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DPR – SAVITRI RIVER (BANKOT CREEK) (45.47KM) NW-89

Our ref.: **P.010257-W-10305-006**

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 – SAVITRI RIVER (BANKOT CREEK) (45.47KM) NW-89**

Comments:

Revision No.	Date	Prepared / Revision By	Description
01	2019 05 09	Bidhan Chandra JHA	Final Submission

REV.	YY/MM/DD	STAT.	WRITTEN	VERIFIED	APPROVED	VALIDATED
01	19/05/09	Active	SARIKA KUMARI	ARUN KUMAR	N. SIVARAMAN	B.C.JHA

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

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

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 – 89 – Savitri River (Bankot Creek) 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 25/12/2016 to 03/01/2017.

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

Terminal Land Survey was carried out on 28/04/2017.

Geotechnical Borehole was carried out from 14/06/2017 to 16/06/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

Stake Holder’s meet was considered on 04/12/2017 at “Mumbai” and the viewpoints have been summarized and placed appropriately.

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			
		BANKOT CREEK/SAVITRI RIVER (NW-89)			
A	**GENERAL**				
1	***Location***				
a	Cluster	Cluster-7			
b	State(s)	Maharashtra			
c	Co-ordinates& Name of Place	**Start**		**End**	
	Place	Harihareswar near Bankot Creek		Sape	
	Latitude	17°58'47.2472"N		18°05'54.11"N	
	Longitude	73°02'15.0195"E		73°20'08.81"E	
B	**TECHNICAL**				
1	***Waterway***				
a	National Waterway Number	NW-89			
b	Class	IV			
c	Type (Tidal/Non-Tidal)	Fully Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		45.47km	45.47km	Nil	
d	Average Tidal Variation, if applicable	Average Tidal variation in the waterways is 3.07 m			
		Chainage (km)	HW	LW	Tidal Variation (m)
		1.17	3.616	0.616	3.000
		10.13	3.550	0.474	3.076
		20.25	3.220	0.070	3.150
		33.21	3.153	0.160	2.993
		45.47	3.180	0.060	3.120
e	Chart Datum				
	Description/Basis	Adi Mahad 17°59'30.3371"N 073°07'07.421"E	Pangalol 18°03'39.8544"N 073°10'24.548"E	Ambet 18°04'06.3721"N 073°16'39.084"E	Tol Phata 18°05'51.8303 "N 73°20'08.060" E
	Value (from Zero of Gauge)	-0.162* m	- 0.623m *	- 0.592m *	-0.822*
		* below of Zero of Gauge			
f	LAD Status (w.r.t. CD)				
		Stretch-1	**Stretch-2**	**Stretch-3**	**Total**
	Stretch (From......To......)	0 – 15.00	15.00 -30 .00	30.00-45.47	
	Length with LAD < 1.2 m	0.000	0.000	3.470	3.470
	With LAD from 1.2-1.4 m	0.000	0.150	0.000	0.150
	With LAD from 1.5-1.7 m	0.000	0.000	0.000	0.000
	With LAD from 1.8-2.0 m	0.000	0.000	1.000	1.000
	With LAD > 2.0 m	15.000	14.850	11.000	40.850
	Grand Total				45.470 km

#	Particulars	Details				
g	Target Depth of Proposed Fairway (m)	2.0 m of Class IV Waterway				
h	Conservancy Works Required					
	Type of Work	**Stretch-1**	**Stretch-2**	**Stretch-3**	**Total**	
	Dredging Required (Cum.)	0.00	416.15	262467.63	262883.78	
	Bandalling	Nil	Nil	Nil	Nil	
	Barrages & Locks	Nil	Nil	Nil	Nil	
	River Training/Bank Protection (Km.)	8 nos (Bank Protection) A length of 500 m is suggested at locations of Ch. 9.5 km; Ch. 22 km; Ch. 24.2 km; Ch. 30.05 km; and 2000 m length between Ch. 31.25 km and 33.25 km.				
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*	30m to 50m	6.5m to 9.0m	
	HT/Tele-communication lines	HT Lines/EL	3	195m to 625m	4.5 m to 10.50m	
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil	
		· 1 Under construction				
2	***Traffic***					
a	Present IWT Operations (type of services)	No cargo operation on river. At the mouth of the river Bankot port (non-major) is operational. However traffic handled at this port is very inconsistent in nature.				
b	Major industries in the hinterland (i.e. within 25 km. on either side)	Chemical Industries located in Mahad MIDC.				
c	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	ü Major roads - SH 100 which is a curvy road runs parallel to Savitri River from Raigad district side. However SH 102 passing in Ratnagiri District is not parallel to the river and the road is very curvy. NH 66 is also in the close proximity of the river. Industries use NH66 for transporting goods to JNPT for export purpose. ü Major railway – Konkan railway line is the only railway line running in both Raigad and Ratnagiri district that crosses the river. Mangaon, Karanjadi & Veer, Sape are passenger railway stations				

#	Particulars	Details				
		in the catchment of the river.				
d	Commodities	**In-bound**			**Out-bound**	
1	Chemical/ container	Mahad MIDC			JNPT - Export	
e	Future Potential ('000 Trucks)					
	Name of Commodity	**5 years (Fy-20)**	**10 years (Fy-25)**	**15 years (Fy-30)**	**20 years (Fy-35)**	**25 years (Fy-40)**
	Proposed IWAI Terminal					
	No traffic potential for Savitri River. However under certain condition and only if Government provides subsidy possible Ro-Ro traffic for river is as under.					
1	Liquid, Chemicals (Ro-Ro) ('000 Trucks)	67	82	100	122	148
3	***Terminals/Jetties***					
a	Terminal/Jetty - 1	RO-RO				
	Location (Bank/city/district)	18°05'55"N & 73°20'11.56"E near Dasgaon (left bank) in Raigadh district				
	Type/Services	Ro-Ro vessel mobility				
	Facilities	--				
	Approach	Road is available				
	Land Ownership					
	Area (ha.)	**Govt.**			**Private**	
		NIL			2.1	
4	***Design Vessel***					
a	Type	Ro-Ro Vessel				
b	No. & Size	52.8 m - 55 m x 14 m, Initially suggested 2 nos of Ro-Ro vessels on promotional basis				
c	Loaded Draft	1.8 m / 2.5 m+				
d	Capacity	21 TEU				
5	***Navigation Aids***					
a	Type	Beacon and Light / Buoy and Light				
b	Nos.	20 Nos. / 110 Nos.				
b	Communication Facilities	--				
C	**FINANCIAL**					
1	***Project Cost***					
a	Capital Cost	Fairway			Ro-Ro	
		With development Phase 2 / Phase 2 A	Without development Phase 1		With development	
	Cost (INR in Cr)	79.74 / 66.61	9.97		30.78	
b	O & M Cost	12.84 / 10.90	2.17		2.07	

#	Particulars	Details		
2	***User Charges***			
a	For IWAI	-		
b	For Operator	-		
3	***Financial Internal Rate of Return (%)***	Fairway		Ro-Ro
		With development Phase 2 / Phase 2 A	Without development Phase 1	With development
a	For IWAI	Non-existent / Non-existent	15 %	- 6 % / - 6 %
b	Operator	-		
4	***Economic Internal Rate of Return (%)***	Fairway		Ro-Ro
		With development Phase 2 / Phase 2 A	Without development Phase 1	With development
		24 % / 26 %	166 %	73 % / 65 %
5	***Any other Important Feature***			

EXECUTIVE SUMMARY

Savitri River is one of the waterways declared as National Waterway in March, 2016 as NW 89. Savitri River originates in Mahabaleshwar and flows through Raigad and Ratnagiri districts and eventually meets Arabian Sea at Harihareshwar. It passes through Poladpur, Mahad, Mangaon, and Shrivardhan taluks. There are a number of Shiva temples along the banks of river Savitri. The land along the banks of the Savitri is mostly rocky. The high-water spring-tides go up to Mahad. Savitri River valley is located in the south of the Raigad District. Savitri River forms the border between Raigad and Ratnagiri districts.

The stretch of Savitri River (Bankot Creek) starting from Arabian Sea at Harihareshwar Lat 17°58'47.2472"N, Long 73°02'15.0195"E to Bridge near Sape at Lat 18°05'53.37"N, Long 73°20'09.05"E has been 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 45.47 Kms from Lat 17° 58' 47.2472" N, Long 73° 02' 15.0195" 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 analysing 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, one Bridge is under construction (@ Ch 0.6 km), which is having sufficient clearances maintained, as ascertained. The Bridge @ Ch. 33.29 km is having clearances as 50 m HC and 9 m VC, which is almost within the Class IV standards for Ro-Ro vessel mobility. Third Bridge is out of the operational area. (@ Ch 45.73 km). 2 HT Lines are present in the operational area, which are having sufficient clearances. No pipe line is crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 18 Nos. Of Bend locations have been identified in the study stretch, with 173 m as lowest at Ch. 33 km.

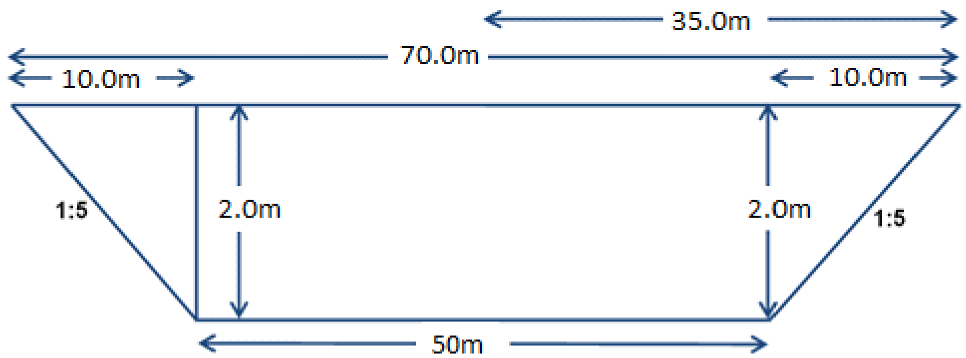
Existing waterway is being used for good mobility in the mouth near Bankot creek and for fishing. The fairway without any development can have safe navigation to Class IV standard of National Waterway for a length of about 40 kms. Yet there is no utilization of this waterway. However, keeping in view the proximity of Industrial Belt in the end stretch of the River, (MIDC, Mahad) being planned and designated by Maharashtra State Government, with the identified major industry as Chemical industry, the possibility of Ro-Ro mobility could be established with an estimated Ro-Ro vehicles mobility to the extent of 67,000 vehicles P. A in FY 20 and expected grow to an extent of 148,000 vehicles P. A in FY 40. There is a possibility of this mobility directly from JNPT / MbPT through IWT vessel traversing the costal route and the full stretch of the Savitri River.

The fairway requirements are being considered for analysis for its maximum / optimum utilization. The most advantageous part of this waterway is that the initial 42 kms out of the 45.47 km has water depth > 2.0 m. This will facilitate the mobility of class IV vessel and accordingly, it is proposed for the development as Class IV for Ro-Ro mobility with 21 TEUs. The vessel requirement is 52.8 m to 55 m (Length) x 14 m (Breadth) x 1.8 m / 2.5 m+ (Draft / Depth). Accordingly, the fairway requirement is 50 m (Bottom Width) x 2.0 m (Depth) with Bend Radius of 800 m. Clearance corridor of 50 m Horizontal Clearance (HC) and 8 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel.

Keeping in view the most advantageous aspect of the Fairway availability, no investment has been proposed. In the proximity of Ch 40 km, there is an approach road existing in South side (Bank near “Owale” village) connecting SH 70 and near Ch. 42 km on the North side (Bank near “Sape” village) connecting SH 100. NH 66 is connected (from both the sides) with a lead of 15 kms – 16 kms. Accordingly, phase 1 has been proposed (up to 40 km / 42 km) without any investment / rather very nominal investment to facilitate Ro-Ro operation to achieve the initial estimated volumes (to decide upon the investment in phase 2) and if the same is able to achieve full estimated volumes, no investment is suggested. The promotional aspect with observation is proposed up to FY 25.

A nominal investment for development 20 Nos of Lattice Bridge with Lighting; Institutional build up and L. S provisions have been worked out for INR 9.98 Cr in Phase 1.

If Phase 2 is to be considered, after having meticulous observation of the growth mobility, the fairway stretch between Ch 40 km / Ch 42 km or to the end is proposed to be developed along with the development of IWAI Ro-Ro Terminal, appropriately.



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
0.00	15.00	TIDAL ZONE				20.4	4.3	0.00	0.00
15.00	30.00					19.7	1.6	150	416.15
30.00	45.47					14.7	-2.1	3250	262467.63
							Total	3400	262883.78

In Phase 2, in order to provide a safe navigable fairway, along with the above quantum of Dredging (about 2.6 Lakhs Cu. M of ordinary soils and 0.3 Lakhs Cu. M of hard soils); Bank Protection (Total 4000 m); Day / Night Navigation (110 Nos of Beacon / Light); The Bend locations will be tackled with Bank Protection, as above.

The Terminal requirement has been considered with 1 Roll-On Roll-Off (Ro-Ro) IWT Terminal. Taking into the consideration of the origin and destination and fairway, the most probable location identified is near Ch 45 km, on the left side of the river with approx. Lat 18° 05' 55" 'N and Long 73° 20' 11.56" E near Ch 45.20km. This location is having good accessibility to the road.

A tentative Land requirement has been worked out and arrived at with 19,258 Sq. M and the Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Dasgaon Village; Mahad Taluka; Raigarh District of Maharashtra state. Geotechnical Investigations are under progress at this location. Terminal Infrastructure has been considered to suit to the Ro-Ro operation.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
RO RO	75	16.60

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

The Vessel Design has been discussed with international standards, as in vogue. To meet the mobility of the existing cargo, though, it was proposed / recommended for the convoy, the following standards have been considered.

Ro-Ro Vessel: **(21 TEU)** **INR 900 Lakhs each**

Length: 52.8 m to 55 m

Breadth: 14 m

Loaded Draft / Depth: 1.8 m / 2.5 m+

Propulsion: Marine Diesel Engines of 3 x 375 Bhp

2 Ro-Ro vessels may be required at the initial stages in FY 20 to consider the promotional Phase 1 mobility. If Phase 2 implementation is established with due analysis, suggested the deployment carefully i.e., one additional vessel in the following sequence of FY 30; FY 32; FY 34; FY 36; FY 38 and FY 40.

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

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

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

As explained above, the development is suggested in TWO Phases. Phase 1 is with minimal investment for considering the promotional mobility. Phase 2 may have to be considered only after establishing the growth possibility for the increased Ro-Ro mobility.

Investment in Phase 1 is working out to INR 9.98 Cr.

Investment in Fairway in Phase 2 is working out to INR 79.73 Cr.

Investment in Fairway in Phase 2 (without Dredging & Shifting Terminal nearer to Ch 40 km / 42 km) is working out to INR 66.61 Cr.
Investment in Ro-Ro Terminal in Phase 2 is working out to INR 30.78 Cr.

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

Parameter	Phase 1	Phase 2		Phase 2A	
	Fairway	Fairway	Ro-Ro Terminal	Fairway	Ro-Ro Terminal
Project Cost	9.97	79.74	30.78	66.61	30.78
Revenue (FY40)	3.42 (FY2030)	10.21	6.38	9.08	6.38
FIRR	15%	Non-existent	-6%	Non-existent	-6%
EIRR	166%	24%	73%	26%	65%

It is recommended to consider Phase 1 Promotional mobility till 2025 / 2026, with a nominal investment, with the operation up to 40 km / 42 km. No investment is suggested for further development, without any meticulous assessment for developing the entire study stretch of Savitri River (Bankot Creek) of about 45 kms with Class IV system of the NW standards to facilitate the Ro-Ro vessel mobility.

CHAPTER 1: INTRODUCTION

1.1. Project Background and Summary of Previous Study

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

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

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

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

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

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

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

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

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

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

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

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

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
1.	Amba River	NW-10	44.971	Maharashtra
2.	Dabhol Creek/ Vashishti River	NW-28	45.228	Maharashtra
3.	Kalyan-Thane-Mumbai waterway, Vasai creek and Ulhas River	NW-53	145	Maharashtra
4.	Rajpuri Creek	NW-83	31	Maharashtra
5.	Revadanda creek / Kundalika River	NW-85	30.736	Maharashtra
6.	**Savitri River (Bankot creek)**	**NW-89**	**45.47**	**Maharashtra**
7.	Shastri River/ Jaigad creek	NW-91	52	Maharashtra
8.	Chapora River	NW-25	25	Goa

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
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 Savitri River (Bankot Creek) (NW 89) is under consideration in the present DPR.

1.2. Brief Scope of Work and Compliance statement

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

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

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

1.2.1. Fairway Development

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

1.2.2. Traffic Confirmations

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

1.2.3. Terminal Development:

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

1.2.4. Vessel Requirement

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

1.2.5. Financial Analysis

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

1.3. Brief Methodology & Approach:

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

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

1.4. Project **Location / Details of** Study **Area:**

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

TABLE 1-2: Waterways for Stage II study

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

The present study is about the Savitri River (Bankot Creek) – NW 89 for a distance of 45.47 kms from the Arabian Sea at Harihareswar to Upstream, in the state of Maharashtra.

TABLE 1-3: Description of Savitri River (Bankot Creek) (NW-89)

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Savitri River (Bankot Creek) (NW-89)
2	State/ District through which river passes	The Savitri River (Bankot Creek) passes through the Raigad and Ratnagiri districts of Maharashtra State.
3	Length of the river / canal	Out of the total length, 45.47 km length of the Savitri River (Bankot Creek) starts from Arabian Sea at Harihareshwar Lat 17°58'47.2472"N, Long 73°02'15.0195"E to Bridge near Sape at Lat 18°05'53.37"N, Long 73°20'9.05"E has been declared as new national waterway.
4	Map	The index map of Savitri River (Bankot Creek) showing proposed waterway stretch, topographic features and road networks are shown in Figure1.1. The study stretch of the Savitri River (Bankot Creek) for the Detailed Project Report (DPR) is presented in Volume-**II** Drawing No. **P. 010257-W-20301-A06 (Sheet – 1 to 7).**
Characteristic of River		
5	River Course	Savitri River originates in Mahabaleshwar and flows through Raigad and Ratnagiri districts and eventually meets Arabian Sea at Harihareshwar. It passes through Poladpur, Mahad, Mangaon, and Shrivardhan taluks. There are a number of Shiva temples along the banks of river Savitri. The land along the banks of the Savitri is mostly rocky. The high-water spring-tides go up to Mahad. Savitri River valley is located in the south of the Raigad District. Savitri River forms the border between Raigad and Ratnagiri districts. Coconut and Areca nuts gardening is well practiced in the Savitri valley.
6	Tributaries / Network of Rivers / Basin	Kal River is the major tributary of river Savitri which enters from the right (north) near Dasgaon. In its course through the district the Savitri River receives six large tributaries, four from the right bank, and two from the left.
7	Catchment Area	The total catchment area of Savitri River (Bankot Creek) is 2889 sq. km.

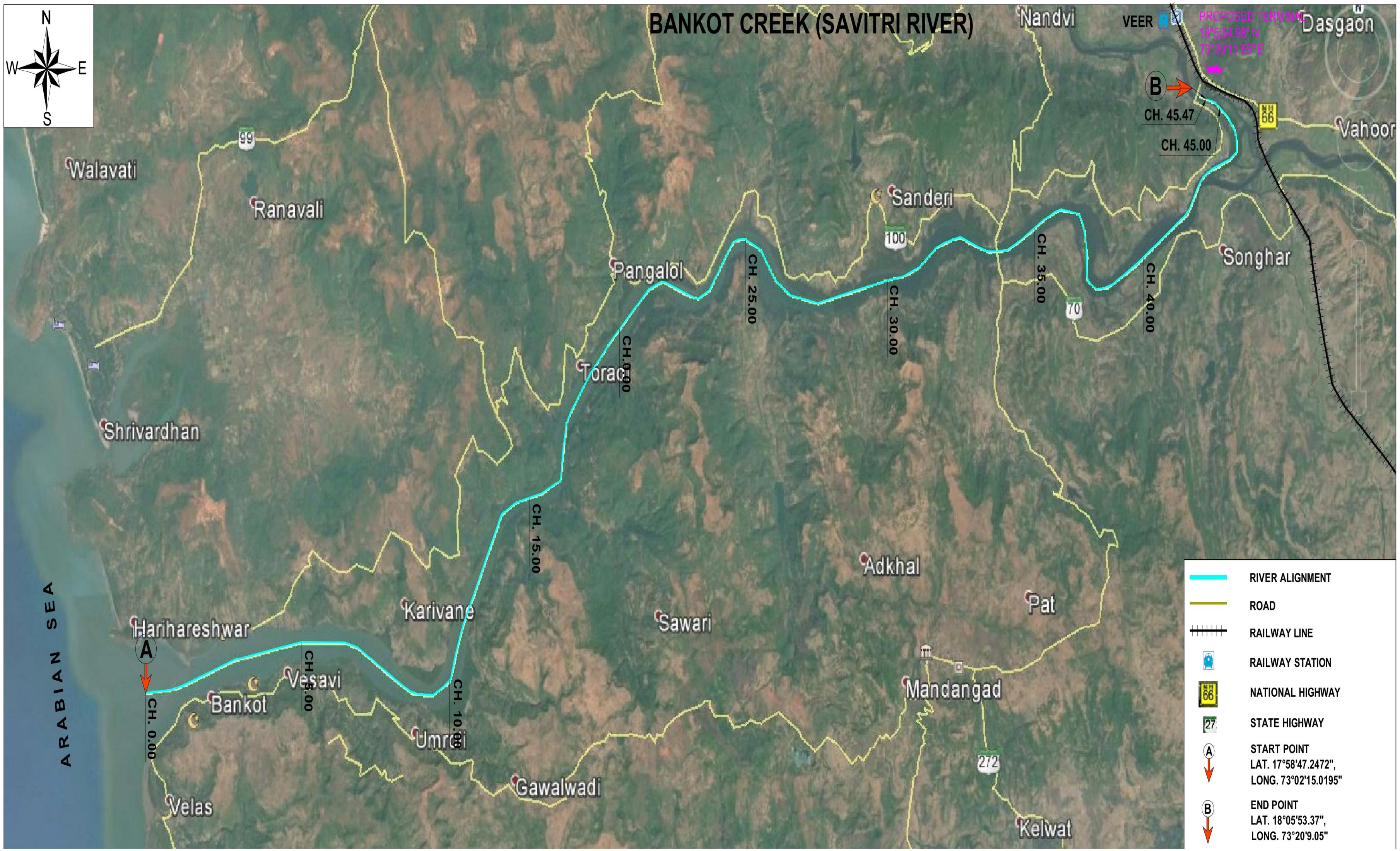


FIGURE 1-1 : INDEX MAP

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, harbors etc.), determination of bed depth of water bodies, by soundings (for navigation, location of rocks, sand bars, navigation light).

2.1.1. Waterway in General and Hydro-morphological Characteristics

Waterway in General

Savitri River originates in Mahabaleshwar hills and flows through Raigad district and eventually meets Arabian Sea at Harehareshwar in Maharashtra state, India. It passes through Poladpur, Mahad, Mangaon and Shrivardhan taluka while flowing in the south west direction. The total length of the river from origin to its outfall in the Arabian Sea is about 99.0km. The present study focusses on 45.47 km with 0.00km being the confluence with the Arabian Sea.

The Savitri River is bounded by Dasgav, Sape, Songhar, Warathi, Ambet, Vicharewadi and Padwe in the upper stretch, Phalasap, Pewe, Dandnagari, Kudgaon, Shigwan and Kole in the middle stretch and Borkhat, Umroli, Karivane, Vesavi, Harihareshwar and Bangkot in the lower stretch.

FIGURE 2-1: Catchment Area Map of Savitri River (Source: Google Earth)

The total catchment area of Savitri River basin is 2889 sqkm. The catchment receives an average annual rainfall of about 3493mm. The major tributary of Savitri River is Kal River which enters from right (north) near Dasgaon.

A map showing Savitri catchment basin is shown in above figure. The figure indicates that the river flows close to the coastal region; thus the lower stretch of river is expected to be tidal affected zone. 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.

The soil texture of the river bed has been observed during the reconnaissance survey. It has been observed that that sandy clay soil is found in most part of the river under study stretch.

Formation of braiding pattern is popularly attributed to heavy sediment load in a river having a wide and shallow cross section. Rise in river bed levels, rise in flood levels, accumulation of silt rendering channels shallow, bank erosion as a result of development of multiple channels and sudden change in flow direction are some of the conditions associated with braided rivers. However from the survey it was seen that there is no braiding in this river course.

Any part of river falls under rapid zone, i.e. having relatively steep gradient in the river bed may cause 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 Savitri 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 has been given 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.

A. Savitri 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 (November, 2005, April, 2011, November, 2013 and October, 2016).

FIGURE 2-2 : River stretch from Ch 0.00km to 10.00km in November, 2005 (Source: Google Earth)

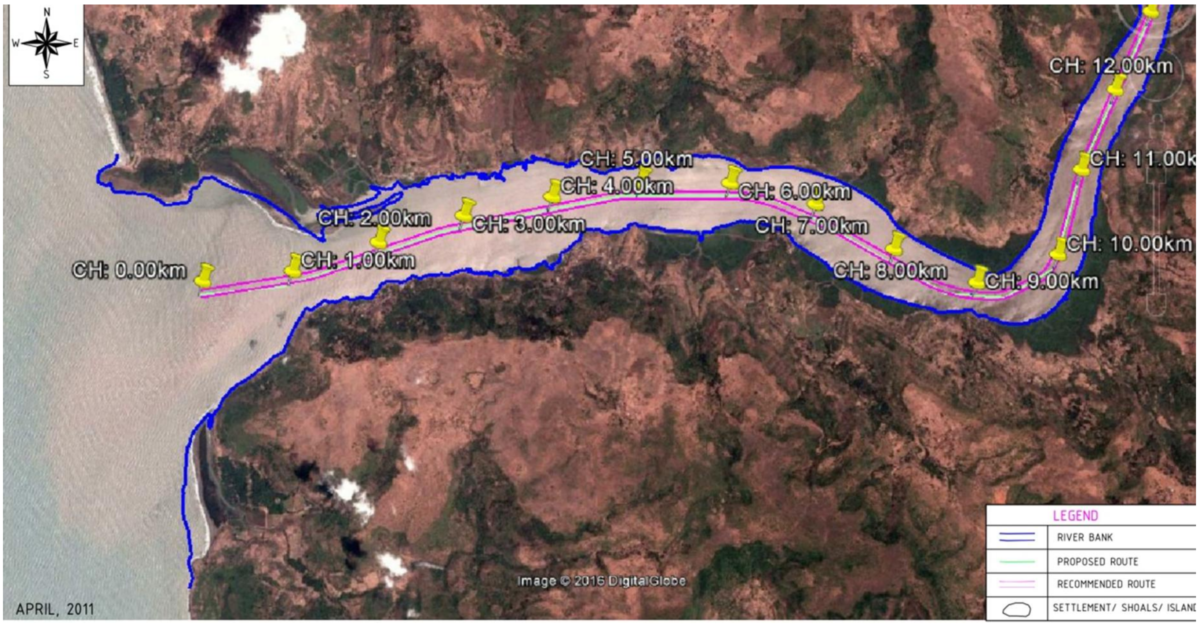


FIGURE 2-3 : River stretch from Ch 0.00km to 10.00km in April, 2011 (Source: Google Earth)

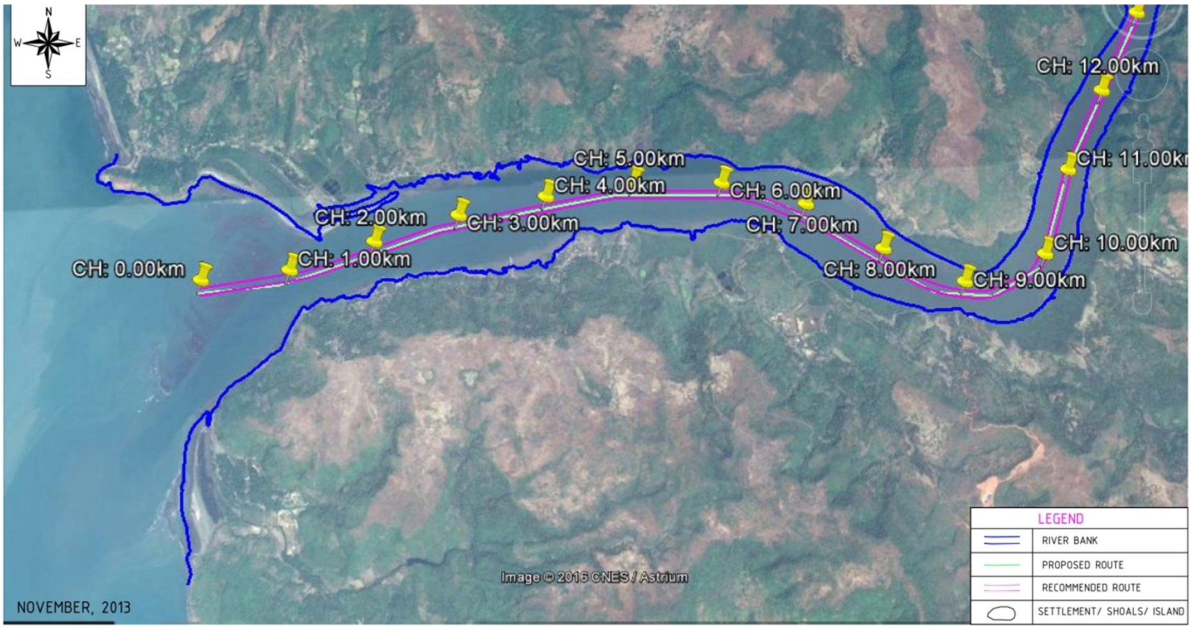


FIGURE 2-4 : River stretch from Ch 0.00km to 10.00km in November, 2013 (Source: Google Earth)

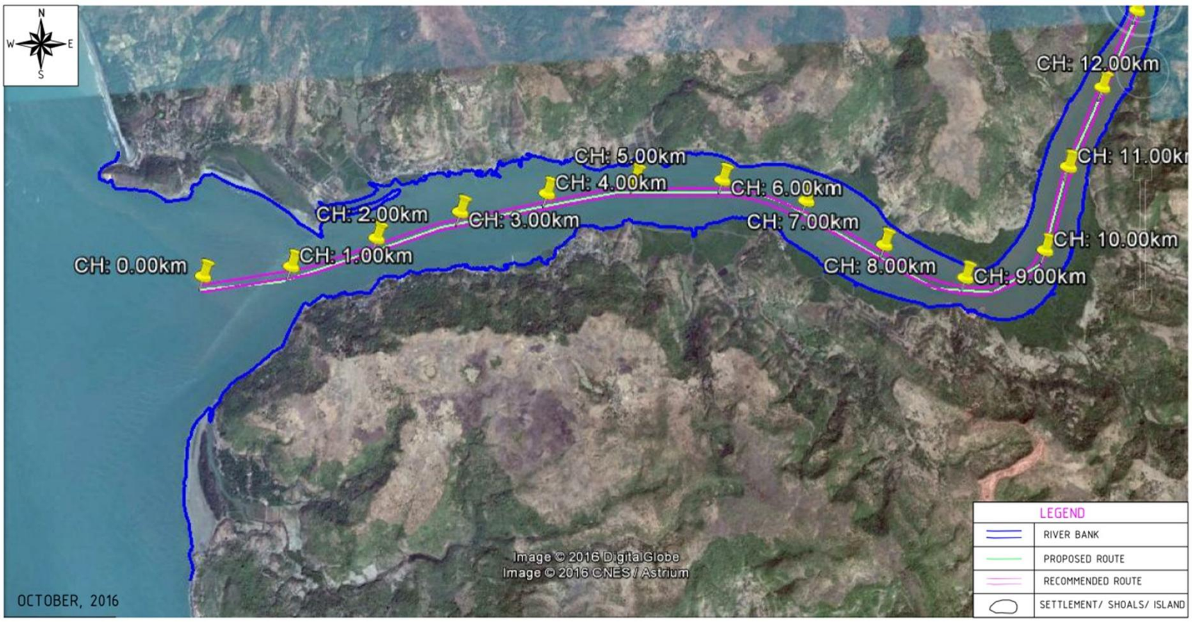


FIGURE 2-5 : River stretch from Ch 0.00km to 10.00km in October, 2016 (Source: Google Earth)

From the image of November, 2005, it can be seen that there is minor effect accretion throughout the stretch. Comparing all the four figures, it is observed that there is erosion of right bank near the mouth at Ch 1.00 km. It is also seen that there has been some deposition along both the banks up to Ch 6.00 km from 2005 to 2013. However from 2013 to 2016, there is erosion from both banks in the same region.

The river flows through a wide bend at Ch 9.00 km.

Savitri River (Ch 11.00 km - Ch 20.00 km)

The satellite images for the stretch of next 10 km for four time periods have been placed (November, 2005, April, 2011, November, 2013 and November, 2016).

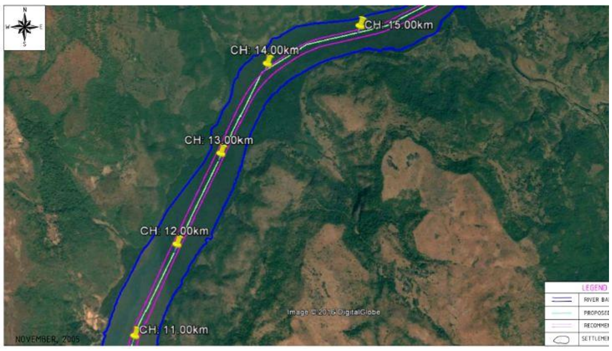


FIGURE 2-6: River stretch from Ch 11.00km to 15.00km in November, 2005 (Source: Google Earth)

FIGURE 2-7: River stretch from Ch 11.00km to 15.00km in April, 2011 (Source: Google Earth)

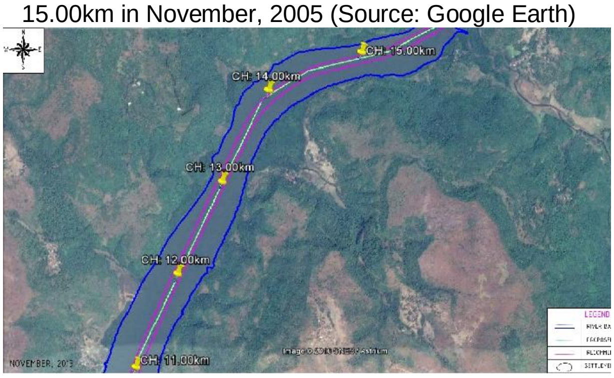


FIGURE 2-8: River stretch from Ch 11.00km to 15.00km in November, 2013 (Source: Google Earth)

FIGURE 2-9: River stretch from Ch 11.00km to 15.00km in November, 2016 (Source: Google Earth)

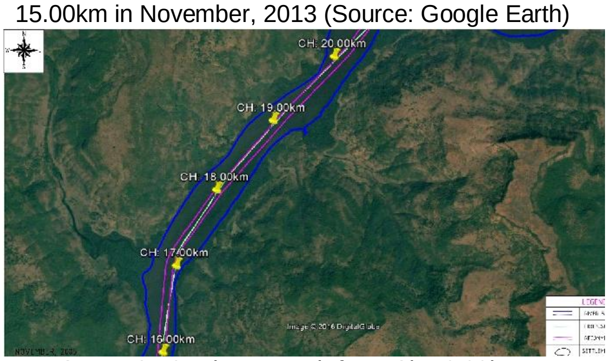


FIGURE 2-10: River stretch from Ch 16.00km to 20.00km in November, 2005 (Source: Google Earth)

FIGURE 2-11: River stretch from Ch 16.00km to 20.00km in April, 2011 (Source: Google Earth)

FIGURE 2-12: River stretch from Ch 16.00km to 20.00km in November, 2013 (Source: Google Earth)

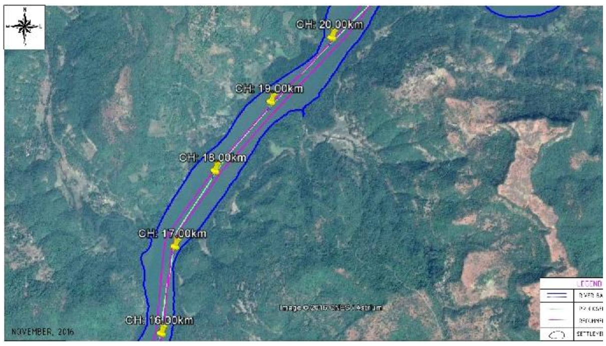


FIGURE 2-13: River stretch from Ch 16.00km to 20.00km in November, 2016 (Source: Google Earth)

From the image of November, 2005, it can be seen that there is minor effect accretion up to Ch 12.00 km.

There are no other significant changes in the stretch.

Savitri River (Ch 21.00 km - Ch 30.00 km)

The satellite image for the stretch of last 10 km for four time periods has been (February, 2004, April, 2011, November, 2013 and November, 2016).

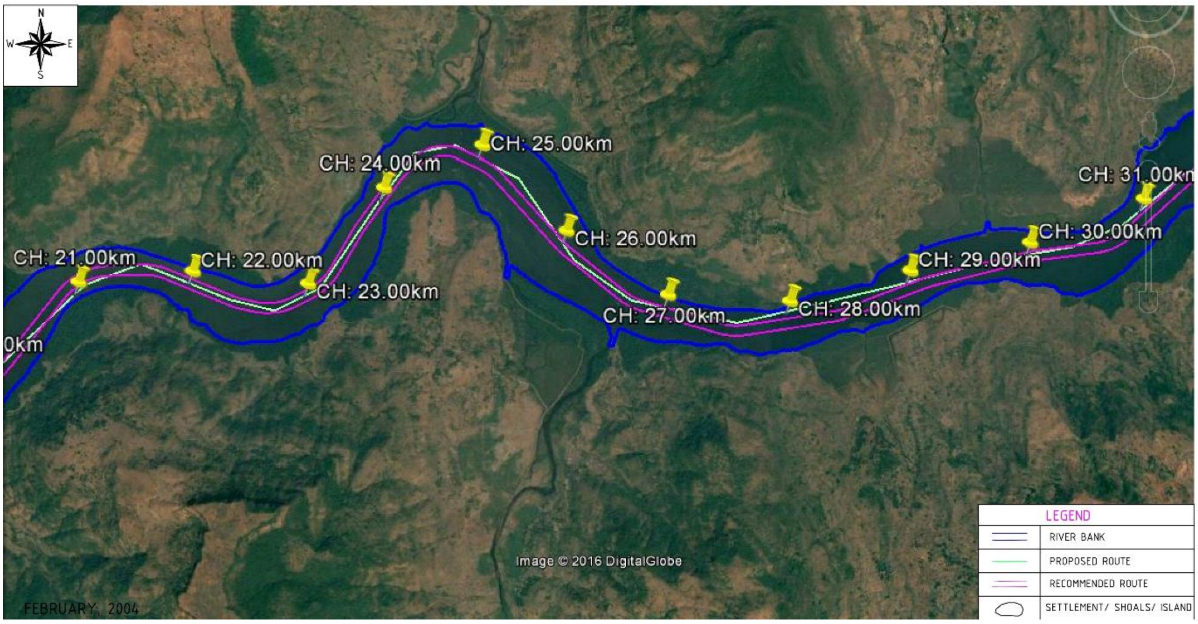


FIGURE 2-14 : River stretch from Ch 21.00km to 30.00km in February, 2004 (Source: Google Earth)

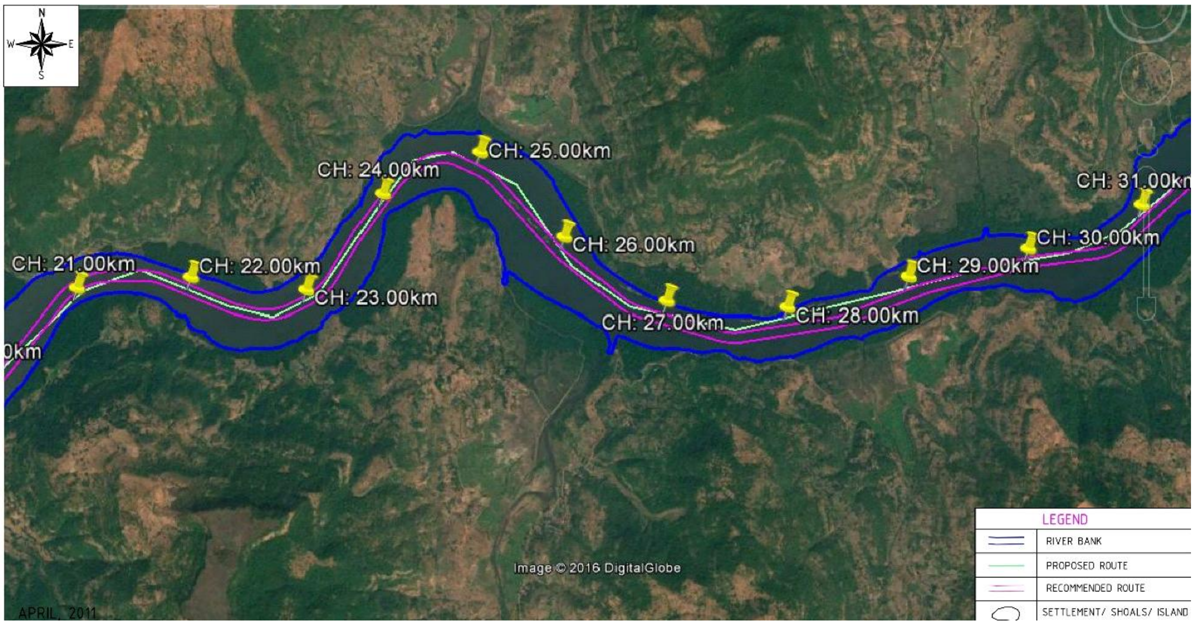


FIGURE 2-15 : River stretch from Ch 21.00km to 30.00km in April, 2011 (Source: Google Earth)

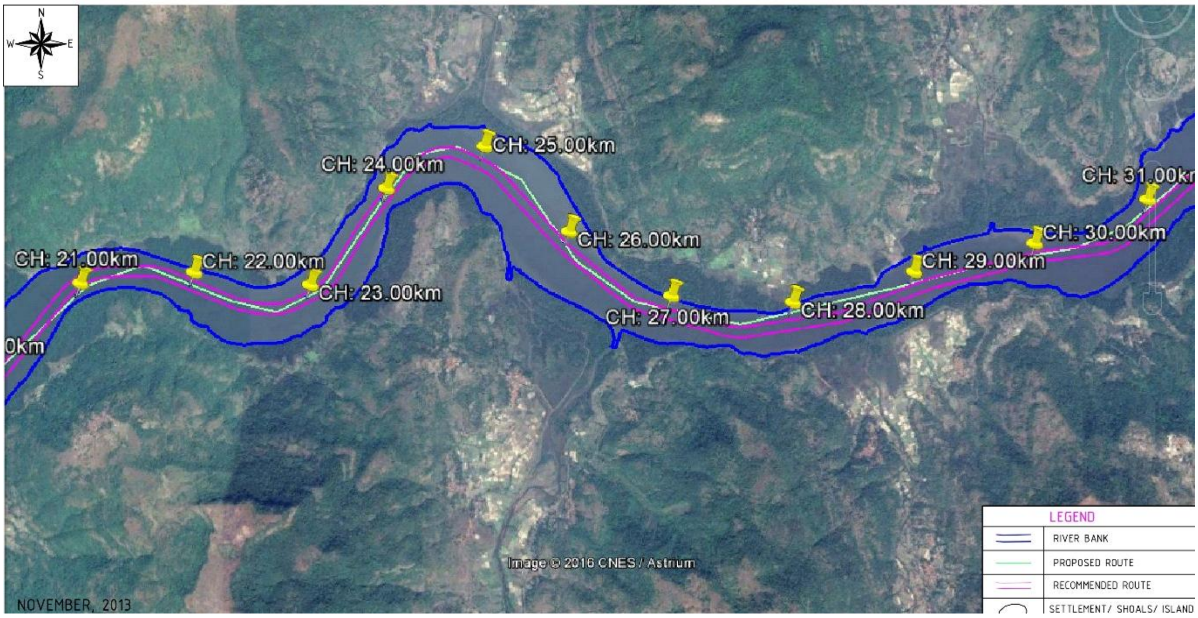


FIGURE 2-16 : River stretch from Ch 21.00km to 30.00km in November, 2013 (Source: Google Earth)

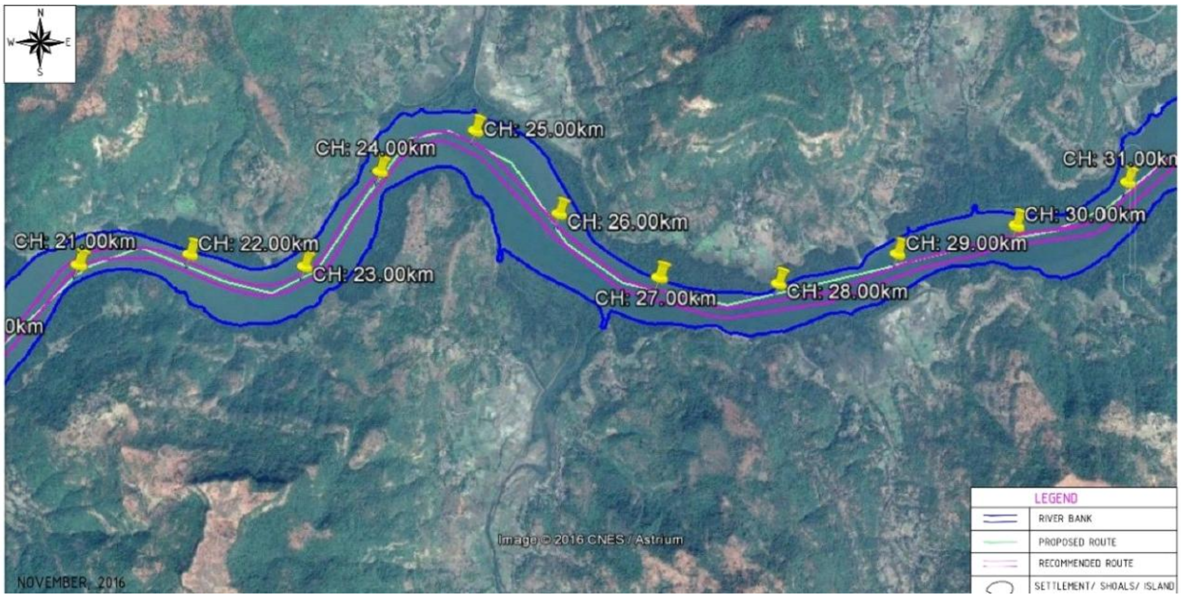


FIGURE 2-17 : River stretch from Ch 21.00km to 30.00km in November, 2016 (Source: Google Earth)

From the image of November, 2013, it is seen that there is minor effect of accretion on the left bank between Ch 23.00 km and Ch 24.00 km, on both the banks near Ch 26.00 km and on the right bank near Ch 30.00 km.

A tributary joins at the left bank near Ch 27.00 km. The river flows through a wide bend near Ch 22.00 km and Ch 24.00 km.

Savitri River (Ch 31.00 km - Ch 40.00 km)

The satellite image for the stretch of last 10 km for four time periods has been (February, 2004, April, 2011, November, 2013 and November, 2016).

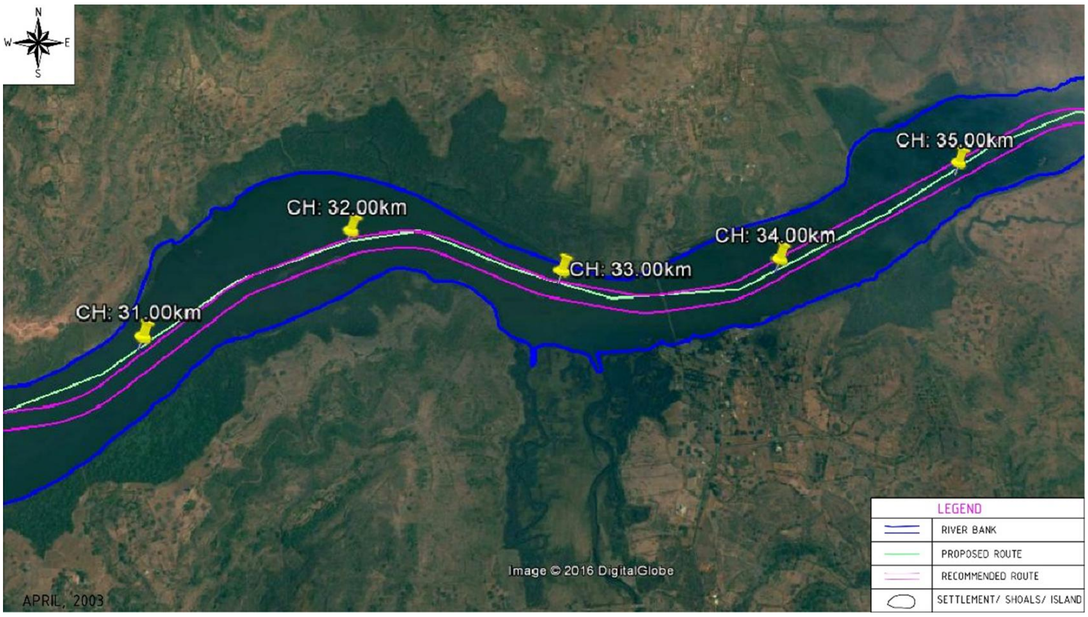


FIGURE 2-18 : River stretch from Ch 31.00km to 35.00km in April, 2003 (Source: Google Earth)

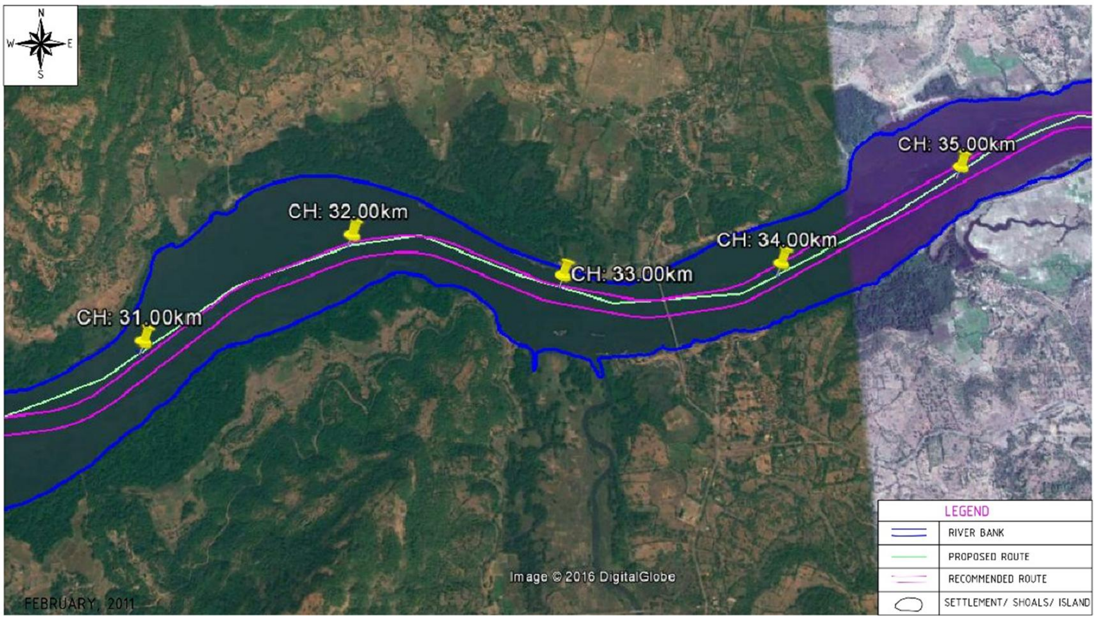


FIGURE 2-19 : River stretch from Ch 31.00km to 35.00km in February, 2011 (Source: Google Earth)

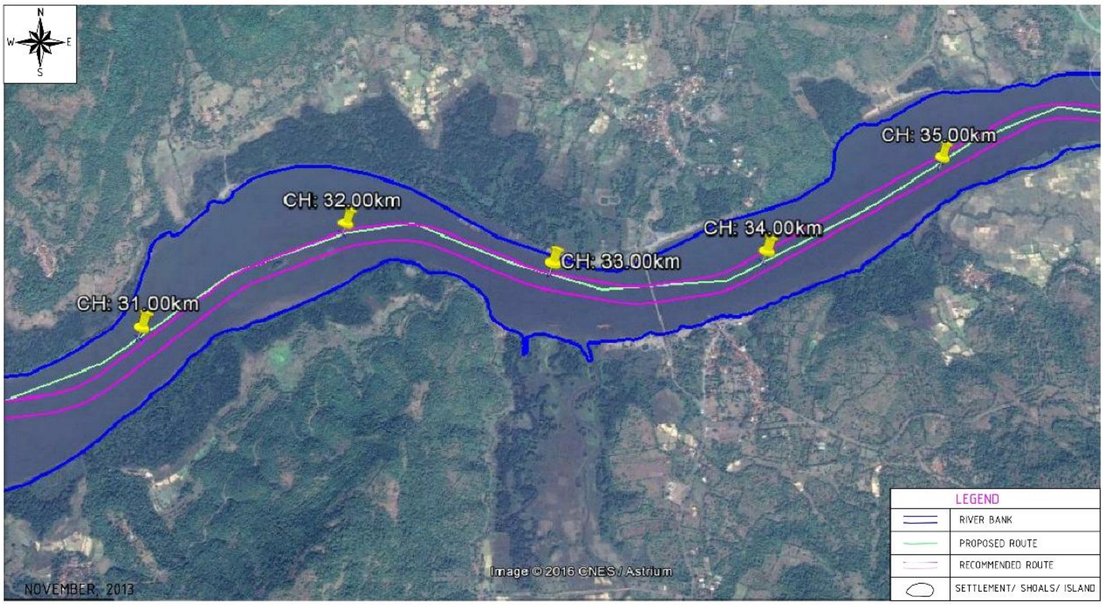


FIGURE 2-20 : River stretch from Ch 31.00km to 35.00km in November, 2013 (Source: Google Earth)

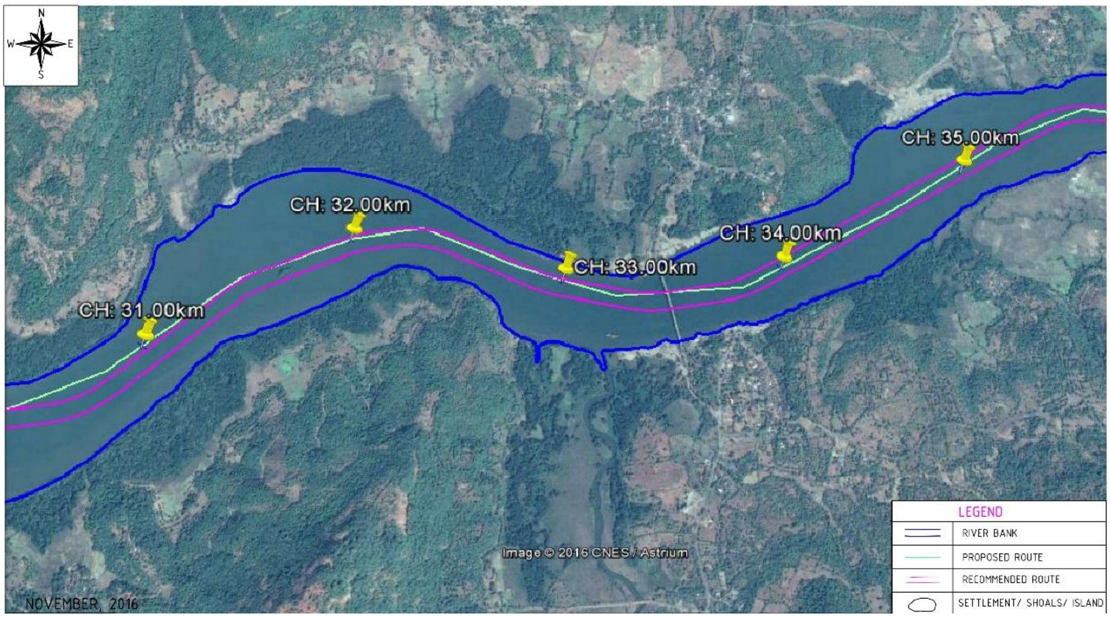


FIGURE 2-21 : River stretch from Ch 31.00km to 35.00km in November, 2016 (Source: Google Earth)

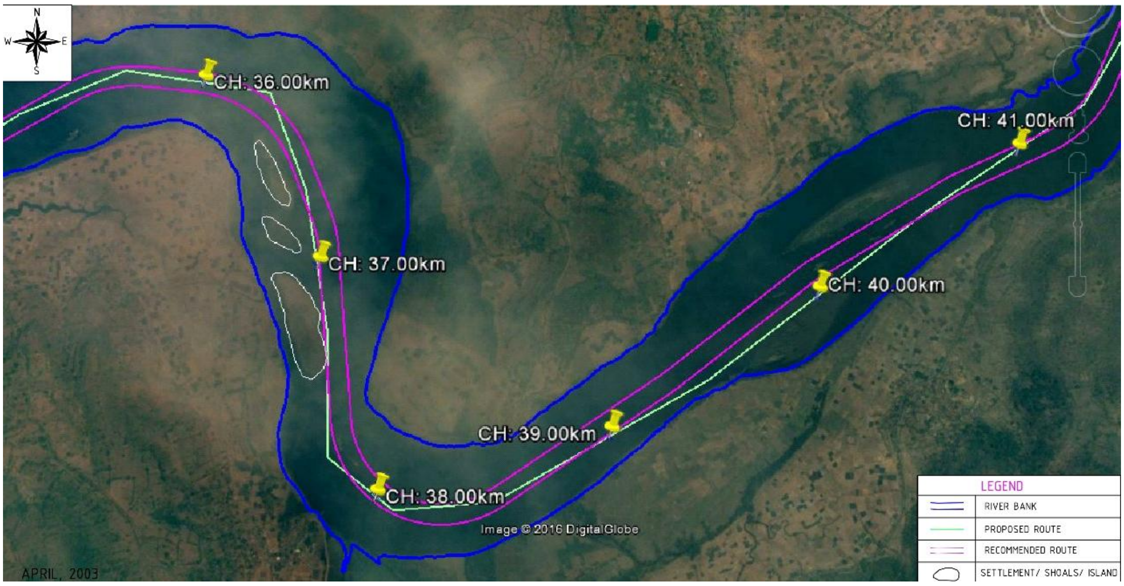


FIGURE 2-22 : River stretch from Ch 36.00km to 40.00km in April, 2003 (Source: Google Earth)

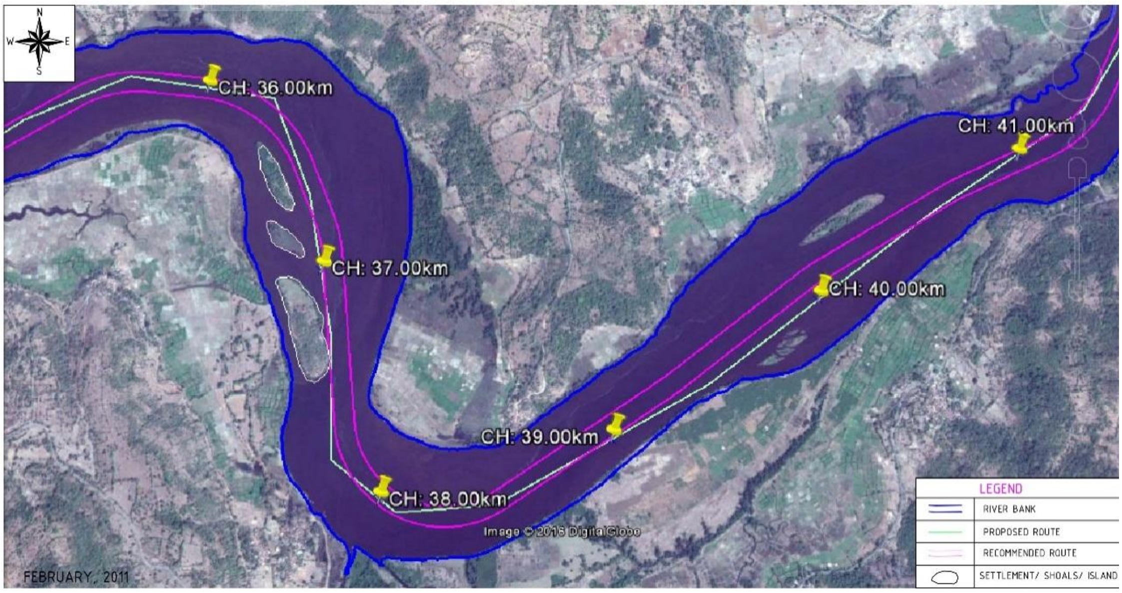


FIGURE 2-23 : River stretch from Ch 36.00km to 40.00km in February, 2011 (Source: Google Earth)

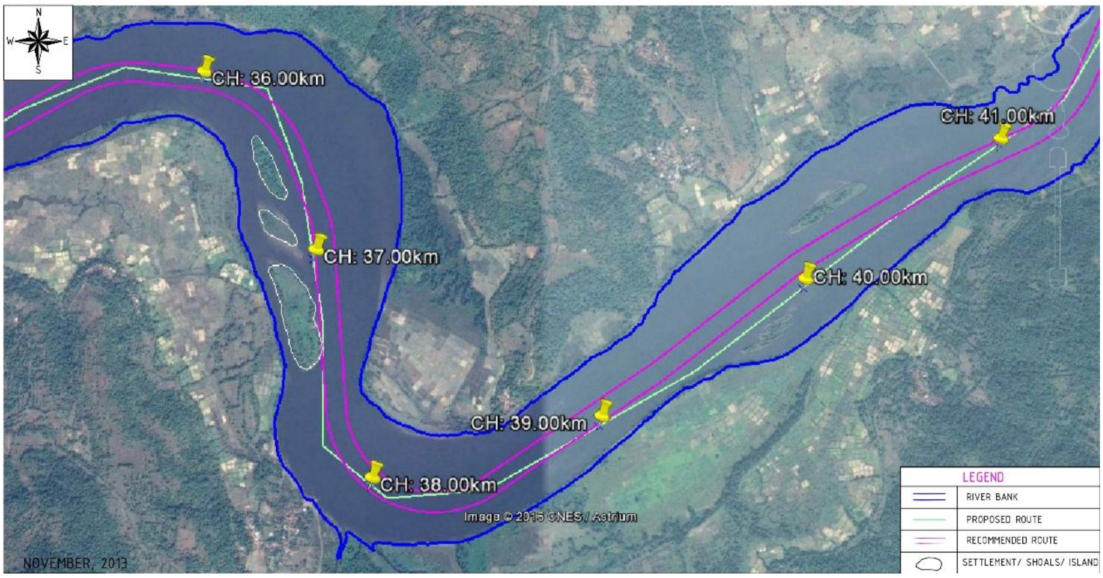


FIGURE 2-24 : River stretch from Ch 36.00km to 40.00km in November, 2013 (Source: Google Earth)

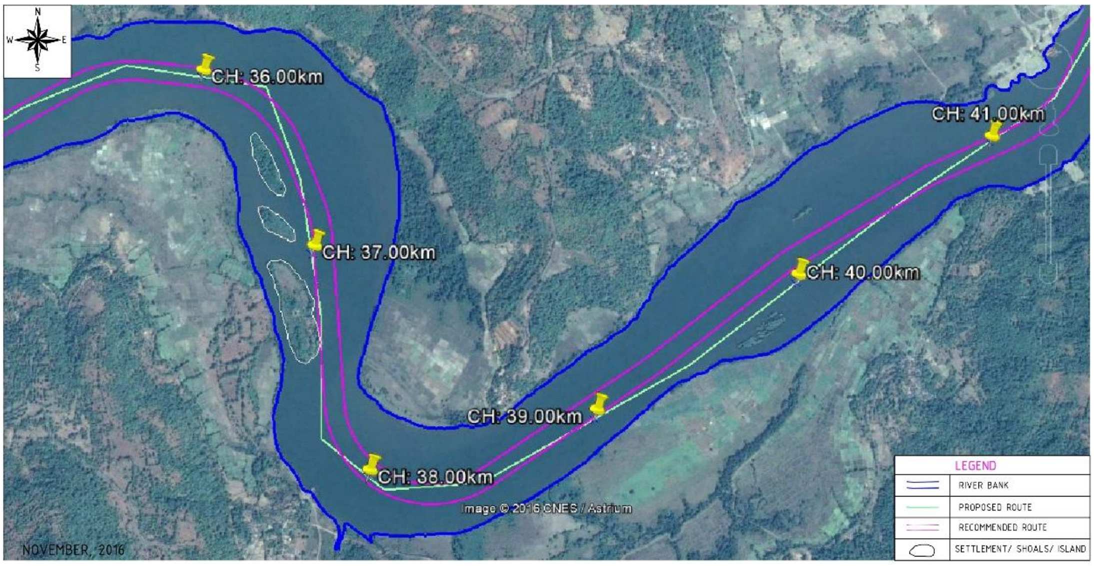


FIGURE 2-25 : River stretch from Ch 36.00km to 40.00km in November, 2016 (Source: Google Earth)

Three shoals are present near the left bank near Ch 37.00 km. Slight migration of the shoals are observed towards the left bank from April, 2003 to November, 2013. Two big shoals are observed near Ch 40.00 km in April, 2003. However the size of the shoals decreases drastically in February, 2011. In November, 2016 the size become insignificant. This suggests either submergence or erosion of shoals.

