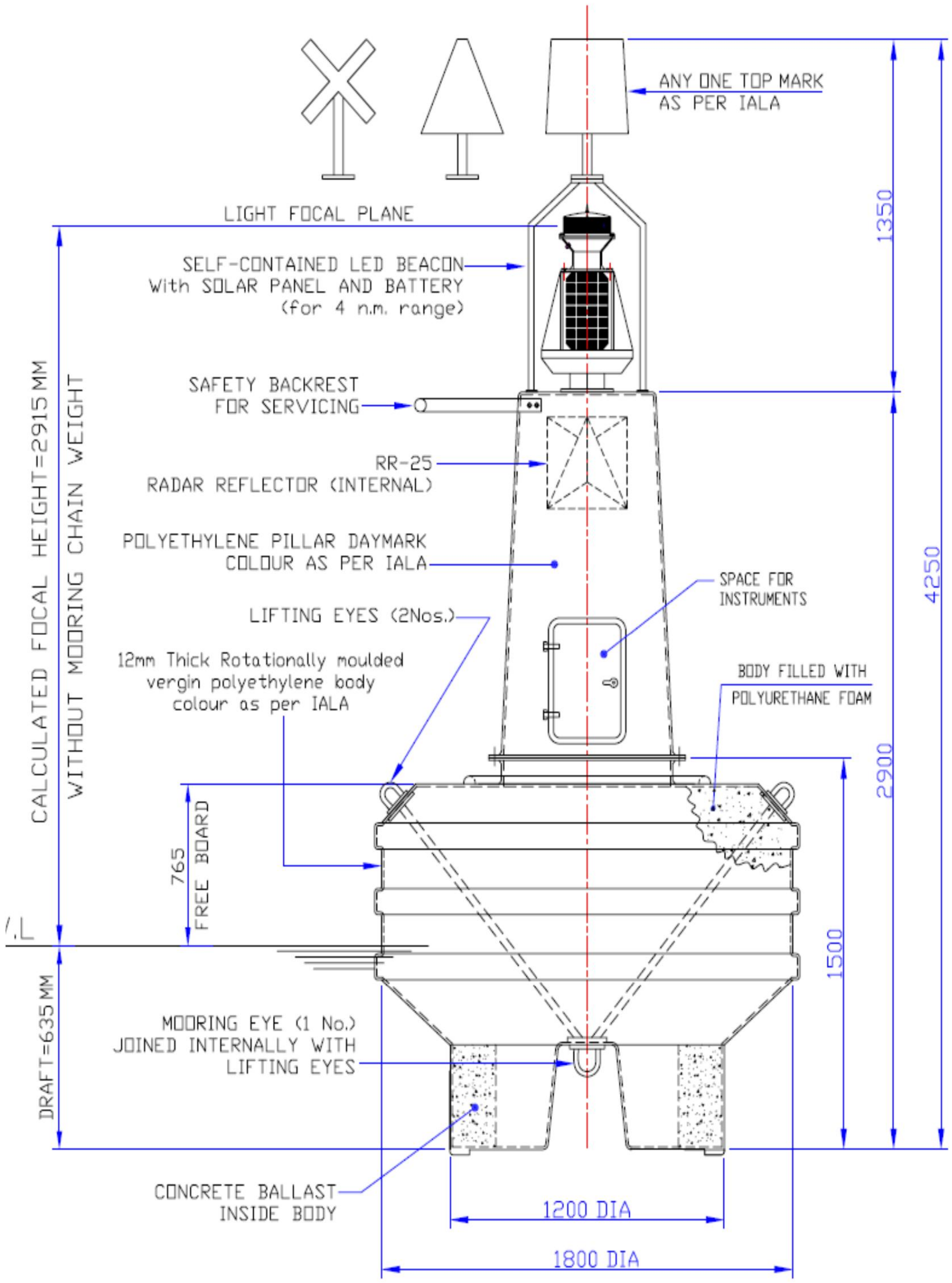
In the Shore based system, for the west flowing National Waterways of Cluster 7 and Cluster 6, it has been preferred to have a Beacon / Light system, wherein the Buoy / Light system has been preferred.

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

BEACON WITH LIGHT SYSTEM:



BUOY WITH LIGHT SYSTEM:



Specifications of BUOY & LIGHT:

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:

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).

1 Set - Mooring gear – Each set comprised of the following:

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.

Note: 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.

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:

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.).

1 No. - PLC 12 programmable microprocessor based LED controller (fitted in the base of the Lantern). Main description is given as below:

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. Seismic loading

Earthquake loads shall be adopted as applicable for the site as per IS 1893 – 2002. Kundalika 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 12 m has been considered from the HFL. As observed from bore hole data, results obtained from geotechnical investigation rock is encountered at a depth of 5 m, hence, the pile shall be socketed into the rock at EL (-)2.3m.

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. (Refer Volume-II **Drawing No.P.010257-W-20341-E05** for details).

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.

For LO-LO berthing structure an overall width of 32 m is provided.

The deck of LO-LO shall be provided at approx. 1 m above HFL. Expansion loops has been provided along the stretch at almost 30-40 m

A staged construction approach is assumed in the design viz:

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

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

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

S.No	Type	Total Length	Total Width
1	LO-LO	120 m	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.

In 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

In general ,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	Truck Loading (IRC Class)	Uniform Vertical Live Loading T/m²
(1)	(2)	(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 has been considered.

c) Seismic Forces

Kundalika river / Revdanda creek 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 and deck slab 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)

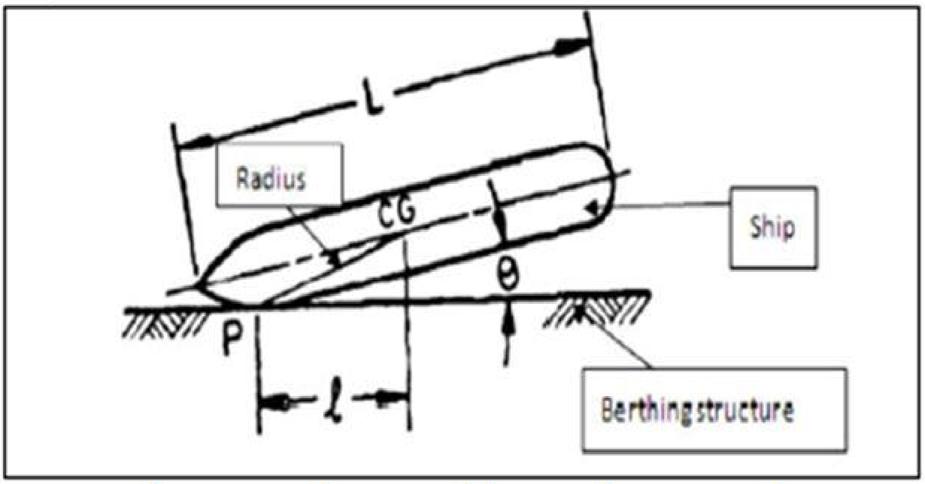
V = Berthing Velocity in m/s

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 (with 2 vessels berthing simultaneously)

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

D= draught of vessel =1.94 m

L = length of vessel =90 m

W= unit weight of water

Cm =1.067

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)

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 = 108.8kNm/4 = 27.2 kNm. (Total length LO LO =120 m, considering expansion joints at almost every 30 m)

Thus a moment of 27.2 kNm/m has been applied in the software.

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 board side of the vessel.

IS 4651_III, gives Bollard Pulls of vessel as below

For 4000DWT Line pull = 200 kN (total for 120 m deck with 2 vessels simultaneous berthing)

200/4 = 50 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 v2/2g per m2

Where

v = velocity =1 m/s

W= 10 kN/m2

F = 0.51 kN/m2

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.

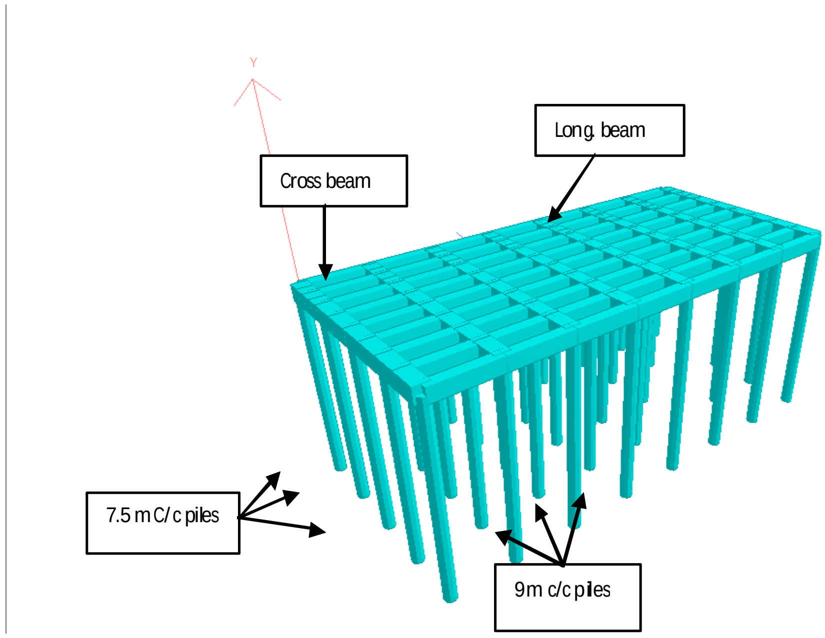


FIGURE 6.9: Perspective view of 3 dimensional model prepared in STAAD for LO-LO

SIZING OF LO-LO

Member Description	Length(m) C/C	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	7.5	1.8	1.8		Concrete
Longitudinal Beams	9	1.2	1. 5		Concrete
Cast In situ Slab				0.15	Concrete
Pile Diameter, OD		1.2	7.5*		Concrete

* Including socket length of 2 m

It is evident that the soil above the rock bed shall be scoured during HFL condition as calculated Scour level is more than Rock level. In order to carry the specified load the pile has be socketed into the competent rock. Considering competent rock at EL. -4.8m, socket length of the pile has been calculated as follows:

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

	Rock Socketed Pile : REVDANDA LO-LO				
1.	METHOD 1 : UCS directly established using standard method of testing, IRC 78-2014				
1.1.	Input				
	Rock Quality Designation, RQD		=	48	%
	Core recovery, CR		=	68	%
	Uniaxial Compressive Strength (UCS), qc		=	65.6	MPa
	Dia of Pile		=	1.2	m
	Length of Socket		=	1.5	m
	Load on Pile		=	5000	KN
	Grade of Concrete		=	M40	
	Scour Depth		=	5.8	m
1.2.	Pile Capacity				
	Ultimate end bearing capacity of socketed pile, Re	Ksp*qc*df*Ab	=	58759.95	KN
	Coefficient base on CR & RQD, Ksp		=	0.66	
	Depth Factor		=	1.5	
			=	1.2	
	Area of base, Ab	pi* d2/4	=	1.13	m^2
	Ultimate side socket shear, Raf	As* Cus	=	10305	KN
	Ultimate shear strength of rock along socket length, Cus		=	1.822	MPa
	Using Shear Capacity of rock	0.225*qc^0.5	=	1.822	MPa
	Using Shear Capacity of concrete	3*(fck/35)^0.5	=	3.207	MPa
	Area of socket, As	pi*d*L	=	5.65	m^2
	Ultimate capacity of socketed pile, Qu	Re + Raf	=	27269.81	KN
	Allowable capacity of socketed pile, Qallow	Re/3 + Raf/6	=	7372.40	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.

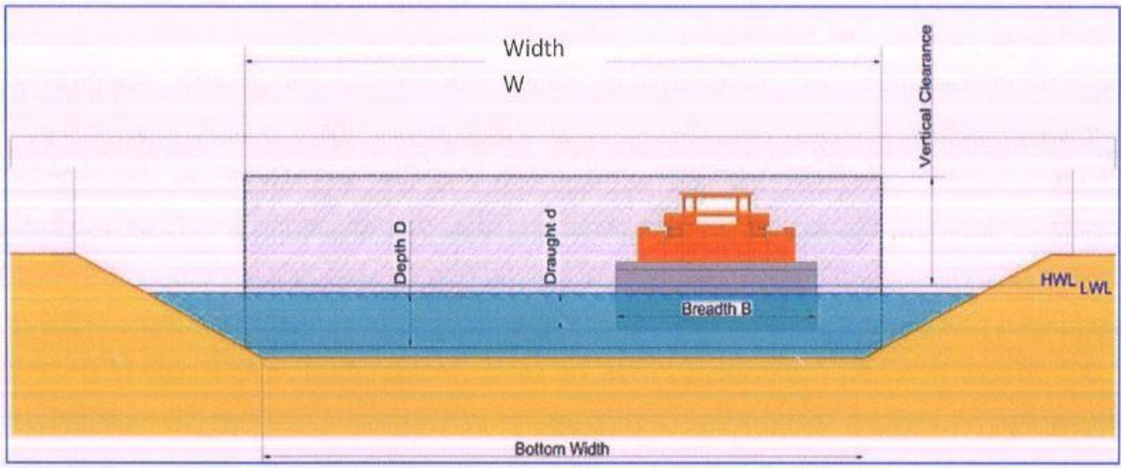


FIGURE 7.1: Dimensions – one way navigation Channel

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

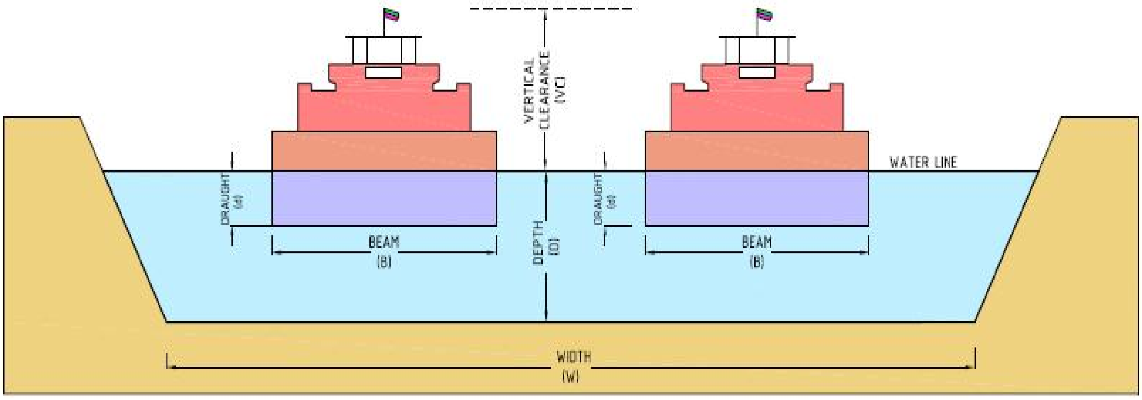


FIGURE 7.2: Dimensions – Two way navigation Channel

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**.

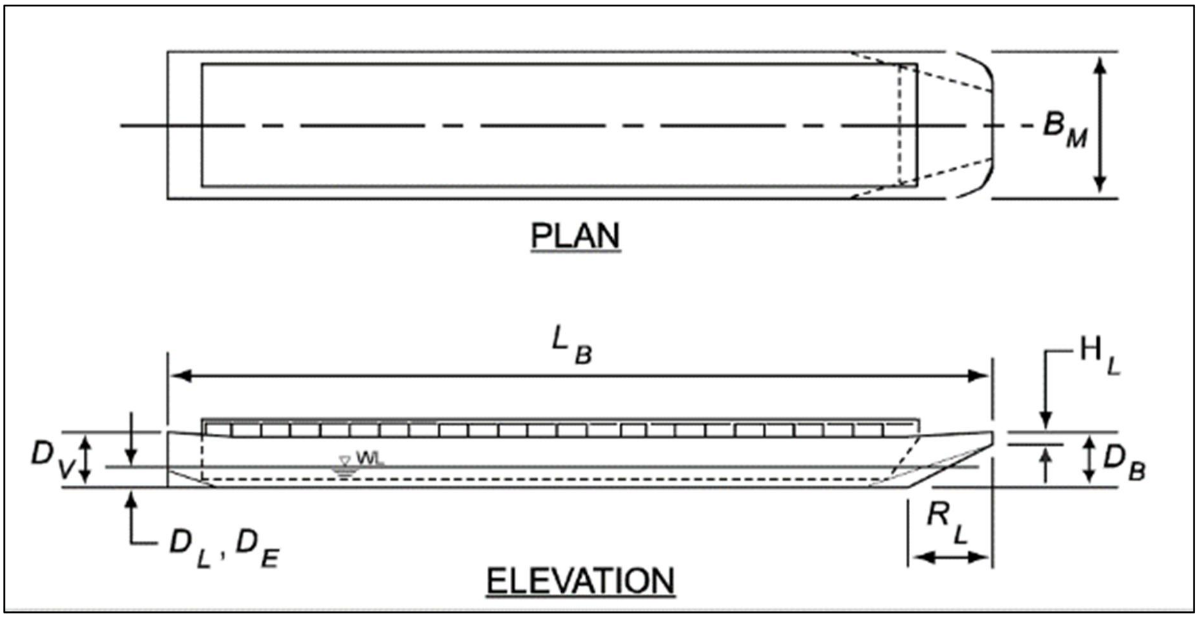


FIGURE 7.3: Plan and Elevation of vessel

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					Pushed Convoys					Minimum Height under Bridges
			Type of Vessels Characteristics					Type of convoys: General Characteristics					
			Designation	Maximum Length	Maximum Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage	
				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 Canel	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
	F/B	D/d	n	F/B	D/d	Waterway F x 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 have 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 Kundalika has been limited to Class IV in the proposed stretch up to Ch 26 km, keeping in view the cargo mobility etc.,.

View of Sanegaon Jetty

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 Laying 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 “Kundalika” has been considered, as a part of development of this waterway. Hence, the present discussions are being concentrated only on Cargo Vessels.

The river Kundalika is being used with the mobility of about 2000 T – 2700 T / 3000 T vessels upto Sanegaon / Salav jetties. These vessels are plying with tidal advantage for smooth uninterrupted mobility. The existing IWT Traffic volumes are to an extent of about 1.25 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, which is most amenable for the initial period stretch up to the Sanegaon Port. The same combination may be sufficient for usage by other operators and up to the proposed Terminal of IWAI @ Ch. 26 km.

For the above scenario, the most suitable vessel size has already been defined in Class IV of the classification. The SPV will be with the max sizes of 86 m x 14 m x 2.5 m for SPV and the same has not been recommended. 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 way Navigation. 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: (2000 T) {Not Recommended}

Length:	86 m to 90 m
Breadth:	12 m to 14 m
Loaded Draft / Depth:	2.5 m / 3.0 m +
Cargo Capacity:	2000 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 to 14 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 maneuver in the west flowing rivers like Kundalika 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 2029, the vessel requirement will be as detailed.

1 PT + 2 DBs may be required by 2029. {Construction from 2025 to 2029}

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.,.

JSW projects for mobility to Sanegaon are having their own captive terminal system with fully equipped equipments and also they are equipped with Vessel asset for the project. 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.

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 jetties to handle the Bulk / Break Bulk cargo of 0.12 MMTPA in FY 30 to 1.12 MMTPA in FY 40.

Bulk / Break Bulk Cargo: In the proposed IWAI Terminal location, maximum designed propositions are catered with 1 Berth of 120 m length to accommodate 2 Dumb Barges at a point of operation and considering 2 cranes (Each Crane of 125 TPH with 80 % efficiency) in each Berth with 20 Hrs of operation, it can clear about 1.2 MMTPA.

The Bulk / Break Bulk cargo is to be moved from Anchorage to IWAI Berth i.e., for a distance of about 30 Kms. (Anchorage to Kundalika River Mouth is about 4 Kms + Distance in the river upto IWAI Terminal is about 26 Kms). Keeping in view the average speed of the vessel as 15 to 16 Kmph, the journey Time is 2 Hrs.

The TAT will be as detailed:

Loading at Anchorage 20 Hrs + Onward Journey 2 Hrs + Unloading at Terminal 20 Hrs + Return Journey 2 Hrs = Total 44 Hrs say 48 Hrs.

7.6. Number of Vessels Required

In order to handle Bulk / Break Bulk cargo, 1 unit of 1 PT + 2 DBs in 2 days of TAT with 48 Hrs round trip can carry 2000 T. Accordingly, in 300 days, it can handle about 0.3 MMTPA, wherein 2 units with 2 PTs + 4 DBs can handle about 0.6 MMTPA.

Yet, it is proposed to go ahead with 2 units of 1 PT + 2 DBs i.e., 2 PTs + 4 DBs, which may have to be carefully increased. Besides, this proposal is only after the capacity saturation, which may take some time to settle.

1 PT + 2 DBs may be required by 2029. {Construction from 2026 to 2029}

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 specific repair yard in the study stretch of Kundalika River to attend the repairs of IWT Vessels plying in this region.

It was observed that the nearest IWT ship repair facility for the vessels plying on “Kundalika River” is in “Sewri” area in Mumbai, which is about 55 Kms from the mouth of “Revadanda Creek”. The prominent shipyard is one being promoted by “Brilliant Seagull”, as noted.

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: (2000 T) {Not Recommended} with Length – 86 m to 90 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 2.5 m / 3.0 m +; Cargo Capacity – 2000 T and Propulsion by Marine Diesel Engines of 2 x 625 Bhp is costing about **INR 1000 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 to 14 m; Loaded Draft / Depth: 1.8 m / 2.0 m + Cargo Capacity: 1000 T is costing about **INR 500 Lakhs each.**

{+ is the indication for provision of additional Depth, keeping in view the coastal movement of these vessels}.

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 2 days turnaround (150 Cycles) of which 4 Hrs mobility in a cycle, say with 5 Hrs / Cycle, cost per annum will be as detailed.
- 150 cycles x 5 Hrs x {0.1 Liter per hour x 3 Engines x 800 Bhp} x INR 70 per Litre = **INR 126 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 fool 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 has 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 schematic form in the Figure below.

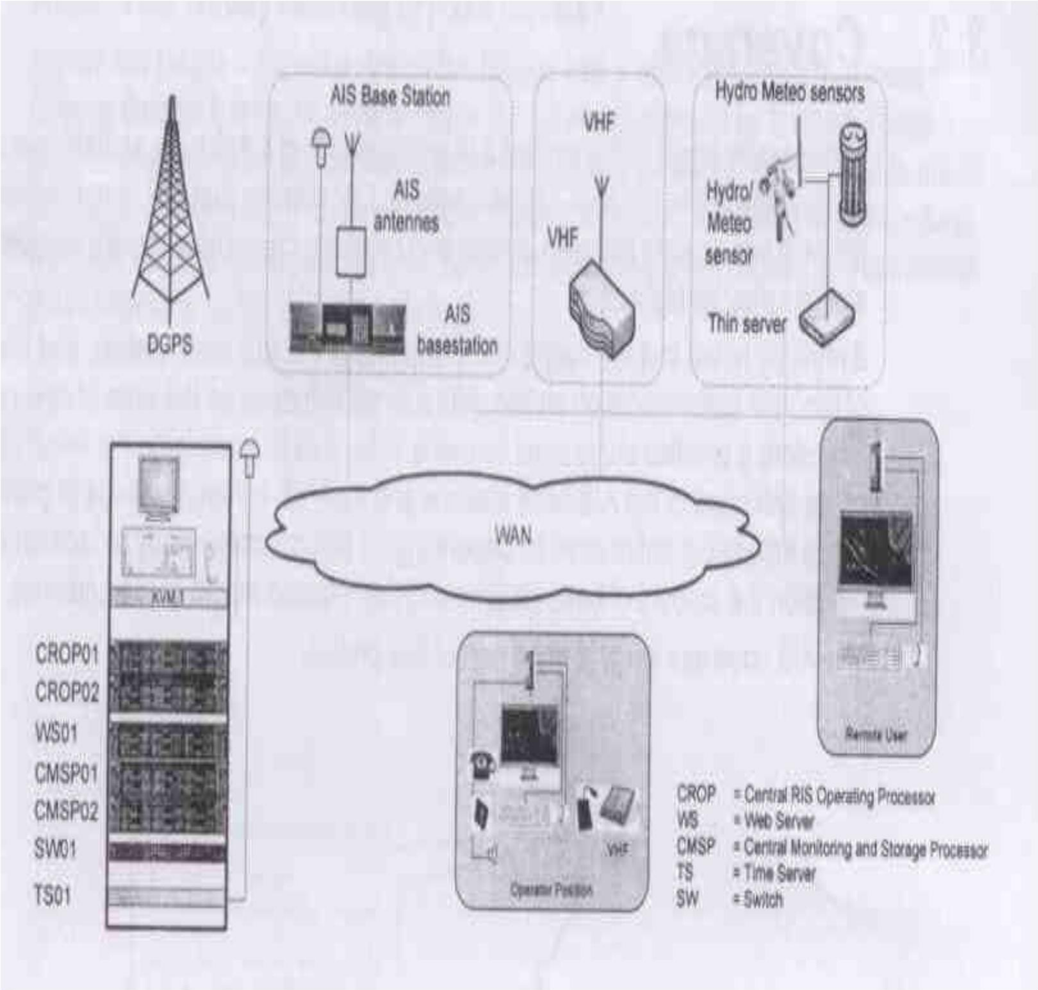
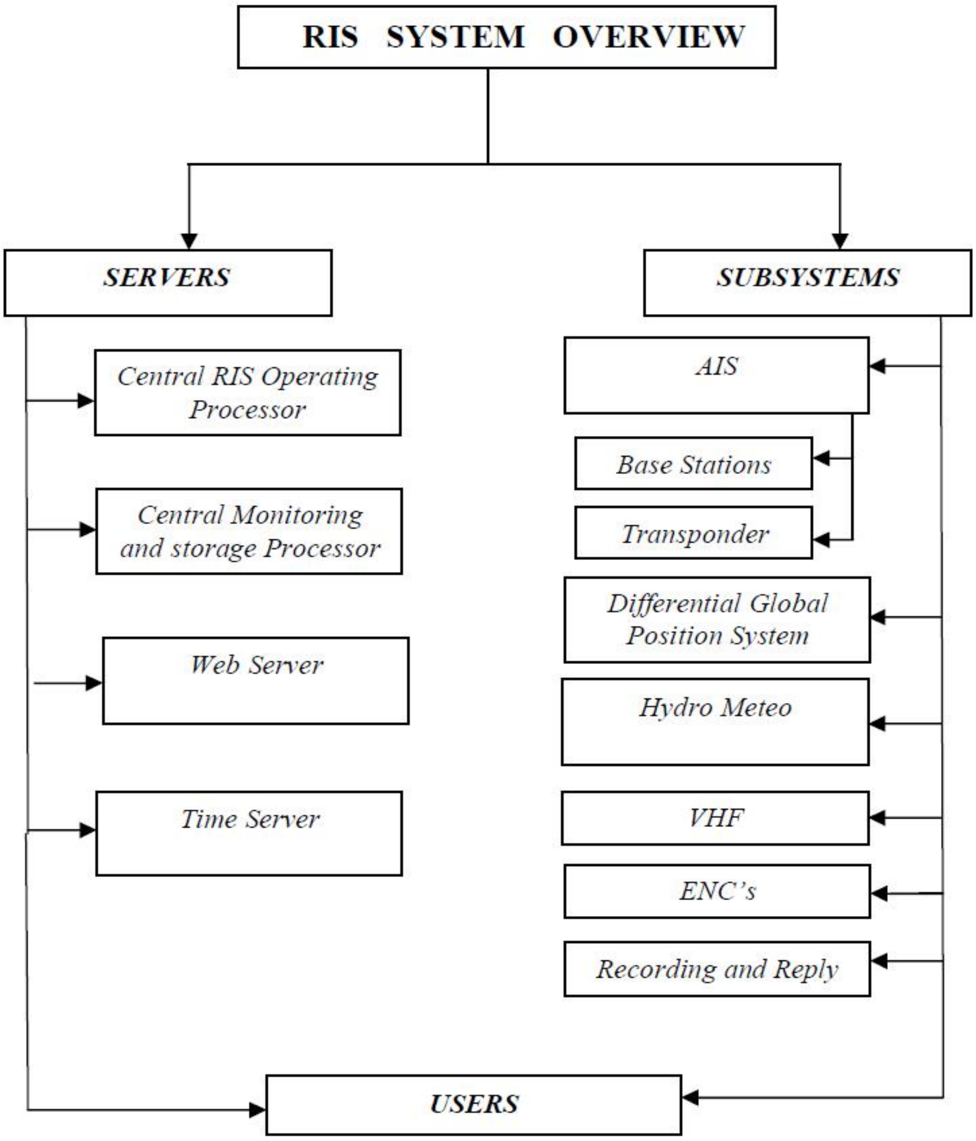


Fig 8.1 Main components of the RIS system are given below in flowchart:



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 require interface with the systems available / working on the 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 Equipment's 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 fool-proof communication / navigation system in the National Waterways joining the sea in both West / East coast.

