TRACTEBEL

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CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DPR OF CLUSTER VII OF PROPOSED 53 NATIONAL WATERWAYS

FEASIBILITY REPORT-CHAPORA RIVER (33KM) - (NW-25)
Project No. P.009051
Document No. P.009051-W-10204-D01
Final Report

Goa and Maharashtra | INDIA

Inland Waterways Authority of India (IWAI) - Government of India Ministry of Shipping - Head Office

23 September 2016

Report

Rev.02

RESTRICTED

CATEGORY-II WATERWAYS: STAGE-I REPORTS
SALIENT FEATURES AT A GLANCE

<table>
<tr><th>Sl.No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>Tractebel Engineering Pvt. Ltd.</td></tr>
<tr><td>2.</td><td>Cluster Number & State(s)</td><td>Cluster-VII & Goa</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW#</td><td>Chapora River (33km), NW-25</td></tr>
<tr><td>4.</td><td><u>Navigability status</u></td><td></td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions (from…….to, length, average tidal variation)</td><td>Tidal (Chainage 0.0 km to Chainage 28.70 km, average tidal variation of 1.15 m), Non Tidal (Chainage 28.70 km to Ch 33.00 km, average water depth 0.5 m)
Tidal variation is 2.30m /0.00m</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t.CD)
i) Survey period (25 & 26 Feb., 2016)
ii) < 1.0 m (km)
iii) 1.0 m to 1.5 m (km)
iv) 1.5 m to 2.0 (km)
v) >2.0 m (km)</td><td>
<table>
<tr><th>0-4</th><th>4-10</th><th>10-17</th><th>17-23</th><th>23-28.7</th><th>Total</th></tr>
<tr><td>0.35</td><td>1.00</td><td>-</td><td>0.15</td><td>1.20</td><td>2.70</td></tr>
<tr><td>-</td><td>1.00</td><td>0.39</td><td>0.31</td><td>1.20</td><td>2.90</td></tr>
<tr><td>0.17</td><td>0.50</td><td>0.39</td><td>0.46</td><td>0.60</td><td>2.12</td></tr>
<tr><td>3.48</td><td>3.50</td><td>6.22</td><td>5.08</td><td>2.70</td><td>20.98</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross Structures
i) Dams, weirs, barrage etc. (total number; with navigation locks or not)
ii) Bridges, Power cables etc. (total number; range of horizontal and vertical clearances)</td><td>Cross Structures
i) 1 no. barrage (no navigation lock)
ii) 5 no. of Bridges, HC: 20 m to 50 m , VC: 6.5 m to 8.5 m
2 no. HT line, VC : 13.0 m to 20.0 m
(VC are above MHWS / HFL)</td></tr>
<tr><td>d)</td><td>Avg. discharge & no. of days</td><td>Since the entire stretch (upto Ch 28.7km) is tidal, discharge of the river is not relevant for navigability.</td></tr>
<tr><td>e)</td><td>Slope (1 in……)</td><td>1 in 4715</td></tr>
<tr><td>5.</td><td><u>Traffic Potential</u></td><td></td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td>Ferry Services between Camurlim- Pernem are operational.</td></tr>
<tr><td>b)</td><td>Important industries within 50 km</td><td>Vironik Micronutrients, Crompton Greaves Ltd & Pai Kane Group within the hinterland. (For details Refer Annexure 4.1)</td></tr>
<tr><td>c)</td><td>Distance of Rail & Road from Industry</td><td>Chapora River in the study stretch is well connected with Mumbai Goa National Highway at middle of study stretch 13.80 km. Nearest railway station is 6.1 km from Bardez i.e. at Tivim which is about 46 km from Madgaon Railway station and has direct rail connection with several major cities in India</td></tr>
<tr><td>6.</td><td>Consultant’s recommendation for going ahead with Stage-II (DPR preparation)</td><td>Recommended for development as Class-III waterway for Ch 0.00 km to 16.49km and further Class-II upto for Ch 28.70km.</td></tr>
<tr><td>7.</td><td>Any other information/comment</td><td>A barrage exist at Ch 28.7km, therefore waterway can be confined upto this location.</td></tr>
</table>