There is minor effect of accretion on left bank of the river between Ch 31.00 km and Ch 32.00 km and similarly between Ch 34.00 km and Ch 35.00 km.

From all the four figures, a bridge is noted between Ch 33.00 km and Ch 34.00 km.

A tributary join the river from left bank near Ch 33.00 km. The river flows through a wide bend near Ch 38.00 km.

Savitri River (Ch 41.00 km - Ch 45.47 km)

The satellite image for the stretch of last 5.47 km for four time periods has been (February, 2011, April, 2011, November, 2013 and November, 2016).

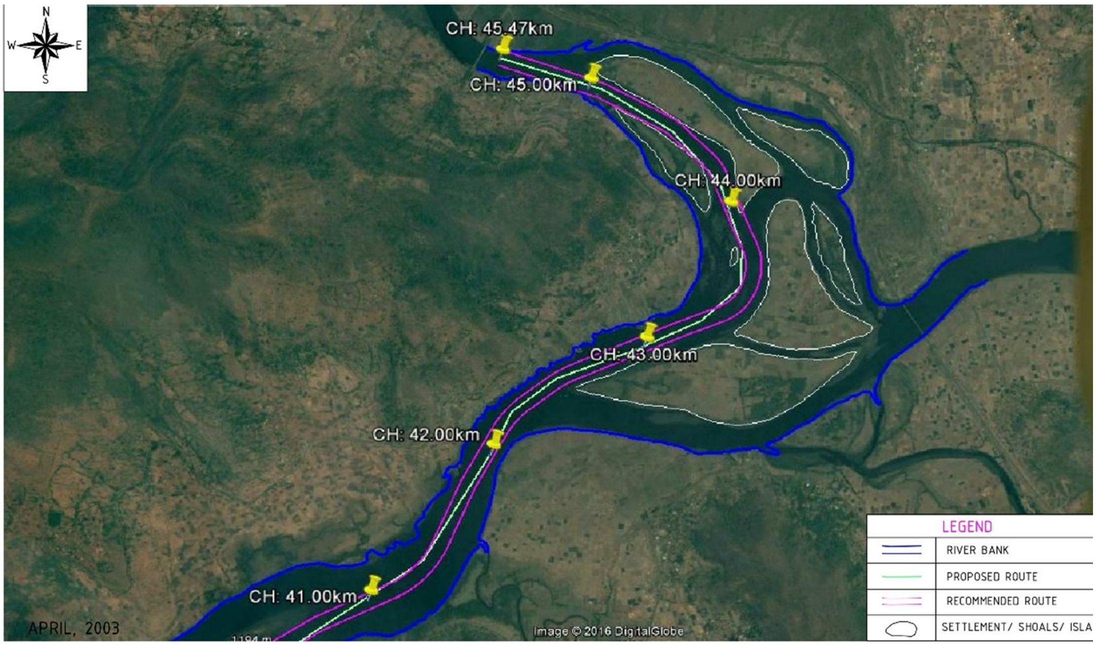


FIGURE 2-26 : River stretch from Ch 41.00km to 45.47km in April, 2003 (Source: Google Earth)

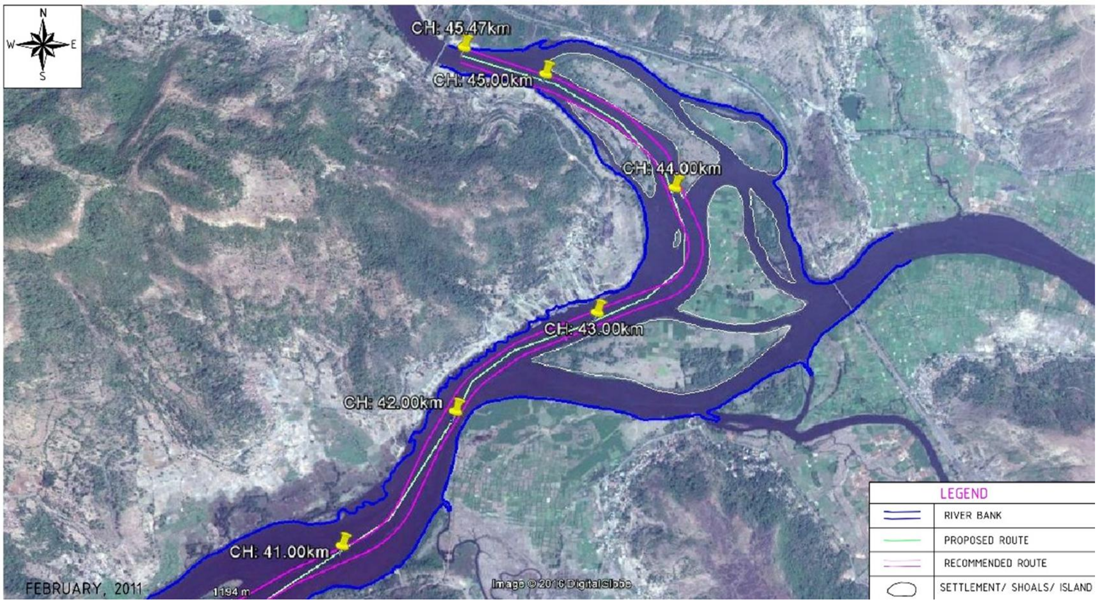


FIGURE 2-27 : River stretch from Ch 41.00km to 45.47km in February, 2011 (Source: Google Earth)

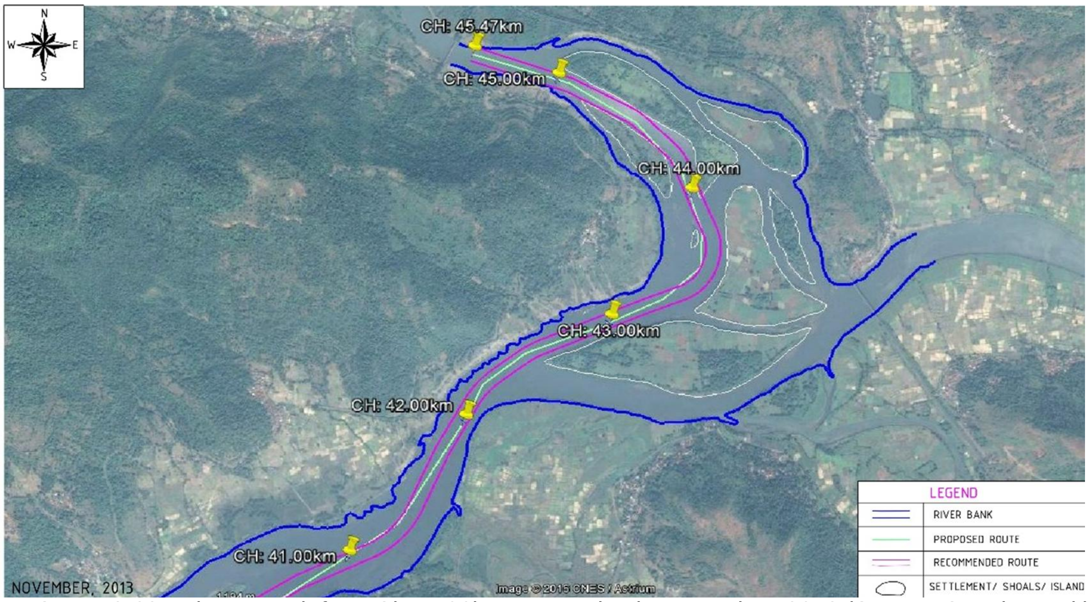


FIGURE 2-28 : River stretch from Ch 41.00km to 45.47km in November, 2013 (Source: Google Earth)

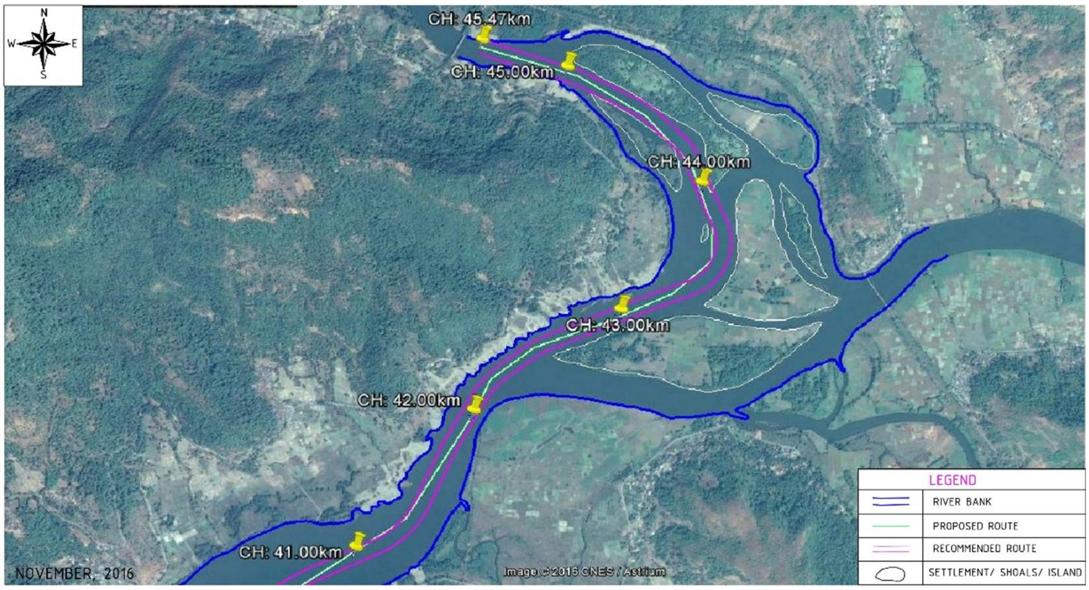


FIGURE 2-29 : River stretch from Ch 41.00km to 45.47km in November, 2016 (Source: Google Earth)

From al the four figures, six shoals, of which three shoals have some settlement, are observed between Ch 43.00 km and Ch 45.00 km. The relative positions of the islands and settlement of soil remains same with negligible migration. With presence of these settlements the width of river decreases between Ch 44.00 km and Ch 45.00 km.

Two tributaries join the river from left bank between Ch 41.00 km and Ch 43.00 km.

Conclusion

From Ch 0.00 km to Ch 45.47 km, a total of nine shoals are present which were found to have negligible migration in duration of recent five years, i.e., February, 2011 to November, 2016. Only 416.15cum dredging is required upto Ch 42.00 km and between Ch 42.00 km to Ch 45.47 km, dredging of 2.63 lakh cu.m is required. Four tributaries are found in the entire study stretch.

2.1.2. Existing Hydrological / Topographical Reference levels

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

TBM no.	Location	Chainage (KM)	Latitude (N) Longitude (E)	Easting (m) Northing (m)	BM Height above MSL (m)	BM Height above SD (m)
SAV-1	Bankot	1.17	17°58'53.2530"N 073°02'55.2173"E	293373.119 E 1989220.768N	3.428	5.388
SAV-2	Adi Mahad	10.13	17°59'30.5389"N 073°07'07.2380"E	300799.893 E 1990290.557 N	2.525	4.421
SAV-3	Panglol	20.25	18°03'40.3440"N 073°10'24.0343"E	306665.476 E 1997912.940 N	3.840	5.247
SAV- 4	Ambet	33.21	18°04'07.0255"N 073°16'38.8209"E	317694.696 E 1998627.362 N	2.474	3.830
SAV- 5	Tol Phata	45.470	18°05'51.8178"N 073°20'06.6885"E	323836.178 E 2001792.941 N	2.038	3.302

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

Sl.No.	Location	Latitude	Longitude	Z0*(m)
1	Bankot	17°58'48''	73°03'08''	-1.960

**- 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 at Ch 10.13km

Transfer of Sounding Datum											**H- 533**	
For Semi - Diurnal Tides												
Date and Time of 1st LW Observation at Established Gauge = 29.01.2017, 19.00hrs												
	Position of Established Gauge	Lat	17°58'53.2026"N				Position of Established Gauge		Lat		17°59'30.3371"N	
		Long	073°02'55.441"E						Long		073°07'07.421"E	
		Name	Bankot, TP-1						Name		Adi Mahad, TP-2	
	At Established Gauge @ 1.17km						At New Gauge @ 10.13km					
	Height Above CD				Contribution for		Height Above zero of Tide Gauge				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.616	x	1		0.62	-	0.474	x	1		0.47
b	3.616	-	x	1	3.62		3.550	-	x	1	3.55	
c	-	1.286	x	3		3.86	-	1.140	x	3		3.42
d	3.246	-	x	2	6.49		3.193	-	x	2	6.386	
e	-	0.716	x	3		2.15	-	0.600	x	3		1.80
f	3.606	-	x	1	3.61		3.570	-	x	1	3.57	
g	-	1.146	x	1		1.15	-	1.030	x	1		1.03
	Sum of Contribution				13.71	7.77	Sum of Contribution				13.506	6.72
	Observed M. H.W.				3.43		Observed M.H.W.				3.3765	
	Observed M.L.W.					0.97	Observed M.L.W.					0.84
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.46	Observed Mean Range = r				=	2.536
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.20	Observed Mean Level = m'				=	2.1085
	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						(B) Where 'True Spring M.L (M)' at					
	Established gauge is known						Established gauge is not known					
	From A.T.T (Table V of Part II)											
	MHWS		=									
	MLWS		=									
	True Spring M.L. (M)		=		0.00							
	Note : True Spring M.L. (M) = (MHWS + MLWS)/2											
	SD =	m' (M'-M) - M*(r/R)					SD =	m'-((M*r)/R)				
	SD =	0.00 m above of Zero of Gauge					SD =	-0.162 m below Zero of Gauge				

TABLE 2-4: Details of Chart Datum Used for Data Reduction at Ch 20.25km

Transfer of Sounding Datum	H- 533

For Semi - Diurnal Tides

Date and Time of 1st LW Observation at Established Gauge = 29.01.2017, 19.00hrs

Position of Established Gauge			Position of Established Gauge		
	Lat	17°58'53.2026"N		Lat	18°03'39.8544"N
	Long	073°02'55.441"E		Long	073°10'24.548"E
	Name	Bankot, TP-1		Name	Pangalol, TP-3

	At Established Gauge @ 1.17km						At New Gauge @ 20.25km					
	Height Above CD				Contribution for		Height Above zero of Tide Gauge				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.616	x	1		0.62	-	0.070	x	1		0.07
b	3.616	-	x	1	3.62		3.220	-	x	1	3.22	
c	-	1.286	x	3		3.86	-	0.700	x	3		2.10
d	3.246	-	x	2	6.49		2.870	-	x	2	5.74	
e	-	0.716	x	3		2.15	-	0.190	x	3		0.57
f	3.606	-	x	1	3.61		3.300	-	x	1	3.3	
g	-	1.146	x	1		1.15	-	0.630	x	1		0.63
	Sum of Contribution				13.71	7.77	Sum of Contribution				12.26	3.37
	Observed M. H.W.				3.43		Observed M.H.W.				3.065	
	Observed M.L.W.					0.97	Observed M.L.W.					0.42

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

Observed MLW = Sum of Contribution of LW / 8

Observed Mean Range = R	=	2.46	Observed Mean Range = r	=	2.64375
R = M.H.W. - M.L.W.			r = M.H.W. - M.L.W.		
Observed Mean Level = M'	=	2.20	Observed Mean Level = m'	=	1.743125
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 =	-0.623 m below of Zero of Gauge

TABLE 2-5: Details of Chart Datum Used for Data Reduction at Ch 33.216km

Transfer of Sounding Datum	**H- 533**

For Semi - Diurnal Tides

Date and Time of 1st LW Observation at Established Gauge = 29.01.2017, 19.00hrs

Position of Established Gauge			Position of Established Gauge		
	Lat	17°58'53.2026"N		Lat	18°04'06.3721"N
	Long	073°02'55.441"E		Long	073°16'39.084"E
	Name	Bankot, TP-1		Name	Ambet, TP-4

	At Established Gauge @ 1.17km						At New Gauge @ 33.216km					
	Height Above CD				Contribution for		Height Above zero of Tide Gauge				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.616	x	1		0.62	-	0.160	x	1		0.16
b	3.616	-	x	1	3.62		3.153	-	x	1	3.153	
c	-	1.286	x	3		3.86	-	0.650	x	3		1.95
d	3.246	-	x	2	6.49		2.820	-	x	2	5.64	
e	-	0.716	x	3		2.15	-	0.240	x	3		0.72
f	3.606	-	x	1	3.61		3.240	-	x	1	3.24	
g	-	1.146	x	1		1.15	-	0.590	x	1		0.59
	Sum of Contribution				13.71	7.77	Sum of Contribution				12.033	3.42
	Observed M. H.W.				3.43		Observed M.H.W.				3.00825	
	Observed M.L.W.					0.97	Observed M.L.W.					0.43

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.	=	2.46	Observed Mean Range = r r = M.H.W. - M.L.W.	=	2.58075
Observed Mean Level = M' M' = (M.H.W +M.L.W.)/2	=	2.20	Observed Mean Level = m' m' = (M.H.W.+M.L.W.)/2	=	1.717875

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 below of Zero of Gauge	SD =	-0.592 m below Zero of Gauge

TABLE 2-6: Details of Chart Datum Used for Data Reduction at Ch 44.47km

Transfer of Sounding Datum											**H- 533**	
For Semi - Diurnal Tides												
Date and Time of 1st LW Observation at Established Gauge = 29.01.2017, 19.00hrs												
	Position of Established Gauge		Lat	17°58'53.2026"N			Position of Established Gauge		Lat		18°05'51.8303"N	
			Long	073°02'55.441"E					Long		073°20'08.060"E	
			Name	Bankot, TP-1					Name		Tol Phata, TP-5	
	At Established Gauge @ 1.17km						At New Gauge @ 45.47KM					
	Height Above CD				Contribution for		Height Above zero of Tide Gauge				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.616	x	1		0.62	-	0.060	x	1		0.06
b	3.616	-	x	1	3.62		3.180	-	x	1	3.18	
c	-	1.286	x	3		3.86	-	0.460	x	3		1.38
d	3.246	-	x	2	6.49		2.840	-	x	2	5.68	
e	-	0.716	x	3		2.15	-	0.130	x	3		0.39
f	3.606	-	x	1	3.61		3.380	-	x	1	3.38	
g	-	1.146	x	1		1.15	-	0.390	x	1		0.39
	Sum of Contribution				13.71	7.77	Sum of Contribution				12.24	2.22
	Observed M. H.W.				3.43		Observed M.H.W.				3.06	
	Observed M.L.W.					0.97	Observed M.L.W.					0.28
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.46	Observed Mean Range = r				=	2.7825
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.20	Observed Mean Level = m'				=	1.66875
	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 below of Zero of Gauge				SD =	-0.822 m below Zero of Gauge				

2.2. Existing Waterway Structures

2.2.1. Bridges

The details of Bridges crossing the Savitri River are given in the Table below. The bridges do not require any modification.

TABLE 2-7: Details of cross structures

*MHWS (4.42m) as per Mumbai Port

Sl.No	Structure Name	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS *(m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank **Right Bank**	**Left Bank** **Right Bank**					
1	Road Bridge	0.60	RCC	Bankot	Left Bank 17°59'7.05"N 73° 2'31.27"E Right Bank 17°58'45.06N 72°02'32.33"E	Left Bank 292672.99 m E 1989652.41mN Right Bank 292697.00 mE 1988976.00mN	-	-	-	-	Under construction
2	Road bridge	33.21	RCC	Mharpal	Left Bank: 18°04'07.80N 73°16'39.27E Right Bank: 18° 3'51.85"N 73°16'43.19"E	Left Bank: 317708.00 m E 1998651.00mN Right Bank: 317818.95mE 1998159.64mN	500	6	50	9.0	Operational
3	Road Bridge	45.475	RCC	Toll Phata (Dabhol)	Left Bank 18°05'51.41N 73°20'07.48E Right Bank: 18°05'55.64N 73°20'9.84"E	Left Bank 323859.4mE 2001780.1mN Right Bank: 323929.89mE 2001909.73 mN	150	5	30	6.5	Operational

2.2.2. Electric Lines / Communication Lines

The details of Electric lines/ Communication lines crossing the Savitri 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 all the HT line after Ch 41.97km may need modification. The support base of these HT line will have to be raised by 8.5 m to 14.5 m to get the required clearance.

TABLE 2-8: Details of High Tension Lines

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
1	HTL	41.97	Jui (Dabhol) savitri river	Left Bank: 18°05'2.69"N 73°20'04.79"E Right Bank: 18°04'43.95"N 73°20513.77"E	Left Bank: 323766.69mE 2000283.07mN Right Bank: 324025.53mE 1999704.70mN	2	625	10.5	Complete
2	HTL	42.125	Jui (Dabhol) savitri river	Left Bank: 18°05'4.21"N 73°20'06.99"E Right Bank: 18° 4'47.86"N 73°20'18.06"E	Left Bank: 323831.97mE 2000329.13mN Right Bank: 324152.79mE 1999823.72mN	2	595	10.5	Complete
3	EL	45.475	Toll Phata	Left Bank 18°05'51.41"N 73° 20'07.48"E Right Bank 18°05'55.64"N 73°20'9.84"E	Left Bank 2001780.1mN 323859.4mE Right Bank 2001909.73 mN 323929.89mE	2	195	4.5	Complete

2.2.3. Pipe Lines / Cables

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

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

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

2.2.5. Bends

On the proposed waterway route, there are many bends in Savitri River, which are given in the Table below.

TABLE 2-9: River Bend Radius in Savitri River

Sr. No.	Chainage (Km)	Radius
1.	4.00	8150.00
2.	6.60	2322.00
3.	9.50	562.00
4.	14.50	714.00
5.	21.00	979.00
6.	22.00	650.00
7.	23.25	794.00
8.	24.20	436.00
9.	25.80	1542.00
10.	29.81	627.00
11.	30.29	629.00
12.	31.50	465.00
13.	32.25	272.00
14.	33.00	173.00
15.	35.80	812.00
16.	36.80	2402.00
17.	38.00	222.00
18.	43.50	598.00

2.3. Velocity and Discharge Details

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

TABLE 2-10: Current meter deployment locations and discharge details

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
1	1.17	17°59'04.5087"N 073°02'50.6093"E	293241.18 1989568.27	2.9	1.45	0.827	3671.71	3036.50
2	10.13	17°59'26.0029"N 073°07'15.3694"E	301037.71 1990148.67	3.7	1.85	0.812	2907.05	2360.52

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
3	20.25	18°03'35.0262"N 073°10'26.2208"E	306728.16 1997748.81	6.2	3.1	0.767	2812.21	2156.97
4	33.21	18°04'00.6976"N 073°16'39.7210"E	317719.35 1998432.57	5.8	2.9	0.695	3073.08	2135.79
5	45.47	18°05'53.6745"N 073°20'09.2894"E	323913.16 2001849.33	1.7	0.85	0.591	237.20	140.19

The period of survey is December-January, which is a normal flow condition. As per the statistics collected, the maximum velocity is 3.10m/s and discharge is 3036.5m^3/s at the gauging station at Ch 1.17km near the confluence of the river and the Arabian Sea.

2.4. Waterway description

Savitri River (Ch 0.00km – Ch 15.00km)

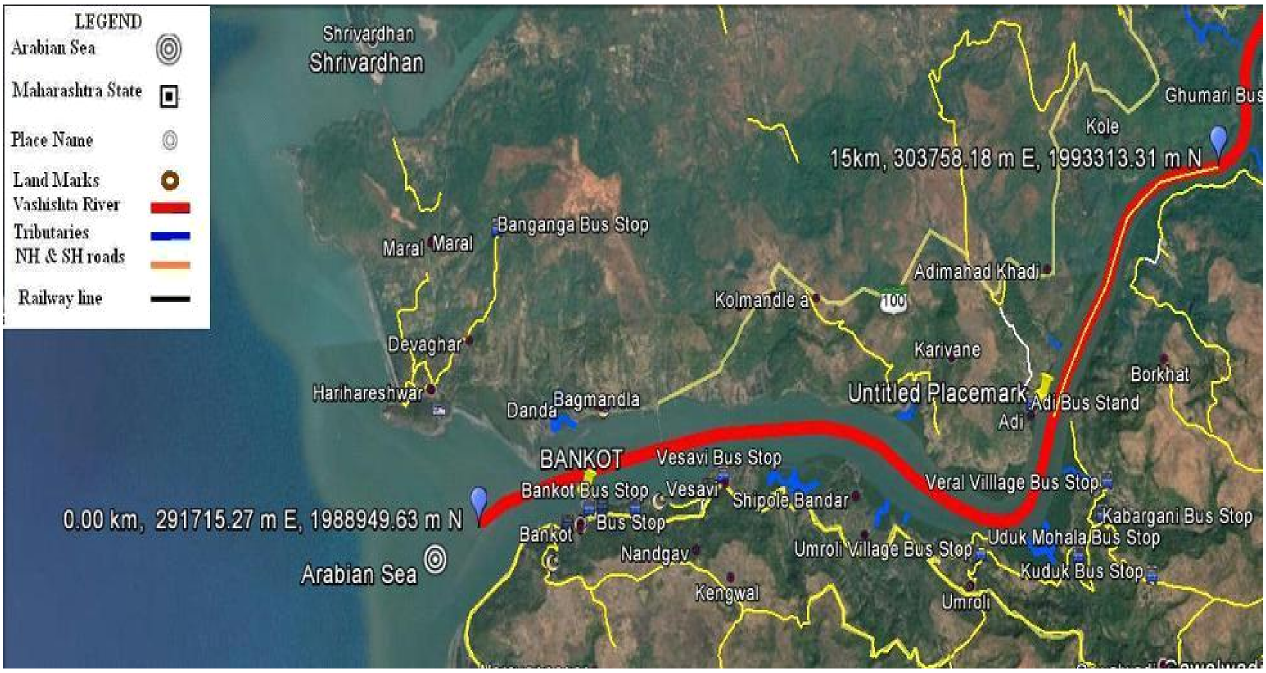


FIGURE 2-30: Savitri River from Ch 0.00km to Ch 15.00km

TABLE 2-11: Reduced depth from Ch 0.00km to Ch 15.00km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty. (cu.m)
From	To	Max	Min			
0.00	1.00	8.7	5.2	0.0	0	0.00
1.00	2.00	4.7	4.3	0.0	0	0.00
2.00	3.00	5.0	4.9	0.0	0	0.00
3.00	4.00	9.1	5.4	0.0	0	0.00
4.00	5.00	16.7	6.6	0.0	0	0.00
5.00	6.00	8.2	6.5	0.0	0	0.00
6.00	7.00	8.5	6.4	0.0	0	0.00
7.00	8.00	16.9	6.8	0.0	0	0.00
8.00	9.00	18.5	6.6	0.0	0	0.00
9.00	10.00	7.5	6.3	0.0	0	0.00
10.00	11.00	7.3	6.3	0.0	0	0.00
11.00	12.00	9.6	5.8	0.0	0	0.00
12.00	13.00	13.0	9.3	0.0	0	0.00
13.00	14.00	12.4	8.9	0.0	0	0.00
14.00	15.00	20.4	10.1	0.0	0	0.00

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). A bridge to Bankot is currently under construction on the North bank at Ch 0.55km. Bankot Jetty is located at Ch 1.12km on the South bank of the river. A fishing jetty is seen at Ch 2.20km. A passenger jetty is located at Ch 2.30km on the North bank. Ferry jetties are found at Ch 2.60km on opposite banks. A passenger ferry operates between these two jetties from Bankot to Bagmagla. Three jetties are found on the South bank at Ch 13.68km, Ch 14.80km and Ch 15.37km. Some agricultural fields are seen on the South bank near Ch 14.90km. No Dam, Barrages, Weirs, Anicut, Locks, no gauge and discharge site as established by Central Water was observed.

Savitri River (Ch 15.00km – Ch 30.00km)

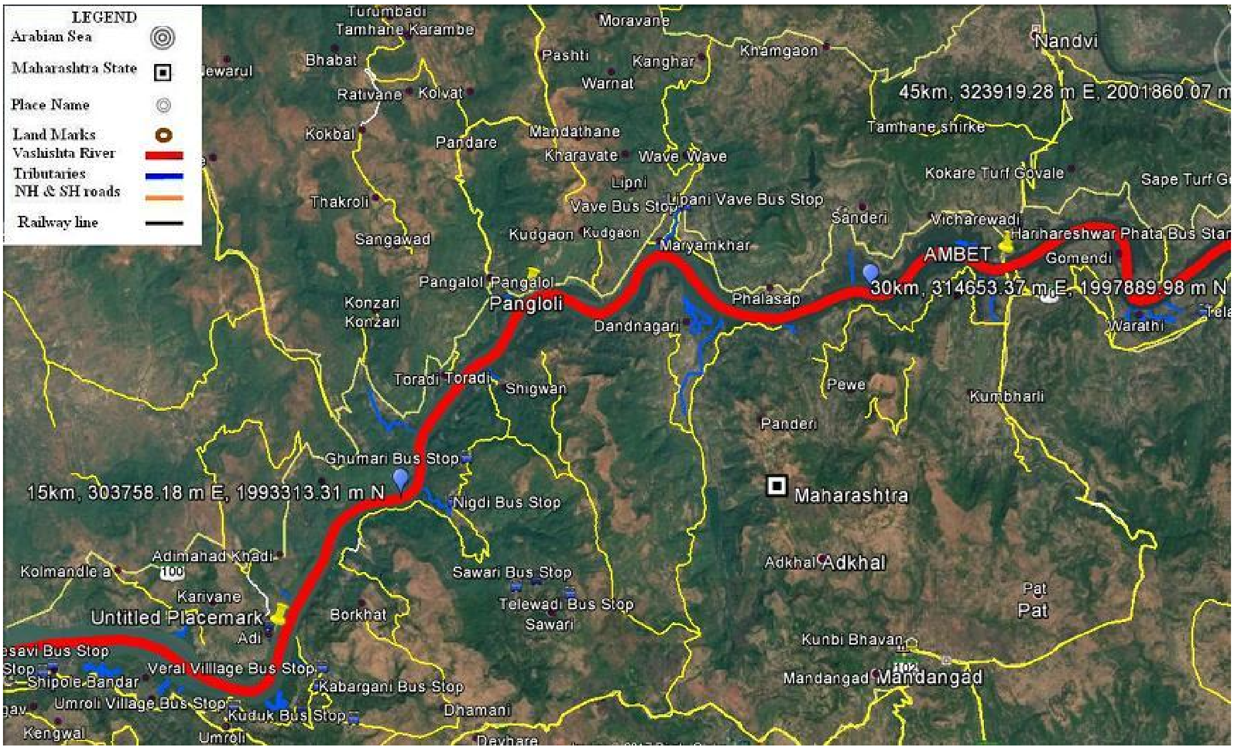


FIGURE 2-31: Savitri River from Ch 15.00km to Ch 30.00km

TABLE 2-12: Reduced depth from Ch 15.00km to Ch 30.00km

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty.(cu.m)
From	To	Max	Min			
15.00	16.00	19.7	13.5	0.0	0	0.00
16.00	17.00	18.2	6.8	0.0	0	0.00
17.00	18.00	10.2	6.7	0.0	0	0.00
18.00	19.00	12.7	8.2	0.0	0	0.00
19.00	20.00	14.7	6.5	0.0	0	0.00
20.00	21.00	12.4	7.6	0.0	0	0.00
21.00	22.00	14.7	6.5	0.0	0	0.00
22.00	23.00	15.9	6.1	0.0	0	0.00
23.00	24.00	18.5	9.0	0.0	0	0.00
24.00	25.00	12.3	9.4	0.0	0	0.00
25.00	26.00	9.8	1.6	150.0	416.15	416.15
26.00	27.00	12.9	9.8	0.0	0	416.15
27.00	28.00	16.1	11.9	0.0	0	416.15
28.00	29.00	16.5	10.1	0.0	0	416.15
29.00	30.00	17.5	8.8	0.0	0	416.15

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). Three jetties are seen in this section. Two are on the East bank at Ch 16.43km & at Ch 18.45km and another one is on the West bank at Ch 17.72km. Two jetties are seen on the North bank at Ch 20.28km and at Ch 23.64km. Five jetties are located in this section of river. One jetty is on Northern bank at Ch 25.74km. Another four are located on the southern bank at Ch 25.20km, Ch 26.14km, Ch 27.46km and Ummberset Fishing Jetty Ch 29.08km. A small tributary meets Savitri River on the North bank at Ch 29.10km. It carries water from the Sanderi Dam from the North. No Dam, Barrages, Weirs, Anicut, Locks, no gauge and discharge site established by Central Water was observed

Savitri River (Ch 30.00km – Ch 45.47km)

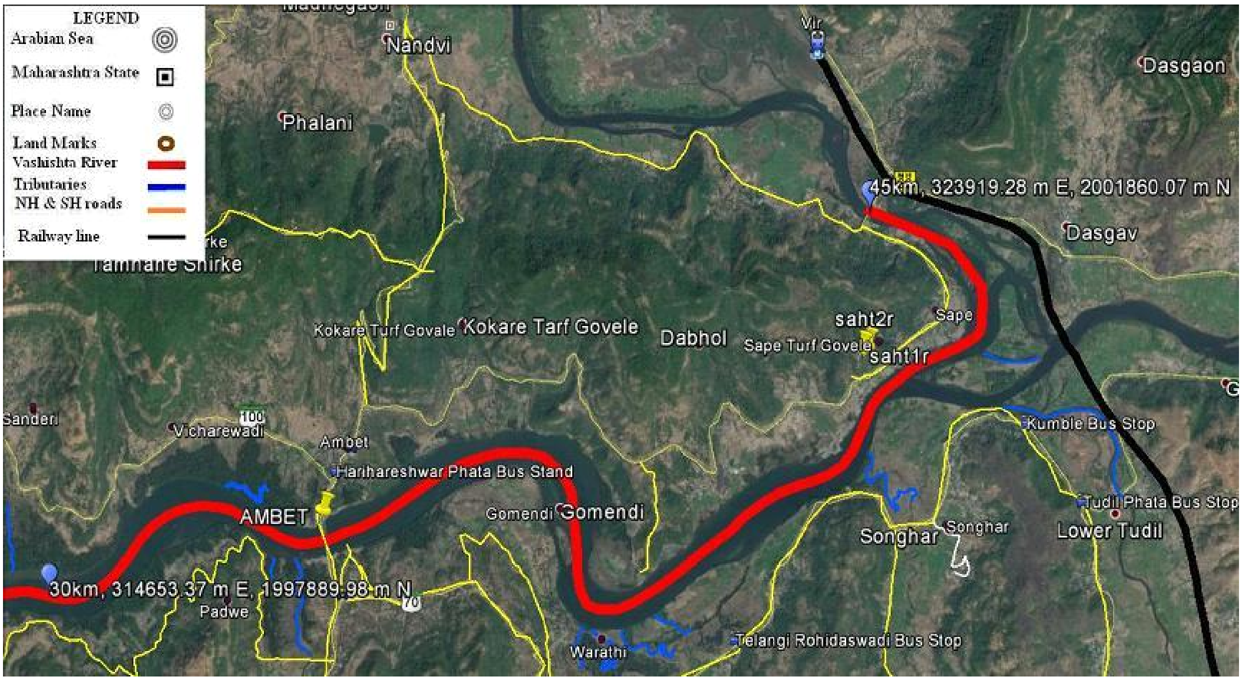


FIGURE 2-32: Savitri River from Ch 30.00km to Ch 45.47km

TABLE 2-13: Reduced depth from Ch 30.00km to Ch 45.47km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty.(cu.m)
From	To	Max	Min			
30.00	31.00	13.1	7.0	0.0	0	0.00
31.00	32.00	12.4	6.8	0.0	0	0.00
32.00	33.00	14.6	10.9	0.0	0	0.00
33.00	34.00	13.1	10.3	0.0	0	0.00
34.00	35.00	12.6	4.9	0.0	0	0.00
35.00	36.00	9.9	5.8	0.0	0	0.00

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Qty.(cu.m)
From	To	Max	Min			
36.00	37.00	11.4	6.2	0.0	0	0.00
37.00	38.00	14.7	6.8	0.0	0	0.00
38.00	39.00	10.5	4.7	0.0	0	0.00
39.00	40.00	10.2	4.3	0.0	0	0.00
40.00	41.00	10.8	3.6	0.0	0	0.00
41.00	42.00	9.2	2.6	0.0	0	0.00
42.00	43.00	3.6	-1.0	800.0	61405.79	61405.79
43.00	44.00	0.0	-2.1	1000.0	149736.9	211142.72
44.00	45.00	3.1	-0.1	1000.0	20423.14	231565.86
45.00	45.47	1.0	-1.3	450.0	30901.77	262467.63

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). Warathi Fishing Jetty is located near the village on the South Bank at Ch 37.90km. Dabhol Fishing Jetty is located on the North bank at Ch 39.85km. Sand dumping yard was observed from Ch 41.70km to Ch 41.90km on the North-West bank of the river. High Tension Line crosses the river bank at Ch 41.97km and Ch 42.125km. Savitri River at Toll Phata Bridge near Sape village (Lat. 18° 05' 54.11"N, Long. 73° 20' 08.81"E) is the end location of National Waterway NW-89. The river segment from Ch 42.70km to the end of the stretch was not approachable. However, the cross-structures, such as bridges, HT lines, which are in the proximity to this stretch, have been referred based on the observations at the site.

2.5. Water and Soil Samples analysis and Results

TABLE 2-14: WATER SAMPLE RESULTS

SAMPLE NO.	LOCATION	Easting	Northing	WATER SAMPLES	
				Sediment concentration (ppm)	pH
SAV-1	Bankot	293241.00	1989568.00	462	7.36
SAV-2	Adi Mahad	301037.71	1990148.67	157	7.48
SAV-3	Pangalol	306728.00	199748.00	190	7.25
SAV-4	Ambet	317719.35	1998432.57	253	7.05
SAV-5	Tol Fata	323913.00	2001849.00	345	7.48

The river water is slightly basic in nature with average pH being 7.32

TABLE 2-15: SOIL SAMPLE RESULTS

SAMPLE NO.	LOCATION	Easting	Northing	Specific Gravity	Grain Size Analysis (%)				Cu	Cc
					Gravel	Sand	Silt	Clay		
SAV-1	Bankot	293241.00	1989568.00	2.57	0	4	69	27	-	-
SAV-2	Adi Mahad	301037.71	1990148.67	2.63	3	38	37	22	-	-
SAV-3	Pangalol	306728.00	199748.00	2.58	0	2	64	34	-	-
SAV-4	Ambet	317719.35	1998432.57	2.67	38	59	3		15.357	1.098
SAV-5	Tol Fata	323913.00	2001849.00	2.65	0	88	6	6	-	-

The river bed is silty clay with sand loam at Bankot, sandy silt with clay at Adi Mahad, silty clay at Pangalol, sandy with gravel at Ambet and sandy at Tol Fata. Thus the river bed can be concluded to be sandy and silty at most parts with and gravel 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 42km from the Fairway point of view.

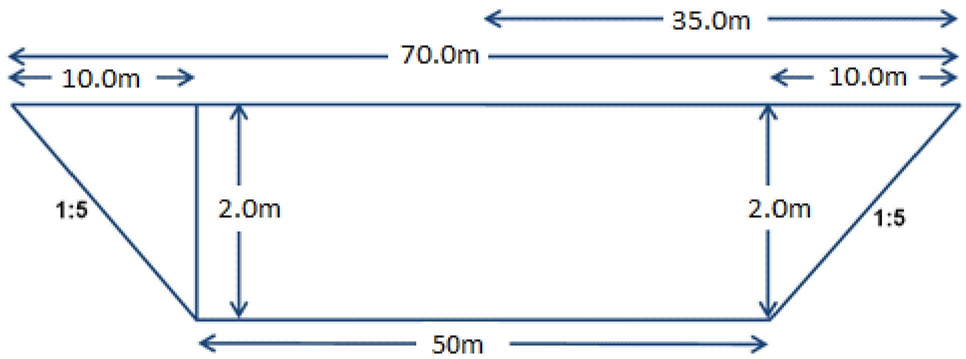
As per the IWT traffic data, the river Savitri is not having any cargo Traffic. However, the end point of the river is having good connectivity with Chemical plants, which are depending on JnPT for all the Raw materials etc., with EXIM operations. This either can be directly operated from / to JnPT or from the mouth of the river (Bankot Port). Hence, the fairway improvements will facilitate the Ro-Ro mobility. The Day / Night navigation may be a boost for such operations with quick turn around time etc.

Accordingly, to meet the estimated traffic volumes of about 67,000 Trucks in FY 20 to 148,000 Trucks in FY 40 and keeping in view the favorable fairway condition, 21 TEU 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 up to the Ch. 45.228 km. The vessel requirement is 70 m (Length) x 12 m (Breadth) x 2.0 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. Modified vessel deployment is suggested to meet the 21 TEU criteria.

With regard to the cross structures in the study stretch, one Bridge is under construction (@ Ch 0.6 km), which is having sufficient clearances maintained, as ascertained. The Bridge @ Ch. 33.21 km is having clearances as 50 m HC and 9 m VC, which are within the Class IV standards for Ro-Ro vessel mobility. Third Bridge is out of the operational area. (@ Ch 45.475 km). 2 HT Lines are present in the operational area, which are having sufficient clearances.

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

In order to meet the mobility of Ro-Ro vessel, the convoy system of Class IV has been concluded. The Ro-Ro vessel of 21 TEU is being planned for which the depth of the channel is being planned with 2.0 m and hence the class IV is more amenable from the fairway point of view, however with depth as 2.0 m. 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.)	Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)
From	To	Max.	Min.		Per km drg	Min.	Max.		Per km drg
0.00	15.00	TIDAL ZONE				4.3	20.4	0	0.00
15.00	30.00					1.6	19.7	150	416.15
30.00	45.47					-2.1	14.7	3250	262467.63
							Total	3400	262883.78

Accordingly, the shoal length is of 3,400 m and the respective Dredging quantity has been taken into consideration for 2.62 Lakh Cu. M. Considering 10 % addition for variation, the same is working out to 2.88 Lakhs Cu. M. 10 % of this quantity is being considered as hard strata. Accordingly, 2.60 Lakhs Cu. M has been considered as General soil and hard strata has been taken as 0.30 Lakhs Cu. M.

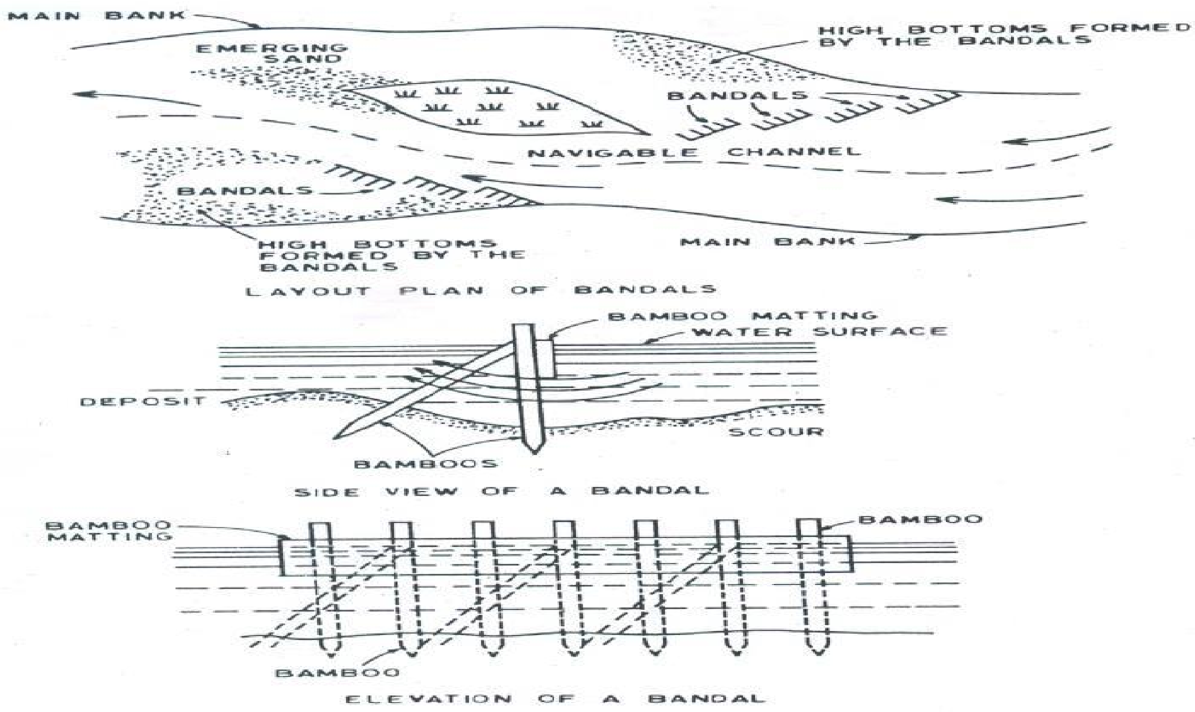
3.3. Proposed Conservancy Activities

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

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

3.3.1. Low Cost structures

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



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

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

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

In the full study stretch, there is a need of dredging the shoal length of about 3,400 m and the respective Dredging quantity of 2.60 Lakhs Cu. M has been considered as General soil and hard strata has been taken as 0.30 Lakhs Cu. M. The general soil may have to be taken up through CSD. Hard soil Dredging 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.

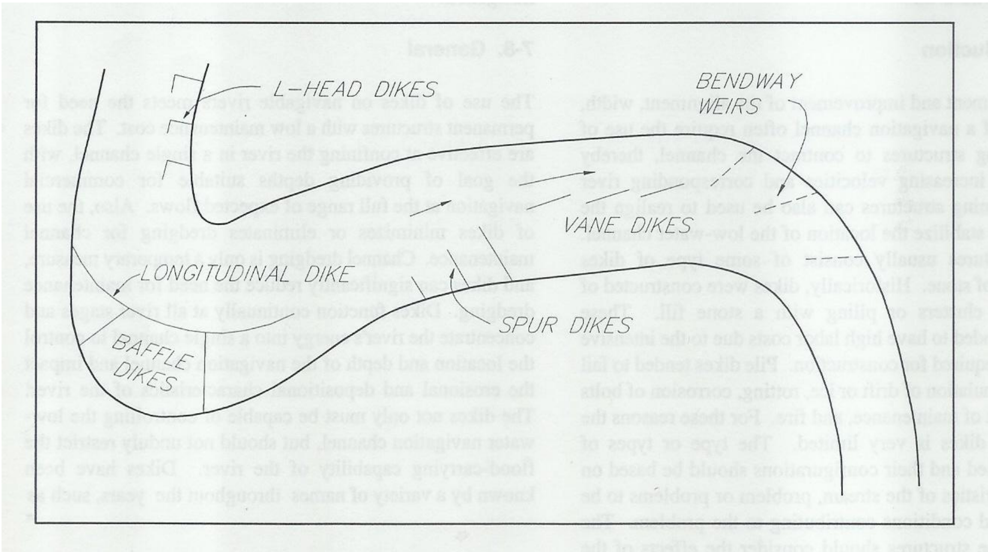


FIGURE 3-1: Types of dike structures

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, as detailed in the Figure.

In wider reaches, it is suggested the provision of spurs with “Gabions with Boulders”. 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.

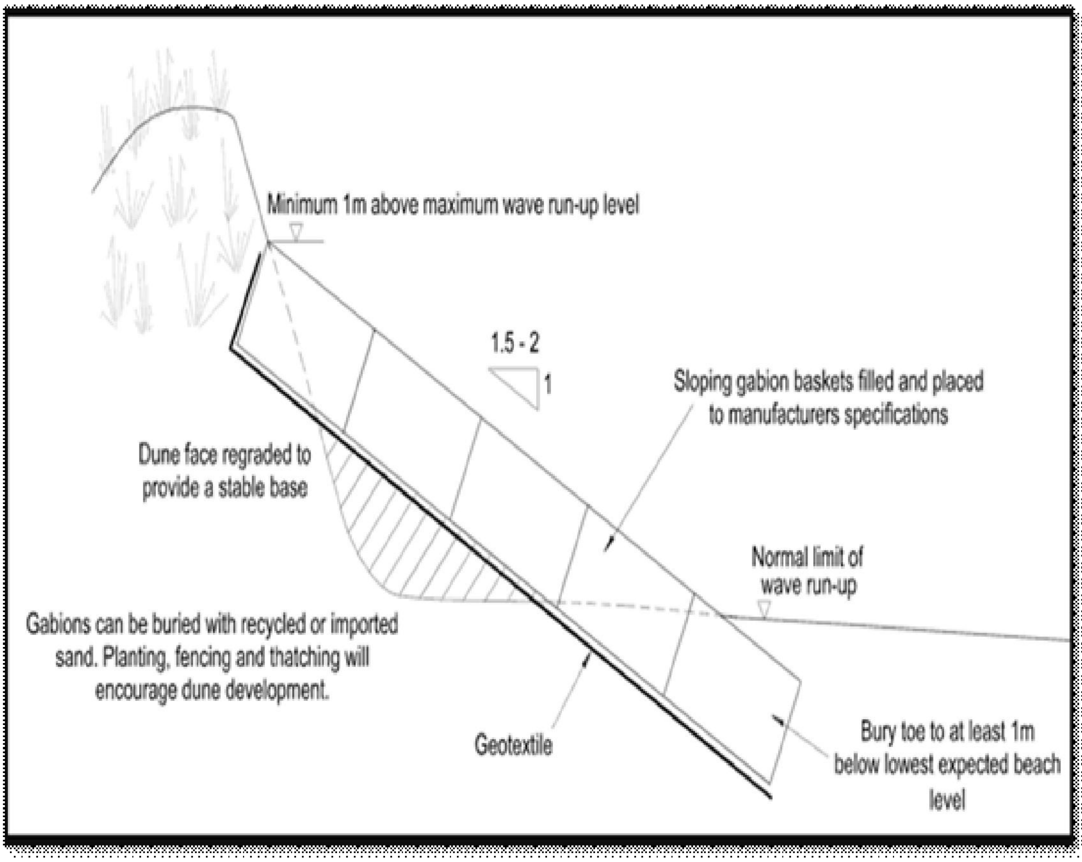
In the study stretch, the least bend radius is 173 (against 800) at Ch 33 km. It is proposed to tackle the Bend problems through Bank Protection. Hence, the River Training work is not suggested.

3.4. Bank Protection / Embankment Strengthening

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

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

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



It has been proposed to consider the Bank Protection in the vulnerable locations. In the study stretch, 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, especially in Bends.

Keeping in view the above phenomenon, a provision of 4000 m has been catered. A length of 500 m is suggested at locations of Ch. 9.5 km; Ch. 22 km; Ch. 24.2 km; Ch. 30.05 km and 2000 m length between Ch. 31.25 and 33.25. The protection work is proposed with the Gabions filled with rocks.

3.5. Navigation Markings / Navigation Aids

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

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

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

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

Keeping in view the 4 nm light and considering the clear visibility range as 8000 m, the interval can be considered as 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 20 Nos in the initial phase 1 stretch upto Ch. 45.228 kms {45000 / 5000 + 11 Bends) of Shore Marks with Beacon Light unit.

Regarding the Buoy & Light system, considering the clear visibility range as 500 m and in Zigzag position (i.e., 1 Left Mark then 1 Right Mark and 1 Left Mark), it is estimated to provide 110 Nos {45000 / 500 + 8 Bends + 10 % approx.) of Buoy and Light unit (with chain attachments etc.). 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. It is suggested the Buoy & Light system in the phase 2 development, which can be considered with due analysis at that point of time. The requirement has been worked to 110 Nos.

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

In the total stretch, there are Three Bridges of which the Bridge at Ch 0.55 is under construction. The clearances are more than 100 m x 10 m, as ascertained. The other 2 Bridges are having adequate clearance for Class IV and hence there is no need of any Bridge modification.

In the total stretch, Three HT Lines are in existence at Ch 42.12; 42.22 and 45.37. The suggested Terminal location is before Ch 42, there is no need of any Power Cable modification. However, nominal provision towards stringing has been catered.

No cross structures viz., Dams / Barrages & Locks / Weirs / Anicuts / Aqueducts are observed in the present study stretch. Hence, modification doesn't arise.

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 ascertained, the Savitri River is not being used for regular inland Navigation, except at the mouth of the river. Keeping in view the concentrated Industrial clusters at the end of the Waterway stretch and observing the mobility of vehicles dominantly from / to JNPT, It is proposed to consider the Ro-Ro operation through Sea / Waterway.

The most advantageous aspect of the Savitri River is the availability of Fairway for 40 Kms from the mouth (Ch. 0 km) and there is no need to consider any investment. In the proximity of Ch 40 km, there is an approach road on the left side / south side, where the SH 70 is very near to the bank (Bank near "Owale" village), which is connected to NH 66 at Mahad with a lead of about 16 kms.

Accordingly, phase 1 has been considered (up to 40 km) without any investment / rather very nominal investment to facilitate Ro-Ro operation to achieve the initial estimated volumes (to decide upon the investment in phase 2) and if the same is able to achieve full estimated volumes, no investment is suggested. The promotional aspect with observation is up to FY 25. In addition, an alternative to avoid the Dredging has been considered, in which case the Ro-Ro Terminal can be shifted nearer to Ch. 40 Kms. This possibility also has been considered as Phase 2 A.

Accordingly, Phase 1 is with a nominal investment for considering the promotional mobility with a tie up through an entrepreneur and if the nominal growth is achieved, then the investment decision of phase 2 from FY 26 till FY 29 along with the IWAI Terminal development is proposed.

The Phase 1, Fairway development is INR 9.98 Cr.

The Phase 2, Fairway development is INR 79.73 Cr.

The Phase 2 A (No Dredging / Terminal Shift) is INR 66.61 Cr.

Cost estimates are placed with details in Chapter 11.

3.9.2. O&M Cost

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

CHAPTER 4: TRAFFIC STUDY

4.1. General

Market analysis for Savitri river catchment area comprises of the analysis for existing and potential waterway traffic (cargo and passenger traffic), their existing trends of flow between origin and destination and the feasibility of diversion from existing transport/shipping modes to waterways.

Savitri River originates in Mahabaleshwar and flows through Raigad district and meets Arabian Sea at Harihareshwar. Savitri River forms a border between Raigad & Ratnagiri district. The navigable length of the river is 44 Km. There exist one non major port at the mouth of the river, namely Bankot.

FIGURE 4-1: Savitri River Overview

FIGURE 4-2: Waterfront area of Savitri river

4.2. Influence area / Hinterland Analysis

Savitri River flows through Raigad and Ratnagiri districts. There are fifteen talukas in Raigad district, namely Alibag, Pen, Panvel, Karjat, Uran, Khalapur, Roha, Sudhagad (Pali), Mangaon, Murud, Mhasala, Shrivardhan and Poladpur. In Ratnagiri district, there are nine talukas, namely Ratnagiri, Chiplun, Sangameshwar, Khed, Dapoli, Rajapur, Guhagar, Lanja and Mandangad. Savitri River touches boundaries of Shrivardhan, Mhasla and Mahad talukas in Raigad district and Mandangad taluka in Ratnagiri district. The river flows through Poladpur, Mahad, Mangaon and Shrivardhan talukas.

The primary catchment area of Savitri River consists of hilly terrain. The catchment area covers Harihareshwar, Diveagar in the north and Murud village in south from Bankot side. Primary catchment area of the river from Mahad side includes villages in the south till Tulsi Kh. village & till Nizampur in the north.

Savitri River is in between Kundalika and Vashishthi River. On the bank of these two rivers, there exist two non-major ports, Salav & Sanegaon jetty at Kundalika River and Dabhol port at Vashishthi River. These jetties and port are fully operational. Hence, there is less scope for the secondary catchment area of Savitri River. The industries located in the secondary catchment area of Savitri River would prefer the fully functional non major ports, i.e. Salav & Sanegaon jetty and Dabhol port. Some of the talukas in the primary catchment area also share their border with Dighi & Dabhol port, thereby limiting scope for the river.

4.2.1. Demography Profile of Hinterland

The table below shows taluka wise population in Raigad and Ratnagiri district. In Raigad, Shrivardhan taluka is the most populated, whereas in Ratnagiri, Mandangad is the most populated taluka.

TABLE 4-1: TALUKAS WISE POPULATION AROUND SAVITRI RIVER

District	Taluka	Population
Raigad	Mhsala	50,235
	Shrivardhan	60,952
	Mahad	1,38,955
	Mangaon	1,41,078
	Poladpur	39,520
Ratnagiri	Mandangad	62,123
	Dapoli	1,44,084
Total		6,36,947

Source: Census, 2011

Local people residing in Shrivardhan, Mahad have another employment generation source i.e. tourism. Local people residing in these areas are mainly doing agriculture for their living, apart from working in industries located in MIDC. People have their own private land where they grow coconut, Mango trees etc.

4.2.2. Economic profile of Maharashtra

The hinterland of Savitri River includes Raigad and Ratnagiri districts. Parts of Navi Mumbai like Kharghar and Panvel come in Raigad district. Past few years have witnessed major developments in Navi Mumbai, which has helped to boost economy of Raigad district. Petrochemical, Iron & Steel industries of Raigad district have helped in urbanization of the district. Ratnagiri district is considered as socio-economically underdeveloped, hence it would not provide much opportunity for the proposed waterway in Savitri River.

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. Whereas growth rate has declined in secondary sector, the tertiary sector's growth remains stagnant.

TABLE 4-3: Sectoral 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 and Tertiary sectors of Maharashtra state. As depicted in the chart, Primary sector consists of Mining, Agriculture, Fishing and Forestry. Whereas Secondary sector includes different types of manufacturing industries. Service based industries come under Tertiary sector.

Economy Sectors of Maharashtra

Primary

- Mining
- Agriculture
- Fishing
- Forestry

Agriculture production in Maharashtra contributes more than 55% to GSDP but there is lack of organized sector for farming in Raigad.

Marine fish production has shown growth over the years compare to inalnd fishing

Minerals like limestone, bauxite etc. found in Raigad, Ratnagiri areas

Secondary

All types of manufacturing industries comes under secondary sector.

In raigad district there are iron & steel, chemical factories and traders dealing with minerals are present.

Tertiary

All other service providing industries like banking & insurance, Hotels and restaurants, Communications etc. comes under this sector.

About 40% of India's internet users are in Maharashtra

FIGURE 4-3: Sectors of Maharashtra

4.2.2.1. PRIMARY SECTOR

In Primary sector, major growth has been witnessed Agriculture sector, followed by Forestry sector. Growth rate of Fishing and Mining sectors are lesser than Agriculture and Forestry.

TABLE 4-4: Primary sector historic growth in Maharashtra

(INR in Crore)

Primary Sector	2009	2010	2011	2012	2013	2014
Agriculture	1,549	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

Raigad District

Agriculture sector contributes as a prominent sector to the economy of Raigad district. There are three regions in agriculture sector.

- Sea Shore region – Alibaug
- Hill Top region – Khalapur, Sudhagad
- Kharland region – Panvel, Pen, part of Alibaug

Mango and Cashew are two major commercial crops of Raigad district.

Raigad district is emerging as important Industralised hub. Hence more people are migrating towards Industrial sector. Most of the young population of the district has migrated to other states and cities for better employment opportunities. This results in acute shortage of farm labour, so adequate measures are taken for Agriculture Mechanization. At present, migrants from Uttar Pradesh and Nepal work in Agriculture sector. They are engaged in cashew seed collection and Alphonso Mango Orchards and fisheries.

Ratnagiri District

Coconut trees, Areca Palm, Mango, Cashew Nuts, Jackfruit, Ratambi etc are found in Ratnagiri district.

Rice is the main crop in the district. Local people lack crop management and because of this saturation or oversupply situation arises. Alphonso Mango are major exporter and also it is processed in the local market for storage purpose. Vegetable cultivation in the district is not on an advanced scale therefore vegetables are supplied from other nearby districts to Ratnagiri.

Rose, Marigold, Jarbera, Gladiolus, Aster, Gerbera are produced on open floriculture land and in Greenhouses. 80 Ha. Area is under floriculture. Greenhouses are found in Chiplun, Ratnagiri, Guhagar and Dapoli taluka. This sector offers employment and entrepreneurship opportunity for masses.

Following table describes other agriculture productions in the catchment area of river.

TABLE 4-5: Agriculture Productions in the catchment area of Savitri River

Taluka	Rice		Nachni		Tur Pulse		Total
	Area (Ha)	Production (MT)	Area (Ha)	Production (MT)	Area (Ha)	Production (MT)	Production (MT)
Poladpur	3,929	11,787	1,480	1,332	80	64	13,183
Mhsala	1,984	5,952	300	270	34	27	6,249
Srivardhan	3,110	9,330	225	203	14	11	9,544
Dapoli	8,400	27,200	2,300	3,220	-	-	30,420
Total	17,423	54,269	4,305	5,025	128	102	59,396

Source: Department of Agriculture, MH

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

b. Fishing

There are more than 90% traditional fishermen operating in whole Maharashtra. There is no inland fishing activity going on in Savitri River.

Following graph represents fish production in whole Maharashtra. It is clearly visible that marine fish production is more than inland fish production. Coastal region of Ratnagiri is famous for fishing activity.