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

Metrological Equipment's (Anemometer, Barometer, Relative Humidity)

Wind Speed

- Range: 0 to 60 m/s
- response time 250 ms
- accuracy : 0 to 35 m/s: ±0.3 m/s or ±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: ±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: ±0.3 °C
- Output resolution and unit: 0.1 °C

Barometric pressure

- Range: 600 to 1100 hPa
- Temp: -50 to +60 °C
- Accuracy: ±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: ±3 %RH within 0 to 90 %RH ±5 %RH within 90 to 100 %RH

Output resolution and unit: 0.1 % RH

Control Station Servers (CROP / CMSP / WS / TS)

Central RIS Operating Processor (Application cum Data base Server)

- 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.

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

- 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. 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 "REVADANDA CREEK / KUNDALIKA RIVER (NW-85)"

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
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**

COST FOR RIS SYSTEM ON “REVADANDA CREEK / KUNDALIKA RIVER (NW-85)”

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
B.	**MANPOWER COST**			
	1ST 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 1st year			**29,40,000**
	Total for 2nd year (7 % on the previous year)			**3,145,800**
	Total for 3rd year (7 % on the previous year)			**3,366,006**
	Total for 4th year (7 % on the previous year)			**3,601,626**
D.	**CAMC for 4 years**			
	1st year			**-Nil-**
	2nd year (10 % on the Capital Cost)			**70,00,000**
	3rd year (+ 10 % on the previous year Cost)			**77,00,000**
	4th 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 requirement and only indicative.

C. Cumulative Annual Maintenance Cost is indicative.

D. The Annual License Cost may vary according 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.

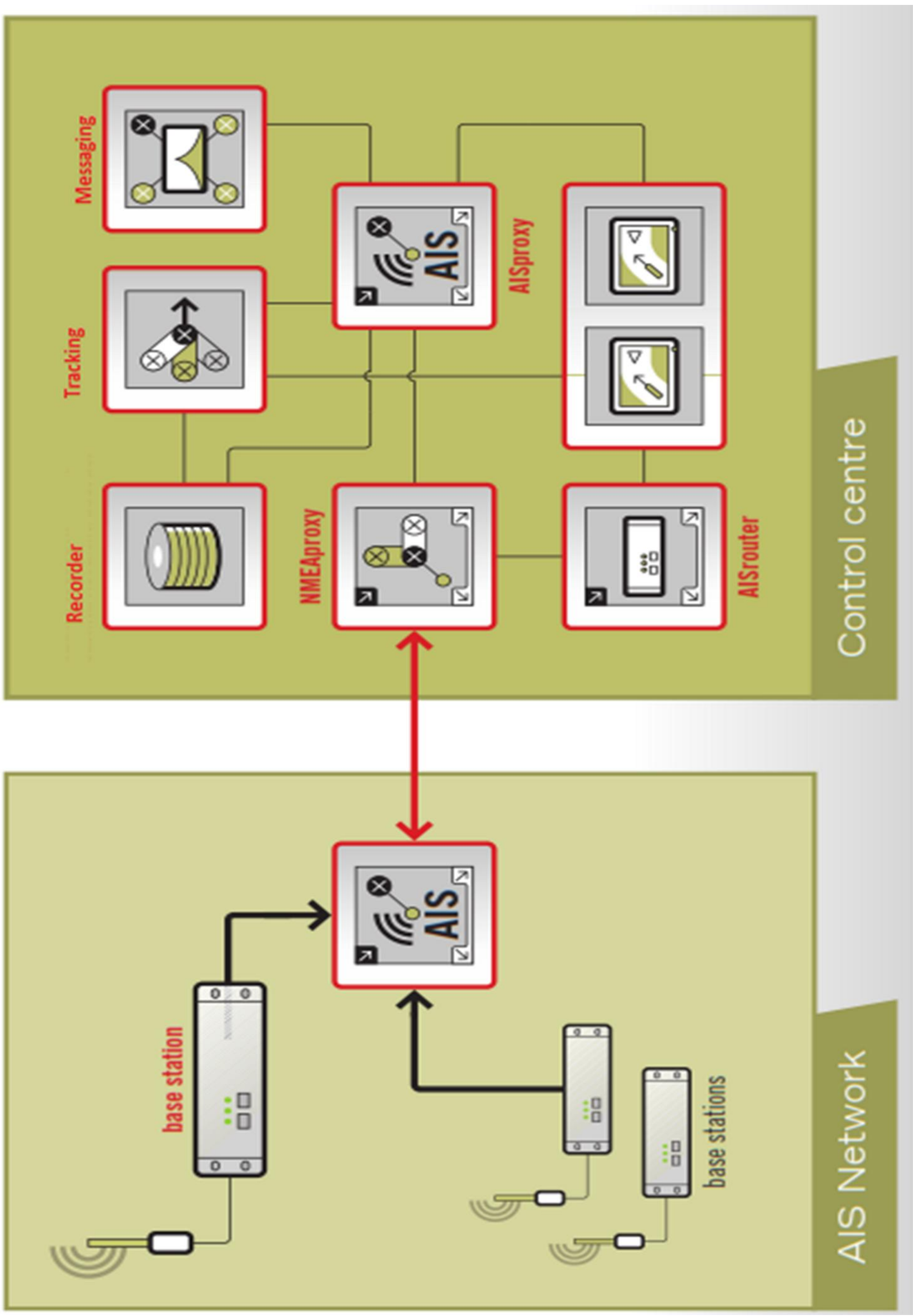
Further, the following indicative Figures / Diagrams are placed herewith.

1. ***Typical Automatic Identification System (AIS) on Revadanda Creek / Kundalika River and its connectivity to Control Centre***
2. ***Diagram indicating the Proposed Centres (RR) along the National Waterway***
3. ***Typical line diagram showing the interface of other systems with the Radar system are placed herewith.***

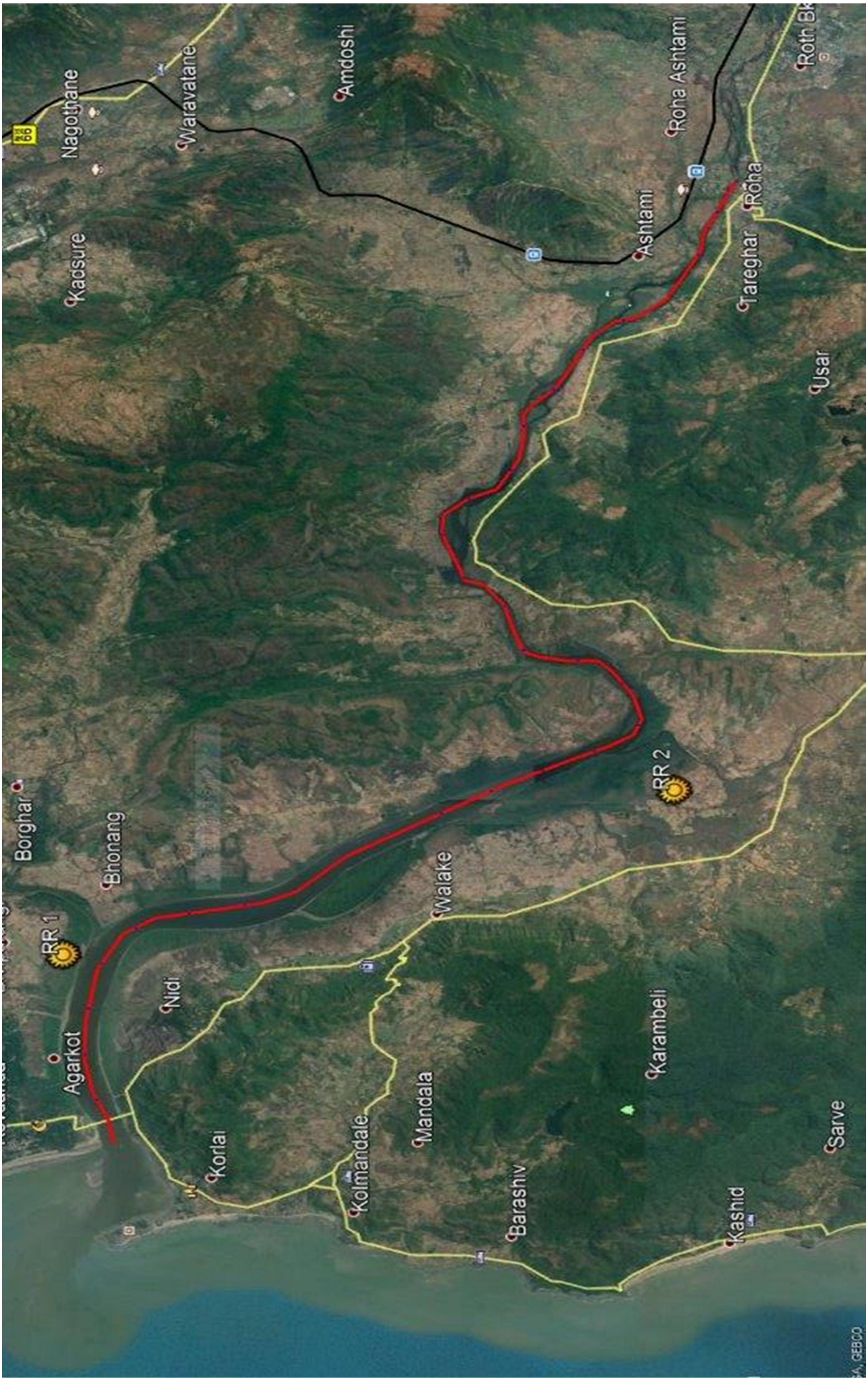
AIS (Automatic Identification System)

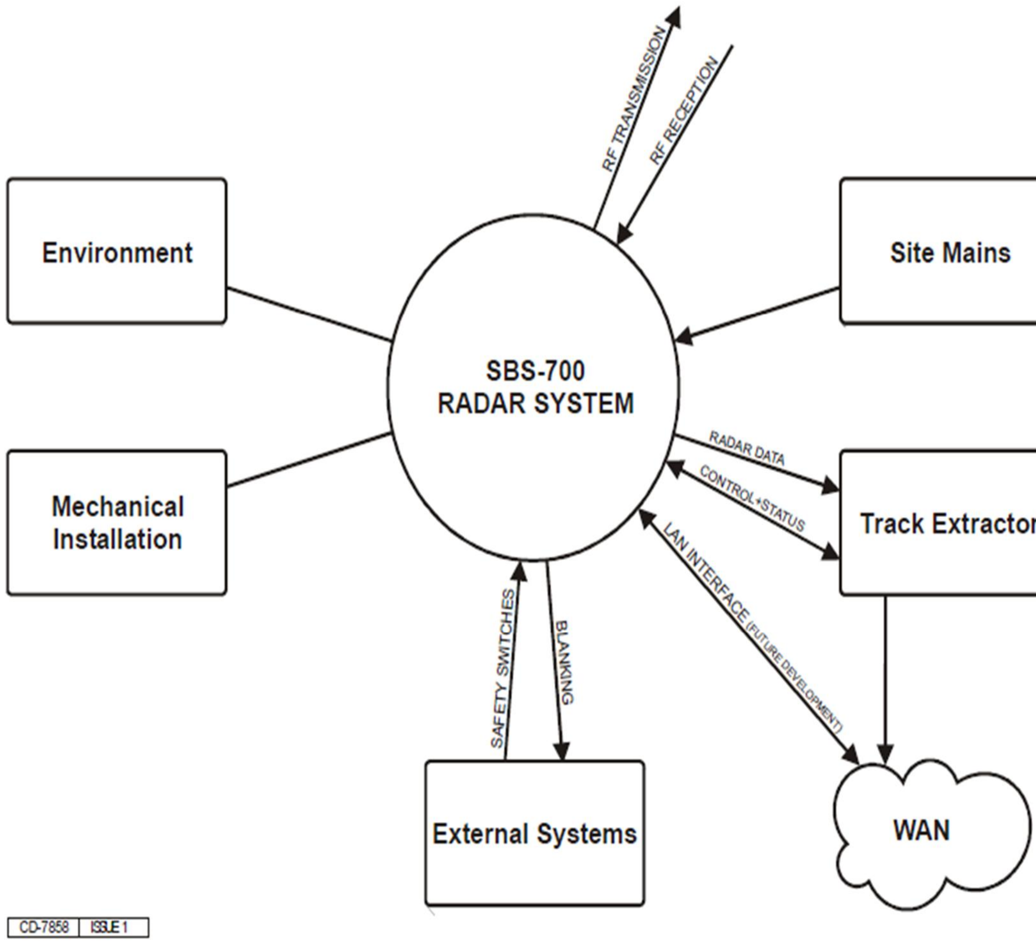
Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

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)


Nagothane
Waravatane
Amdoshi
Roha Ashtami
Kadsure
Ashtami
Roha
Tareghar
Usar
Borghar
Bhonang
RR 2
Walake
RR 1
Nidi
Agarkot
Karambeli
Mandala
Korlai
Kolmandale
Barashiv
Kashid
Sarve


RF TRANSMISSION
RF RECEPTION
Environment
Site Mains
SBS-700
RADAR SYSTEM
Mechanical
Installation
RADAR DATA
CONTROL+STATUS
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. 85 under the National Waterways Act 2016 and is located on Kundalika River in the Raigad district of Maharashtra State. It is a 30.73 km stretch of the Kundalika river beginning from the Arabian Sea at Revadanda at Lat 18°32'19.85"N, Lon 72°55'32.80"E to the Bridge on Roha-Astami road near Roha Nagar at Lat 18°26'31.50"N, Lon 73°07'10.74"E.

The environmental setting in the project area is described in the sections that follow.

9.2.1. Physiography

Physiographically, Maharashtra state may be divided into three natural divisions - the Maharashtra Plateau, the Sahyadri or the Western Ghats and the Coastal Strip (the Konkan).

Maharashtra Plateau: The major physical characteristics of the state include many small plateau and river valleys. In the north, the plateau is flanked by Satpuda ranges, which run in the East-West direction in Maharashtra. The river Narmada flows along the north boundary of Maharashtra, and other major rivers like Krishna, Godavari, Bhima, Penganga-Wardha, and Tapi-Purna have carved the plateau in alternating broad river valleys and intervening highlands.

The Sahyadri Range: The Western Ghats of Maharashtra known as the ‘Sahyadri’ mountain ranges have an average elevation of 1000-1200 m above the MSL. The Sahyadri hills run parallel to the sea coast, with many offshoots branching eastwards from the main ranges (Satmala, Ajanta, Harishchandra, Balaghat and Mahadeo). The special features are the hills of Trimbakeshwar, Matheran and the Mahableshwar plateau. Its highest peak is Kalsubai at an altitude of 1650 m. Most of the rivers in Maharashtra originate in the Sahyadri and then divide to join the eastward and westward flowing rivers. These ranges are also characterized by a number of ghats, the important ones being Thal, Bor, Kumbharli, Amba, Phonda and Amboli.

The Konkan Coastal Strip: The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the Konkan coastal strip. It is barely 50 km in width; it is wider in the north and narrows down in the south. River creeks and branches of the Sahyadri, which reach right up to the coast, dissect this coastline. The important creeks in Konkan are Terekhol, Vijaydurg, Rajapuri, Raigad, Dabhol, Daramthar, Thane and Vasai. The rivers of Konkan rise from the cliffs of Sahyadri and have a short swift flow into the Arabian Sea. Some important rivers are Ulhas, Savitri, Vashishthi and Shastri.

(Source: State of Environment Report: Maharashtra, Prepared by Indira Gandhi Institute of Development Research, Mumbai, Sponsored by Maharashtra State Pollution Control Board, Ministry of Environment and Forests, Government of India)

Raigad District, where the proposed waterway is located, is mainly composed of Sahyadri Hills at one side and Arabian Sea at the other side. Raigad district forms a part of Maharashtra littoral, the micro level divisions of coastal plain. It is slightly elongated in the north - south direction. Raigad has a long indented coastline. The length of the coastline is about 240 kms, with a number of creeks and inlets. Though the district forms an important part of the traditional Konkan Plain, it is characterized by ruggedness and uneven topography.

On the basis of variation in local relief, the district can be classified into six group's viz. Sahyadri Hills, Konkan Forested Hills, Sudhagad Plateau, Ulhas Basin, Kal- Savitri Valley and Raigad Coast.

The topography is mainly hilly regions of the Sahyadri Ranges and sandy beaches near the Arabian Sea. The Sahyadri stretches like a huge wall from North to South of the District having valleys & peaks. Many rivers originate from these ranges. The villages & towns are located in between Sahyadri Hills & Arabian Sea. The following Rivers are the important Rivers of the region:

- Amba River
- Kundalika River
- Bamangar River
- Savitri River

(Source: Brief Industrial Profile of Raigad District, MSME-Development Institute, Ministry of MSME, Government of India)

Kundalika River originates in Western Ghats at an altitude of 820 masl and meets the Arabian Sea near Revadanda in Raigad district. Initially River Kundalika flows in South West direction up to Patnus village and then turns to North-West till it joins the Arabian Sea. After covering a distance of about thirty two kilometers in westerly course, the river meets the tide at Roha, and for about thirty one kilometers more to the west and north-west, stretches a tidal inlet falling into the Arabian Sea at Revadanda. The total length of the river from origin to its outfall in the Arabian Sea is about 74.0 km.

The Revadanda Creek/Kundalika River receives two major streams during its course. About 5 kilometers at the upstream of Chaul village, one tributary meets at the right bank near Bhonang village. The other chief tributary is Achalbag, which after draining the hills near the Janjira border falls into the Kundalika about sixteen kilometers downstream of Roha.

The total catchment area of Kundalika River / Revadanda Creek is 825 sq km.

9.2.2. Geology and Seismicity

The entire area of the State forms a part of the “Peninsular Shield”, which is composed of rocks commencing from the most ancient rocks of diverse origin, which have undergone considerable metamorphism. Over these ancient rocks of Precambrian era lie a few basins of Proterozoic era and of permo carboniferous periods which are covered by extensive sheets of horizontally bedded lava flows comprising the Deccan trap. More than 80% area of the State is covered by these Deccan trap, which have concealed geologically older formations. The most important economic minerals such as coal, iron ore, manganese ore, limestone, etc. are found in the geologically older formations.

Structurally, the entire area of the state forms a part of the “Peninsular Shield” of India which represents a fairly stable block of earth crust that has remained unaffected by, mountain building movements, since the advent of the Palaeozoic era. Some of the subsequent movements in the crust have been of the nature of normal and block faulting which have laid down certain portions bounded by tensional cracks of faults giving rise to basins in which sedimentary beds of the Gondwana age have been deposited, particularly in the Vidarbha region giving rise to the important limestone as Penganga beds and coalfields of the Pench-Kanhan valley, the Umred – Bander field, the Wardha valley and Vidarbha valley.

It is generally accepted that the Western coast has been formed as a result of the faulting. Along this coast from Ratnagiri to Mumbai, and further north in Thane district there exists a series of hot springs arranged almost in linear fashion which suggests that they are situated on a line of fracture. Further evidence regarding the formation of west coast by faulting is offered by the Western Ghats comprising Deccan trap lava flows, which are several hundred metres thick near the coast and which gradually thins out east wards.

In the Raigad District, Deccan trap basalt of upper Cretaceous to lower Eocene is the major rock formation and intruded by a number of dykes. The western part of the district consisting of basalt flows are altered to laterite. Recent deposits comprising beach sand and alluvium occur along the coast and in the river mouth.

A massive earthquake struck Maharashtra on September 30, 1993 at Killari in Latur district. Extensive damage was caused to life and property in the districts of Latur and Dharashiv with 7,928 people killed, 16,000 injured and 15,847 livestock killed. In Latur and Dharashiv, 52 villages were razed to ground wherein 27,000 houses, amenities and related infrastructure facilities were totally damaged. Nearly 2,20,000 houses in the adjoining villages of Latur and Dharashiv and 11 other districts of Solapur, Satara, Sangli, Beed, Parbhani, Ahmednagar, Nanded, Kolhapur, Aurangabad, Pune and Nashik suffered varying degrees of damage. A moderately strong earthquake of magnitude 5.1 Richter occurred on 14 March 2005, with its epicentre around Koyna. This area has been witnessing a large number of tremors of low magnitude consistently over a quarter of a century since the first earthquake appeared in 1968.

As per the seismic zoning map of India, the project area falls under seismic zone III.

(Source: Maharashtra: National Disaster Risk Reduction Portal, National Institute of Disaster Management)

9.2.3. Climate

The climate of the State is tropical. The Western Ghats hill ranges run north to south separating the coastal districts of Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg from rest of the State.

The State experiences four seasons during a year. March to May is the summer season followed by rainy season from June to September. The post monsoon season is October and November. December to February is the winter season.

The weather is mostly humid throughout the year. The maximum summer temperature varies between 36°C and 41°C and during winter the temperature oscillates between 10°C and 16°C.

Maharashtra receives its rainfall mainly from south-west monsoon. Rainfall starts in the first week of June and July is the wettest month. The rainfall in state varies considerably. There is heavy rainfall in the coastal region, scanty rains in rain shadow areas in the central part and moderate rains in eastern parts of the state.

The Konkan sub-division comprising of coastal districts and Western Ghats receive the heaviest rains, the Ghats receive more than 6000 mm and the plains 2500 mm. Rainfall decreases rapidly towards eastern slopes and plateau areas where it is minimum (less than 500 mm). The Kundalika catchment receives an average annual rainfall of about 3143 mm.

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

9.2.4. Soils

The National Bureau of Soil Survey and Land Use Planning (NBSS &LUP) has divided the State of Maharashtra into 356 soil-mapping units, which are broadly categorized as follows:

- Soils of Konkan coast
- Soils of Western Ghats
- Soils of Upper Maharashtra
- Soils of Lower Maharashtra

About 96.4 per cent of the states geographic area is subjected to various degrees of erosion. The soil profile reveals that the incidence of severe erosion is the highest in the Western Ghats 53.1 percent), followed by lower Maharashtra (11.5 percent).

The soil status of Maharashtra is residual, derived from the underlying basalts. In the semidry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier, better suited for Rabi crops.

In the rainy Konkan, and the Sahyadri Range, the same basalts give rise to the brick-red laterites, which are productive under a forest-cover, but readily stripped into a sterile varkas when devoid of vegetative cover.

The main types of soils found in the Raigad district are forest soils, varkas soils, rice soils, khar or salt soils, coastal alluvium and laterite soils. The project area has sandy clay soil in most part of the river stretch coming under NW-85.

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

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, and settlement, industrial and commercial purposes. Whereas, uncultivable waste land, barren and fallow land are unused lands.

As per the land use data provided in the District Census Handbook for Raigarh district (Census 2011), For the District as a whole, 29.77 percent of the total area is cultivable. Among all the Community Development (C.D.) Blocks, Alibag has the highest percentage of cultivable area (44.83 percent) and Tala has the lowest percentage (16.13 percent). Only 9.15 percent of the cultivable area of the District is irrigated. Roha C.D. Block has the highest percentage of irrigated area to cultivable area (24.52 percent) and Mhasla has the lowest (0.94 percent). (Source: District Census Handbook: Raigarh, Series-28, Part XII-A, Directorate of Census Operations, Maharashtra, Census of India 2011).

The project area is characterized by mixed land use comprising largely mangrove forests and agricultural land interspersed with minor settlements, fishing jetties and roads.

Detailed analysis of Land Use / Land cover in the project area is to be taken up as part of the EIA study to be carried out for the project by IWAI.

9.2.6. Ambient Air and Noise Quality

The Air (Prevention & Control of Pollution) Act, 1981 of India describes air pollutants as '*Any solid, liquid or gaseous substance (including noise)* present *in the atmosphere in such concentration as may or tend to be injurious to human beings or other living creatures or plants or property or environment*'. The condition of air quality in the surroundings is the ambient air quality.

In India the Central Pollution Control Board (CPCB) coordinates the air quality monitoring regime through its nationwide programme known as National Air Quality Monitoring Programme (NAMP). CPCB has been monitoring ambient air quality through 363 stations in 139 cities across the country as of November, 2009.

Limited relevant secondary data on ambient air and noise quality is available for the project area. As per the Annual Report (2010-11) of Maharashtra Pollution Control Board (MPCB), ambient air quality has been assessed through fifty-five locations under National Air Quality monitoring Programme (NAMP), eight locations under State Air Quality Monitoring Programme (SAMP) and eight locations under Continuous Ambient Air Quality Monitoring (CAAQM).

The Annual Report (2010-11) of MPCB observes that there is rise in level of SO_2 in few commercial and residential areas as compared to the preceding two year's ambient air quality monitored at different locations under NAMP, SAMP Project & CAAQM Stations. However, compared to the preceding year the level of NOx is reduced in industrial areas while a rise is seen in its level in residential and commercial locations.

With respect to air quality in Raigad region, the above mentioned Annual Report of MPCB states that Raigad region accommodates highly polluted areas like Panvel, Khopoli and also major industrial areas like Patalganga, Roha and Mahad. The ambient air quality was monitored at five industrial locations, four residential locations and one commercial location.

As per the MPCB report, there is improvement in the quality of air in Roha and Mahad locations as the levels of SPM and RSPM were found well within prescribed limits as compared to the preceding three years. Panvel city and Khopoli were found to be most polluted places in the Region.

The report states that the problem of major Air Pollution arises due to heavy traffic density near Panvel and Kamothe area. Moreover, there is typical problem of non-availability of buffer zone between the residential and the industrial zone, resulting in the said problems.

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 a few minor settlements and some industries with emission norms regulated by the SPCB.

Primary data on ambient air and noise quality monitoring in the project area is to be collected as a part of the EIA study to be commissioned by IWAI.