Date: 23-09-2016

Consultant signature

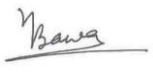
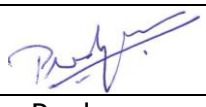
CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT OF PROPOSED 53 NATIONAL WATERWAYS

CHAPORA RIVER

(NW-25)

CLUSTER - VII

GOA AND MAHARASHTRA, INDIA

					
02	23.09.2016	For Acceptance	N Bawa	Pradyumna Machhkhand	B. C. Jha
Rev.	Date	Description	Prepared By	Checked By	Approved By

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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
DFPCL	Deepak Fertilizers & Petrochemical Corporation
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 Transportation
KP	Km Points
LAD	Least Available Depth
LNG	Liquefied Natural Gas
MHWS	Mean High Water Spring
MIDC	Maharashtra State Industrial Development Corporation
MMB	Maharashtra Maritime Board
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MSEB	Maharashtra State Electricity Board
MSME	Micro, Small & Medium Enterprises
MSPGC	Maharashtra State Power Generation company
MTPA	Metric Tonne Per Annum
NH	National Highway
NTPC	National Thermal Power Corporation
NTPC 1980	National Transport Policy Committee, 1980
NW	National Waterway
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
RGPPL	Ratnagiri Gas and Power Private Limited
SEB	State Electricity Board

SH	State Highway
UP	Uttar Pradesh
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

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Annexure 3.1	Overview Chart for Chapora River Bathymetry
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Annexure 3.3	Digital Data, Chainage vs Water Depth, Bathymetric Survey
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EXECUTIVE SUMMARY

A. Introduction

The available water resource in the globe can be used and utilized in various ways whereas Inland Water Transport (IWT) is one among them. The water bodies can be utilized for IWT also. India has been bestowed with vast water bodies consisting of rivers, canals, backwaters, creeks and lakes and having the potential for development of efficient waterways transport network. However, when compared to the development of IWT in certain countries, the same is to be geared up in our country. IWT mode remains underdeveloped 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 42% in European Union, 8.7% in China and over 8% in USA. This is a great economic opportunity loss to the country.

Based on various earlier studies on IWT, subsequent to the recommendations of National Transportation Policy Committee (NTPC 1980) and in order to give more thrust to the Inland Water Transport mode, duly keeping in view the major benefits of this mode viz., Cheaper operational cost on comparison / Higher fuel efficiency / Eco friendly nature of the mode, the IWT development system is under consideration in our country. The potential through IWT mode can be used as an alternate and supplementary mode of transportation in certain favorable conditions.

India has about 14,500 km of navigable waterways which comprise Rivers, Canals, Backwaters, Creeks, etc., out of which about 5200 km of the river and 4000 km of canals can be used by mechanized crafts. About 55 million tonnes of cargo is being moved annually by Inland Water Transport (IWT). Its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the River Brahmaputra, the River Barak, the Rivers in Goa, and the Backwaters in Kerala, Inland Waters in Mumbai area and the Deltaic regions of the Godavari - Krishna Rivers.

Inland Waterways Authorities of India (IWAI), a statutory body under the Ministry of Shipping, Government of India, intends to explore the navigational potential of newly declared national waterways across the country for year round commercial navigation.

National Waterways Act, 2016 has come into force to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation and for matters connected therewith or incidental thereto. There are now a total of one hundred and eleven national waterways altogether across the country which include five existing national waterway besides 106 newly declared waterways as national waterways through National Waterways Act, 2016. The objective is to promote integrated development of waterways throughout the country so as to have a considerable and

maximum mode shift to IWT, which can reduce the density in rail/road apart from the environmental benefits of IWT mode.

It has been planned to study in two stages comprising feasibility study in stage-I followed by preparation of DPR in stage-II and recommending thereafter the possibility of composite and integrated development of proposed newly declared national waterways to achieve navigation and to develop water transport facilities.

This report presents study detail of stage-I of national waterway of Chapora Rive in the State of Goa. Chapora River has been designated as national waterway-25 with its description in the gazette notification as, Chapora River from Arabian Sea near Chapora Lat 15°36'33.27"N, Long 73°44'0.93"E to Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E.