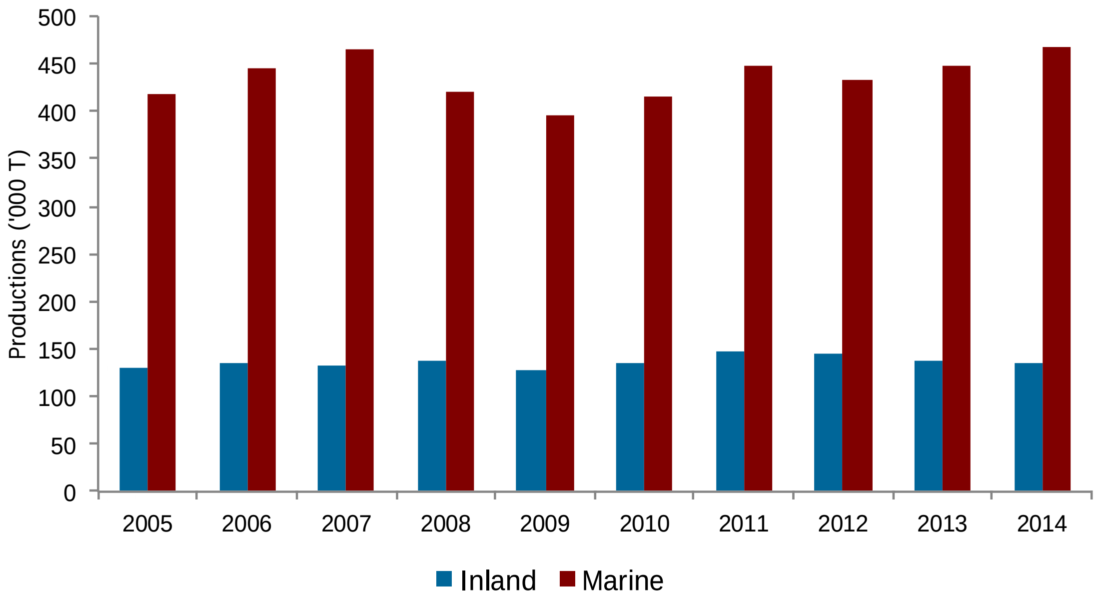


FIGURE 4-4: Fish productions in Maharashtra

Table 4-6: Inland & Marine Fish Productions in MH (000 T)

Year	Inland	Marine
2004-05	130	418
2005-06	135	445
2006-07	132	464
2007-08	137	420
2008-09	127	396

Year	Inland	Marine
2009-10	135	416
2010-11	149	447
2011-12	145	434
2012-13	137	449
2013-14	135	467

Source: Department of Fisheries, MH

At present no fishing activity found in Savitri River. However, in the catchment area of river there are few fish landing points where fishing is carried out.

FIGURE 4-5: Fishing Point on river

In Shrivardhan & Dapoli taluka, both coastal & inland fishing take place. In Shrivardhan taluka, inland fishing takes place only in Kudgaon & Bagmandla villages. In Dapoli taluka, fishing activity is carried out only in Veshwi – Bankot village. Rest all the villages are located near coast, so marine fishing is carried out extensively. It can be seen from Table 4 6that in those villages where inland fishing takes place, fish catch has reduced over the years.

TABLE 4-7: Historic fish production in the hinterland of Savitri River

District	Taluka	Villages	2005	2006	2007	2008	2009
Raigad	Shrivardhan	Dighi	648	673	576	643	550
		Kudgaon	280	202	126	141	129
		Aadgaon	242	346	367	373	343
		Mehndali	258	262	99	79	44
		Bhardkhol - Diveagar	3,446	3,432	3,176	3,276	3,490
		Bagmandla	214	149	129	145	130
		Total	5,088	5,064	4,473	4,657	4,686
Ratnagiri	Dapoli (Burondi Village)	Veshwi-Bankot	2,473	1,495	1,203	854	701
		Kelshi	927	591	432	302	264
		Aade/Uttambar	2,006	1,509	994	765	715
		Burondi	1,788	2,503	1,390	1,575	1,389
		Kolthere	855	566	394	468	420
		Oni/Bhati	1,267	868	291	288	275
		Veldur/Navanagar/Dhopave	3,589	2,654	1,766	1,064	1,012
		Asgoli	1,727	1,148	1,051	611	560
		Palshet	481	450	344	309	322
		Budhal	75	139	121	103	135
		Kondkaru	1,117	516	694	528	379
		Velneshwar	837	779	520	395	468
		Sakharhedvi	280	412	173	132	63
		Total	17,422	13,630	9,373	7,394	6,703

(Production in MT)
Source: Department of Fisheries, MH

Looking at the geographical location of Raigad district, major emphasis has been given for the development of Fisheries activities and its infrastructure development in the district. Raigad district has a coastline of 240 km and 168 fishing villages covering 40 fishery centres located along the coast. Jitada fish or Sea Bass is supposed to be the king of fish in Raigad and taken as inland fish enterprise. Bulk of the fish catch is consumed in Mumbai. Certain species like Squids, Cuttle fish, Ribbon fish, Perches etc., are frozen and exported to overseas markets like Taiwan, Korea, Japan, China and Middle East countries. The shipments are transported from Jawaharlal Nehru Port Trust (JNPT) and Mumbai Port Trust (MbPT).

Ratnagiri district has 167 km long sea coast. Fishery activity is one of the major economic activity providing livelihood opportunities to large number of people of Ratnagiri district. In Ratnagiri, people of nine tahsils i.e. 99 villages along the coast are engaged in extraction and development of marine fisheries. Ratnagiri coast has rich variety of fish. Ghol, Wagli, Wam, Pomfret, Shingala, Ravas, Karel, Tambusa, Dori, Chand, Surmai, Palu and Bombay Duck are important types of fish which are found along the coast of Ratnagiri. Prawn processing is carried out in a big scale which has a great demand abroad. Shell fisheries are also exploited in a number of creeks, backwaters, and estuaries along the coast. Fishery related infrastructure is good in Ratnagiri district. There are 18 ice factories, 4 cold storages, 4 freezing plants, 4 processing plants and 6 fish meal plants. In Ratnagiri district annual average production of marine fish is about 72318 metric tones in 2008-09 and 87690 metric tonnes in 2012-13, which accounts about 99% of the total fish production.

Fishing season commences from September and lasts till the end of May. During the monsoon season, fishing activity practically seizes except in the creeks. Distribution of fish production varies from tahsil to tahsil. Inland fisheries of the Ratnagiri district, which yield hardly 0.09% of the total fish production, is mostly carried on in the rainy season that is from June to August when the fishermen do not venture into the sea. Inland fisheries of Ratnagiri district as compared to marine fisheries are less developed. The main reason is short rapid and seasonal characteristics of Ratnagiri's rivers.

c. Forestry

Raigad District

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 unorganized. Dense forest is of 566 sq. km. In Raigad district there is one Phansad wildlife and Karnala Bird sanctuary. Shriwardhan is mostly covered with mango and coconut trees.

In Dapoli Taluka, the forest area is only four square miles. Superior quality of Teak and other moist deciduous species grow in this area.

Ratnagiri District

85% of land area in Ratnagiri district is a hilly region. From Umroli village in Ratnagiri district to Padwe village have very high hills, having elevation more than 350 meter. Ratnagiri classified forest area is 5,860 Ha. There are lot of private lands & unclassified forest area in the district.

TABLE 4-8: Ratnagiri District Taluka wise forest distribution

Taluka	Geographical Area (Ha.)	Forest Area (Ha)
Mandangad	42,576	123
Dapoli	86,339	-

Source: Mahaagri.gov.in

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 the Raigad region. Many of the local people are engaged in making bamboo basket and other wooden products, required to pack mangoes. There are small units of making pickles and papad and making Amsuls from Kokam as well. Khed, Chiplun have MIDC areas but they are closer to Vashishthi River compared to Savitri River. Mandangad & Dapoli taluka do not have any MIDC estate. The below table shows GSDP by industry of origin.

TABLE 4-9: GSDP by industry of origin

(INR in Crore)

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 indicates that state is slowly turning into developed economy. There are very few resorts in the catchment area of Savitri River.

4.2.2.4. INFRASTRUCTURE ANALYSIS

Infrastructure plays major role in the development. It is essential to understand various types of infra around river and new development that would become support-connecting 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

SH 100 which is a curvy road runs parallel to Savitri river from Raigad district side. However SH 102 passing in Ratnagiri District is not parallel to the river and the road is very curvy. NH 66 is also in the close proximity of the river. There exist two bridges on Savitri river. One bridge is near Mahad, which is at the end point of the river and another bridge connects Ambet village in Raigad district with Islampur in Ratnagiri district.

FIGURE 4-6: Curvy & narrow road

Source: Site visit

b. Railway

Konkan railway line is the only railway line running in both Raigad and Ratnagiri district that crosses the river. Mangaon, Karanjadi & Veer are passenger railway stations in the catchment of the river.

c. Airport

There exists no airport in the primary or secondary catchment area of Savitri River.

4.2.2.6. EXISTING INFRASTRUCTURE

MIDC are engaged in providing supportive infrastructure for industries located in the area. Roads, Water supply, street lights, communication facility, post office etc. are some of the facilities provided to attract industries to set up their plant. TATA Power has developed its solar power plant of 3 MW at Mulshi Dam and also Pumped storage plant (unit) of 150 MW in Bhira village, which is just 10 km. away from the industrial area.

Following table summarizes existing landing points for passenger, fish and cargo as well as ports infrastructure in the catchment area of river.

TABLE 4-10: Type of jetties in the catchment area of Savitri River

Name	Passenger	Fishing	Natural landing point	Cargo	Other	Total
Mandad	-	7	4	-	-	11
Dighi	2	4	2	2	-	10
Kumbharu	-	1	5	-	-	6
Shriwardhan	-	7	3	-	-	10
Bankot	40	-	-	1	2	43
Kelshi	-	-	5	1	-	6

Source: MMB

There exist more jetties in Bankot in the catchment area of Savitri River, followed by Mandad. Passenger jetties exist only in Dighi and Bankot. Fishing jetties are available in Mandad, Dighi, Kumbharu and Shriwardhan. Cargo jetties are available only in Dighi, Bankot and Kelshi.

TABLE 4-11: Existing storage areas in the catchment of Savitri River

District	Number of godowns	Capacity (MT)
Raigad	32	14,700
Ratnagiri	26	11,550
Total	58	26,250

Source: Economic survey of MH, 2015

The table above depicts that number of storage areas is more in Raigad district, with more capacity than Ratnagiri district.

TABLE 4-12: Facilities at Kelshi Port

Port	Handling Capacity ('000 T)	Draft (m)	Largest Vessel Received ('000 DWT)
Kelshi	305	3	0.8

Source: Indian Minerals Yearbook, 2012

Kelshi and Bankot both are non-major ports in the catchment area of Savitri River.

FIGURE 4-7: Infrastructure logistics captive jetty at Umroli village (Source: Google Earth)

Source: Google Earth

Fomento Resources Alliance Member Company, namely Infrastructure Logistics commenced its operation in the year 2001. The Company was formed to cater dry bulk market in the state. Jetty in the above image was built exclusively to export Bauxite from Guhagar area. The Loading capacity at jetty is 3,00,000 Ton. In the midstream, bauxite from the barges gets loaded in bigger vessels by self-grab vessel or crane.

4.2.2.7. UPCOMING INFRASTRUCTURE

Below image shows ongoing bridge construction, connecting Danda of Raigad district and Bankot of Ratnagiri district. Both these locations are located at the mouth of Savitri river. It is expected that this bridge would be operational by end of 2017 or early 2018 and would be used for transportation.

FIGURE 4-8: Upcoming bridge at the mouth of Savitri river

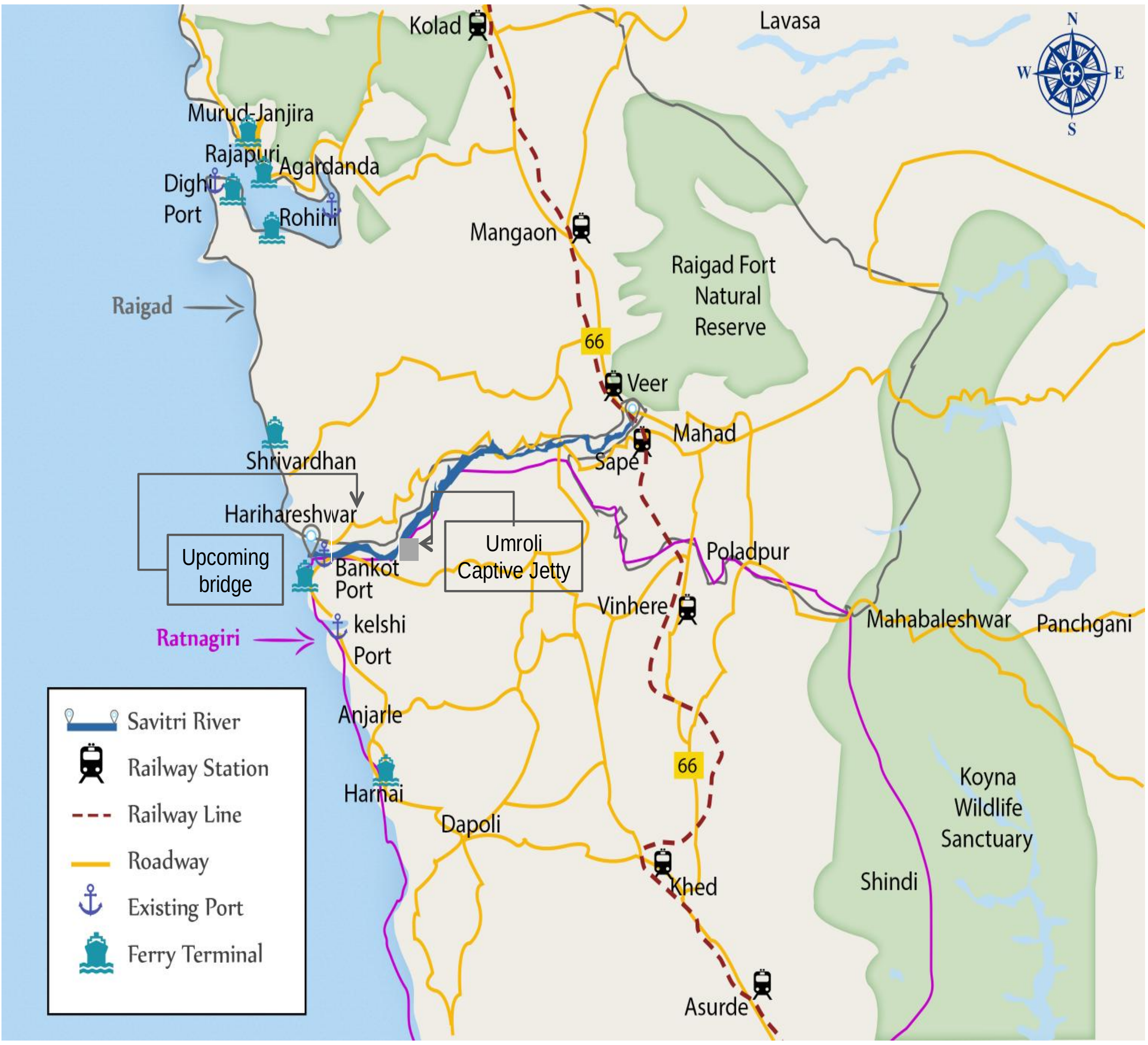


FIGURE 4-9: Existing & Upcoming Infrastructure

4.2.3. Existing & Proposed Industries

Chiplun & Khed are industrial estates in Ratnagiri district, but both are located more than 50 km away from Savitri River. Chiplun is closer to Vashishthi River than Savitri River. Both these industrial estates would not provide any opportunity for Savitri River because of their distance from the river. Ville Bhagad MIDC in Mangaon taluka is located 30 km away from Savitri River & it is closer to Kundalika River, thereby this MIDC area would also not provide any scope for the waterway in Savitri River. Posco Steel, Pioneer Gas Power Limited are two major industries in Ville Bhagad MIDC.

In Fy 2010, there was an uproar that Harihareshwar Power Plant of 1,600 MW would be set up in Vesavi village in Ratnagiri district and this plant would be based on imported coal. Distance between Bankot port and Vesavi village is hardly 2 km. This power plant is a joint venture between BHD group of Malaysia and Mumbai based Etsinta Energy, but it is not likely that this power plant would come up in near future. There is strong opposition from the local people because according to the local people the development of the proposed plant in the region would hamper horticulture, fishing etc. based business.

4.2.3.1. EXISTING INDUSTRIES

Mahad MIDC is the closest industrial estate from Savitri River. Table 4 12 summarizes some of the major industries in the MIDC area and their distance from Port and proposed terminal location. At present all the industries are using JNPT port for transportation. Containers reach JNPT within 4 to 5 hrs.; this time excludes custom clearance. These industries are reluctant to use Savitri River for various reasons like depth of water etc.. However with the support of IWAI in maintaining depth and other supportive measures, there exists a possibility of diverting road traffic of containers to containerized Ro-Ro vessels. The diversion of traffic from roadways to waterway would help to decongest the traffic on NH 66 (Mumbai-Goa Highway).

TABLE 4-13: Industries in the catchment area of Savitri River

Area	Industries	JNPT (Km)	Bankot (Km)	Dasgav (Km)	Opportunity
Mahad MIDC	Jbs Pharma Chemical	129	73	18	☓
	Shalco Industries	129	73	19	☓
	Duflon Industries	129	73	19	☓
	Sequent Scientific	130	74	21	☓
	Hikal	128	72	18	☓

Area	Industries	JNPT (Km)	Bankot (Km)	Dasgav (Km)	Opportunity
	Privi Organics	126	70	17	χ
	Chaitali Petro-Chem Industries	126	70	17	χ
	Laxmi Organic Industries	128	72	8	χ
	Embio	130	74	20	χ
	Vinati Organics	129	74	20	✓

Additional Mahad industrial area is located more than 20 km away. The River flows from one side of this additional area. However this water body, flowing next to additional MIDC does not come under the navigable stretch of Savitri River. River also gets further narrower after 44 km. This MIDC area is still on planning stage. At present, there is no plan to set up an industrial plant in this area; neither any plot in this additional area is allotted to any industries. In coming years if any industry sets up its plant in this area, it could use a proposed terminal in Savitri River.

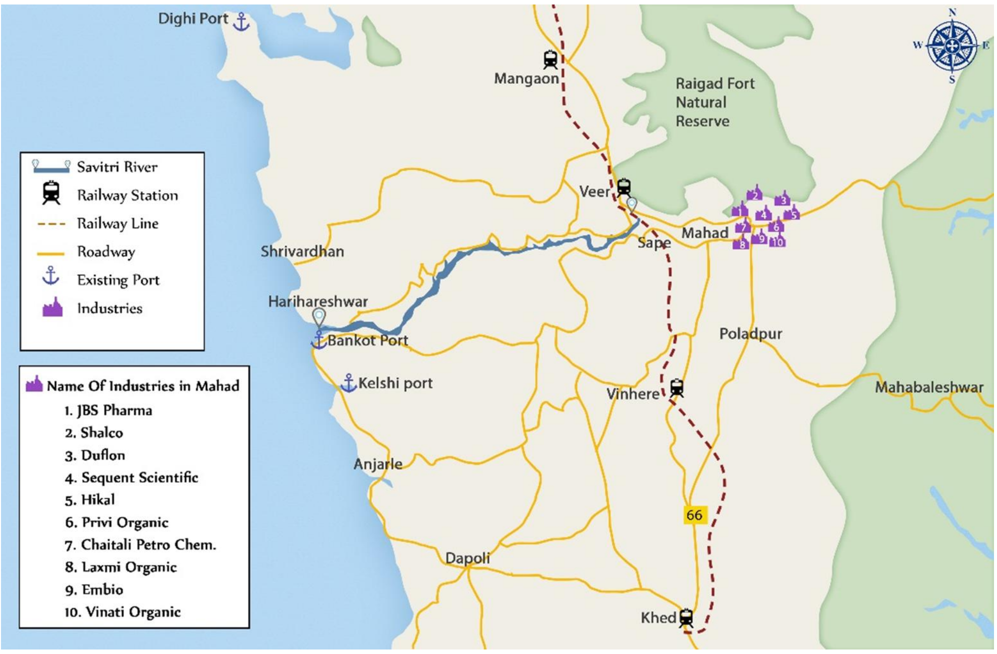


FIGURE 4-10: Infrastructure in the catchment area

Privi Organic

Privi Organic's plant is located in MIDC on 64,255 sq. meter area. The Plant manufactures and exports aroma chemical. The Plant has installed capacity of 21,000 TPA. The Company has its own storage area, located in MIDC area. The storage capacity for raw material is 2,000 MT. Finished product storage capacity is 900 MT. The Company prefers using JNPT port due to logistic advantage and time factor. Therefore no potential for Savitri River.

Embio Ltd

Embio Limited, a leading global player in the domain of controlled substances and chiral molecules manufactured through bio-transformation. Embio Manufacturing plant is located in the MIDC area of Mahad on Mumbai -Goa highway. The plant has enough infrastructure to handle large and small raw material, other Pharmaceutical ingredients, advanced intermediates, chiral intermediates and chiral resolving agents.

TABLE 4-14: Embio plant capacity

Plant	Capacity in KL (Reactor Volume)
Fermentation	640
Ephedrine Hydrochloride	28
Pseudoephedrine Hydrochloride	24
MPP-1	30
MPP-3	8
MPP-4	35
MPP-5	25
Small Volume Plant	2

Source: Company Website

Company did not show any interest in shifting cargo to waterways. Thereby no potential for Savitri river

Laxmi Organic Industries

This Manufacturing plant manufactures Alcohol-based Chemicals. The plant is located in Raigad and has adequate infrastructure to handle reactions across a broad range of temperatures, ranging from 700°C to -25°C. The Company also has refrigeration capacity (more than 2000 Tr) that enables to handle large volumes of refrigeration loads. Company was not willing for modal shift.

Shalco Chemical

Shalco Chemical has expanded its business from manufacturing chemicals to stainless steel, welded pipes & tubes. Its Manufacturing facility is based on 2,20,000 sq. ft. area. However company prefers JNPT for transportation.

Hikal Industry

The first plant of Hikal industry in Mahad started its operation in 1991. The Company signed long term supply agreement with Hoescht India. This plant manufactures chemical for Pharmaceutical and Agrochemical industries. Finished product of the plant is used in various drugs making. The Plant is specialized in manufacturing Custom Synthesis and Contract Manufacturing of Agrochemicals, Intermediates and

Specialty Chemicals. The Company has 12 chemical synthesis laboratories spread on 1,200 sq. ft. of area each. They did not show any willingness to use Savitri River.

Duflon

Duflon in recent times developed its own investment-casting foundry in Ahmedabad, Gujarat. Europe, Africa, Australia, South and North America are their export business areas. The Plant's manufacturing facility is spread over an area of 110,000 sq. feet. The company has acquired 250,000 sq. feet of land for future development. Though this company is expanding however they were not willing for shifting cargo to Savitri River.

Sequent Scientific

This company has many other manufacturing plant located in other states of India like Andhra Pradesh, Karnataka. The Company has its plant in Turkey also. The Company manufactures raw material used for human health and veterinary care. The Company's plant at Mahad is considered as a largest facility, which manufactures anti-parasitic agent. Stride Shasun and Sequent have formed alliance to merge some of their bulk drugs business. The Company is expanding its animal healthcare business in the past years through acquisition.

Provides no potential for Savitri River as company did not show any willingness for shifting cargo to waterways.

Vinati Organic

The Company started its operation in 1989. It has two plants, both situated in Maharashtra at Mahad (Raigad) and Lote Parashuram (Ratnagiri). Vinati Organics (VOL) is the world's largest producer of IBB & ATBS and the largest manufacturer of IB & HP MTBE in India. Vinati industry is the only industry which showed willingness to use Savitri River because the plant has easy access to Savitri River from the back side of the plant. However stretch of Savitri at back side of plant do not come in the defined scope of Savitri River. It would not prove commercially attractive to develop Savitri River for one industry.

4.2.3.2. ADDITIONAL MAHAD MIDC

This additional MIDC has developed a dam on Savitri River for water supply. Capacity of dam is 29 million cubic meter. There is also truck terminus available for parking etc. Piramal India, Kopran Research Laboratories, Sandoz are few companies located in this MIDC.

Kopran Research Laboratories

Koparan has active pharma ingredients plant in additional Mahad MIDC area. At this plant formulation of ingredient takes place. Their main plant is in Khopoli. From this plant by using own vehicles cargo goes to JNPT port for export purpose and also to their Khopoli plant. Total 5 to 6 consignment per month they dispatch to JNPT. The total cost per ton by using roadway from their plant to JNPT is about five to six thousand. They find it more convenient to use roadways than shift to waterways as it involves multiple handling.

Piramal Healthcare

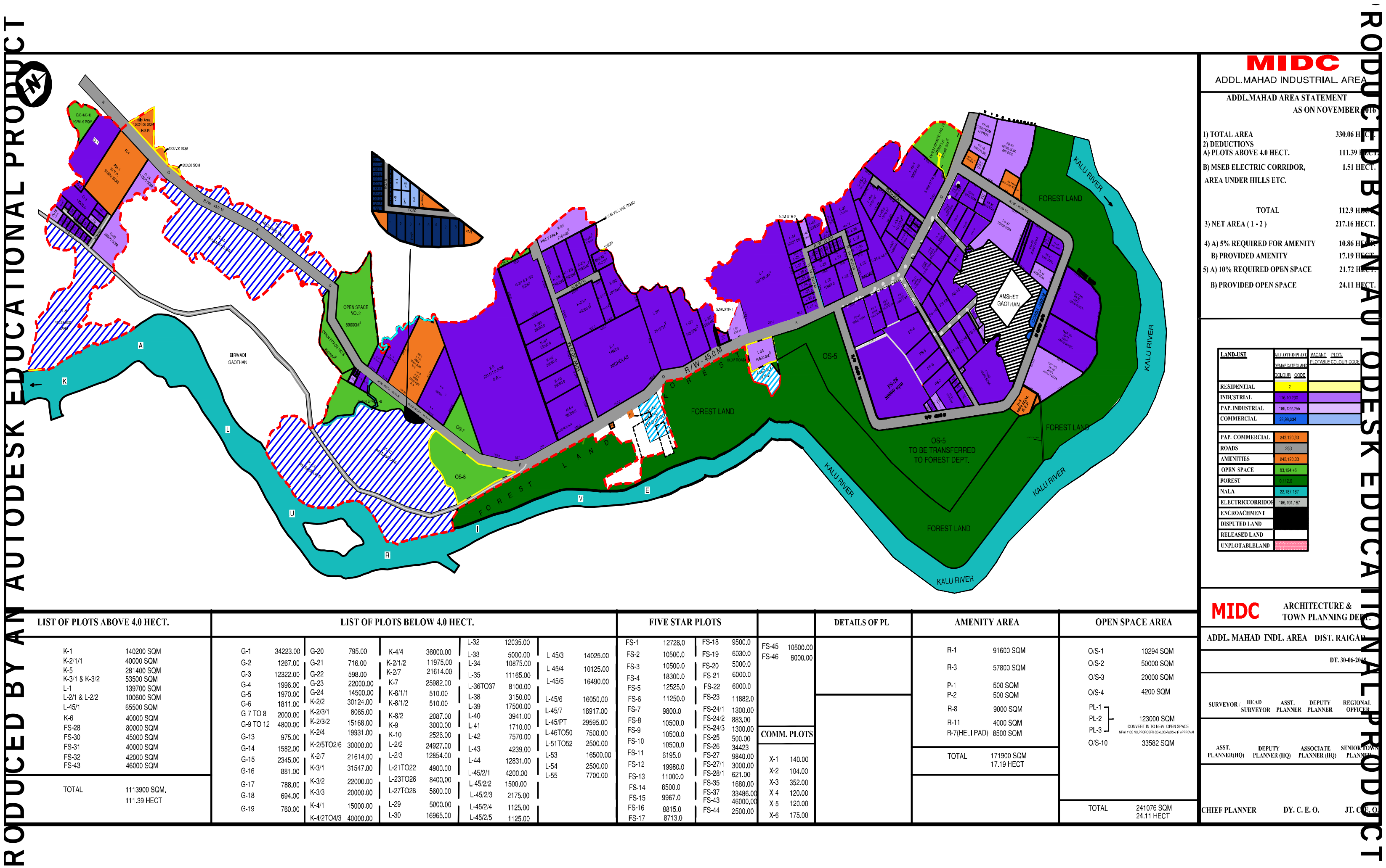
This plant is established in the year 1995 on 35 acres of land. Piramal use JNPT port for exporting their pharma products. 15 LCL and 10 containers of 40 ft. per month is dispatched from plant to JNPT. LCL includes full truck, tempo or pickup. About five to six hours it takes to reach JNPT from their plant. Company manufactures their own products and also does custom manufacturing for Novartis India, Solvay Pharma, Sandoz, and UNICEF.

There are three plants of Piramal in this MIDC. This company is also not willing to shift cargo to waterways.

TABLE 4-15: Piramal Mahad plant capacity

Dosage Form	Unit	Capacity p.a
General Tabs	MIO	2,500
Hormone Tabs		625
Sugar Coated vitamins & mineral tabs		625
Liquids		34
Sachets		100
Vitamins & Mineral Blends	Tons	900

Source: Piramal website



Source: MIDC

FIGURE 4-11: Additional Mahad MIDC Map

Apart from three major client i.e. Piramal Healthcare, Koparan Research Laboratories and Sandoz the rest of the industrial plots in additional MIDC area has been put up for auction. Annexure of the same is attached in this report.

4.2.3.3. FIVE STAR MAHAD MIDC

Apart from Mahad MIDC and additional Mahad MIDC there is another MIDC called Five Star MIDC. Only D. G. Infrastructure Pvt. Ltd. has its operation in this MIDC. There are no plots or sheds available in this MIDC area.

4.2.4. Traffic from Major & Non Major Ports

There exists Major or non-Major ports in the catchment area of the river. This section would analyze the historic traffic of existing ports, which would help to understand the potential to divert a part of the ports' traffic to the proposed waterway in Savitri River.

Non Major Ports

There is only one non major port at the mouth of the river i.e. Bankot which has not handled any major cargo in large volume. It can be seen from the below table that apart from Fy 15 Bankot port has not handled any commodity in the last five years.

TABLE 4-16: Commodity wise historic traffic of Bankot Port

Bankot Port	2012	2013	2014	2015	2016
Mineral	-	-	-	57	-
Project Cargo	-	-	-	-	-
Total	-	-	-	57	-

Source: MMB

The above table shows that Bankot Port has handled mineral in Fy 15. The port has not handled any other cargo other than mineral in last 5 years. Mineral cargo handled in Fy-15 includes Bauxite at Umroli.

Major Ports

There does not exist any major port in the primary catchment area of Savitri River. Industries located in Mahad MIDC are using JNPT port for their EXIM trade. All the major ports are located more than 100 km away. There is direct connectivity between JNPT and Industrial plants of the region.

4.3. Commodity Composition

4.3.1. Mineral

Ratnagiri District

5 mn T of Bauxite and 7 mn T of Silica sand reserves are found in Ratnagiri district. Fomento Resources has granted bauxite mining lease of 92 Ha up till 2020 in the village of Gudeghar in Mandangad taluka of Ratnagiri district. Fomento Resources

has received an approval from MMB for the development of a captive jetty, 10 km from the lease area at Umrolli village.

TABLE 4-17: Minerals composition in Ratnagiri district

Mineral	Lease	Non Forest Area (Ha.)
Silica Sand	8	454
Bauxite	6	778
Total	14	1,232

Source:Mahadgm.gov.in

Rajapur taluka is located near Vijaydurg connecting Sindhudurg district thereby it does not include in the catchment area of Savitri river.

TABLE 4-18: Taluka wise number of mines in Ratnagiri district

Tahsil	Silica Sand	Bauxite
Rajapur	8	-
Mandangad	-	2
Dapoli	-	4
Total	8	6

Source: Mahadgm.gov.in

Raigad District

There exist 12 mn T of bauxite reserves in the Raigad district area. The below table shows the existing number of mines in the talukas in Raigad district.

TABLE 4-19: Bauxite in Raigad district

District	Tahsil	Number of mines	Non forest area (Ha.)
Raigad	Pen	1	484
	Shrivardhan	7	
	Total	8	

Source: Mahadgm.gov.in

4.3.2. Sand Mining

Sand mining is illegal in Maharashtra but still at some places this activity is carried out. Sand mining would not provide any scope for the proposed waterway in Savitri river. The below imgaes show sand mining in different sites near Sape Village along the bank of Savitri river.

FIGURE 4-12: Sand Mining near Sape village

4.4. Originating & Terminating commodities

The cargo handled at non major ports in the primary catchment area of the river is very inconsistent in nature. These ports lack supportive infrastructure and strong connectivity. All the roads in the catchment area of river are curvy in nature. Savitri River is surrounded by hills. There exist very few manufacturing industries in the catchment area of the river and in overall Konkan region. The major reason for lack of industries in the region is strong opposition of the local people for setting up power plant or any major industry in the region. The following table summarizes major commodities and possibility of diverting these commodities to the proposed waterway in Savitri River.

TABLE 4-20: Commodities and potential for Savitri River

Commodity	Potential	Reasoning
Thermal Coal	X	There does not exist any TPP in the catchment area of the river. Harihareshwar TPP project of 1,600 MW capacity, got deferred due to strong opposition from local community. Aquiring a clear land for development of any industrialized plant is a big issue in Konkan region. If this TPP comes in near future, it would be developed at the mouth of the river i.e. Harihareshwar and this would not benefit Savitri river.
Steel	X	Maharashtra Seamless plant of Jindal is located in Sukeli village, which comes in the catchment area of Amba river. JNPT and MbPT are also in close proximity from the plant. Distance from Maharashtra Seamless plant to tail of Savitri river is more than 45 km. Distance between MH seamless and PNP terminal is about 33 km.
Iron Ore	X	Bankot port has handled minerals (Bauxite) only in Fy 15, in last five years. This shows inconsistency of mineral traffic handled at the port.
POL	X	HPCL, BPCL and IOCL together have formed alliance for developing 60 mn T p.a refinery on 15,000 acres of land, along the West Coast in Konkan region. However land parcel size and acquisition of land is major hindrance. It is difficult to get huge size of land in the region due to hilly terrain. GOI has requested to develop refinery in small parcel size of land. Though even after site visit, land area for this project has not yet been identified. At present POL distribution in Konkan region takes place via roadways. Even if in future on a smaller scale their plant gets developed, it would not provide any potential to Savitri river.
Fertilizer	X	Major fertilizer Plant i.e. RCF has its own rail siding; logistics & distribution of fertilizer takes place by third party distributor. Deepak fertilizer plant located in Khopoli region, Raigad district distribute fertilizer, using roadways. Deepak fertilizer also exports its products using JNPT. RCF and Deepak fertilizer do not come in the catchment area of Savitri river.
Chemical	X	Existing chemical industries located in Mahad are not willing to use any terminal located in Savitri river. Industries prefer JNPT due to direct road connectivity and no multiple handling. However All the trucks use only one way to reach JNPT i.e. NH 66;

Source: Mantrana Maritime Advisory Pvt Ltd

4.5. Passenger Traffic

Passenger traffic consists of Ro-Ro traffic and also people visiting famous locations in the catchment area of Savitri River.

4.6. Tourism Traffic

All the tourist places are located in the hilly terrain. Most of the tourist places include forts. Forts located on high hilly areas are not very popular among visitors but Raigad fort has ropeway system. Other forts have steps. Shrivardhan and Harihareshwar are the only two tourist places, located at the mouth of the river, which could be visited by every age group of tourists.

TABLE 4-21: Famous Tourist Spots around Savitri River

Location	River	Distance (km)
Shrivardhan	Savitri	6
Harihareshwar	Savitri	2
Mahad	Savitri	7
Raigad Fort	Savitri	19
Bankot Fort	Savitri	1
Kondhavi Fort	Savitri	22
Pratapgad Fort	Savitri	31

4.6.1. Shrivardhan & Harihareshwara

Both Shrivardhan and Harihareshwar are accessible by Konkan railway. Nearest railway station is Mangaon, which is 45 km away. These places could be accessed Via NH 66 and SH 99. Auto Rickshaw and six seaters move between Harihareshwar and Shrivardhan.

4.6.2. Mahad

Mahad has only one famous Ganapati temple namely “Varadvinayak.” This temple is one of the “Ashtavinayak” temples of Ganapati. This temple is famous among Maharashtrian community. Veer railway station on Konkan railway line is 13 km away from Mahad town. A major hindrance to use Savitri River for tourism near Mahad is crocodile infestation in this part of the river. During Monsoon, the river stretch near Mahad is infested with crocodiles. Crocodiles could be seen during this season easily as it is their breeding season.

4.6.3. Raigad Fort

In the year 1674 Maratha King Chatrapati Shivaji Maharaj built this fort and made it his capital. By climbing 1,450 steps, tourists can reach the top of the fort. There is also ropeway service available for people who cannot climb steps. Ropeway service crosses diagonal length of 760 meter and steep ascent of 420 meter in just four minutes. The cost of Two-way ticket for using this ropeway is INR 270 each person. At “Shivajayanti” festival many people pay visit to this fort.

4.6.4. Bankot Fort

This fort is located in Diveagar in Bagmandala. This fort is also called as Himmatgad. According to History, this fort was captured by Portuguese and then later acquired by Marathas.

4.6.5. Kondhavi Fort

This fort was built to protect Kashedi Ghat, which connects Poladpur to Khed-Chiplun. This Ghat section is a part of NH 66 at present.

4.6.6. Pratapgad fort

This fort is located in Satara district. Mahabaleshwar is very close to this fort about 25 km away. This fort is a famous trekking spot. By roadway from Panvel to Poladpur is the ST bus route to reach to this fort.

4.6.7. Blue Green Exotica Camping Resort

Located in the Adkhal village in Mandangad taluka in Ratnagiri district surrounded by hilly areas. This resort is surrounded by jungles, water stream and waterfall. Each cottage of the resort is located next to the flowing water. This resort is based on 120 acres of green forest and one acre is dedicated to lawn and landscape. Stream flowing through one side of resort is seasonal.

4.6.8. Dapoli Beach

Dapoli has longest stretch of beach in whole Konkan coastal stretch. This place is also called as Mini Mahabaleshwar. This place is based on the height of 800 to 1,000 ft. above sea level in the mountain range. Dapoli beaches are famous as they are clean, broad and not over crowded.

4.7. Ro-Ro Traffic (Existing)

All the passenger ferry terminals of Maharashtra are located on the coastal areas as per data provided by MMB. There is Vesavi – Bagmandhe ferry line on the river. This route is located at 27 km from Mandangad & Bagmandale (Tal. Shrivardhan) 4 km from Harihareshwar. This ferry service was started by Suvarnadurga Shipping & Marine Services in 2007. The ferry service is operational from Vesavi from 7 am to 10 pm. Ferry service runs with interval of 1 hr. Morning and evening hours are the busiest hours of traffic. Only one ferry is plying on the river. At present company has not received any other demand from local people to start another ferry service on the Savitri River. Following Table 4 21 describes passenger traffic handled at various ferry terminals in the primary catchment area of Savitri river. All these passenger ferry terminals are located on the coastal side and not inside the river.

TABLE 4-22: Passenger ferry terminal in the catchment area of Savitri River

(000')

Ferry Terminal	2012	2013	2014	2015	2016
Shrivardhan	1	1	2	3	1
Kumbharu	1	3	2	6	2
Bankot	231	242	233	251	242
Kelshi	11	10	11	15	3
Total	244	256	248	275	247

Source: MMB

FIGURE 4-13: Vesavi Bagmandhe Ferry

A new bridge is under construction at the mouth of the river. Construction of this new bridge would make the passenger traffic handled by Vesavi Bagmandhe nil.

4.8. Growth Trend

4.8.1. Cargo Growth for Savitri River

All the industries located in Mahad MIDC area are using JNPT port for EXIM purpose. There is direct road connectivity from plant to port. Loading Unloading time has reduced, due to direct connectivity. All these industries are chemical based industries. Majority of industries are not willing to use Savitri River for cargo transportation due to multiple handling. Cargo generated from industries located in Mahad is containerized cargo. Industries receive shipment within 6 hrs. Timeframe. Multiple handling would increase time. In summer season water level saturate near Mahad. Savitri is a seasonal river; hence in rainy season, water level increases in upstream of the river. All these factors would restrict smooth cargo operation. Apart from industries located in Mahad MIDC, there do not exist any other industries within 25 km of stretch. Developing a container terminal on Savitri River would not be attractive in terms of attracting cargo.

4.8.2. Passenger Growth

A new bridge is under construction at the mouth of the river. Raigad & Ratnagiri districts would have another direct road connectivity apart from NH 66 & SH 272. This development would increase passenger traffic on roadways. People who travel from Raigad towards Ratnagiri would have another option apart from existing ferry, NH 66 & State highway. There exists a possibility of diverting NH 66 traffic to this new bridge. Once the new bridge opens up for public, existing passenger traffic operating between Vesavi Bagmandhe would become nil. Therefore in future no passenger growth would be there in Savitri River.

4.8.3. Tourism Growth

Harihareshwar, Shrivardhan and Dapoli beach are few famous tourist spots, located at the mouth of Savitri River. At present, these tourist places are accessible by passenger ferry service and roadways. Upcoming bridge on the mouth of the river would also act as another mode to access these tourist spot. Therefore it is less likely that any tourist would use Savitri River to visit tourist places. Riverfront resorts could be developed at the mouth that could attract tourists. Few watersport activities like kayaking, boating etc. could be started on a smaller scale to attract more tourist traffic in future.

4.8.4. Comparison of FSR & DPR study

TABLE 4-23: Analysis of FSR Study

Commodity	Source	DPR Consideration	Potential	Reasoning
Minerals	-	✓	✗	Kelshi port is mostly used for mineral handling. Bankot port handled mineral cargo (Bauxite) only in Fy 15 in the span of five years. This shows inconsistent volume & growth of mineral, thereby limiting scope of handling minerals for another IWT terminal.
Thermal Coal	Harihareshwar TPP	✓	✗	The Project of this TPP was deferred due to strong opposition of locals. This situation still exists and there would not be any positive change in near future. No existing coal movement was found on river. This TPP location is at the mouth of the river, hence it would not benefit Savitri river.
Steel	Maharashtra Seamless	✓	✗	Maharashtra Seamless plant is located in Sukeli village near Nagothane and does not come in the catchment area of Savitri river. No other iron & steel based industries were found during site visit. Maharashtra Seamless plant is closer to PNP and Dharamtar.
POL	BPCL & HPCL	✓	✗	Obtaining a land on the western coast side is a challenging task due to strong opposition of locals. Setting up a POL refinery would be difficult.
Fertilizer	RCF, DFPCL	✓	✗	Considered but no potential because RCF does not look after logistics & distribution of fertilizer. Also, the company has its own rail siding. Deepak Fertilizer plant does not come in the primary catchment area.
Chemical	Mahad MIDC	✓	✗	Chemical companies use JNPT port and did not show any willingness to use Savitri river due to multiple handling, time factor involved etc.
Food Grain	-	✓	✗	Food grain is locally consumed; hence provides no opportunity for the waterway.
Passen	-	✓	✗	Upcoming bridge on the river would make existing

Commodity	Source	DPR Consideration	Potential	Reasoning
ger				passenger ferry traffic nil. Also, less population of villages and easy accessibility of roadways, which run parallel to the river minimizes the potential for the waterway.
Tourism	-	✓	✗	Watersport activity could be introduced near Harihareshwar & Shrivardhan to attract more tourism traffic. These are the two famous tourist attractions on mouth of Savitri river. Apart from that no other tourist place exist.

Source: Consultant's Analysis

TABLE 4-24: Overall River Attractiveness

Traffic	Attractiveness	Reasoning
Cargo (Industrial & Commodities)	✗	Industries located in Mahad MIDC area are using JNPT port for EXIM trade. Within 4 hrs (excluding custom clearance), container reaches port & vice versa. Due to direct connectivity to JNPT & multiple handling involved in Savitri river, industries are not willing to use river for their container transportation.
Fishing	✗	Inland fishing volume is very low and gets consumed locally.
Passenger	✗	Due to low population in villages, located on the bank of the river, passenger ferry service might not attract large number of passengers. New upcoming bridge at the mouth of the river would also pose threat to existing Vesavi Bagmandhe passenger ferry line in future.
Tourism	✗	Ratnagiri region is hilly region & the land on the banks of the river has high elevation. Roads passing through villages are very narrow. It might be difficult to attract tourists to Savitri river because most of the tourism places like Shrivardhan, Harihareshwar, Bankot fort are located at the mouth of the river. From Mahad to Harihareshwar, there is direct road connectivity (SH 100) from Raigad district, which runs parallel to river; thereby limiting scope to start ferry service connecting Mahad & Harihareshwar. However waterfront resorts and activities could be developed on the river to attract more tourist traffic.

Source: Consultant's Analysis

4.9. Forecasting & Potential IWT Assumptions

The inference drawn from above analyses and after interacting with port's authority, industries, and local people is that Savitri River does not hold potential for transportation of cargo. However, it is assumed that there may exist potential for Ro-Ro operation on the river only under certain ideal conditions. Existing industries that use JNPT port for dispatching their container by using NH 66 could use Ro-Ro service, provided the shift induces cost and time savings. Broadly, the logistics should favor the switch to IWT, both operationally and commercially.

It is also assumed that apart from chemical containers, other liquid cargo like LPG etc., which at present use the same NH-66 to transport in Konkan region, could also use Ro-Ro service. Based on site visit and inputs from industries, it is assumed that approximately 158 trucks ply on a daily basis on NH 66 that gets destined in Mahad. If the aforementioned conditions are met, then even this traffic could be targeted by IWT.

4.10. Terminal wise IWT Traffic Analysis (Exception Case)

Hinterland analysis and during site visit of Savitri river consultant did not find industries (Mahad) that could use river for transportation of cargo. Not a single industry showed willingness to use waterways. There is no scope for developing alternate port facility for cargo handling. Some of the factories in the hinterland use JNPT ports for their EXIM trade. There exist direct road connectivity from Plant to port. This is the main reason that all the industries use JNPT port for trade. Raw material and finished product in the form of container/tankers on trailers are transported using NH 66, i.e. Mumbai- Goa highway to JNPT. NH66 crosses over a Ghat and slow movement of trucks here causes road congestion. Cargo from these industries uses roadways to reach port. There exists a possibility to shift these trucks from roadways to waterways using customized ro-ro ships. Trucks instead of using roadways could use ro-ro to reach their final destination, as long as land allocations and other provisions are made at the port to run this ferry service. This modal shift would be a function of logistics cost savings in comparison to the existing modes of transportation. Figure 4 14 shows proposed terminal location B1 (Dasgaon) and connectivity.

FIGURE 4-14: Proposed Terminal Location

Source: Google Earth

4.10.1. Logistic cost comparison for Ro-Ro (Exception Case)

The current transportation logistics adopted by the industries in Mahad MIDC indicates their preference for moving their exim cargo. Unless and until there is very strong and a practical driving factor industries would not shift to waterways. Lower integrated logistics cost, as compared to road logistics cost, can act as the most ideal distinguishing criterion in this regard. Based on this comparison only, viability of the proposed Ro-Ro Terminal can be ascertained.

The Following Figure 4.15. Illustrates time and distance difference between the current roadway movement and the proposed route using the Savitri waterway:

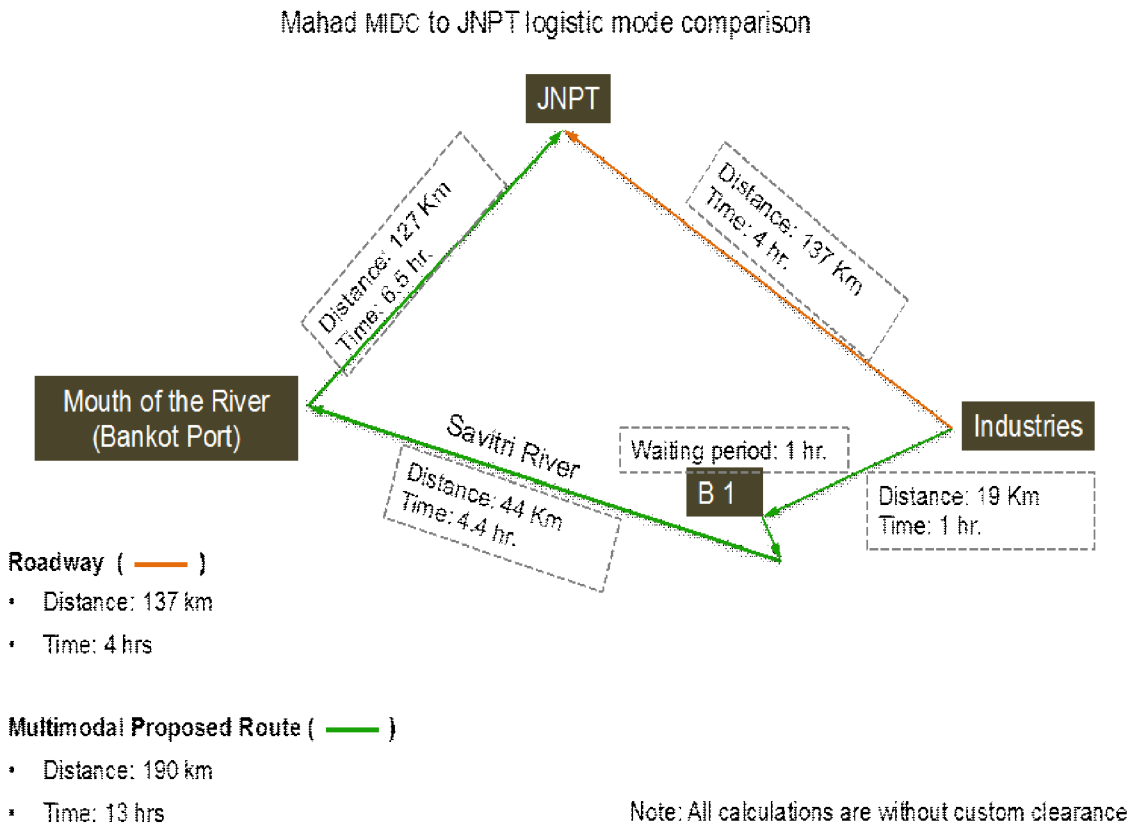


FIGURE 4-15: Time & Distance comparison

It is evident from the graphical representation above that time required to cover the distance to reach JNPT is more in case of multimodal route of waterway and road. Therefore, time and cost involved in multimodal transportation is also more compared to roadway. Proposed IWT route also involves multiple handling of trucks. This adds to the total logistic cost involved in transportation. An elaboration on the impact on overall logistics cost difference is depicted in the logistics cost comparison chart between the two modes in the following Figure 4-16. The table shows logistics comparison in two different cases under Ro-Ro cost dynamics. In Case I, vessel with a cumulative engine power of 839 kW and 20 kmph speed has been considered. In Case II, vessel with only one engine of 350 kW power and loaded speed of 10 kmph has been taken for cost comparison.

Ro-Ro/Trade Cost Dynamics

Origin	Destination
JNPT	Mahad

Ro-Ro Cost Dynamics (190 km)

Steps involved	Unit	Case I	Case II
Engine	kW	839	350
Engine fuel requirement	l/hr	222	102
Per Truck Ro-Ro Tariff	INR/Truck	9,233	8,832
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**9,375**	**8,974**

Truck Cost Dynamics (137 km)

Components	Cost (Rs.)	Cost
Fuel	INR	2,195
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**3,440**

Figure 4-16 Logistic cost comparison

Figure 4-16 gives the one-way cost breakup; similar cost would be applied for the return journey.

Two scenarios have been considered to arrive at logistic cost for a possible Ro-Ro service on the proposed IWT route. In case of Ro-Ro logistics cost analysis, Ro-Ro Tariff assumes costs related to the multi-modal logistics. This includes nominal fairway charges, charges associated with vessel chartering and the associated fuel cost, and port-related charges (berth hire and port dues). Traffic diversion from road to waterway entails cost saving in relation to truck transportation cost. Primarily, this saving is on fuel cost and toll charges. While calculating Ro-Ro cost dynamics, these haven't been considered, as these cost heads will never feature in Ro-Ro transportation logistics. In case of truck cost dynamics, there are other parameters that influence the total roadway logistics cost. These include Repair & Maintenance cost, driver/crew wages, truck finance cost, profit & other costs. Including these for truck logistics analysis will necessitate inclusion of the same cost heads in case of Ro-Ro cost dynamics. However, these costs will be nullified, as their impact on both the logistics cost dynamics will produce a similar cost escalation, leading to a similar logistics cost difference. It is assumed that IWAI will develop the entire infrastructure (Terminal & Navigation), and hand it over to the operator without looking to recover the development cost. IWAI will also be required not to take Terminal charges, Fairway usage charges, etc. in order to increase the appeal of any Ro-Ro service on Savitri River.

Costs involved in both the Ro-Ro cases are on the higher side when compared to roadways. This cost difference favours the roadway, as the difference between the two discussed transportation modes is at least over INR 5,000. In case of just Ro-Ro cost comparison, Case II is marginally cheaper than Case I.

Two scenarios have been considered to arrive at logistic cost for the proposed Ro-Ro route. However, cost involved in both the cases is relatively on higher side as compared to roadways. There are various costs associated with multi-modal transportation, like cost of multiple handling (loading, unloading whenever there is a change in mode of transportation) etc. which are not applied to roadways transportation. It is assumed that IWAI will be developing the entire infrastructure (Terminal & Navigation), and hand it over to the operator without looking to recover the development cost. IWAI will also not be taking Terminal charges, Fairway usage charges, etc. in order to increase the appeal of Ro-Ro Terminal.

4.10.1.1. Ro-Ro TERMINAL WITH SUBSIDY

It is evident from the logistics cost comparison that both the cases of waterway movement will be costlier than existing mode of transportation using roadways by a significant margin. As per Case I (higher engine power 839 KW), the logistics cost difference for roadway and waterway is INR 5,935/truck. Cost of transporting per truck on the waterway with the said engine configuration would be more than twice as expensive as roadway. In Case II (Lower engine power 350 KW), this cost difference is narrower with INR 5,534/truck. For development of Ro-Ro Terminal and for it to attract the projected traffic, government needs to subsidize the shift by offering the cost difference to the transporters. The subsidy amount will compensate for high logistics cost, but additional incentives need to be offered to make up for the increase in time and distance. IWAI should bear costs associated with maintenance of the Terminal (repairs and maintenance) and the navigation infrastructure (dredging, night navigation, buoys, etc.). A combination of subsidy and incentives is needed to induce shift of traffic from existing roadways to waterway for EXIM requirements of the industries in Mahad MIDC.

The higher cost difference could be reduced or have a relatively negligible impact on the appeal of waterway logistics over the competing modalities. It's assumed that exim requirements of the industries in Mahad will continue to rise, leading to increase in cargo volume on road. Shift of higher cargo volumes over to the waterway could make up for the higher per-truck logistics cost. This could also lead to a lower subsidy amount required for disbursal to the transporters to influence them to shift to waterways. In order to approach deployment of Ro-Ro under suitable market conditions, IWAI should observe the market for the next 3 years. In the event exim requirements for Mahad industries continue their upward trend, as projected in traffic volumes up to 2040, decision for setting up Ro-Ro Terminal on Savitri River could be taken by 2020. Taking into account construction period of 2 years, the Ro-Ro terminal should become operational by 2022. This is an ideal scenario, suggested to explore and exploit possible opportunities leading to development of the said Ro-Ro Terminal.

As per site visit and based on the overall traffic movement on the Highway (NH 66), it was inferred that about 750 trucks plied along this roadway route on a daily basis.

This road traffic includes movement for both the industrial regions of Mahad and Lote Parshuram. It has been assumed that 60% (450 trucks/day) of this movement could shift to waterway. Out of this daily traffic of 450 trucks, Mahad MIDC has been assigned a lower share of 35% (158 trucks/day) traffic, on account of it being smaller than Lote Parshuram industrial area. This is the base traffic that could be shifted to waterway in the event a ro-ro service is started on Savitri River in future. Based on industry inputs, this share has been further split into 60%-40% ratio, where larger share is for importing raw materials and the latter for exporting finished goods. Maharashtra's secondary sector has grown at an average rate of 4% between 2009 and 2014. This growth rate was applied to derive future traffic volume that could be moved on the River for cargo originating and destined for industries in Mahad.

TABLE 4-25 : Terminal & commodity wise projections

Name of the waterway: NW-89 (Savitri River, 45.47 km)

Sr. No	Name of Cargo	Type of Cargo	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Co-ordinates	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (No Terminal Present on River)														
Proposed Terminal Opportunity for IWAI														
1	Liquid, Bulk, break bulk	Ro-Ro	Mahad	B1 - Dasgaon	JNPT	B1 - Dasgaon	18° 05'56.41"N, 73°20'22.35"E	('000 Trucks)	0	27	33	40	49	59
			JNPT	n/a	Mahad				0	40	49	60	73	89
Total									0	67	82	100	122	148

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

Source: Consultant's Analysis

At present there is no existing terminal or jetty on the river. Only Bankot port which is a non-major port under MMB is located at the mouth of the river. However cargo traffic handled at this port is very inconsistent in nature. Industries use JNPT port for all EXIM purpose. There do not exist any major Cement, Coal based power plant, fertilizer industry, Iron & Steel industries in the catchment area of the river. There is no plan for any upcoming industry in the region.

The projections for Ro-Ro traffic on Savitri river is influenced by following factors

- No cargo traffic potential due to absence of Thermal Power Plants, Iron & steel industries, Fertilizers units etc. No upcoming plans of these sectors within the hinterland of Savitri in coming years.
- Existing chemical industries predominantly use roadways and they are unwilling to shift to waterways.
- Logistic cost comparison between roadway & multimodal route
- Secondary sector performance in Maharashtra
- Direct road connectivity from industrial units of the hinterland to JNPT

All the assumptions are based on inputs provided by industrial units and site visit.
Mahad MIDC is one of the major industrial areas, which has close proximity to Savitri River.
Majority of industrial units inside this MIDC are chemical based and most of them have small-scale operation. There is no major port in the hinterland. Bankot Port, which is a riverine and non- major port located on the mouth of the river, lacks container-handling facility. Due to these factors, all the industries in the hinterland use JNPT for EXIM purpose. NH 66 (Mumbai-Goa) is used for transporting cargo from industries in the hinterland to JNPT.

Industries did not show willingness to use Savitri River, stating cost and time as major decisive factor. A detailed logistic cost analysis of present mode (roadway) v/s multimodal route justifies the same. There is huge difference in logistic cost of the two modes. One-way cost for per truck on roadway is INR 3,440. Whereas, in multimodal route of Case I and Case II, cost is INR 9,375/truck and INR 8,974/truck respectively. Hence, it is concluded that due to huge cost difference, industries would not prefer waterway for transporting their cargo. However, provided subsidy & additional incentives, industries might opt for waterways as an alternate mode of transportation.

Another major reason is time involved in transportation. Multimodal route would take 13 hrs. to reach JNPT without custom clearance; whereas through roadway, it takes around 4 to 5 hrs. (Excluding custom clearance) to reach JNPT. Considering all these factors, it is not feasible to develop Ro-Ro on a stand-alone basis. Thus, hypothetically, assuming the Government provides Operational subsidy & additional incentives, traffic was projected.

· It was observed during road survey undertaken on NH 66 that on an average 450 trucks/day move which are destined to chemical hub, located in the hinterland of Savitri (Mahad MIDC) & Vashishti (Lote Parshuram MIDC). It is assumed that 35% of trucks would be shifted to river Savitri because scale of operation of Mahad MIDC is comparatively smaller than Lote Parshuram MIDC, which is in the hinterland of river Vashishti. Due to larger scale of operation in Lote Parshuram MIDC, 65% share is assumed for river Vashishti.

· The base traffic considered for river Savitri, i.e. 35% of 450 trucks/day, is increased at a moderate growth rate of 4% Y-O-Y. 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%.

Further, total traffic projected on Savitri is divided into two-way truck traffic, i.e. from industrial units to JNPT & vice versa. As per interaction with industries, it was found that number of trucks moving from JNPT to industries is higher compared to movement of trucks from industries to JNPT. Hence, it is assumed that 60% of total traffic projected for Savitri would move from JNPT to industries and 40% of total projected traffic would move from industries to JNPT.

4.10.1.2. RO-RO TERMINAL WITHOUT SUBSIDY

Without the offer of aforementioned subsidy amount, industries would not deviate from their current logistics practice. In such a case, Ro-Ro Terminal on Savitri River will not be a viable enterprise to pursue. Therefore, in such a scenario, it is not recommended to develop Ro-Ro Terminal on the River.

Also, in the event the market doesn't show marked increase in traffic volume for the Mahad industries, the decision to set up a Ro-Ro terminal on Savitri River becomes irrelevant. The cost difference between roadways and waterways will remain the same or widen even further. Even in the ideal situation where the government will be willing to compensate the cost difference, the Ro-Ro terminal is unlikely to generate profits in the long run. A combination of increased costs, time, and distance will weigh on the overall appeal and benefits of waterway movement, deterring potential customers.

Abbreviation	Full Form
DES	Directorate of Economics & Statistic
GOM	Government of Maharashtra
GSDP	Gross State Domestic Product
MT	Metric Ton
Sq. Km	Square Kilometer
Ha.	Hectare
SH	State Highway
MW	Mega Watt
MIDC	Maharashtra Industrial Development Corporation
MMB	Maharashtra Maritime Board
DWT	Deadweight Tonnage
TPA	Tons Per Annum
MMTPA	Million Metric Tonnes per Annum
TPP	Thermal Power Plant
MMB	Maharashtra Maritime Board
MbPT	Pulverised Coal injection
MH	Jawaharlal Nehru Port Container Terminal
HPCL	Nhava Sheva International Container Terminal
BPCL	Central Warehousing Corporation
IOCL	International Container Transshipment Terminal
GOI	Government of India
RCF	Rashtriya Chemicals Fertilizers Limited
POL	Petroleum
ICTT	International Container Transshipment Terminal

CHAPTER 5: TERMINALS

5.1. General Review

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

5.2. Identification and Site Location

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

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

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

Savitri River valley (Bankot creek) is located in the south of the Raigad District. Savitri River forms the border between Raigad and Ratnagiri districts. Coconut and Areca nuts gardening is well practiced in the Savitri valley.

The River in the study stretch is well connected with both Rail & Road network available within 15.0 km of distance from the nearest industrial area (MIDC-Mahad).

Important industries within 50 km are MIDC-Mahad; Laxmi Organic Industries Ltd., M/s Chaitali Petro- Chem Industries Pvt. Ltd., Om Chemicals, Caprolactam Chemicals Ltd.,Vinati Organics Ltd., JBS Pharma Chem Pvt. Ltd., M/s Privi Organics Ltd., Titan Laboratories Pvt. Ltd.

At present, it is being utilised by ferry service for Passenger / Tourism. Ferry Services between Harihareshwar to Bankot, Bagmandala to Veshvi and Kolmandala to Veshviare are operational. About 0.27 MMTPA of cargo is moving through Bankot Creek. 25 jetties all along the study stretch are being utilized for Fishing and Local transportation.

Taking into the consideration the origin and destination and fairway, the most probable Terminal location has been considered at approx. Lat 18° 05' 55.00" N and Long 73° 20' 11.56" E near Ch 45.20km.

The traffic volumes, as identified at Savitri are domestic. The chemical industry in MIDC, Mahad is having high potential of mobility for its raw material and finished product to JNPT / MbPT. Accordingly, to meet the above traffic volumes, 1 Roll-on Roll-off (Ro-Ro) Berthing facility and IWT Terminal has been planned. This traffic has been taken into consideration for IWAI Terminal development on Savitri River.

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

Terminal Land Area Requirement for the Waterway Savitri in Cluster 7

S.No.	Facility	Nos.	Size	Area (m2)
1	Open Nobility Area (Nominal)	1	100 m x 100 m	10000
2	Covered Storage Godown (Nominal)	1	50m x 30m	1500
3	Ro-Ro Truck Parking	20	16m x 3m	960
4	40' Container Stack Yard	20	40 Sq. m	800
5	Main Parking Area	1	30m x 30m	900
6	Public Utility	1	6m x 4m	24
7	Weigh bridge	1	8m x 3m	24
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9
9	Area under internal Roads	1	7.5m x 150m	1125
10	Administration building	1	12 m x 15 m	180
11	Business Area	1	10m x 3m	30
12	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
13	Staff Parking Area-2 wheelers	1	8m x 2m	16
14	Security shed for watch and ward	2	4m x 4m	32
15	Electrical facility	1	5m x 5m	25
16	Fuel Bunkers	1	10m x 5m	50
17	Water Supply Room	1	3m x 4m	12
18	Fire and Safety Room	1	3m x 4m	12
19	DGPS receiver & transmitter shed	1	8m x 4m	32
20	DG shed	1	5m x 5m	25
21	Canteen with Store	1	12m x 8m	96
22	Sewerage Treatment Plant (STP)	1	15m x 15m	225
23	Overhead Tank	1	10m dia	100
24	Green Area	1		1000
25	Future Requirement	1		2000
				19258

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-X06**. With regard to the Land, there is no need of consideration of any phased development, since the ground development shall be taken up at initial phase itself. Further, the Terminal location is connected to the NH 66 near “Dasgav” village and the distance is only 50 m (Estimated cost of 0.75 Cr), which may have to be taken up by the concerned agency.