9.2.7. Ambient Water Quality

Since the entire river stretch coming under NW-85 is tidal and sea water is mixed with the river water, it is not used for irrigation or drinking purposes. There are industries established on the bank of Kundalika River and they discharge their waste into the river. However, discharge of effluents by these industries is to be regulated by the Maharashtra State Pollution Control Board.

Water quality samples have been collected and tested for four sample locations along the NW-85 stretch as part of the hydrographic survey carried out for preparation of the present DPR. The sample locations include Revadanda, Kude, Gophan and Roha and the pH value of all the four samples is found to be over 7, which indicates that water in the project area is alkaline in nature.

As per the status of river water quality provided in the Annual Report (2010-11) of Maharashtra Pollution Control Board (MPCB), the rivers Patalganga, Kundalika, Amba and Savitri are of great importance for water supply to the industries as well as are the sources of 'drinking water'.

With respect to Kundalika River, the MPCB Annual report states that the MIDC has established an industrial estate at Dhatav on the bank of this river. The river Kundalika is a prime source of water for these industries and also to the nearby villages and Roha city. River Kundalika has been assessed through seven locations. The results indicate improvement in water quality except at Gofan village.

As per another report published by the Maharashtra State Pollution Control Board in April 2014 titled 'Water Quality Status of Water Bodies of Maharashtra with Recourse to Analytical / Statistical Tools (2007-2011)', water quality was monitored at five locations on Kundalika River namely Varasgaon, Roha Bridge, Are Khurd, Salav Bridge and Dhatav Jackwell.

It was observed that pH and Nitrate were as per the MPCB standards at all the stations of Kundalika River. However, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Ammonia exceeded by 20%, 60% and 30% respectively at Are Khurd and near Salav Bridge. The non-compliance with MPCB standards at Are Khurd and near Salav Bridge could be due to the CETP discharge and fishing activity at these stations. For Total Coliform (TC), exceedance was observed only at Varasgaon station.

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 Maharashtra is measured at 156 locations on 49 rivers and among them 153 locations are non-complying to the Water Quality Criteria with respect to BOD. These 153 locations are on 49 rivers. The names of 49 polluted rivers are; Wena, Wainganga, Godavari, Bhima, Krishna, Ulhas, **Kundalika**, Tapi, Girna, Panchganga, Nira, Bhatsa, Rangavali, Indrayani, Chandrabhaga, Vashishti, Mithi, Kanhan, Koyna, Amba, Amravati, Bindusara, Darna, Ghod, Gomai, Hiwara, Kan, Manjra, Mor, Morna, Mula, Mula- Mutha, Mutha, Panzara, Patalganga, Pawna, Pedhi, Pehlar, Penganga, Purna, Savitri, Sina, Surya, Urmodi, Vel, Vaitrana, Venna, Waghur and Wardha. These rivers are classified in priority classs I, II, III, IV and V based on the level of BOD. **With a BOD range of 4.6-29.0, the identified polluted stretch of 25 km of Kundalika River, which runs from Salav to Roha, has been categorized as Priority Class II which means it falls in a relatively more polluted category.**

Central Ground Water Board (CGWB) has been monitoring the ground water quality of the Raigad district over the last four decades through its established monitoring wells. The objective is to develop an overall picture of the ground water quality of the district. During the year 2011, the Board had carried out the ground water quality monitoring of 20 monitoring wells. The parameters analyzed included pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F). As per this study, the concentration of most of the parameters was found to be within desirable limits of the BIS standards for drinking water (IS-10500-91, Revised 2003). Accordingly, **the potability of ground water in the wells monitored in the district was found to be good.** (Source: Ground Water Information, Raigad District, Maharashtra, Central Ground Water Board, Ministry of Water Resources, Government of India, 2013)

Primary data on water quality monitoring in the project area is to be collected as a part of the EIA study to be commissioned by IWAI.

9.2.8. Susceptibility to Natural Hazards

Maharashtra is prone to various disasters such as drought, floods, cyclones, earthquake and accidents. As per the State of Environment Report for Maharashtra published by the Ministry of Environment and Forests, Raigad District is vulnerable to floods, earthquakes, cyclones and droughts.

As per a report of National Institute of Disaster Management (NIDM) prepared for the State of Maharashtra, a number of landslides had occurred in Mumbai and Raigad districts due to heavy rains in July and August 2005 killing several people and causing loss to property. (Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

Further analysis relating to susceptibility of the project area to natural hazards is to be taken up during the course of the EIA study to be commissioned by IWAI.

9.2.9. Estuary and Coastal Zone

The Maharashtra coast is characterized by pocket beaches flanked by rocky cliffs of Deccan basalt on one side and estuaries with patches of mangroves on the other. Maharashtra state has about 720 km long indented coastline, which is marked by the presence of major estuaries and narrow creeks. It comprises of the coastal districts of Thane, Raigad, Greater Bombay, Ratnagiri and Sindhudurg. The shoreline is generally straight.

(Source: State of Environment Report: Maharashtra, Prepared by Indira Gandhi Institute of Development Research, Mumbai, Sponsored by Maharashtra State Pollution Control Board, Ministry of Environment and Forests, Government of India)

Raigad district, where the proposed waterway is located, has a coastline of 240 km. Raigad has luxuriant growth of mangroves in Alibagh and Roha division.

In Alibagh near Dharamtar creek, density of *A. marina*, *Acanthus ilicifolius* and *Ceriops tagal* is high near the confluence of the creek and Arabian Sea, but it gradually decreases thereafter. At some places natural regeneration of *Avicennia marina* is seen.

In Roha forest division, mainly Kundalika River, Rajapuria creek, Mhasla creek, Srivardhan, Savitri River are home to luxuriant growth of mangroves.

In Kundalika River, species found are *A. marina*, *Ipomoea* sp., *Acanthus ilicifolius*, *Sonneratia apetala, Pongamia pinnata* etc.

In Rajapuria creek more than 50 % of the area is covered with *R. mucronata*. Other species are *Avicennia officinalis*, *Avicennia marina*, *Acanthus ilicifolius*, *Excoecaria agallocha* and *Ipomoea* sp.

Species found in the Mandad river area are *Rhizophora sp.*, *Ceriops tagal*, *Avicennia sp*., *Sonneratia apetala*, *Excoecaria agallocha*, *Aegiceras corniculatum* etc. *Acacia* is also seen in this area.

In Mhasla creek mangrove species are scattered and show poor growth. Here, species encountered are *Sonneratia alba* and *Avicennia sp*.

Srivardhan area is dominated mostly by *Sonneratia alba*. Height of these plants varies from 20-25 ft. Other dominating species are *Rhizophora mucronata*, *Rhizophora apiculata*, *Ceriops tagal*, *Avicennia alba* and *Bruguiera gymnorhiza*. Root suckers are observed around the roots of *Sonnerartia alba*.

Along the banks of Savitri river very narrow strips of mangroves are seen. Density of these mangroves is between 40-70 %. Species found are *Sonneratia apetala*, which dominates about 70 % of the area, followed by *Avicennia marina* and *Rhizophora sp.* Height of the *Sonneratia apetala* trees is about 20- 30 ft. Density of mangroves in this area is high due to inaccessibility to the place.

(Source: Coastal Zones of India, Space Application Centre, ISRO, Ahmedabad, sponsored by the Ministry of Environment and Forests, Government of India, 2012).

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 CRZ categorization provided in the CRZ Notification, 2011, the NW-85 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.

Prohibited and Regulated Areas with respect to protected monuments 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 metres 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 metres in all directions shall be regulated area in respect of every ancient monument and archeological site and remains.

As per the information available on the website of Archaeological Survey of India, none of the structures under the category of National / State protected monuments are located close to the project site for the suggested stretch for development. Therefore, no clearance requirement is envisaged with respect to these structures.

A list of the protected monuments located in Raigad District is provided in Table 9-1 below.

TABLE 9-1**:** PROTECTED MONUMENTS IN RAIGAD DISTRICT, MAHARASHTRA

S.No.	Name of Monument / Site	Location	District
1.	Songad (Songiri)	Achloli	Raigad
2.	Cathedral	Agarkot	Raigad
3.	Chaukoni-Castle or factory of Cheul	Agarkot	Raigad
4.	Church & Convent of the Augustinians	Agarkot	Raigad
5.	Dominican Church & Convent	Agarkot	Raigad
6.	Jesuit Church & Convent	Agarkot	Raigad
7.	Kothi	Agarkot	Raigad

S.No.	Name of Monument / Site	Location	District
8.	One Buruj	Agarkot	Raigad
9.	St. Francis Xavier's Chapel	Agarkot	Raigad
10.	Satkhani Buruj	Agarkot	Raigad
11.	Two Gates-Potra DA Mar & Potra DA Terra	Agarkot	Raigad
12.	HiraKota old Fort	Agarkot	Raigad
13.	Kolaba Fort Containing i) Manik Chawada, ii) Nanisahibn's palace iii)North Causeway, iv) Padmavati shrine v) Reservoir Apsaras, vi) Sarja Kot vii) Shrine of Bhawani, viii) Shrine of Maruti ix) Shrine of Yashvantadari x) South causeway xi) Talghar xii) Temple of Bopdeo xiii) Temple of anpati-pen-Chyaten xiv) Temple of Gulabai or Mahtshuri xv) Temple of Kanoba xvi) Temple of Mahadev xvii) Thorle wada xviii) Tomb of a Mahammadan saint.	Alibag	Raigad
14.	Cave	Ambivli	Raigad
15.	Birwadi Fort	Birwadi	Raigad
16.	Barber's Mahal	Cheul	Raigad
17.	Dadar (Stair Case)	Cheul	Raigad
18.	Kaman(Arch)	Cheul	Raigad
19.	Mosque	Cheul	Raigad
20.	Rajkot	Cheul	Raigad
21.	Tomb of Angre	Cheul	Raigad
22.	Wada of Dancing Girls	Cheul	Raigad
23.	Chandragad	Dhavala	Raigad

S.No.	Name of Monument / Site	Location	District
24.	Elephanta Caves	Gharapuri	Raigad
25.	Ghereagad or Surgad Fort	Ghera Surgad	Raigad
26.	Ghosalgad Fort	Ghosale	Raigad
27.	Old Fort containing a temple of the God Kangormel & Two tanks	Kadasari Kangori	Raigad
28.	Buddhist Caves	Gomashi	Raigad
29.	A percipitious hill near Raigad Fort Containing one rock-cut cistern of water. It was formerly used as a jail for prisoners.	Kadasari Lingana	Raigad
30.	Kol Caves	Kol	Raigad
31.	Caves in Survey No. 49 & No. 50	Kol	Raigad
32.	Kondane Caves	Kondane	Raigad
33.	Korlai Fort	Korlai	Raigad
34.	Avchitgad	Medhe	Raigad
35.	Kuda Caves	Kuda	Raigad
36.	Kasa (Kamsa) fort	Murud	Raigad
37.	Thanala Caves	Nadsur	Raigad
38.	Nagothane Bridge	Nagothane	Raigad
39.	Khadsambla Caves	Nenavali	Raigad
40.	Jijamata's Samadhi consisting of four Towers	Pachad	Raigad
41.	Jijamata's Wada comprising four dilapated houses & three wells surrounded by a stone wall.	Pachad	Raigad
42.	Caves	Pale	Raigad
43.	Caves near the Kotali Fort	Peth	Raigad
44.	Kotali Fort with two iron guns and one bronze gun	Peth	Raigad

S.No.	Name of Monument / Site	Location	District
45.	Janjira Fort	Rajapuri	Raigad
46.	Tombs at Kholkar Najik Ghumaj (Khokeri Ghumaj)	Rajapuri	Raigad
47.	Fort of Raigad	Raigad	Raigad
48.	Tala Fort	Tala	Raigad
49.	Ancient bricks stupa at Elephanta Island	Gharapuri	Raigad
50.	Kondane Caves	Khapoli	Raigad

Source: http://www.asimumbaicircle.com/images/list-of-protected-monuments-n-forts.pdf

9.2.11. Flora and Fauna

Flora

The Sahyadri Hills and Valleys are full of rainforest. The forest has Ain (*Terminalia crenulata*), Mango (*Mangifera indica*), Apta (*Bauhinia racemosa*) , Ashok (*Saraca indica*), Babhul (*Acacia Arabica*), Behda (*Terminalia bellerica*), Nimb (*Azadirachta indica*), Chandan (*Santalum album*), Dhavda (*Anogeissus latifolius*), Palas (*Butea monosperma*), Khair (*Acacia catechu*), Banian tree (*Ficus benghalensis*), Bamboo (*Bambusa bambos*), Teak tree (*Tectona grandis*), Kusum (*Schleichera oleosa*), Hed (*Haldina cordifolia*) and several other palnt species. The forest department has recorded more than 300 bushes / plants in the district which have medicinal properties. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

Mangroves are found to be located on both banks of the Kundalika 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.

Fauna

With a coastline of about 240 kms, Raigad is one of the most important maritime districts of the Maharashtra state. Fishing ranks only next to agriculture as a means of livelihood. The fishing industry is mainly dependent upon the exploitation of marine resources. The fishing seasons commence from September and lasts till the end of May. There is practically no fishing activity in the monsoon season, except in the creeks, lakes and rivers. Mora, Karnaja, Revas, Mandwa, Alibag, Revdanda, Rajpuri, Dighi and Bagmandala are important fishing ports in the district. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.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 q*), 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.
(Source:http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

9.2.12. National Parks, Forests, Wildlife Sanctuaries and Reserves

Forest is the second largest land use after agriculture in the State. The share of Forestry in GSDP (at current prices) during 2013-14 was 2.2 per cent. At the end of year 2013-14, the total forest area of the State was 61,733.91 sq km (provisional) constituting about 20.1 per cent of geographical area of the State as against the target of 33 per cent set under National Forest Policy, 1988.

The jurisdiction of the total forest area in the State is divided amongst Forest Department (55,368.6 sq km, provisional), Forest Development Corporation of Maharashtra (FDCM) (3,590.2 sq km provisional), Private forest brought under possession of Forest Department (1,162.4 sq km provisional) and Revenue Department (1,612.8 sq km, provisional).

Out of the total forest area 50,882.8 sq km was reserved, 6,733.2 sq km was protected and 4,117.9 sq km was unclassed forest.

Forest provides major products like timber, firewood and minor products like bamboo, tendu leaves, gum, grass, etc. All these forest produce are of great value in terms of generating revenue and providing livelihood to local people.

(Source: Economic Survey of Maharashtra, 2014-15, Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, Mumbai)

Raigad District, where the project is located, is fairly rich in Forest Areas. The district has a forest cover of 1486.94 sq. kms, out of which 79.17 per cent forest is a reserved forest, 10.60 per cent is protected forest and 10.17 per cent is unclassified forest. Out of the total 96.55 per cent forest is under the forest department and remaining under the revenue department.

(Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

The Sahyadri Hills and Valleys are full of rainforest. The forest has Ain (*Terminalia crenulata*), Mango (*Mangifera indica*), Apta (*Bauhinia racemosa*) , Ashok (*Saraca indica*), Babhul (*Acacia Arabica*), Behda (*Terminalia bellerica*), Nimb (*Azadirachta indica*), Chandan (*Santalum album*), Dhavda (*Anogeissus latifolius*), Palas (*Butea monosperma*), Khair (*Acacia catechu*), Banian tree (*Ficus benghalensis*), Bamboo (*Bambusa bambos*), Teak tree (*Tectona grandis*), Kusum (*Schleichera oleosa*), Hed (*Haldina cordifolia*) and several other palnt species. The forest department has recorded more than 300 bushes / plants in the district which have medicinal properties. (Source:http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

There are six National parks, 47 Sanctuaries and four Conservation Reserves in the State. According to 'Status of Tigers in India, 2014' report, the number of estimated tigers in the State is 190 as against 169 in 2010. (Source: Economic Survey of Maharashtra, 2014-15, Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, Mumbai)

Phansad Wildlife Sanctuary is situated in the Raigad District of Maharashtra between 72^0 54' to 73^0 02' North latitude and between 18^0 20' to 18^0 22' East longitude and is spread over an area of 69.79 sq km. It was declared as a Wildlife sanctuary in 1986.

Karnala Bird Sanctuary (18°53'N and 73°7'E) is situated in Panvel taluka of Raigad district and is about 60 km from Mumbai on the Mumbai-Goa Highway (NH-17), with an elevation range of approximately 20 mts to 450 mts. It was declared as a sanctuary in 1968 with an area of 4.48 sq.km. In 1975 the area was increased to 12.11 sq.km (or 1,211 hectares). Situated in the Biogeographic province of Malabar Plains Region the Sanctuary is part of one of the spurs of the Northern Sahyadri Range in the Western Ghats. The highest point of the sanctuary is the Karnala Fort at 450 mts. (Source: Raju Kasambe and Asif Khan, Checklist of birds of Karnala Bird Sanctuary, District Raigad, Maharashtra, Newsletter for Birdwatchers 55(2) 2015)

The NW-85 waterway is located at distance of approximately 4.5 km from the boundary of the Phansad Wildlife Sanctuary. However, a study of the project alignment and its surrounding area on the Google Map reveals no component of the proposed waterway falls either within the Wildlife sanctuary or within the Eco-Sensitive Zone (ESZ) declared around the Phansad Wildlife Sanctuary.

9.2.13. Socio-economic Profile

Maharashtra is the second largest state in India in terms of population and has geographical area about 3.08 lakh sq. km. It has a population of 11.24 crore (Census 2011) which is 9.3 per cent of the total population of India and is highly urbanised with 45.2 per cent people residing in urban areas.

The State has 36 districts which are divided into six revenue divisions viz. Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur for administrative purposes, with effective machinery for planning at the district level. For local self-governance in rural areas, there are 34 Zilla Parishads, 351 Panchayat Samitis and 27,873 Gram Panchayats. The urban areas are governed through 26 Municipal Corporations, 226 Municipal Councils, 13 Nagar Panchayats and seven Cantonment Boards.

Raigad district, where the proposed waterway is located, is included in the Konkan division. Raigad district is one of the four coastal districts situated along the western coast of the State and is located between north latitude 17°51'00" and 19°08'00" and east longitudes 72°50'00" and 73°40'00". It is bounded by Thane district in the north, Ratnagiri district in the south, Pune district in the east and Arabian Sea forms the western boundary having a length of about 250 km.

Alibag is the District Headquarters of Raigad District. Alibag is situated on western coast of India and on the shores of the Arabian Sea.

Raigad district presently consist of 42 towns and 1909 villages spread over 15 tahasils namely Alibag, Murud, Panvel, Uran, Mangaon, Tala, Mahad, Poladpur, Pen, Karjat, Khalapur, Roha, Sudhagad, Shriwardhan and Mhasala.

The total geographical area of Raigad district is 7152 sq km. For administrative purposes the district is divided into 8 sub divisions viz., Alibag, Panvel, Mangaon, Mahad, Pen, Karjat, Roha and Shriwardhan.

Alibag sub-division includes Alibag and Murud tahsils; Panvel sub-division includes Panvel and Uran; Mangaon sub-division includes Mangaon and Tala; Mahad sub-division includes Mahad and Poladpur; Pen has one Tahsil namely Pen; Khalapur and Karjat tahsils are included in Karjat Sub-division; Roha sub-division has Roha and Sudhagad tahsils; and Shriwardhan sub-division has Shriwardhan and Mhasala tahsils.

Details of Sub-Divisions, Tahasils, Villages, Circles and Sazzas in Raigad district are provided in Table 9-2 below.

TABLE 9-2: DETAILS OF SUB-DIVISIONS, TAHASILS, VILLAGES, CIRCLES AND SAZZAS IN RAIGAD DISTRICT

Sr. No	Name of Sub-Division	Name of Tahasil	No. of Villages	No. of Circles	No. of Sazzas
1.	*Alibag*	*Alibag*	218	7	44
		Murud	74	3	14
	Total Talukas in Sub-division	2	292	10	58
2.	*Panvel*	*Panvel*	178	6	35
		Uran	62	3	17
	Total Talukas in Sub-division	2	240	9	52
3.	*Mangaon*	*Mangaon*	187	5	31
		Tala	61	2	8
	Total Talukas in Sub-division	2	248	7	39
4.	*Mahad*	*Mahad*	183	6	36
		Poladpur	87	3	14
	Total Talukas in Sub-division	2	270	9	50
5.	*Pen*	*Pen*	171	5	30
	Total Talukas in Sub-division	1	171	5	30
6.	*Karjat*	*Karjat*	185	5	28
		Khalapur	141	3	20
	TotalTalukas in Sub-division	2	326	8	48
7.	*Roha*	*Roha*	162	4	26
		Sudhagad	99	3	15
	Total Talukas in Subdivision	2	261	7	41
8.	*Shriwardhan*	*Shriwardhan*	78	3	18
		Mhasala	84	2	14
	Total Talukas in Sub-division	2	162	5	32
District Total	8	15	1970	60	350

Source: http://raigad.nic.in

The District Collector along with the District Judge, Superintendent of Police, Chief Executive Officers of the State Government look after the development and regulatory functions in the district. At the tahsil level the Tahsildar, Block Development Officer, Judicial Magistrate, Deputy Engineers and other officers look after their respective department for development and regulatory functions.

In 2011, Raigad had a population of 2,634,200 comprising 1,344,345 males and 1,289,855 females respectively. There was a change of 19.31 percent in the population in 2011 compared to population as per 2001. In the previous census of India 2001, Raigad District recorded increase of 20.99 percent to its population compared to 1991. Scheduled Castes (SCs) and Scheduled Tribes (STs) constitute 5.1% and 11.6% respectively of the total population of the State.

District Highlights – 2011 Census

· Raigad is the coastal district of Maharashtra. There are many small ports on the seashore of the district. Nhava-Sheva is famous international port located at Uran.

· Rasayani is the main industrial centre developed with large scale public and private limited industries.

· That Vayshef is famous for fertilizer plants.

· The 125 years old famous observatory is located in Alibag.

· Pen town is famous for manufacturing of Ganesh idols in Maharashtra. Thousands of Ganesh idols are manufactured every year in this town.

· Raigad fort, the capital of Shivaji Maharaj's Kingdom is located near Mahad, where Samadhi of Shivaji Maharaj is existed.

· 'Harihareshwar' in Shrivardhan tahsil is famous for old Shiv Mandir. It is known as south kashi.

· The famous Ashtavinaya kamandir, Shri Ballaleshwar temple is located at Pali on Nagothane Khopoli Road in Sudhagad tahsil and Shri Varadvinayak temple is at Mahad village in Khalapur tahsil.

· Elephanta caves in Uran tahsil are tourist's main attractions. Hundreds of people visit these caves daily.

· Matheran, the hill station of tourist's attractions is located in this district.

· There are 49 uninhabited villages in the district.

· Alibagtahsil is having the highest number of villages (212) in the district.

· Raigad district has higher sex ratio (959) compared to the state (929).

· Choul Village in Alibag C.D. Block is the most populated (9894 persons) and Palambe village in Alibag C.D. Block is the least populated (2 persons).

Source: District Census Handbook: Raigad, Census of India -Series-28, Part XII-B, Directorate Of Census Operations, Maharashtra, 2011.

Rice (*Oryza sativa*) is an important crop in the Raigad district. Other important crops that are grown in the district include common millet – Vari (*Panicum miliaceum*), finger millet- Nagli (*Eleusine coracana*), carpet legume – Val (*Dolichos lablab*), spiked dolichos- Pavta (*Dolichos lablab L*), pigeon pea – Tur (*Cajanus cajan*), cow pea – Chavali (*Vigna catjang*), horse gram – Kulth (*Macrotyloma uniflorum*). In the coastal soil, crops like coconut (*Cocos nucifera*), areca nut – Supari (*Areca catechu*), mango (*Mangifera indica*), cashew nut (*Anacardium occidentale*), jackfruit (*Artocarpus heterophyllus*), sapota / chickoo (*Achras zapota L*), kokum (*Garcinia indica*) and watermelon (*Citrullus vulgaris)* etc. are grown. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

With a coastline of about 240 kms, Raigad is one of the most important maritime districts of the Maharashtra state. Fishing is next to agriculture as a means of livelihood. The fishing industry is mainly dependent upon the exploitation of marine resources. The fishing season commences from September and lasts till the end of May. There is practically no fishing activity in the monsoon season, except in the creeks, lakes and rivers. Mora, Karnaja, Revas, Mandwa, Alibag, Revdanda, Rajpuri, Dighi and Bagmandala are important fishing ports in the district.

The district is well connected with the state capital and surrounding districts, tehsils and villages through road, rail and waterways. The road network consists of express way, national highways, state highways, major district roads and village roads. The rail network consists of broad gauge and narrow gauge. The districts headquarter and other 15 tehsils of district are well connected to each other by roadway, railway and waterways for transport and trade to major cities within the state.

9.3. Potential Environmental and Social Impacts of the Project

Based on the traffic demand analysis, the present DPR recommends development of NW-85 in two phases – Phase 1 and Phase 2.

Potential Environmental and Social Impacts in Phase 1

The stretch for development is limited stretch from Ch. 0.00 km to Ch. 20 km out of the total stretch of 30.736 km designated as NW-85.

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 – Yes
v. Installation of Navigational Lights - Yes

Phase 1, thus, does not require any terminal construction, approach road development or bank protection works. It involves dredging for creation of a navigable channel and installation of beacon lights only. Therefore, no land use change is anticipated to occur due to the development of the project as proposed in Phase 1.

For operation in Phase I, existing jetties at Salav (Ch 0.00 km) and Sanegaon (Ch 20-21 km) shall be used. Access roads to these jetties already exist. Accordingly, no additional road construction is envisaged in Phase I of the project. Consequently, no land use change is anticipated on account of construction of approach / access roads in Phase I.

The estimated quantity of dredged material in Phase 1 is 1.48 Lakhs Cu. M of Ordinary Soil and 0.17 Lakhs Cu. M of Hard Soil. 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 dumping 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.

The proposed construction period is of three years. 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.

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 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.

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 near Zolambe.
ii. Construction of access roads – Yes, 7.5 wide road for a length of 500 m.
iii. Bank protection works – Yes, at 8 locations comprising a total length of approximately 4 km.
iv. Dredging of the river in the proposed waterway stretch – No.
v. Installation of navigational lights – Yes.

Phase 2, thus, envisages construction of a terminal facility, approach road development, bank protection works and Buoy & Light system for Cargo operations.

Limited land use change will occur due to the construction of terminal facility for the operation of the proposed waterway in Phase 2. 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. 3.3 ha of land is estimated to be required for terminal construction. The land identified for terminal construction is located near Ch 26.00 km and is entirely privately owned.

For Phase 2, construction of 7.5 m wide road for 80 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 bank protection works shall be required is 4.0 km covering eight locations.

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, and 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.

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 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.

9.4. EMP and Mitigation of Environmental Effects

As already stated most of the potential impacts will be limited to the construction period.

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 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, if any, 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 Maharashtra Pollution Control Board (MPCB) 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 entire project area falls under the tidal zone. Besides, the Kundalika River is flanked by dense mangroves for most part of the waterway stretch. **Based on the categorization provided in CRZ Notification, 2011, the NW-85 project shall fall under CRZ – I. Accordingly, the project shall require obtaining clearance under the CRZ Notification 2011.**

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 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, Forest and Climate Change (MoEFCC) 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.