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Chapora River (NW-25)
2	State/ District through which river passes	Chapora River demarcates the border of Pernem, Bardez and Bicholim talukas in Goa
3	Length of the river / canal	Out of the total 65km length, 33km length of the Chapora River starts from Arabian Sea at Morjim Lat 15°36'33.27"N, Long 73°44'0.93"E to Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E has been declared as new national waterway. The index map of Chapora River showing proposed waterway stretch, topographic features and road networks is shown in **Figure1.1 & Figure 1.2**.
4	Map	The index map of Chapora River showing proposed waterway stretch, topographic features and road networks is shown in **Figure1.2**. The section of the Chapora River under feasibility study for inland waterway showing reconnaissance survey routes is presented in **Drawing No. P. 009051-W-20201-A01 (Sheet – 1 to 4)**.
4	Catchment Area	The total catchment area of Chapora River basin is 530sq. km.

B. Methodology Adopted

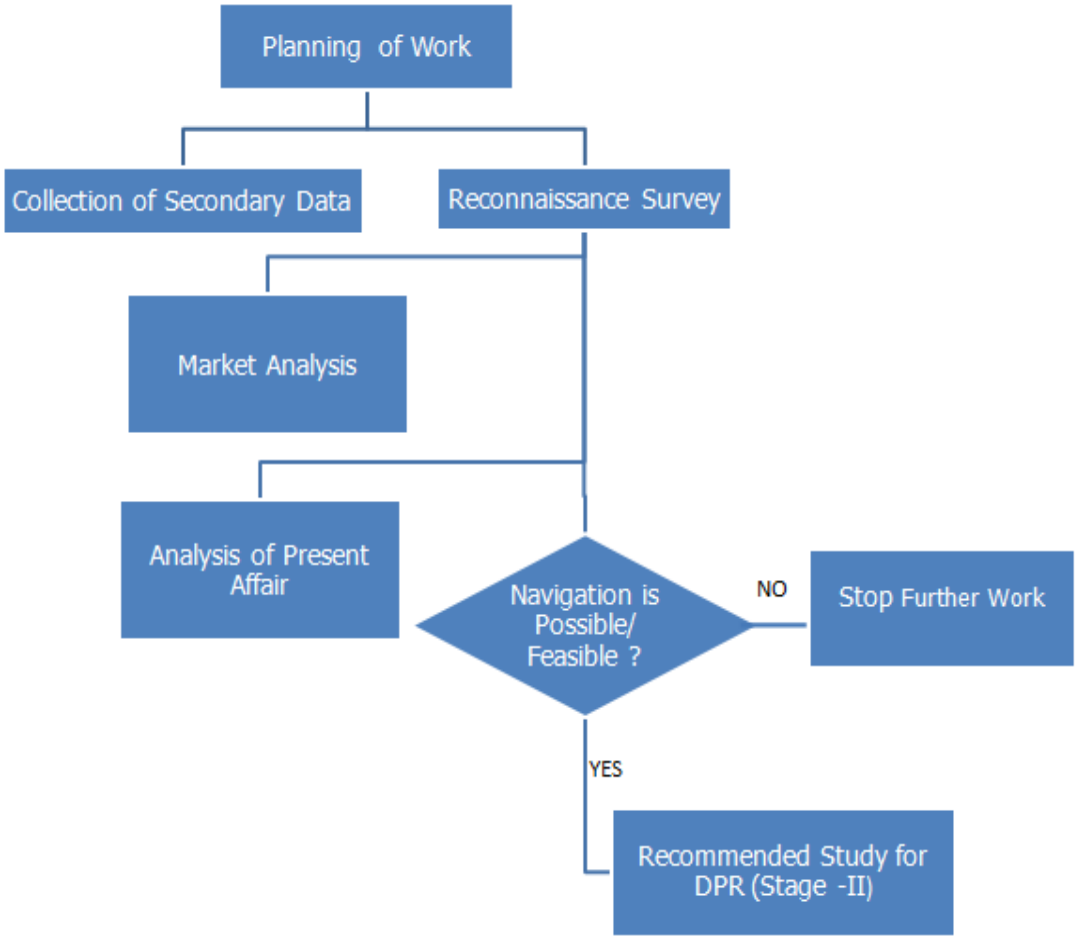
The feasibility of the navigation in the considered waterway has been examined from the following three perspectives:

a) The Physical System: - It includes the study of hydrographic characteristics of the channel/stability of channel/water depth/width of river/ LAD/ terminal/ infrastructure/ cross over structure/ sediment analysis/ physical constraints/ hindrances etc.