Accordingly, a layout plan demarcating the infrastructure requirement is developed Refer Volume-II Drawing No. **P.010257-W-20311-A06** for details.

5.4. Land Details

The Land area identified is at Location as below

TABLE 5-1: Terminal Land Details

Coordinates (UTM) N/E	**2001899.498**	**324288.952**
Coordinates (DMS) N/E	**18°05'55"N**	**73°20'11.56"E**
Village	Dasgaon	
Taluka	Mahad	
District	Raigarh	
State	Maharashtra	
Nearest Town	Mahad	
Distance of town (km)	10	
Land use	Private Land presently under filling	
Ownership	Private	
Water Distance	on edge of land 5m	
Nearest Road	NH-66	
Road Distance (m)	43	
Nearest Railhead	Veer Railway stn	
Railhead Distance	8km	
Nearby major Structure	Bridge on river	
Terrain	River bank land	
Soil/Subsurface strata	Presently filled by RBM	
Surveyed Area (Approx.)	25682 (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 selected area/site is very near to Dasgaon (a village in Raigad District in Maharashtra) on the left bank of Kal River (a right bank tributary of Savitri River). The Dasgaon area forms a small part of the “Konkan region”, an important geomorphic unit located due immediate west of the western slope of the Western Ghat escarpment and due east of the Arabian Sea. The landscape of the area is characterized by nearly north - south trending hill ranges separated from one another by narrow, nearly flat pediment slopes of uneven width.

Geologically, the area around Dasgaon forms a small part of the western Deccan Province and exposes lava flows having compound, pahoehoe as well as simple flow morphologies. The lava sequence exposed in the area has gentle southerly as well as westerly gradient and they been grouped under Indrayani, Karla, Diveghat formations (GSI, 2001). The lava sequence is intruded by a number of bsasaltic/ doleritic intrusive majority of which trend in NNE-SSW or NW-SE directions and is also seen cut by a few NW-SE trending regional fracture zones. In the area located due west of Dasgaon, the lava sequence is capped by laterite especially in parts of Mhasala and Shrivardhan Talukas.

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.

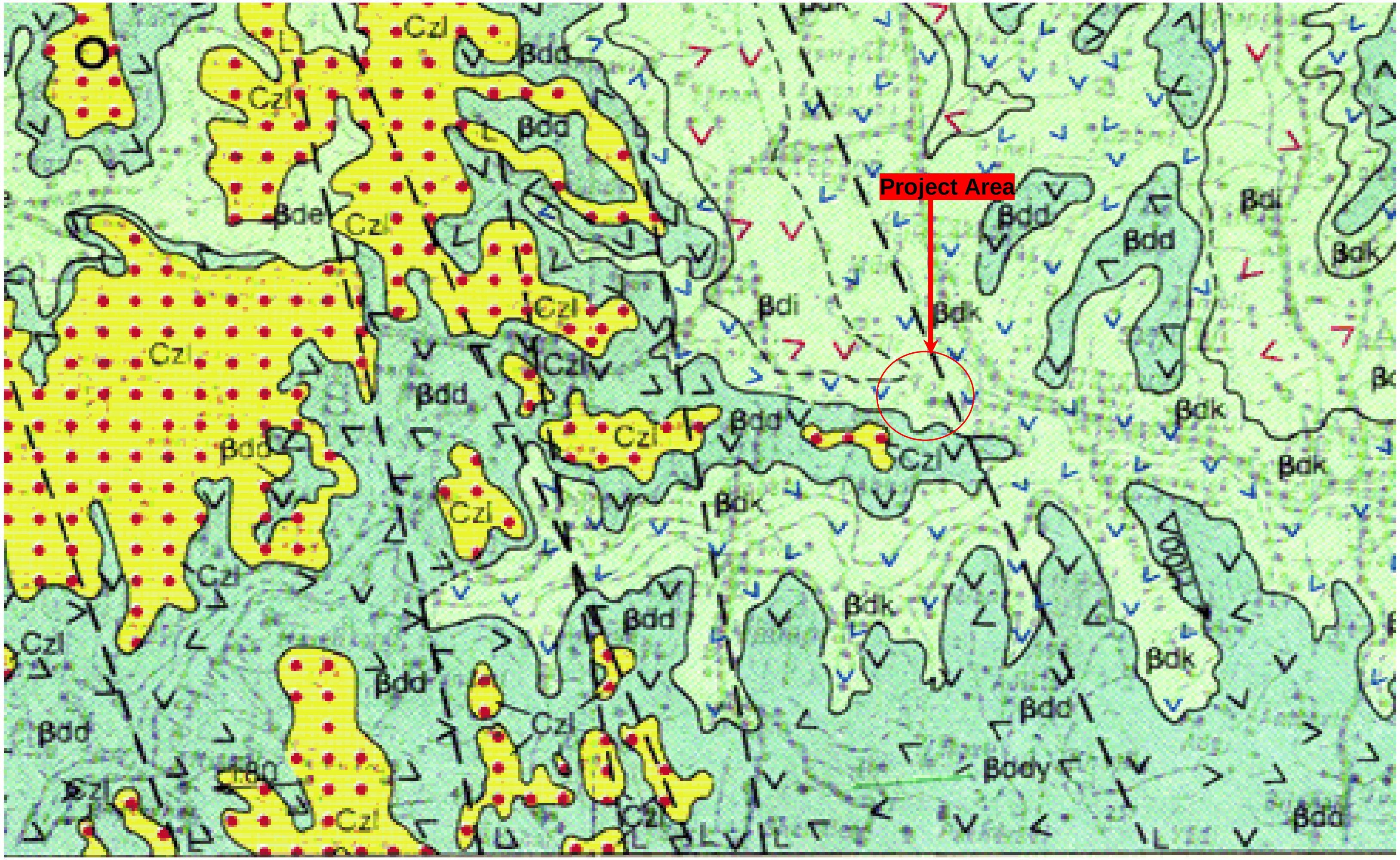


Figure 5.1: Blow up of the Project area from geological quadrangle map (Figure 1.3)

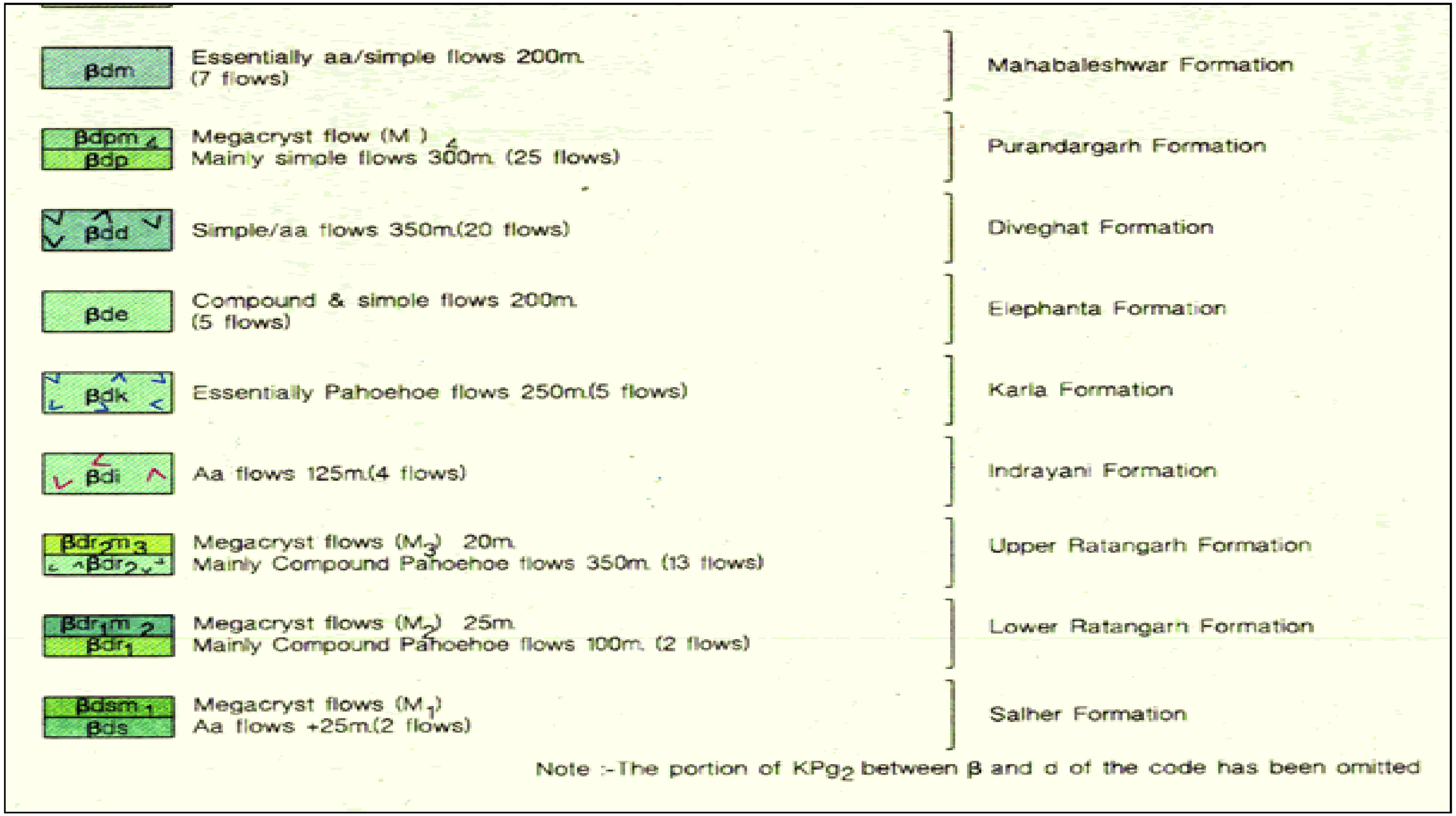


Figure 5.2: Index of the geological quadrangle map (47F)

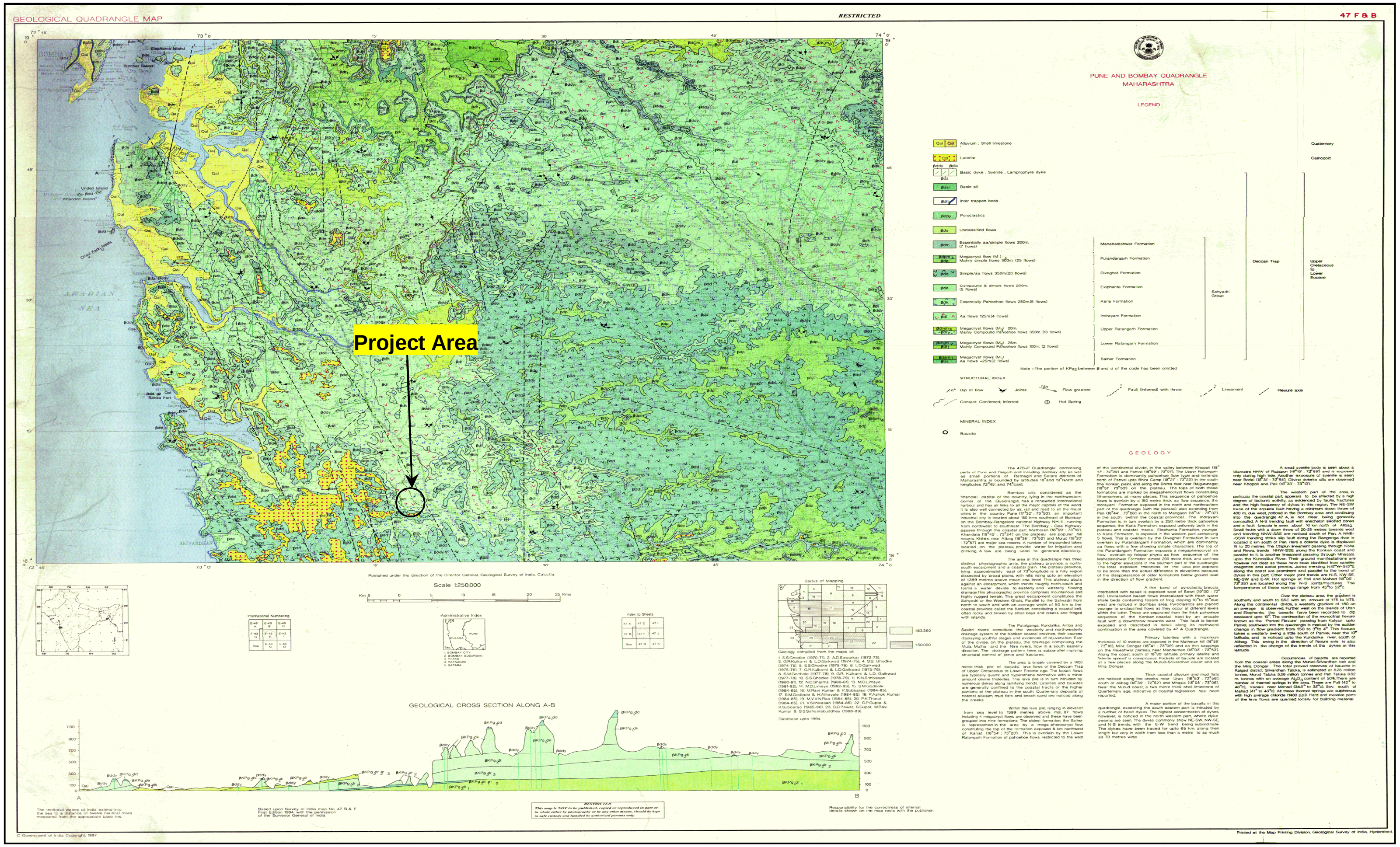


Figure 5.3: Geological Quadrangle map (47F) showing Project area (Source: Geological Survey of India)

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 project area forms a part of Savitri River basin. The Savitri and Kal rivers, which are tidal rivers, constitute the major drainage of the study area. The lower order drainage of the area is largely dendritic and occasionally rectangular with higher order streams and rivers flowing either in northerly or southerly direction and joining westerly flowing Savitri River. Other rivers of the area include Gandhari River, and Nageshwari Nadi. The rectangular drainage pattern of the lower order streams as well as the north-south orientation of the tributaries of Savitri River appears to be controlled by joint/ fracture trends in the bed rock.

The location of the selected site on Google earth is shown as Figure 5.4 while the enlarged view of the same is shown as Figure 5.5 while the figures showing the actual condition of the site is shown as Figure 5.6, 5.7 and 5.8 respectively.

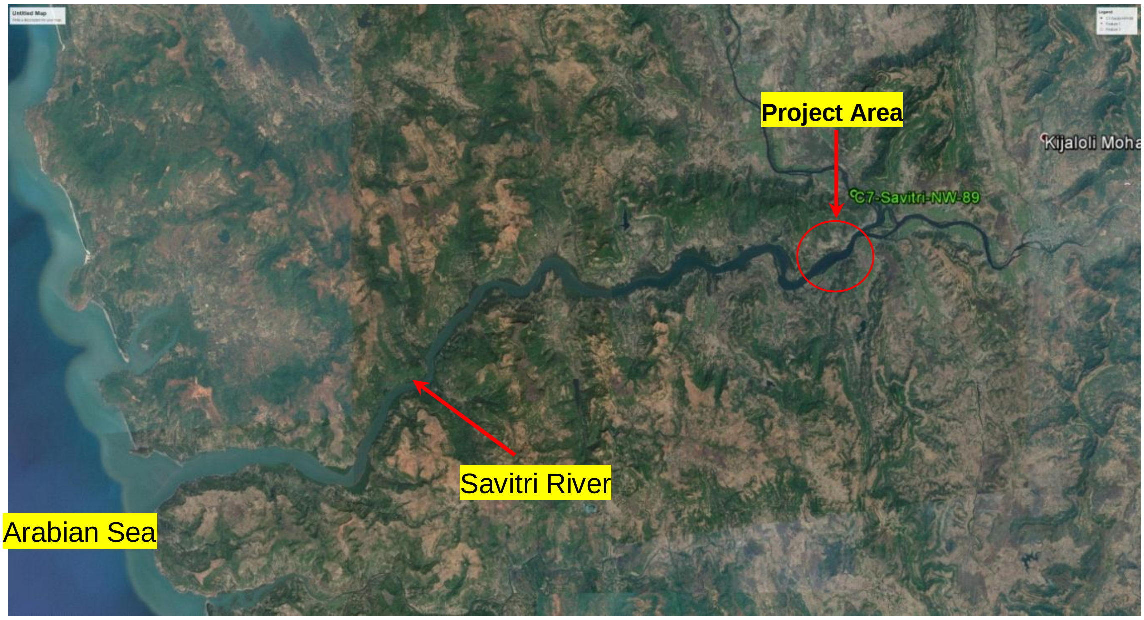


Figure 5.4: Google earth image showing Project area (in Circle)

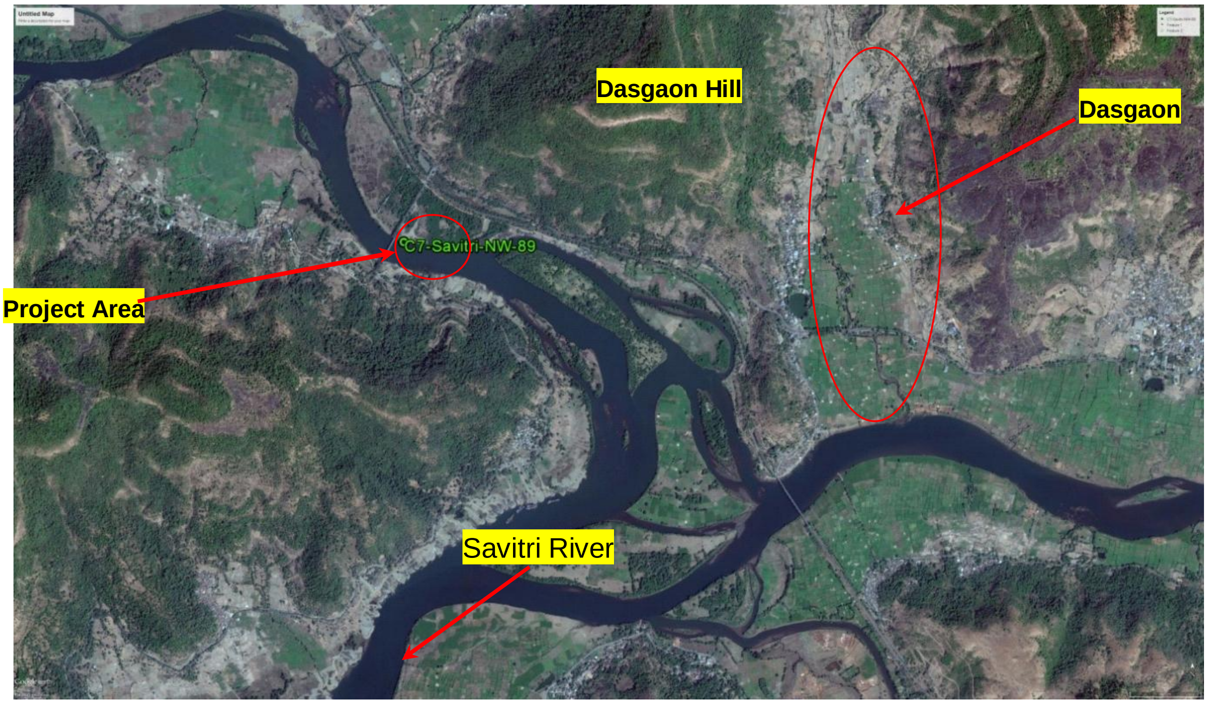


Figure 5.5: Enlarged view of Google earth image showing Project area (in Circle)

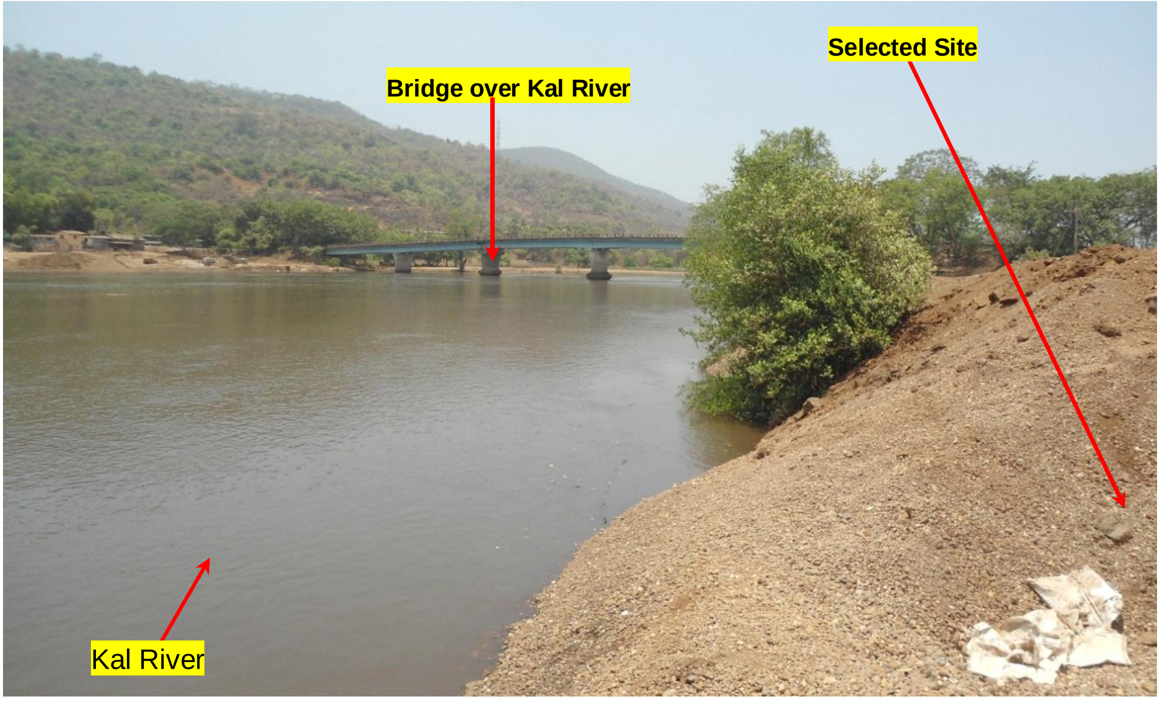


Figure 5.6: Image showing River Savitri and part of selected site

Figure 5.7: Image showing River Savitri and part of selected site (while surveying)

5.5.3. General Geology and Stratigraphy

Generally the project site/area represents a sub-hilly terrain having gentle to moderate slopes over which vegetation has grown up. All the slopes are covered with thick soil cover having protected forest or agricultural land over it. Savitri is the main river which passes through the region and it has very well fed the area. The nearby area to the river are occupied by alluvium which can be seen deposited along its both the banks. These deposits extend ever large areas and are comprised of loose grit & fine silt, sand and clay deposits which supports the agricultural activities in the area.

Dasgaon hill (**Figure 1.5**) is a nearly flat topped north-south trending hill which is wider in its southern part and tapers in the northern part. The hill section exposes stack of pahoehoe lava lobes which together form a typical compound lava flow. The internal structure of individual lava lobes such as basal vesicular zone with pipe vesicles, nearly vesicle free cores, vesicular/ amygdular crusts and glassy rinds can be best studied in road section located at northern end of hill. In addition, a few loose blocks with casts of ropy lava can also be observed. According to the lithostratigraphic classification scheme developed by Godbole et. al., (1996), the lava flow exposed at Dasgaon belongs to the Karla formation of Sahyadri Group.

The exposures at the northernmost end of the Dasgaon hill where, NH – 17 cuts across the hill and at places where, rockmass has been cut into terraces for the construction of the dwellings can be described as nearly fresh to sparsely/ slightly altered (W0 – W1) whereas, in the other parts of the hill, the rockmass is moderately to highly to completely altered (W2 – W4) and is unevenly covered by in-situ soil column (W5).

5.5.4. Sub-surface Investigations

The selected site has been investigated by one drill hole (BS-1) which has been drilled for depth of 11.50 m. The detail of the drill hole is tabulated below in **Table 5-2**.

Table 5-2: 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.	BS-1	Centre of Terminal Area, Right bank of Kal river (tributary of Savitri river)	11.50	0	4.0	4.0	Greyish Brown Medium Dense Silty Gravelly Sand	11-12			1.60 m below GL
				4.0	5.5	1.5	Completely Decomposed Rock	60			R stands for Refusal
				5.5	11.5	6.0	Greyish / Brownish Highly to Moderately Weathered Basalt.	R	45-79	Nil-54	

The description of the drill hole is as given below.

BS-1: Drill hole BS-1 has been drilled over the terminal location area on the left bank of Kal River (right bank tributary of Savitri River). The drill hole has been drilled vertically down to the depth of 11.50m from EL.9.75m to EL. -1.75m. The drill hole has encountered 4.00m thick Greyish Brown Medium Dense Silty Gravelly Sand followed by 1.5m thick layer of completely decomposed rock. After this (5.50m depth) the drill hole has encountered Greyish, highly to moderately weathered Basalt up to the termination of drill hole. The core recovery in the bed rock varies from 45.00%-79.00% and RQD ranges from 0.00%-54.00%.

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

Three 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 5-3**.

Table 5-3: Summary of In-Situ Test Results

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Greyish Brown Medium Dense Silty Gravelly Sand	1.5	2.1	12
		3	3.6	11
2	Completely Decomposed Rock	4.5	5.1	60

Laboratory Test Results

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

3 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 5-4**.

Table 5-4: 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/cm³		%	%	%	%	%	%	%	%	%			Kg/cm²	degree	C_C	e_0	G
BS-1	Greyish Brown Medium Dense Silty Gravelly Sand	1.50	2.10	SPT	1.86	1.62	14.57	0	81	19						SM						2.63
		3.0	3.60	SPT				5	74	21						SM						2.61
	Completely Decomposed Rock	4.5	5.1	SPT	1.85	1.64	12.65	7	52	28	13	32	18	14		SC						2.64

Testing on Rock Core Samples

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 5-5**.

Table 5-5: 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 to Moderately Weathered Basalt.	5.5	7.0	80	4.43	97.44					
		7	8.5	130	5.02	110.39					
		10	11.5	3010		136.77	3.84E+04	0.2	0.85	2.14	2.81

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 5-6: Soil parameters adopted for the analysis

Depth		Strata Type	Average N Value	Thickness (m)	Unit Weight (kN/m^3)	Cohesion (kN/m^2)	Angle of Internal Friction (Degrees)	Compression Index (Cc)	Initial void Ratio (e_0)
From (m)	To (m)								
0	1.5	Sand	12	1.5	18.6	0	32.5	-	-
1.5	3.0	Sand	11	1.5	18.6	0	31.5	-	-
3.0	5.0	Gravel	60	2.1	18.6	0	40.0	-	-

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-5.1**.

Table 5-7: 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	202	262	328	399
2.	2.0 m x 2.0 m	212	269	329	393
3.	2.5 m x 2.5 m	225	279	336	396
4.	3.0 m x 3.0 m	239	291	346	403

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 5-8: 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	1812	193
2.	1.3 m	5	3082	289
3.	1.4 m	5	3589	325

5.6. Terminal Infrastructure including equipment

The land area identified is measuring to about 25682 Sq. m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities for the terminal has been worked out to 19258 Sq. m, which can be accommodated within the Land proposed to be taken on Acquisition.

Considering the Class IV waterway classification, RO- RO facility shall be planned at the terminal location.

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. The requirements of the berth differ depending on the nature of traffic being handled at the berth. The size of the structure shall depend on the largest vessel likely to use the berth. 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 (if any), traffic, and water level variation. The RO RO berth has been designed for 40ft container loading as per IRC classification.

Deck Level

As per IS 4651_IV, the deck level of the RO RO structure shall be fixed based on the variations in water levels during the monsoon and non-monsoon season. Keeping this in view, the deck of RO RO is maintained in a slope of 1:12, maintaining the deck level at the shore side at 1m above the highest water level .On the river side, the deck level is fixed maintaining under keel clearance of 0.5 m below the vessel. The position of vessel approaching the berth shall vary corresponding to the water depth available at site. The fixed ramp shall be submerged in water corresponding to the variations in water level available at site.

Deck Dimensions

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

TABLE 5-9: Salient Features of RO RO Structure

Description	Length(m)	Width (m)
RORO	75	16.60

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-E06**)

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

5.8. Terminal Costing

5.8.1. Capital Cost

The Capital Cost for the fairway has been considered in Chapter 11 along with the proposed development for RO-RO Terminal facilities at the defined location. The Capital Cost of terminal works out to be about 30.78 Crores.

5.8.2. O&M Cost

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

CHAPTER 6: PRELIMINARY ENGINEERING DESIGNS

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

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

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

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

To ensure effective disposal of sediment load.

To provide minimum water depth required for navigation.

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

6.1.1. River Training through Spurs

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

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

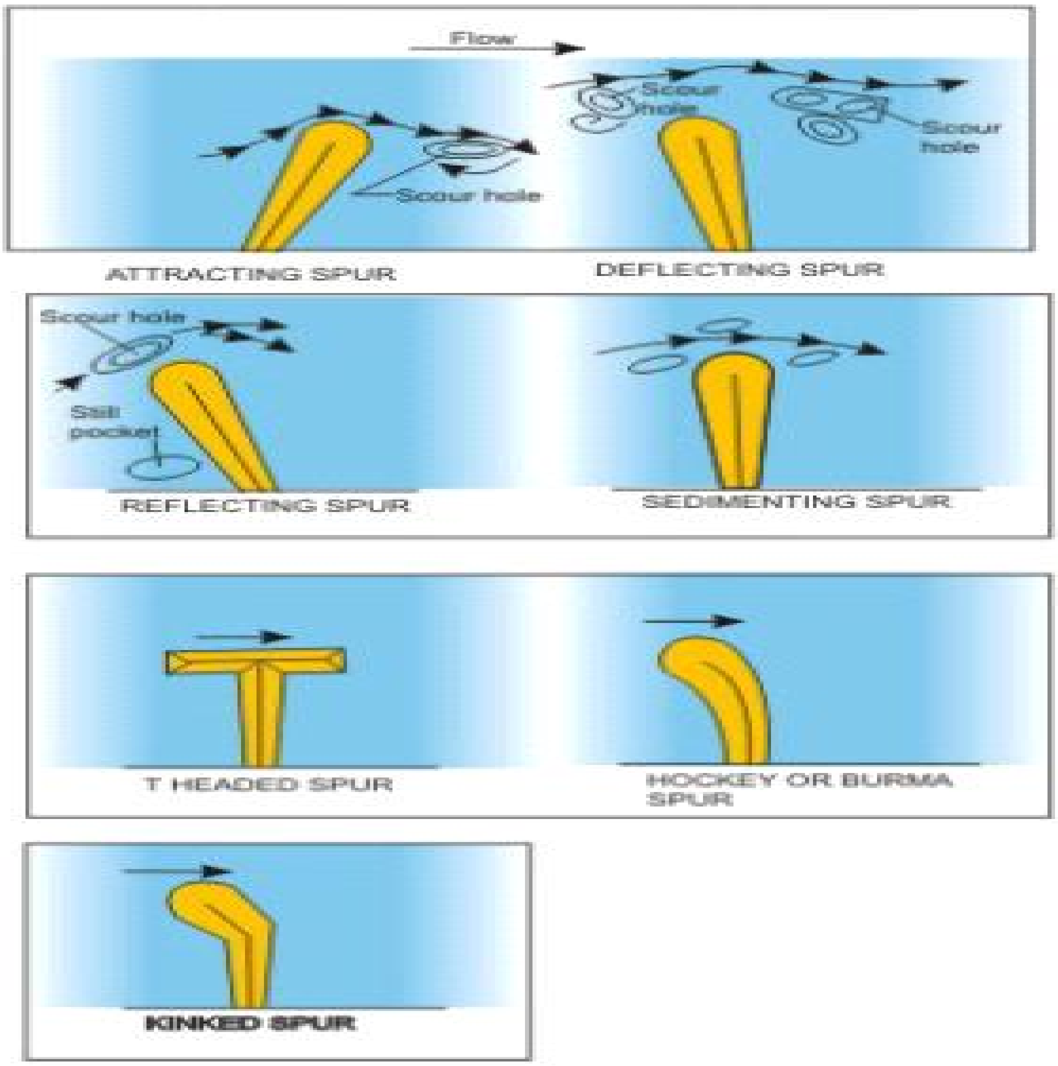


FIGURE 6-1: Different types of Spur

General Design Considerations

Layout of Spurs

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

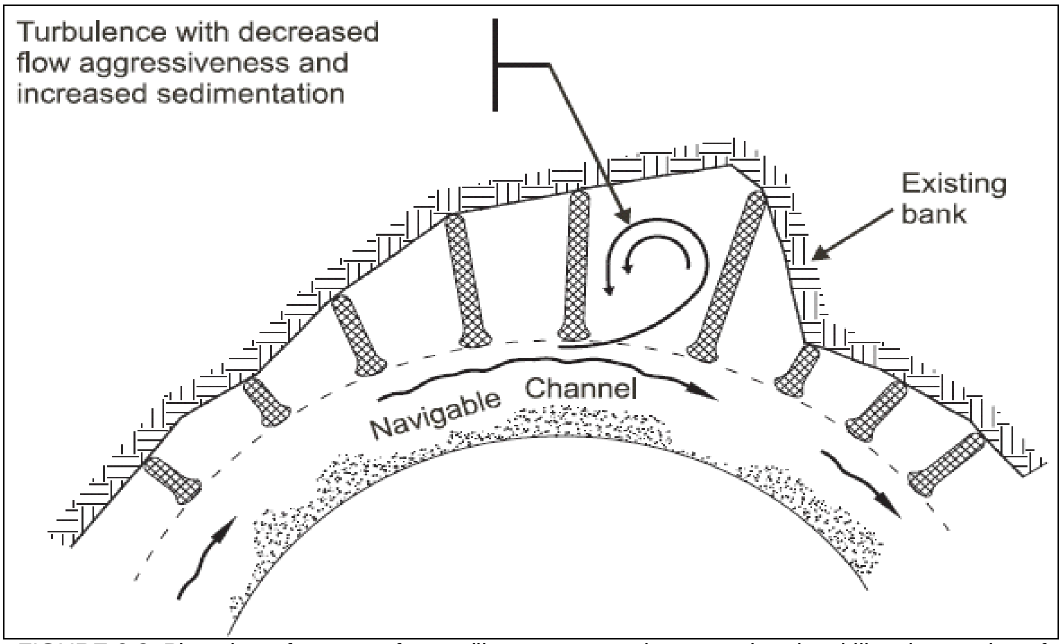


FIGURE 6-2: Plan view of system of spur-dikes constructed to control and stabilize the erosion of the outer band

Spacing

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

Where,

U = depth-averaged velocity (m/s)

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

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

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

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

e_{SP} should never exceed 1.

For the navigational requirement

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

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

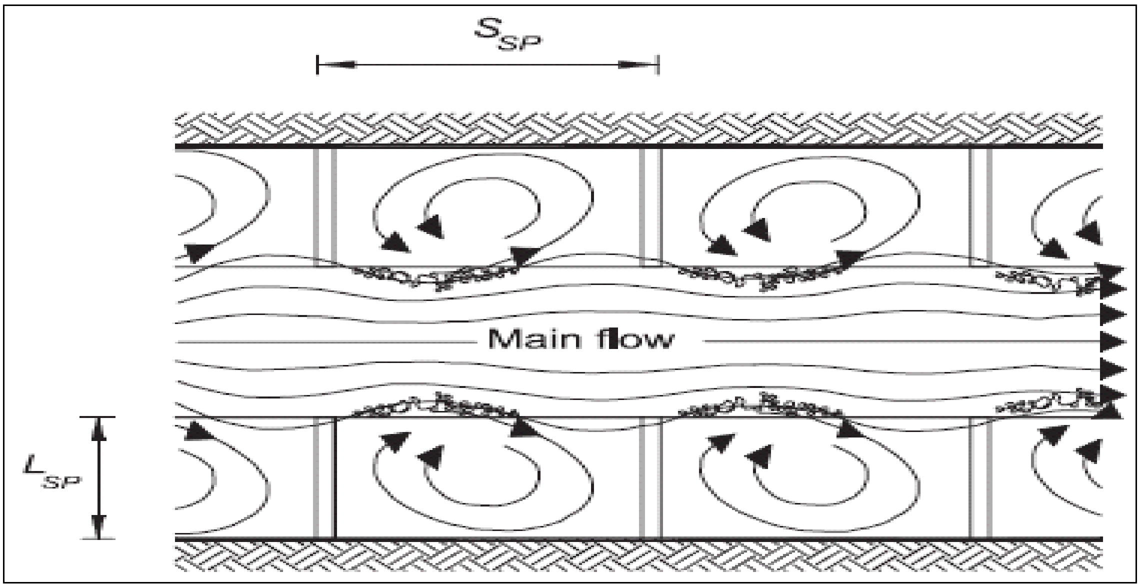


FIGURE 6-3: Diagram showing the length and spacing of the individual dikes with respect to the river width

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

Length

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

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

Top width of spur

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

Free board

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

Side slope

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

Size of stone of pitching

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

Thickness of pitching

Thickness of pitching is determined from the formula,

$T = 0.06\ Q\ 1/3$,

Where, Q = design discharge in Cumecs.

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

Provision of filters

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

A typical layout of a spur is shown in Figure.

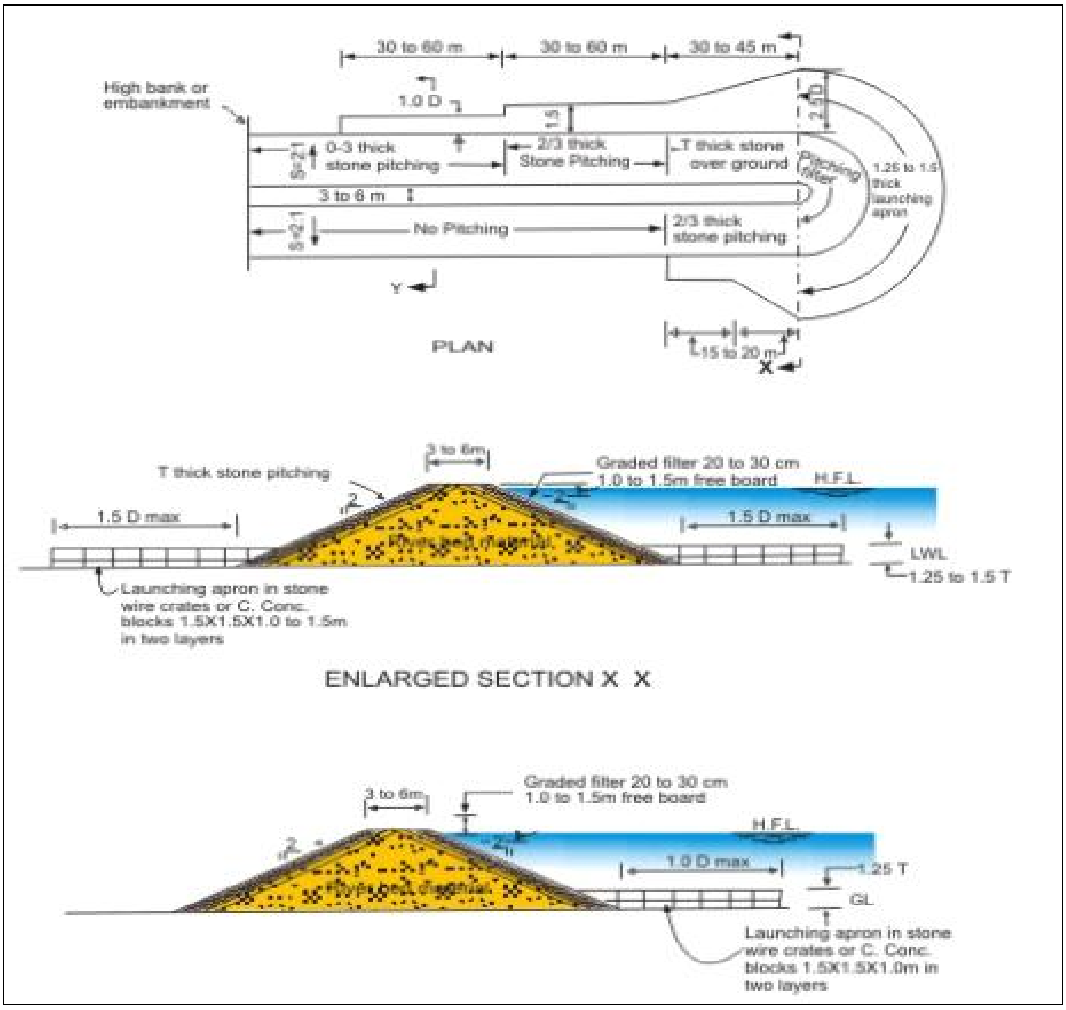
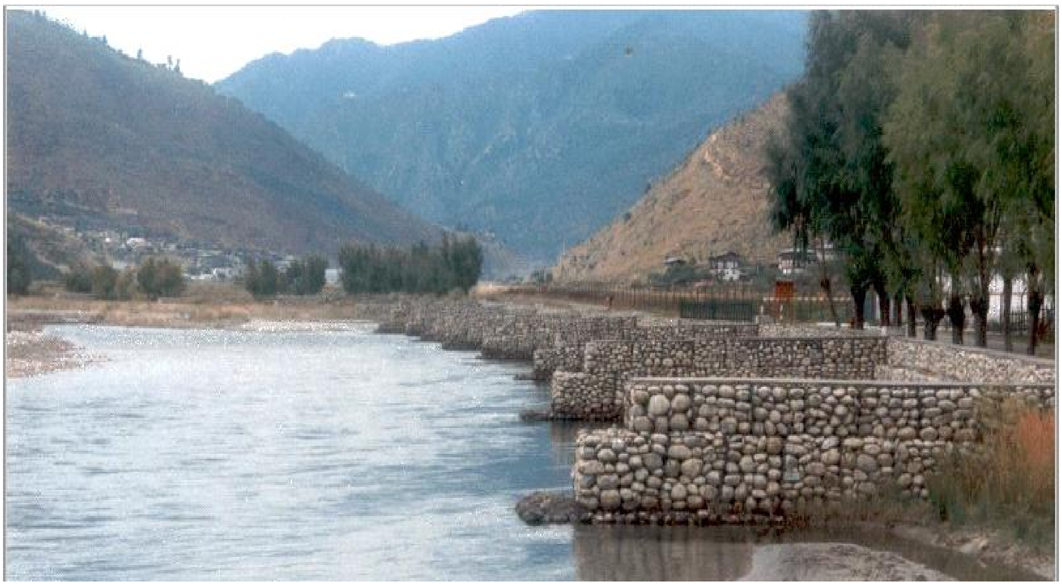


FIGURE 6-4: Typical layout and section of spur

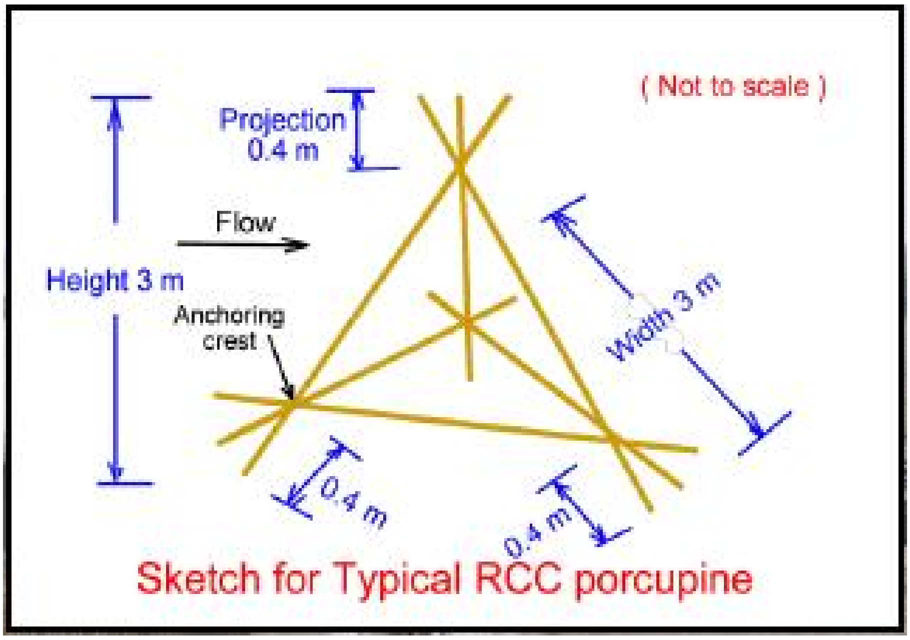
Impermeable spurs



Series of spurs

6.1.2. River Training through Porcupines

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



6.2. Bank Protection

6.2.1. Basis of Design

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

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

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

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

A. Design Principles

Applicable Codes, Standards and Guidelines

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

- IS1893 (Part1): 2002. Criteria for earthquakes resistant design of structures
- IS7894: 1975. Code of practice for stability analysis of earth dams
- IS8408:1992. Planning and design of groins in alluvial rivers
- IS10751:1994. Planning and design of guide banks for alluvial rivers
- IS12094:2000. Guidelines for planning and design of river embankments
- IS14262:1995. Planning and design of revetment guidelines
- IS11532:1995. Construction and maintenance of river embankments.
- Escarameia M. (1998). River and Channel revetments: a design manual. Thomas Telford Publications, London.
- Bezuijen A. and Vastenburg E.W. (2013). Geosystems: Design Rules and Applications. CRC Balkema.
- PIANC (2015). Guidelines for Protecting Berthing Structures from Scour Caused by Ships. Report no.180.
- PIANC (2014). Harbour approach channels design guidelines. Report no. 121.
- CIRIA, CUR, CETMEF (2007). The Rock Manual. The use of rock in hydraulic engineering (2nd edition). C683, CIRIA, London.
- Pilarczyk, K.W. (2000). Geosynthetics and Geosystems in Hydraulic and Coastal Engineering. Taylor & Francis Group, London & New York.
- Lafleur, J. (1999). Selection of geotextiles to filter broadly graded cohesionless soils. Geotextiles and Geomembranes, 17(5), p. 299-312.
- BAW (1993). Code of practice - Use of geotextile filters on waterways. BAW, Karlsruhe.

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

B. Design Vessel

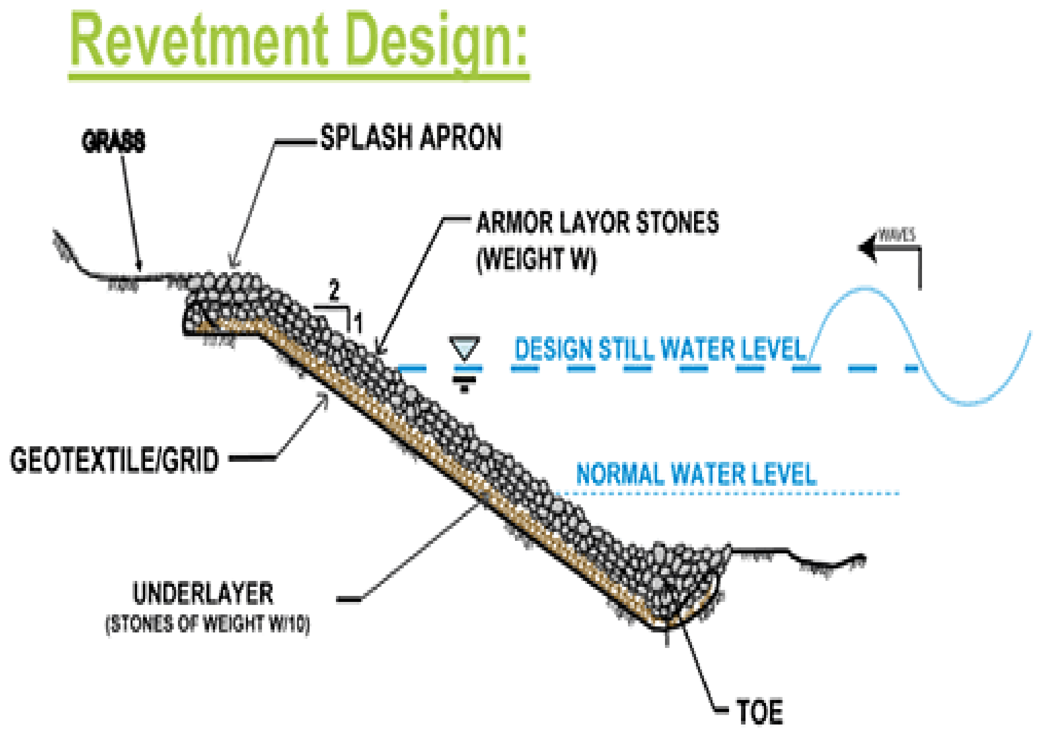
Vessel features are important in the design because moving vessels induce waves and currents in the river, which are a hydraulic load on the bank and river bed. These parameters will influence the design of the free board, the hydraulic stability of the structure and the size of the scour protection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

C. Design requirements for Revetments

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

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

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



D. Filter

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

E. Toe protection

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

F. Anchoring

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

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

G. Hydraulic and Geotechnical Design

1) Revetment

a. Stone size

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

- δ = friction angle between the geotextile bag surface and the subsoil, 20 degrees is recommended to be a conservative value;
- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made;
- The specific gravity of the stones is 2.65.

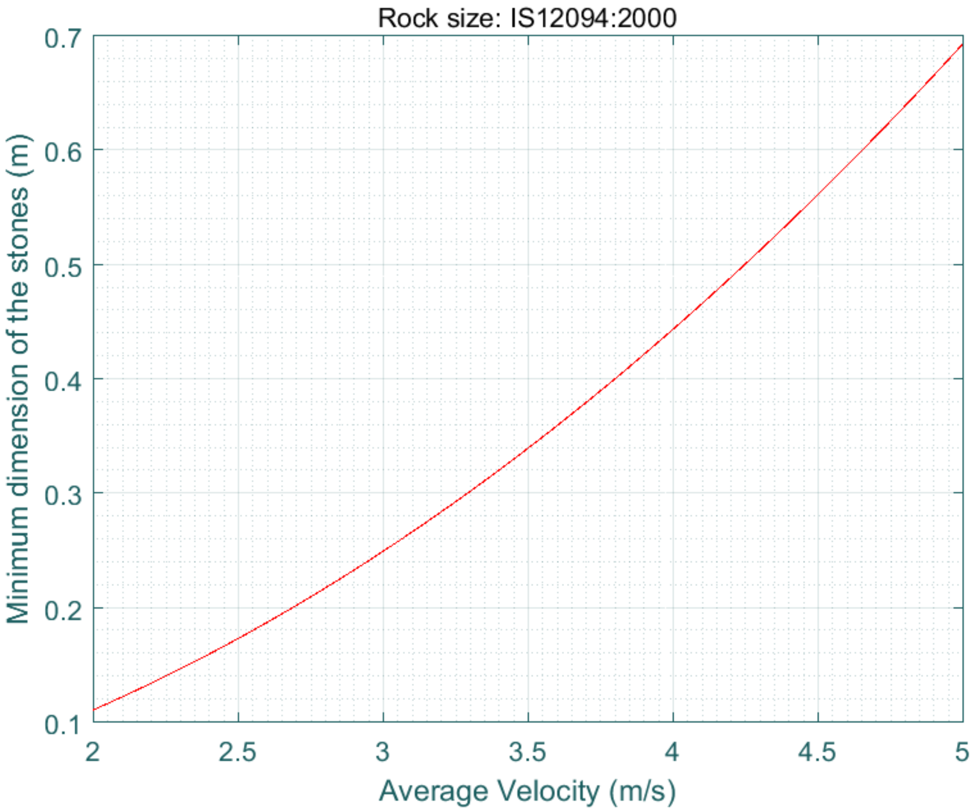


FIGURE 6-5: Minimum rock size according to the IS12094

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

b. Gabion size

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

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

Where:

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

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

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

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

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

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

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

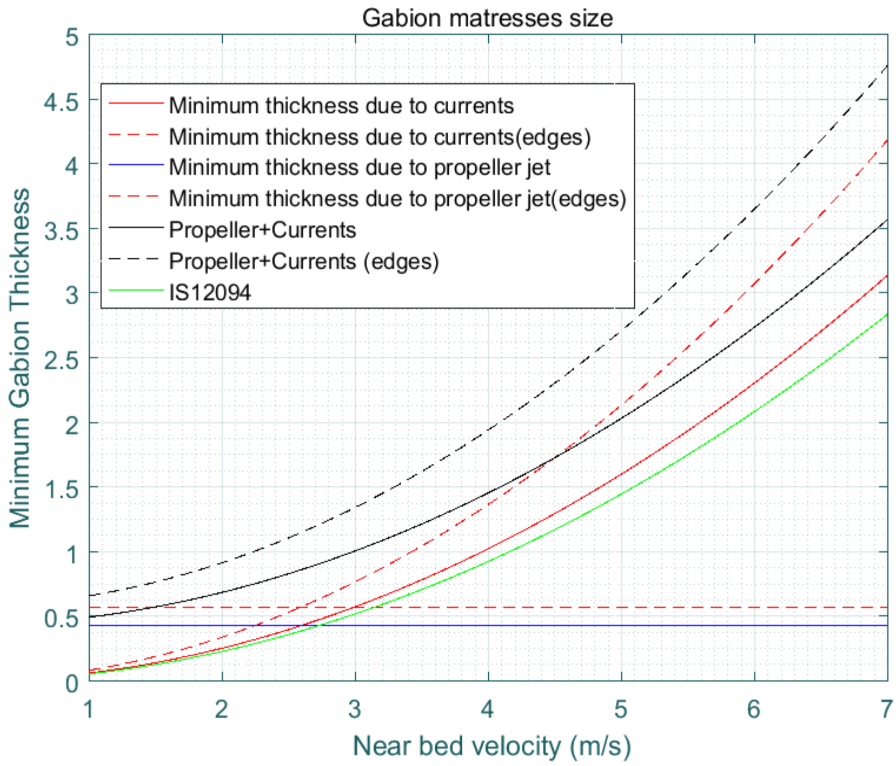


FIGURE 6-6: Minimum required thickness for revetment

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

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

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

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

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

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):

$$d_m = S_f C_s C_v d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{0.5} \frac{V}{\sqrt{g d K_1}} \right]^{2.5}$$

Where:

[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

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

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

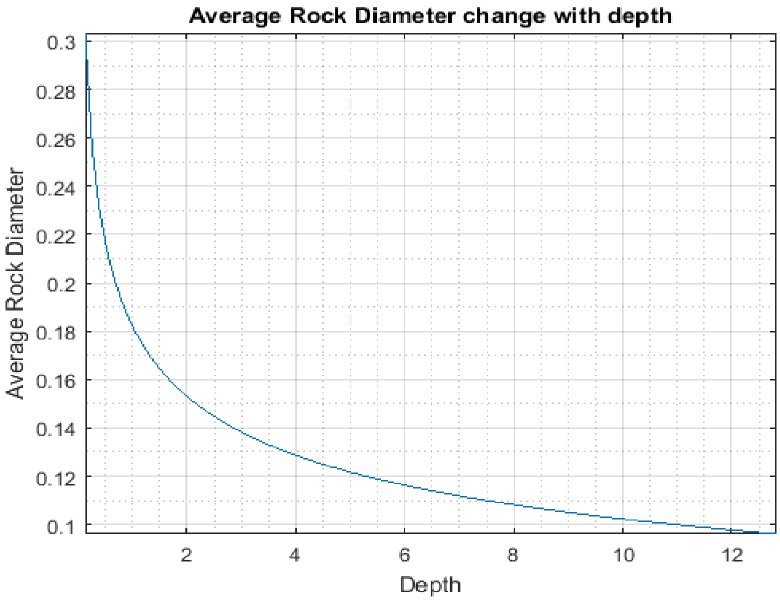


FIGURE 6-7: Minimum average rock diameter

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

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

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

Property	European standard references	Suggested requirements
Amour stone grading	EN 13383-1:2002	CP90/180 or equivalent
Type of rock	Petrography	Calcareous, siliceous, metamorphic or igneous rock

d. Gabion specifications

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

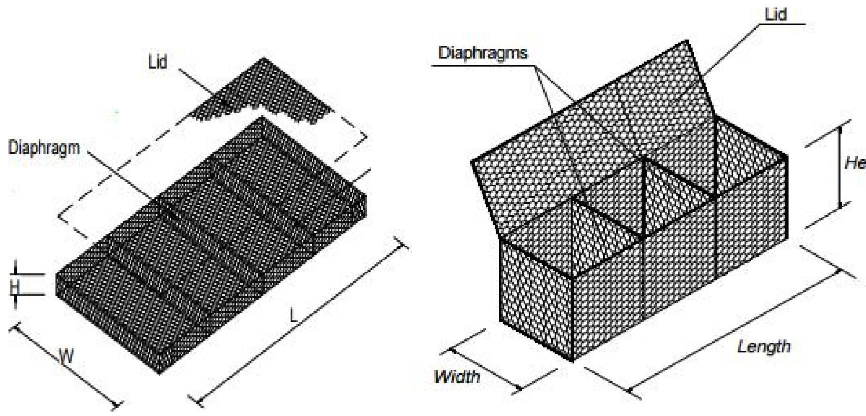


FIGURE 6-8: Example of a gabion mattress and gabion basket

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

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

TABLE 6-3: European standards for the wire mesh

Wire Properties	European testing	Content
Steel wire composition	EN 10218-2:1997	Steel composition, strength
Steel mesh composition	EN 10223-3:1998	Mesh 60 mm x 80 mm wire: d = 2.2 or 2.4 mm Selvedge wire= 2.7 mm Mesh 80 mm x 100 mm wire: d = 2.7 mm Selvedge wire = 3.40 mm
Corrosion protection (galvanising)	EN 10244-1:2001 EN 1024402:2001	Thickness of the coating conforms to class A, mass of coating mc, depends on wire diameter: d = 2.2or 2.4 mm, mc = 23- g/m^2 d = 2.7 mm, mc = 245 g/m^2
Corrosion protection (polymer coating)	EN 10245-1:2001 EN 10245-2:2001 EN 10245-3:2001	Requirements for organic coating, PVC or PE, thickness, composition, strength, durability, flexibility
Tensile strength	EN 10223-3	60 mm x 80 mm: Tensile = 35 kN/m 80 mm x 100 mm: Tensile = 51 kN/m
Elongation	EN 10233-3	Elongation shall not be less than 10%

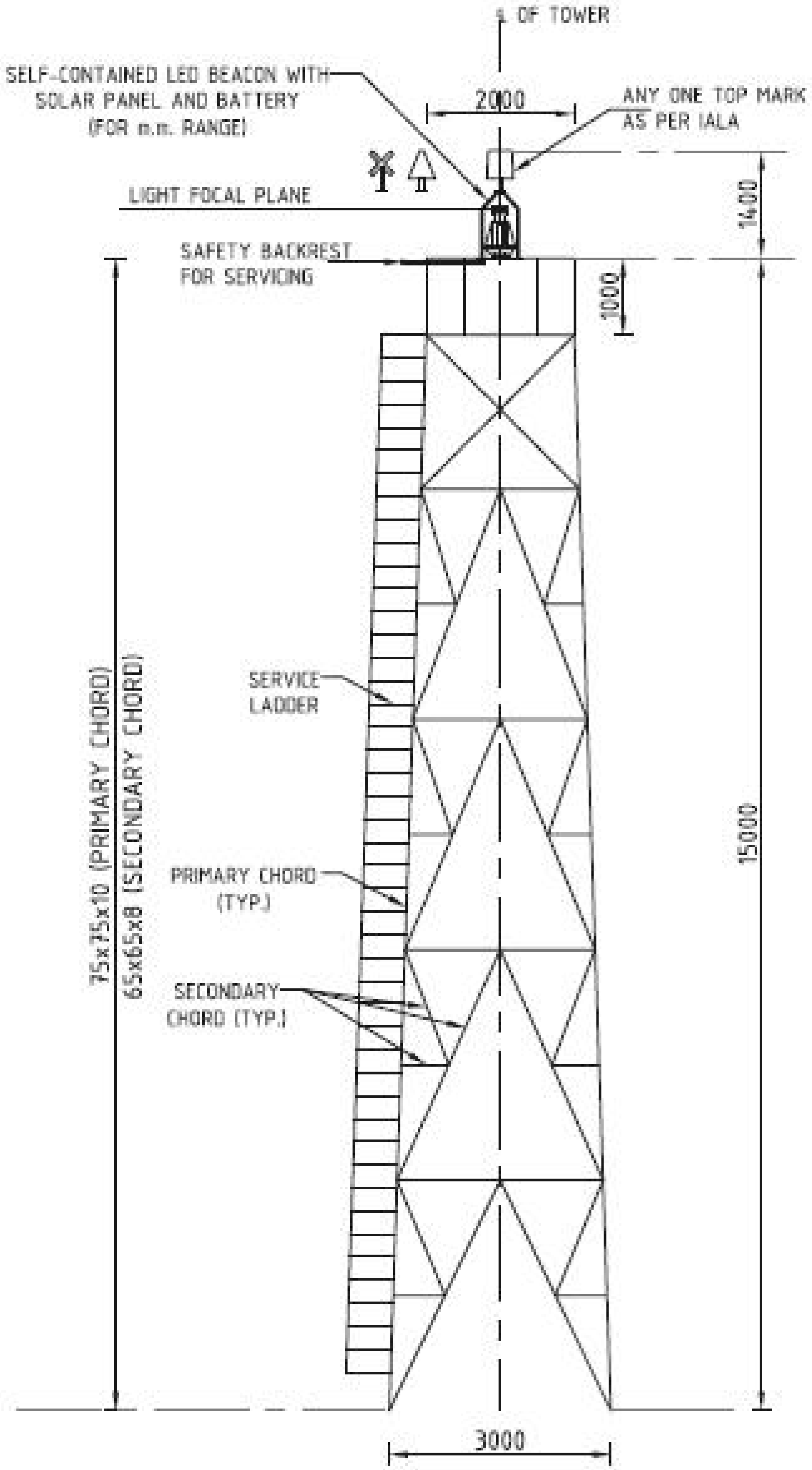
6.3. Navigation Aids

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

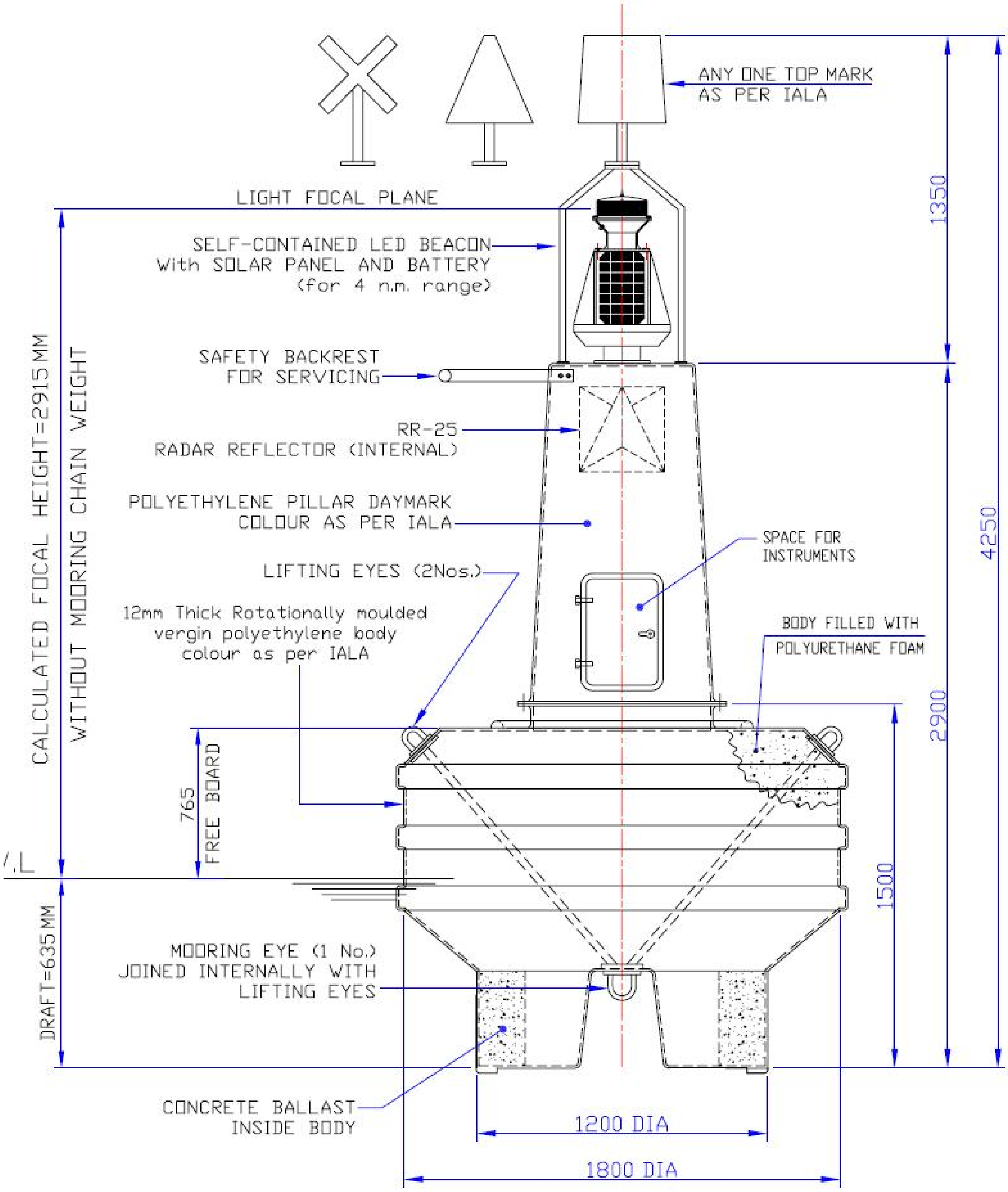
In the Shore based system, for the west flowing National Waterways of Cluster 7 and Cluster 6, it has been preferred to have a Beacon / Light system, wherein the Buoy / Light system has been preferred.