Forest Clearance

Even though mangroves are present on both banks of the Kundalika River along the NW-85 stretch, no Forest Clearance on this account is required to be obtained for the project as envisaged for development in Phase 1, which is recommended for development.

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. However, 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 9-3 below.

TABLE 9-3: MAJOR CLEARANCES / APPROVALS / PERMITS AND THEIR APPLICABILITY TO THE PROJECT

S. 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, 1980	No clearance of mangrove vegetation or diversion of any forest land for any other purposes is involved in the development of NW-85 for the recommended stretch.
3.	Wildlife Clearance	No	Wildlife Protection Act, 1972	No part of the project falls within the boundary of any of the protected areas or 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 9-4**:** 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 – 9-5).**
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 9-5.

TABLE 9-5: 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
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 @ 10 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 9-6**:** 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 9-7)**
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 9-7**:** 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 monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil &	Surface and ground water to be monitored separately	Per sample with various parameters	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)
		grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.					
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
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 9-8: 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 9-5 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost
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 9-9 given below:

TABLE 9-9: 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 & 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	
9.	Data Entry Operator	6	21700	253,890	
10.	Driver	1	21700	42, 315	25 % extra for statutory allowances and 20 % extra for perks have been taken into consideration.
11.	Attendant	6	21700	253,890	
	Total	25		1,652,820	
	Chief Engineer's Office Component				
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.
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.

Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
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 Kundalika 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 Kundalika River is being used extensively with good IWT mobility, which can be considered as the maximum utility in the West Coast Rivers. The same is being used by M/s JSW with the mobility to their captive port in Sanegaon through Salav area on the right side, whereas other stake holders are also using the river with the mobility from the opposite side on the Left side. Based on the traffic studies, there is an estimated cargo in Bulk / Break Bulk apart from the captive cargo, which may have to be considered at a newly identified terminal location at Zolambe on the left side.

However, this Lo-Lo Terminal can be planned after the saturation of utilization of the existing infrastructure at Sanegaon. In view of the above, the costing has been segregated into two Modules i.e., 1. Development of Fairway alone to support the captive cargo presently being moved and for its demand. 2. Development of Lo-Lo facility in the proposed IWAI Terminal at Zolambe at FY 30.

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 Kundalika Fairway Development for Captive Terminal Operations (Phase 1)

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule	Annexure
A	**Fairway**			
1	Dredging			
(i)	General Soil	444.00	3 yrs in Phase 1	11.2
(ii)	Hard Soil	153.00		
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	Phase 2	
(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	1 yr in Phase 1	11.4
5	Land Acquisition	0.00		
	Sub-total (A)	**734.58**		
B	**Modification of Structures**			
(i)	Bridges	0.00		
(ii)	Cables	0.00		
(iii)	Dams	0.00		
(iv)	Barrages	0.00		
(v)	Locks	0.00		

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule	Annexure
(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		
(ii)				
	Sub-total (D)	**405.00**	3 yrs in Phase 1	
	Sub-total (A)+(B)+(C)+(D)	**1139.58**		
E	Environmental Management Plan Cost@5% of Prime cost	56.98	3 yrs in Phase 1	
F	Project Management & consultancy Charges @10% of Prime cost	113.96	3 yrs in Phase 1	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	113.96	3 yrs in Phase 1	
	Project total Hard Cost	**1424.48**		
		14.24	Crores	

TABLE 11-2: Abstract of Cost for Kundalika Fairway Development for Captive Terminal Operations (Phase 2)

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule	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	4928.65	Phase 2	11.3
(iii)	Porcupine			
4	Night Navigation			
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	218.56	3 yrs in Phase 2	11.4
5	Land Acquisition	0.00		
	Sub-total (A)	**5147.22**		
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		
	Sub-total (C)	**0.00**		

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule	Annexure
D	**Institutional Requirement**			
(i)	Office Development Cost	0.00		
	Sub-total (D)	**0.00**		
	Sub-total (A)+(B)+(C)+(D)	**5147.22**		
E	Environmental Management Plan Cost@5% of Prime cost	257.36	3 yrs in Phase 2	
F	Project Management & consultancy Charges @10% of Prime cost	514.72	3 yrs in Phase 2	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	514.72	3 yrs in Phase 2	
	Project total Hard Cost	**6434.02**		
		64.34	Crores	

The Lo-Lo facility requirement has been worked out and placed herewith.

TABLE 11-3: Abstract of Cost for Kundalika LOLO Facility (Phase 2)

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
A	**Terminals**		
(i)	Land	363.13	11.5
(ii)	Riverine Components	1146.75	11.6
(iii)	Infrastructure Components including internal roads	1583.46	11.7
(iv)	Approach Road Cost	14.80	11.8
(v)	Bank Protection Works for terminal	328.54	11.9
	Sub-total (A)	**3436.68**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Cargo Handling Equipments**		
(i)	Ambulance - 1 no.	10	
(ii)	Dumper Trucks 16 T Capacity - 0 no.	0	
(iii)	Cranes with 125 T Capacity - 1 no.	200	
(iv)	Fork lift trucks 20 T Capacity - 2 no.	96	

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
	Sub-total (C)	**306.00**	
	Sub-total (A)+(B)+(C)	**3742.68**	
D	Environmental Management Plan Cost@5% of Prime cost	187.13	
E	Project Management & consultancy Charges @10% of Prime cost	374.27	
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	374.27	
	Project total Hard Cost	**4678.34**	
		46.78 crores	

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

Fairway: As explained above, the project is being considered in 2 Phases. The development of fairway will be completed in 3 Years (36 months), in phase 1 to facilitate the existing cargo mobility, who are operating through their own captive jetties. The phase 2 development is to be considered after critical observation / analysis. If the growth pattern for the cargo beyond the existing operators' requirement is observed then the phase 2 development with the Lo-Lo terminal provision etc., are to be considered. The phase 2 development is 3 yrs from 2025 / 2026 to 2029.

Vessels:

1 PT + 2 DBs may be required by 2029. {Construction from 2026 to 2029}

1 PT + 2 DBs may be required by 2038. {Construction from 2036 to 2038}

CHAPTER 12: IMPLEMENTATION SCHEDULE

12.1. Time Frame

The Time Frame for the development of river Kundalika is being considered in Two Phases i.e., in phase 1, the development will be considered to facilitate the ongoing IWT Traffic of M/s JSW / M/s Indo Energy International Ltd., and in phase 2, the required development to facilitate the hinterland cargo mobility on observation / on confirmation.

The period of development has been considered as 36 months in both the cases, whereas, the phase 1 ends after 3 yrs of commencement and phase 2 ends in 2029.

In phase 1, the components of Dredging; provision of Beacons / Lights; 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 FY 30, it is proposed to develop 1 Lo-Lo Jetty Terminal to facilitate the mobility of the identified IWT divertible Traffic along with nominal Bank Protection are proposed to be developed. The Implementation Schedule in Pictorial form is placed at Annexure 12.2.

12.2. Phasing

The fairway development is in 36 months.

Lo-Lo Terminal also in 36 months, of course with the module of 1 Berth + 2 Cranes and however, the development will be considered with the availability of Terminal in FY 30 and after having meticulous observation of traffic growth.

The Vessel requirement will be taken care by Entrepreneurs i.e., 2 PTs + 4 DBs at the final stages.

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

Revdanda River development has been distinguished across two Phases. This is depicted in the following Table 13 1:

TABLE 13-1: Revdanda River Development in Phases

Sub-sector	2018	2020	2027	2029	2029	2040
Fairway	Development					
	Phase 1					
			Development			
			Phase 2			
Lo-Lo			Construction			
			Phase 2			

The plan is to develop the fairway in 2 phases, while the Lo-Lo terminal will be developed in one phase, but post an observation period scheduled from 2020 to 2027. Traffic study indicates that the proposed Lo-Lo terminal at Zolambe is likely to observe traffic only after the capacity at the existing jetty at Sanegaon becomes inadequate at meeting the coal traffic demand. The earliest possible year when the terminal will handle any traffic is 2029. With due consideration of 3 years for construction period of the terminal, construction work towards setting up the terminal should start by 2027 and finish by 2029. By 2029, 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. The observation period between 2020 and 2027 will be used to evaluate the market and to arrive at the decision of going ahead with Phase 2 development of the fairway, and for the development of the terminal. In the event the market is not conducive for fairway expansion, Phase 1 operational status quo will be maintained, wherein traffic moving on the river will not exceed 3 mn tonnes, a condition guarding realization of phase 2 and development of the Lo-Lo Terminal. 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 FY29 in Phase 2. Similarly, Lo-Lo terminal will also commence operation by FY29.

13.2. Input Sheet

The following table lists all the assumptions and input values used in the financial modeling of Revdanda River. This includes financial analysis for the navigation infrastructure (fairways), and terminal operations (Lo-Lo):

TABLE 13-2: Input Sheet for Revdanda 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
Revenue Share	Annual	4%	4%
Area Total	Ha		1.07
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	26	
Chainage (Lo-Lo – Revdanda Anchorage)	Km		27.7
Tariff for Revenue Calculation			
Various Revenue Sources	**Unit**	**Fairway**	**Lo-Lo**
Fairway Cost			
Movement of vessel	GRT/km	0.1	
Charges of Handling Coal			
Vessel Berthing Charges	Per GRT		1000
Vehicle Unloading Charges	Per Truck		1
Revenue prospects from Ancillary Activity			
Truck Parking Charges	Per Day		50
Weigh Bridge Charges	Per Truck		100
Leasing Space Coffee Shops	Per Day		500
Lease space for Rest/Retiring	Rs/Day/Truck		30
Operation & Maintenance			
Description	**Unit**	**Fairway**	**Lo-Lo**
Civil Infrastructure	Cost		1%
Dredging		10%	
Ship Operating Cost			
Utilities		5%	5%
Machinery Infrastructure			5%
IT & Other Soft Factors		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 – 2x43.9; Ro-Ro 2x34.74, Lo-Lo & Vessel – 2 x 59.36	
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 CO2/t-km	60	Tractebel
Rail	g CO2/t-km	13.3	
IWT	g CO2/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, 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 70% of the rated DWT. The chainage of 27.7 km is from the Lo-Lo Terminal (5 km upstream of Sanegaon jetty) to Revdanda Anchorage near Korlai Fort. In case of fairway revenue calculations, only one-way trip across the chainage of 26 km is considered. In EIRR, round-trip distance is considered in each of the sub-sector's economic viability evaluation.

13.3. Revenue

Revenue for the cumulative stretch of Revdanda River will be generated from the core operations, which include utilization of the fairways by existing and potential users, and operation at the Lo-Lo terminal. Secondary revenues sources, labeled "Ancillary Revenue", will be generated from sources like truck parking, weighbridge, land leasing for commercial operations (tea-stall, coffee shops, inn, etc.), and leased resting area for truck operators. The revenue break-up and total revenue for IWAI on Revdanda River are presented in the table below:

TABLE 13-3: Revenue for Revdanda River (INR Lakhs)

Revenue Source	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Total Fairway Revenue	**55**	**83**	***122****	***163****	***219****
Fairway (Phase 2)					
Total Fairway Revenue	**-**	**-**	**127**	**194**	**300**
Lo-Lo Terminal (Phase 2)					
Total Cargo-related Revenue	-	0	2	16	42
Total Ancillary Revenue	-	0	14	82	211
Total Lo-Lo Terminal Revenue	**-**	**0**	**17**	**98**	**253**

** Will be the volume if there's no Phase 2 development for fairway and no construction of the Lo-Lo Terminal*

In Phase 1 for fairway, traffic moved on the river post FY27 will not exceed 3 mn tonnes on account of the presumed capacity saturation at the Sanegaon jetty. This indicates a less-than-favorable market for additional investment towards fairway development and for setting up a terminal. Essentially, phase-1 fairway revenue will result from its utilization for moving coal traffic for the Sanegaon jetty. Beyond the observation period of 2027, phase 2 may materialize or not depending on the market conditions. In the event it does, then the projected traffic of phase 1 on fairway will not stand validated. Instead, the revenue for the fairway will be that of Phase 2, which combines traffic from both the Sanegaon jetty and the surplus volume that may be handled at the IWAI jetty at Zolambe.

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 (INR Lakhs)	Investment Cost (INR Lakhs)		
		1st Year	2nd Year	3rd Year
Fairway				
Fairway	734.6	293.8	220.4	220.4
Institutional Requirement	405	81	162	162
Environmental Management Plan Cost@5% of Prime cost	57	19.	19	19
Project Management & consultancy Charges @10% of Prime cost	114	38	38	38
Contingencies and Unforeseen Items of Works@10% of Prime cost	114	38	38	38
Total Project Cost	**1,424.5**	**469.8**	**477.3**	**477.3**
Fairway (Phase 2)				
Fairway	5,147.2	1,853	1,647.1	1,647.1
Environmental Management Plan Cost@5% of Prime cost	257	77.2	77.2	77.2
Project Management & consultancy Charges @10% of Prime cost	515	154.4	154.4	205.9
Contingencies and Unforeseen Items of Works@10% of Prime cost	515	154.4	154.4	205.9
Total Project Cost	**6,434**	**2,239**	**2,033.1**	**2,161.8**
Lo-Lo Terminal (Phase 2)				
Terminal	3,436.7	1,375	1,031	1,031
Cargo Handling Equipment	906	181	362	362
Environmental Management Plan Cost@5% of Prime cost	187.1	56	56	75
Project Management & consultancy Charges @10% of Prime cost	374.3	112	112	150
Contingencies and Unforeseen Items of Works@10% of Prime cost	374.3	112	112	150
Total Project Cost	**4,678.3**	**1,717**	**1,434**	**1,528**

For Lo-Lo Terminal, 1 Push Tugs (PT) and 2 Dumb Barges (DB) may have to be procured to cater to the projected traffic between FY29 and FY40. The onus of these vessel acquisitions lie with the private operator and not IWAI. Hence, these will 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 PT + 2DB
Vessel Cost	Lakhs	1400
Running Cost	Lakh/annum	108
Crew	No.	16
Crew Wages	Lakh/annum	0.5
Crew Cost	Lakh/annum	96
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)	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)							
Manpower Expenditure							
Fibre Boat for Inspection	2	2.00	4	6	7	9	12
Hydrographer	1	8.00	26	34	43	55	70
Executives	2	3.00	20	25	32	41	53
Engineer	1	4.00	13	17	22	28	35
Total Salary (INR Lakh)			**64**	**82**	**104**	**133**	**170**
Fairway (Phase 2)							
Manpower Expenditure							
Fibre Boat for Inspection	2	2.00			5	6	8
Hydrographer	1	8.00			28	35	45
Executives	2	3.00			21	27	34
Engineer	1	4.00			14	18	23
Total Salary (INR Lakh)					**67**	**86**	**109**

Parameter	No.	CTC p.a. / person (INR Lakh)	FY20	FY25	FY30	FY35	FY40
Lo-Lo Terminal (Phase 2)							
Manpower Expenditure							
Manager Cargo Handling	1	6.00	-	-	21	27	34
Security Guards (Jetty x 2)	2	1.80	-	-	13	16	20
Executives for billing and commercial	1	3.00	-	-	10	13	17
Weighbridge	1	2.0			7	9	11
Total Salary (INR Lakh)			**0**	**0**	**82**	**105**	**134**

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. The above manpower schedule and expenditure elaborates upon the expenses from FY20, when operation commences for the waterway. A similar case will prevail for the Lo-Lo terminal, where manpower costs provided above will come into effect from FY29, last year of the construction period. Also, expenses in case of the Lo-Lo terminal isn'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	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Gross Block	1,424	1,424	1,424	1,424	1,424
Depreciation & Amortization	123	66	66	24	9
Cumulative Depreciation & Amortization	205	723	1,052	1,339	1,424
Net Block	1,220	701	372	86	-
Fairway (Phase 2)					
Gross Block			6,434	9,934	11,581
Depreciation & Amortization			583	547	652
Cumulative Depreciation & Amortization			1,542	4,128	7,386
Net Block			4,892	5,806	4,195
Lo-Lo Terminal (Phase 2)					
Gross Block	-		4678.4	4678.4	4678.4
Depreciation & Amortization	-		419.2	232.1	232.1
Cumulative Depreciation & Amortization	-		1111.7	2721.2	3881.6
Net Block	-		3566.6	1957.1	796.8

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: O & M Cost (INR Lakh)

Parameters	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Maintenance Cost	81	103	132	168	215
Total O&M	**81**	**103**	**132**	**168**	**215**
Fairway (Phase 2)					
Maintenance Cost	-	-	924	1,180	1,506
Total O&M	**-**	**-**	**924**	**1,180**	**1,506**
Lo-Lo Terminal (Phase 2)					
Direct Operational Cost	-	-	109	444	1,332
Maintenance & Other Cost	-	-	68	113	210
Total O&M	**-**	**-**	**177**	**557**	**1,542**

TABLE 13-9: P&L Statement (INR Lakh)

Parameter	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
PBIT	**-115**	**-129**	**-144**	**-171**	**-203**
Depreciation	123	66	66	24	9
Interest	102	38	-	-	-
PBT	**-339**	**-232**	**-210**	**-194**	**-211**
Tax	-	-	-	-	-
PAT	**-339**	**-232**	**-210**	**-194**	**-211**
Fairway (Phase 2)					
PBIT			**-970**	**-1,181**	**-1,433**
Depreciation			583	547	652
Interest			402	111	-
PBT			**-1,955**	**-1,839**	**-2,084**
Tax			-	-	-
PAT			**-1,955**	**-1,839**	**-2,084**
Lo-Lo (Phase 2)					
PBIT	**-**		**-278**	**-936**	**-1,163**
Depreciation	-		419	232	232
Interest	**-**		292	80	-
PBT	-		**-989**	**-1,247**	**-1,395**
Tax	**-**		**0**	**0**	**0**
PAT	**-**		**-989**	**-1,247**	**-1,395**

None of the sub-sector projects may turn out to be a profitable venture. The relatively high development cost and then the constantly escalating O&M costs, while traffic prospects rise at a slow pace, translate into losses.

The following table is the ultimate assessment of the viability of the individual projects planned under the development of the Revdanda River:

TABLE 13-9: FIRR for Revdanda River (INR Lakh)

Parameter	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 2)					
Project Cashflow(Pre-tax)	-592	-129	-144	-171	-203
Project IRR(Pre-tax)	**Non-existent**				
Project Cashflow(Post-tax)	-592	-129	-144	-171	-203
Project IRR(Post-tax)	**Non-existent**				
Fairway (Phase 2)					
Project Cashflow(Pre-tax)			-970	-1,181	-1,433
Project IRR(Pre-tax)	**Non-existent**				
Project Cashflow(Post-tax)			-970	-1,181	-1,433
Project IRR(Post-tax)	**Non-existent**				
Lo-Lo Terminal (Phase 2)					
Project Cashflow(Pre-tax)	0	0	-278	-936	-1,163
Project IRR(Pre-tax)	**NA**				
Project Cashflow(Post-tax)	0	0	-278	-936	-1,163
Project IRR(Post-tax)	**NA**				

Negative returns across the board reinforce the earlier assessment that these projects will not provide positive returns for the foreseeable projected period. Based on the EIRR for these sub-sectors, Viability Gap Funding (VGF) can be sought to get these projects off the ground.

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.

All the two sub-sectors under Revdanda River development would require financial intervention to be implemented. A strong EIRR could warrant capital inflow from state and/or central government in this regard in the form of Viability Gap Funding (VGF). The need for EIRR is evident for both the phases in fairway development and the Lo-Lo Terminal. Estimated EIRR for each of these sub-sectors is presented in the table below:

TABLE 13-10: Project EIRR (INR Crores)

Parameters	FY20	FY25	FY30	FY35	FY40
		Fairway (Phase 1)			
Economic Cash Outflow	29	32	34	34	34
Net Cash Flow to Project	23.74	31.70	34.28	33.97	33.57
Project EIRR	**155%**				
		Fairway (Phase 2)			
Economic Cash Outflow			37	42	48
Net Cash Flow to Project			37	42	48
Project EIRR	**63%**				
		Lo-Lo Terminal (Phase 2)			
Economic Cash Outflow	-	-	2.3	6.7	13
Net Cash Flow to Project	-	-	2	7	13
Project EIRR	**7%**				

All the sub-sector projects exhibit positive impact on the local economy, and invariably, the economy of the state and the nation. These are adequate indicators for these sub-sector projects to be eligible for VGF.

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 13-11: Sensitivity Analysis (+10% Revenue, +10% Project Cost)

Revenue Source	FY20	FY25	FY30	FY35	FY40
		Fairway (Phase 1)			
Revenue	61	92	134	180	241
PAT	-367	-247	-220	-201	-215
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				

Revenue Source	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 2)					
Revenue	-	-	140	214	330
PAT	-	-	-2144	-2015	-2282
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Lo-Lo Terminal (Phase 2)					
Revenue	-	-	17	99	257
PAT	-	-	-1067	-1284	-1,427
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				

TABLE 13-12: Sensitivity Analysis (+10% Revenue, -10% Project Cost)

Revenue Source	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Revenue	61	92	134	180	241
PAT	-301	-201	-176	-158	-166
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Fairway (Phase 2)					
Revenue	-	-	140	214	330
PAT	-	-	-1743	-1628	-1831
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Lo-Lo Terminal (Phase 2)					
Revenue	-	-	17	99	257
PAT	-	-	-911	-1208	-1,355
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				

TABLE 13-13: Sensitivity Analysis (-10% Revenue, +10% Project Cost)

Revenue Source	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Revenue	50	75	110	147	197
PAT	-377	-263	-243	-231	-256
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Fairway (Phase 2)					
Revenue	-	-	114	175	270
PAT	-	-	-2167	-2051	-2338
Project IRR (Pre tax)	**Non-existent**				

Revenue Source	FY20	FY25	FY30	FY35	FY40
Project IRR (Post tax)	**Non-existent**				
Lo-Lo Terminal (Phase 2)					
Revenue	-	-	17	96	249
PAT	-	-	-1068	-1287	-1,435
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				

TABLE 13-14: Sensitivity Analysis (-10% Revenue, -10% Project Cost)

Revenue Source	FY20	FY25	FY30	FY35	FY40
Fairway (Phase 1)					
Revenue	50	75	110	147	197
PAT	-312	-217	-199	-188	-207
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Fairway (Phase 2)					
Revenue	-	-	110	172	271
PAT	-	-	-1770	-1666	-1886
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				
Lo-Lo Terminal (Phase 2)					
Revenue	-	-	114	175	270
PAT	-	-	-1766	-1664	-1887
Project IRR (Pre tax)	**Non-existent**				
Project IRR (Post tax)	**Non-existent**				

Under no scenario does the project produce positive FIRR. This means that even in imaginable optimistic conditions of higher revenue and lower cost, these projects are highly unlikely to generate positive returns in the projected period up to FY40. Prima facie, this indicates that the overall project is not a commercially sound investment to make.

13.8. Risk Factors & Mitigation

Risk is a function of the probability of an event's occurrence and the impact it can have on the project. The major risk associated with the Project is the capacity at Sanegaon jetty not reaching saturation level for the observed period of projections, i.e. up to FY40. This could either be due to market's sluggishness, or the operator of the jetty expanding its capacity to accommodate any foreseeable increase in coal demand. Other risks typically impressing upon such a project are political, technical, environmental, and financial in nature. A broad assessment of such risks for the Revdanda River waterway development project is depicted in below table:

The following table enumerates risks identified in executing the Project, the rationale behind it, and the potential mitigation or management measures:

TABLE 13-15: Risk Factors & Mitigation measures

Risk	Description	Likelihood*	Impact**	Risk Rank#	Mitigation / Management
No capacity saturation	Even in an optimistic market scenario, where the demand for coal increases manifold, the Sanegaon jetty is quick to expand its capacity, leaving not scope for any other infrastructure (Lo-Lo Terminal) to handle the traffic that could've trickled over	3	5	15	· Exploring other alternatives for cargo handling at the IWAI Terminal · Shelving the idea for Lo-Lo Terminal, and perhaps, focus on further development of the fairway, if necessary
Low or Uncertain Future traffic	In the event supporting conditions are present to develop the Lo-Lo terminal, the subsequent traffic is not adequate enough for the terminal to turn profit or sustain the same for a longer period	3	4	12	· Lowered cost of handling to widen the margin. · Targeting different commodities to supplement the terminal's income
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

*, ** - Severity increases with the scale; # - Likelihood x Impact

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 scheme and the projects are monitored by the Ministry of Finance 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.

All the sub-sector projects under the development of Revdanda are commercially unviable, but economically viable. So, these sub projects are eligible for VGF. A broad analysis is undertaken in the following table to test if use of VGF will have any bearing on the returns of the individual projects:

TABLE 13-16: Probable impact of VGF on project returns

Reduction in Project Cost	Fairway (Phase 1)		Fairway (Phase 2)		Lo-Lo Terminal	
	-20%	-40%	-20%	-40%	-20%	-40%
Project IRR (Pre Tax)	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
Project IRR (Post Tax)	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent	Non-existent
Project EIRR	183%	225%	77%	96%	10%	14%

Fairway could benefit from government grants (both central and state), when the traffic on the river eventually increases beyond a certain point. However, that's mere speculation at this juncture, and the fairway is just as non-responsive to federal financial intervention as the Lo-Lo terminal is. This suggests that none of these sub-sector projects are likely to achieve viability even with VGF.

13.10. Conclusion

The following table gives a snapshot of the project cost and viability indicators for all the sub-sector developments under Revdanda River:

TABLE 13-17: Critical indicators for the Revdanda River Project

Parameter	Unit	Fairway (Phase 1)	Fairway (Phase 2)	Lo-Lo Terminal
Project Cost	INR Cr.	14.24	64.34	46.8
Revenue (FY40)	INR Cr.	2.19	3.0	2.53
FIRR	%	Non-existent	Non-existent	Non-existent
EIRR	%	155%	65%	7%

CHAPTER 14: CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Kundalika River (NW 85) in the stretch of 30.736 Kms from Lat 18° 32' 16.7857" N, Long 72° 55' 33.4735" 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:

- Detailed Hydrographic Survey has been carried out and based on the Survey carried out / Site data collected / subsequent to the Morphological analysis etc., the required developments in the Fairway along with interrelated activities have been identified. As such there is no major Regime disturbance in the study stretch.
- Existing waterway of the study stretch is being used for mobility of the cargo of M/s JSW and M/s Indo Energy International Ltd., through their captive jetties located around Ch 20 Km and Ch 21 Km. The cargo for the captive jetty at Sanegaon is about 1.20 MMTPA in FY 16 and expected to increase to 3.00 MMTPA in FY 30 consisting of Coal. The increase is due to the plant capacity expansion and other increased planned activities in the hinterland.
- The Coal cargo in captive jetty of Sanegaon, on saturation, may have to be augmented with other terminal and to be developed by IWAI i.e., to meet the Coal cargo of 0.12 MMTPA in FY 30 and 1.12 MMTPA in FY 40. Accordingly, a Lo-Lo Terminal is proposed in FY 29 to meet the future Coal cargo traffic, which is to be developed by IWAI.
- Keeping in view the classification of NW 85 as Class VII according to the notification, the Terminal construction has been provided with Class VII Vessel.
- In order to meet the mobility of 2000 T, the convoy system of Class IV has been concluded. Further, an alternative of mobility of Self Propelled Vessel with 70 m x 12 m x 1.8 m of 1000 T was thought of, but may not be economical in operation. Accordingly, the Dredging quantities have been worked out for the Indian class of Class IV convoy system for the subject study.
- The vessel / convoy requirement for Class IV is 170 m (Length) x 12 m (Breadth) x 1.8 m (Draft).
- Suggested the development in 2 Phases i.e., in Phase 1 – Partial Development of Fairway up to 26.00 Kms (for Class IV vessel mobility) and in Phase 2 – Balance Fairway Development and Development of 1 Lo-Lo Terminal at Ch. 26 Km.