b) The Current Functions: - It covers the current utilization of the river – existing navigation/ ferry services/ jetties/ cross over structures/ irrigation facilities/ dam/ barrage/ canals/ fishery/mining etc.

c) The Market Potential: - This aspect covers ferry services, existing cargo movement, existing rail & road network, population served, local produces, industrial establishment, future potential, transfer of cargo movement to inland waterways transport system etc.

Work Execution for stage-I study has been depicted through following diagram.



Execution Diagram of Stage I

C. Collection of Data and Analysis

Reconnaissance survey has been conducted through an expert agency for collection of primary data and various secondary data have also been collected from different sources e.g. benchmark, G & D data & chart datum from IWAI, Govt. of India / MMB, Govt. of Maharashtra / MSME, Govt. of India/ Maharashtra Pollution Control Board, Mumbai/ Cargo Movement Data for the Year 2014 and 2015 provided by IWAI, Govt. of India/

Captain of Ports, Govt. of Goa/ WRD, Govt. of Goa/ WRD, Govt. of Maharashtra/ IOCL, Govt. of India undertaking, respective district authorities of State Govt. of Maharashtra and information available in the public domain through web.

A review of the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways has been done for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps.

D. Observations and Inferences

Following conclusions have been derived for establishing the navigability of the proposed waterway;

1. The river length as given by IWAI is 33km, whereas the total surveyed length along the river to capture the thalweg is 28.70km. The deepest channel route has been reckoned as 28.70km. All inferences derived for identifying the navigable length have been derived with reference to the deepest channel length (28.70km).
2. The river is tidal affected for a majority of length under study and relevant chart datum has been used. 73% of the surveyed length (starting from 0.00km - confluence of river with sea near Chapora) has water depth more than 2.0m, however not continuous. The average tidal variation is 1.15m with maximum high tide of 2.3m and low tide of 0.00m as per the records available for this region. The average tide height of 1.15m would be an added advantage for the safe navigation.
3. It has been observed that the feasibility study suggests that the river is navigable without any significant obstructions up to the Rail Bridge (at Ch. 16.49km) and it can traverse up to the end of the stretch i.e., up to Ch 28.70 with different class where a Barrage exists. Accordingly, the stretch has been classified as Class III up to Ch 16.49km and the balance stretch as Class II.
4. The lengths of the waterway, with a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart datum have been compiled in the main report. This is given in Table 3.8 of the report and is being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-4	5.8	0.5	3.48	0.17	-	0.35
4-10	9.7	0.1	3.50	0.50	1.00	1.00
10-17	13.1	1.3	6.22	0.39	0.39	-
17-23	14.3	0.7	5.08	0.46	0.31	0.15
23-28.7	8.4	0.1	2.70	0.60	1.20	1.20
Total			**20.98**	**2.12**	**2.90**	**2.70**
28.7-33	Topographic survey due to shallow water depth, 0.2m to 0.8m.					

5. Two H. T. Lines are crossing the study stretch with the vertical clearance of 13.0m and 20.0m MHWS. The minimum vertical clearance required shall be 20.1m corresponding to 220kVA transmission line.
6. The Rail Bridge at Ch 16.49km is to be considered with single lane operation.

The description & classification of the waterway has been presented schematically based on the survey observation and duly keeping in view the river classification criteria in Table 3.17 as reproduced below.

Criteria	Classification																			
Length of waterway from start (km)	1	3	4	6	7	9	10	11	13	14	16	17	19	20	22	23	24	26	27	28.7
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V																	C-II		
Raod Bridge Vert. Clearance	C-III												C-II							
Raod Bridge Hor. Clearance	C-III												C-II							
HT Line Vert. Clearance	All Class										Needs Raising of HT Base									
Bend Radius	C-II																			
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

E. Cargo Feasibility

Iron Ore & other Mineral Mines are located in the vicinity of Chapora River and with the upliftment of ban on mining in Goa, movement of the same via Chapora River offers a potential for development of IWT. The direct connectivity of Chapora River with Chapora Fishing Port also provides a positive outlook for development of Inland & Coastal Shipping. However, the volumes etc. that would be diverted to IWT will be studied in detail at DPR stage.