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

BEACON WITH LIGHT SYSTEM:



BUOY WITH LIGHT SYSTEM:



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

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

<u>1 Set - Mooring gear – Each set comprised of the following:</u>

1 No. - 3M x 26 mm dia open link chain with enlarged end links.

1 No. - 15M x 26 mm dia open link pendant chain with enlarged end links.

4 Nos. - 26 mm nom. dia forelock end shackles.

1 No. - 26 mm nom. dia swivel piece with end links.

1 No. - 250 kg. M.S. stockless Anchor.

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

<u>Solar Operated LED lighting 1 No. MLB-200-4 Self-contained LED beacon fitted with PLC-12 programmable LED controller. Specification of Each Light is as detailed below:</u>

Luminous range: 4 n. miles. (T 0.74) / Light Colour: as per IALA System. (Red) / Light Source : High intensity Light Emitting diodes (LEDs) with UEP to 60,000 hrs of burning life / Optical system : 200 mm dia clear polycarbonate UV stabilized diffuser lens / Lantern Body : High impact polystyrene / Cable entry : M l6 Cable glands fitted / Fixing : 4 fixings for Ml 0 bolts at 200 mm PCD / Lantern weight : 3.0 kg (approx.).

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

Input Voltage: 12 V to 18 V d. c / Output Voltage: Switch-mode stabilized to suit LED operating current / LED load (max): upto 12 Amp. at 12 V d.c / Light Character: Any of the 256 IALA character can be selected / Solar charge regulator: Provided in the PLC-12 circuit / Light control: Automatic ON/ OFF by Photo diode / Protection: Against reverse polarity and excessive input voltage / Temperature range : -20°C to + 60°C.

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

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

6.4. Cargo Terminals and River Ports

Design Criteria

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

Design Life

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

Material Properties

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

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

Structural Steel

Minimum yield stress: 250 N/mm²

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

Reinforcing Steel (Corrosion Resistant)

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

Yield Strength	500 Mpa
Elongation	14.5%

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

Cover to Reinforcement

The clear cover to main reinforcement shall be as follows:

Piles	100 mm
Deck Slab	75 mm
Longitudinal beams:	75 mm

Columns:	75 mm
Cross Beams	75 mm

Concrete Grades

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

Overall Deflection Criteria

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

Deflection limits

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

Crack Control

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

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

Corrosion Protection Painting

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

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

Classification of Loads

A. General Loading

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

Density of reinforced concrete 25.0 kN/m3

Density of Steel 78.5 kN/m3

Density of plain concrete 24.0 kN/m3

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

In addition superimposed dead load and live load shall be considered

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

1. Loads from the River Side:

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

2. Loads from Deck

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

3. Loads from Shore

Seismic loading

Earthquake loads shall be adopted as applicable for the site as per IS 1893 – 2002. The river fall under Zone IV, 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	IV
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.24
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 16 m has been considered from the HFL.

However, as per Bore hole (BS-1) since rock is available at a higher elevation at the proposed location, therefore scour depth will not have any significance. The pile shall be socketed into the rock.

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

The structure shall be designed for its self-weight and also for forces arising due to wind / seismic loads, current forces, vehicular loads etc as explained below.

For RO-RO berthing structure, an overall width of approx. 16.6 m is provided

The deck of RO-RO shall be submerged in water with varying water levels, depending on the season. Expansion loops shall be provided along the stretch at almost every 35-40 m.

Towards the terminal facility i.e. the shore end the deck has been considered above MHWS of 4.42 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 RO-RO berthing structures considered in design has salient features as below:

TABLE 6-5: Salient Features of Ro-Ro

Description	Total Length(m)	Total Width (m)
RORO	75	16.60

Design Loads on Berthing Structures

a) Dead Load

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

For RO RO 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 and trailers. 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 RO – RO berthing structure, vehicular loading as per IRC 6 Class 70R as defined below shall be considered

1. A Tracked vehicle of 70 ton load or
2. Wheel load of 100 ton or
3. Bogie axle load of 40 ton, whichever is critical.

Moving loads has been applied in STAAD Pro software for all the three load cases defined above to obtain the maximum value of bending moment and shear force.

c) Seismic Forces

The river is in zone IV 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 =0.24

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 $P_z = 0.6\ V_z^2$

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) 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 2000 Tonnes displacement Line pull = 100 KN (total)

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.

f) Current Forces

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

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

Where v = velocity =3.1 m/s

W= 10 kN/m^2

F = 4.89 kN/m^2

Load Combinations

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

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

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

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

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

Structural Analysis and Design of Berthing Structures

Based on the structural arrangement and loadings described above, a 3-D model was developed in Staad Pro software for RO-RO 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.

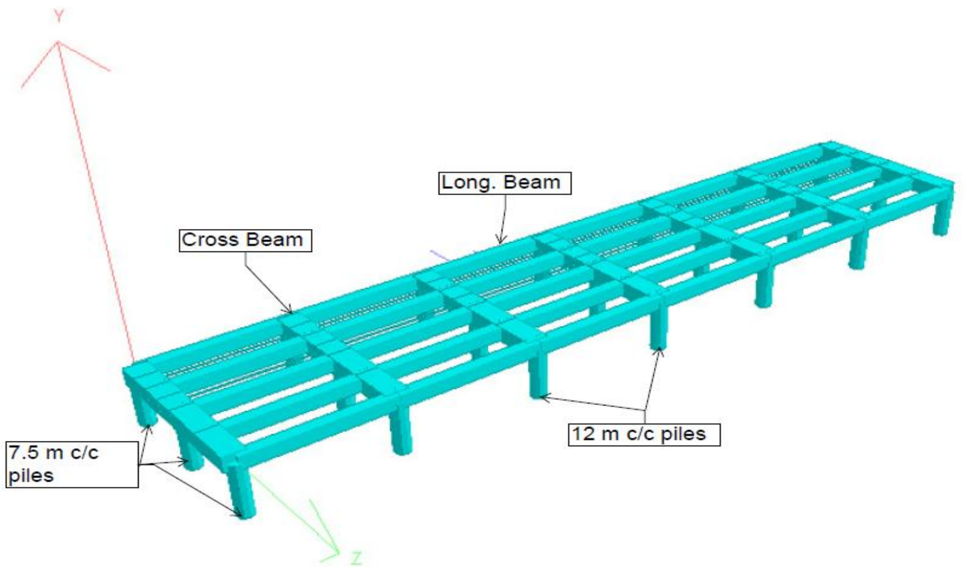


FIGURE 6-9: Perspective view of 3 dimensional model prepared in STAAD for RO-RO

SIZING OF RO-RO

Member Description	Length(m)	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	7.5	1.8	1.5		Concrete
Longitudinal Beams	12	1.0	1.25		Concrete
CastIn situ Slab				0.15	Concrete
Pile Diameter, OD		1.3			Concrete

The foundation level of the deck is +3.65 m CD and the weathered rock bed is available at +5.75 m CD, thus excavation shall be required to be done in weathered and also in hard stratum for founding the structure. Although for proper transference of the load into the hard rock stratum we would recommend a minimum 500 mm socketing of 1.3m dia pile into the rock as per Cl.9, IRC 78-2014.

6.5. Construction Schedule

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

CHAPTER 7: VESSEL DESIGN

7.1. General Review

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

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

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

7.2. Design Basis

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

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

7.2.1. Vessel Classification adopted in Indian Inland Waterway

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

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

TABLE 7-1: Classification of Inland Waterways for Rivers

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

TABLE 7-2: Classification of Inland Waterways for Rivers

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

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

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

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

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

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

TABLE 7-3: Classification of Vessel Size

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

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

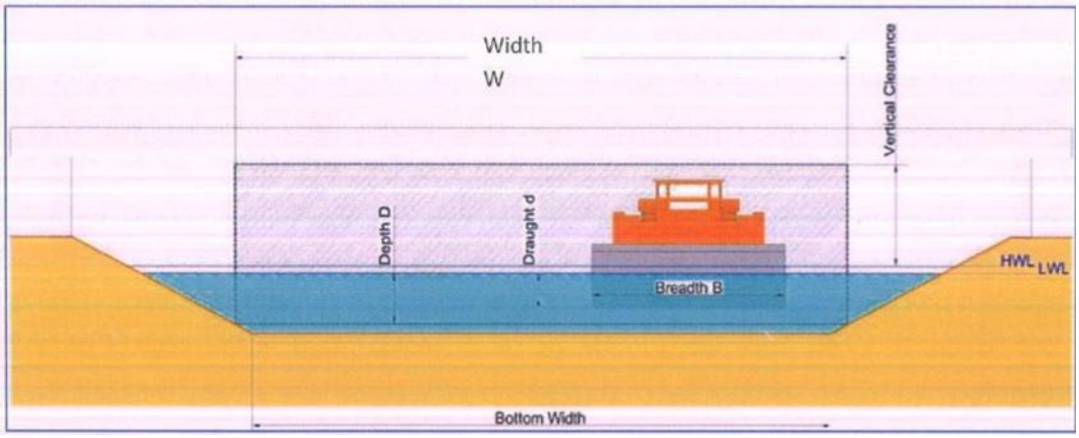


FIGURE 7-1: Dimensions – one way navigation Channel

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

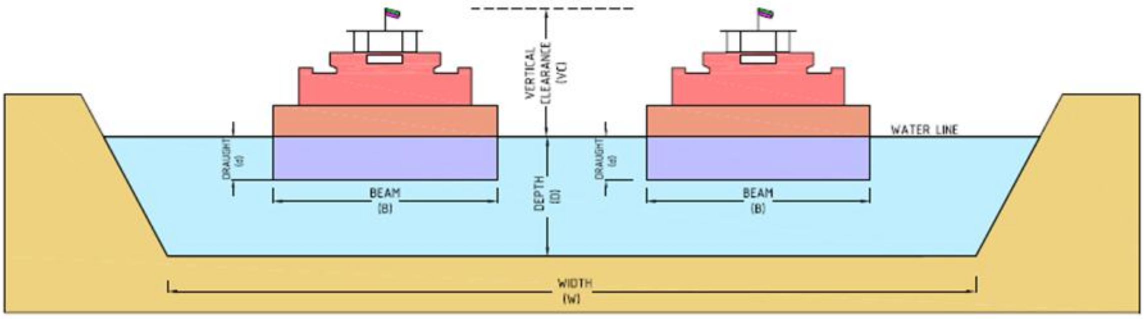


FIGURE 7-2: Dimensions – Two way navigation Channel

7.2.2. Vessel Classification of USA Inland Waterway

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

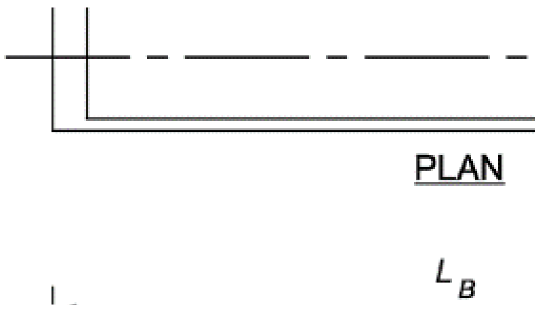


FIGURE 7-3: Plan and Elevation of vessel

TABLE 7-4: Typical Barge Tow Characteristics

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

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

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

7.2.3. Vessel Classification of European Inland Waterway

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

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

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

7.2.4. Vessel Classification of China Inland Waterway

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

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

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

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

TABLE 7-8: Waterway Ratios of different Countries

Relative Waterway Dimensions from Guidelines for different Countries

Location	Ship	Two-lane			One-lane		Driving Quality
	(B x L x D)	F/B	D/d	n	F/B	D/d	category
China 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 Width “F / B”	
Factor on Depth “D / d”	
Indian classification – Rivers – SPV / Single Channel	1.10 to 1.20
Indian classification – Canals – SPV / Single Channel	1.39 to 1.50
Others – Waterways – SPV / Single Channel	1.20 to 1.40
Indian classification – Rivers – Convoy	1.10 to 1.20
Indian classification – Canals – Convoy	1.39 to 1.50
Others – Waterways – Convoy	1.20 to 1.40
Factor on Cross Section Area “n”	
Indian classification – Waterways – SPV / Single Channel	4.63 to 7.86
Indian classification – Canals – SPV / Single Channel	5.63 to 6.00
Others – Waterways – Convoy	4.90 to 8.70

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

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

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

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

7.3. Type of proposed Vessels

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

In brief, the study stretch of river Savitri has been limited to Class IV in the proposed study stretch, keeping in view the cargo of Ro-Ro mobility etc.,.

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

The river Savitri is being limitedly used only in the “Bankot” Creek area and the study stretch is being used with fishing vessels. These vessels are plying with tidal advantage for smooth uninterrupted mobility.

With regard to the Ro-Ro operation, mobility of 67,000 vehicles (preferably of 40 TEU container trucks) P A by FY 20 is estimated and expected to be increased to 148,000 vehicles P A by FY 40. The vessel size proposed for such mobility will be considered at the initial stage with 52.8 m to 55 m LOA x 14.0 m Breadth x 1.8 m Loaded Draft / 2.50 m Depth, which can carry 21 Nos. TEU. The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. The requirement will be worked out based on the Turn around Time etc.

7.4. Proposed Vessel Size and Specifications

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

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

Ro-Ro Vessel:	**(21 TEU) {Recommended} INR 900 Lakhs each**
Length:	52.8 m to 55 m
Breadth:	14 m
Loaded Draft / Depth:	1.8 m / 2.5 m +
Cargo Capacity:	16 TEUs - 21 TEUs
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp

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

Keeping in view the type of cargo as Bulk / Break Bulk, the SPV and the DBs will be considered as a Hold type. The structural designs of vessels are to be considered as per the Inland Vessels Act and as per the rules of Indian Register of Shipping. Further, the vessels now proposed are to maneour in the west flowing rivers like Savitri 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 / Vessels 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.

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.,.

Ro-Ro Operation:

The Ro-Ro Terminal is provisioned to meet the mobility of 67,000 vehicles per annum (preferably the containers) {40,000 in one way} in FY 20 which may increase to 148,000 Vehicles per annum {89,000 in one way} in FY 40. Considering 330 days operation, the daily volumes will be of about 121 in FY 20 to 270 vehicles in FY 40.

The origin of Ro-Ro vessels mobility is being planned from JNPT / MbPT, which is about 120 Kms and accordingly, the total distance can be considered as 160 Kms. Taking the average speed of 20 Kmph, it will take about 8 Hrs for one mobility.

The TAT will be as detailed:

Entry / Exit of Vehicles at JNPT / MbPT 1 Hr + Onward Journey 8 Hrs + Entry / Exit of Vehicles at Terminal 1 Hr + Return Journey 8 Hrs = Total 18 Hrs. say the turnaround time 0.75 day.

7.6. Number of Vessels Required

In order to handle the initial traffic of 40,000 Vehicles (One sided), (121 Vehicles per day), it is essential to deploy 6 Nos. of Ro-Ro Vessels. However, the Ro-Ro operation is suggested only on promotional basis and hence it is suggested with cautious approach and may need to be suspended at any point of time

2 Ro-Ro vessels may be required at the initial stages in FY 20.

Additional 4 from FY 28 / 30 onwards, one additional vessel will have to be acquired in the year FY 30; FY 32; FY 34 and FY 36. A total of 6 vessels would be needed to handle the projected traffic of FY 40.

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. No repair yard exists in the study stretch of Savitri River / Bankot Creek to attend the repairs of IWT Vessels plying in this region.

The Agardanda Shipyard in Rajpuri Creek and Lavgan Dockyard and Katale Shipyard in Jaigd River (Shastri River) are approachable from Bankot Creek.

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.

Ro-Ro Vessel: with Length – 52.8 m to 55 m; Breadth – 14 m; Loaded Draft / Depth – 1.8 m / 2.5 m +; Cargo Capacity – 16 Nos – 21 Nos. TEUs and Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 900 Lakhs each.**

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 Ro-Ro Vessel, for which the indicative O & M Costs have been worked out.

1 Ro-Ro Vessel (For 1 Year)

1 Ro-Ro vessel Running cost for 330 days operation with 18 Hrs turnaround (4 cycles in 3 days) of which 18 Hrs (16 Hrs Engine Hrs) mobility in 3 days, cost per annum will be as detailed.

440 cycles x 18 Hrs x {0.1 Liter per hour x 3 Engines x 375 Bhp} x INR 70 per Liter = INR 623.70 Lakhs Per Annum.

8 Nos. Crew on 1 Ro-Ro vessel @ INR 0.50 Lakhs per month.

Crew cost for 12 months will be 12 x 8 x 0.5 = INR 48 Lakhs Per Annum per Unit.

Repair Cost is @ 2 % P. A of CAPEX i.e., 0.02 {1 x 900} = INR 18 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 foolproof 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.

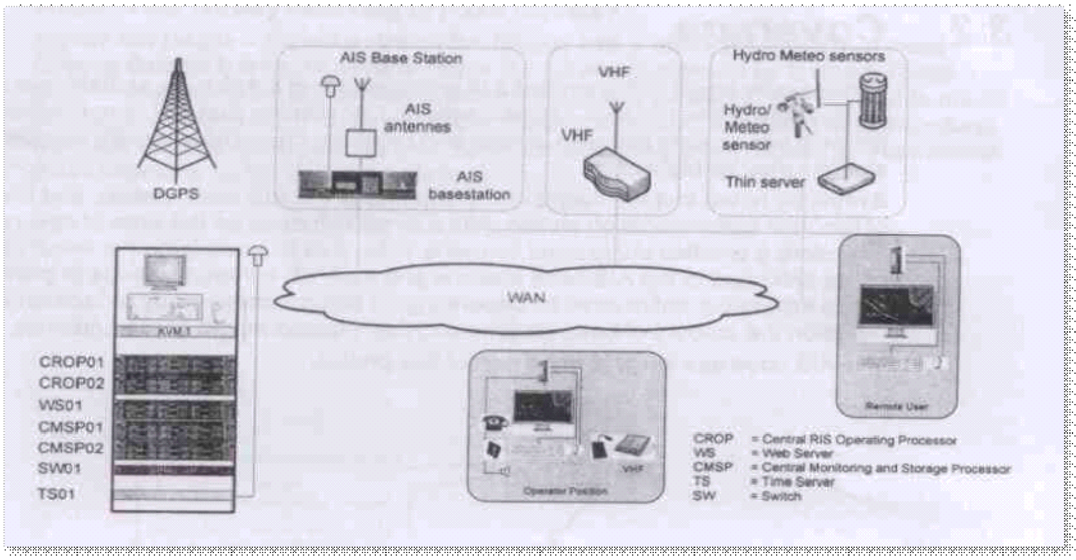
8.1.2. GPS

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

8.1.3. RIS / AIS / Radar / VTMS

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

The general technical solution is depicted in Figure below.



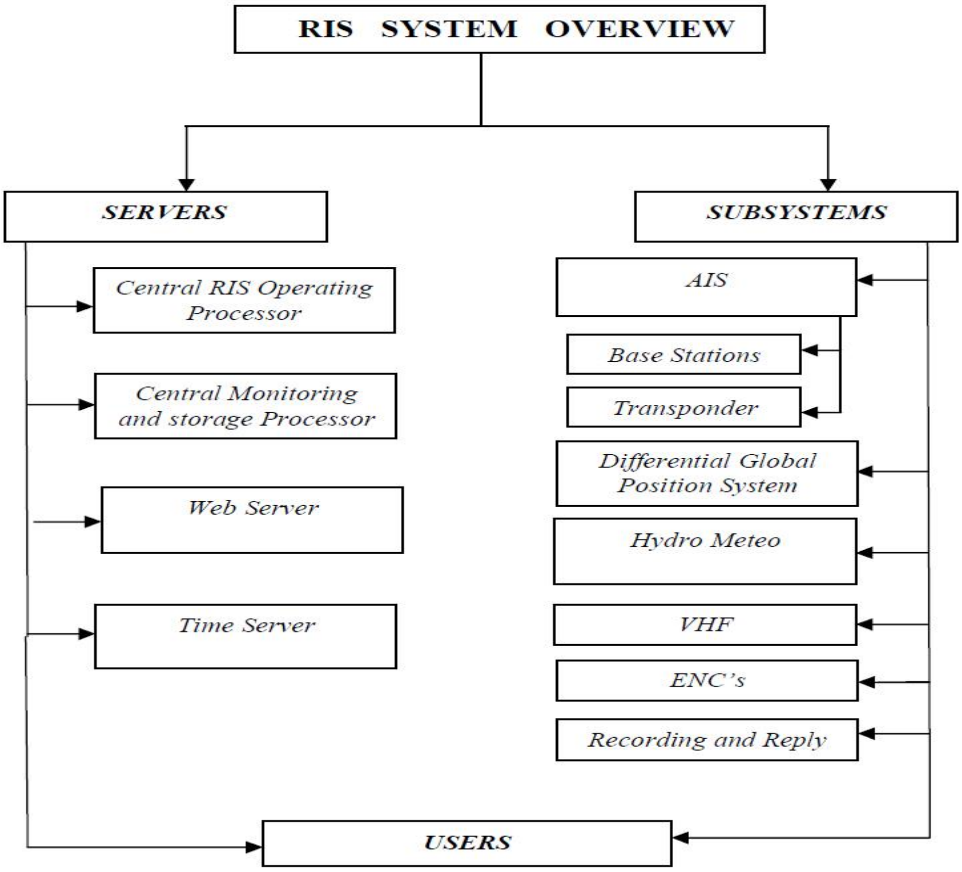


FIGURE 8-1: Main components of the RIS system

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

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

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

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

The list of equipment's include

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

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

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

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

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

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

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

Observations:

1. AIS receiver is must on board the vessels utilizing the Waterway.

2. Preferred to provide the RADARs installed at selected locations, for easy tracking of vessels.

3. Trained Operators can effectively be utilized for ensuring proper running of RIS system.

8.1.4. Vessel / Hydrographic Survey equipment

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

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

8.2. Existing System

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

8.3. Additional requirement

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

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

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

Regarding the RIS on "Bankot Creek / Savitri River", there is no considerable cargo mobility to substantiate the provision of RIS. However, the cost details are provisioned for taking up the same, at later date, if the need is judicious.

At this stage, it is recommended to proceed ahead with the available Mobile Networking system and later on an amenable system can be adopted, subsequent to the considerable progress on "National Coastal Grid of VTMS".

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: $\pm$0.3 m/s or $\pm$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: $\pm$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. Costing

8.5.1. Capital Cost / O & M Cost

Provision of RIS is not suggested, at this point of time. However, cost implications are placed.

COST FOR RIS SYSTEM ON "SAVITRI RIVER / BANKOT CREEK (NW-89)"

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**
B.	**MANPOWER COST**			
	1^{ST} YEAR			
	1 Engineer * 1 NW * 12 months p. a	12	35,000	4,20,000
	3 Operators * 2 Sites * 12 months p. a	72	20,000	14,40,000
	3 Security * 2 Sites * 12 months p. a	72	15,000	10,80,000
	Total for 1^{st} year			**29,40,000**
	Total for 2^{nd} year (7 % on the previous year)			**3,145,800**
	Total for 3^{rd} year (7 % on the previous year)			**3,366,006**
	Total for 4^{th} year (7 % on the previous year)			**3,601,626**
D.	**CAMC for 4 years**			
	1^{st} year			**-Nil-**
	2^{nd} year (10 % on the Capital Cost)			**70,00,000**
	3^{rd} year (+ 10 % on the previous year Cost)			**77,00,000**
	4^{th} year (+ 10 % on the previous year Cost)			**84,70,000**

COST FOR RIS SYSTEM ON "SAVITRI RIVER / BANKOT CREEK (NW-89)"

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
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 Savitri River and its connectivity to Control Centre

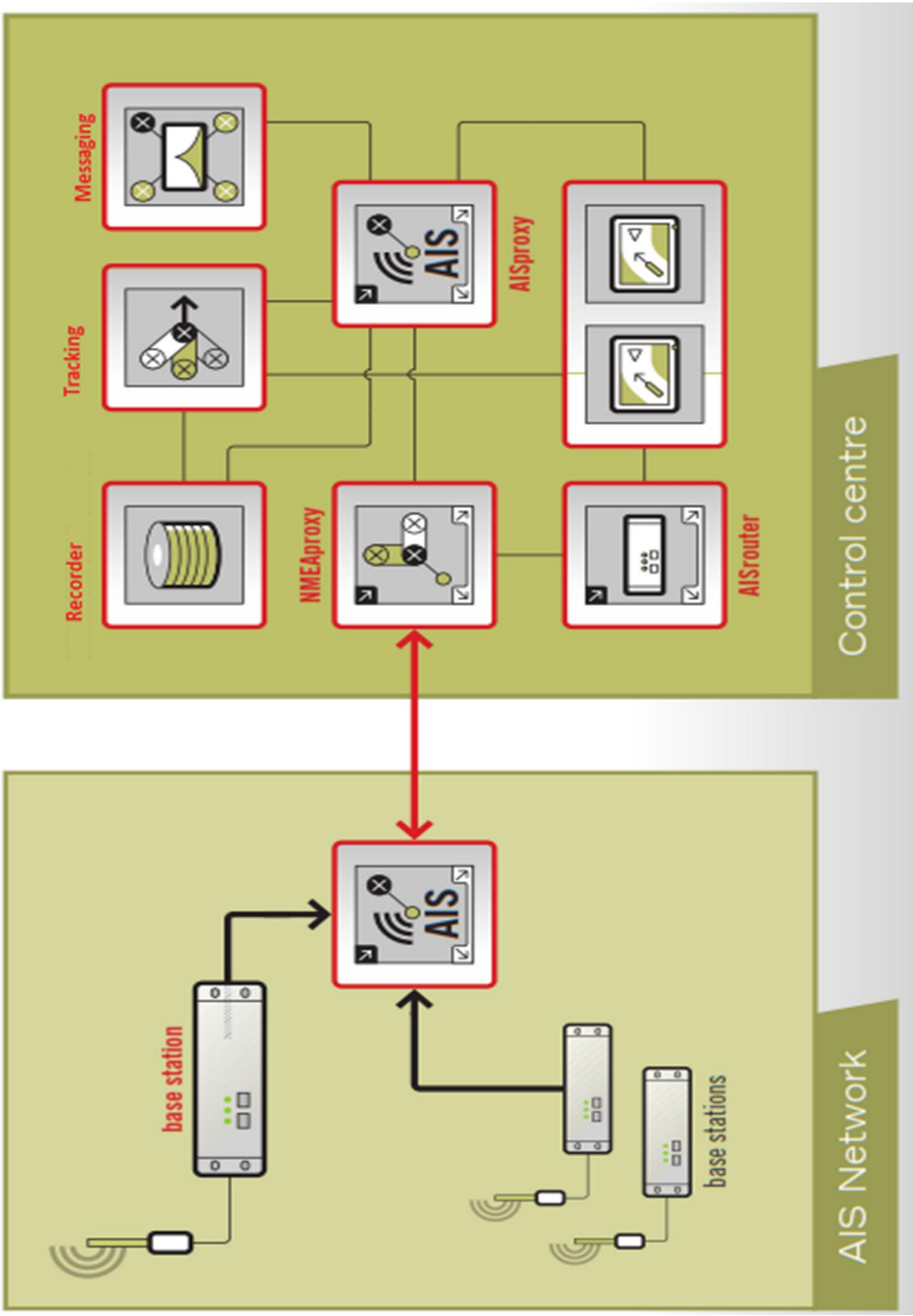
2. Diagram indicating the existing Centres (MR) along the coast and Proposed Centres (RR) along the National Waterway

3. Typical line diagram showing the interface of other systems with the Radar system are placed herewith.

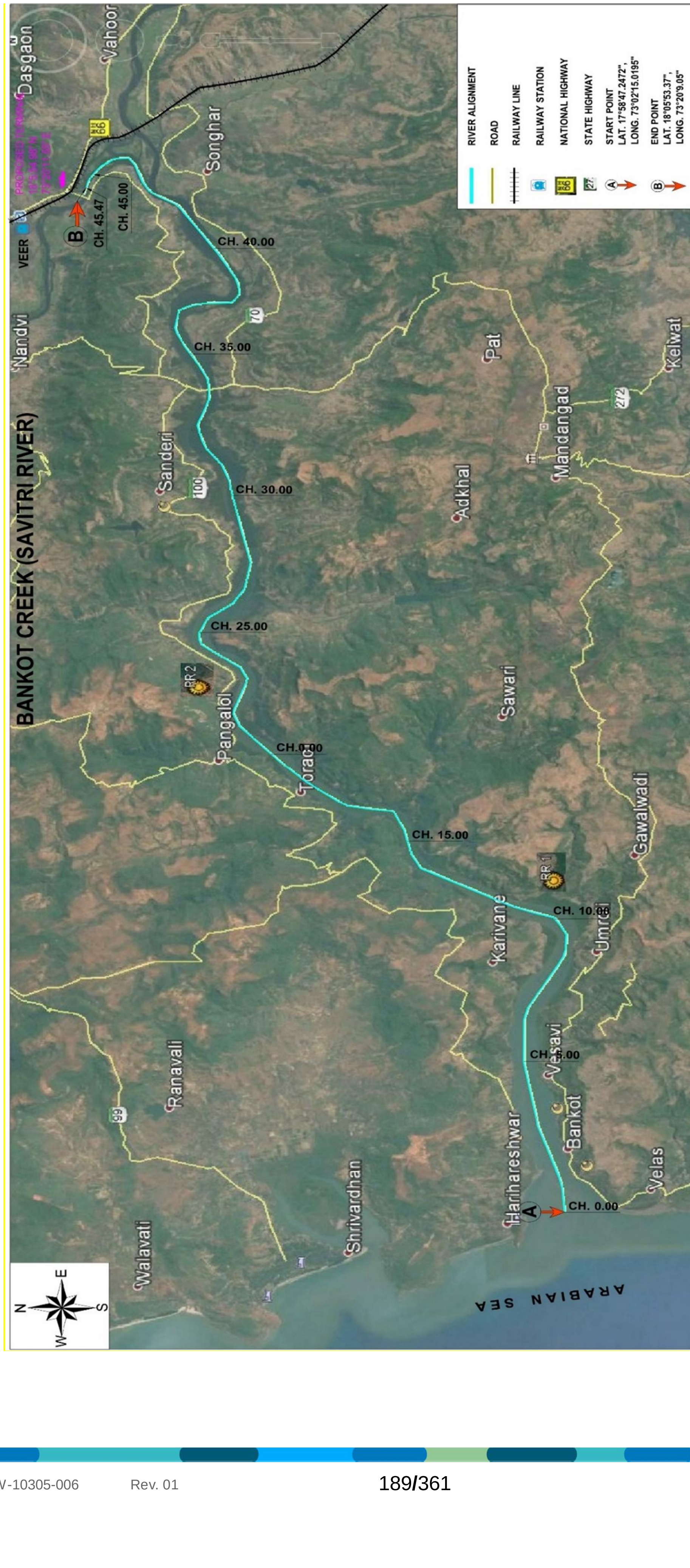
AIS (Automatic Identification System)

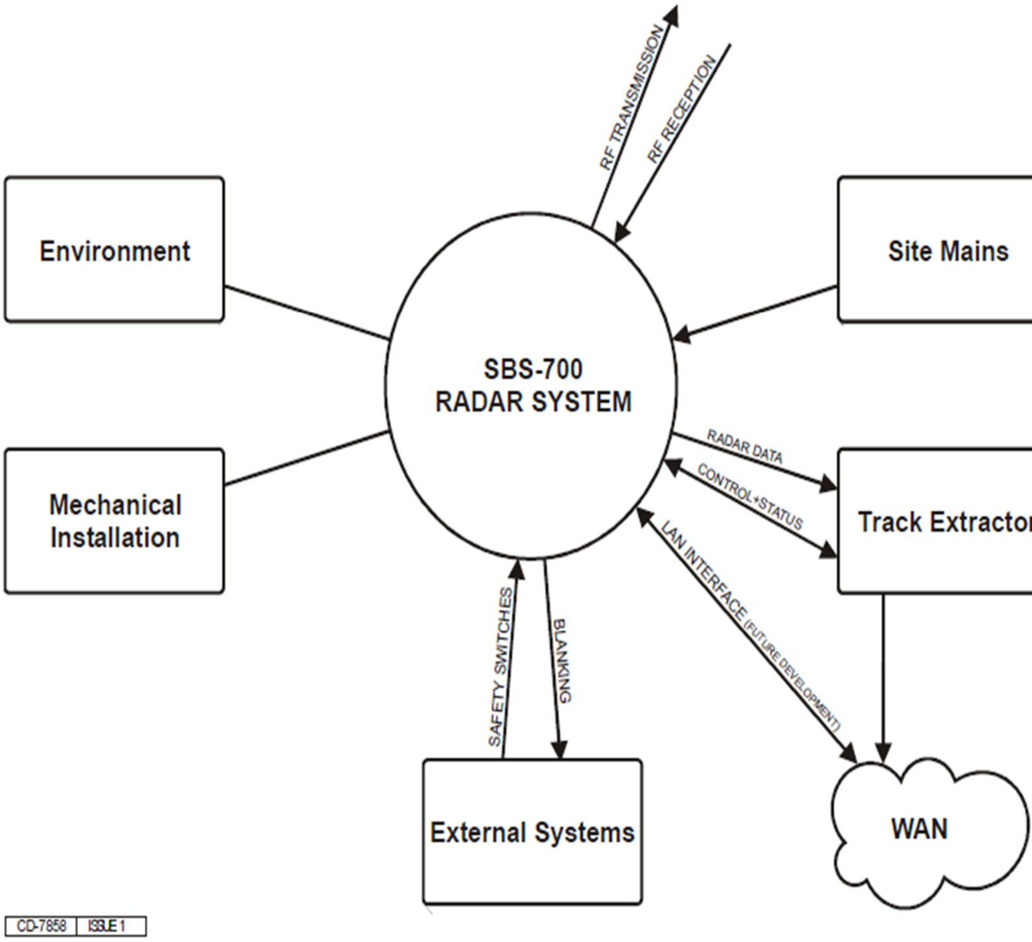
Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

The AIS Base Stations installed in VTS will receives ships information and send to data processing for process and display on Display Terminals



AIS (Automatic Identification System)


BANKOT CREEK (SAVITRI RIVER)
RIVER ALIGNMENT
ROAD
RAILWAY LINE
RAILWAY STATION
NATIONAL HIGHWAY
STATE HIGHWAY
START POINT
LAT. 17°58'47.2472",
LONG. 73°02'15.0195"
END POINT
LAT. 18°05'53.37",
LONG. 73°20'9.05"
CH. 0.00
CH. 5.00
CH. 10.00
CH. 15.00
CH. 25.00
CH. 30.00
CH. 35.00
CH. 40.00
CH. 45.00
CH. 45.47
A
B
RR 1
RR 2
Dasgaon
Vahoor
Songhar
VEER
Nandvi
Sanderi
Pangaloli
Torade
Pat
Adkhal
Mandangad
Kelwat
Sawari
Gawalwadi
Karivane
Umroli
Vesavi
Bankot
Velas
Harihareshwar
Ranavali
Shrivardhan
Walavati
ARABIAN SEA
N
E
S
W


RF TRANSMISSION
RF RECEPTION
Environment
Site Mains
SBS-700
RADAR SYSTEM
RADAR DATA
CONTROL+STATUS
Track Extractor
Mechanical
Installation
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. 89 under the National Waterways Act 2016 and is located on Savitri River in the Raigad district of Maharashtra State. It is a 45.47 km stretch of the Savitri River (Bankot Creek) beginning from Arabian Sea at Harihareshwar at Lat 17°58'47.2472"N, Long 73°02'15.0195"E and ending near the Bridge near Sape at Lat 18°05'53.37"N, Long 73°20'9.05"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 seacoast, 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: Maharashtra, National Disaster Risk Reduction Portal, National Institute of Disaster Management, Ministry of Home Affairs, government of India, website: http://nidm.gov.in/pdf/dp/Maharashtra.pdf).

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:

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

(Source: Brief Industrial Profile of Raigad District, Ministry of Micro, Small and Medium Enterprises, Government of India)

Savitri River originates in Mahabaleshwar and flows through Raigad and Ratnagiri districts and eventually meets Arabian Sea at Harihareshwar. It passes through Poladpur, Mahad, Mangaon, and Shrivardhan taluks. There are a number of Shiva temples along the banks of river Savitri. The land along the banks of the Savitri is mostly rocky. The high-water spring-tides go up to Mahad. Savitri River valley is located in the south of the Raigad District. Savitri River forms the border between

Raigad and Ratnagiri districts. Coconut and Areca nuts gardening is well practiced in the Savitri valley.

Major portion of the river is affected by tide (backwater effect) of the Arabian Sea. The river is tidal affected for full length under study and relevant chart datum has been used. 99% of the surveyed length has water depth of more than 4.0 m and this is a continuous reach starting from 0.00km (At confluence of river with sea near village Harihareshwar near the creek). The average tidal variation is 2.37 m with maximum high tide of 4.42 m and low tide of 0.32 m as per the records available for this region. The average tide height of 2.37m would be an added advantage for the safe navigation. (Source: DPR study for the present project)

The total catchment area of Savitri River (Bankot Creek) is 2889 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.

(Source: Maharashtra, National Disaster Risk Reduction Portal, National Institute of Disaster Management, Ministry of Home Affairs, Government of India, website: http://nidm.gov.in/pdf/dp/Maharashtra.pdf).

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 epicenter 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, Ministry of Home Affairs, Government of India, website: http://nidm.gov.in/pdf/dp/Maharashtra.pdf)

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).

(Source: Maharashtra, National Disaster Risk Reduction Portal, National Institute of Disaster Management, Ministry of Home Affairs, government of India, website: http://nidm.gov.in/pdf/dp/Maharashtra.pdf)

The Climate of Raigad District, where the project is located, is generally hot and moist. The district receives seasonal rainfall from south west monsoon during June and September and the average annual rainfall for the district as a whole is 3029 mm. (Source: Change in General Land Use Pattern in Raigarh District: A Geographical Analysis, Variorum, Multi- Disciplinary e-Research Journal Vol.-01, Issue-IV, May 2011, website: www.ghrws.in)

The climate of the district is typical of west coast and characterized with plentiful and regular seasonal rainfall, oppressive weather in summer and high humidity throughout the year. The mean minimum temperature is 17.7°C and mean maximum temperature is 31.8°C. The analysis of long term rainfall data indicates that normal annual rainfall over the district ranges from 2200 mm to more than 3000 mm in the plains and it is above 5000 mm in the hills. The minimum rainfall is in the northwest around Uran (2197 mm) and maximum around Mahad (3360 mm). (Source: Ground Water Information, Raigarh District, Maharashtra, Central Ground Water Board, Ministry of Water Resources, Government of India, 2013)

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. (Source: Maharashtra, National Disaster Risk Reduction Portal, National Institute of Disaster Management, Ministry of Home Affairs, Government of India, website: http://nidm.gov.in/pdf/dp/Maharashtra.pdf)

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. (Source: Ground Water Information, Raigarh District, Maharashtra, Central Ground Water Board, Ministry of Water Resources, Government of India, 2013)

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, 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.

As per the topographic survey carried out as part of the present DPR, most of the area along the Savitri River is surrounded by Forest Mountains. At a few places, there is cultivation land. Crops like Rice, Nachni and Tur pulse is produced in catchment area of Savitri River.

Between Ch 0.00 to Ch 15.00 km, settlements are seen on both sides of the river. A fishing jetty is seen at Ch 2.20 km. A passenger jetty is located at Ch 2.30 km on the North bank. Ferry jetties are found at Ch 2.60 km on opposite banks. A passenger ferry operates between these two jetties from Bankot to Bagmagla. Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river banks. Umbroli Jetty is on the South bank of the river at Ch 8.24 km. Vegetation is seen along the river banks. A jetty is located near Ch 10.10km on the West bank close to the village Adi. Three jetties are found on the South bank at Ch 13.68 km, Ch 14.80 km and Ch 15.37 km. Some agricultural fields are seen on the South bank near Ch 14.90km.

Several jetties exist in the stretch between Ch 15.00 km to Ch 30.00 km. Two are on the East bank at Ch 16.43 km & at Ch 18.45 km and another one is on the West bank at Ch 17.72 km. Two jetties are seen on the North bank at Ch 20.28 km and at Ch 23.64 km. One jetty is on Northern bank at Ch 25.74 km. Another four are located on the southern bank at Ch 25.20 km, Ch 26.14km, Ch 27.46 km and Ummberset Fishing Jetty is located at Ch 29.08 km. Vegetation is seen along both the banks of the river. Most of the area along the Savitri River is surrounded by Forest Mountains. Cultivation land exists at few places in this stretch.

The stretch between Ch 30.00 km to Ch 45.47 km has a small island with trees. The island is located in the middle of the river at Ch 31.20 km. Ambet Village on the North bank and Mhapral on the South bank are connected by Ambet to Mhapral Road Bridge at Ch 33.29 km. Islands are seen between Ch 36.20 km to Ch 37.50 km. A small resort is built on the Island at Ch 37.20 km. Small islands with trees are observed at Ch 39.80 km and Ch 40.20 km. Warathi Fishing Jetty is located near the village on the South Bank at Ch 37.90 km. Dabhol Fishing Jetty is located on the North bank at Ch 39.85 km. Sand dumping yard was observed from Ch 42.50 km on the North-West bank of the river. High Savitri River at Toll Phata Bridge near Sape village (Lat. 18° 05' 54.11"N, Long. 73° 20' 08.81"E) is the end location of National Waterway NW-89. Farming was also observed on a few islands.

Fishing activity is a common aspect of the creek in current utilization. The fishing season is active throughout the year in Savitri River (Bankot Creek).

The land for terminal location for the project has been identified near village Shirghalim at Ch 14.00 km. The proposed terminal site is at a distance of 10 km from Mahad. The area surveyed for terminal location is approximately 11950 sq m. The land identified for terminal location is privately owned.

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.

The project area has a few minor settlements and some industries with emission norms regulated by the SPCB. Accordingly, the overall ambient air / noise quality in the project area is anticipated to be within permissible limits. No secondary data on ambient air and noise quality is available for the project area. The impact on the existing ambient air and noise quality is largely limited to the emissions due to vehicular movement and movement of men and material during project construction phase.

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 quality monitoring in the project area may be collected at a later stage as part of the EIA study as required.

9.2.7. Ambient Water Quality

Savitri River originates in Mahabaleshwar and flows through Raigad and Ratnagiri districts and eventually meets Arabian Sea at Harihareshwar. It passes through Poladpur, Mahad, Mangaon, and Shrivardhan taluks. Some industries are established on the bank of this river but these are not located close to the project area. Discharge of effluents by these industries is regulated by the Maharashtra State Pollution Control Board. Savitri river water quality in the proposed stretch, as observed at site, does not appear to be impacted by industrial effluents.

Surface water quality analysis has been done at five sample locations in the project stretch as part of the hydrographic survey carried out for the present DPR study. The sample locations for water quality analysis include Bankot, Adi Mahad, Pangalol, Ambet and Tol Fata. The pH value for all the five locations has been found to be over 7, which indicates the alkaline nature of water in the identified stretch of NW-89 in the Savitri River.

As per the 'Status of River Pollution' provided in the Annual Report (20101-11) of (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'. Water is supplied from Savitri River to Navenagar of Mahad industrial estate and to some nearby villages. The report states that the water quality of river Savitri was monitored at five locations where it was observed that water quality was deteriorated due to increase in COD and Total Coliform level as compared to the previous year. The highest COD (2693 mg/l) was recorded at Ovale village.

According to the report titled 'River Stretches for Restoration of Water Quality' published by the Central Pollution Control Board in February 2015 (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15), 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. However, the identified polluted stretch of 2 km of Savitri River, which runs from Dadli to Muthavali, lies beyond the proposed NW-89 stretch.

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 measured at seven locations on Savitri River namely Goregaon, Kangule, Ovale, Nangalwadi, Shedav Dov, Dadli and Muthavali villages. The Water Quality index (WQI) evaluated for the available data of the Savitri River indicated that the water quality was good to excellent at all the stations except at Goregaon, Mahad in Raigad District where the monthly WQI varied between moderately good to excellent.

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. However, **the identified polluted stretch of 2 km of Savitri River, which runs from Dadli to Muthavali, has been categorized as Priority Class III which means it falls in a moderately 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, Raigarh 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, where the proposed project is located, 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 pinata* 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 gymnorrhiza*. Root suckers are observed around the roots of *Sonneratia 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.

The entire NW-89 project area falls under the tidal zone. Accordingly, the proposed project will require clearance under the CRZ Notification 2011.

9.2.10. Archaeological and Heritage Locations

Prohibited and Regulated Areas with respect to protected monuments are defined in the **Ancinet 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

S.No.	Name of Monument / Site	Location	District
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
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

S.No.	Name of Monument / Site	Location	District
21.	Tomb of Angre	Cheul	Raigad
22.	Wada of Dancing Girls	Cheul	Raigad
23.	Chandragad	Dhavala	Raigad
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
45.	Janjira Fort	Rajapuri	Raigad

S.No.	Name of Monument / Site	Location	District
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

There are several structures of religious significance located on the banks of river Savitri in the stretch identified as NW-89. Harihareswar Temple is located closed to the start point of NW-89. There are also sevral mosques located along the waterway stretch. However, the proposed project does not interfere in any manner with the said structures.

As per the information available on the website of Archaeological Survey of India, none of these structures come under the category of National / State protected monuments. Therefore, no clearance requirement is envisaged with respect to these structures.

A list of these structures along with their distance from the proposed waterway is provided in Table 9-2 below.

TABLE 9-2**:** Structures of Religious Significance Located Close to the Project

Sl.No	NAME OF STRUCTURE	RIVER BANK (SAVITRI)	SHORTEST DISTANCE FROM NW-89 (km)
1	Harihareshwar Temple	Right	1.7
2	Bankot Fort	Left	1.07
3	Jama Masjid	Left	0.48
4	Dariya Masjid	Left	0.44
5	Imam Masjid	Left	0.35
6	Ahmadiyah Masjid	Left	0.52
7	Dariya Masjid	Right	0.73
8	Mosque	Left	0.42
9	Mosque	Left	0.6
10	Jama Masjid	Right	1.89

9.2.11. Flora and Fauna

9.2.11.1. 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 plant 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 Savitri 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.

9.2.11.2. 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, Revadanda, 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 affinis*), Ribbon Fish (*Lepturacanthus savala*), Dhoma (*Sciaena dussumieri*), Seer Fish (*Scomberomorus guttatus*), Silver bar (*Chirocentrus dorab*), Sepia (*Sepia officinalis*), Mud Crab (*Scylla serrata*), Prawns (*Penaeus monodon*) etc and bulk of the catch is sent to local market and Mumbai market. (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 km, 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)

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)

A study of the project alignment and its surrounding area upto a radius of 10 km on the Google Map reveals that no components of the proposed waterway fall under any of the Protected Areas or their Eco-Sensitive zones.

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 9-3 below.

TABLE 9-3: 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
	Total Talukas 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 tourists 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.
- Alibag tahsil 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 km, 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 tahasils 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 DPR provides for two Phases for development of the proposed project – one without any new development of fairway or of terminal (the stretch being limited to 40 km of the National Waterway 89), and another with development of fairway and terminal (covering the entire stretch of 45.47 km under NW 89).

Potential Environmental and Social Impacts in Phase 1

No construction activities as proposed for Phase I development. Phase I envisages development of the waterway from Ch 0.00 km to Ch 40.00 km and this Phase does not require any dredging, terminal construction, approach road development or bank protection works. Thus no land use change is anticipated to occur due to the development of the project as proposed in Phase I.

Impacts on aquatic ecology during operation of the project need to be established as part of the EIA study to be commissioned for the project separately by IWAI. The project does not involve any dislocation of population.

The positive impacts of the project will include improved waterway facilities and other allied infrastructure facilities for the local population. It will also generate some employment and small business opportunities for the local population.

Potential Environmental and Social Impacts in Phase II

The construction activities as proposed for Phase II are as follows:

i. Construction of terminal buildings – Yes, one terminal in Phase 2.
ii. Construction of access roads – Yes, 7.5 wide road for a length of 43 m
iii. Bank protection works – Yes, for a total length of approximately 5 km
iv. Dredging of the river in the proposed waterway stretch – Yes

v. Installation of navigational lights - Yes

Phase II, thus, envisages development of the entire stretch from Ch 0.00 km to 45.47 km and involves dredging in the stretch between Ch 40.00 km to 45.47 km, construction of one terminal near Ch 45.00 km, bank protection works for 5 km and construction of 7.5m wide and 43 m long approach road.

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. 1.92 ha of land is estimated to be required for terminal construction. The land identified for terminal construction is located near Ch 45.00 km and is entirely privately owned.

For Phase II, construction of 7.0 m wide road for 305 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 II of the project. The cumulative length for which the bank protection works shall be required is 5.0 km.

The project involves limited dredging for creation of a navigable channel. Phase II requires dredging to the tune of 2.90 Lakhs Cu. M. 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. Since limited dredging is involved, impact on aquatic ecology is also anticipated to be negligible.

Impacts on aquatic ecology due to dredging and disposal of the dredged material within the river banks, however, 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.

No structures are present over the land identified for construction of terminal or related project components. Therefore, the project does not involve any dislocation of population.

Taking into consideration the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices.

The positive impacts on the project will include improved waterway facilities and other allied infrastructure facilities the local population. It will also generate some employment and small business opportunities for the local population.

9.4. EMP and Mitigation of Environmental Effects

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

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 Savitri River is flanked by mangroves for most part of the waterway stretch. Based on the categorization provided in CRZ Notification, 2011, the NW-89 project shall fall under CRZ – I. Accordingly, the project shall require obtaining clearance under the CRZ Notification 2011.

The Ministry of Environment, Forest and Climate Change (MoEFCC), Govt. of India, under the provision of Environment (Protection) Act, 1986, had issued a notification in February, 1991, declaring an area of 500 m from the high tide line along the sea coast, bays and estuaries and up to 100 m from the rivers and creeks as a Coastal Regulation Zone. The developments within this zone are required to be regulated in accordance with the provisions of the notification and the Coastal Zone Management Plan which the State Govt. is required to prepare for the area.

The CRZ Notification 1991 was later amended and a new Notification was issued in 2011 namely CRZ Notification 2011.

The CRZ Notification, 2011 declares the following areas as CRZ:

i. the land area from High Tide Line (HTL) to 500 mts on the landward side along the sea front.

ii. the land area between HTL to 100 mts or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance up to which development along such tidal influenced water bodies is to be regulated shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans (hereinafter referred to as the CZMPs).

Explanation - For the purposes of this sub-paragraph the expression tidal influenced water bodies means the water bodies influenced by tidal effects from sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like.

iii. the land area falling between the hazard line and 500mts from HTL on the landward side, in case of seafront and between the hazard line and 100mts line in case of tidal influenced water body the word 'hazard line' denotes the line demarcated by Ministry of Environment, 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 50meters 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

No forest clearance is required for terminal construction (Phase II) as the land identified for terminal location is entirely privately owned.

Even though mangroves are present on both banks of the Savitri River along the NW-89 stretch, no Forest Clearance on this account is required to be obtained for the project as envisaged 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. 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 9-4 below.

TABLE 9-4: 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-89.
3.	Wildlife Clearance	No	Wildlife Protection Act, 1972	No part of the project falls within the boundary of any of the protected areas or within their eco-sensitive zones.
4.	CRZ Clearance	Yes	CRZ Notification 2011	The entire project falls in CRZ I.

9.6. Cost Implications

As per the scope of services for further environmental and social impact assessment (EIA & SIA) studies and requirement of obtaining all mandatory statutory clearances for the project approximately 1 to 1.5 year is adequate period for consultancy services (1 year for non-CRZ and 1.5 year for CRZ waterways) related to EIA & SIA studies. In this regard, the project authority may engage to QCI/NABET accredited EIA consultant for Category – A projects, who shall conduct rapid EIA & SIA studies and shall prepare a stand-alone EMMP (EMP & EMoP) for inclusion in the contractor bid documents. The generation of environmental baseline data at pre-construction stage along with environmental monitoring during construction and operation stages shall be carried out by the NABL/MoEF&CC approved laboratory to assess the project performance during entire project cycle.

The estimated cost for conducting EIA-EMP & SIA studies along with obtaining all mandatory statutory clearances at pre-construction stage and timely and effective implementation of EMMP (EMP & EMoP) during construction and operation stages have been described in the following sections.

9.6.1. Estimated Cost at Pre-Construction Stage

The statutory fee shall be paid by the project authority for obtaining all mandatory statutory clearances. The estimated environmental and social budget for EIA-EMP & SIA studies have been summarized below:

TABLE 9-5**:** 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 – 9-6).**
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 9-6

TABLE 9-6**:** 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 @ 15 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 9-7**:** 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 an yearly basis for entire construction period (**Table 9-8)**
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 9-8**:** 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 & grease, Phenolic compounds, Residual	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)
		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 pre-construction stage, the environmental monitoring and supervision to be done by the project proponent.

TABLE 9-9**:** 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 9-6 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
3.	Solid Waste Management	2	Lump-sum cost
4.	Sanitary facilities nearby terminals	2	Lump-sum cost
5.	Disaster Management Plan (if applicable)	2	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**13.20**	Per Year

9.6.4. Summary of Estimated Environmental & Social Budget

This covers the consultancy fee at pre-construction stage along with implementation of EMMP (EMP & EMoP) during construction and operational stages of the project. The statutory fee along with the cost of private and government land acquisition shall be borne by the project proponent. This has been summarized in Table 9-10 given below:

TABLE 9-10**:** Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (Rs.)	Remark
1.	Pre-Construction Stage	63.20	Lump-sum
2.	Construction Stage	34.60	
3.	Operational Stage	13.20	
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		111.00	

In Words: Tentative estimated cost is Rs. 111.00 Lakhs.

The above proposed expenditure may have to be considered against the allocated provisions under the head of Fairway Development and Terminal Development.

CHAPTER 10: INSTITUTIONAL REQUIREMENTS

10.1. Organizational Set up / Establishment

The Inland Waterways Authority of India (IWAI) has been carved out duly taking over the responsibilities etc., of the erstwhile Inland Water Transport (IWT) directorate under Ministry of Surface Transport / Ministry of Shipping with a vision of more thrust on the IWT sector along with more Autonomy, by an Act of Parliament (IWAI Act 82 of 1985). Accordingly, IWAI is vested with the functions / duties and responsibilities connected to the safe navigation in the National Waterways and in the interconnected waterways, where IWT is considered for development. The Para 14 of IWAI ACT 82 of 1985 is provisioned with the Functions and Powers of authority, as detailed, which is self-explanatory.

Functions and Powers of the authority:

14. (1) The Authority may-

(a) carry out surveys and investigations for the development, maintenance and better utilization of the national waterways and the appurtenant land for shipping and navigation and prepare schemes in this behalf; (b) provide or permit setting up of infrastructural facilities for national waterways;

(c) carry out conservancy measures and training works and do all other acts necessary for the safety and convenience of shipping and navigation and improvement of the national waterways;

(d) control activities such as throwing rubbish, dumping or removal of material, in or from the bed of the national waterways and appurtenant land, in so far as they may affect safe and efficient, shipping and navigation, maintenance of navigable channels, river training and conservancy measures;

(e) remove or alter any obstruction or impediment in the national waterways and the appurtenant land which may impede the safe navigation or endanger safety of infrastructural facilities or conservancy measures where such obstruction or impediment has been lawfully made or has become lawful by reason of long continuance of such obstruction or impediment or otherwise, after making compensation to person suffering damage by such removal or alteration;

(f) provide for the regulation of navigation and traffic (including the rule of the road) on national waterways; (g) regulate the construction or alteration of structures on across or under the national waterways;

(h) disseminate navigational meteorological information about national waterways;

(i) ensure co-ordination of inland water transport on national waterways with other modes of transport; and (j) establish and maintain pilotage on national waterways;

(k) enter into joint ventures concerning inland shipping by way of equity participation.

14. (2) The Authority may also-

(a) advise the Central Government on matters relating to inland water transport;

(b) study the transport requirement with a view to co-coordinating inland water transport with other modes of transport;

(c) carry out hydrographic surveys and publish river charts;

(d) assist, on such terms and conditions as may be mutually agreed upon, any State Government in formulation and implementation of scheme for inland water transport development;

(e) develop consultancy services and provide such services, on such terms and conditions as may be mutually agreed upon, in India and abroad in relation to planning and development of waterways for shipping and navigation or any facility thereat;

(f) conduct research in matters relating to inland water transport including development of craft design mechanization of country crafts, technique of towage, landing and terminal facilities, port installations and survey techniques;

(g) lay down standards for classification of inland waterways;

(h) arrange programme of technical training for inland water transport personnel within and outside the country; and

(i) perform such other functions as may be necessary to carry out the provisions of this Act.

14. (3) Any dispute arising out of or concerning the compensation referred to in clause(e) of subsection(1) shall be determined according to the law relating to like disputes in the case of land required for public purposes.

14. (4) Every scheme, prepared by the Authority to carry out functions under sub-sections(1) and (2), involving capital expenditure exceeding the amount as may be prescribed, shall be submitted to the Central Government for approval.

14. (5) The Central Government may either approve the scheme submitted to it under sub-section (4) without modification or with such modifications as it may consider necessary or reject the scheme with directions to the Authority to prepare a fresh scheme according to such directions.

In order to consider a planned and systematic implementation with the assigned functions of the authority, a strong Institutional mechanism is required.

If we keenly observe the Institutional systems of similar administrations / establishment globally and the parallel administrations / establishments nationally, the key factor emerging out of the same is only the Policy and procedure of implementation of the assigned responsibilities. It is yet a debatable aspect i.e., whether to have a full pledged organization so as to undertake the works through contractual agencies or to have a mechanism of Out Sourcing the work along with supervision to different contractual agencies (Out Sourcing the work to an agency and the Project Management to other agency).

10.2. Man Power Requirement

It is suggested that the Outsourcing the work to a contractual agency is the best Phase 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	
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	Annexure 10.2 may be referred.
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.
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 Savitri 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 Savitri River is being used extensively only in the mouth through Bankot port. Based on the traffic studies, there is a possibility of using the entire study of Savitri River for IWT navigation with Ro-Ro mobility as a support system for Chemical Industry in MIDC, Mahad through the proposed IWT Terminal in Dasgaon on the left side of the river.

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 Savitri Fairway Development for Ro-Ro Terminal Operations (Phase 1)

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	0.00	
(ii)	Hard Soil	0.00	
2	Low Cost River Structures		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	0.00	
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	0.00	
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	393.09	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**393.09**	
B	**Modification of Structures**		
(i)	Bridges	0.00	
(ii)	Cables	0.00	
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
	Sub-total (C)	**0.00**	
D	**Institutional Requirement**		
(i)	Office Development Cost	405.00	
	Sub-total (D)	**405.00**	
	Sub-total (A)+(B)+(C)+(D)	**798.09**	
E	Environmental Management Plan Cost@5% of Prime cost	39.90	
F	Project Management & consultancy Charges @10% of Prime cost	79.81	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	79.81	
	Project total Hard Cost	**997.61**	
		9.98 crores	

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

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	780.00	11.2
(ii)	Hard Soil	270.00	11.2
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	11.3
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	369.88	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**6348.53**	

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
B	**Modification of Structures**		
(i)	Bridges	0.00	
(ii)	Cables (3 Nos)	30.00	
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**30.00**	
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	0.00	
	Sub-total (D)	**0.00**	
	Sub-total (A)+(B)+(C)+(D)	**6378.53**	
E	Environmental Management Plan Cost@5% of Prime cost	318.93	
F	Project Management & consultancy Charges @10% of Prime cost	637.85	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	637.85	
	Project total Hard Cost	**7973.16**	
		79.73	

TABLE 11-3: Abstract of Cost for Savitri Fairway Development for Ro-Ro Terminal Operations (Phase 2 A – No Dredging & Terminal Shift)

S.No.	Item Description	Amount (in Lakh Rs.)
A	**Fairway**	
1	Dredging	
(i)	General Soil	0.00

S.No.	Item Description	Amount (in Lakh Rs.)
(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
(iii)	Porcupine	
4	Night Navigation	
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	369.88
5	Land Acquisition	0.00
	Sub-total (A)	**5298.53**
B	**Modification of Structures**	
(i)	Bridges	0.00
(ii)	Cables (3 Nos)	30.00
(iii)	Dams	0.00
(iv)	Barrages	0.00
(v)	Locks	0.00
(vi)	Others	0.00
	Sub-total (B)	**30.00**
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	0.00
	Sub-total (D)	**0.00**
	Sub-total (A)+(B)+(C)+(D)	**5328.53**
E	Environmental Management Plan Cost@5% of Prime cost	**266.43**

S.No.	Item Description	Amount (in Lakh Rs.)
F	Project Management & consultancy Charges @10% of Prime cost	**532.85**
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	**532.85**
	Project total Hard Cost	**6660.66**
		66.61

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

TABLE 11-4: Abstract of Cost for Savitri River Ro-Ro facility

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
A	**Terminal** (only 1 RO RO so total cost)		
(i)	Land	552.85	11.5
(ii)	Riverine Components	439.82	11.6
(iii)	Infrastructure Components including internal roads	1204.84	11.7
(iv)	Approach Road (External) Cost	9.95	11.8
(v)	Bank Protection Works for terminal	255.18	11.9
	Sub-total (A)	**2462.64**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Cargo Handling Equipments**		
(i)	Ambulance - Nil.	0	
(ii)	Dumper Trucks 16 T Capacity - Nil.	0	
(iii)	Cranes with 50 T Capacity - Nil.	0	
(iv)	Fork lift trucks 20 T Capacity - Nil.	0	
	Sub-total (C)	**0.00**	
	Sub-total (A)+(B)+(C)	**2462.64**	
D	Environmental Management Plan Cost@5% of Prime cost	123.13	
E	Project Management & consultancy Charges	246.26	

S.No.	Item Description	Amount (in Lakh Rs.)	Annexure
	@10% of Prime cost		
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	246.26	
	Project total Hard Cost	**3078.30**	
		30.78	

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. Careful observation will be considered till FY 25. Investment decision or otherwise will be considered then. As such, the Phase 2 is not recommended at this point of time.