- In order to provide a safe navigable fairway, for two way navigation, 1.48 Lakhs Cu. M of ordinary soils + 0.17 Lakhs Cu. M of hard soils may have to be dredged in the Phase 1 and also proposed the provision of 7 Beacon / Light system, so as to facilitate the existing mobility.
- Regarding the Berthing Structures, as worked out, Salient features are tabulated.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
LO LO	120	32

- The cost estimates have been worked out for the above suggested 2 Phases. Fairway in Phase 1 is working out to INR 14.24 Cr.

  Fairway in Phase 2 is working out to INR 64.34 Cr.

  Lo-Lo Terminal in Phase 2 is working out to INR 46.8 Cr.
- All the capital assets will be provisioned in 36 months. Phase 2 is not recommended at this stage. Investment decision for Phase 2 may have to be considered in 2025 after observing the growth trend between 2020 and 2025.
- The FIRR and EIRR have been worked out and the details are placed

Project Modules	FIRR	EIRR
Fairway (Phase 1)	Non-existent	155 %
Fairway (Phase 2)		65 %
Lo-Lo Terminal		7%

- It is recommended to develop the stretch of Kundalika River for about 26.00 Kms with Class IV convoy system of the NW standards, in phase 1, wherein the phase 2 investments in Fairway and Lo-Lo Terminal will be considered at later stage after having growth confirmations.

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	
c) Tiger or Elephant Reserve		ü	
d) Biosphere Reserve		ü	
e) Reserved / Protected Forest		ü	
f) Wetland		ü	
g) Important Bird Areas		ü	
h) Mangroves Areas	ü		Mangroves are not present in the Terminal location and the development of NW-85 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	
k) World Heritage Sites		ü	
l) Archeological monuments/ sites (under ASI‟s Central / State list)		ü	

Screening Question	Yes	No	Details / Remarks
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	
6. Is the project involved dredging?	ü		
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 requires acquisition of private land?		ü	
11. Is the proposed project activity result in loss of direct livelihood / employment?		ü	

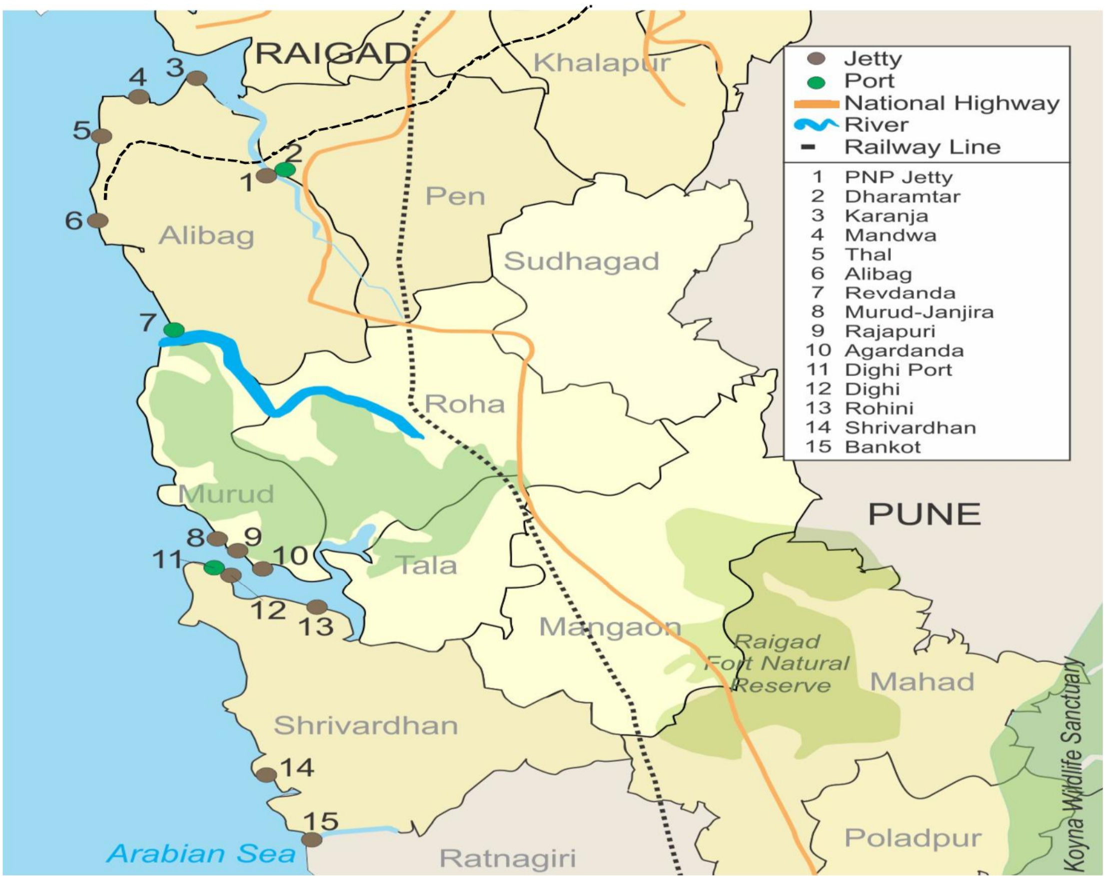
Screening Question	Yes	No	Details / Remarks
12. Is the proposed project activity affect schedule tribe/ caste communities?		ü	

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 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 – Originates from Sahyadri hills and flows through talukas of Sudhagarh, Roha and Murud in Raigarh district of Maharashtra and merges with Arabian Sea through Revdanda creek at Revdanda
- Catchment area – Murud, Roha, Sudhagad, Tala & Mangaon districts of Maharashtra
- Population – As per census 2011, total population residing in Mangaon taluka is 1,59,613, Murud taluka 74,207, Roha taluka 167,110 and Tala taluka 40,619
- Economic activities – Rice, Tur and Nachani cultivation under Agriculture activities, Marine Fishing, industrial activities.
- Industrial Cluster - 3 MIDC - Dhatav, Vile Bhagad & Usar and 2 industries in Salav – JSW & Welspun Maxsteel
- Connectivity
  - Major roads - NH 66, Local roads along the Kundalika River on both side.
  - Major railway – Konkan railway line, 5 kms away from Roha (End point of River).
- Specific Developments
  - Capacity expansion of Sanegaon Jetty
  - Expansion of Salav Jetty – Development of new Jetty will handle 21 MT of RM & 10MT of FG
  - Korlai Port - Development of Deep water facility at Korlai Village
- Catchment area Map



15.2.2. Navigation Baseline

- Existing Waterway Usage

Salav & Sanegaon are the two operational jetties in Kundalika River. Salav Jetty is operated by JSW, where Iron ores & other Raw materials are imported from other countries for the steel plant. Another jetty at Sanegaon is operated by IEIL; it handles imported coal for the industries, located in interiors of Maharashtra. Many expansion plans are lined up for future for these jetties.

- Sanegaon handled 1,200,000 Tonnes of coal in Fy'16
- Salav handled 40,000 Tonnes of Iron Ores in Fy'16
- 23 Number of jetties are present along the study stretch of Kundalika River.
- Total 3 Numbers of bridges are found in the study stretch with Horizontal Clearances of 15m to 50m and Vertical Clearances of 4.5m to 10.5m respectively.
- No Dams, Barrages and weirs are found in the study stretch

15.2.3. Market Baseline

- Potential Market
  - Bulk commodities – Coal

Commodity	Source	Reasoning
Coal	Indo Energy International – Sanegaon Jetty	Coal is already transported through waterways to Sanegaon jetty and further distributed in Khopoli Industrial area and some nearby small industrial units. Coal requirement for Khopoli industrial areas and small industrial in the region is likely to increase in coming years. Once coal handling capacity of Sanegaon Jetty is fully utilized then additional cargo could be diverted on the identified terminal at the river in future.

15.2.4. Forecasting Years

Sl. No.	Name of Cargo	Type of Cargo*	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Co ordinates	Unit p.a	Volume's (mn Tonnes)					
									Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
	Existing Captive Jetty - JSW Salav													
1	Iron Ores	Bulk	Import	n/a	Salav Plant	JSW Salav jetty	n/a	mn T	0.04	0.05	0.08	0.14	0.25	0.43
	Existing Private Jetty - Sanegaon Jetty (Jetty has a capacity of 3mn Tonnes Coal and 2 mn Tonnes Multipurpose)													
1	Coal	Bulk	Import	n/a	Khopoli	Sanegaon	n/a	mn T	1.20	2.44	2.75	3.00	3.00	3.00
	Proposed Terminal Opportunity for IWAI													
1	Coal	Bulk	Import	n/a	Nearby Coal based industries in MH	Zolambe (IWAI)	18°27'53" N 73°05'09" E	mn T	0.00	0.00	0.00	0.12	0.57	1.12

* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.

15.2.5. Presentation of Forecast

Sl. 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 Captive Jetty - JSW Salav										
1	Iron Ore	Bulk	Import	JSW Salav Plant	mn T- Km	0.08	0.1	0.16	0.28	0.5	0.86
	Existing Private Jetty - Sanegaon Jetty (Jetty has a capacity of 3mn Tonnes Coal and 2 mn Tonnes Multipurpose)										
1	Coal	Bulk	Import	TPP in MH	mn T - Km	24	48.8	55	60	60	60
	Proposed Terminal Opportunity for IWAI										
1	Coal	Bulk	Imported Coal + MbPT diversion	TPP in MH	mn T - Km	0	0	0	3	14.25	28

15.2.6. Market Success Factors

The market success factor regarding the development of the Kundalika River is the present fairway availability with abundant required navigational channel parameters which is presently being utilized in advantageous manner. Accordingly, on the right bank near Sanegaon, industry is flourishing with captive terminal, which is also considering the future expansion based on the IWT mobility for its raw material. Three MIDC proposals in the hinterland will have lot of game change on IWT. The Roha industrial zone at the end point of the river is another important factor. Expected to have lot of implications after the proposed developmental activities.

15.2.7. Forecasting Methodology

Potential for cargo movement in Kundalika River exists only for coal. At present 1.2 mn T coal is being transported using the river at Sanegaon jetty. Coal is further distributed to the industries, located in Khopoli. MbPT, a major port of Maharashtra used to handle coal at a very large scale, but now its handling on land has been banned. This banned coal would get diverted to non-major ports of Maharashtra by means of barges using IWT route. Majority of this diversion would get shifted to Amba River, towards Dharamtar Port and rest would be diverted to Kundalika River. It is assumed that 30% of MbPT's coal cargo could shift to Sanegaon Jetty. Presently, traffic handled at Sanegaon Jetty is sufficient as per its capacity, and there is still enough spare capacity to handle increase in traffic volume. Hence, there is no need to develop any new infrastructure till 2030. A new terminal by IWAI could be developed in the year 2030 (tentative), provided the future cargo demand outpaces Sanegaon jetty's capacity, and the promoters do not decide to augment the jetty's capacity. The surplus traffic, which Sanegaon will not be able to handle due to probable capacity constraints, can be shifted to the proposed terminal at Zolambe. It is evident that the proposed terminal would only attract cargo once the capacity at Sanegaon Port has been exhausted. However, if private operators (Sanegaon Jetty) expand its capacity, there would not be any need for IWAI to develop a new jetty at Zolambe.

15.3. Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	· Land, compensation and resettlement : No · Capital dredging: (Phase 1) 1.48 lakhs cu.m Ordinary soil – 4.44cr 0.17 lakhs cu.m Hard soil – 1.53cr · River training/bank protection: (Phase 2) 8 Nos-4000m · Locks: No · Barrages: No · Channel market · Night navigation (Phase 1: Beacon & Lights) 7 Nos – 1.38cr (Phase 2: Buoy & Lights) 65 nos – 2.19 cr · Other: Communication system – No
Terminal Infrastructure		Lo-Lo facility · Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) · Loading/uploading and other equipment (itemized) Considered · 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

Cost type	Cost categories	Components to be itemized
	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 · Vessel capital amortization (or leasing cost equivalent) Considered as per standard · 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 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:** (a) Navigation infrastructure (Phase 1) – INR 14.24 crore (b) Navigation infrastructure (Phase 2) – INR 64.34 crore (c) Terminal Lo-Lo Cost - INR 46.78 crore

Item	Requirements
	· **O & M costs:** (a) Navigation infrastructure (Phase 1) - INR 2.15 crore (b) Navigation infrastructure (Phase 2) - INR 15.06 crore (c) Terminals Lo-Lo Cost - INR 15.42 crore Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel** (a) Navigation infrastructure (Phase 1) - INR 16 crore (b) Navigation infrastructure (Phase 2) - INR 22 crore (c) Terminals Lo-Lo Cost - INR 5.0 crore **Saving on Vehicle Operating Cost** (a) Navigation infrastructure (Phase 1) - INR 15 crore (b) Navigation infrastructure (Phase 2) - INR 20 crore (c) Terminals Lo-Lo Cost - INR 4.6 crore · **Savings in road/rail accident costs** (a) Navigation infrastructure (Phase 1) - INR 2 crore (b) Navigation infrastructure (Phase 2) - INR 2.1 crore (c) Terminals Lo-Lo Cost - INR 2 crore · **Saving in carbon emissions** (a) Navigation infrastructure (Phase 1) - INR 0.6 crore (b) Navigation infrastructure (Phase 2) - INR 0.9 crore (c) Terminals Lo-Lo Cost - INR 0.2 crore
Standard values	To ensure consistency between evaluations of different waterways the following has been used: Vehicle operating Cost · Road : INR 2.58/tons-km · Rail : INR 1.41/tons-km · IWT: INR.1.06/tons-km · Road accident Loss: INR 7.73 Lakhs/km · Rail accident Loss: INR 0.77 Lakhs/km · Carbon shadow price : 20 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	Initial construction period has been adopted as 3 years for Navigation infrastructure and Lo-Lo terminal. Fairway will be developed in two phases, with first phase development

Item	Requirements
	starting from 2018 to 2020, and the second phase between 2027 and 2029. For the Lo-Lo terminal, construction period will be from 2025 to 2027. A total 20 years for operation period has been taken into account entire operation - Phase-1 operation for fairway (FY20 – FY27, or FY20 – FY40), and Phase-2 operation for both the fairway and the Lo-Lo terminal (FY27 – FY40).
EIRR	The EIRRs for all the individual projects under development of the Revdanda River are positive. However, these projects are not commercially viable, because FIRR for all the sub-segment projects are non-existent. Immediate prospects for fairway utilization exist, and cargo volume is expected to grow in the coming future as per the growth of secondary sector. This bodes well for fairway, and decent revenue could be generated, provided market driven tariff rates are applied (as against IWAI rates used in the financial model). It is also essential to develop the fairway at Revdanda along with night navigation. Under the optimistic conditions of brisk market growth in the near future, other industries may be tempted to use the developed waterway of Revdanda to move their cargo. Development of Revdanda as an alternate mode for transportation of cargo for industries is likely to generate employment. Economic IRR of Navigational Structure (Phase 1 & Phase 2), and the Lo-Lo terminal are 155%, 65% and 7% respectively.
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

Item	Requirements
Objective	To assess financial internal rates of return and financial payback periods of Revdanda 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 operations. **Returns for Navigation infrastructure (Phase 1) are:** Total Revenue: INR 2.2 cr. in FY40 O&M Cost: INR 2.15 cr. in FY40 Tax: INR 0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR -2.0 cr. In FY40 Project Capital Cost (with escalation): INR 14.24 cr. Net Cash Flow: INR -2.0 cr. In FY40 **Returns for Navigation infrastructure (Phase 2) are:** Total Revenue: INR 3.0 cr. in FY40

Item	Requirements
	O&M Cost: INR 15.06 cr. in FY40 Tax: INR 0.0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR -14.32 cr. In FY40 Project Capital Cost (with escalation): INR 64.34 cr. Net Cash Flow: INR -14.33 cr. In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 2.53 cr. in FY40 O&M Cost: INR 15.42 cr. in FY40 Tax: INR 0.0. In FY40 (@ 30% on EBITDA) EBIDA: INR -11.62 cr. In FY40 Project Capital Cost (with escalation): INR 46.78 cr. Net Cash Flow: INR -11.63 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. **Returns for Navigation infrastructure (Phase 1) are:** Total Revenue: INR 2.2 cr. in FY40 O&M Cost: INR 2.15 cr. in FY40 Tax: INR 0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR -2.0 cr. In FY40 Project Capital Cost (with escalation): INR 14.24 cr. Net Cash Flow: INR -2.0 cr. In FY40 **Returns for Navigation infrastructure (Phase 2) are:** Total Revenue: INR 3.0 cr. in FY40 O&M Cost: INR 15.06 cr. in FY40 Tax: INR 0.0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR -14.32 cr. In FY40 Project Capital Cost (with escalation): INR 64.34 cr. Net Cash Flow: INR -14.33 cr. In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 2.53 cr. in FY40 O&M Cost: INR 15.42 cr. in FY40 Tax: INR 0.0. In FY40 (@ 30% on EBITDA) EBIDA: INR -11.62 cr. In FY40 Project Capital Cost (with escalation): INR 46.78 cr. Net Cash Flow: INR -11.63 cr. In FY40
Evaluation period	Construction period has been adopted as 3 years for all the sub-segment projects. For fairway (Phase 1), a total 20 years for operation period has been considered, in the

Item	Requirements
	event further development on the River and setting up of Lo-Lo Terminal doesn't seem feasible. Otherwise, the first phase will last only till FY27, giving way to the Phase 2 development of the fairway between 2027 and 2029. For the Lo-Lo terminal, the operation period is from FY29 to FY40.
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 positive. : 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: The project for development of Revdanda River does not exhibit any potential for positive rate of return on investment (FIRR). Factors influencing healthy financial returns of the project are: • Potential revenue likely to be generated across the board is not significant enough, mainly because of low traffic potential and relatively high development cost for fairway and the terminal. • The tariff rates provided by IWAI are too low, which further impacts revenue potential, and eventually, viability of the project within the projected period up till FY40.
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.: • Any potential increase in coal volume in the future will be absorbed by equivalent capacity expansion at the Sanegaon jetty, leaving no surplus volume for another terminal to target. • Future traffic may not be as high as the projected estimate.
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 <u>WATER AND BOTTOM SAMPLES</u>

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 <u>COLLECTION OF TOPOGRAPHICAL FEATURES</u>

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 <u>SURVEY CHART PREPARATION</u>

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.

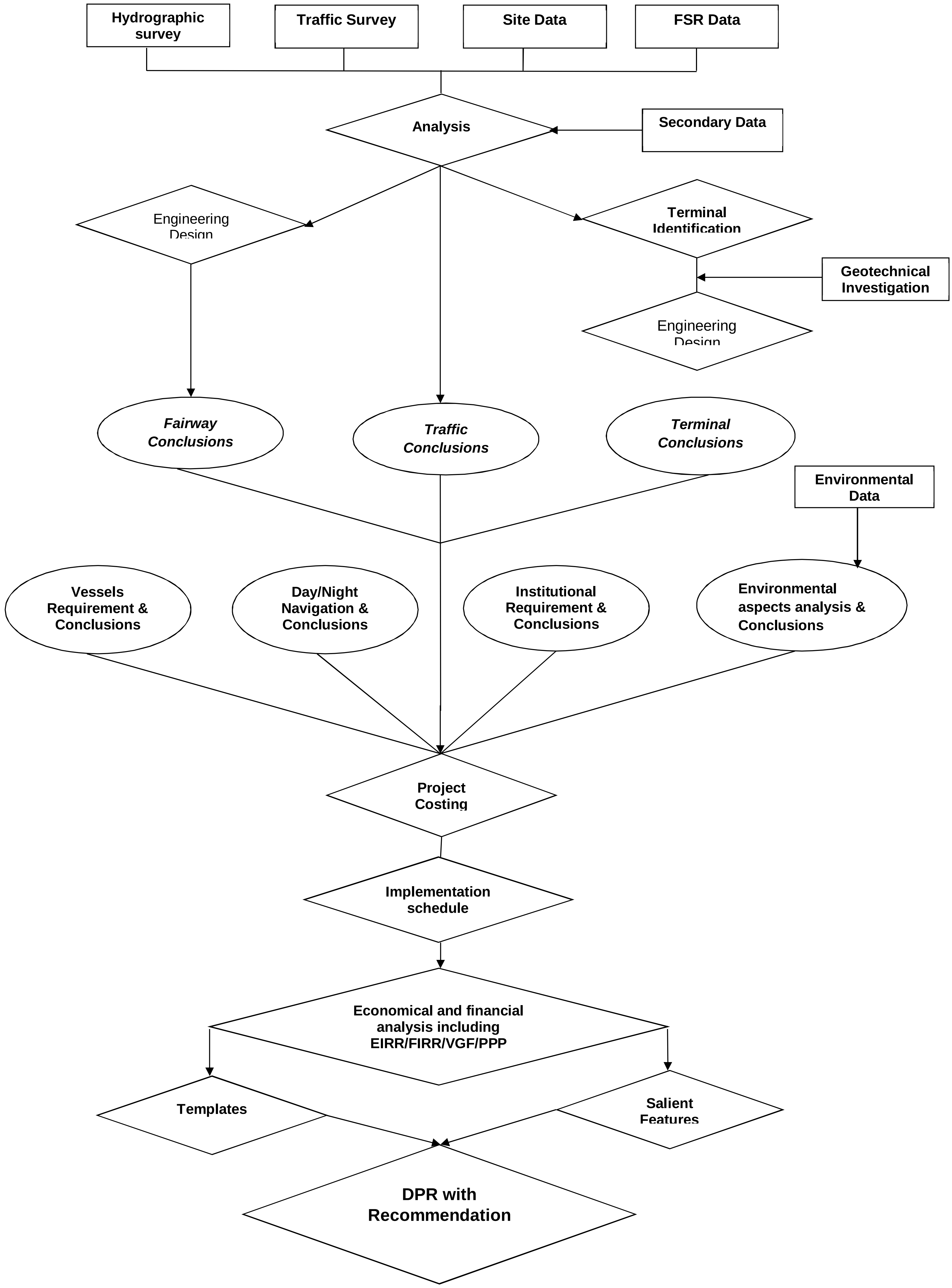
Note 5:- Role and responsibilities of the Key Professional shall be as per the requirement of the project and Terms of Reference of the tender document and the same has to be access by prospective bidder.

ANNEXURE 1.2 – COMPLIANCE ON TOR OF THE AGREEMENT

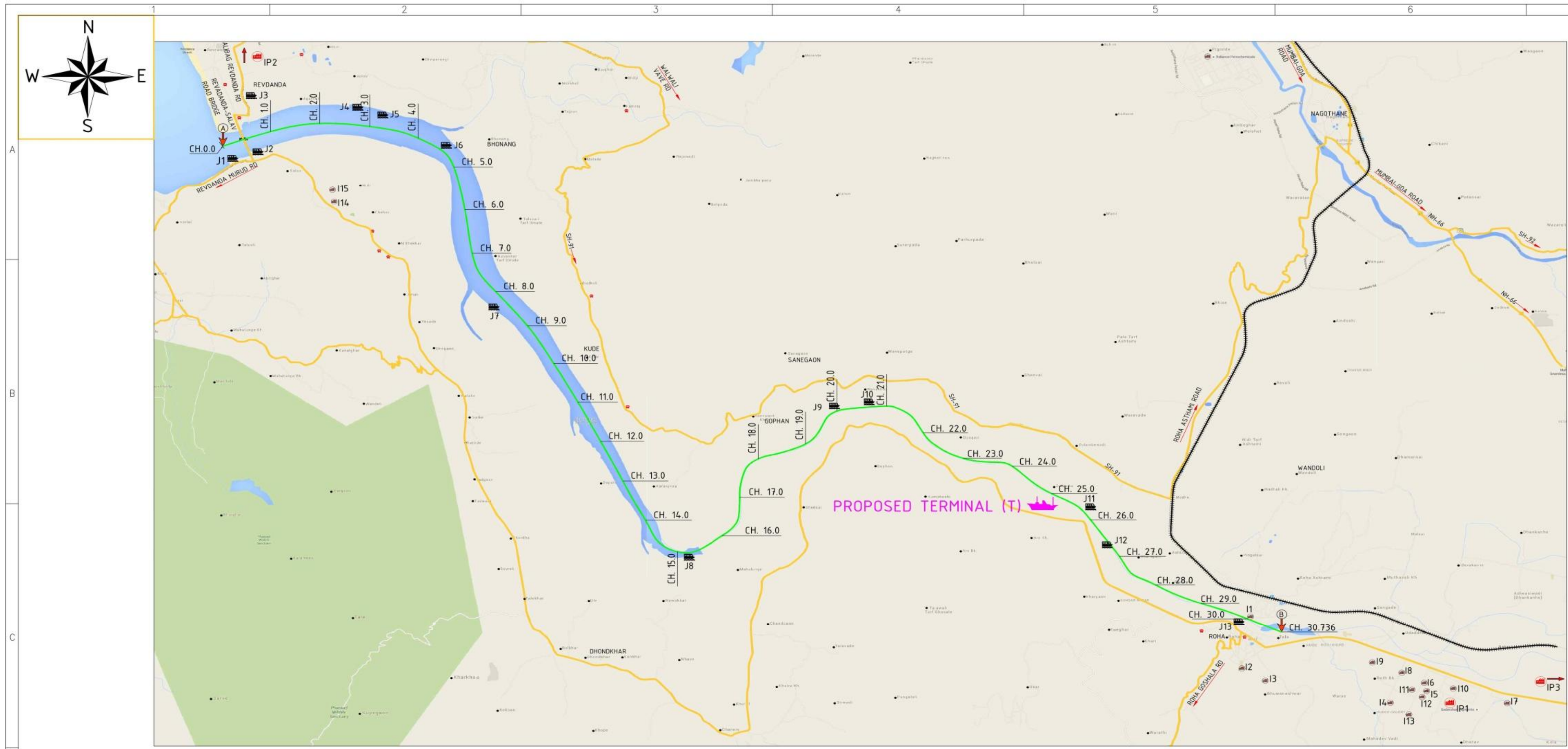
COMPLIANCE ON THE TERMS OF REFERENCE
REVADANDA CREEK / KUNDALIKA RIVER (NW 85)

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 BENCH MARK PILLARS – a)	-do-
1.2.1.2 WATER LEVEL GAUGES i) & ii)	-do-
1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY – a) to k)	-do-
1.2.1.4 CURRENT VELOCITY AND DISCHARGE MEASUREMENT – a) to e)	-do-
1.2.1.5 WATER AND BOTTOM SAMPLES – a) – i) to vi)	-do-
COLLECTION OF TOPOGRAPHICAL FEATURES – a) to j)	-do-
1.2.1.6 SURVEY CHART PREPARATION – a) to n)	-do-
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 REVADANDA CREEK/KUNDALIKA RIVER



LEGEND

	BUS STOP
	HISTORICAL PLACE
	TERMINAL (PROPOSED)
	EXISTING INDUSTRY
	PROPOSED INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	ROAD BRIDGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/CREEK/SMALL RIVER
	FERRY LINE
	STUDY STRETCH
	RAILWAY LINE
A	START POINT FROM ARABIAN SEA, LAT. 18°32'16.7857", LONG. 72°55'33.4735"
B	END POINT AT MHASALA LAT.18°26'31" LONG. 73°07'09.98"

PROPOSED WATERWAY LENGTH 30.736Km

SCALE 0 2km 5.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	KOLAI KOLIVADA JETTY	J1
2	SALAV JETTY	J2
3	REVADANDA BYPASS JETTY	J3
4	AGRAV JETTY	J4
5	AGRAV UGHADI JETTY	J5
6	DIV PANRANGI	J6
7	SHIRGAON JETTY	J7
8	NAHVE NOKHAR JETTY	J8
9	SANEGAON ASHRAM JETTY	J9
10	SANEGAON JETTY	J10
11	ARE BUDRUK JETTY	J11
12	BHONANG JETTY	J12
13	ROHA JETTY	J13

LIST OF PROPOSED INDUSTRIES/INDUSTRIAL AREAS EXPANSIONS

SL.	DESCRIPTION	SYMB.
1	MIDC ROHA INDUSTRIAL AREA	IP1
2	MIDC USAR * (TENTATIVE LOCATION)	IP2
3	MIDC VILE BHAGAD INDUSTRIAL AREA * (AROUND 39 Km FROM ROHA, Via MIDC ROAD)	IP3

LIST OF EXISTING INDUSTRY

SL.	DESCRIPTION	SYMB.
1	EXCEL INDUSTRIES LIMITED	I1
2	KORES (INDIA) LIMITED	I2
3	ROHA BUILDINGS	I3
4	PEPSICO INDIA HOLDINGS PRIVATE LIMITED	I4
5	SEMPERTRANS INDIA PRIVATE LIMITED	I5
6	ANEK PRAYOG PVT LTD	I6
7	ANSHUL SPECIALITY MOLECULES PVT. LTD.	I7
8	LIME CHEMICALS LTD.	I8
9	CLARIANT CHEMICALS INDIA LIMITED	I9
10	VALENTINE AGRO PVT LTD.	I10
11	ROHA DYECHEM PVT. LTD.	I11
12	BEC CHEMCALS PVT.LTD.	I12
13	NEELIKON FOOD DYES & CHEMICALS LTD.	I13
14	JSW STEEL SALAV	I14
15	WELSPUN MAXSTEEL	I15

TITLE	LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES VICINITY OF REVADANDA CREEK/KUNDALIKA 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

Industry	Name of the person	Designation
Excel Industries	Mr. Anand Patankar	Sr. Executive
Maharashtra Seamless	Mr. Vaibhav Sadiawal	Sr. Executive - Exports

Name of Company: Excel Industries

Contact Person: Mr. Anand Patankar

Designation: Sr. Executive

100% of raw materials for Roha Plant are imported by JNPT using roadways. At present they are not facing any problem in road transportation. As per the company, water flow of Kundalika River is tide based, which could create hindrance in this proposed water Multi Modal Transportation. If IWAI provides low logistics cost compared to roadways, then the company would surely shift its cargo to the proposed waterway from the existing mode of transportation. Transportation cost would be the main factor for diversion, followed by time & safety measures. Vessels loaded with raw materials could directly come to the proposed terminal at Zolmabe by coastal route till Revdanda and would move further following the waterway on Kundalika River.