Two Industrial Estates viz. Tuem & Colvale are located within a distance of 5 km from waterway. The possibility of diverting the cargo of these estates via inland shipping will be studied at DPR stage.

The development of Ferry Services for Passenger/Tourist traffic will be studied at DPR stage.

The mobility of Fish through Inland and Coastal Shipping also offers a potential for growth in cargo traffic along the waterway. Economics of the same will be studied in detail at DPR stage.

F. SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objectives of the study for development of the waterway for year round commercial navigation and identifying the internal & external factors that are favorable and unfavorable in the development of the waterway.

Strength

1. 73% of the surveyed length has water depth more than 2m and is safe for navigation.

2. The above depth of more than 2m is almost available, in the 73% of the study stretch up to the Barrage at Ch 28.69km, however not continuous. Certain patches may be required to be attended with a moderate conservancy activity involving dredging.
3. The entire study stretch is tidal affected (27.69km). The maximum water level fluctuation of 2.3m has been observed and this will strengthen the safe mobility of vessels in the waterway.
4. Approximately 3.1 lacs of population are residing in the region of Pernem, Bardez and Bicholim talukas.
5. The Existing Fish movement will have some influence on IWT, with the river stretch development.
6. A considerable Iron Ore and Mineral cargo are divertible from / to hinterland, on upliftment of mining policy in the region, as per the preliminary study.
7. The nearby Industrial Estates (two nos) may be an additional strength for IWT.
8. Ferry service with Passenger / Tourism potential is in existence.
9. Fish mobility is in existence.

Weakness

1. Presently, there is no IWT movement. However, the traffic estimations present an optimistic picture for IWT.
2. The waterway clearances available at Rail Bridge at Ch 16.49km and Road Bridge at Ch 17.06km are alarming for future IWT development.

Opportunity

1. 73% of the surveyed length has water depth more than 2 m, which can be used advantageously for the mobility of hinterland cargo.
2. The entire stretch is in tidal zone and the tidal effect can be used advantageously.
3. Approximately 3.1 lacs of population is residing in the region of Pernem, Bardez and Bicholim talukas, which will have direct or indirect benefits from the IWT and related projects coming up in the area.
4. A considerable Iron Ore and Mineral cargo are divertible from the hinterland, on upliftment of mining policy in the region, as per the preliminary study.
5. The nearby Industrial Estates (two nos) are an opportunity for better utilization of the stretch to mobilise IWT cargo.
6. The Existing Fish movement will have some influence on IWT, on its development.
7. The existing Ferry service with Passenger / Tourism potential will support IWT, if developed.
8. The present Rail and Road connectivity though may be competing with IWT may also be an opportunity for creating an efficient intermodal hub for IWT.
9. Policies are to be firmed up for development of IWT in this stretch.

Threat

1. The Mumbai – Goa Highway and State Highways SH-2; SH-124 and SH-130 in the study area may create competing modes of transport especially with respect to cargo traffic for the proposed waterway.
2. The present rail network also may pose some threats as an alternative mode of transport.
3. The scattered marginal mangrove trees in certain places may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.

G. Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. Henceforth, the development of the proposed national waterway involves physical interference in the form of dredging, construction of terminals at the identified locations, modification of HT Lines at crossing locations to provide a minimum vertical clearance of 20.1m (with respect to 220 kVA) or the case may be combined with some unforeseen expenses. Moderate dredging effort has been envisaged with an average dredging of 1.0m required in 7.7km of the length of proposed waterway reckoned with reference to ascertained data. The cost of dredging has been considered @ INR 230 per cum. The cost of terminal has been estimated @ INR 20.0 crore each for two terminals. HT line crossing shall need modification which shall require two towers at the bank of requisite height and the stringing over pair of poles crossing the Chapora River. The cost of transmission tower has been estimated to be INR 20.00 lacs each and the stringing cost across the towers shall be INR 4.0 lacs per pair of towers. The total estimated cost for modification to two HT Lines shall be INR 2 x 44.0 lacs = INR 132.0 lacs. The cost of navigational aids for day/night navigation has been considered as INR 350 lacs. 10% of the amount for dredging, terminal construction, tower / bridge modification and night navigational aids has been envisaged as unforeseen. The tentative total cost of development to make the river navigable round the year to achieve safe navigation for the required classification of vessel mobility has been estimated to INR 56.60 crore. (Reproduced below is Table 5.1).