CHAPTER 12: IMPLEMENTATION SCHEDULE

12.1. Time Frame

The development of river Savitri is proposed to be considered in TWO Phases. Keeping in view the availability of fairway depth up to Ch 40 Km, the Phase 1 development is suggested with a nominal investment for considering the promotional mobility of Ro-Ro operation between JnPT and to the end reach of the National Waterway (the industrial cluster).

This Phase 1 operation will be considered till 2025 and after having meticulous analysis, based on the observed growth of mobility, the Phase 2 investment decision may have to be taken. The Phase 2 investment is not suggested, if the growth is not observed.

In order to facilitate the estimated Ro-Ro traffic, in Phase 2, Fairway development, the activities of Dredging; Bank protection; Day / Night Navigation facilities; 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. An alternate of No Dredging & Terminal shift nearer to Ch 40 Km also has been thought off and the Financials have been worked out for the same. The Implementation Schedule in Pictorial form is placed at Annexure 12.1 for Phase 1 and Annexure 12.2 for Phase 2.

12.2. Phasing

The Phase 1 development is with immediate effect for considering the Promotional mobility.

The Phase 2 / Phase 2 A development, if to be considered, will be in 36 months from FY 26 to FY 28.

The Vessel deployment, however, will be taken care by Entrepreneurs.

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

Savitri River development has been distinguished across two development modules. This is depicted in the following Table.

Table 13-1 Savitri River Development

<table>
<tr><th colspan="2">Sub-sector</th><th>FY20</th><th>FY22</th><th>FY30</th><th>FY32</th><th>FY40</th></tr>
<tr><td>Phase 1</td><td>Fairway</td><td colspan="3">Operational (with nominal investment)</td><td></td><td></td></tr>
<tr><td rowspan="4">Phase 2</td><td rowspan="2">Fairway</td><td></td><td></td><td colspan="2">Total Development</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Total Operational</td></tr>
<tr><td rowspan="2">Ro-Ro</td><td></td><td></td><td colspan="2">Development</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Operational</td></tr>
<tr><td rowspan="4">Phase 2A</td><td rowspan="2">Fairway</td><td></td><td></td><td colspan="2">Partial Development</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Partial Operational</td></tr>
<tr><td rowspan="2">Ro-Ro</td><td></td><td></td><td colspan="2">Development</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Operational</td></tr>
</table>

Source: Tractebel; Consultant

Note: Total Development refers to development of entire 45kms stretch and Partial development refers to the development of fairway only 40/41 kms of chainage.

A Phase 1 will be instituted between FY20 and FY30, the fairway of up to 40 km chainage will be utilized for Ro-Ro operation, with nominal investment for night navigation. No Ro-Ro terminal will be set up in Phase 1, as the temporary arrangement at a 40 km chainage location will suffice to cater to the estimated truck traffic. By the end of FY30, IWAI have 2 options i.e Phase 2 – Development of entire 45kms of Fairway + Ro-Ro Terminal and Phase 2A – Partial Development of Fairway i.e upto 40kms without dredging + Ro-Ro Terminal. Based on the technical study, IWAI will decide to move ahead either with Phase 2 or Phase 2A. So post Phase 1 i.e FY30 – FY40, the project could go in one of the two directions i.e either proceed with Phase 2 (entire fairway development) or Phase 2A (partial fairway development without dredging) along with Ro-Ro terminal construction. Construction / Development period for all Phase 2 / 2A is considered for 3 years and operational would start from the last year of construction / development. Phase 1 would start operating from 1st year itself i.e FY20 because no major development would be undertaken in this phase.

Proposed IWT route involves multiple handling of trucks, this adds to the total logistic cost involved in transportation. Total time and cost involved in this multimodal transportation is more as compared to roadway in all phases. An elaboration on the impact on overall logistics cost difference in Phase 2A i.e with chainage of 40kms is depicted in the logistics cost comparison chart between the two modes in the following Figure 4-16.

Ro-Ro/Trade Cost Dynamics

Origin	Destination
JNPT	Mahad

Ro-Ro Cost Dynamics (190 km)

Steps involved	Unit	Case I	Case II
Engine	kW	839	350
Engine fuel requirement	l/hr	222	102
Per Truck Ro-Ro Tariff	INR/Truck	9,233	8,832
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**9,375**	**8,974**

Truck Cost Dynamics (137 km)

Components	Cost (Rs.)	Cost
Fuel	INR	2,195
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**3,440**

Figure 13-1: Logistic cost comparison

Figure 13.1 gives the one-way cost breakup; similar cost would be applied for the return journey.

It is evident that costs involved in both the Ro-Ro cases are on the higher side when compared to roadways. This cost difference favours the roadway. As per Case I the logistics cost difference for roadway and waterway is INR 5,935/truck. Cost of transporting per truck on the waterway would be nearly three times as expensive as roadway. In Case II, this cost difference is narrower with INR 5,534/truck. In case of just Ro-Ro cost comparison, Case II is marginally cheaper than Case I. This cost comparison highlights the subsidy amount required per truck i.e cost difference for waterways and roadways, in order to influence the industries into opting for IWT. In addition to subsidy, other measures would be needed to package and promote IWT as a better option over other modes, despite the increased transportation time and distance in the former's case.

13.2. Input Sheet

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

Table 13-2 Input Sheet for Savitri River project

Description	Unit	Fairway	Ro-Ro
Loan Tenure	Years	10	10
Moratorium Period (Years Construction)	Years	3	3
Rate of Interest	Annual	11%	11%
Corporate Tax	Annual	30%	30%
Cargo Revenue Escalation	Annual	6%	6%
Other Revenue Escalation	Annual		6%

Description	Unit	Fairway	Ro-Ro
Administrative Cost	of Revenue	3%	2%
Manpower Cost Escalation	Annual	5%	5%
Other Costs Escalation	Annual		6%
Fairway Chainage	km	40*, 45	
Chainage (mouth of the river to Ro-Ro Terminal)	Km		40*, 45
** Fairway chainage during Phase 2A*			
Tariff for Revenue Calculation			
Various Revenue Sources	**Unit**	**Fairway**	**Ro-Ro**
Fairway Cost			
Movement of vessel	INR/ GRT-km	0.5	
Charges of Handling Ro-Ro Trucks			
Vessel Berthing Charges	Per Vessel/Day		1,000
Vehicle Unloading Charges	Per Truck		50
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**	**Ro-Ro**
Civil Infrastructure	Cost		1%
Dredging		10%	
Ship Operating Cost			
Utilities		5%	5%
Machinery Infrastructure			5%
IT & Other Soft Factors		5%	5%
Insurance Cost	Capex	2%	2%

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	2x40 or 2x45	
Fuel price	Rs/Litre	60.00	
Vehicular Operating Cost (VOC)			

Description	Unit	Fairway	Ro-Ro
Road	Rs/t-km	2.58	
Rail	Rs/t-km	1.41	Tractebel
IWT	Rs/t-km	1.06	
Direct Employment Creation			
Road	Per Million t-km	20	
Rail	Per Million t-km	2	
IWT	Per Million t-km	0.5	Tractebel
Employment cost	Rs Lakhs per Annum	2.5	
Emission Reduction			
Road	g CO2/t-km	60	
Rail	g CO2/t-km	13.3	Tractebel
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 or provided by IWAI. Fairway and terminal tariff have been taken from IWAI. The vessel parcel size is estimated at 90% of the rated DWT, and GRT is estimated at 75% of the rated DWT. In case of fairway and Ro-Ro revenue calculations, only one-way trip across the chainage is considered. In EIRR, round-trip distance is considered in each of the sub-sector's economic viability evaluation.

Keeping in line with the Phase 1 and Phase 2 / Phase 2A all the subsequent sections will include financial analysis accordingly.

13.3. Revenue

Revenue for the cumulative stretch of Savitri River will be generated from the core operations, which include utilization of the fairways by the potential users from the Mahad industry, and operation at the Ro-Ro 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 Savitri River are presented in the table below:

Table 13-3 Revenue for Savitri River (INR Lakhs)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Fairway (40Kms)	260	423	342	-	-	-
Phase 2						
Fairway (45Kms)	-	-	-	468	627	1,021

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Ro-Ro Terminal	-	-	-	294	393	638
Phase 2A						
Fairway (40Kms)	-	-	-	416	558	908
Ro-Ro Terminal	-	-	-	294	393	638

Source: Consultant

In Phase 1, FY20 has been reserved for laying the necessary groundwork to initiate the operation and in the same year the estimated traffic will start moving the fairway. In next Phase, FY30 to FY32 has been considered for development and from last year of construction period i.e FY32 the terminal and fairway will be operational and start generating revenue. The lack of any considerable investment bodes well for returns in case of fairway utilization. Even in case of development post promotional period, the high traffic volume and increased chainage will continue to favorably impact the revenue prospects.

13.4. Costs

This section presents the total project cost, and equity-debt distribution in phased manner. The following table shows these cost-heads for both the core business operations:

Table 13-4 Project Cost

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
Phase 1				
Phase 1 – Fairway (40kms)				
Fairway	393.1	393.1	-	-
Institutional Requirement	405.0	405.0	-	-
Environmental Management Plan Cost@5% of Prime cost	39.9	39.9	-	-
Project Management & consultancy Charges @10% of Prime cost	79.8	79.8	-	-
Contingencies and Unforeseen Items of Works@10% of Prime cost	79.8	79.8	-	-
Total Project Cost	**997.6**	**997.6**	-	-
Phase 2				
Fairway Development (45kms)				
Fairway	6,378.5	2,551.4	1,913.6	1,913.6
Environmental Management Plan Cost@5% of Prime cost	318.9	95.7	95.7	127.6
Project Management & consultancy Charges @10% of Prime cost	637.9	191.4	191.4	255.1
Contingencies and Unforeseen Items of Works@10% of Prime cost	637.9	191.4	191.4	255.1
Total Project Cost	**7,973.7**	**3,029.8**	**2,391.9**	**2,551.4**

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
Phase 2 - Ro-Ro Terminal				
Terminal	2,462.6	985.1	738.8	738.8
Environmental Management Plan Cost@5% of Prime cost	123.1	36.9	36.9	49.3
Project Management & consultancy Charges @10% of Prime cost	246.3	73.9	73.9	98.5
Contingencies and Unforeseen Items of Works@10% of Prime cost	246.3	73.9	73.9	98.5
Total Project Cost	**3,078.3**	**1,169.8**	**923.5**	**985.1**
Phase 2A				
Fairway Development (40kms)				
Fairway	5,328.5	2,131.4	1,598.6	1,598.6
Environmental Management Plan Cost@5% of Prime cost	266.4	79.9	79.9	106.6
Project Management & consultancy Charges @10% of Prime cost	532.9	159.9	159.9	213.1
Contingencies and Unforeseen Items of Works@10% of Prime cost	532.9	159.9	159.9	213.1
Total Project Cost	**6,660.7**	**2,531.1**	**1,998.2**	**2,131.4**
Ro-Ro Terminal				
Terminal	2,462.6	985.1	738.8	738.8
Environmental Management Plan Cost@5% of Prime cost	123.1	36.9	36.9	49.3
Project Management & consultancy Charges @10% of Prime cost	246.3	73.9	73.9	98.5
Contingencies and Unforeseen Items of Works@10% of Prime cost	246.3	73.9	73.9	98.5
Total Project Cost	**3,078.3**	**1,169.8**	**923.5**	**985.1**

The only cost fairway utilization in Phase 1 will entail is for shore marking with lattice bridge and for lighting equipment. Cost for dredging activity and bank protection works will be incurred only during the Phase 2A.

For Ro-Ro operations, 2 Ro-Ro vessels may be required during the promotional period. An additional 6 vessels will be needed, whose acquisition will be spread across FY30, FY32, FY34, FY36, FY38, and FY40. So, a total of 8 vessels are needed to cater to the estimated Ro-Ro traffic on the River. The onus of these vessel acquisitions will be with the private operator and not IWAI. Hence, these costs will not be factored in to develop model for the Ro-Ro 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 Ro-Ro
Vessel Cost	Lakhs	900
Running Cost	Lakh/annum	624
Crew	No.	8
Crew Wages	Lakh/annum	6
Crew Cost	Lakh/annum	48
Repair Cost (@2% Capex)	Lakh/annum	18

Source: Tractebel

13.5. Financial Analysis / FIRR

The financial indicators dictating FIRR for individual ventures, viz. fairways development and terminal operations have been presented in Tables below. 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	FY32	FY35	FY40
Phase 1								
Phase 1 – Fairway (40kms)								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	4	5	7	-	-	-
Hydrographer	1	8	24	31	39	-	-	-
Executives	2	3	18	23	29	-	-	-
Engineer	1	4	12	15	20	-	-	-
Total Salary (INR Lakh)	**6**	-	**58**	**74**	**94**	-	-	-
Phase 2								
Fairway (45kms)								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	-	-	4	5	7
Hydrographer	1	8	-	-	-	26	31	39
Executives	2	3	-	-	-	20	23	29
Engineer	1	4	-	-	-	13	15	20
Total Salary (INR Lakh)	6	-	-	-	-	**64**	**74**	**94**
Ro-Ro Terminal								
Manpower Expenditure								
Manager Cargo Handling	1	6	-	-	-	20	23	29
Security Guards (Jetty x 2)	2	2	-	-	-	12	14	18
Executives for billing and commercial	1	3	-	-	-	10	11	15
Total Salary (INR Lakh)	**4**	**-**	-	-	-	**42**	**48**	**62**

Parameter	No.	CTC p.a. / person (INR Lakh)	FY20	FY25	FY30	FY32	FY35	FY40
Phase 2A								
Fairway (40kms)								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	-	-	4	5	7
Hydrographer	1	8	-	-	-	26	31	39
Executives	2	3	-	-	-	20	23	29
Engineer	1	4	-	-	-	13	15	20
Total Salary (INR Lakh)	6	-	-	-	-	**64**	**74**	**94**
Ro-Ro Terminal								
Manpower Expenditure								
Manager Cargo Handling	1	6	-	-	-	20	23	29
Security Guards (Jetty x 2)	2	2	-	-	-	12	14	18
Executives for billing and commercial	1	3	-	-	-	10	11	15
Total Salary (INR Lakh)	**4**	**-**	-	-	-	**42**	**48**	**62**

Source: Consultant

Manpower cost has been considered in Total Project Cost under "Institutional Requirement". However, this investment component toward manpower will accommodate expenses only for the initial years, covering construction period. Manpower expenses in case of the Ro-Ro 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	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Gross Block	998	998	998	-	-	-
Depreciation & Amortization	-	84	44	-	-	-
Cumulative Depreciation & Amortization	-	420	641	-	-	-
Net Block	998	577	357	-	-	-
Phase 2						
Fairway (45kms)						
Gross Block	-	-	3,030	7,973	7,973	7,973
Depreciation & Amortization	-	-	-	723	723	404
Cumulative Depreciation & Amortization	-	-	-	1,197	3,365	5,511
Net Block	-	-	3,030	6,776	4,608	2,462
Ro-Ro Terminal						
Gross Block	-	-	1,170	3,078	3,078	3,078
Depreciation & Amortization	-	-	-	279	279	156
Cumulative Depreciation & Amortization	-	-	-	462	1,299	2,128
Net Block	-	-	1,170	2,616	1,779	951

Depreciation & Amortization	FY20	FY25	FY30	FY32	FY35	FY40
Phase 2A						
Fairway (40kms)						
Gross Block	-	-	2,531	6,661	6,661	6,661
Depreciation & Amortization	-	-	-	604	604	337
Cumulative Depreciation & Amortization	-	-	-	1,000	2,811	4,604
Net Block	-	-	2,531	5,661	3,850	2,057
Ro-Ro Terminal						
Gross Block	-	-	1,170	3,078	3,078	3,078
Depreciation & Amortization	-	-	-	279	279	156
Cumulative Depreciation & Amortization	-	-	-	462	1,299	2,128
Net Block	-	-	1,170	2,616	1,779	951

Source: Consultant

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	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	140	178	217	-	-	-
Total Cost	**140**	**178**	**217**	**-**	**-**	**-**
Phase 2						
Fairway (45kms)						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	-	-	301	901	1,027	1,284
Total Cost	-	-	**301**	**901**	**1,027**	**1,284**
Ro-Ro Terminal						
Direct Operating Costs	-	-	16	19	26	42
Maintenance and Other Cost	-	-	27	121	135	165
Total Cost	-	-	**43**	**141**	**161**	**207**
Phase 2A						
Fairway (40kms)						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	-	-	251	764	871	1,090
Total Cost	-	-	**251**	**764**	**871**	**1,090**
Ro-Ro Terminal						

Parameters	FY20	FY25	FY30	FY32	FY35	FY40
Direct Operating Costs	-	-	16	19	26	42
Maintenance and Other Cost	-	-	27	121	135	165
Total Cost	-	-	**43**	**141**	**161**	**207**

Table 13-9 P&L Statement (INR Lakh)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
PBDIT	**120**	**246**	**126**	-	-	-
Depreciation	-	84	44	-	-	-
Interest	71	32	-	-	-	-
PBT	**48**	**130**	**82**	-	-	-
Tax	14	39	24	-	-	-
PAT	**34**	**91**	**57**	-	-	-
Phase 2						
Fairway (45kms)						
PBDIT	-	-	**-301**	**-433**	**-399**	**-262**
Depreciation	-	-	-	723	723	404
Interest	-	-	217	570	352	20
PBT	-	-	**-517**	**-1,725**	**-1,474**	**-686**
Tax	-	-	-	-	-	-
PAT	-	-	**-517**	**-1,725**	**-1,474**	**-686**
Ro-Ro Terminal						
PBDIT	-	-	**-43**	**153**	**232**	**431**
Depreciation	-	-	-	279	279	156
Interest	-	-	84	220	136	8
PBT	-	-	**-127**	**-346**	**-183**	**268**
Tax	-	-	-	-	-	80
PAT	-	-	**-127**	**-346**	**-183**	**187**
Phase 2A						
Fairway (40kms)						
PBDIT	-	-	**-251**	**-348**	**-313**	**-182**
Depreciation	-	-	-	604	604	337
Interest	-	-	181	476	294	17
PBT	-	-	**-432**	**-1,428**	**-1,211**	**-536**
Tax	-	-	-	-	-	-
PAT	-	-	**-432**	**-1,428**	**-1,211**	**-536**
Ro-Ro Terminal						
PBDIT	-	-	**-43**	**153**	**232**	**431**
Depreciation	-	-	-	279	279	156

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Interest	-	-	84	220	136	8
PBT	-	-	**-127**	**-346**	**-183**	**268**
Tax	-	-	-	-	-	80
PAT	-	-	**-127**	**-346**	**-183**	**187**

Source: Consultant

Only Phase 1 is expected to turn out to be a profitable venture. Virtually non-existent development and O&M cost during this Phase allows this sub-sector project to derive higher profit. This is an exceptional case, and possible only in an absolutely ideal market condition wherein the industry is willing to shift all its cargo operation to the IWT. However in Phase 2 & 2A, the relatively high construction cost and subdued revenue generating potential for the Fairway is evident in the losses till FY40. Ro-Ro Terminal is evident in the losses till FY36 and start generating profit beyond FY36.

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

Table 13-10 FIRR for Savitri River (INR Lakh)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Project Cashflow(Pre-tax)	-878	246	126	-	-	-
Project IRR(Pre-tax)	**19%**					
Project Cashflow(Post-tax)	-892	207	101	-	-	-
Project IRR(Post-tax)	**15%**					
Phase 2						
Fairway (45kms)						
Project Cashflow(Pre-tax)	-	-	-3,330	-2,984	-399	-262
Project IRR(Pre-tax)	**Non-existent**					
Project Cashflow(Post-tax)	-	-	-3,330	-2,984	-399	-262
Project IRR(Post-tax)	**Non-existent**					
Ro-Ro Terminal						
Project Cashflow(Pre-tax)	-	-	-1,213	-832	232	431
Project IRR(Pre-tax)	**-4%**					
Project Cashflow(Post-tax)	-	-	-1,213	-832	232	351
Project IRR(Post-tax)	**-6%**					
Phase 2A						
Fairway (40kms)						
Project Cashflow(Pre-tax)	-	-	-2,782	-2,479	-313	-182
Project IRR(Pre-tax)	**Non-existent**					
Project Cashflow(Post-tax)	-	-	-2,782	-2,479	-313	-182

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Project IRR(Post-tax)	**Non-existent**					
			Ro-Ro Terminal			
Project Cashflow(Pre-tax)	-	-	-1,213	-832	232	431
Project IRR(Pre-tax)	**-4%**					
Project Cashflow(Post-tax)	-	-	-1,213	-832	232	351
Project IRR(Post-tax)	**-6%**					

Source: Consultant

As highlighted earlier, the extraordinary revenue prospect for fairway in Phase 1 will enable this sub-sector project to generate higher rate of returns. It's the imbalance between negligible cost and extremely high revenues that has made this possible. While in Phase 2 & 2A, development of Fairway and Ro-Ro Terminal is likely to be a loss-making venture. Based on the EIRR for both sub-sector, Viability Gap Funding (VGF) can be sought.

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 CO_2 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.

Only the Ro-Ro sub-sector under Savitri River development would require financial intervention from the government. A strong EIRR could warrant capital inflow from state and/or central government in the form of Viability Gap Funding (VGF). Estimated EIRR for each of these sub-sectors is presented in the table below:

Table 13-11 Project EIRR (INR Crores)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
			Phase 1			
			Phase 1 – Fairway (40kms)			
Economic Cash Outflow	-1	19	23	-	-	-
Net Cash Flow to Project	-10	19	23	-	-	-
Project EIRR	**166%**					
			Phase 2			
			Fairway (45kms)			
Economic Cash Outflow	-	-	-2	23	25	29
Net Cash Flow to Project	-	-	-32	-3	25	29
Project EIRR	**24%**					

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
	Ro-Ro Terminal					
Economic Cash Outflow	-	-	-	25	27	32
Net Cash Flow to Project	-	-	-12	15	27	32
Project EIRR	**73%**					
	Phase 2A					
	Fairway (40kms)					
Economic Cash Outflow	-	-	-2	20	22	26
Net Cash Flow to Project	-	-	-27	-1	22	26
Project EIRR	**26%**					
	Ro-Ro Terminal					
Economic Cash Outflow	-	-	-	22	24	28
Net Cash Flow to Project	-	-	-12	12	24	28
Project EIRR	**65%**					

Source: Consultant

All the sub-sector projects exhibit positive impact on the local economy, and invariably, the economy of the state and the nation.

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

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Revenue	286	466	377	-	-	-
PAT	41	105	69	-	-	-
Project IRR (Pre tax)	**20%**					
Project IRR (Post tax)	**16%**					
Phase 2						
Fairway (45kms)						
Revenue	-	-	0	515	690	1124
PAT	-	-	-569	-1891	-1614	-745
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Ro-Ro Terminal						
Revenue	-	-	-	323.0	432.1	702.0
PAT	-	-	-138.0	-374.6	-194.2	213.4

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Project IRR (Pre tax)	**-4%**					
Project IRR (Post tax)	**-5%**					
Phase 2A						
Fairway (40kms)						
Revenue	-	-	-	458	613	999
PAT	-	-	-475	-1,564	-1,325	-580
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Ro-Ro Terminal						
Revenue	-	-	-	323.0	432.1	702.0
PAT	-	-	-138.0	-374.6	-194.2	213.4
Project IRR (Pre tax)	**-4%**					
Project IRR (Post tax)	**-5%**					

Source: Consultant

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

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Revenue	286	466	377	-	-	-
PAT	62	134	91	-	-	-
Project IRR (Pre tax)	**30%**					
Project IRR (Post tax)	**23%**					
Phase 2						
Fairway (45kms)						
Revenue	-	-	-	515	690	1,124
PAT	-	-	-465	-1,468	-1,213	-429
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Ro-Ro Terminal						
Revenue	-	-	-	323.0	432.1	702.0
PAT	-	-	-115.8	-260.1	-95.4	249.0
Project IRR (Pre tax)	**0%**					
Project IRR (Post tax)	**-1%**					
Phase 2A						
Fairway (40kms)						
Revenue	-	-	-	458	613	999
PAT	-	-	-389	-1,210	-989	-316
Project IRR (Pre tax)	**Non-existent**					

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Project IRR (Post tax)	**Non-existent**					
			Ro-Ro Terminal			
Revenue	-	-	-	323.0	432.1	702.0
PAT	-	-	-115.8	-260.1	-95.4	249.0
Project IRR (Pre tax)	**0%**					
Project IRR (Post tax)	**-1%**					

Source: Consultant

Table 13-14 Sensitivity Analysis (-10% Revenue, +10% Project Cost)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
			Phase 1			
			Phase 1 – Fairway (40kms)			
Revenue	234	381	308	-	-	-
PAT	6	48	23	-	-	-
Project IRR (Pre tax)	**10%**					
Project IRR (Post tax)	**7%**					
			Phase 2			
			Fairway (45kms)			
Revenue	-	-	-	421	565	919
PAT	-	-	-569	-1,982	-1,736	-944
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
			Ro-Ro Terminal			
Revenue	-	-	-	264.3	353.5	574.4
PAT	-	-	-138.0	-432.2	-271.2	125.9
Project IRR (Pre tax)	**-9%**					
Project IRR (Post tax)	**-9%**					
			Phase 2A			
			Fairway (40kms)			
Revenue	-	-	-	375	502	817
PAT	-	-	-475	-1,645	-1,433	-756
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
			Ro-Ro Terminal			
Revenue	-	-	-	264.3	353.5	574.4
PAT	-	-	-138.0	-432.2	-271.2	125.9
Project IRR (Pre tax)	**-9%**					
Project IRR (Post tax)	**-9%**					

Source: Consultant

Table 13-15 Sensitivity Analysis (-10% Revenue, -10% Project Cost)

Parameter	FY20	FY25	FY30	FY32	FY35	FY40
Phase 1						
Phase 1 – Fairway (40kms)						
Revenue	234	381	308	-	-	-
PAT	26	77	45	-	-	-
Project IRR (Pre tax)	**18%**					
Project IRR (Post tax)	**14%**					
Phase 2						
Fairway (45kms)						
Revenue	-	-	-	421	565	919
PAT	-	-	-465	-1,559	-1,334	-627
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Ro-Ro Terminal						
Revenue	-	-	-	264.3	353.5	574.4
PAT	-	-	-115.8	-317.6	-172.4	161.4
Project IRR (Pre tax)	**-5%**					
Project IRR (Post tax)	**-6%**					
Phase 2A						
Fairway (40kms)						
Revenue	-	-	-	375	502	817
PAT	-	-	-389	-1,291	-1,097	-492
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Ro-Ro Terminal						
Revenue	-	-	-	264.3	353.5	574.4
PAT	-	-	-115.8	-317.6	-172.4	161.4
Project IRR (Pre tax)	**-5%**					
Project IRR (Post tax)	**-6%**					

Source: Consultant

Under no scenario does the development of Fairway both fully and partial produce FIRR. This means that even in imaginable optimistic conditions of higher revenue and lower cost, Fairway terminal is highly unlikely to generate returns in the projected period up to FY40. Prima facie, this indicates that development of fairway is not a sound investment to make. However, in Phase 1 i.e nominal investment in fairway upto 40kms shows very positive IRR in every scenario. This is just because of very low operating cost and high revenue from fairway usage. Ro-Ro terminal in both the Phases i.e Phase 2 & 2A shows negative returns.

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 industry's willingness to shift to IWT, even with possible subsidy. This happens when industries find end-to-end logistics cost of fairway & Ro-Ro Terminal higher than the existing mode of transportation i.e. roadways. In this situation, industries may reject using this mode & continue using roadways. The promotional campaign will provide a strong indicator for the market's willingness in this regard. Other risks typically impressing upon such a project are political, technical, environmental, and financial in nature. A broad assessment of such risks for the Savitri River waterway development project is depicted in Table 13-16. The following enumerates risks identified in executing the Project, the rationale behind it, and the potential mitigation or management measures:

Table 13-16 Risk Factors & Mitigation measures

Risk	Description	Likelihood*	Impact**	Risk Rank#	Mitigation / Management
Unwillingness of industries	Cost/Time Factor & Multiple handling reduces logistics advantage of waterway cargo movement, against the competing existing road movement.	3	3	9	· Incorporate industries' expectations in terms of infrastructure and facilities · Tariff low enough to appeal prospective industries, and to retain profitable operation for IWAI
Seasonal river	Draft of the river reduces in summer, which is not ideal for carrying cargo. This reduces the potential for cargo movement through river in future.	3	3	9	· Undertake regular maintenance Dredging
Uncertain Future traffic	No development or Expansion plans of considered industries. This restricts cargo growth in near future.	2	4	8	· Seamless end-to-end logistics, favouring inland waterway movement, incentivizing waterway movement other alternatives. · Lower tariffs
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

Source: Consultant

*, ** - 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.

Development of Fairway and Ro-Ro Terminal in both the phases is commercially unviable, but economically viable. So, these particular sub-sectors 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 return of the Ro-Ro Terminal:

Table 13-17 Probable impact of VGF on project returns

Reduction in Project Cost	Phase 2		Phase 2A	
	-20%	-40%	-20%	-40%
Fairway				
Project IRR (Post Tax)	-	-26%	-	-23%
Project EIRR	33%	46%	35%	49%
Ro-RO Terminal				
Project IRR (Post Tax)	-1%	4%	-1%	4%
Project EIRR	87%	110%	79%	100%

Source: Consultant

Even with significant financial support from the government, fairway fails to produce the desired positive IRR in both the phases. Ro-Ro terminal shows positive return only after getting the grant from both central and state government i.e upto 40% of total project cost.

13.10. Conclusion

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

Table 13-18 Critical indicators for the Savitri River Project (INR Cr.)

Parameter	Phase 1	Phase 2		Phase 2A	
	Fairway	Fairway	Ro-Ro Terminal	Fairway	Ro-Ro Terminal
Project Cost	9.97	79.74	30.78	66.61	30.78
Revenue (FY40)	3.42 (FY2030)	10.21	6.38	9.08	6.38
FIRR	15%	Non-existent	-6%	Non-existent	-6%
EIRR	166%	24%	73%	26%	65%

Source: Consultant

The positive returns in case of fairway in Phase 2 & 2A are unrealistic. Even if the FIRRs were within normal limits, the likelihood of this or all the sub-sector projects actually coming online would be dependent on the logistics cost differential and the government's intervention to address that. If in future, industries located in Mahad don't show marked increase in traffic volume, then the decision to set up a Ro-Ro terminal on Savitri river becomes irrelevant. The cost difference between roadways and waterways will remain the same or widen even further. Even in the ideal situation where the government will be willing to compensate the cost difference, the Ro-Ro terminal is unlikely to generate profits in the long run. A combination of increased costs, time, and distance will weigh on the overall appeal and benefits of waterway movement, deterring potential customers.

It is evident from the logistics cost comparison that both the cases of waterway movement will be costlier than existing mode of transportation using roadways by a significant margin. For development of Ro-Ro Terminal and for it to attract the projected traffic, government needs to subsidize the shift by offering the cost difference to the transporters. The subsidy amount will compensate for high logistics cost, but additional incentives need to be offered to make up for the increase in time and distance. IWAI should bear costs associated with maintenance of the Terminal (repairs and maintenance) and the navigation infrastructure (dredging, night navigation, buoys, etc.). A combination of subsidy and incentives is needed to induce shift of traffic from existing roadways to waterway for EXIM requirements of the industries in Mahad MIDC. The following chart depicts the annual subsidy cost government will have to incur if it were to go ahead with cargo movement on Savitri.

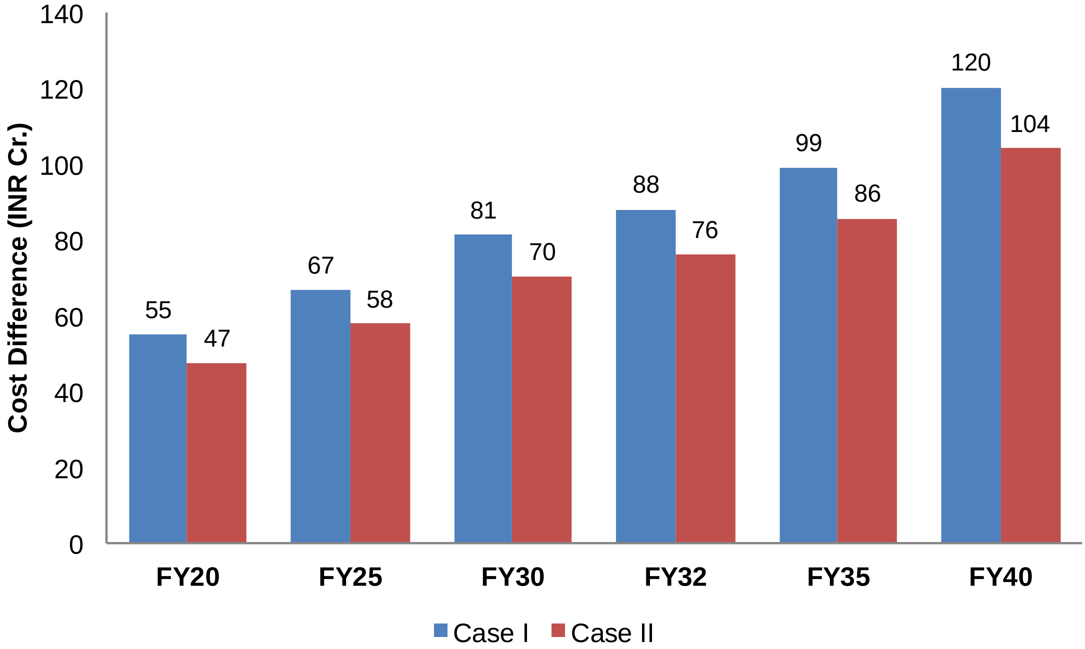


Figure 13-2 Annual Subsidy Expense (INR Cr.)

Source: Consultant

As per the chart above, INR 47 Cr. is the lowest subsidy expense to be given by government in order to make this project feasible. The combined revenue of Fairway and Ro-Ro does not create even half of investment cost. The project will achieve BEP only with the support of subsidy i.e after FY33 in case I and FY36 in case II. This sole reason of steep subsidy requirement, on account of the wide logistics cost difference, renders this entire project unviable. So, unless the government is willing to bear the high cost of subsidy, development of Savitri River is not a commercially sound investment prospect.

CHAPTER 14: CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Savitri River (NW 89) in the stretch of 45.470 Kms from Lat 17° 58' 47.2472" N, Long 73° 02' 15.0195" E has been carried out as per the Terms of Reference (ToR)

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.
- The National Waterway (NW 89) "Savitri River (Bankot Creek)" is having a 2.0 m depth (w. r. to CD) up to 40 kms out of 45.47 kms. Inspite of such fairway availability, there is no cargo mobility in the river.
- Keeping in view the proximity of Industrial Belt in the end stretch of the River, MIDC, Mahad {being planned and designated by Maharashtra State Government}, the possibility of Ro-Ro mobility could be established with an estimated Ro-Ro vehicles mobility to the extent of 67,000 vehicles P. A in FY 20 and expected grow to an extent of 148,000 vehicles P. A in FY 40. There is a possibility of this mobility directly from JNPT through IWT vessel traversing the costal route and the full stretch of the Savitri River.
- Accordingly, the possibility of Ro-Ro mobility has been considered with Class IV standard of Waterway with 50 m Bottom Width of fairway and 2.0 m Depth of fairway with a vessel / convoy requirement for Class IV as 170 m (Length) x 12 m (Breadth) x 1.8 m (Draft).
- A promotional operation has been suggested for initial operation with 2 Ro-Ro vessels (Deployment by Entrepreneur) between JnPT and Ch 40 km, just downstream of the tributary, near "Dasgaon Jetty", where approach road is existing in South side (Bank near "Owale" village), which is connected to NH 66 with a lead of 16 kms through SH 70.
- This promotional aspect is proposed as Phase 1, where there is no investment (rather nominal investment) for development. 20 Nos of Lattice Bridge with Lighting and L. S provisions have been worked out for INR 9.98 Cr in Phase 1.

- Ø No development is suggested till a critical and micro level analysis with observation of increase in volumes of Ro-Ro operation. If there is any need for investment, then Phase 2 can be considered.
- Ø As a part of Phase 2 development, in order to provide a class IV safe navigable fairway, Dredging of 2.6 Lakhs Cu. M in Soils and 0.30 Lakhs in Hard Soils; 4000 m of Bank Protection; 110 Nos of Day / Night Navigation Buoy / Light etc., have been suggested.
- Ø (Ro-Ro) IWT Terminal has been proposed taking into the consideration of the origin and destination and fairway. The most probable location identified is on the left side of the river with approx. Lat 18° 05' 55" N and Long 73° 20' 11.56" E. This location is having good accessibility to the road and the tentative Land requirement has been arrived at with 19,258 Sq. M in the Dasgaon Village; Mahad Taluka; Raigarh District of Maharashtra state.
- Ø Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 75 m and width as 16.60 m.
- Ø In order to facilitate the Ro-Ro operation, The following Vessel type and size have been considered i.e., the type as Ro-Ro Vessel with 21 TEU capacity LOA 52.8 m to 55 m; Breadth 14 m; Loaded Draft / Depth 1.8 m / 2.5 m+; Propulsion with Marine Diesel Engines of 3 x 375 Bhp and with Average Speed (with Load) of 20 Kmph. The indicative cost is about INR 900 Lakhs.
- Ø The cost estimates have been worked out and segregated into Fairway Module with capital cost of 79.73 Cr. followed with Ro-Ro jetty Module at a capital cost of 30.78 Cr. (approx.). Implementation of phase 1 is with immediate effect and phase 2 is 36 months ending 2029. Phase 2 A is to limit the waterwat up to Ch. 40 km.
- Ø The FIRR and EIRR have been worked out and the details are placed.

Parameter	Phase 1	Phase 2		Phase 2A	
	Fairway	Fairway	Ro-Ro Terminal	Fairway	Ro-Ro Terminal
Project Cost	9.97	79.74	30.78	66.61	30.78
Revenue (FY40)	3.42 (FY2030)	10.21	6.38	9.08	6.38
FIRR	15%	Non-existent	-6%	Non-existent	-6%
EIRR	166%	24%	73%	26%	65%

- Ø It is recommended to consider Phase 1 Promotional mobility till 2025 / 2026 with the operation up to 40 km / 42 km. No investment is suggested for further development, without any meticulous assessment for developing the entire study stretch of Savitri River (Bankot Creek) of about 45 kms with Class IV system of the NW standards to facilitate the Ro-Ro vessel mobility.

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	Land identified for terminal construction (Phase 2) is entirely privately owned.
f) Wetland		ü	
g) Important Bird Areas		ü	
h) Mangroves Areas	ü		Mangroves are present on both banks of Savitri river in the NW-89 stretch, but the development of NW-89 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	Harihareswar Temple and other structures located close to NW-89 are not enlisted as protected monuments. Moreover, the project does not have any adverse impact on these structures.
2. Is the project located in whole or part in / near any Critically Polluted Areas identified by CPCB?		ü	
3. Is, there any defense		ü	

Screening Question	Yes	No	Details / Remarks
installations near the project site?			
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		No land vegetation or buildings are to be affected by the project.
6. Is the project involved dredging?		ü	Dredging will be required only if Phase 2 is taken up for development. The DPR recommends selection of Phase 1 which does not involve any dredging.
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 are falls in CRZ I.
9. Is the project involved any demolition of existing structure?		ü	
10. Is the project activity require acquisition of private land?		ü	Acquisition of private land will be required only if Phase 2 is taken up for development. The DPR recommends selection of Phase 1 which does not involve any terminal construction.
11. Is the proposed project activity result in loss of direct livelihood / employment?		ü	
12. Is the proposed project activity affect schedule tribe/ caste communities?		ü	No land acquisition is envisaged for Phase 1 which is recommended for development based on the present studies. Acquisition of private land shall be required for terminal construction only if Phase 2 is taken up for development.

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	Required only as part of the 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 - Savitri River originates in Mahabaleshwar and flows through Raigad district and meets Arabian Sea at Harihareshwar. Savitri River forms a border between Raigad & Ratnagiri district. The primary catchment area of Savitri River consists of hilly terrain.
- Catchment area – Mhsala, Shrivardhan, Mahad, Mangaon, Poladpur taluka of Raigad district and Mandangad, Dapoli taluka of Ratnagiri district.
- Population – As per census 2011, total population residing in above mentioned taluka of both the districts is 6,36,947
- Economic activities –Agriculture activities, Fishing, industrial activities
- Major industries - Chemical industries in Mahad MIDC
- Connectivity
  - ü Major roads - SH 100 which is a curvy road runs parallel to Savitri River from Raigad district side. However SH 102 passing in Ratnagiri District is not parallel to the river and the road is very curvy. NH 66 is also in the close proximity of the river.
  - ü Major railway – Konkan railway line is the only railway line running in both Raigad and Ratnagiri district that crosses the river. Mangaon, Karanjadi & Veer, Sape are passenger railway stations in the catchment of the river.
- Specific Developments

  Danda of Raigad district and Bankot of Ratnagiri district. Both these locations are located at the mouth of Savitri River. It is expected that this bridge would be operational by end of 2017 or early 2018 and would be used for transportation.
- Catchment area Map

15.2.2. Navigation Baseline

- Existing Waterway Usage
  - ü There exist two bridges on Savitri River. One bridge is near Mahad, which is at the end point of the river and another bridge connects Ambet village in Raigad district with Islampur in Ratnagiri district.
  - ü Apart from existing ferry near to mouth of the river, no other vessels/boat ply on river.
  - ü There exist captive jetty of Infrastructure logistics at Umroli village on river to handle Bauxite.
  - ü Bankot, one of the non-major port of Maharashtra located on the mouth of Savitri.

15.2.3. Market Baseline

- Potential Market

  No cargo potential exist for Savitri River. However a possibility of ro-ro traffic under certain conditions has been discussed in detail in Chapter 4 section no. 4.10

Commodity	Source	Reasoning
POL	BPCL & HPCL	Obtaining a land on the western coast side is a challenging task due to strong opposition of locals. Setting up a POL refinery would be difficult.
Chemical	Mahad MIDC	Chemical companies use JNPT port and did not show any willingness to use Savitri river because of time & cost involved.

15.2.4. Forecasting Years

- IWT Share for possible ro-ro
  - ü Ro-Ro traffic share of IWT is 60%. It is assumed that even though ro-ro service is developed, there would be some trucks who would still prefer roadway.
  - ü Out of total share of IWT in Ro-Ro service, for Savitri river IWT share is considered as 35%.

Following table depicts possible ro –ro traffic only if Government provides subsidy.

Name of the waterway: NW-89 (Savitri River, 45.47 km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Origin Terminal on NW**	**Final Destination**	**Destination Terminal on NW**	**Co-ordinates**	**Unit p.a**	**Fy-16**	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Existing Terminals on River (No Terminal Present on River)														
Proposed Terminal Opportunity for IWAI														
1	Liquid, Bulk, break bulk	Ro-Ro	Mahad	B1 - Dasgaon	JNPT	B1 - Dasgaon	18° 5'55.00"N, 73°20'11.56"E	('000 Trucks)	0	27	33	40	49	59
			JNPT	n/a	Mahad				0	40	49	60	73	89
Total									0	67	82	100	122	148
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

15.2.5. Presentation of Forecast

Sr. No	Name of Cargo	Type of Cargo	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Co-ordinates	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Name of the waterway: NW-89 (Savitri River, 45.47 km)														
Existing Terminals on River (No Terminal Present on River)														
Proposed Terminal Opportunity for IWAI														
1	Liquid, Bulk, break bulk	Ro-Ro	Mahad	B1 - Dasgaon	JNPT	B1 - Dasgaon	18° 5'55.00"N, 73°20'11.56"E	('000 Trucks - Km)	0	83,106	1,01,574	1,23,120	1,50,822	1,81,602
			JNPT	n/a	Mahad				0	1,23,120	1,50,822	1,84,680	2,24,694	2,73,942
Total									0	2,06,226	2,52,396	3,07,800	3,75,516	4,55,544
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

15.2.6. Market Success Factors

The market success factor regarding the development of the Savitri River is the present fairway availability with abundant required navigational channel parameters. (42 Kms of the waterway in 45 Kms is having > 2.0 m). The Chemical Industry in MIDC, Mahad (within the near reach of Savitri River) with origin destination for raw material and finished product to JNPT and MbPT will have lot of game change on IWT. Ro-Ro mobility is the success factor for the present scenario.

15.2.7. Forecasting Methodology

Following are assumptions and methodology taken into consideration to determine possible ro-ro traffic under certain conditions.

- Total number of trucks per day traveling on NH 66 from JNPT/MbPT is 750. Out of this total traffic, 60% could use ro-ro service on both Savitri & Vashishti river. Industries located nearby both rivers use JNPT port for export purpose therefore it is assumed that Ro-Ro traffic share for Savitri river is assumed to be 35% of 450 per day.

- Out of this daily traffic of 450 trucks, Mahad MIDC has been assigned a lower share of 35% (158 trucks/day) traffic, on account of it being smaller than Lote Parshuram industrial area

- Based on industry inputs, this share has been further split into 60%-40% ratio, where larger share is for importing raw materials and the latter for exporting finished goods.

- Maharashtra's secondary sector has grown at an average rate of 4% between 2009 and 2014.

- This growth rate was applied to derive future traffic volume that could be moved on the River for cargo originating and destined for industries in Mahad

- Projections are made considering Government would provide subsidy to make ro-ro service commercially viable.

15.3. Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	· Land, compensation and resettlement : No · Capital dredging: 2.6 lakhs cu.m Ordinary soil – 7.8 cr 0.3 lakhs cu.m Hard soil – 2.7cr · River training/bank protection: 8 Nos-4000m – 49.29 cr · Locks: No · Barrages: No · Channel market 20 Nos–3.93cr (Phase 1: Beacon & Lights) · Night navigation 110Nos–3.69cr (Phase 1: Buoy & Lights) · Other: Communication system – Nil -.
Terminal Infrastructure		Ro-Ro 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 · Bank maintenance · Other Considered as per standard
	Terminals	· Terminal operations · Terminal maintenance · Other Considered as per standard
	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) · Total costs · (Cost/tons-km for use in evaluation) Considered as per standard
Recurrent costs		Periodic major capital costs that may occur over life of assets

Cost type	Cost categories	Components to be itemized
		: 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:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 9.98 crore *ii) Phase 2 (FY30 – FY40)* (a) Navigation infrastructure – INR 79.74 crore (b) Terminal Ro-Ro Cost - INR 30.78 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 66.61 crore (b) Terminal Ro-Ro Cost - INR 30.78 crore · **O & M costs:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 2.17 crore *ii) Phase 2 (FY30 – FY40)*

Item	Requirements
	(a) Navigation infrastructure – INR 12.84 crore (b) Terminal Ro-Ro - INR 2.07 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 10.90 crore (b) Terminal Ro-Ro - INR 2.07 crore Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 9.89 crore *ii) Phase 2 (FY30 – FY40)* (a) Navigation infrastructure – INR 16.47 crore (b) Terminal Ro-Ro Cost - INR 14.08 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 14.64 crore (b) Terminal Ro-Ro Cost - INR 12.51 crore **Saving on Vehicle Operating Cost:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 8.96 crore *ii) Phase 2 (FY30 – FY40)* (a) Navigation infrastructure – INR 14.93 crore (b) Terminal Ro-Ro Cost - INR 12.76 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 13.27 crore (b) Terminal Ro-Ro Cost - INR 11.34 crore · **Savings in road/rail accident costs:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 3.28 crore

Item	Requirements
	ii) Phase 2 (FY30 – FY40) (a) Navigation infrastructure – INR 3.69 crore (b) Terminal Ro-Ro Cost - INR 3.69 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 3.28 crore (b) Terminal Ro-Ro Cost - INR 3.28 crore · **Saving in carbon emissions:** *i) Phase 1 (FY20 – FY40)* (a) Navigation infrastructure – INR 0.39 crore *ii) Phase 2 (FY30 – FY40)* (a) Navigation infrastructure – INR 0.66 crore (b) Terminal Ro-Ro Cost - INR 0.56 crore *ii) Phase 2A (FY30 – FY40)* (a) Navigation infrastructure – INR 0.58 crore (b) Terminal Ro-Ro Cost - INR 0.50 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	The Phase 1 for waterway utilization is assumed to start from FY20, whereby no development is required (for chainage of 40 km from the river

Item	Requirements
	mouth). On the back of market response at the end of 30, future development decisions will be made under 2 options i.e Phase 2 (45 kms fairway + Ro-Ro Terminal) and Phase 2A (40kms fairway + Ro-Ro Terminal). A development period of 3 years (FY30 – FY32) has been allotted in Phase 2 & 2A, here traffic will commence from FY32, the last year of development. Ro-Ro Terminal will be constructed beyond 40kms in Phase 2 and within 40kms in Phase 2A. The construction period for the terminal will also be from FY30 to FY32.
EIRR	The EIRR for all the individual projects under development of the Savitri River are positive. However, of all the sub-segment projects, Fairway with development is not commercially viable, because of the non-existent FIRR. Immediate prospects for fairway utilization exist, and cargo volume is expected to grow in the coming future as per the growth of secondary sector. It is essential to develop the fairway at Savitri along with night navigation. At present, industries located in catchment area are using roadways to reach JNPT for EXIM trade. However, the high logistics cost for the waterway will act as a major deterrent, and possibly dissuade any interested party from making the switch. This is despite the extremely low tariff rates applied by the IWAI. Development of Savitri as an alternate mode for transportation of raw materials and finished products for industries is likely to generate employment. The waterway would decongest the roads by traffic diversion and likely to save fuel used in road transportation along with reduction in environment pollution. The reduction of vehicular operating cost due to use of Savitri is also likely to generate overall benefits to the project. Economic IRR of Navigational Structure in Phase 1 is 166%, Phase 2 24% and 26% in Phase 2A. For the Ro-Ro Terminal, the EIRR comes at 73% & 65% in Phase 2 & 2A 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

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
Objective	To assess financial internal rates of return and financial payback periods of Savitri River
Financial evaluation approach	Financial evaluation of each river upgrading project should estimate and present actual cash flows (cost and revenues) at market prices within the inland waterway sector consisting of the two sub-segments: (a) navigation infrastructure; (b) terminal operation. **Returns for Navigation infrastructure are:** *i) Phase 1 (FY20 – FY30)* Total Revenue: INR 3.42 cr. in FY30 O&M Cost: INR 2.17 cr. in FY30 Tax: INR 0.24 cr. In FY30 (@ 30% on EBITDA) EBIDA: INR 1.26 cr. In FY30 Project Capital Cost: INR 9.98 cr. Net Cash Flow: INR 1.01 cr. In FY30 *ii) Phase 2 (FY30 – FY40)* Total Revenue: INR 10.21 cr. in FY40 O&M Cost: INR 12.84 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -2.62 cr. In FY40 Project Capital Cost: INR 79.74 cr. Net Cash Flow: INR -6.61 cr. In FY40 *iii) Phase 2A (FY30 – FY40)* Total Revenue: INR 9.08 cr. in FY40 O&M Cost: INR 10.90 cr. in FY40 Tax: INR 0.0 In FY40 (@ 30% on EBITDA) EBIDA: INR -1.82 cr. In FY40 Project Capital Cost: INR 66.61 cr. Net Cash Flow: INR -5.15 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** *i) Phase 2 (FY30 – FY40)* Total Revenue: INR 6.38 cr. in FY40 O&M Cost: INR 2.07 cr. in FY40 Tax: INR 0.08 In FY40 (@ 30% on EBITDA) EBIDA: INR 4.31 cr. In FY40

<table>
<tr><td colspan="2">Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.</td></tr>
<tr><td>Item</td><td>Requirements</td></tr>
<tr><td></td><td>Project Capital Cost: INR 30.78 cr.
Net Cash Flow: INR 1.97 cr. In FY40

ii) Phase 2A (FY30 – FY40)

Total Revenue: INR 6.38 cr. in FY40
O&M Cost: INR 2.07 cr. in FY40
Tax: INR 0.08 In FY40 (@ 30% on EBITDA)
EBIDA: INR 4.31 cr. In FY40
Project Capital Cost: INR 30.78 cr.
Net Cash Flow: INR -1.97 cr. In FY40</td></tr>
<tr><td>Disaggregation</td><td>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 are:

i) Phase 1 (FY20 – FY30)

Total Revenue: INR 3.42 cr. in FY30
O&M Cost: INR 2.17 cr. in FY30
Tax: INR 0.24 cr. In FY30 (@ 30% on EBITDA)
EBIDA: INR 1.26 cr. In FY30
Project Capital Cost: INR 9.98 cr.
Net Cash Flow: INR 1.01 cr. In FY30

ii) Phase 2 (FY30 – FY40)

Total Revenue: INR 10.21 cr. in FY40
O&M Cost: INR 12.84 cr. in FY40
Tax: INR 0.0 In FY40 (@ 30% on EBITDA)
EBIDA: INR -2.62 cr. In FY40
Project Capital Cost: INR 79.74 cr.
Net Cash Flow: INR -6.61 cr. In FY40

iii) Phase 2A (FY30 – FY40)

Total Revenue: INR 9.08 cr. in FY40
O&M Cost: INR 10.90 cr. in FY40
Tax: INR 0.0 In FY40 (@ 30% on EBITDA)
EBIDA: INR -1.82 cr. In FY40
Project Capital Cost: INR 66.61 cr.
Net Cash Flow: INR -5.15 cr. In FY40

Returns for Ro-Ro Terminal operations are:</td></tr>
</table>

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	i) Phase 2 (FY30 – FY40) Total Revenue: INR 6.38 cr. in FY40 O&M Cost: INR 2.07 cr. in FY40 Tax: INR 0.08 In FY40 (@ 30% on EBITDA) EBIDA: INR 4.31 cr. In FY40 Project Capital Cost: INR 30.78 cr. Net Cash Flow: INR 1.97 cr. In FY40 *ii) Phase 2A (FY30 – FY40)* Total Revenue: INR 6.38 cr. in FY40 O&M Cost: INR 2.07 cr. in FY40 Tax: INR 0.08 In FY40 (@ 30% on EBITDA) EBIDA: INR 4.31 cr. In FY40 Project Capital Cost: INR 30.78 cr. Net Cash Flow: INR -1.97 cr. In FY40
Evaluation period	The Phase 1 for waterway utilization is assumed to start from FY20, whereby no development is required (for chainage of 40 km from the river mouth). On the back of market response at the end of Phase 1 in FY30, future development decisions will be made under 2 options I,e Phase 2 (45kms fairway + Ro-Ro) and Phase 2A (40kms fairway + Ro-Ro). A development period of 3 years (FY30 – FY32) has been allotted in fairway development. Traffic across the next phases will commence from FY32, the last year of development. Ro-Ro Terminal will be constructed beyond 40kms in Phase 2 and within 40kms in Phase 2A. The construction period for the terminal will also be from FY30 to FY32.
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: Except for the development of fairway and Ro-Ro

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	Terminal (Phase 2 & 2A), the project to operate fairway without investment (Phase 1) has positive rate of returns on investment (FIRR). Factors influencing healthy financial returns of the project are: • The optimistic scenario where no development will be undertaken on the fairway, up to a chainage of 40 km from the mouth of the river. This is made possible due to availability of adequate depth across this stretch, negating any further need for dredging. • Absence of development requirement on fairway up to 40 km chainage means no cost, while revenue continues to be generated. This has an unnaturally and intensely positive impact over the returns for the fairway. • Even in the case of developing the waterway in Phase 2 & 2A, the quantum of revenue over project costs is low, leading to loss throughout the projection period of up to FY40, and generating no impact on the rate of returns. • Ro-Ro Terminal is highly unlikely to provide good returns, on account of high development cost, coupled with too low tariff rates assigned by the IWAI. This also severely impacts the viability of the entire Ro-Ro terminal sub-segment project. If total logistics cost is lower as compared to existing mode of transportation, then industries would divert to waterways and roads would get decongested.
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.: • The market doesn't respond at all, or the expected appeal of the waterway is far dilute than expected. This will make the Phase 1 irrelevant, and may even cast a serious doubt on the need to develop the fairway further to coax the industries to consider making the shift. • Future traffic is uncertain, as there exists no development or expansion plans of industries in Mahad Region. This would reduce the potential of cargo growth in near future. • Majority of industries are not willing to shift from existing mode of transportation because of the seasonal nature of defined stretch. Draft of the

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	river reduces in the summer and water level increases in monsoon, which is not ideal for smooth cargo operation. • Industries are very much concerned about the time factor. Multiple handling in proposed waterway route would increase the time. • If overall logistics cost including tariff charged for usage of terminal & fairway are higher than existing mode of transportation, industries would not opt for the waterway.
Checking and Replicability	Systematic checks of spreadsheets and logic trail have been done keeping in mind the input data, assumptions and calculations.

ANNEXURES

ANNEXURE 1.1 – TOR OF THE AGREEMENT

SECTION-6 TERMS OF REFERENCE

1.0 OBJECTIVE OF THE STUDY:

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India. After carrying out the feasibility study if there is scope for navigation and potential to develop waterway transport facility, a Detailed Project Report needs to be prepared for those waterways which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

The study would consist of 2 stages:

1. **Stage-1**
2. **Stage-2**

1.1 STAGE-1

Stage-I is only for feasibility of the waterway for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-1 would consist of the following activities:

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

1.1.1 Reconnaissance Survey

The detailed field reconnaissance survey may be taken up immediately after the analysis of available data. The primary tasks to be accomplished during the reconnaissance surveys include:

i- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the proposed waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

ii- Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks enroute are also to be collected. horizontal and vertical clearance is to be given as approximate on visual assessment. Photographs are required to be submitted in the report.

iii- Topographical features of the proposed Inland Waterways.
iv- Typical physical features along the alignment i.e. land use pattern:
v- Preliminary identification of stretches having year round flow and critical depth for navigational purpose.
vi- Preliminary Traffic identification on the proposed Inland Waterways.
vii- Inventory of major aspects including proposed Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features
viii- Critical areas requiring detailed investigations and
ix- Requirements for carrying out supplementary investigations
x- Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.
xi- Type and extent of existing utility services along the alignment.
xii- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

The data derived from the reconnaissance surveys may be utilized for planning and programming the detailed surveys and investigations. All field studies including the traffic surveys should be taken up on the basis of information derived from the reconnaissance surveys. For the critical locations, River cross sections survey needs to be carried out.

1.1.2 Collection and Review of Available Data

A review has to be done based on the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Consultant has to collect available data for the proposed Inland Waterways from the State Agencies and Central Water Commission. An introductory letter will be issued by IWAI for collecting information from State / Central Government.

An inception report has to be prepared which would consist of the findings based on the analysis of the existing data and reconnaissance surveys.

1.1.3 Feasibility Report

The Consultant has to prepare Feasibility Report for the proposed waterways based on the available data and reconnaissance survey. It must include the following prospects:

1. **Introductory considerations:**
   The Consultant shall provide an introduction, describing the scope of the assignment, its methodology in fulfilling the assignment and the expected outcome of the assignment.

2. **Analysis of present state of affairs:**
   The Consultant shall provide a quantitative and qualitative description of the current utilization of proposed inland waterways. In addition, the Consultant shall describe the status of goods transport, including utilization of road and transport, as well as river facilities.

3. **Market Analysis:**
   The consultant shall analyze the market and potential usage of proposed Inland Waterways. This analysis shall examine both the existing market and the potential future market. Contractor has to collect the details of available Industries along the waterway, type of production in these industries, ferry services, type of crop along the waterway, previous history of movement of cargo in the waterway etc. Above is to be collected after discussion with local village people while conducting reconnaissance survey etc. and also after interaction with State Govt. Officials, Irrigation / Water Resources departments.

4. **Reconnaissance Survey:**
   Analysis of the data collected in the reconnaissance survey should reflect the possibility of year round flow in the proposed Inland Waterways to achieve the commercial navigation. It should also consist the map of proposed Inland Waterways indicating existing cross structures viz. bridges, dams etc. Navigability of the waterway (for the periods) is to correlate with CWC/Irrigation water level data.

The Consultant has to submit the Feasibility Report for proposed Inland Waterways. Consultant also has to emphasize that which stretches of proposed inland waterways has potential of possible navigation. Only for those stretches of proposed inland waterways, which have potential of possible navigation, Stage 2 has to be carried out.

After obtaining approval from IWAI for identified stretches, Consultant may proceed for Stage - 2. Based on the feasibility report, IWAI will accord the approval for Stage-II, and stretch for DPR will be based on feasibility study.

1.2 STAGE-2

For Stage-2, Consultant has to carry out detailed hydrographic survey, topographic survey, traffic survey and selection of terminal locations.

Stage-2 would consist of the following activities:

1A. Hydrographic Survey & hydro-morphological survey

1B. Traffic Survey & Techno economic feasibility

1C. Preparation of Detailed Project Report

1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY

Based on the recommendation after reconnaissance survey of proposed Inland Waterways, Hydrographic survey may be carried out as per the International Standards including the following for finding the potential of proposed Inland Waterways for inland navigation:-

(i) The detailed hydrographic survey is to be carried out in WGS’84 datum.

(ii) The horizontal control is to be made using DGPS with minimum 24 hours observations at some platform/base.

The vertical control is to be established with respect to the chart datum / sounding datum from the following methods:-

i. Chart datum/ sounding datum already established by Port Authorities (Chart Datum), Central Water Commission (Average of last six years minimum Water Level) / State Irrigation Department (Full Supply Level (FSL)) and at their gauge stations along the river/canal. Secrecy undertaking forms etc. will be provided by IWAI for collection of CWC data. Introductory letter will be issued to the successful Consultant for collection of other required information from State Departments.
ii. Standard method shall be adopted for transfer of datum in rivers/canals. For tidal reaches standard transfer of datum as per Admiralty Manual shall be adopted.
iii. **By erection of tide gauges – at every 10km interval and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc.**

Other Terms of Reference for the survey work shall be as given below: -

1.2.1.1 BENCH MARK PILLARS

a. Construct Bench Mark Pillars of dimension 0.3m x 0.3m x 1.5m (0.6m above GL) RCC pillar with 6mm thick 50mm dia GI pipe inserted (as per construction drawing of Survey Pillar in the tender document), at every 10km interval. Detailed description of the bench mark along with its position and value to be given in the report for future recovery.

1.2.1.2 WATER LEVEL GAUGES

i. Water level gauges are to be erected at every 10 km interval along the canal/river **and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc. simultaneously.** Readings are to be taken at 1 hr interval for 12 hours (6 AM to 6 PM) or for the entire period of survey. The gauges are to be connected to a nearest Bench Mark by leveling and its datum value shall be established w.r.to MSL & CD. Water level gauges are to be installed temporarily during the survey period.
ii. At least 2 gauges (one U/s and one D/s at 10 Km apart) shall be read simultaneously and soundings to be carried out within the gauge stations. Soundings are to be reduced for datum of a gauge for 5km length of the canal/river on both side of a gauge.