Name of Company: Maharashtra Seamless

Contact Person: Mr. Vaibhav Sadiawal

Designation: Sr. Executive - Exports

Raw Materials like Rods, Pallets, etc. are majorly imported from Russia. Finished products like pipes are exported to various countries, mostly Oil Production based countries. Approx. 50,000 to 60,000 tonnes of finished products are exported annually by JNPT. Roadway is used for transportation between the Port and the Plant. There exists one single lane road, which is in poor condition that connects both the ends; i.e. the port and the plant. During daytime, trucks cannot be moved due to heavy congestion on road. Trucks move during night, between 9 pm to 9 am.

If IWAI provides cost effective river movement facilities, then the company would surely divert its cargo from roadways to the proposed waterway. Containers that arrive at JNPT could be moved to Kundalika river by coastal movement till Revdanda and further following the waterway on Kundalika River would reach the destination i.e. Roha. This proposed multimodal route is time & cost saving for the company. The proposed terminal at Zolambe is just 20 km away from the plant of Maharashtra Seamless. Once this route gets operational then it would be beneficial for the company.

Reference:

1. Mr. Shiv Kumar Singhal – Director (Appointment can be fixed once concrete planning of Kundalika waterway is done)
2. Mr. R. S. Gupta – Dispatch G. M (Can meet him during site visit, detailed discussion of Distribution – Domestic & International)

ANNEXURE 5.1– CALCULATION OF SAFE BEARING CAPACITY

TRACTEBEL
ENGIE

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)	=	**200.0**	KN/m^3	For BR-1
Angle of Internal Friction (ϕ)	=	**0.0**	degree	For BR-1
Bulk Unit weight (γ)	=	**17.2**	KN/m^3	For BR-1
Unit weight of water (γ_w)	=	**10**	KN/m^3	
Submerged Unit Weight	=	**7.2**	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	=	1.000	(cl. 3 of IS 6403)	
Depth factor (dc)	=	1.4	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dq)	=	1.2	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dγ)	=	1.2	(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)	=	0	degree
Bearing capacity factor (Nc')	=	**5.14**	For Punching Shear Failure
Bearing capacity factor (Nq')	=	**1.00**	For Punching Shear Failure
Bearing capacity factor (Nγ')	=	**0.00**	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 = **0.50** (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')

461.00 KN/m^2

Load at 50 mm Settlement = 332.00 kN/m^2 (As per Calcula

Safe Bearing Capacity = 332.00 kN/m^2

Calculation of Settlement as per IS 8009 (Part I) - 1976

Proposed Depth of foundation =	3.0	m
Total depth of Borehole =	10.5	m
Depth of bed rock =	5.00	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-1 for Settlement =	0.00	m
Effective thickness of Layer-2 for Settlement =	0.45	m

Available Soil properties at different depths are given below;

	Layer-1	Layer-2		Layer-2	
Start Level (EL) of Layer =	**0**	**2.1**	m	**3.45**	m
End Level (EL) of Layer =	**2.1**	**3.45**	m	**5.00**	m
Average Unit Weight =	7.20	7.10	kN/m^3	7.10	kN/m^3
Cohesion (C) =	200	200	kN/m^2	0	kN/m^2
Angle of Internal Friction (ϕ) =	0	0	degree	30	degree
Compression Index (Cc) =	0.432	0.378		0.00	
Initial void Ratio (e_0) =	0.96	1.06		0.00	
				Two Layers	

Initial pressure at the center of Layer-1 Below Foundation Level (σ_0) :	0.00	kN/m^2
Initial pressure at the center of Layer-2 below Foundation Level (σ_0) :	16.72	kN/m^3
Pressure increment at the base of footing =	**461.00**	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=	1037.25	kN

Calculation of settlement for Layer-1

Length of load dispersion at top of Layer-1 (L) =	1.5	m
Width of load dispersion at top of Layer-1 (W) =	1.5	m
Pressure increment at top of Layer-1 =	**461.00**	**kN/m^2**
Length of load dispersion at middle of Layer-1 (L) =	1.500	m
Width of load dispersion at middle of Layer-1 (W) =	1.500	m
Pressure increment at middle of Layer-1 =	**461.00**	**kN/m^2**
Length of load dispersion at top of Layer-1 (L) =	1.50	m
Width of load dispersion at top of Layer-1 (W) =	1.50	m
Pressure increment at top of Layer-1 =	**461.00**	**kN/m^2**
Average pressure increment for Layer-1 (as per Simpson's rule) =	**461.00**	**kN/m^2**
Total Settlemt of Layer-1 (Sf) =	0.0000	m
	0.00	**mm**

Calculation of settlement for Layer-2

Length of load dispersion at top of Layer-2 (L) =	1.50	m
Width of load dispersion at top of Layer-2 (W) =	1.50	m
Pressure increment at top of Layer-2 =	**461.00**	**kN/m^2**

Length of load dispersion at middle of Layer-2 (L) =	1.725	m
Width of load dispersion at middle of Layer-2 (W) =	1.725	m
Pressure increment at middle of Layer-2 =	**348.58**	**kN/m^2**
Length of load dispersion at top of Layer-2 (L) =	1.95	m
Width of load dispersion at top of Layer-2 (W) =	1.95	m
Pressure increment at top of Layer-2 =	**272.78**	**kN/m^2**
Average pressure increment for Layer-2 (as per Simpson's rule) =	**354.68**	**kN/m^2**
Total Settlemt of Layer-2 (Sf) =	0.1110	m
	111.00	**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 =		21.51	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) =		0.000903	m	
		0.90342	mm	
Total Settlement including immediate settlement =		**111.91**	**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 =		69.38	mm	
Allowable Settlement for Isolated footing =		50.0	mm (Table -1 of IS 1904-1986)	
Load at 50 mm Settlement =		**332.00**	**kN/m^2**	

ANNEXURE 5.2– CALCULATION OF PILE CAPACITY

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 BR-1

Dia of Pile (D) =	1.00 m		0 to 5 m			
Ground Level =	0.0 m	Submerged Unit Weight (kN/m^3) =	7.18			
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	Ki = Earth Pressure Coefficient	**Value**	**ϕ (Degree)**	**Factor**	
Length of Pile below Scour level =	5.0 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	0	200	0	0.00	0.25	10.77	4.71	235.6
2.1	-2.1	0	200	0	0.00	0.25	15.08	1.88	94.2
3.45	-3.45	0	200	0	0.00	0.25	24.77	4.24	212.1
5.00	-5	35	0	35	1.25	0.00	35.90	4.87	129.3

Total Ultimate Skin Friction Resistance, Qst (kN) = 671.22

Total Allowable Skin Friction Resistance, Qst (kN) = 268.49

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) =	0 kN/m^2
Depth of Pile Tip (Pile Bottom) from Ground Level =	5.00 m
Effective Overburden Pressure at Pile Tip =	35.90 kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	35 degree
Bearing Capacity Factor (Nc)	0
Bearing Capacity Factor (Nq)	48.000 (As per IS 2911Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	48.030 (As per IS 6403 -1981)
End Bearing (T) =	1488.82 kN
Allowable End Bearing Capacity of Pile =	**595.53 kN**
Self Weight of Pile =	98.17 kN
Net Bearing Capacity of Pile =	**766.0 kN**

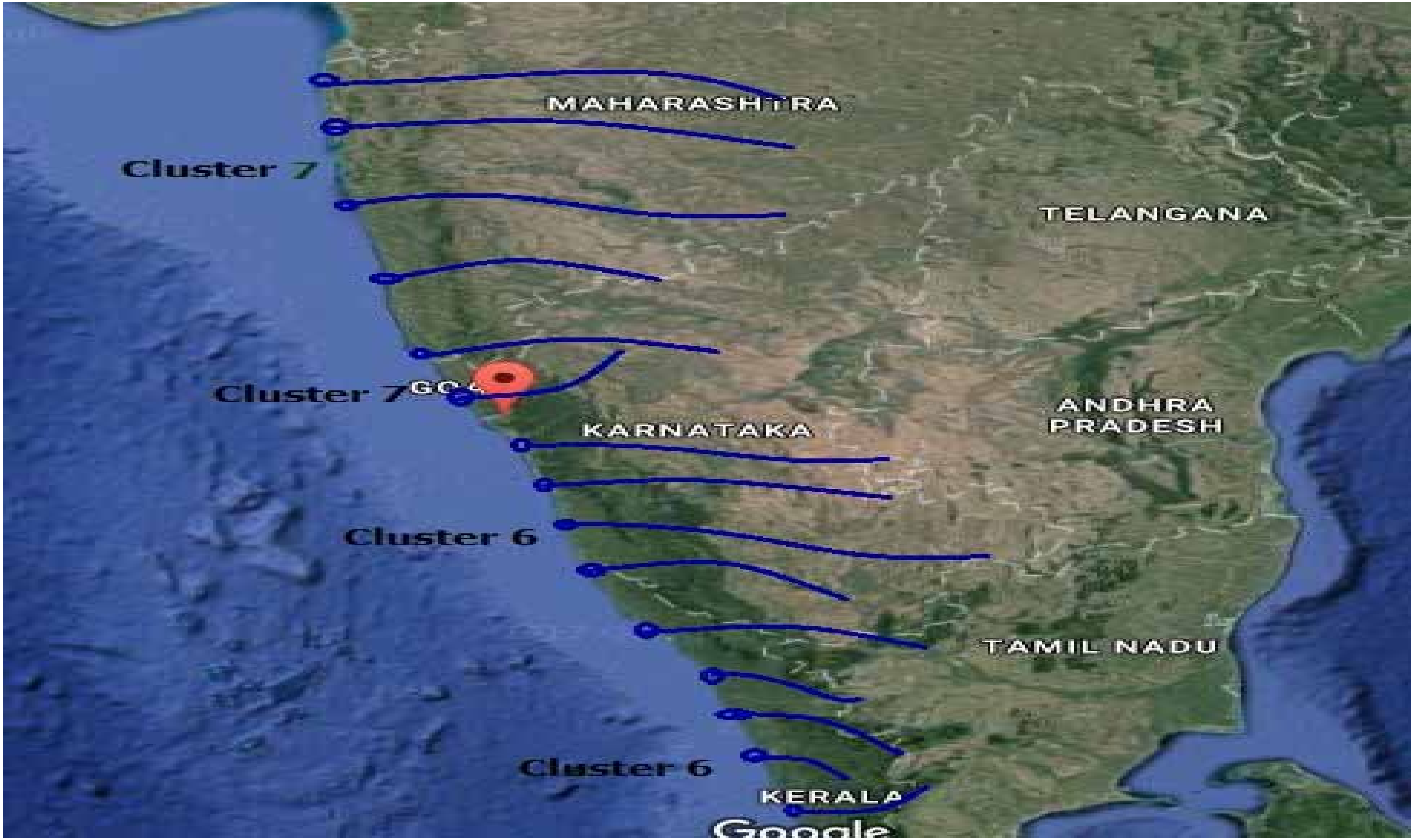
Uplift Capacity of Pile

Safe Uplift Capacity of Pile = 2/3*Frictional Resistance =	178.99
Safe Uplift Capacity (Including Weight of Pile)=	**277.0 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
GOA
KARNATAKA
ANDHRA PRADESH
Cluster 6
TAMIL NADU
Cluster 6
KERALA
Google

Services for skippers

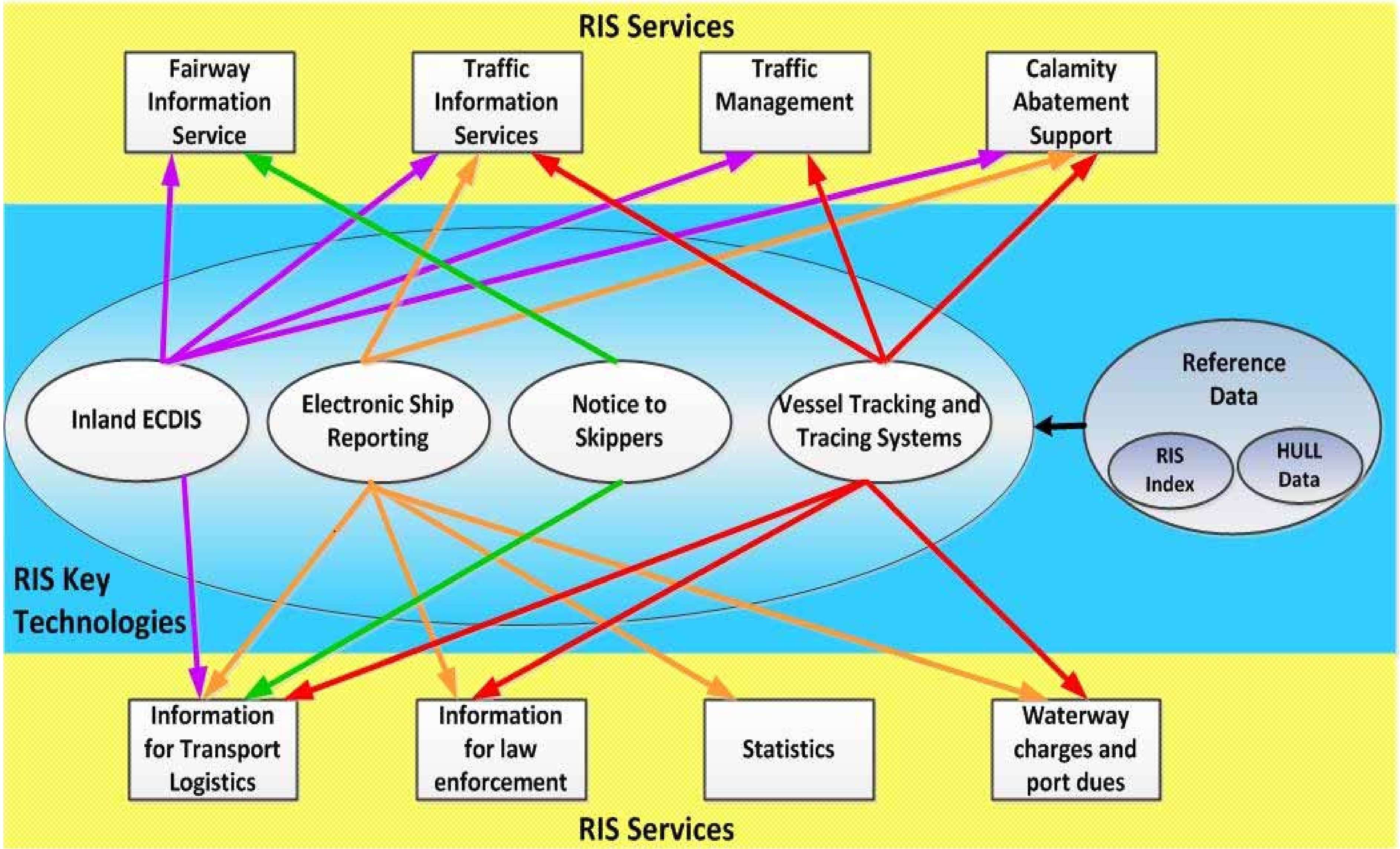
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

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

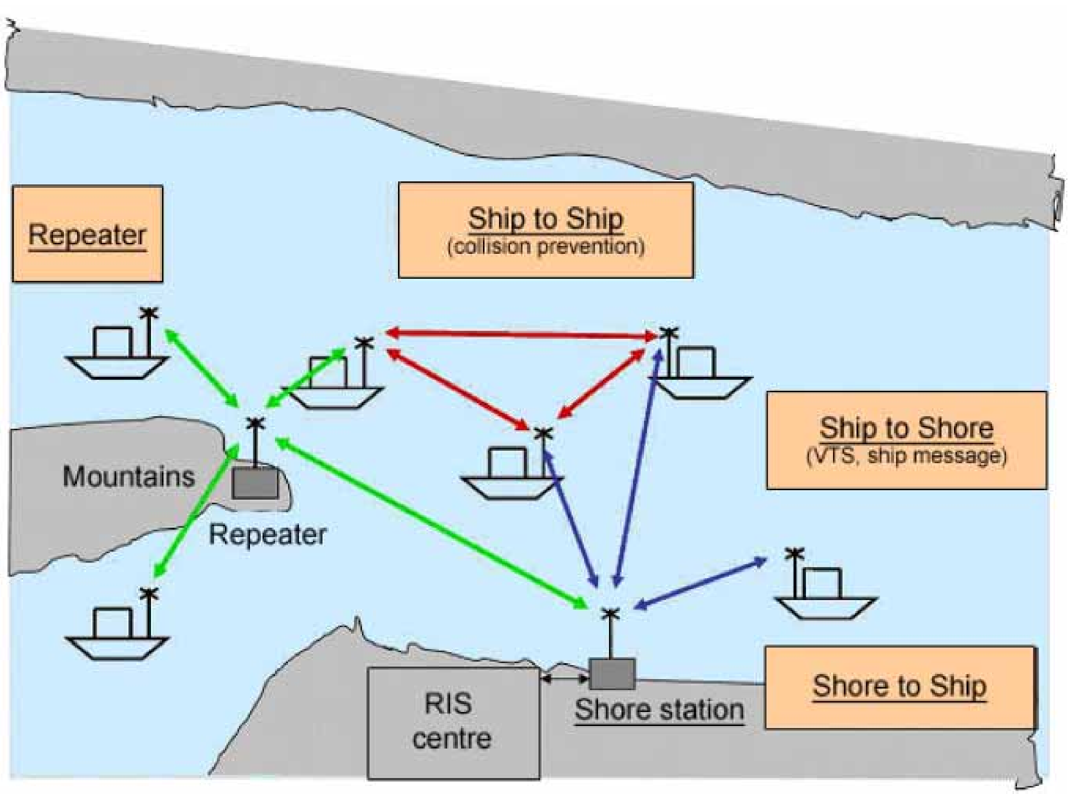

RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notice to Skippers
Vessel Tracking and Tracing Systems
Reference Data
RIS Index
HULL Data
RIS Key Technologies
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services

The key technologies of RIS are

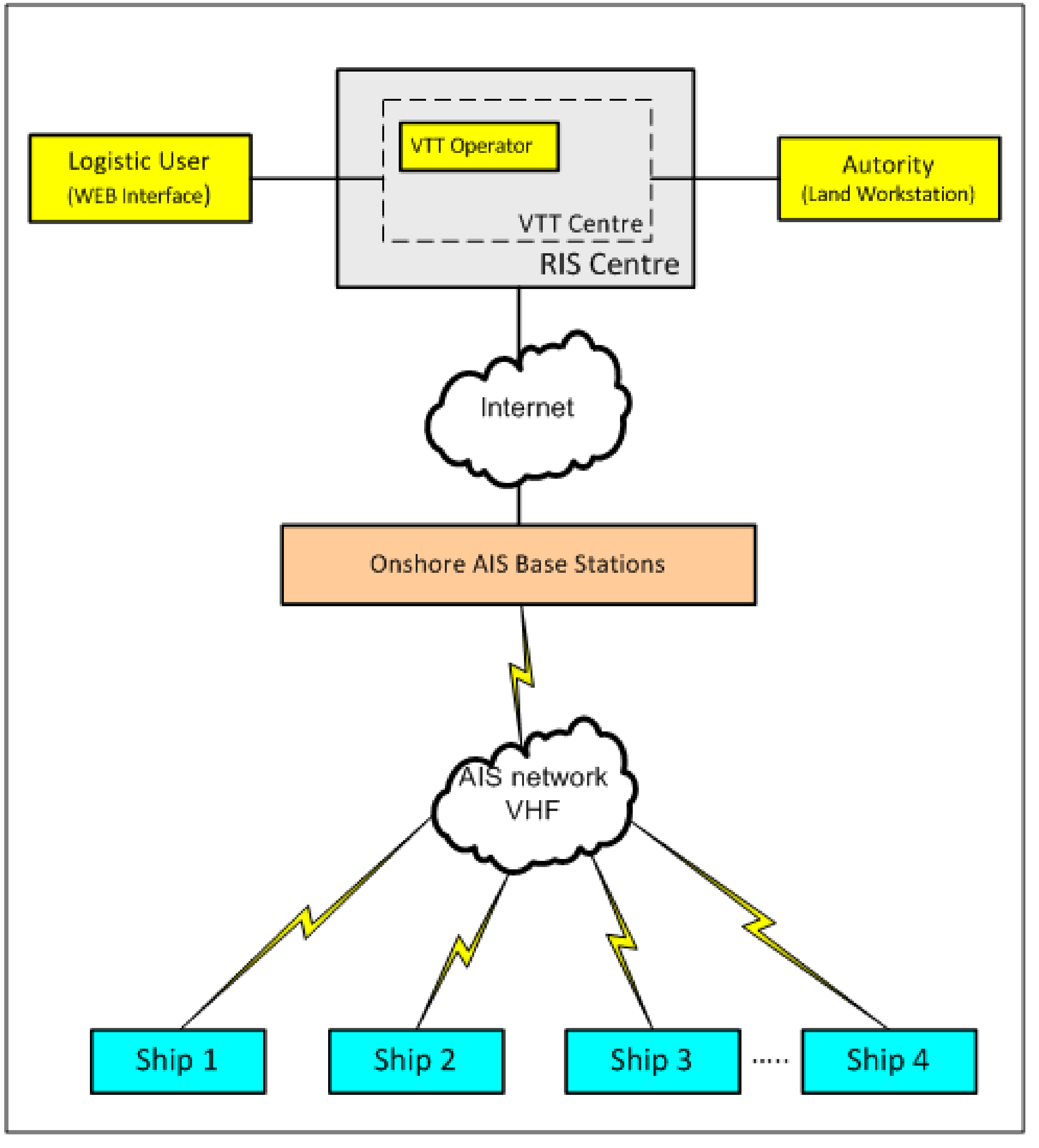
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

Some technologies needs to be adapted to the local laws and operating procedures.