Sl. No.	Name of Waterway	Length of Water way	Dredging Required (w. r. to 2 m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Terminal Proposed	Terminal Cost @ INR 20 Cr each	Cost of Modification of Transmission line	Night Navigation	Total cost incld. 10% unforeseen
		(km)	(km)	INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Chapora River	28.70 / 33.00	7.70	7.10	2.00	40.00	0.88	3.5	56.60

H. Classification of Waterway

The 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 DWT and tug-barge formation in push tug + four barge units of carrying capacity up to 8000 DWT (Ref: IWAI, Gazette Notification dated 26th January 2007).

As per the above Classification of Inland Waterways, the entire waterway of Chapora River (NW 25) of 33.00km length has been classified based on available minimum water depth, bottom width, minimum vertical and horizontal clearances of cross over structures and bend radius in the river. The classification of Chapora River Waterway is described below. (Reproduced below is Table 5.2)

Chainage (km)	Minimum Depth (m)	Bottom Width (m)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)	Bend Radius (m)	Classification of Waterway
0.0 – 16.49	0.1	150.0	8.5 (Bridge) 13.0 (H. T. Line)	30 (Bridge)	350	**Class – III**
16.49 – 28.70	0.1	100.0	6.5 (Bridge)	20 (Bridge)	320	**Class – II**

The study stretch of the waterway is amenable for development as Class III / Class II waterway as explained above. Marginal Dredging may be required. Bridge at Ch 16.49 is to be considered with single lane operation. Further smoothening of bends is essential.

The above stretch of the waterway, hence, can be considered under Class III, which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 500 DWT (approximate size 58m overall length, 9m moulded breadth and 1.5m loaded draft) or one tug and two barges combination of 1000 DWT (approximate size 141m overall length, 9m breadth and 1.5m loaded draft). Further, partial stretch can be considered under Class II, which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 300 DWT (approximate size 45m overall length, 8m moulded breadth and 1.2m loaded draft) or one tug and two barges combination of 600 DWT (approximate size 110m overall length, 8m breadth and 1.2m loaded draft).

I. Recommendation

The national waterway-25 of Chapora River has been identified having potential for development as waterway of Class-III / Class II in the study stretch, as described above. This stretch of the river is, therefore, recommended for stage-II study for preparation of Detailed Project Report (DPR) to establish the viability for implementation as a project.

Accordingly, the national waterway NW-25 of Chapora River is proposed for development as **Class III / Class II** waterway in the stretch of the waterway as depicted below:

River Stretch	0.0 km 16.49km	28.70km
Classification		
	Class- III	**Class-II**
Horizontal clearance (m)	50	40
Vertical clearnce (m)	7	5
Minimum Depth (m)	1.7	1.4
Bottom Width (m)	50	40
Self Propelled Vessel		
Dead Weight Tonnage	500	300
Vessel size (m)	(58 x 9 x 1.5)	45 x 8 x 1.2
Tug + Barge		
Dead Weight Tonnage	1000	600
Vessel size (m)	(141 x 9 x 1.5)	110 x 8 x 1.2

Note:

1. All vertical clearances of cross over structures have been reckoned with MHWS of 2.30m above MSL and details are described in Para 3.3.5.
2. The depths have been reckoned in the tidal stretch with reference to the chart datum of 1.30m (below mean sea level).
3. MHWS –2.30m, HTL—2.30m, LTL—0.00m, Average Tidal Variation—1.15m, Port Name: Marmagao Port