1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY

Sl. No.	Name of the River / Canal	Description of Inland Waterway
CLUSTER-2		
1	DHANSIRI / CHATHE	110 km length of the river from Bridge near Morongi T.E. village Lat 26°24'40.65"N, Lon 93°53'46.75"E to Numaligarh Lat 26°42'1.20"N, Lon 93°35'15.42"E
2	LOHIT RIVER	100 km length of the river from Parasuram Kund Lat 27°52'40.06"N, Lon 96°21'39.70"E to Saikhowa Ghat, Sadiya Lat 27°47'49.14"N, Lon 95°38'13.84"E

3	SUBANSIRI RIVER	111 km length of the river from Gerukamukh Lat 27°27'3.14"N, Lon 94°15'16.12"E to Brahmaputra confluence at Lat 26°52'24.93"N, Lon 93°54'31.26"E
4	TIZU and ZUNGKI RIVERS	42 km length of the river from Longmatra at Lat 25°46'11.98"N, Lon 94°44'35.04"E to Avanghku at Myanmar border Lat 25°35'2.94"N, Lon 94°53'6.12"E and in Zungki river from bridge at Lat 25°48'26.10"N, Lon 94°46'35.96"E to confluence of Zungki and Tizu rivers at Lat 25°46'58.03"N, Lon 94°45'20.51"E
	CLUSTER-3	
1	BIDYA RIVER	55 km length of the river from Lot No. 124 at Lat 21°54'42.88"N, Lon 88°41'8.48"E to near Uttar Danga at Lat 22°11'47.93"N, Lon 88°51'54.93"E
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	15 km length of the river from near Rajani ferry ghat Lat 22°19'57.49"N, Lon 88°54'21.40"E to near Nazat at Lat 22°26'5.40"N, Lon 88°50'11.69"E
3	DVC CANAL	130 km length of the canal from Durgapur Barrage Lat 23°28'47.36"N, Lon 87°18'19.04"E to Confluence point of DVC canal with Hooghly river near Tribeni Lat 23° 0'30.95"N, Lon 88°24'54.72"E
4	GOMAR RIVER	7 km length of the river from near Ramkrishnapur Lat 22°11'53.35"N, Lon 88°44'41.97"E to near Gosaba Kheya ghat at Lat 22°10'5.44"N, Lon 88°47'37.17"E
5	HARIBHANGA RIVER	16 km length of the river from Bangladesh Border Lat 21°53'18.81"N, Lon 89° 1'23.61"E to confluence with Jhila river at Lat 21°58'17.66"N, Lon 88°55'8.38"E
6	HOGLA (HOGAL)-PATHANKHALI RIVER	37 km length of the river from near Parandar Lat 22°12'22.05"N, Lon 88°40'42.77"E to near Sandeshkhai Ferry Ghat at Lat 22°21'12.26"N, Lon 88°52'47.99"E
7	KALINDI (KALANDI) RIVER	8 km length of the river from Bangladesh Border at Hingalganj Lat 22°28'8.48"N, Lon 88°59'46.19"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
8	KATAKHALI RIVER	23 km length of the river from Bangladesh Border near Barunhat Lat 22°30'31.44"N, Lon 88°58'24.53"E to Lebukhali ferry at Lat 22°21'45.36"N, Lon 88°57'30.27"E
9	MATLA RIVER	98 km length of the river from Bay of Bengal at Lat 21°33'4.13"N, Lon 88°38'25.65"E to Canning ferry ghat at Lat 22°18'38.87"N, Lon 88°40'42.65"E
10	MURI GANGA (BARATALA) RIVER	27 km length of the river from Bay of Bengal near Bisalakshmipur Lat 21°37'51.94"N, Lon 88°10'0.24"E to near Kakdwip at Lat 21°52'17.39"N, Lon 88° 9'7.52"E
11	RAIMANGAL RIVER	52 km length of the river from Hemnagar at Lat 22°11'40.58"N, Lon 88°58'1.08"E to Rajnagar at Lat 22°33'56.95"N, Lon 88°56'16.64"E
12	SAHIBKHALI (SAHEBKHALI) RIVER	14 km length of the river from near Ramapur Lat 22°17'52.04"N, Lon 88°56'34.78"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
13	SAPTAMUKHI RIVER	37 km length of the river from Bay of Bengal at Henry Island Lat 21°34'57.35"N, Lon 88°19'8.47"E to near Chintamanipur at Lat 21°51'14.01"N, Lon 88°18'40.50"E
14	THAKURRAN RIVER	64 km length of the river from Bay of Bengal at Lat 21°33'31.95"N, Lon 88°27'45.40"E to Madhabpur at Lat 22° 2'52.19"N, Lon 88°33'27.96"E
	CLUSTER-4	
1	BAITARNI RIVER:	49 kms length of the river from Dattapur village at Lat 20°51'44.61"N, Long 86°33'30.45"E to confluence with Dhamra river near Laxmiprasad Dia at Lat 20°45'13.32"N, Long 86°49'15.36"E

2	BIRUPA / BADI GENGUTI / BRAHMANI RIVER SYSTEM:	102 kms length of the river from Birupa Barrage at Choudwar at Lat 20°30'49.00"N, Long 85°55'20.17"E to confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E including alternative route of 25 kms from Samaspur village at Lat 20°35'40.59"N, Long 86° 6'31.50"E to near Kharagpur village at Lat 20°38'27.77"N, Long 86°17'31.81"E and additional 54 kms length of Brahmani river from confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E to Brahmani river at Katana Lat 20°39'26.28"N, Long 86°44'52.86"E
3	BUDHA BALANGA:	56 kms length of the river from Barrage (approx 300m from Patalipura village) at Lat 21°38'12.96"N, Long 86°50'53.17"E to confluence of Budha Balanga river with Bay of Bengal at Chandipur Fishing Port Lat 21°28'12.14"N, Long 87° 4'11.60"E
4	MAHANADI RIVER:	425 kms length of the river from Sambalpur Barrage at Lat 21°27'34.33"N, Long 83°57'49.80"E to Paradip at Lat 20°19'38.12"N, Long 86°40'16.96"E
	CLUSTER-5	
1	PENNAR RIVER:	29 kms length of the river from Penna Barrage, Pothireddypalem at Lat 14°28'8.38"N, Long 79°59'9.31"E to confluence with Bay of Bengal near Kudithipalem at Lat 14°35'36.75"N, Long 80°11'30.61"E
2	KAVERI / KOLLIDAM RIVER:	364 kms length of the river from Uratchikottai Barrage at Lat 11°29'3.09"N, Long 77°42'13.68"E to confluence with Bay of Bengal at Pazhaiyar Lat 11°21'37.97"N, Long 79°49'53.23"E
3	PALAR RIVER:	141 kms length of the river from rail bridge at Virudampattu, Vellore Lat 12°56'14.07"N, Long 79° 7'29.70"E to confluence with Bay of Bengal at Sadurangapattinam Lat 12°27'52.16"N, Long 80° 9'13.47"E
4	PAZHYAR RIVER:	20 kms length of the river from Bridge near Veeranarayana Mangalam village at Lat 8°13'48.97"N, Long 77°26'27.34"E to confluence with Arabian Sea at Manakudi at Lat 8° 5'15.01"N, Long 77°29'7.61"E
5	PONNIYAR RIVER	125 km length of the river from Sathanur Dam at Lat 12°11'0.06"N, Lon 78°51'1.25"E to Cuddalore at confluence of Bay of Bengal at Lat 11°46'21.76"N, Lon 79°47'41.70"E
6	TAMARAPARANI RIVER:	64 kms length of the river from Sulochana Mudalir bridge, Tirunelveli at Lat 8°43'43.17"N, Long 77°42'53.94"E to confluence with Bay of Bengal near Punnaikayal at Lat 8°38'24.90"N, Long 78° 7'37.85"E
	CLUSTER-6	
1	West Coast Canal	160 kms length of the canal as extension of NW-3 towards north of Kottapuram - from Kottapuram at Lat 10°11'38.32"N, Long 76°12'4.39"E to Kozhikode at Lat 11°13'38.83"N, Long 75°46'43.90"E
2	ALAPPUZHA-CHANGANASSERY CANAL	28 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Changanassery Jetty at Lat 9°26'41.61"N, Lon 76°31'41.76"E
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	38 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Athirampuzha market Lat 9°40'04"N, Lon 76°31'54"E
4	KOTTAYAM-VAIKOM CANAL	28 km from Kottayam, near Kodimatha at Lat 9°34'38.67"N, Lon 76°31'7.67"E to Vechoor joining National Waterway no. 3 at Lat 9°40'0.19"N, Lon 76°24'10.65"E
5	GURUPUR RIVER	10 km length of the river from confluence of Netravathi river at Lat 12°50'44.04"N, Lon 74°49'44.51"E to confluence of Mangalore Port Bridge at Lat 12°55'34.81"N, Lon 74°49'37.34"E

6	KABINI RIVER	23 km length of the river from Kabini Dam Lat 11°58'24.52"N, Lon 76°21'9.69"E to Beeramballi at Lat 11°56'9.55"N, Lon 76°14'17.58"E
7	KALI RIVER	54 km length of the river from Kodasalli Dam Lat 14°55'8.24"N, Lon 74°32'6.90"E to confluence of Kali river with Arabian Sea near Sadashivgad bridge at Lat 14°50'30.95"N, Lon 74° 7'21.32"E
8	NETRAVATHI RIVER	78 km length of the river from Netravathi Dam, Dharmsthala Lat 12°57'55.23"N, Lon 75°22'10.19"E to confluence with Arabian sea at Bengre Lat 12°50'42.73"N, Lon 74°49'28.86"E
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	23 km length of the river from Gangoli Port at Lat 13°38'1.30"N, Lon 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Lon 74°39'15.13"E
10	SHARAVATI RIVER	29 km length of the river from Honnavar Port Sea Mouth at Lat 14°17'56.23"N, Lon 74°25'27.04"E to link at highway at Gersoppa Lat 14°14'14.73"N, Lon 74°39'6.15"E
11	UDAYAVARA RIVER	16 km length of the river from Arabian Sea Mouth at Malpe Lat 13°20'57.24"N, Lon 74°41'28.22"E to Bridge near Manipura Lat 13°17'32.70"N, Lon 74°46'25.56"E
	CLUSTER-7	
1	CHAPORA RIVER	33 kms length of the river from Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E to Confluence of Chapora river with Arabian Sea at Morjim Lat 15°36'33.27"N, Long 73°44'0.93"E
2	MAPUSA / MOIDE RIVER	27 kms length of the river (including Moide river) from bridge on NH17 at Mapusa Lat 15°35'20.79"N, Long 73°49'17.20"E to confluence point of Mapuca & Mandovi rivers at Porvorim Lat 15°30'20.01"N, Long 73°50'42.09"E
3	SAL RIVER	14 kms length of the river from Orlim Deusa Bridge at Lat 15°13'11.41"N, Long 73°57'29.77"E to confluence with Arabian Sea at Mobor Lat 15° 8'31.93"N, Long 73°56'59.89"E
4	AMBA RIVER	45 kms length of the river from Arabian Sea, Dharamtaar creek near village Revas at Lat 18°50'15.14"N, Long 72°56'31.22"E to a Bridge near Nagothane ST Stand at Lat 18°32'19.82"N, Long 73° 8'0.29"E
5	DABHOL CREEK/VASHISHTI RIVER	45 km length of the river from Arabian Sea at Dabhol Lat 17°34'51.33"N, Lon 73° 9'17.83"E to bridge at Pedhe Lat 17°32'39.45"N, Lon 73°30'35.56"E
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	145 km length of the waterway from Arabian Sea at Navi Mumbai Lat 18°55'49.78"N, Lon 72°53'21.67"E via Ulhas river to bridge on State Highway No.76 near Malegaon T. Waredi Lat 19° 2'38.20"N, Lon 73°19'53.79"E Bridge on Kalyan-Badlapur road near Kalyan railway yard at Kalyan Lat 19°14'6.39"N, Lon 73° 8'49.13"E to Kalyan Lat 19°15'35.03"N, Lon 73° 9'27.77"E Vasai Creek from Lat 19°18'53.50"N to Lon 72°47'30.18"E to Kasheli at Lat 19°13'22.84"N, Lon 73° 0'21.44"E
7	RAJPURI CREEK	31 km length of the river from Arabian Sea at Rajpuri Lat 18°18'3.15"N, Lon 72°56'42.94"E to Mhasala at Lat 18° 8'15.37"N, Lon 73° 6'45.35"E
8	REVADANDA CREEK / KUNDALIKA RIVER	31 km length of the river from Arabian Sea at Revadanda Lat 18°32'19.85"N, Lon 72°55'32.80"E to bridge on Roha-Astami Road near Roha Nagar Lat 18°26'31.50"N, Lon 73° 7'10.74"E
9	SAVITRI RIVER (BANKOT CREEK)	44 kms length of the river from Bridge near Sape at Lat 18° 5'54.11"N, Long 73°20'8.81"E to Arabian Sea at Harihareswar Lat 17°58'47.10"N, Long 73° 2'15.01"E
10	SHASTRI RIVER / JAIGAD CREEK	52 kms length of the river from Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57"E to confluence with Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E

CLUSTER-8		
1	MAHI RIVER:	248 kms length of the river from Kadana Dam at Lat 23°18'22.35"N, Long 73°49'37.45"E to confluence with Gulf of Khambhat near Kavi railway station at Lat 22°10'34.71"N, Long 72°30'36.31"E
2	NARMADA RIVER	227 km length of the river from Pandhariya at Lat 21°57'10.37"N, Lon 74° 8'27.46"E to confluence of Narmada with Arabian Sea at Gulf of Khambhat Lat 21°38'26.81"N, Lon 72°33'28.24"E
3	SABARMATI RIVER:	212 kms length of the river from Barrage near Sadoliya at Lat 23°26'49.66"N, Long 72°48'34.85"E to confluence with Gulf of Khambhat near Khambhat at Lat 22° 9'17.99"N, Long 72°27'27.81"E
4	TAPI RIVER:	436 kms length of the river from Hatnur Dam near Mangalwadi at Lat 21° 4'21.99"N, Long 75°56'44.88"E to confluence with Gulf of Khambhat (Arabian Sea) at Lat 21° 2'15.51"N, Long 72°39'29.63"E

#	River/Canal	State	Length (km)	Spacing (m)	Ave. width (m)
CLUSTER-2					
1	Dhansiri / Chathe	Assam	110	150	150
2	Lohit	Assam & Arunachal Pradesh	100	200	1000
3	Subansiri	Assam	111	200	1000
4	Tizu and Zungki	Nagaland	42	50	100
			363		
CLUSTER-3					
1	BIDYA RIVER	West Bengal	55	200	1500
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	West Bengal	15	200	500
3	DVC CANAL	West Bengal	130	100	100
4	GOMAR RIVER	West Bengal	7	200	400
5	HARIBHANGA RIVER	West Bengal	16	200	2000
6	HOGLA (HOGAL)-PATHANKHALI RIVER	West Bengal	37	200	300
7	KALINDI (KALANDI) RIVER	West Bengal	8	200	500
8	KATAKHALI RIVER	West Bengal	23	200	200
9	MATLA RIVER	West Bengal	98	200	2000
10	MURI GANGA (BARATALA) RIVER	West Bengal	27	200	3000
11	RAIMANGAL RIVER	West Bengal	52	200	800
12	SAHIBKHALI (SAHEBKHALI) RIVER	West Bengal	14	200	300
13	SAPTAMUKHI RIVER	West Bengal	37	200	700
14	THAKURRAN RIVER	West Bengal	64	200	1000
			583		
CLUSTER-4					
1	Baitarni	Odisha	49	100	100
2	Birupa / Badi Genguti / Brahmani	Odisha	156	100	200
3	Budha Balanga	Odisha	56	100	100
4	Mahanadi	Odisha	425	200	500
			686		

		CLUSTER-5			
1	Pennar	Andhra Pradesh	29	100	400
2	Kaveri / Kollidam	Tamil Nadu	364	200	400
3	Palar	Tamil Nadu	141	200	500
4	Pazhyar	Tamil Nadu	20	50	100
5	PONNIYAR	Tamil Nadu	125	200	300
6	Tamaraparani	Tamil Nadu	64	150	300
			743		
		CLUSTER-6			
1	West Coast Canal	Kerala	160	50	100
2	ALAPPUZHA- CHANGANASSERY CANAL	Kerala	28	50	100
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	Kerala	38	50	100
4	KOTTAYAM-VAIKOM CANAL	Kerala	28	50	100
5	GURUPUR RIVER	Karnataka	10	100	400
6	KABINI RIVER	Karnataka	23	200	500
7	Kali	Karnataka	54	150	450
8	Netravathi	Karnataka	78	100	300
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	Karnataka	23	150	600
10	SHARAVATI RIVER	Karnataka	29	150	400
11	UDAYAVARA RIVER	Karnataka	16	100	250
			487		
		CLUSTER-7			
1	CHAPORA RIVER	Goa	33	100	250
2	MAPUSA / MOIDE RIVER	Goa	27	50	100
3	SAL RIVER	Goa	14	50	100
4	AMBA RIVER	Maharashtra	45	150	300
5	DABHOL CREEK/VASHISHTI RIVER	Maharashtra	45	150	400
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	Maharashtra	145	150	350
7	RAJPURI CREEK	Maharashtra	31	150	1000
8	REVADANDA CREEK / KUNDALIKA RIVER	Maharashtra	31	150	400
9	SAVITRI RIVER (BANKOT CREEK)	Maharashtra	46	150	400
10	SHASTRI RIVER / JAIGAD CREEK	Maharashtra	52	150	300
			469		
		CLUSTER-8			
1	MAHI RIVER	Gujarat	248	200	400
2	NARMADA RIVER	Maharashtra & Gujarat	227	200	500
3	SABARMATI RIVER	Gujarat	212	200	150
4	TAPI RIVER	Maharashtra & Gujarat	436	200	350
			1123		

Note:- Bathymetric and Topographical survey of specified Waterways is to be conducted for average width specified in above table. Average width of the Waterways is the average of narrow and wider portions of the river. For reservoir / ponding areas, only bathymetric survey of maximum 500m width in the deepest channel is to be carried out. Minimum 100m wide corridor is to be surveyed (only for rivers / canals having less than

60m water width). 100m wide corridor includes width of proposed Waterways. Bathymetric and topographic survey is to be carried out for 50m width on both side from the centre line of the channel.

a. Bathymetric and Topographical survey of proposed Inland Waterways is to be conducted for width specified in above table. Minimum 100m wide corridor is to be surveyed to assess the extent of land acquisition required for 100m wide corridor (100m wide corridor includes width of proposed Inland Waterways).
b. Cross-section sounding lines / leveling are to be run from bank to bank at spacing specified in above table, to identify the navigable channel.
c. Continuous soundings are to be taken by running the sounding boat at constant speed on the cross-section so as to get smooth contours. Intermediate line is to be run at bends, if the line spacing is more than the specified above.
d. For cross-sectional bathymetric survey more than 60m in proposed Inland Waterways, spot levels at line spacing x 20m length grid, on both banks should be taken. If Island or sandchur exist in the middle of the waterway, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
e. If bathymetry cross-section is limited up to 60 mts width in waterway, then Consultant has to cover 100m corridor including spot levels in line spacing x 20m length grid on both banks.
f. If bathymetry cross-sectional is limited up to 20 mts width in waterway, then Consultant has to run three (03) nos. longitudinal lines. One in centre and one each at equal interval (near the edges of water).
g. If bathymetry cross-sectional is limited up to 10 mts width in waterway, then Consultant has to run one (01) no. longitudinal line at centre only.
h. If Island or sandchur exist in the middle of the river, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
i. Surveys in non-approachable areas are to be informed by the Consultant and joint inspection (Consultant's representative & Engineer-In-Charge or his representative) will be held to confirm the non-approachable areas.
j. The survey area may consist of canal sections, rivers, sea openings of different dimensions. Hence, Consultant has to inspect the area to be surveyed and satisfy themselves with respect to site conditions before submission of bid. However, variation in quantity will be considered only for length of the river/canal (longitudinal length).
k. The soundings are to be reduced to the chart datum/ sounding datum established at every gauge stations.

1.2.1.4 <u>CURRENT VELOCITY AND DISCHARGE MEASUREMENT</u>

a. The current velocity and discharge at every 10 km interval shall be observed once in a day during the survey period. Current velocity and discharge at every 10 km interval are to be measured only once at different depths while carrying out survey in that region.
b. Current meter measurement should be taken at 1m below water surface or 0.5d (if depth is less than 1m), where d is measured depth of water & values indicated in the report along with position.
c. Measurements at different depths may be taken by single equipment over three different time spans.
d. Measurement of current velocity at different depth is to be measured for at least 15

minutes or as per listed calibration period of the equipment, under use for this project.

e. Current velocity and discharge can also be measured with the help of ADCP during survey, at every 10km interval. Discharge can be measured either by ADCP or standard formulas.

1.2.1.5 WATER AND BOTTOM SAMPLES

a. Water and bottom samples are to be collected from the deepest route at every 10 km interval and are to be tested and the results/characteristics of the soil and the water are to be incorporated in the report. Soil sample can be collected by a grab and water sample at 0.5d (d-measured depth of water) by any approved systems. The following tests are to be carried out for Bottom samples:-

    i) Grain size distribution
    ii) Specific gravity,
    iii) PH value
    iv) Cu, Cc
    v) Clay silt%
    and Sediment concentration for Water Samples.

1.2.1.5 COLLECTION OF TOPOGRAPHICAL FEATURES

a. Photographs of the prominent features are to be taken and included in the report along with its position.
b. Permanent structures located within this corridor are also required to be indicated on the report & charts.
c. All prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) and other conspicuous objects are to be fixed and indicated on the chart and included in the report.
d. Identify cross structures which are obstructing navigation.
e. Details (horizontal and vertical clearances above High Flood Level in non-tidal area and High Tide Level in tidal area) of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location.
f. Details of water intake/ structures are to be collected and shown on the charts and include in the report.
g. Availability of berthing place, existing jetty, ferry ghats, approach roads etc. are to be indicated on the charts and include in the report.
h. During the survey, conditions of the banks are also required to be collected. It is to be noted that banks are pitched (protected) or not protected. Estimate the length of bank protection, where banks erosion is taking place.
i. Positions and levels of corners of permanent structures within the corridor are to be physically surveyed and marked on survey charts.
j. Approachable roads / rails / places outside the corridor may be incorporated from Toposheets/Google Map/Google Earth.

1.2.1.6 SURVEY CHART PREPARATION

a. The survey chart is to be prepared on a scale of 1:1,000 for Waterways width less than 100m. On a scale of 1:2,000 for Waterways width between 100m to 300m. On a scale of 1:5,000 for Waterways width between 300m to 500m and On a scale of 1:10,000 for Waterways width more than 500m.

b. Contours of 0m, 1m, 2m, 3 m, 5m and 10 m are to be indicated on the charts with respect to Chart Datum / Sounding Datum.

c. Reduced spot levels w.r.to MSL to be indicted on the charts. Spot level values are to be given w.r.t. Mean Sea Level (MSL) & Soundings w.r.t. Chart Datum / Sounding Datum. A separate file (xyz) (soft copy only) is also to be created for spot levels w.r.t. Chart Datum / Sounding Datum for dredging calculation purpose.

d. On completion of the cross-sections, dredge channel is to be identified/ established by linking deepest soundings on the cross-sections. Dredging quantity is to be estimated for developing a navigational channel of

   i. dimension of 32m x 1.8m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is less than or equal to 100m).

   ii. dimension of 45m x 2.0m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is more than 100m).

e. Dredging quantity is to be indicated in the report for per km length of the waterway.

f. Minimum & maximum reduced depth and length of shoal for per km length of the waterway is also to be indicated in the report.

g. Current meter measurement values shall be indicated in the report along with position.

h. The results/characteristics of the soil and the water are to be incorporated in the report.

i. Shallow patches /shoal and submerged sand-chur having less than 1.0 m depth, rocky outcrops, rapids and other navigational impediments are to be indicated on the charts.

j. A brief write up on condition of the locks, Sluice gates, Barrages, Dams etc. (if available) are also to be included in the report. Brief write up based on visual observation, photographs and information from State Irrigation Deptt. and local sources.

k. The chart shall also be suitably updated with prominent land features from the Topo-sheets/site. Available Survey of India (SOI) Topographic sheet will be shared with successful Consultant on receipt of Undertaking. Satellite imageries are not available with IWAI for the designated area. Route map and survey plan will be provided by IWAI to the successful Consultant.

l. All raw data and processed data of Automatic Hydrographic Survey System are required to be submitted. Standard procedure is to be adopted for data processing. All RAW, EDIT, SORT and field data are required to be submitted by the Contractor.

m. All surveyed field data including leveling data (csv file) are required to be submitted.

n. All position data of ground features, waterway structures are to be submitted in both hard copies and soft copies.

1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY

This is a detailed study to make a forecast of the traffic prospects to facilitate the projection of the most promising route for waterway transport and to assess the quantum of traffic of vessels/cargo on that route. This survey is to be under-taken in conjunction with Reconnaissance and Hydrographic surveys so that the Techno Economic feasibility and costs of the alternative proposals can be taken into account while formulating the recommendations.

Modality of conducting traffic survey shall be based on industrial surveys and a traffic projection for a horizon period (say 5, 10, 15 and 20 years) has to be forecasted based on standard methods. Divertible traffic to IWT is also to be assessed.

1.2.3 DETAILED PROJECT REPORT

The scope of works is as follows:

a. Assessment of the morphological, hydrological, hydrographical conditions, and operation and maintenance requirements of the proposed waterways to identify works in sufficient details that are required in respect of:
   - River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation.
   - Navigational aids and communication facilities.
   - Improvements with reference to horizontal and vertical clearances required on the existing or proposed cross structures such as bridges, power cables, locks etc.

b. Geo-tech investigation will be carried out by the consultant as per standard guidelines of Geological Survey of India, Government of India.

c. To conduct necessary investigations for the preliminary design, to ensure a coordinated development to cover waterways engineering works and structures, waterway crossing, navigational structures, riverine ports and terminals, land and rail access.

d. Prepare preliminary engineering designs, drawings and estimates for the optimum structure of river training and bank protection measures and navigational aids to develop and maintain a navigable channel for the waterway system in an EPC mode.

e. For preliminary engineering designs, the data about soil characteristics shall be collected from the local sources based on the structures constructed nearby. In case of critical structures, consultant can suggest that detailed soil investigation including borehole tests etc.

f. River training/bank protection works particularly for those stretches where either the channel is narrow and needs to be widened by dredging or where it is anticipated that the bank can erode due to continuous movement of barges.

g. Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.

h. Prepare a realistic construction schedule for the whole project indicating the priority of different components of the project. The phasing of expenditure is also to be worked. Also suggest phased programs of construction including riverine terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities.

i. Prepare cost estimate for various possible alternatives for the entire proposed infrastructure, handling, and other allied facilities. While comparing the different alternatives, the cost and economy factors shall also be evaluated. The most suitable alternative recommended shall have detailed costing for all the components of the project. The Consultant is to propose the River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation. Alternate possible methods for water augmentation are also to be suggested in detail. FIRR, EIRR, NPV and SWOT analysis are also to be carried out by the Consultant.

j. Assess the environmental impacts due to these development works and suggest suitable environmental management plan (EMP) to mitigate the adverse impacts, if any, including its cost. Flood Plain specialist will be responsible to assess the Environmental Impact and preparation of EMP. Consultant has to identify the Authorities who will give the clearances for EIA/EMP. Consultant will not be required to take clearances from these identified Authorities.

k. Suggest horizontal and vertical clearances to be provided on cross structure such as bridges, power cables, locks etc. for commercial viable navigation in present as well as in future. For this, IWAI guidelines Section-IV, may also be referred to.

2.0 PERIOD OF SERVICES

Consultant may associate with sub Consultant(s) to enhance their expertise. The applicant shall submit a Memorandum of Understanding (MOU) with the Sub Consultant regarding the role and responsibilities of the Associate Company along with the proposal.

2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:

(a) The time of completion of various sub-stages of the assignment will be as given below:

			Cluster -2	Cluster -3	Cluster -4	Cluster -5	Cluster -6	Cluster -7	Cluster -8
	Sl. No	**Activity**	**Time in weeks****						
Stage-I	a)	Mobilization of the Team and submission of Inception Report (2 copies)	6	9	10	11	8	8	15
	b)	Submission of Draft Feasibility Report (3 copies)	9	12	13	14	11	11	18
	c)	Comments from IWAI	11	14	15	16	13	13	20
	d)	Presentation and Submission of Final Pre-feasibility Report (3 copies)	13	16	17	18	15	15	22
Stage-II	a)	Acceptance of Stage-I report and go ahead for Stage-II by IWAI	15	18	19	20	17	17	24
	b)	Submission of Hydrographic Survey Charts and report (3 copies)	23	30	29	31	24	26	38
	c)	Submission of Draft Detailed Project Report (3 copies)	31	38	37	39	32	34	46
	d)	Receipt of comments of IWAI on Draft DPR.	33	40	39	41	34	36	48
	e)	Submission of Final Detailed Project Report (10 copies) after incorporating final comments of IWAI.	39	46	45	47	40	42	54
****reckoned from the date of signing of Contract or 15 days from the date of issuance of work order, whichever is earlier.**									

NOTE: - The consultants are required to submit the following outputs in Stage-II for all the clusters in the enclosed standard templates:-

vi) Traffic Template: at Annex-IV
vii) Project Costing Template: at Annex-V
viii) Financial Evaluation Template: at Annex-VI
ix) Economic Evaluation Template: at Annex-VII
x) Environmental & Social Screening Template: at Annex-VIII

3.0 Minimum Qualification of Key Professionals

Sl. No	Key Professionals	Qualification Criteria
1.	**Waterway Expert (Team Leader)**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Higher professional qualification in Port and Harbor Engineering/Structural Engineering/Geo-technical Engineering will be preferred. **Professional Qualification:** • Minimum 15 years' experience in planning, design, construction, preparing Feasibility Report/Detailed Project Report for various waterway/port/river front development/river training works, terminals, trade facilitations and other infrastructures in different natural and operational conditions with at least 5 years in a reputed firm of consultants.
2.	**Port planning & Infrastructure Specialist**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Postgraduate training/ studies in Port & Harbor Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in Port planning, Port infrastructure Planning and development of physical facilities for port operations. Should be well conversant with different types of port structures and other physical facilities required for the provision of various port services efficiently. Should preferably have experience/ exposure of constructing several modern ports.
3.	**Remote Sensing/GIS Expert**	**Educational Qualification:** • Should be Graduate in Engineering/Geology. Higher professional qualification in Remote Sensing/ Geoinformatics will be preferred. **Professional Qualification:** • Minimum 10 years' experience in waterway/port/river mapping and a demonstrated proficiency in using the GIS software. Working knowledge of spatial data formats and related metadata issues. Working knowledge of web mapping applications, such as Google Earth/Bhuvan.
4.	**Floodplain Specialist**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher professional qualification in Floodplain Management/ Hydrology/Water Resource Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in Floodplain Management. Working

Sl. No	Key Professionals	Qualification Criteria
		knowledge of water and/or wastewater modeling is desirable.
5.	**Hydrographic Expert**	**Educational Qualification:** • Should be ITI in Survey/Diploma in Civil Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 8 years' experience in conducting hydrographic surveys, investigations and measurements, bathymetric surveys/Topographic Survey in a variety of geographical locations and natural.
6.	**Soil Engineer/ Foundation Engineer**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher qualification in Marine Structure/Geotechnical Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of the soil investigation, reclamation work, soil improvement and will be associated in foundation design. He will also be responsible for preparation of cost estimates/BOQ.
7.	**Traffic Surveyor**	**Educational Qualification:** • Should be Graduate in Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of traffic survey of waterways/river/canal or similar facilities.
8.	**Transport Economist**	**Educational Qualification:** • Should be Graduate in transport planning management, transport economics, transport/road/rail/Civil engineering/MBA or equivalent qualifications. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of estimating transport investments and implementing transport programs.

NOTE 1:- If the Key Personnel proposed in the CV does not fulfill the minimum academic qualification, the overall score of his CV will be evaluated as zero. All such Key Personnel (whose CV scores less than 75% or who does not fulfill the minimum qualification) will have to be replaced by the firm. H-1 firm will be intimated for replacement of such personnel and work will be awarded after receipt of CV's fulfilling the tender criteria.

Note 2:- IWAI may call each key personnel of the preferred Consultant at the time of award of work, at the cost of Consultant.

Note 3: - In case during interaction with the key personnel, it is found that the key personnel proposed is un-suitable for the assignment position, his replacement by equivalent or better shall be provided by the consultant. The key personnel with such un-suitable CV shall not be considered in any future bids for that position for two years. No deduction for such replacement, who are not found suitable during interaction shall be made.

Note 4:- Since two clusters only will be awarded to one bidder, the same CVs cannot be proposed for at least two clusters. The same CV's can be proposed if the bidder is bidding for more than two Clusters.

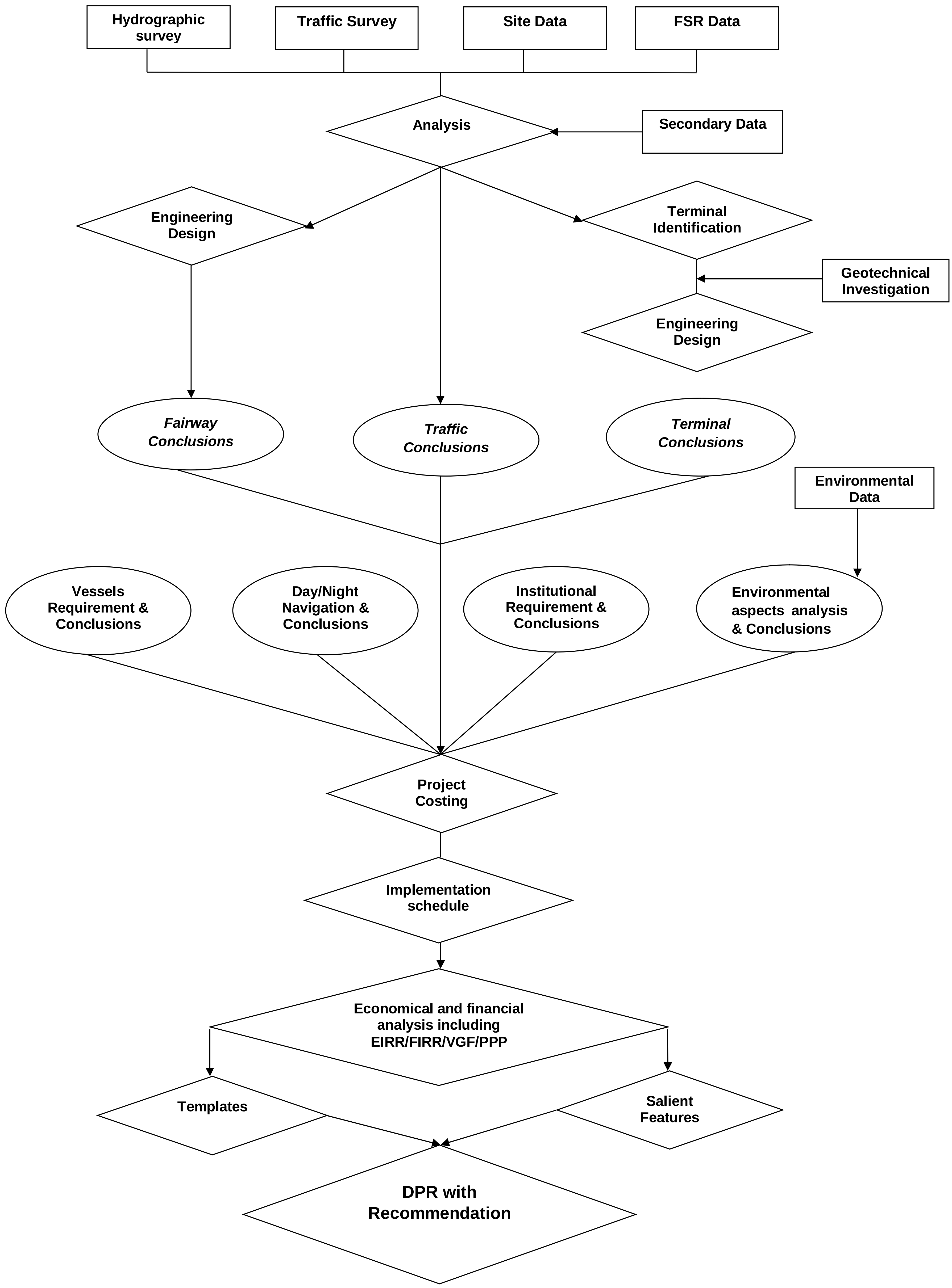
Note 5:- Role and responsibilities of the Key Professional shall be as per the requirement of the project and Terms of Reference of the tender document and the same has to be access by prospective bidder.

ANNEXURE 1.2 – COMPLIANCE ON TOR OF THE AGREEMENT

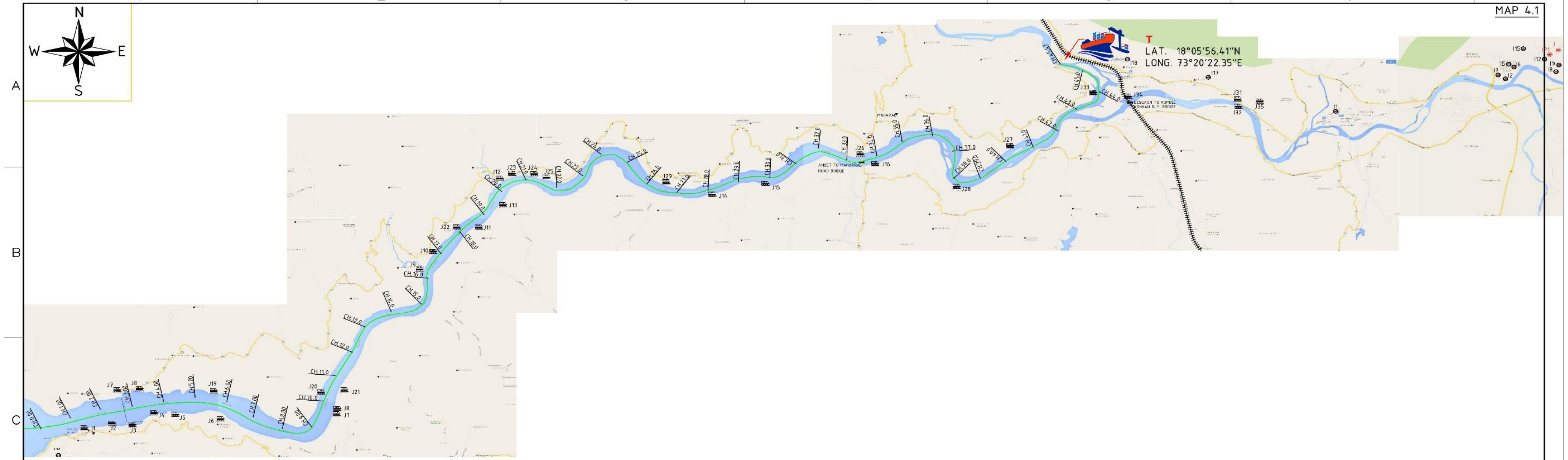
COMPLIANCE ON THE TERMS OF REFERENCE
BANKOT CREEK / SAVITRI RIVER (NW 89)

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 SAVITRI RIVER(BANKOT CREEK)



LIST OF JETTIES		
SL.	DESCRIPTION	SYMB.
1	BANKOT JETTY	J1
2	VESVI VALMIKI JETTY	J2
3	VESVI SLOPE JETTY	J3
4	VESVI JETTY 1	J4
5	VESVI JETTY 2	J5
6	SHIPOLE JETTY	J6
7	AMROLI JETTY	J7
8	VERAL JETTY	J8
9	NIGDI JETTY	J9
10	DEVHARE GOTHE JETTY	J10
11	CHOUKE JETTY	J11
12	SHIGVAN JETTY	J12
13	AMBOVNE JETTY	J13
14	PEVE JETTY	J14
15	UMMBERSET JETTY	J15
16	MAPRAL JETTY	J16
17	BAGMANDLA JETTY	J17
18	KOLMANDLA JETTY	J18
19	KARIMANE JETTY	J19
20	AADI JETTY	J20
21	KHAPCHOUKE JETTY	J21
22	TORADI JETTY	J22
23	PANGLOLI JETTY	J23
24	RAJ BUNDER JETTY	J24
25	KUDGAON JETTY	J25
26	AMBET JETTY	J26
27	DABHOL JETTY	J27
28	VARATHI JETTY	J28
29	PALSHAP JETTY	J29
30	SANDERI JETTY	J30
31	JUI JETTY	J31
32	VAHOOR JETTY	J32
33	DASGAON JETTY	J33
34	DASGAON OLD JETTY	J34
35	GHOTHE JETTY	J35

LIST OF EXISTING INDUSTRY		
SL.	DESCRIPTION	SYMB.
1	LAXMI ORGANIC INDUSTRIES LTD	I1
2	M/S CHAITALI PETRO-CHEM INDUSTRIES PVT. LTD.	I2
3	SHALCO INDUSTRIES PVT LTD.	I3
4	DUFLON INDUSTRIES PRIVATE LIMITED	I4
5	MAHARASHTRA INDUSTRIAL DEVELOPMENT CORPORATION MAHAD	I5
6	OM CHEMICALS	I6
7	CAPROLACTAM CHEMICALS LTD.	I7
8	VINATI ORGANICS LIMITED	I8
9	SEQUENT SCIENTIFIC LIMITED, MAHAD	I9
10	M/S PRIVI ORGANICS LIMITED	I10
11	ASTEC LIFESCIENCES LIMITED	I11
12	JBS PHARMA CHEM PVT. LTD.	I12
13	EMBIO LIMITED	I13
14	TITAN LABORETORIES PVT.LTD.	I14
15	HIKAL LIMITED	I15
16	MAHALAXMI PROCESSING INDUSTRIES	I16
17	ISEES TECHNOLOGIES LLP	I17
18	ALT HOLLOWBLOCK & CONSTUCTION SUPPLY	I18

LIST OF PROPOSED INDUSTRIES/INDUSTRIAL AREAS EXPANSIONS		
SL.	DESCRIPTION	SYMB.
1	MIDC MAHAD	IP1
2	MAHAD 5 STAR MIDC INDUSTRIAL AREA	IP2

LEGEND	
	TERMINALS T LAT. 18°05'56.41"N LONG. 73°20'22.35"E
	BUS STOP
	HISTORICAL PLACE
	PORT
	EXISTING INDUSTRY
	PROPOSED INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/CREEK/SMALL RIVER
	FERRY LINE
	ROUTE PROVIDED BY IWAI
	SURVEY (VESSEL TRACK)
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	RAILWAY LINE

PROPOSED WATERWAY LENGTH 45.47Km

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

SCALE 0 2.5km 6.25KM

CLIENT

INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING
A-13, Sector-1, Noida

SURVEYED BY

Rev.	Y M D	Modifications	Status	Drawn	Checked	Approved	Validated
C	2018-07-05	THIRD SUBMISSION	DPR	HDR	SRI	NSR	BCJ
B	2017-12-19	SECOND SUBMISSION	DPR	NRD	PRK	BCJ	BCJ
A	2017-07-31	FIRST SUBMISSION	DPR	NRD	PRK	BCJ	BCJ

Project

CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -7 OF NATIONAL WATERWAYS

Subject

LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF SAVITRI RIVER (BANKOT CREEK) (MAP 4.1)

CONSULTANT

TRACTEBEL ENGINEERING PVT. LTD.
Intec House, 37
Institutional Area, Sector 44
122002 Gurgaon-INDIA

Status Of Drawing: ISSUED FOR DPR
Scale: Size: A1
DRG N°: P.010257 Rev.: A Sheet: 1 of 1

ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

Industry	Name of the person	Designation
Vinyl Chemicals (India) / Pidilite Industries	Burhade Prakash S.	Production Manager
Laxmi Organic	Manoj Kumar Sen	Deputy Manager, Commercials
Vinati Organics	V.D.Shelar	Vice President
Sudarshan Chemicals	C B Godbole	DGM, Roha
Shalco Chemicals	Shankar Rao. Attada	Manager
Hikal Limited	Rajendra Sen	Production Manager
Chaitali Petro Chemical Industries.	Sudam Dinkar Yadav	Director
Privi Organics	Prashik	

Name of Company: Vinyl Chemicals / Pidilite Industries

Contact Person: Burhade Prakash S.

Designation: Production Manager

Vinyl Acetate Monomer (VAM) is manufactured in the plant located at Mahad in Raigad Dist, Maharashtra, India. It is de-merged with Pidilite Industries in 2007. VAM is now imported from international suppliers and distributed in India.

Mode of Transport (Cargo Movement): Via Roadways from JNPT to Mahad Plant. It takes around 4-5 hrs to reach Mahad from JNPT (Excluding Custom Clearance). It is approximately 120 Km from JNPT.

They are not interested in waterways route for cargo movement due to direct road connectivity from JNPT and just 4 hrs roadways journey.

Name of Company: Laxmi Organic

Contact Person: Manoj Kumar Sen

Designation: Deputy Manager (Commercial)

Laxmi Organic Industries is a specialty chemical manufacturer, focused on two key business segments: Acetyl Intermediates and Speciality Intermediates.

Its plants are situated in a chemical park in Mahad, 120 Km from JNPT.

Mode of Transport: Roadways between JNPT & Mahad. It takes around 4 hrs to reach Mahad from JNPT (Excluding Custom Clearance). It is about 120 Km from JNPT.

Raw materials are imported from China and finished goods are exported to China & Europe.

Volume of Cargo transported via roadways is around 8 containers per month i.e. 1920 Tonnes annually.

The cost of transportation is about 3-5 INR/Kg.

Name of Company: Vinati Organics

Contact Person: V D Shelar

Designation: Vice President

Vinati Organics Limited (VOL) is a specialty chemical company, focusing on manufacturing specialty chemicals and organic intermediaries.

They have two plants, both situated at Mahad (Raigad) and Lote Parashuram (Ratnagiri). Main products are Isobutyl Benzene (IBB) and 2-Acrylamido 2 Methylpropane Sulfonic Acid (ATBS). It is exported to 22 countries worldwide i.e. US, Europe and Asia.

Mode of Transport: Via Roadways between JNPT & Mahad. It takes 5 hrs to reach Mahad from JNPT (Excluding Custom Clearance).

Total Volume of cargo transported from roadways is around 150 Tonnes monthly i.e. 1800 Tonnes annually. The cost of transportation is around 3-5 INR/ Kg.

They are ready to use waterways if cargo will reach the plant in time.

Name of Company: Sudarshan Chemicals

Contact Persons: Mr. CBD Godbole

Designation: DGM, Roha

Sudarshan Chemicals is a leading color & effect pigment manufacturer company. Raw materials are imported from China. They exported to Netherlands, USA, and China & many other international countries. They have two production units in India, one at Mahad & other at Roha.

Mode of Transport: Roadways between JNPT & Mahad. It will take 4-5 hrs to reach Mahad from JNPT (excluding Custom Clearance) or vice versa.

Name of Company: Shalco Chemicals

Contact Persons: Mr. Shankar Rao Attada

Designation: Manager

Shalco Industries utilize welding line tube mills, cold pilger mills and cold draw benches to produce Stainless Steel and Nickel alloy pipes & tubing's.

With years of experience and huge inventory from parent company in Stainless steel, Special Stainless Steel, Duplex, Super Duplex and Nickel Alloys enables us to serve our customers better with short lead times and best of quality. It consists of various Oil and Gas, Chemical, Pharmaceuticals, Fabrication, Heat Transfer and Monitoring, Paper & Pulp, Sugar, Automobile, Cement and Power Industries.

Mode of Transport: Roadways between JNPT & Mahad. It will take 4 hrs to reach Mahad from JNPT or vice versa.

Total Volume of Cargo transported from roadways is around 40 tonnes per month i.e. 480 tonnes annually. Raw materials are imported from China only. It is planning to make 300 Tonnes of raw materials in-house annually. They are not ready to use waterways for cargo transportation as most locally consumed.

Name of Company: Hikal Limited

Contact Person: Mr. Rajendra Sen

Designation: Production Manager

Hikal Limited is major manufacturer of chemicals used in pharmaceuticals & agrochemical industry.

Name of Company: Chaitali Petro Chemical Industries

Contact Person: Mr. Sudam Dinkar Yadav

Designation: Director

Chaitali Petro Chemical Industries is a very small firm. Raw materials are bought locally and finished product is also very small in quantity.

Name of Company: Pirvi Organics

Contact Person: Mr. Prishik

Designation: Manager

Pirvi Organics has two production units at Mahad, which is 120 km from JNPT.

Mode of Transport: Roadways from JNPT to Mahad. It will take 4 hrs from JNPT to reach Mahad Plant. It handles complex unit operations such as pyrolysis, hydrogenation, cyclisation, condensation, esterification, hydration etc.

Volume of cargo transported via roadways to the plant is around 7000 MT annually.

ANNEXURE 5.1– CALCULATION OF SAFE BEARING CAPACITY

Calculation of Safe Bearing capacity as per IS 6403 - 1981

Width of Footing/Raft (B)	=	**1.50** m	
Length of Footing/Raft (L)	=	**1.50** m	
Cohesion (C)	=	**0.0** KN/m^3	For BS-1
Angle of Internal Friction (ϕ)	=	**32.0** degree	For BS-1
Bulk Unit weight (γ)	=	**18.6** KN/m^3	For BS-1
Unit weight of water (γ_w)	=	**10** KN/m^3	
Submerged Unit Weight	=	**8.6** KN/m^3	
Type of Failure	=	**Punching 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	=	3.254 (cl. 3 of IS 6403)	
Depth factor (dc)	=	1.722 (cl. 5.1.2.2 of IS 6403)	
Depth factor (dq)	=	1.361 (cl. 5.1.2.2 of IS 6403)	
Depth factor (dγ)	=	1.361 (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 ($\Phi'=\Phi*2/3$)	=	22.616	degree
Bearing capacity factor (Nc')	=	**30.93**	For Punching Shear Failure
Bearing capacity factor (Nq')	=	**20.71**	For Punching Shear Failure
Bearing capacity factor (Nγ')	=	**29.10**	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')
399.00 KN/m^2

Settlement Calculations

As per Figure 9 of IS 8009 (Part I) 1986

Average SPT Value =	28	
Settlement at a load of 1 kg/cm^2 (100 kN/m^2) =	**8**	mm (For Width = 25 m)
Water Table Correction for Settlement =	0.5	
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)
(Considering Isolated footing as Flexible foundation)		
Settlement after Water Table Correction =	9.92	mm

Load at 50 mm Settlement = 504.03 kN/m^2

Safe Bearing Capacity = 399.00 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 BS-1

Dia of Pile (D) =	1.00 m		0 to 5.1 m		
Ground Level =	0.0 m	Submerged Unit Weight (kN/m^3) =	8.60		
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	32.5	0	32.5	1.13	0.00	12.90	4.71	21.8
3	-3	31.5	0	31.5	1.08	0.00	25.80	4.71	60.1
4.5	-4.5	40.0	0	40.0	1.50	0.00	38.70	4.71	191.3
5.0	-5	40.0	0	40.0	1.50	0.00	43.00	1.57	80.8

Total Ultimate Skin Friction Resistance, Qst (kN) = 353.90

Total Allowable Skin Friction Resistance, Qst (kN) = 141.56

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 =	43.00	kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	40	degree
Bearing Capacity Factor (Nc)	0	
Bearing Capacity Factor (Nq)	120.000	(As per IS 2911Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	109.410	(As per IS 6403 -1981)

End Bearing (T) =	4422.16	kN
Allowable End Bearing Capacity of Pile =	**1768.86**	**kN**
Self Weight of Pile =	98.17	kN
Net Bearing Capacity of Pile =	**1812.0**	**kN**

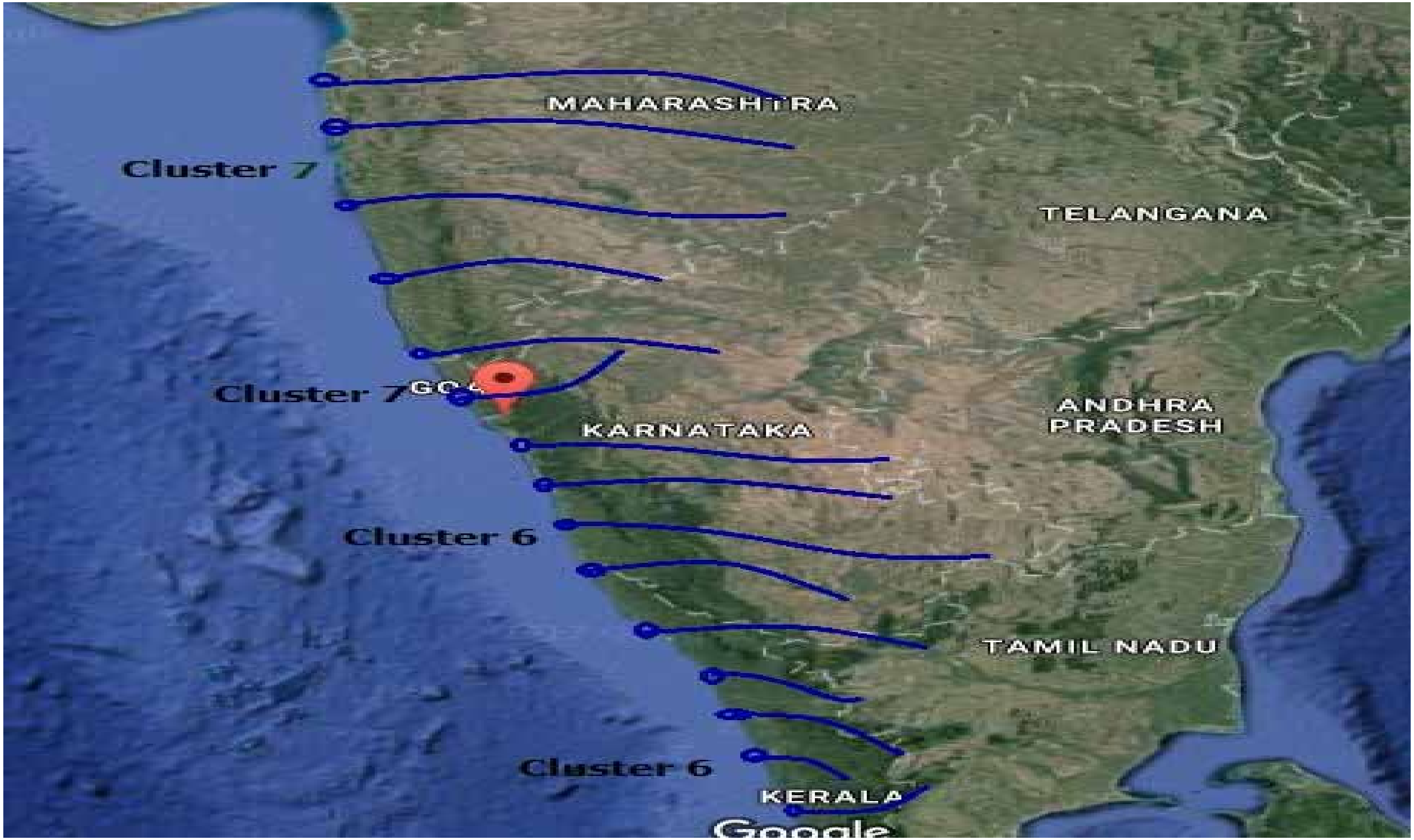
Uplift Capacity of Pile

Safe Uplift Capacity of Pile = 2/3*Frictional Resistance =	94.37	
Safe Uplift Capacity (Including Weight of Pile)=	**193.0**	**kN**

ANNEXURE 8.1– RIS / AIS

RIVER VESSEL TRACKING INFORMATION SYSTEM

- RIS Objective
- Proposed AIS Base Station
- RIS Key Technologies
  - (a) Vessel Tracking & Tracking
  - (b) Onshore Facilities
- AIS Base Station Set up
- AIS Station Tower Design
- AIS Station VHF Range
- AIS Onboard Device
- Onboard ECDIS Interface
- RIS Centre
- Communication Segments
- Bill of Material


MAHARASHTRA
Cluster 7
TELANGANA
Cluster 7
KARNATAKA
ANDHRA PRADESH
Cluster 6
TAMIL NADU
Cluster 6
KERALA
Google

Services for skippers

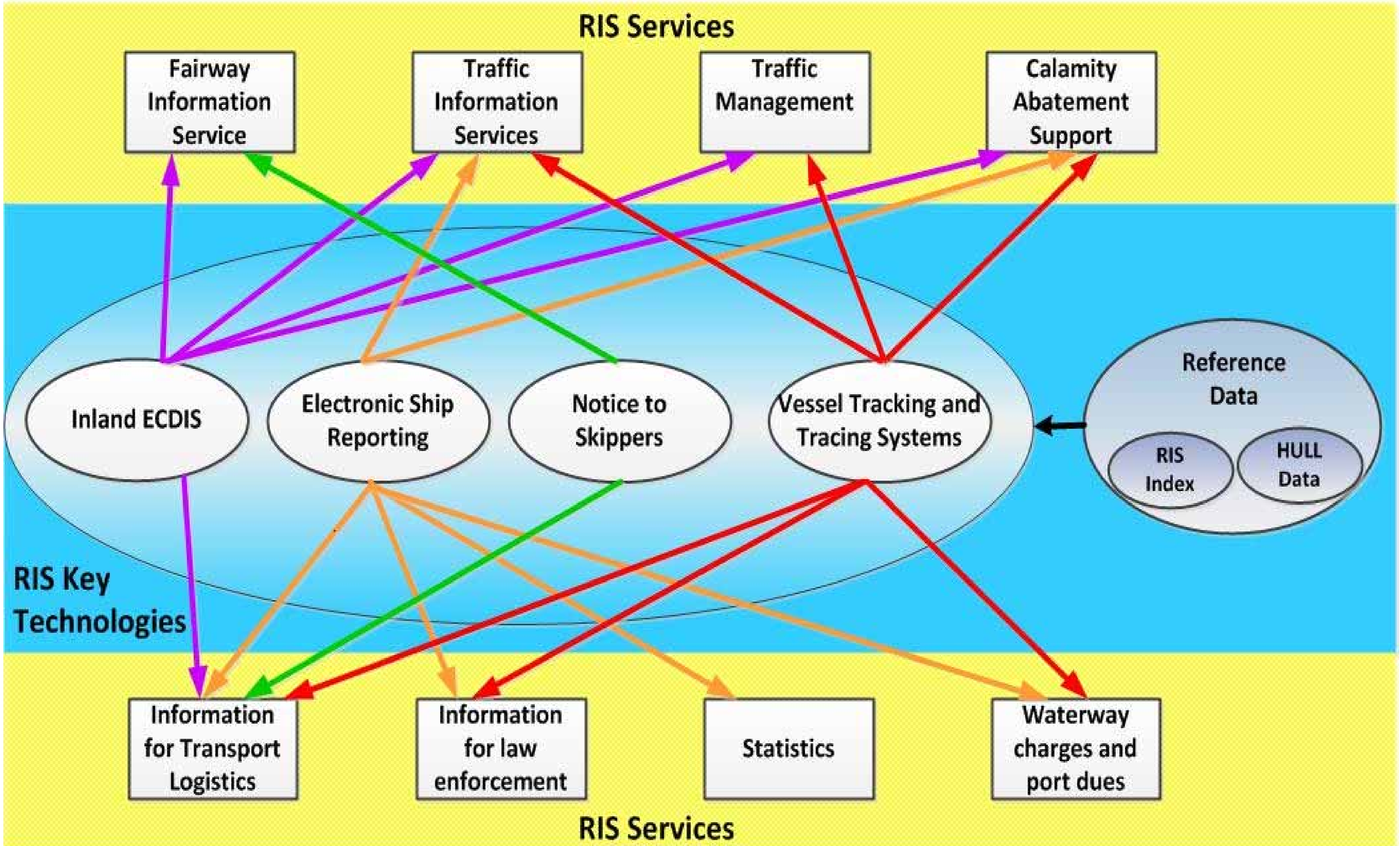
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

Services for authorities

- Real time traffic monitoring (tracking and tracing)
- Analysis of accidents
- Exchange of safety related messages
- Electronic vessel register
- Electronic lock management
- Reception of electronic cargo reports
- Border surveillance

Services for logistic users

- Electronic cargo documents
- Data for fleet management
- Data for voyage planning
- Fairway conditions
- Water level forecast
- Availability of locks
- Calculations of arrival times

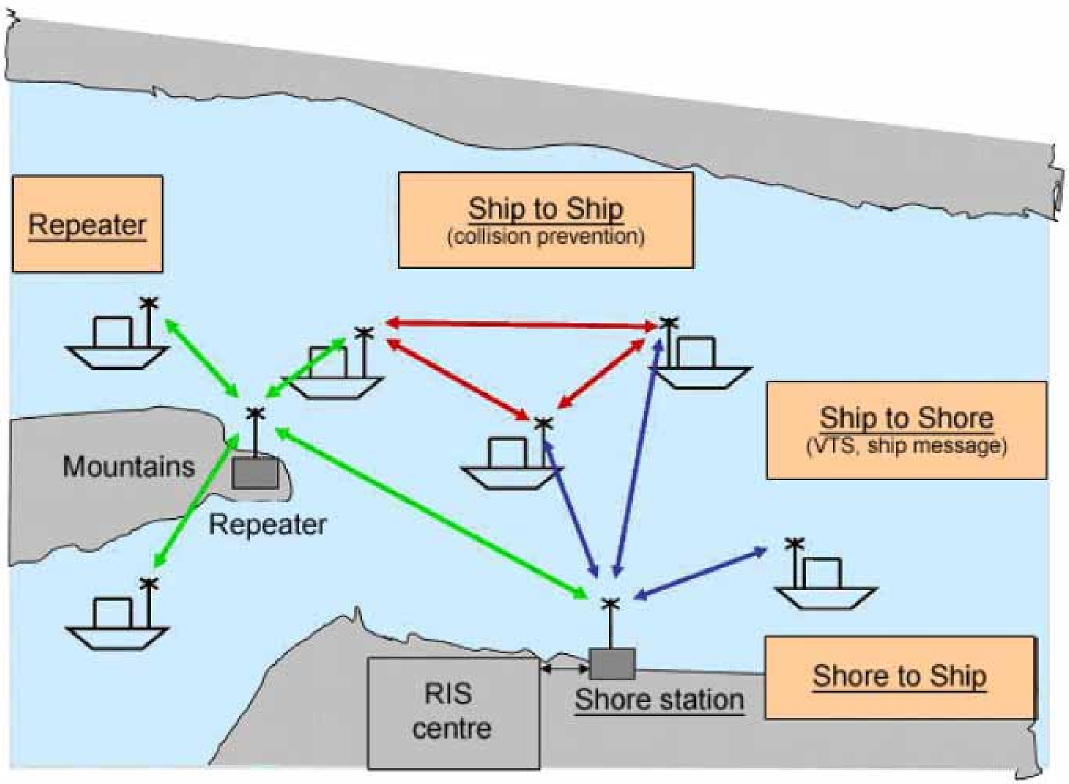

RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notice to Skippers
Vessel Tracking and Tracing Systems
Reference Data
RIS Index
HULL Data
RIS Key Technologies
Information for Transport Logistics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

The key technologies of RIS are

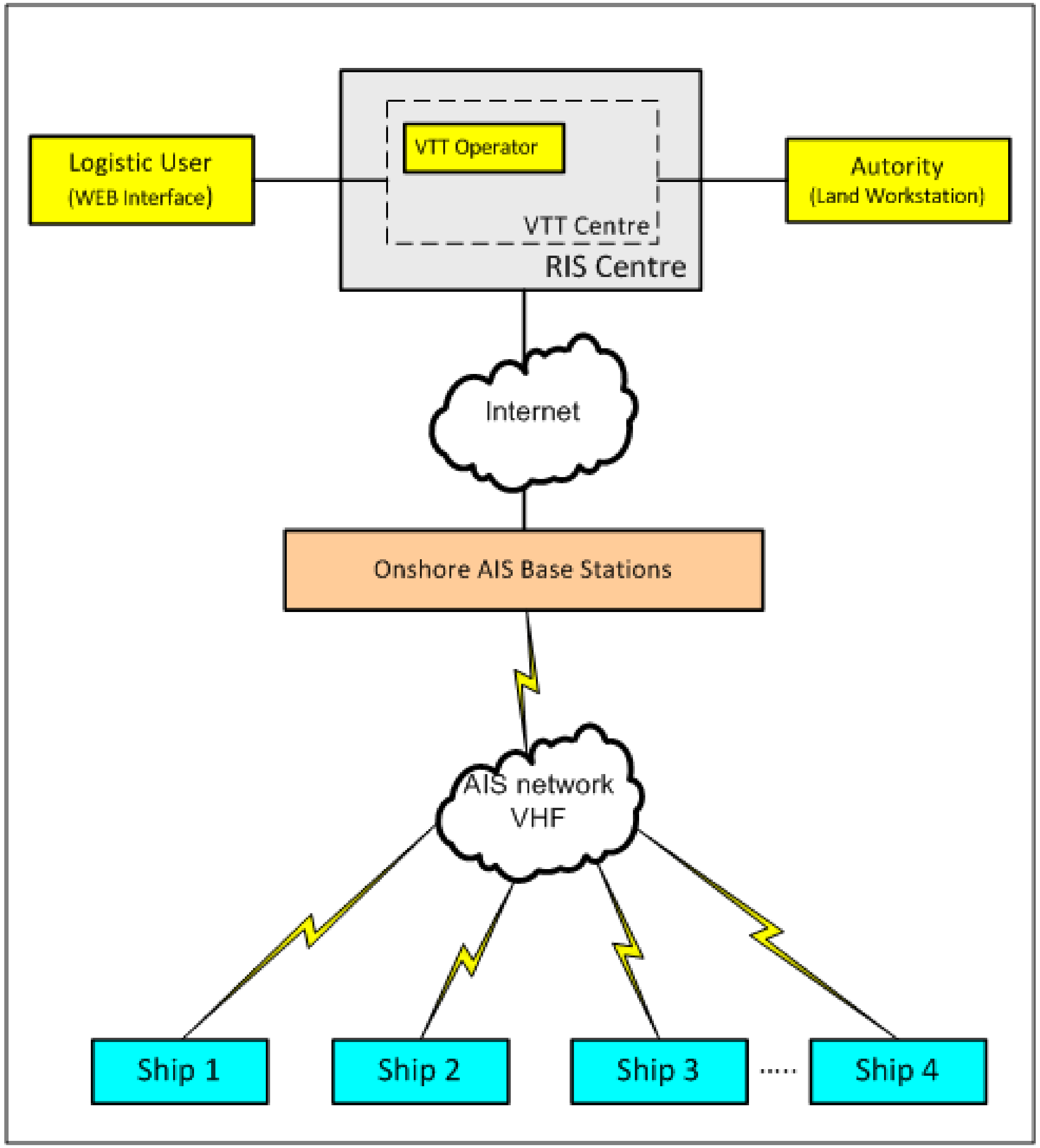
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

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

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

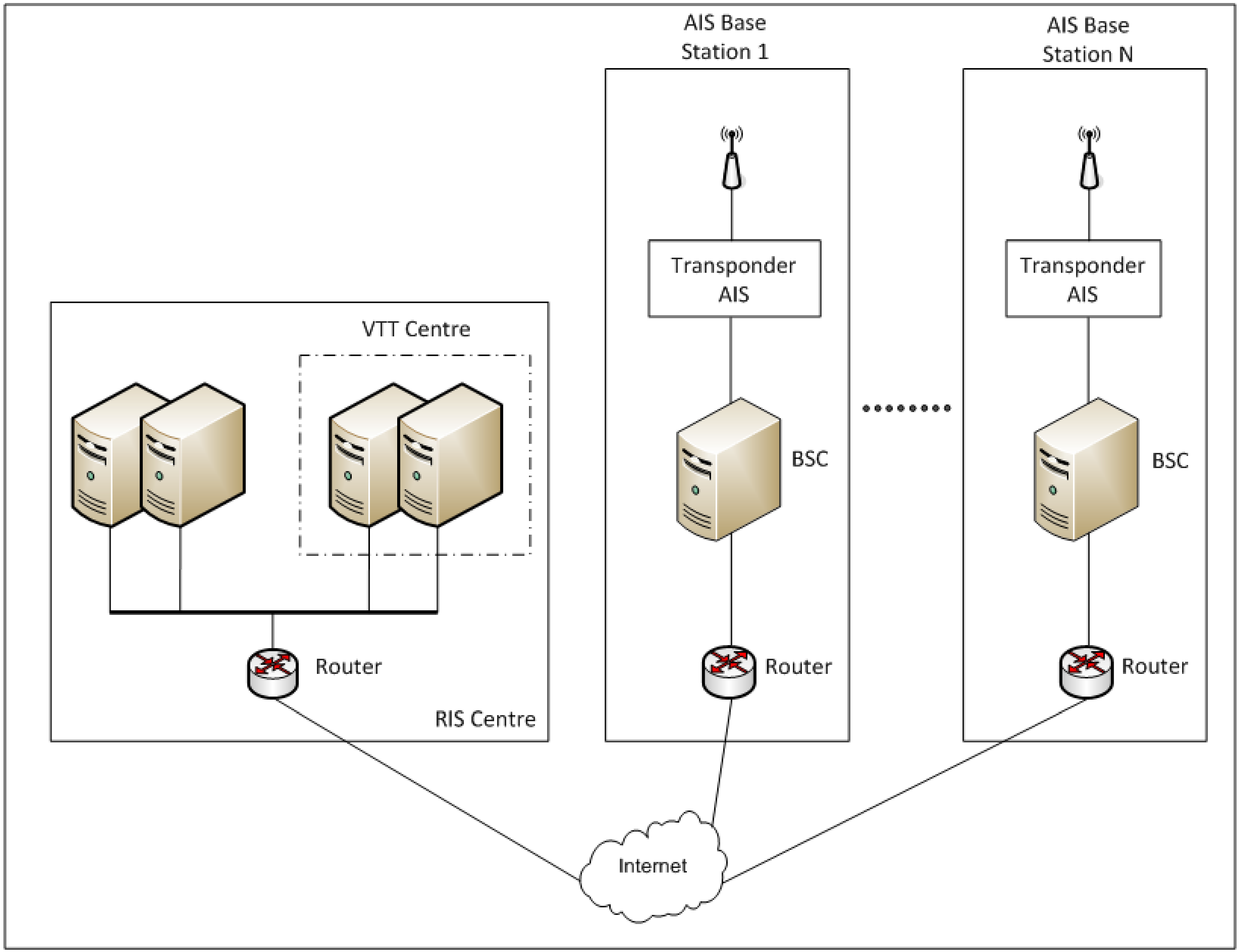


Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS display. AIS systems are meant to boost the safety of navigation by use from vessel-to-vessel alongside onshore Vessel Traffic Services (VTS) to trace and track vessels and to assist in calamity abatement.