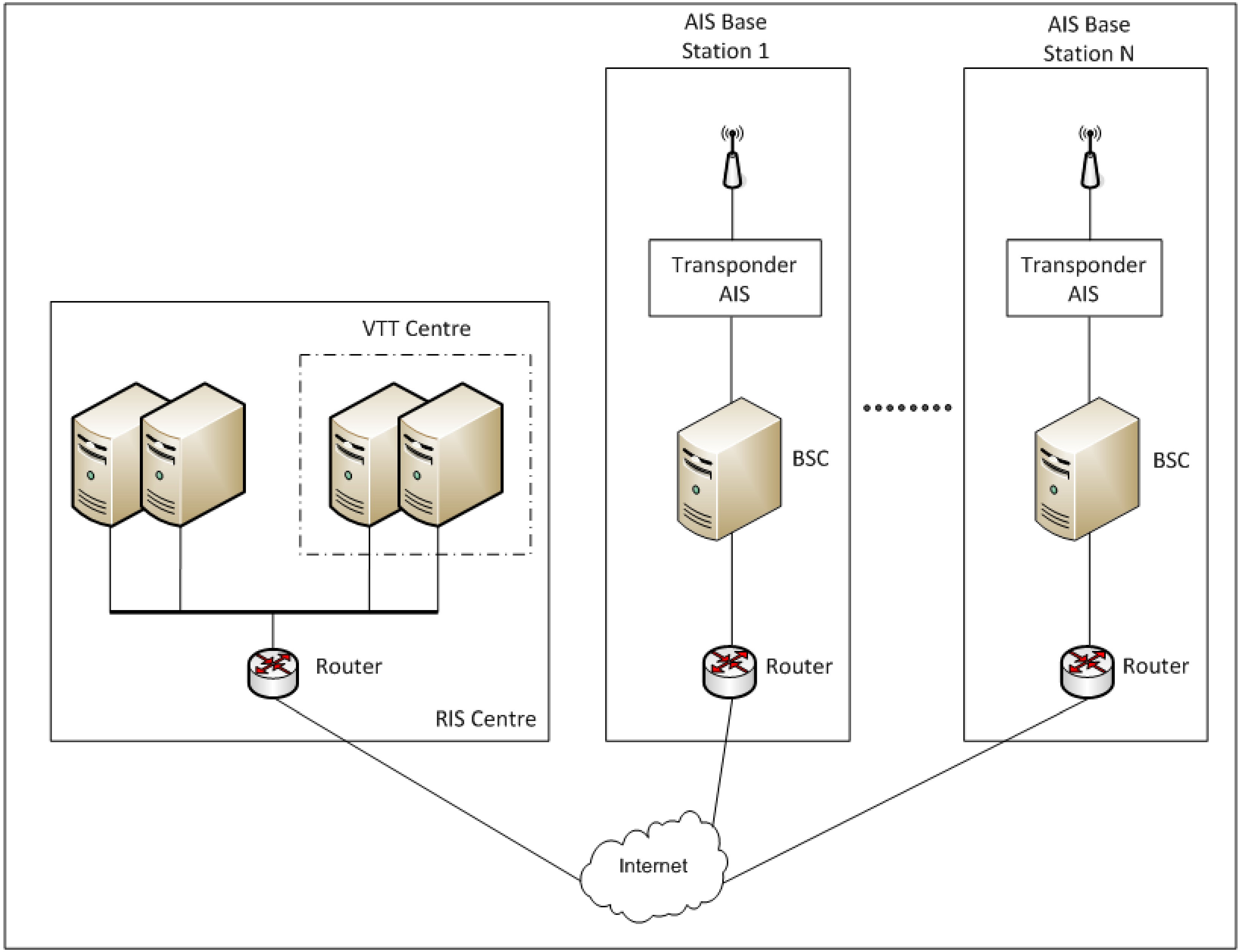
System to get a Strategic and Tactical Traffic Image using AIS technology with INLAND extension



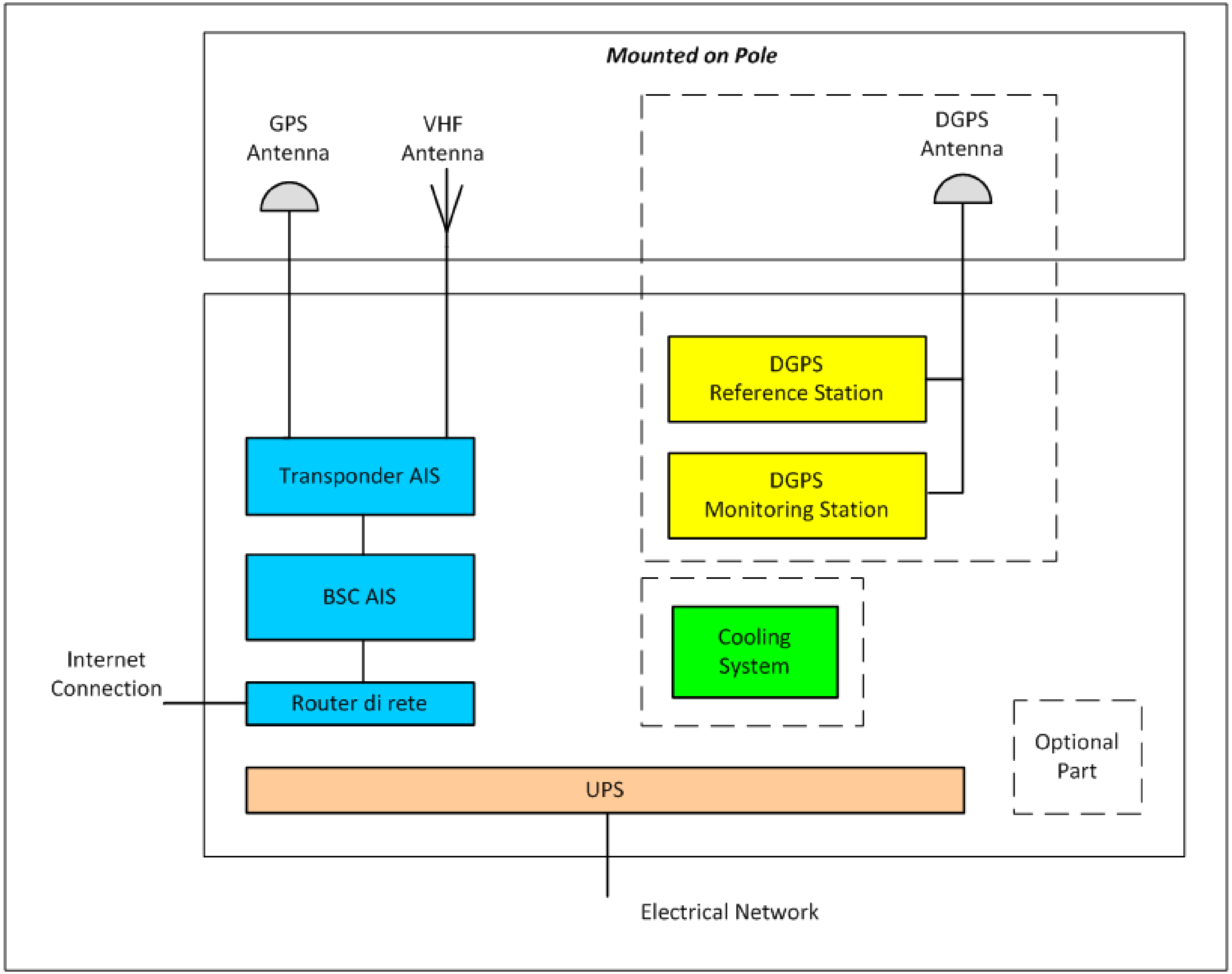
Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS 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



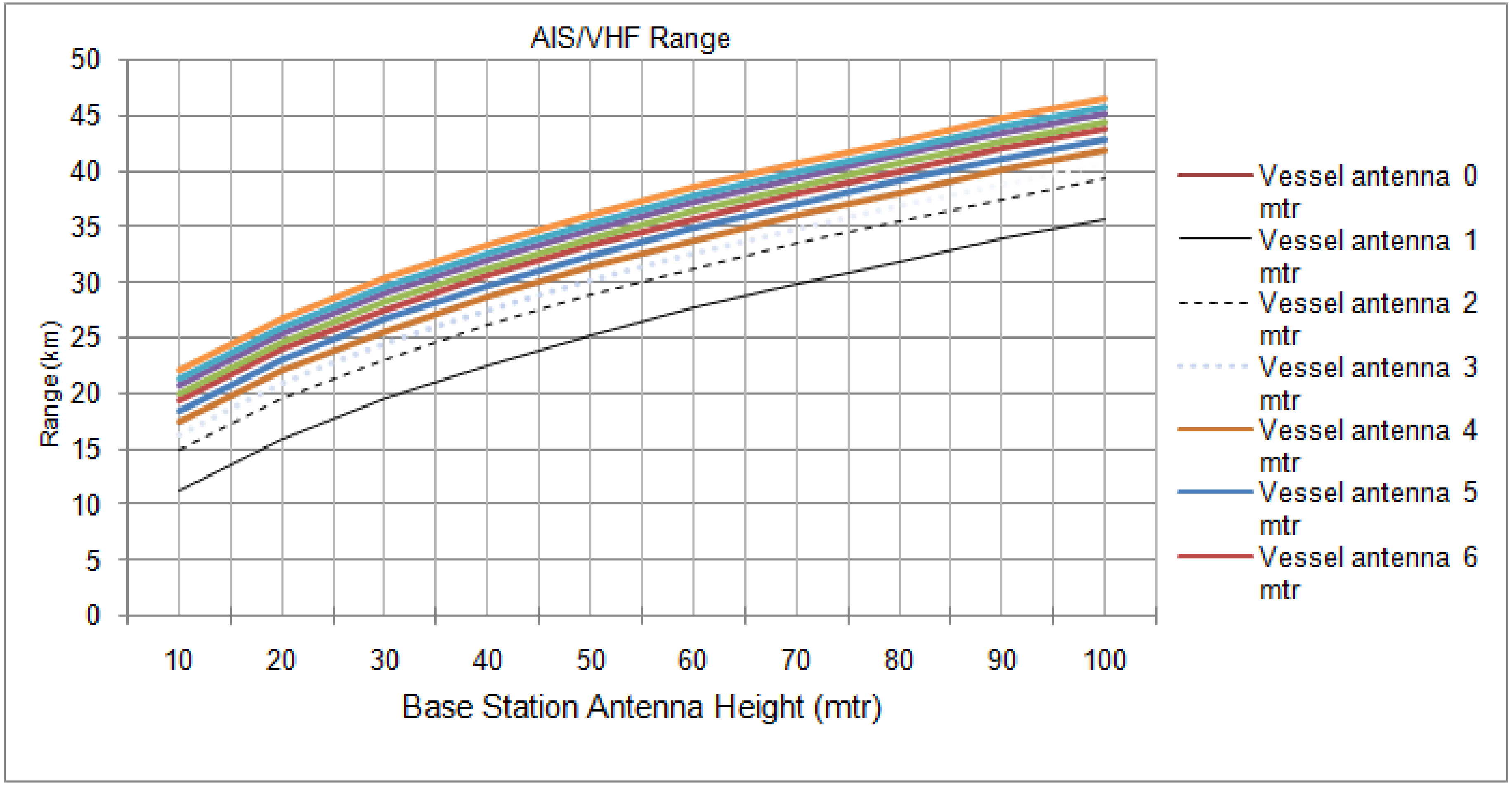
AIS STATION TOWER DESIGN

The type of tower depends upon the environment & also capable to carry Radar. Some of the examples are shown in the pictures