CHAPTER 1: INTRODUCTION

1.1 Introduction to Inland Waterways

The Inland Waterways Authority of India (IWAI) came into existence on 27th October 1986 for development and regulation of inland waterways for shipping and navigation. Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. The Authority primarily undertakes projects for development and maintenance of IWT infrastructure on national waterways through grant received from the Ministry of Shipping, Government of India. The head office of the Authority is at Noida, UP. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration. The Authority also has its regional offices at Patna, Kolkata, Guwahati and Kochi and sub-offices at Allahabad, Varanasi, Bhagalpur, Farakka, Swaroopganj, Hemnagar, Dibrugarh (Assam), Dhubri, Kollam, Vijayawada (Andhra Pradesh) and Bhubaneshwar (Odisha).

India has about 14,500 km 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. About 55 million tonnes of cargo is being moved annually by Inland Water Transport (IWT), a fuel - efficient and environment - friendly mode. Freight transportation by waterways is highly underutilized in India compared to other large countries and geographic areas like the United States, China and the European Union. Its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the River Brahmaputra, the River Barak, the Rivers in Goa, and the Backwaters in Kerala, Inland Waters in Mumbai area and the Deltaic regions of the Godavari - Krishna Rivers.

Besides these organized operations by mechanized vessels, country boats of various capacities also operate in various rivers and canals and substantial quantum of cargo and passengers are transported in this unorganized sector as well. The total cargo moved (in tonne kilometers) by the inland waterway was just 0.1% of the total inland traffic in India. There are now one hundred and eleven national waterways across the country which includes five existing national waterways besides 106 waterways which have been declared recently as national waterways through a central legislation.

1) National Waterway 1

The Ganga - Bhagirathi - Hooghly river system between Haldia (Sagar) & Allahabad.

Estd.	= October 1986.
Length	= 1620 km
Fixed terminals	= G R Jetty 2, Kolkatta, Pakur, Farakka, Gaighat (Patna) & Allahabad.
Floating terminals	= Kolkatta, Diamond Harbour, Katwa, Bahrampur, Jangipur, Bhagalpur, Semaria, Doriganj, Ballia, Ghazipur, Varanasi, Chunar, Allahabad.
Cargo Movement	= 3 million tonnes Approx.

2) National Waterway 2

Sadiya — Dhubri stretch of Brahmaputra river.

Estd = September 1988.
Length = 891 km
Fixed terminals = Pandu
Floating terminals = Dhubri, Jogighopa, Tezpur, Silghat, Jamgurhi, Bogibil, Dibrugarh, Saikhowa and Sadiya
Cargo Movement = 2.0 million tonnes Approx.

3) National Waterway 3

Kottapuram-Kollam stretch of the West Coast Canal, Champakara Canal and Udyogmandal Canal.

Estd = February 1993
Length = 205 km
Fixed terminals = Kottapuram, Aluva, Bolgatty, Willingdon Island, Maradu (Kochi), Cherthala (Vaikom), Thannermukkom, Alappuzha, Thrikkunnapuzha, Kayamkulam (Ayiramthengu), Chavara and Kollam.

Cargo Movement = 1.0 million tonnes Approx.\

4) National Waterway 4

Kakinada–Pondicherry stretch of canals and the Kaluvelly Tank, Bhadrachalam – Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna.

Estd = November 2008
Length = 1095 km

Tentative Cargo Potential = 2.0 million tonnes Approx which can go up to 4.0 million tonnes in next 15 years or so.

5) National Waterway 5

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.

Established = November 2008
Length = 623 km

Tentative Cargo Potential = Coal from Talcher to Dhamra and Paradip ports is the most important potential cargo for this waterway. Immediately after the development of the waterway, it is estimated in the DPR that

about 11.0 million tonnes of cargo can be transported per year which can go up to 23.0 million tonnes in next 15 years or so.

6) 106 Newly Declared National Waterways

For newly declared national waterways, IWAI is carrying out feasibility studies /DPR preparation through a number of consultants.

1.2 Project Background of the Present Study

IWAI, Ministry of Shipping, 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 study in two stages comprising feasibility study followed by preparation of DPR and recommending thereafter the possibility of composite and integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India.