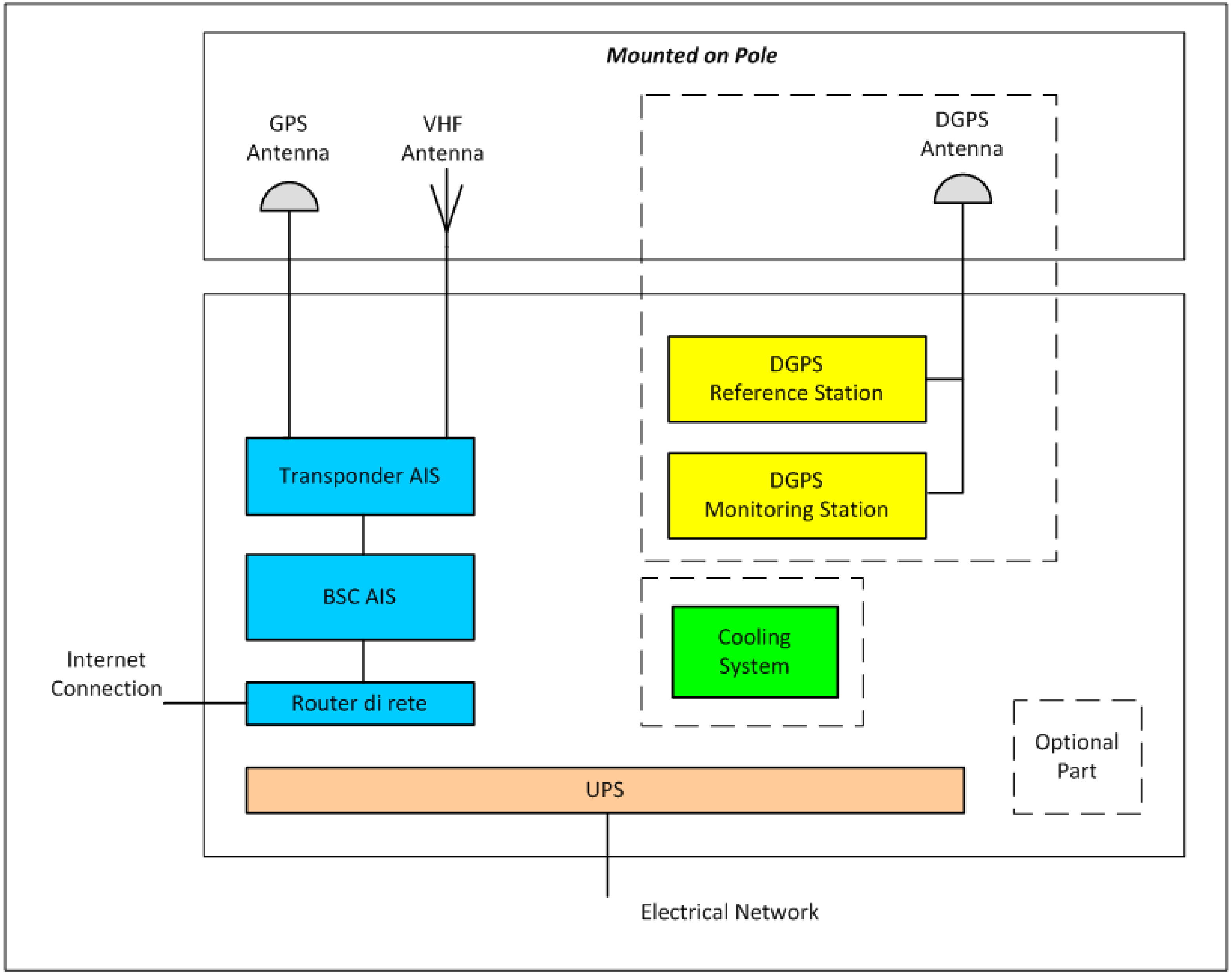


VTT Operator
Logistic User
(WEB Interface)
VTT Centre
RIS Centre
Autority
(Land Workstation)
Internet
Onshore AIS Base Stations
AIS network
VHF
Ship 1
Ship 2
Ship 3
.....
Ship 4

AIS BASE STATION & RIS CENTRE ONSHORE FACILITIES



AIS BASE STATION



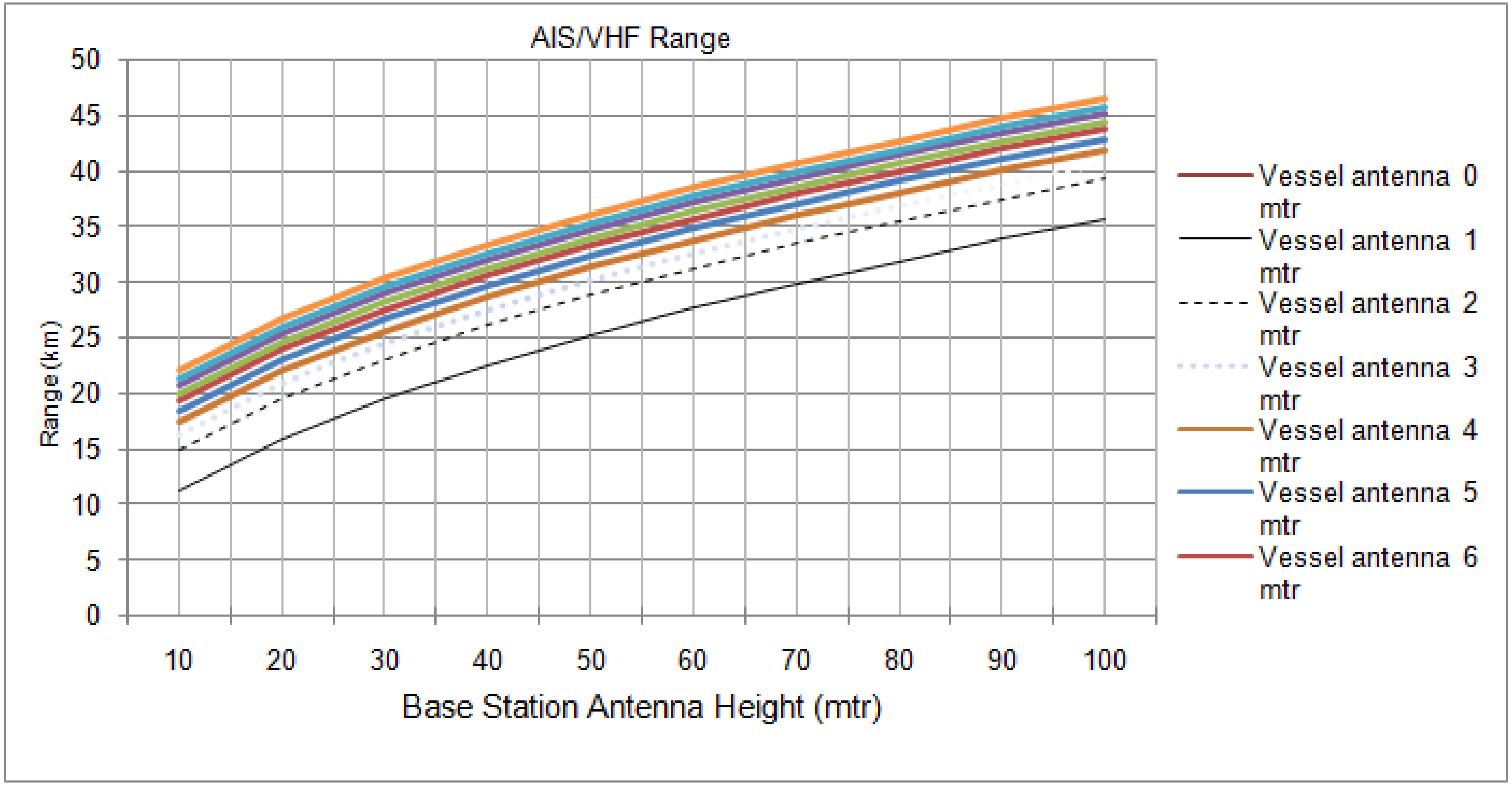
AIS STATION TOWER DESIGN

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

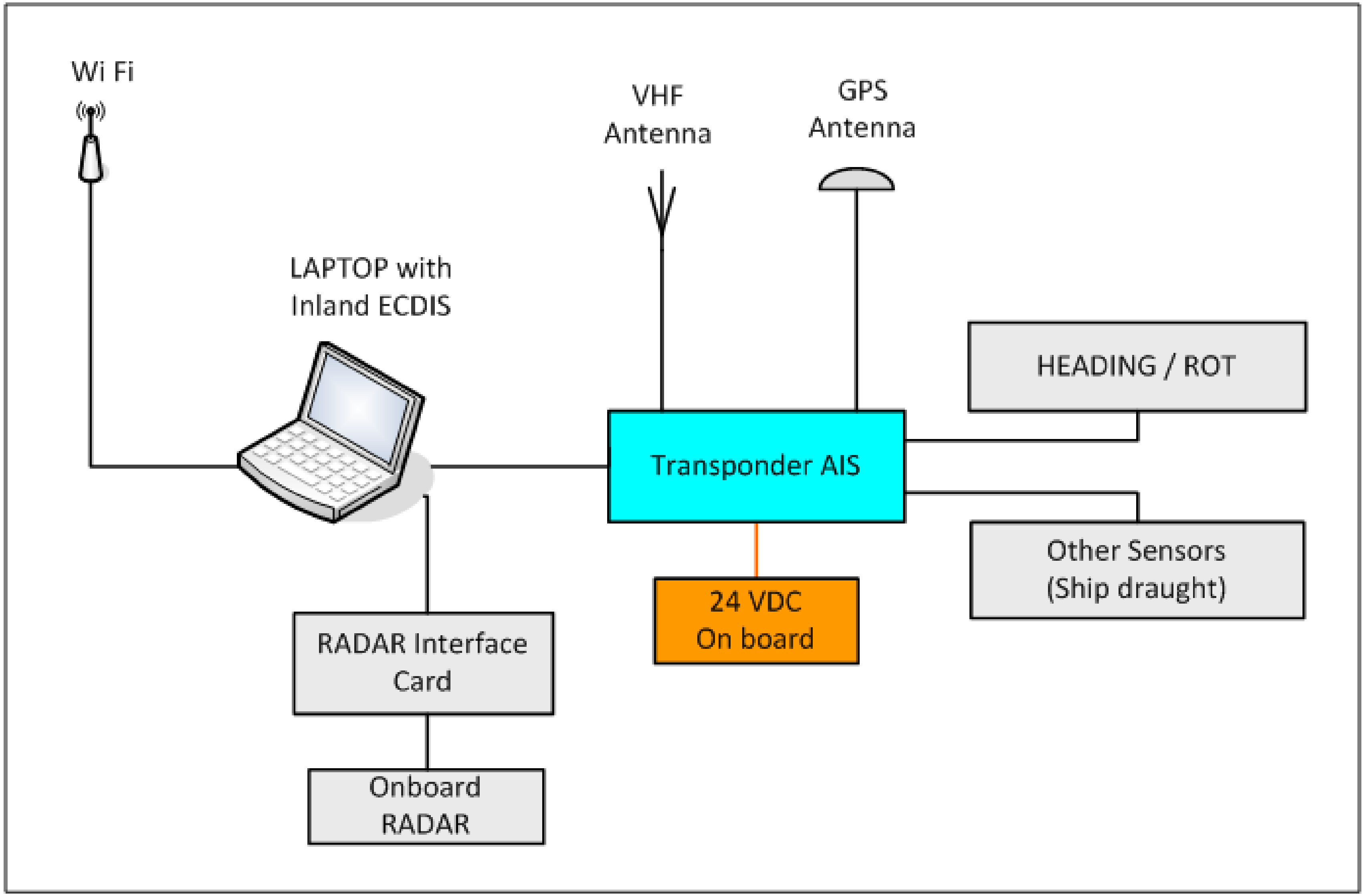
AIS STATION VHF RANGE

AIS/VHF Range												
Base Station antenna Height (mtr.)	Vessel Antenna Height	0	1	2	3	4	5	6	7	8	9	10
10	Range (km)	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		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

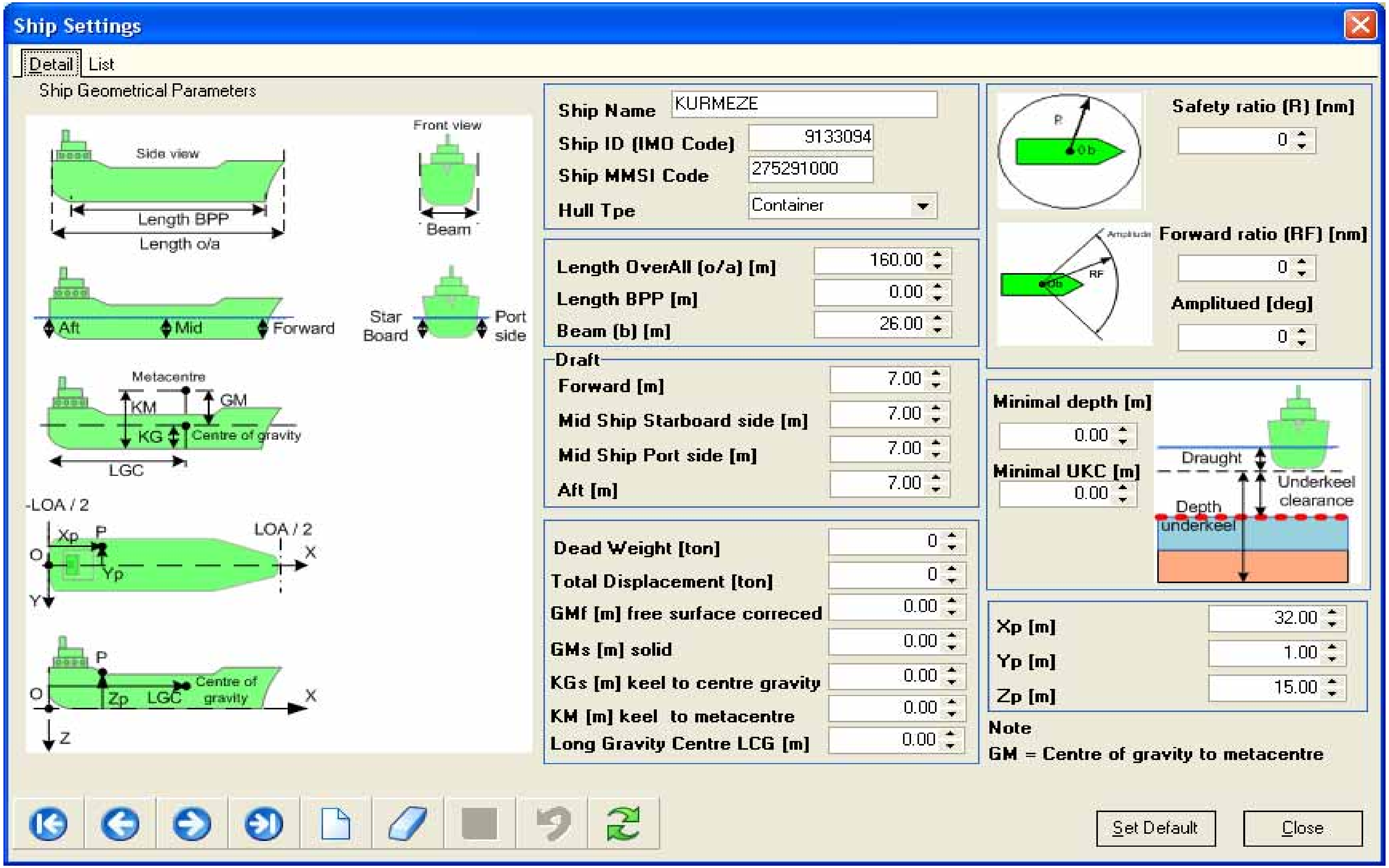
AIS STATION VHF RANGE



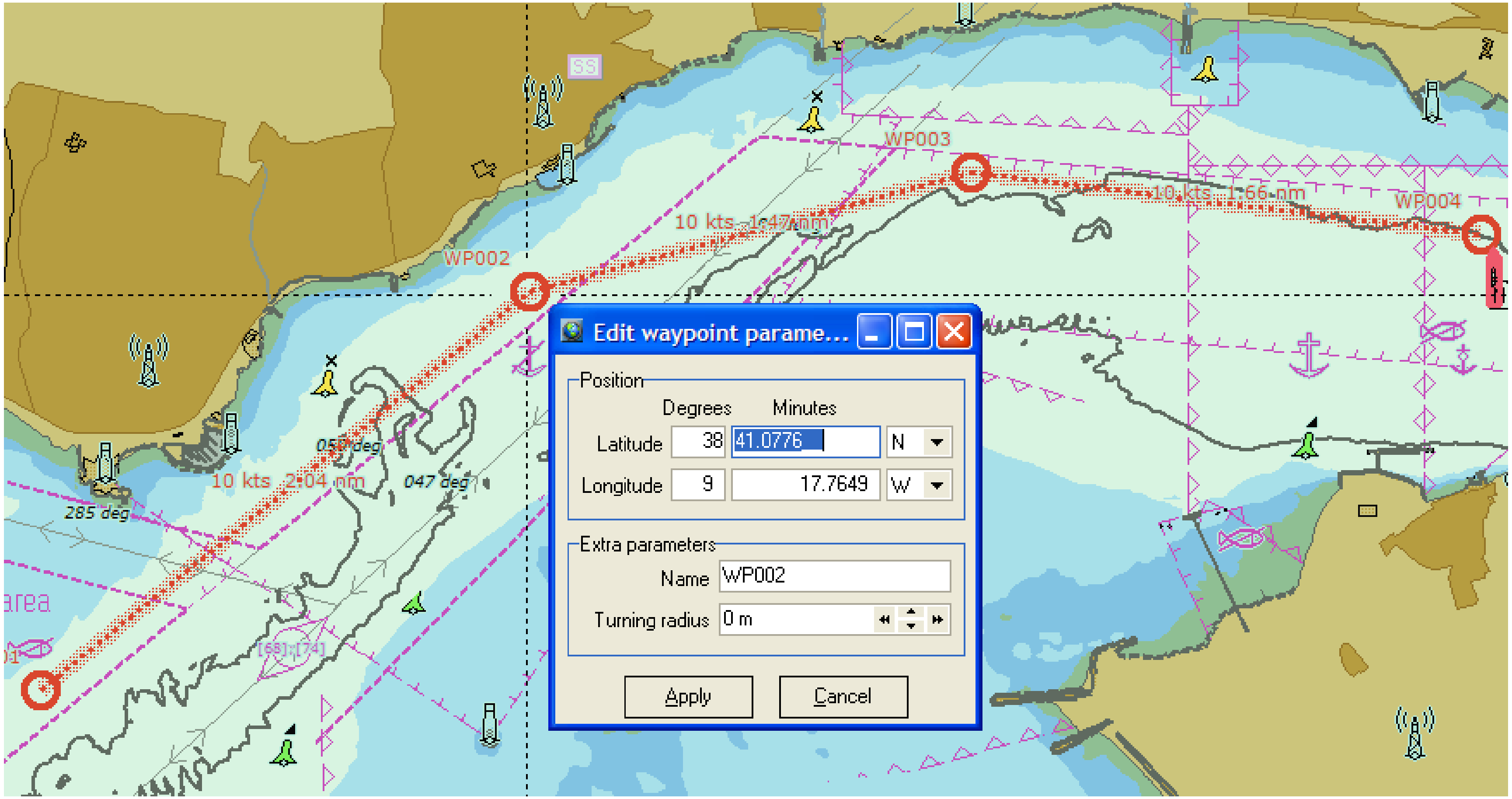
AIS ON BOARD DEVICE



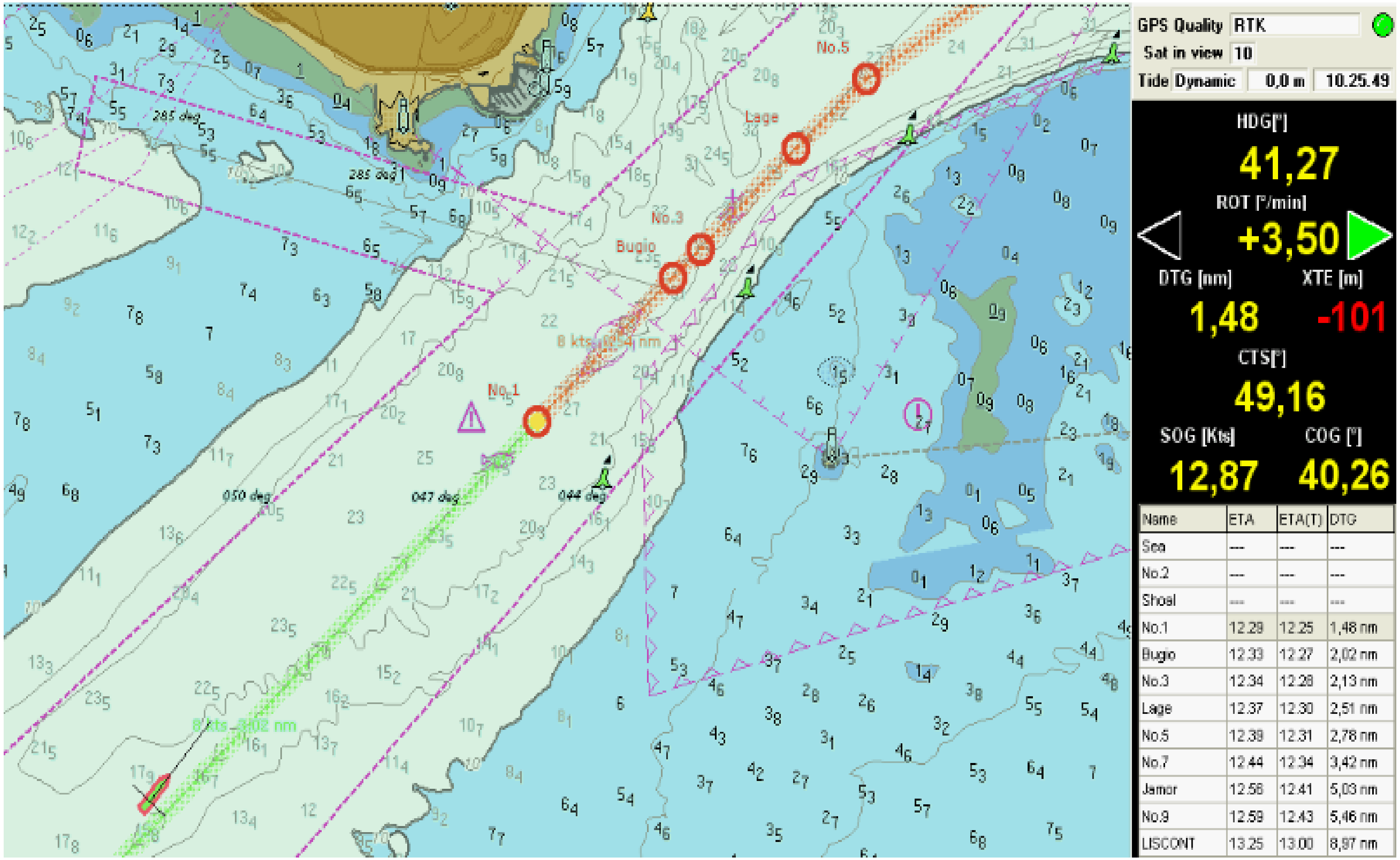
Interface to insert ship data



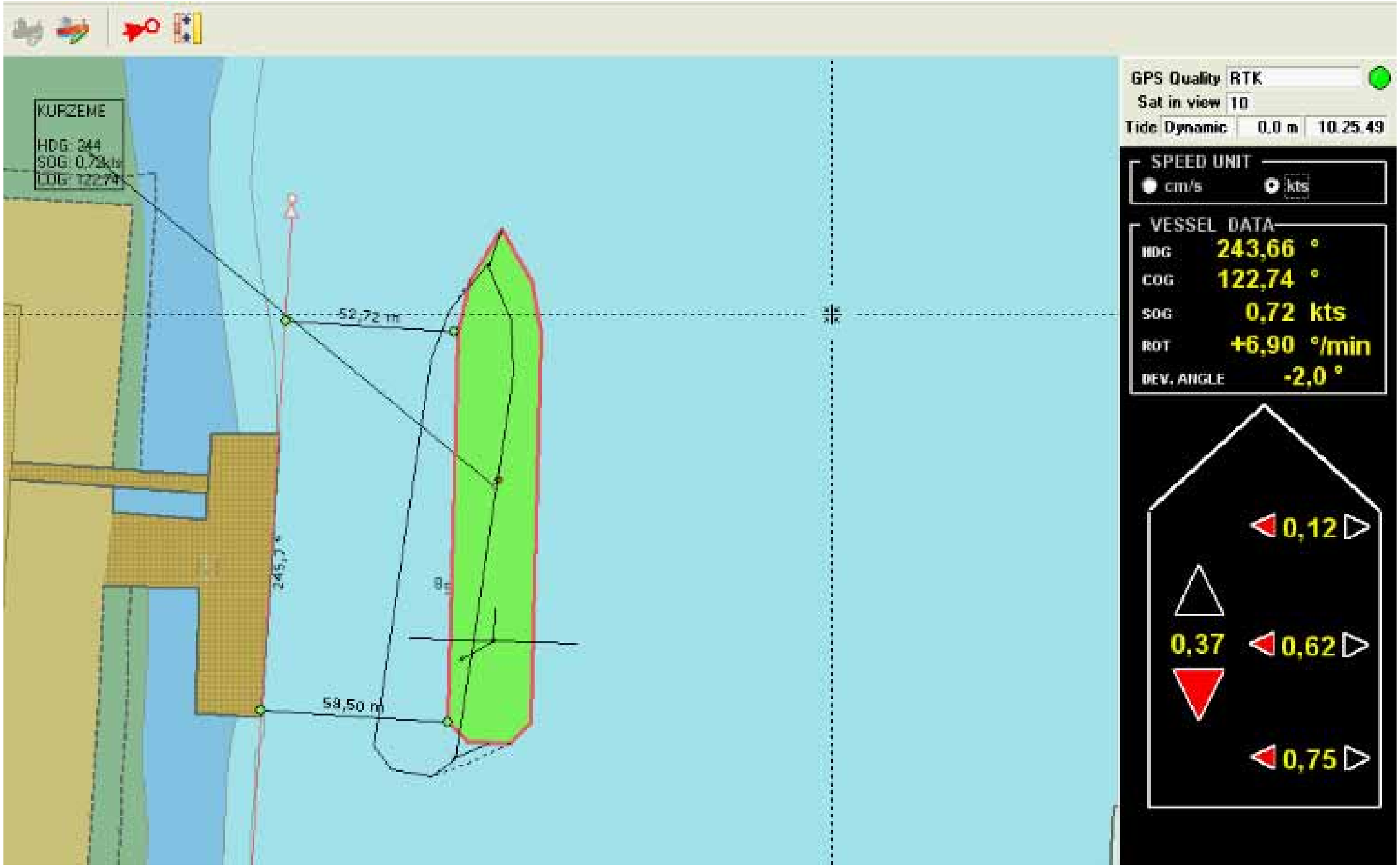
Interface to for voyage planning



Interface in navigation mode

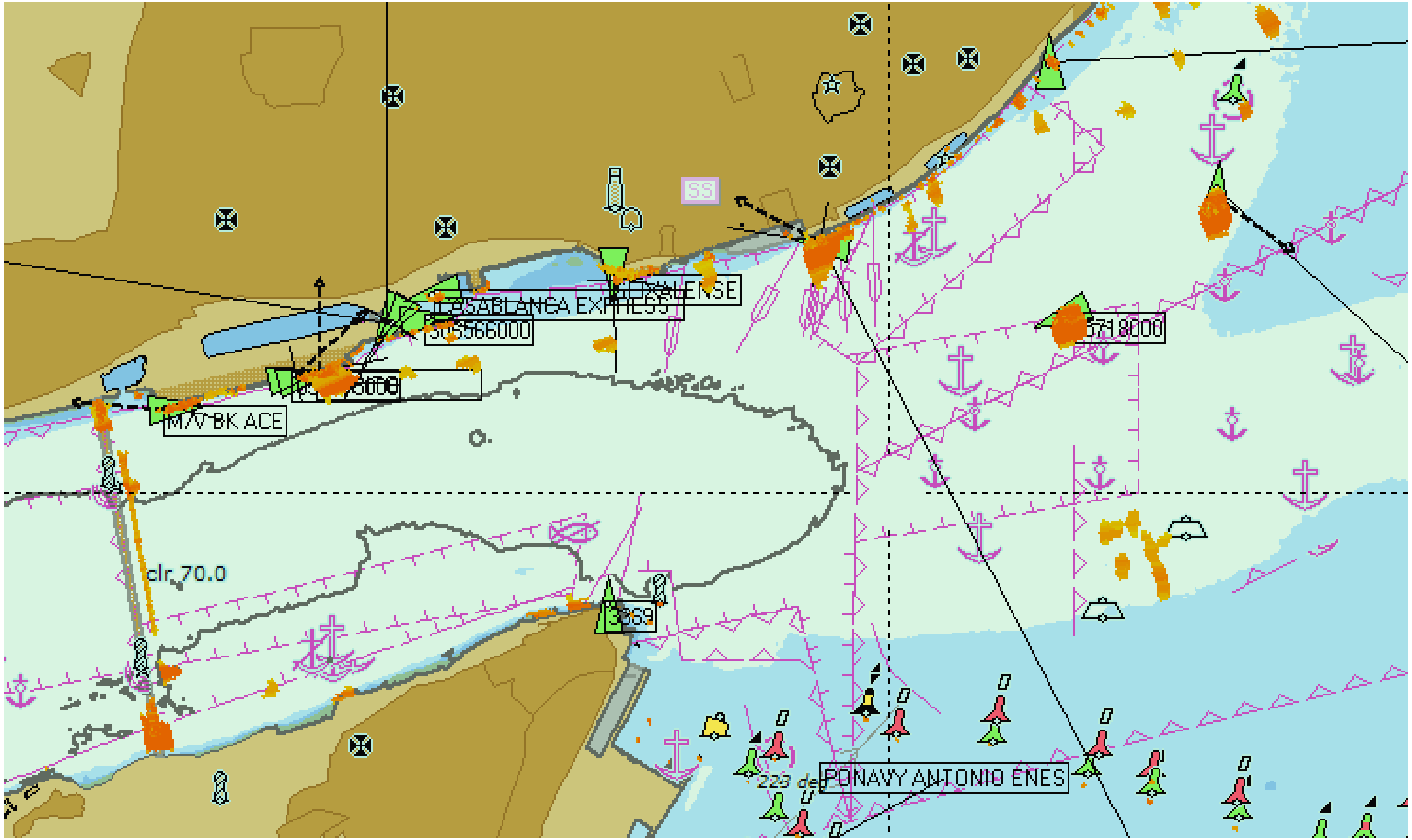


Interface for docking

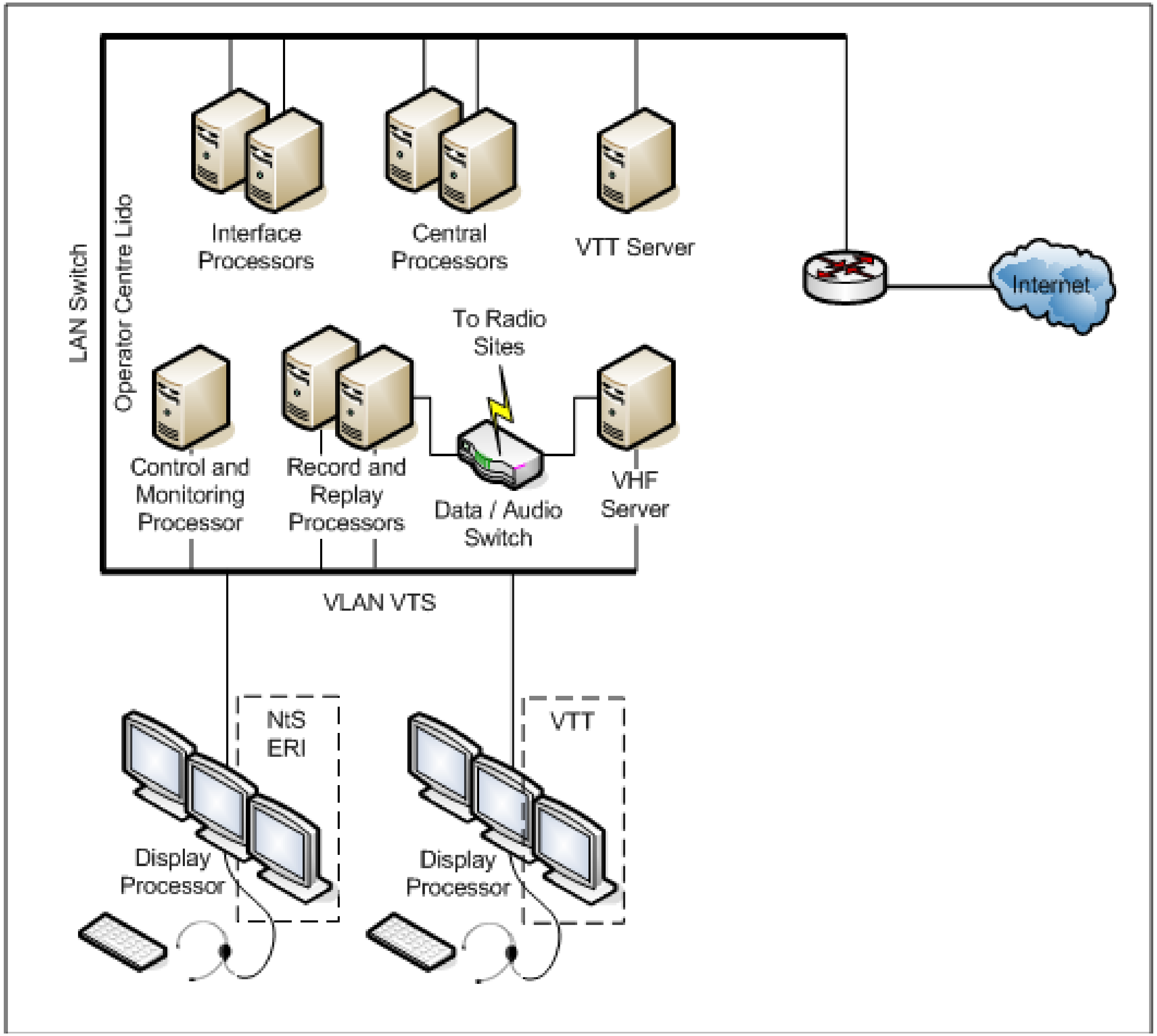


ONBOARD INTERFACE

Tactical Traffic Image + RADAR

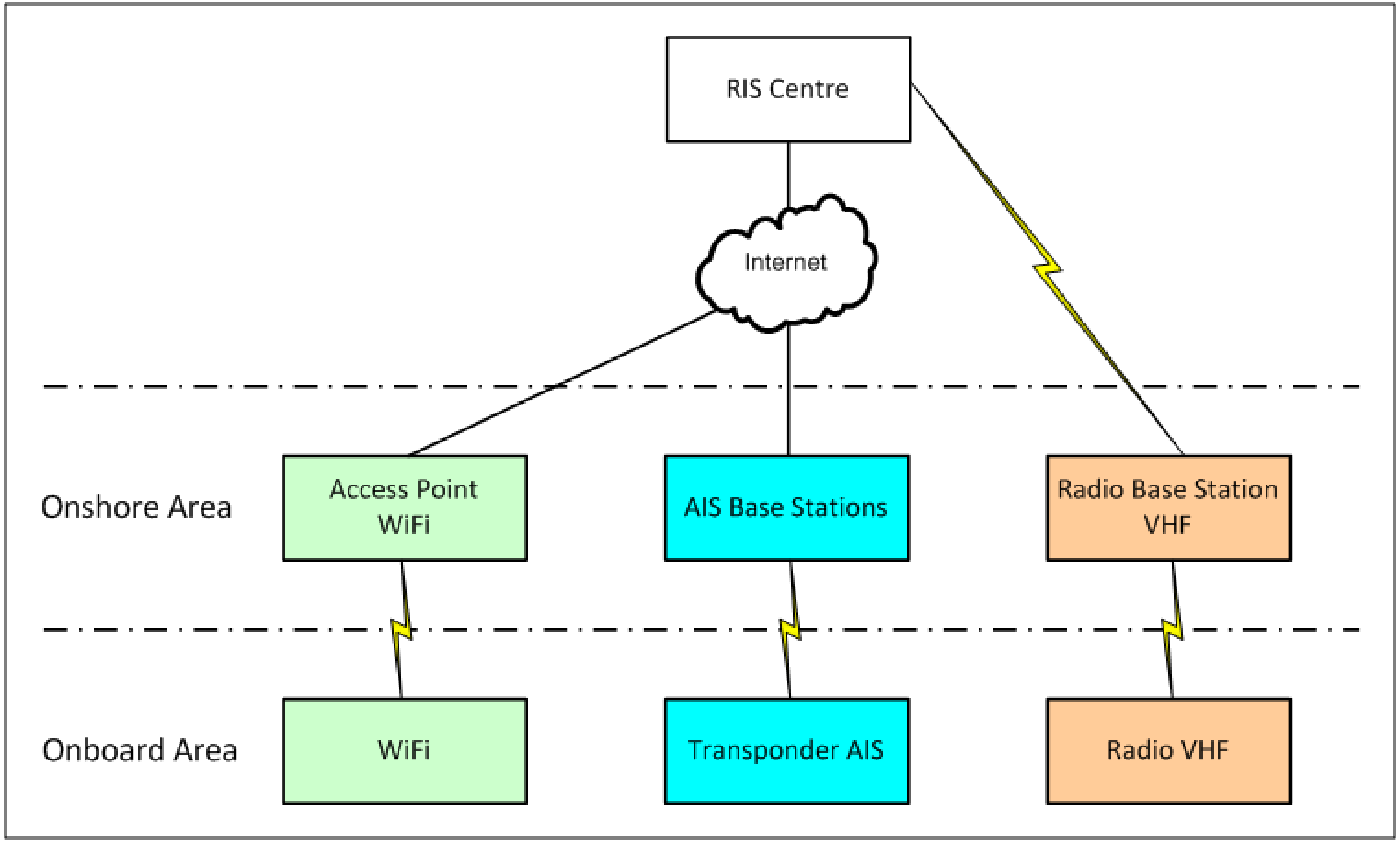


RIS CENTRE


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

ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Operate' shall be obtained from State Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.

ii. The project authority shall ensure that no rivers or tributaries are blocked due to any activities at the project site and free flow of water is maintained.

iii. Shoreline shall not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary.

iv. Dredging shall not be carried out during the fish/turtle breeding seasons.

v. All vessels used in the river will be fitted with noise control and animal exclusion devices so that aquatic life is not unduly disturbed.

vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.

vii. Construction waste including debris shall be disposed safely in the designated areas and in no case shall be disposed in the aquatic environment.

viii. Vessels shall not discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil

ix. The project authority shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.

x. All vessels will also have to comply with 'zero discharge' standards to prevent solid or liquid waste from flowing into the river and affecting its biodiversity.

xi. The dredging shall be carried by integrated and systematic planning by selective grid method by allowing migratory movement of Benthic fauna.

xii. All required Noise and vibration control measures are to be adopted in Dredgers. Cutter section Dredgers should be avoided as much as possible which produces more noise and vibration. No Drilling and Blasting is to be carried out.

xiii. Pre geo-tectonic studies has to be completed and the strata to be dredged is predetermined with complete data pertaining to hardness, compressive and tensile strengths.

xiv. Dredger type and other strata loosening methods shall be preconceived.

xv. Staggered dredging shall be carried based on turbidity monitoring to minimise the impact of turbidity.

xvi. Threshold level of turbidity, which has a minimal effect on fauna, has to be predetermined and Dredging planned accordingly.

xvii. Further silt screens needs to be used for minimising the spread of Turbidity.

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

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

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

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

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

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

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

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

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

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

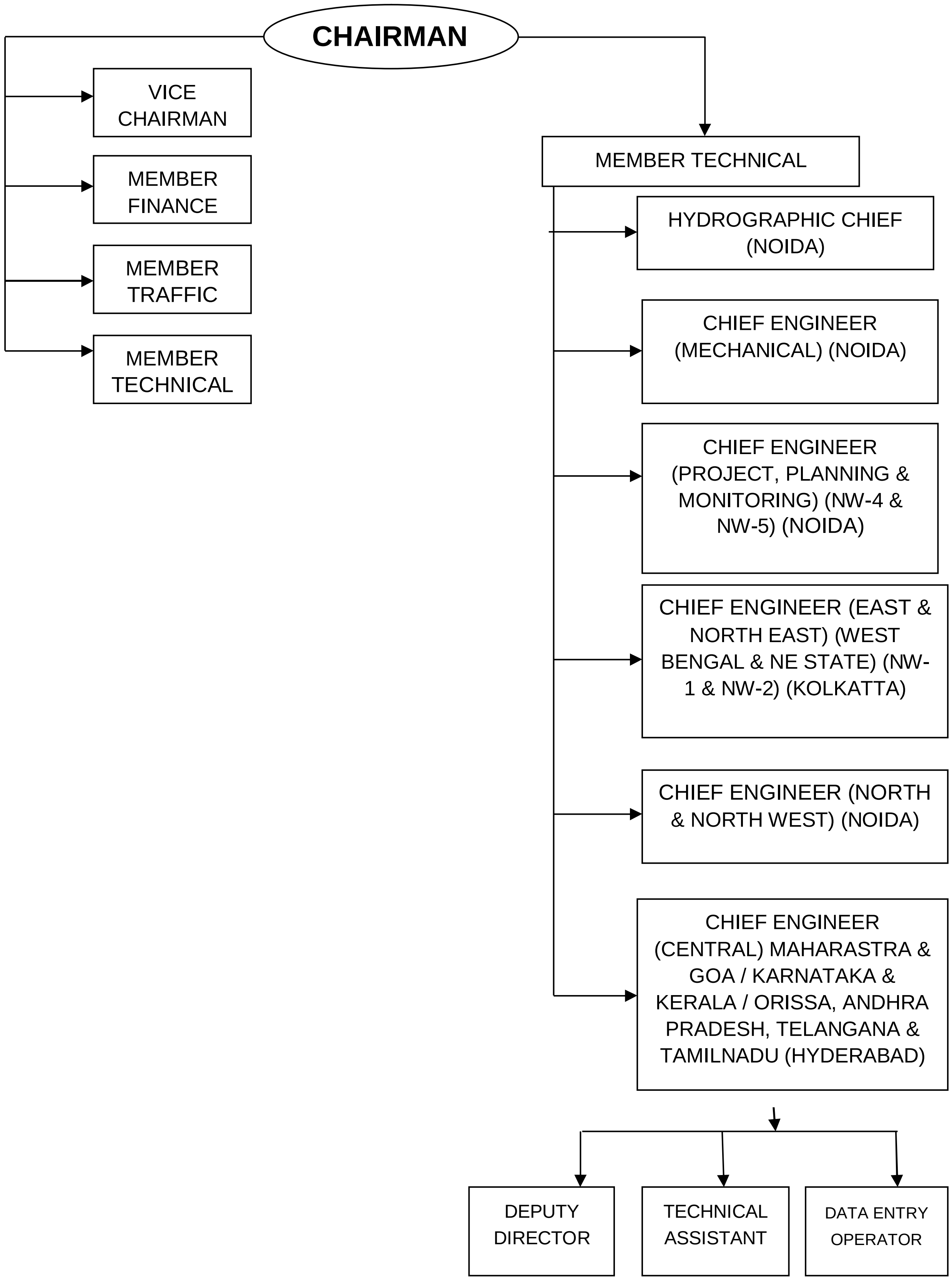
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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

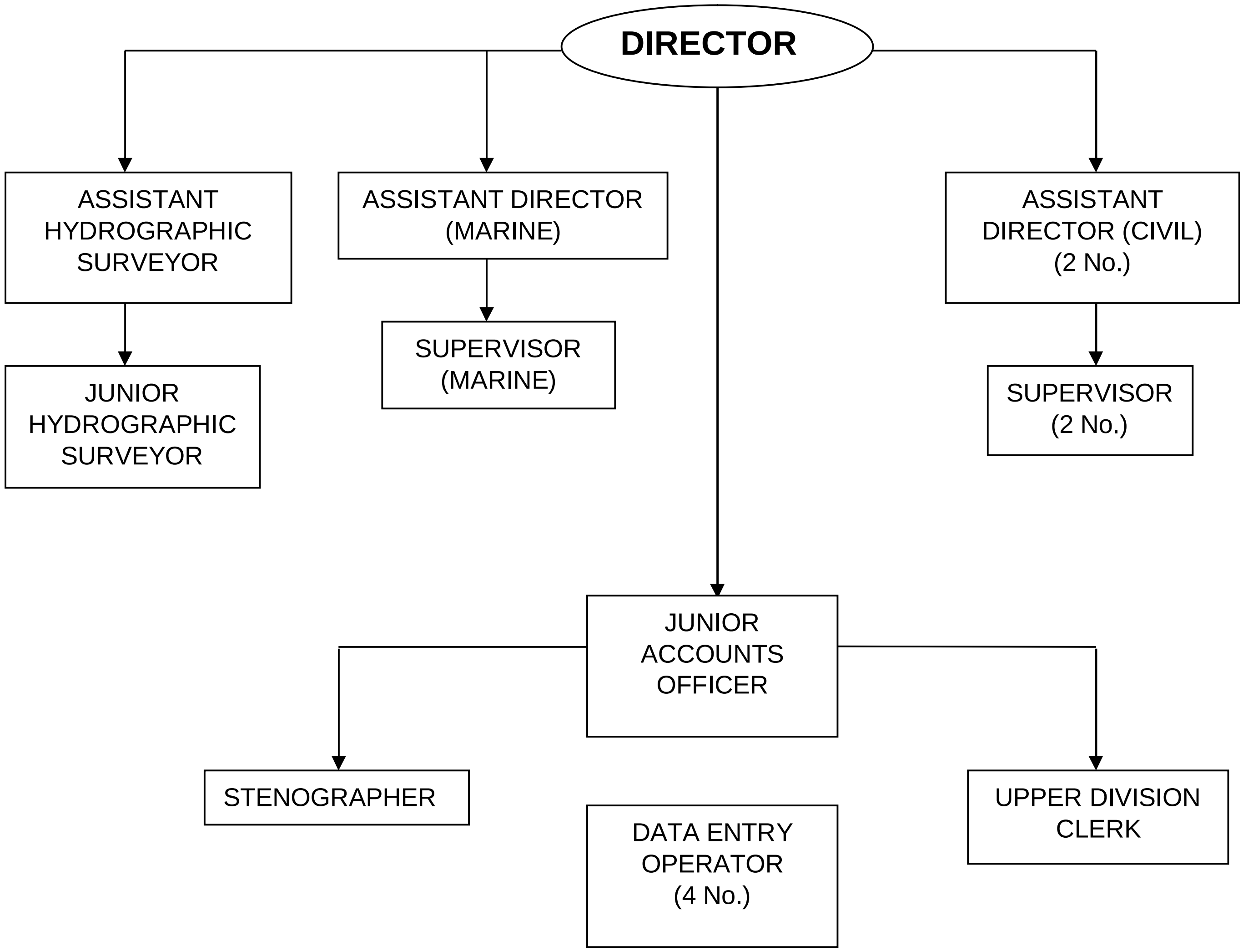
21/12/17

Sharath Kumar Pallerla
Director

ANNEXURE 10.1– INSTITUTIONAL REQUIREMENT HEAD OFFICE COMPONENTS



ANNEXURE 10.2– INSTITUTIONAL REQUIREMENT IN MAHARASTRA AND GOA



ANNEXURE 11.1 – COSTING/FINANCIAL ASSUMPTIONS

FINANCIAL ANALYSIS

Broad Assumptions

Based on Financial Analysis as per DPR of NW5

Abstract

Broadly identified assumptions in order to facilitate financial analysis of Category II shortlisted waterways development

Inland Waterways Authority of India

FINANCIAL ANALYSIS BROAD ASSUMPTIONS[1]:

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	2,60,000	300	780.00
2	Dredging in Hard Soil	Cum	30,000	900	270.00
	Total Cost of Dredging				**1050.00**

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 SAVITRI RIVER

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	17400	3231.30	562.25	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	11380	354.44	40.34	DSR 2016, Cl.no. 22.20, 15% reduction in rate due to market rate status
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	500	2700.00	13.50	Market Rate
	Cost of Bank Protection Works for 500 m				616.08	
	Cost of Bank Protection Works for 1 m				1.23	
	Cost of Bank Protection Works for 4000 m for 8 locations				**4928.65**	

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 and 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	8,65,000	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 of Night Navigation Works		**20**		**393.09**

(Phase 2: Buoy and 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.	110	336,250	369.88
	Cost of of Night Navigation Works				**369.88**

Rates based on Quotation / Market Rates

ANNEXURE 11.5 –COST OF LAND FOR RO-RO

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	25682.00	1120.00	287.64
(ii)	Land required for Road Extension or construction of external approach road	m2	301.00	1120.00	3.37
(iii)	Area under Mangrooves clearance	m2	12841.00	1120.00	143.82
(iv)	Boundary wall 250 mm thk brick masonary (1:6)	m2	907.00	1120.00	10.16
2	Filling & compaction Cost (2.5 m)	m3	64205.00	168.00	107.86
	Total Cost of Land				**552.85**

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 SAVITRI RIVER(BANKOT CREEK) RO-RO FACILITY

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1.0	**RCC Concrete Works (M40 grade concrete)**					
	CONCRETE - Reinforced Cement Concrete of specified Grade M40 in different structural members above pile cut-off level.					
1.1	Providing and laying Vertical M40 Grade Concrete Piles of 1.3 m diameter					
	Vertical Piles					
	Grid A	No	8			
	Grid B	No	8			
	Grid C	No	8			
	Total Piles	cu.m	382			
1.2	Pile Caps (1800x1800x1000)	cu.m	77.76			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	105.00			
	Grid A1	cu.m	105.00			
	Grid B	cu.m	105.00			
	Grid B1	cu.m	105.00			
	Grid C	cu.m	105.00			
1.4	Cross Beams (18000x1500)					
	grid 1 to 8	cu.m	268.56			
1.5	Deck Slab	Cu.m	488.04			
	Total Concrete	**Cu.m**	**1741.63**	**7985.88**	**138.44**	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	Vertical Piles 1.3 m dia	MT	57.34			
2.2	Pile Caps (1800x1800x1000)	MT	6.22			
2.3	Longitudinal Beams (1000x1250)					

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
	Grid A	MT	18.90			
	Grid A1	MT	18.90			
	Grid B	MT	18.90			
	Grid B1	MT	18.90			
	Grid C	MT	18.90			
2.4	Cross Beams (18000x1500)					
	grid 1 to 8	MT	48.34			
2.5	Deck Slab	MT	58.56			
	Total Reinforcement	**MT**	**265**	**63261.82**	**186.41**	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	81120	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	As per Market rate
5.0	**Fenders**					
	Supply and fix in position fender system in the rear side of jetty structure from an approved manufacturer meeting the berthing energy absorption and reaction forces requirements given in technical specification and drawings for the following type of fenders. The rate include design, supply, installation, testing and commissioning of fenders and necessary fixtures such as chains, U bolts, fasteners etc., complete.	LS			30.00	
	Total cost of Riverrine Structures at RORO Terminal				**439.82**	

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 Nobility Area (Nominal)	1	100 m x 100 m	10000	5,934	593.38
2	Covered Storage Godown (Nominal) **	1	50m x 30m	1500	17,801	267.02
3	Ro-Ro Truck Parking	20	16m x 3m	960	1,333	12.79
4	40' Container Stack Yard	20	40 Sq. m	800	8,901	71.21
5	Main Parking Area	1	30m x 30m	900	1,010	9.09
6	Public Utility	1	6m x 4m	24	29441.54	7.07
7	Weigh bridge	1	8m x 3m	24	250000	60.00
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9	29441.54	2.65
9	Area under internal Roads	1	7.5m x 150m	1125	15000	22.50
10	Administration building	1	12 m x 15 m	180	37860.29	68.15
11	Business Area	1	10m x 3m	30	37860.29	11.36
12	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1332.65	1.08
13	Staff Parking Area-2 wheelers	1	8m x 2m	16	1446.50	0.23
14	Security shed for watch and ward	2	4m x 4m	32	4029	1.29
15	Electrical facility	1	5m x 5m	25	14087	3.52
16	Fuel Bunkers	1	10m x 5m	50	5555.56	2.78
17	Water Supply Room	1	3m x 4m	12	14,170	1.70
18	Fire and Safety Room	1	3m x 4m	12	18337	2.20
19	DGPS receiver & transmitter shed	1	8m x 4m	32	6824.75	2.18
20	DG shed	1	5m x 5m	25	6643.5	1.66
21	Canteen with Store	1	12m x 8m	96	13629.69	13.08
22	Sewerage Treatment Plant (STP)	1	15m x 15m	225	12437	27.98
23	Overhead Tank	1	10m dia	100	1923.08	1.92
24	Green Area	1		1000	800	8.00
25	Future Requirement	1		2000	600	12.00
	Total cost of Other Components					**1,204.84**

* Rates worked out based on the DSR rates duly considering related items.

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

** The requirement is to be critically examined, in detail at implementation stage and provisioned accordingly.

ANNEXURE 11.8 – COST OF APPROACH (EXTERNAL) ROADS

S.No.	Item Description	Unit	Estimated Quantity	Rate * (in Rs.)	Amount (in Lakh Rs.)
1	External Roads				
(i)	Pacca Road (7.5m wide road)	m	43.00	15000	6.45
2	Pipe Culvert on External Road			LS	3.50
	Total Cost of Approach Roads				**9.95**

* 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	7203	3231.30	232.73	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	4623	359.96	16.64	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	215	2700.00	5.81	Market Rate
	Cost of Bank Protection Works for 500 m				**255.18**	

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

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

BANKOT CREEK / SAVITRI RIVER

Sl.No.	Items	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
		Phase 1 (12 Months on immediate Pilot Basis)																																			
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils																																				
	Ordinary Soils																																				
	1.b) Dredging																																				
	Hard Soils																																				
	Hard Soils																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (NIL)																																				
	4. Night Navigation																																				
	Beacon/ Lights (Approval & Tendering)																																				
	Beacon / Lights (20 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)																																			
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils (Approvals & Tendering)																																				
	Ordinary Soils (Execution of 2,60,000 Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils (Approvals & Tendering)																																				
	Hard Soils (Execution of 30,000 Cu. M)																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Approval & Tendering)																																				
	River Training Works/ Bank Protection (4000 m @ identified Locations)																																				
	4. Night Navigation																																				
	Buoy/ Lights (Approval & Tendering)																																				
	Buoy / Lights (110 Nos)																																				

*Phase 2 implementation will be from 2026 to 2029 (36 months) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for implementation. Phase 2 A, an alternative without Dredging & Shifting of Terminal nearer to Ch. 40 Km has been worked out in Financial Analysis.

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE RO-RO

BANKOT CREEK / SAVITRI 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																																				
	Cranes with 125 T Capacity																																				
	Fork lift trucks 20 T Capacity																																				
	Environmental Management Plan																																				
	Vessels																																				
B	**Ro - Ro 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 - Nil.																																				
	Cranes with 125 T Capacity - Nil.																																				
	Fork lift trucks 20 T Capacity - Nil.																																				
	Environmental Management Plan																																				
	Vessels																																				

*Phase 2 implementation will be from 2026 to 2029 (36 months) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for implementation. Phase 2 A, an alternative without Dredging & Shifting of Terminal nearer to Ch. 40 Km has been worked out in Financial Analysis.

LIST OF DRAWINGS

Sl.No	DRAWING NAME	DRAWING NUMBER
1.	LAYOUT PLAN OF SAVITRI RIVER (BANKOT CREEK) (7 SHEETS)	P.010257-W-20301-A06
2.	TERMINAL LOCATION MAP OF SAVITRI RIVER (BANKOT CREEK) (1 SHEET)	P.010257-W-20351-X06
3.	TERMINAL LAYOUT PLAN (WITH PROPOSED INFRASTRUCTURE FACILITY (1 SHEET)	P.010257-W-20311-A06
4.	RO-RO TERMINAL PLAN (2 SHEETS)	P.010257-W-20341-E06
5.	BANK PROTECTION TYPICAL SECTION (1 SHEET)	P.010257-W-20303-X06

LIST OF VOLUMES

VOLUME-I MAIN REPORT

VOLUME-II DRAWINGS

VOLUME-IIIA HYDROGRAPHIC SURVEY REPORT

VOLUME-IIIB HYDROGRAPHIC SURVEY CHARTS

VOLUME-IV GEO-TECHNICAL INVESTIGATION REPORT