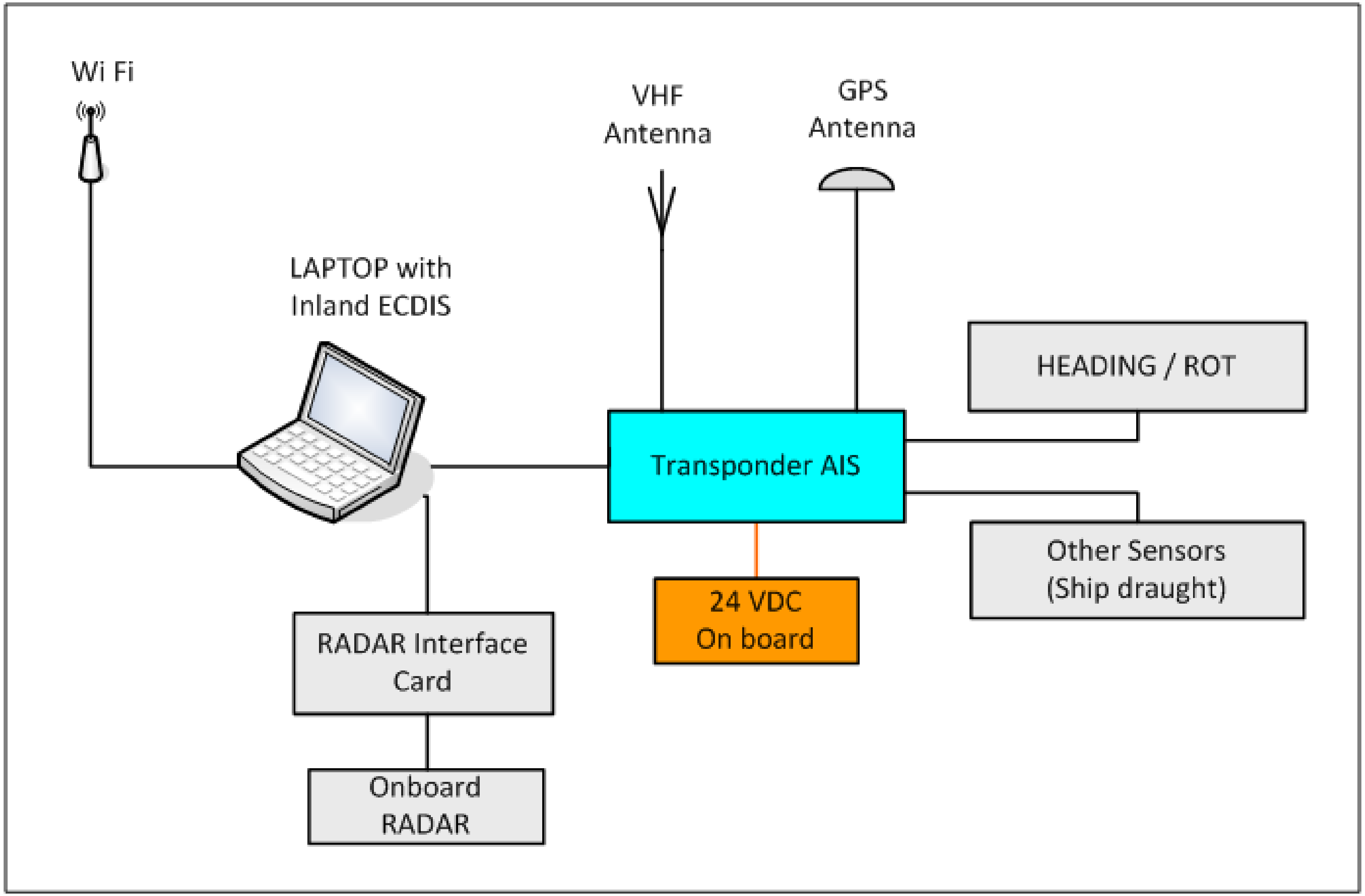
AIS STATION VHF RANGE

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

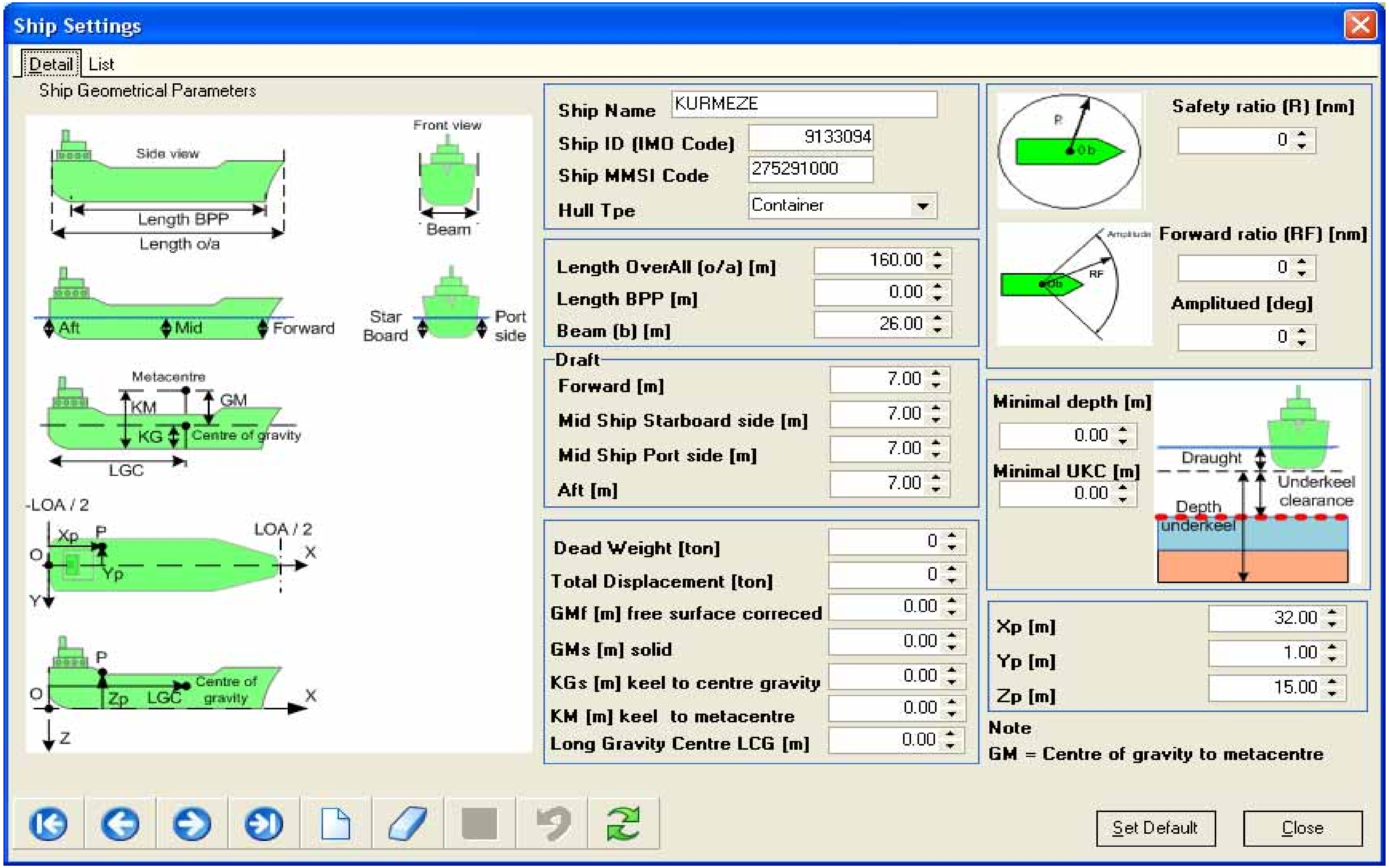
AIS STATION VHF RANGE



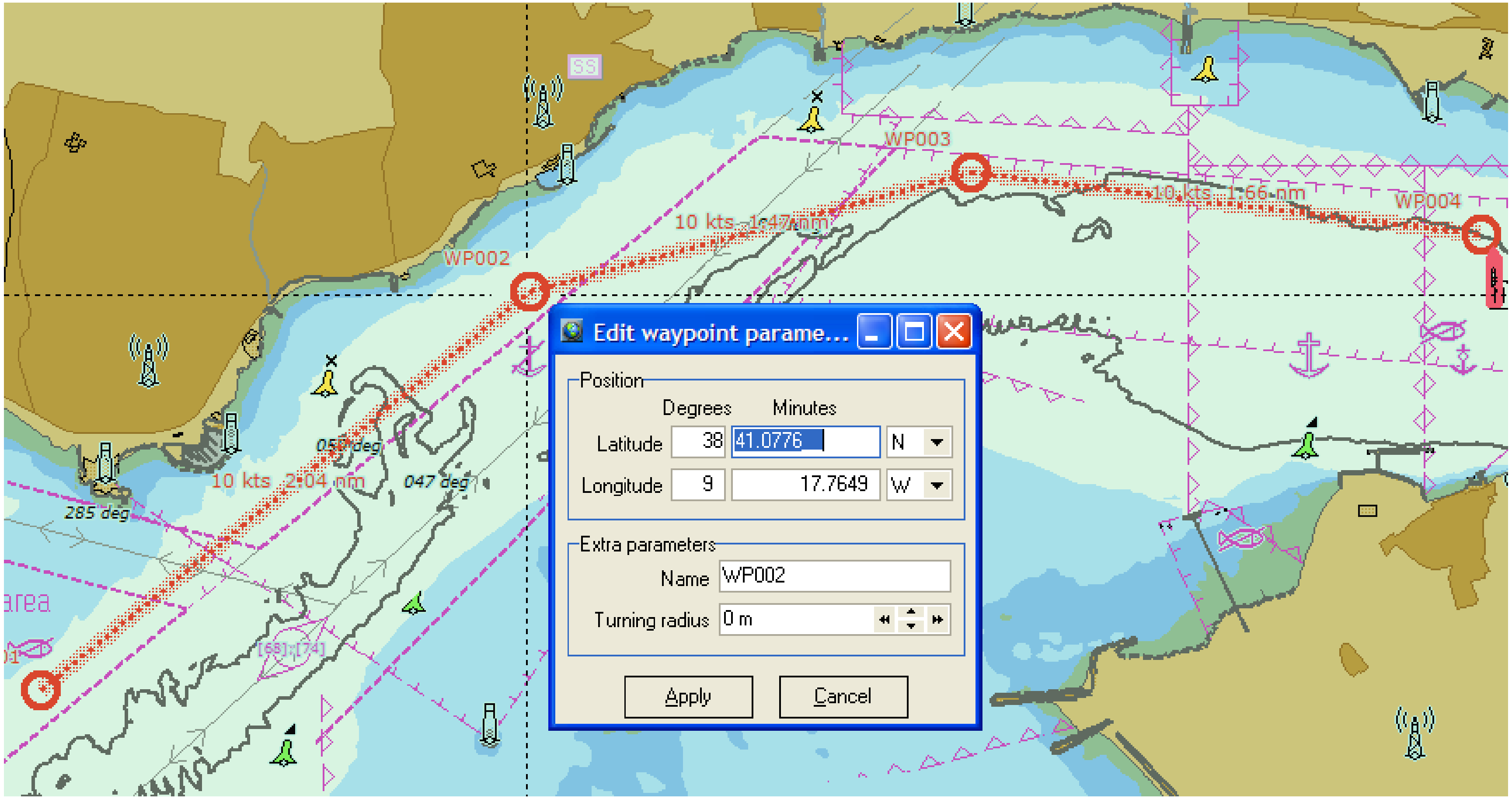
AIS ON BOARD DEVICE



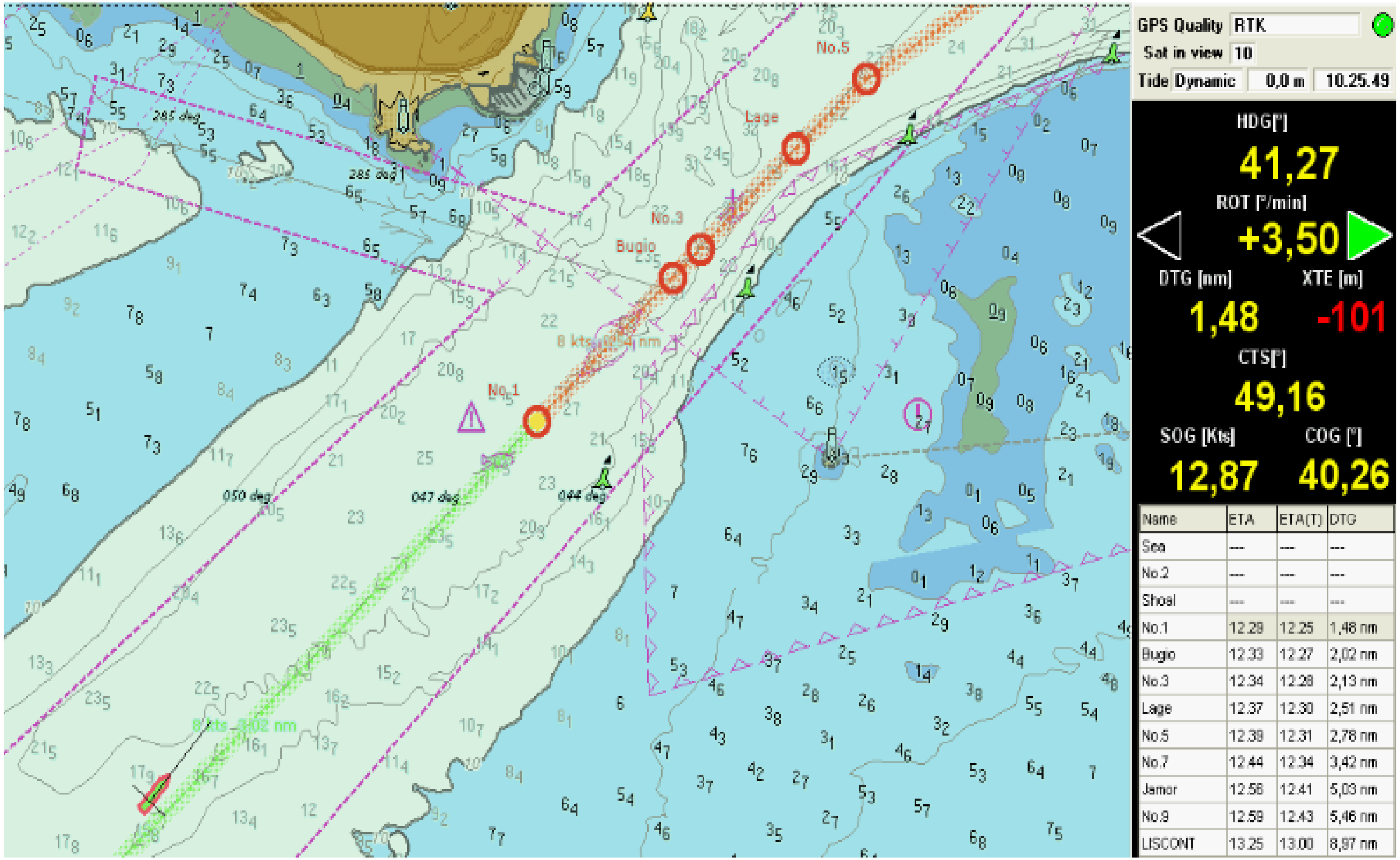
Interface to insert ship data



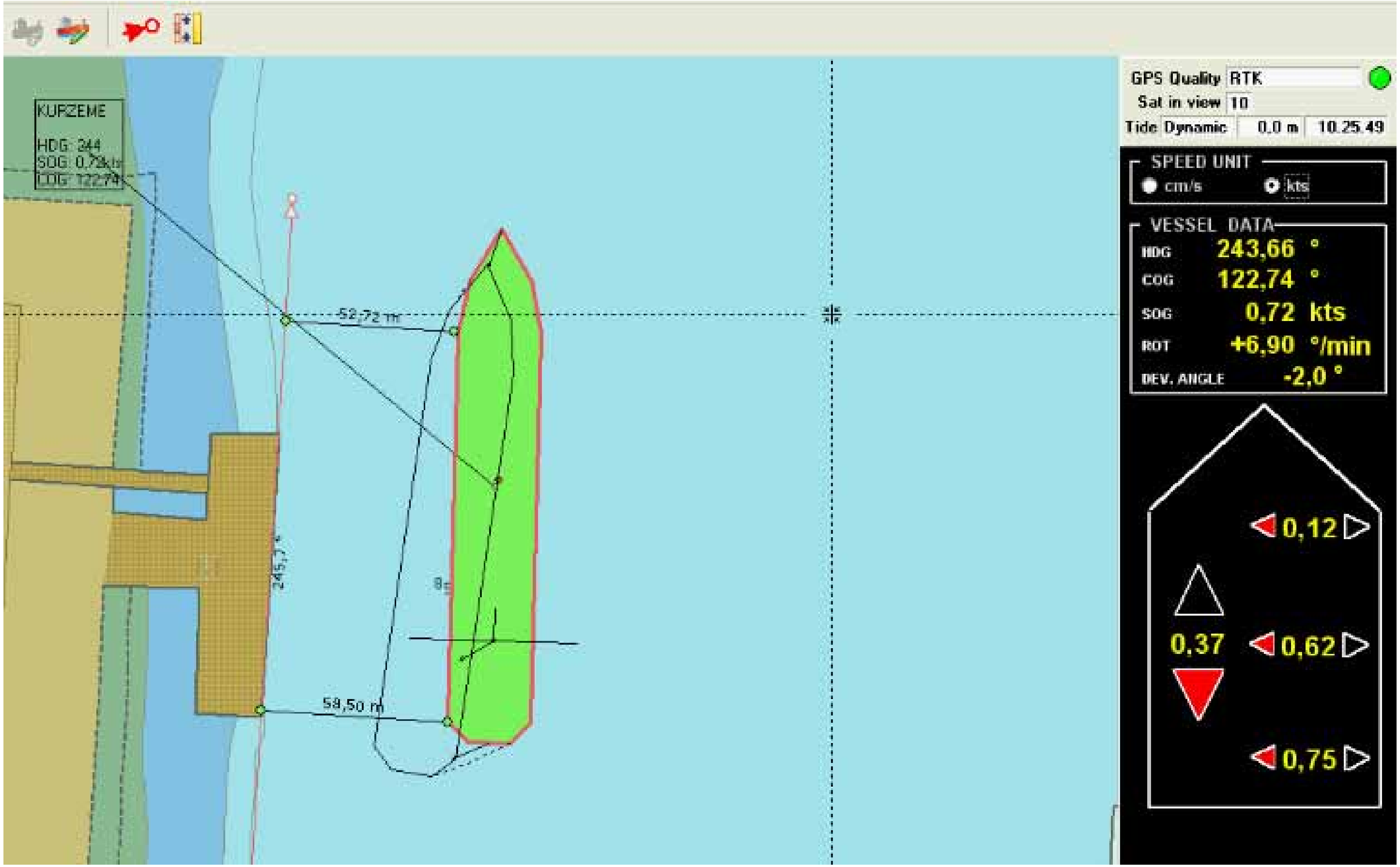
Interface to for voyage planning



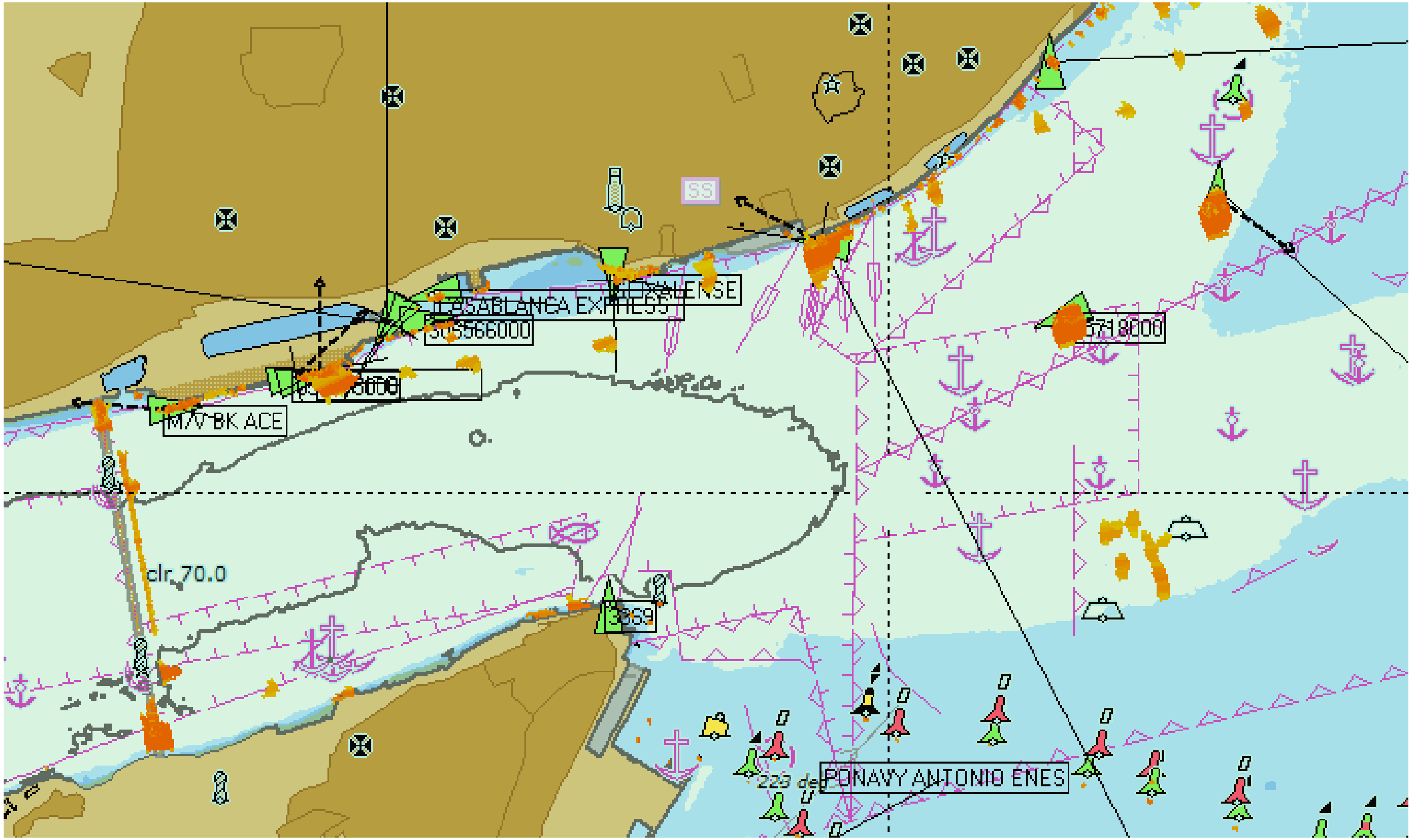
Interface in navigation mode



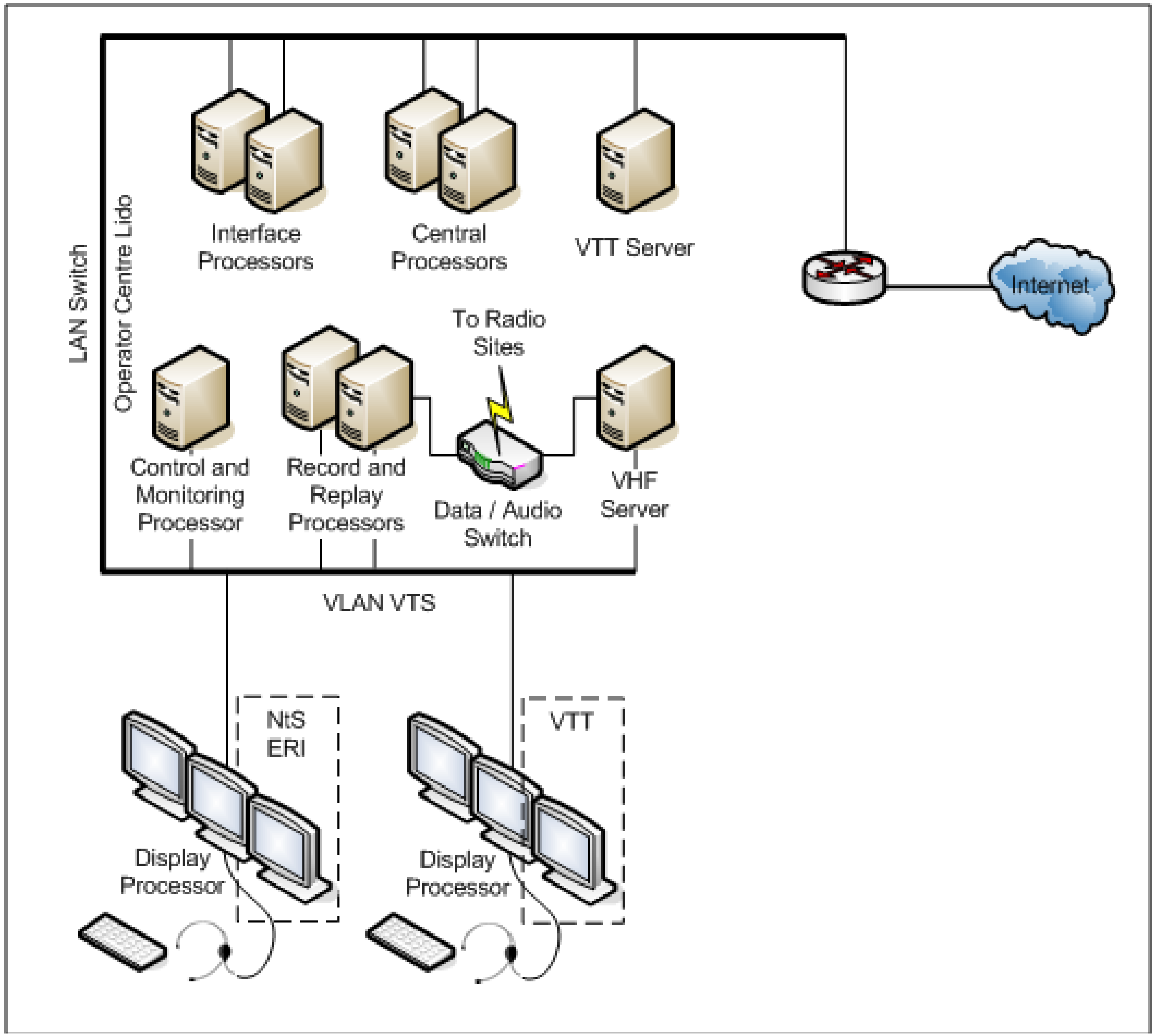
Interface for docking



Tactical Traffic Image + RADAR

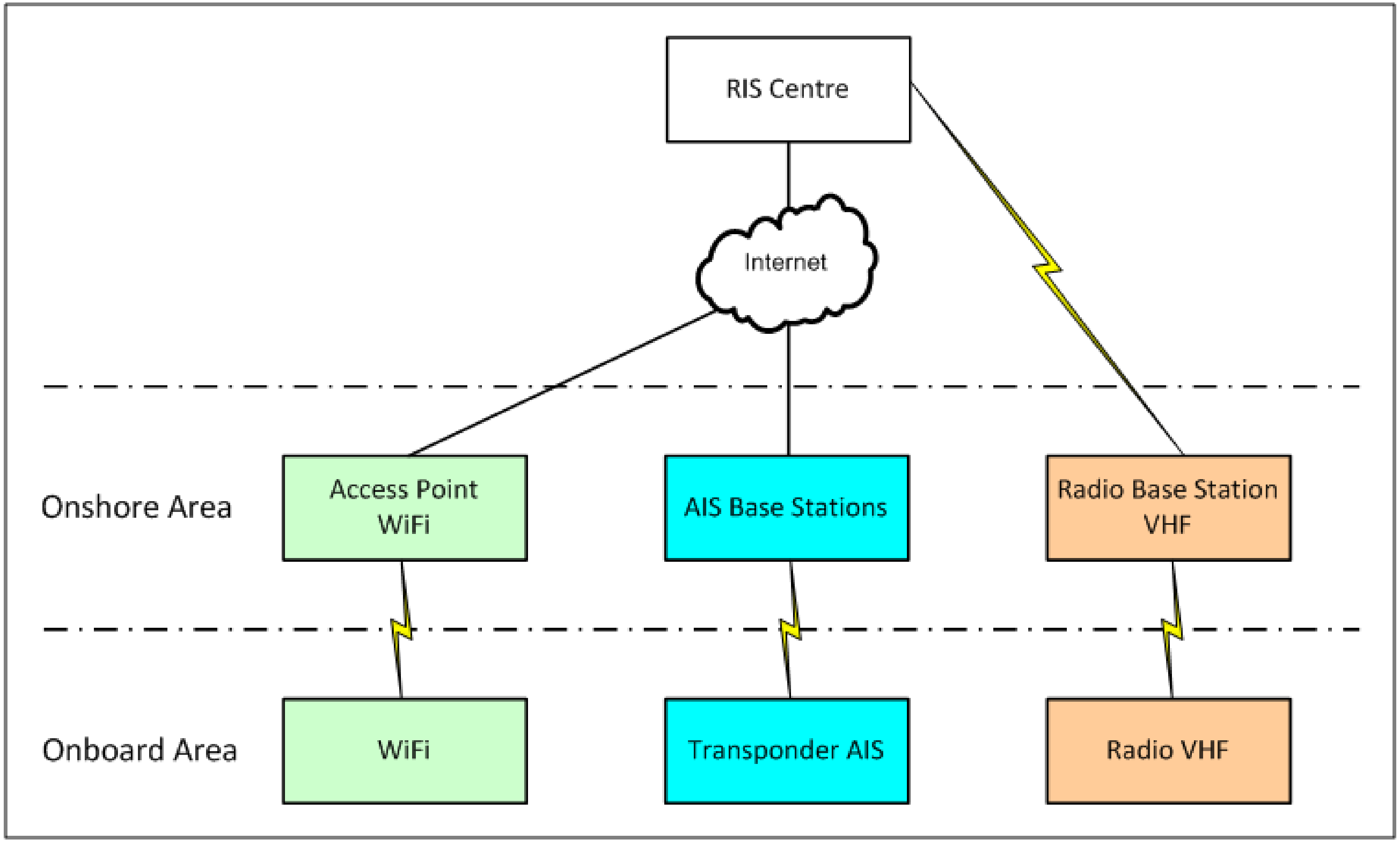


RIS CENTRE


LAN Switch
Operator Centre Lido
Interface Processors
Central Processors
VTT Server
Internet
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

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.

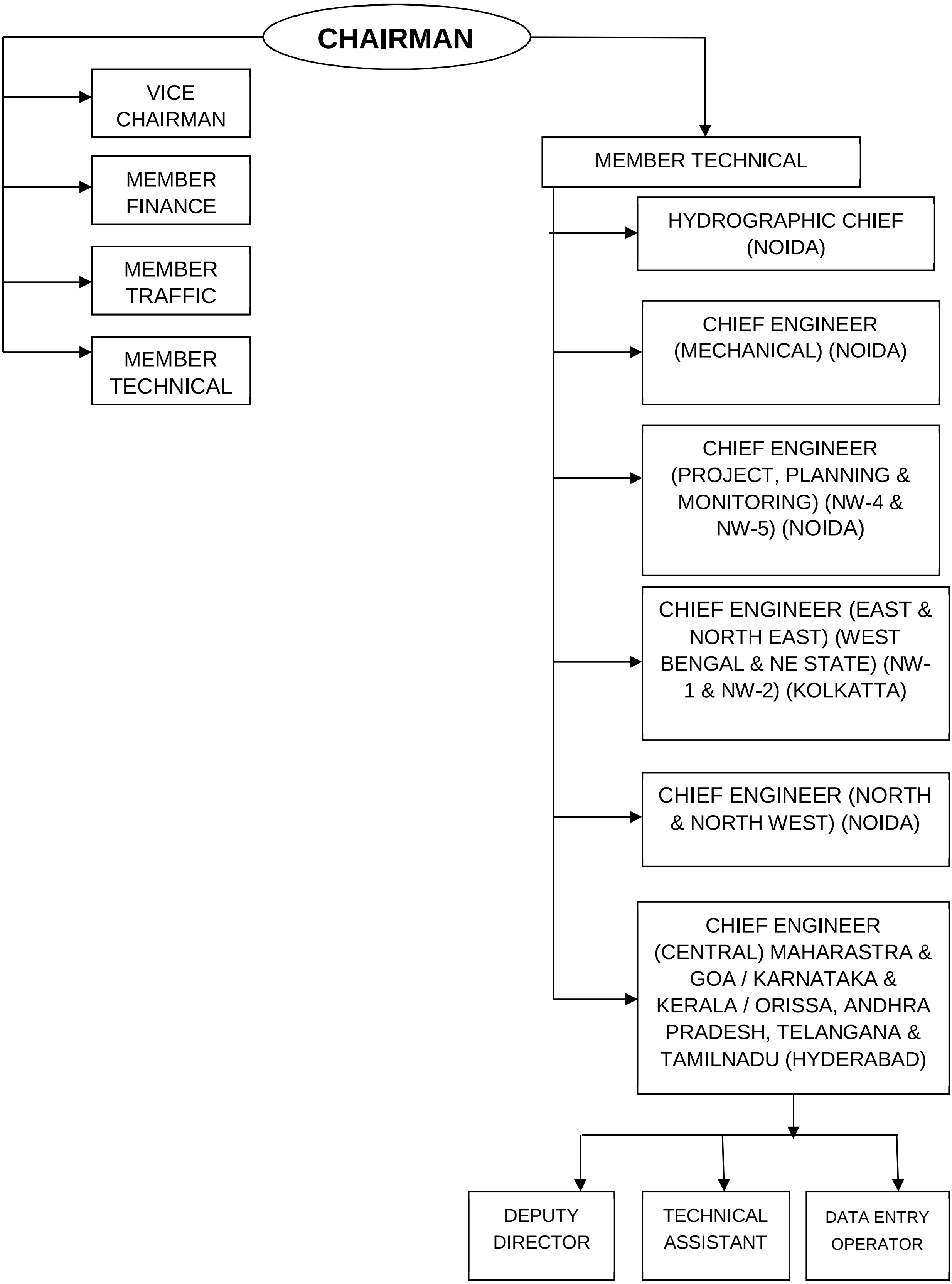
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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.

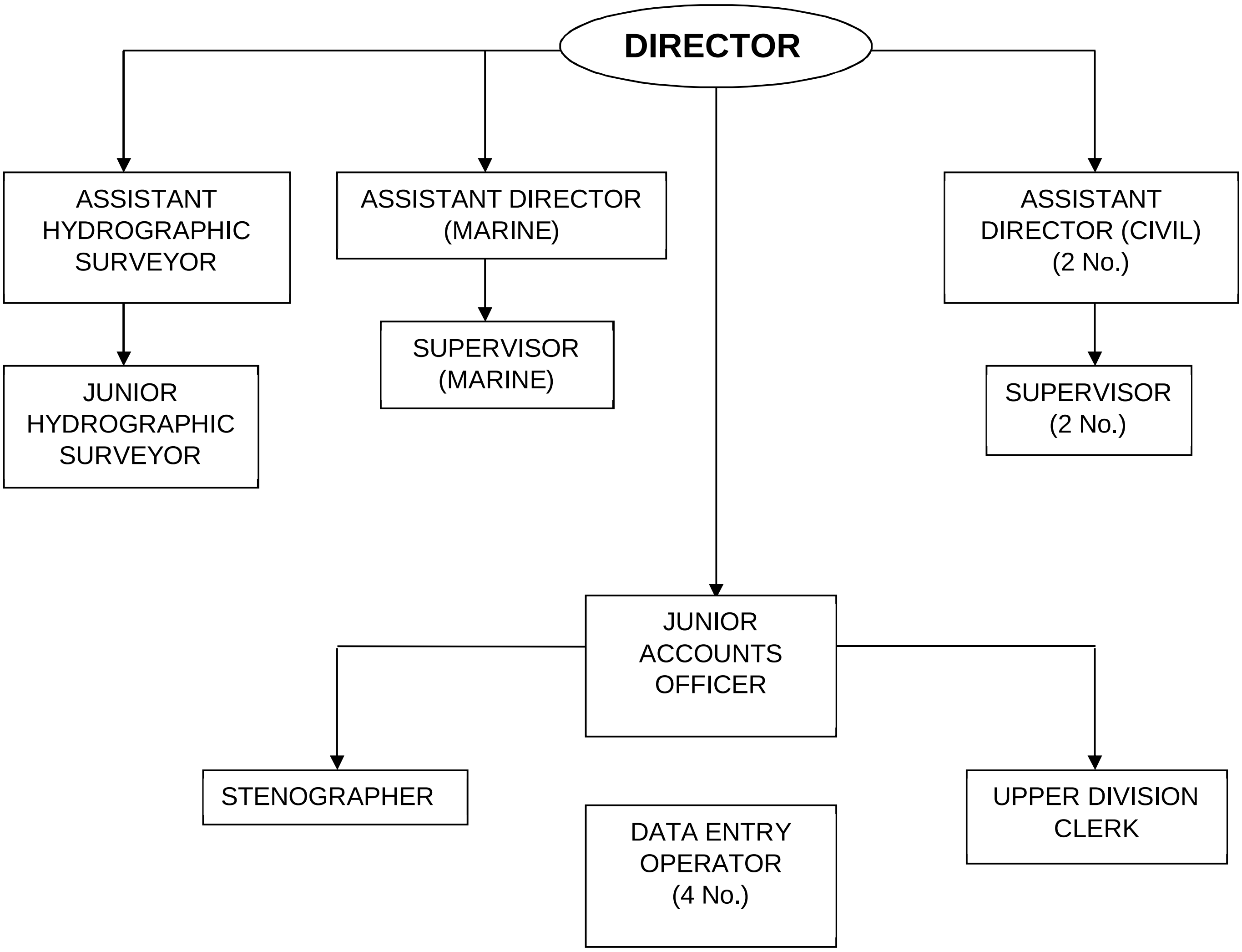
21/12/17

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]:

Capital Expenditure:

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	**Normal Condition** 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	

Operations & Maintenance Expenditure:

(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	148,000	300	444.00
2	Dredging in Hard Soil	Cum	17,000	900	153.00
	Total Cost of Dredging				**597.00**

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	354.45	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 4000 m for 8 locations				**4928.66**	

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 1 (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 2 (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.	65	336,250	218.56
	Cost of Night Navigation Works				**218.56**

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	896.00	286.72
(ii)	Land required for Road Extension or construction of external approach road	m2	750.00	896.00	6.72
(iii)	area under Mangrooves clearance	m2	0.00	1120.00	0.00
(iv)	Boundary wall 250 mm thk brick masonary (1:6) surrounding the entire terminal	m2	1040.00	896.00	9.32
2	Land Cutting/filling considering 1.5m	m3	45056.00	134.00	60.38
	Total Cost of Land				**363.13**

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 KUNDALIKA 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 1.2 m diameter					
	Vertical Piles					
	Grid A	No	14			
	Grid B	No	14			
	Grid C	No	14			
	Grid D	No	14			
	Grid E	No	14			
	Total Piles	cu. m	594			
1.2	Pile Caps (1800x1800x600)	cu. m	136.08			
1.3	Longitudinal Beams (1200x1500)					
	Grid A	cu. m	216.00			
	Grid A1	cu. m	216.00			
	Grid B	cu. m	216.00			
	Grid B1	cu. m	216.00			
	Grid C	cu. m	216.00			
	Grid C1	cu. m	216.00			
	Grid D	cu. m	216.00			
	Grid D1	cu. m	216.00			
	Grid E	cu. m	216.00			

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1.4	Cross Beams (1800x1800)					
	grid 1 to 14	cu. m	970.70			
1.5	Deck Slab	cu. m	1344.00			
	Total Concrete	**cu. m**	**5077.61**	7948.89	403.61	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 1.2 dia	MT	89.06			
2.2	Pile Caps (1800x1800x600)	MT	10.89			
2.3	Longitudinal Beams (1000x1150)					
	Grid A	MT	38.88			
	Grid A1	MT	38.88			
	Grid B	MT	38.88			
	Grid B1	MT	38.88			
	Grid C	MT	38.88			
	GridC1	MT	38.88			
	Grid D	MT	38.88			
	Grid D1	MT	38.88			
	Grid E	MT	38.88			
2.4	Cross Beams (18000x1800)					
	grid 1 to 14	MT	174.73			
2.5	Deck Slab	MT	161.28			

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
	Total Reinforcement	**MT**	**864**	70350.83	608.16	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**					
	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	7	82,500	5.78	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	LS
	Total cost of Riverrine Structures				**1,147**	

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	200 m x 100 m	20000	*4,523*	*904.67*
2	Covered Storage Godown	1	100m x 30m	3000	*13,570*	*407.10*
3	Ro-Ro Truck Parking	0	0	0	*1,333*	*0.00*
4	40' Container Stack Yard	0	0	0	*6,785*	*0.00*
5	Parking for Handling equipments	1	30m x 15m	450	*1,333*	*6.00*
6	Main Parking Area	1	30m x 30m	900	*1,010*	*9.09*
7	Public Utility	1	6m x 4m	24	*29441.54*	*7.07*
8	Weigh bridge	1	8m x 3m	24	*250000*	*60.00*
9	Utility Room (Near Weigh Bridge)	1	3m X3m	9	*29441.54*	*2.65*
10	Internal Roads	1	267 m X 7.5m	2002.5	*15000*	*40.05*
11	Administration building	1	12 m x 15 m	180	*32181.25*	*57.93*
12	Business Area	1	10m x 3m	30	*32181.25*	*9.65*
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*	*2.24*
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	78.5	*1923.08*	*1.51*
25	Green Area	1		1000	*800*	*8.00*
26	Future Requirement	1		2000	*600*	*12.00*
	Total cost of Other Components					***1,583.46***

Items 2 (and Item No. 1) have been factored with observations of Construction material availability within the vicinity

* 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 11.8 –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	80.00	15000	12.00
2	Pipe Culvert on External Road		0.00	LS	2.80
	Total Cost of Approach (External) Roads				**14.80**

* 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	11456.00	2557.13	292.94	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	7603.20	354.54	26.96	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	320	2700.00	8.64	Market Rate
	Cost of Bank Protection Works				**328.54**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

REVADANDA CREEK / KUNDALIKA RIVER

Sl.No.	Items	Phase 1 (36 Months from the commencement)																																			
		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 (Approvals & Tendering)																																				
	Ordinary Soils (Execution of 1,48,000 Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils (Approvals & Tendering)																																				
	Hard Soils (Execution of 17,000 Cu. M)																																				
	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 ending 2029)																																			
	1. Dredging (NIL)																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Approval & Tendering)																																				
	River Training Works/ Bank Protection (4000 m @ 8 Locations)																																				
	4. Night Navigation																																				
	Buoy/ Lights (Approval & Tendering)																																				
	Buoy / Lights (65Nos)																																				

*Phase 2 implementation will be from 2026 / 2027 to 2029 (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.

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE LO-LO

REVADANDA CREEK / KUNDALIKA RIVER

Sl.No.	Items	Phase 2 (36 Months ending 2029)																																			
		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																																				
	Ambulance - 1 no.																																				
	Cranes with 125 T Capacity - 4 no.																																				
	Fork lift trucks 20 T Capacity - 2 no.																																				
	Environmental Management Plan																																				
	Vessels																																				
B	**Ro - Ro Terminal (Phase 2)***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components including internal roads																																				
	Infrastructure Components including internal roads																																				
	Approach Road Cost																																				
	Bank Protection Works for terminal																																				
	Cargo Handling Equipments																																				
	Ambulance - 1 no.																																				
	Cranes with 125 T Capacity - 4 no.																																				
	Fork lift trucks 20 T Capacity - 2 no.																																				
	Environmental Management Plan																																				
	Vessels																																				

*Phase 2 implementation will be from 2026 / 2027 to 2029 (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 KUNDALIKA RIVER (6 SHEETS)	P.010257-W-20301-A05
2.	TERMINAL LOCATION MAP OF KUNDALIKA RIVER (1 SHEET)	P.010257-W-20351-X05
3.	TERMINAL LAYOUT PLAN (WITH PROPOSED INFRASTRUCTURE FACILITY (1 SHEET)	P.010257-W-20311-A05
4.	LO-LO TERMINAL PLAN (2 SHEETS)	P.010257-W-20341-E05
5.	BANK PROTECTION TYPICAL SECTION (1 SHEET)	P.010257-W-20303-X05