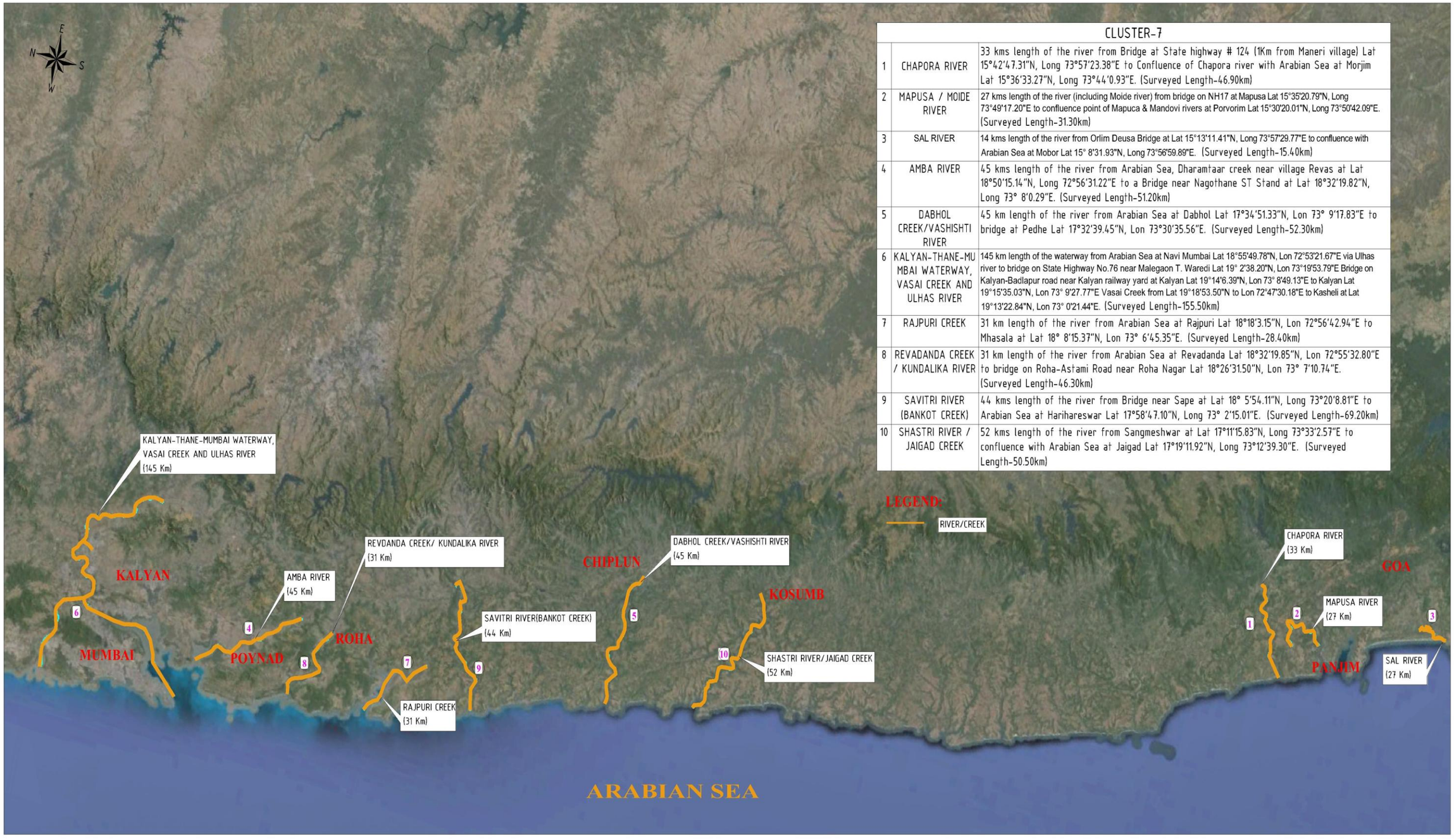
106 more waterways across the country have been declared as new national waterways through a bill passed in the Parliament in March 2016 with contention that the measure is aimed at providing a cheaper mode of transport and reducing traffic burden on the roads. These 106 new national waterways will be in addition to the five existing national waterways. The proposed legislation is aimed at integrated development of inland waterways throughout the country since the water transport is "lagging behind" road and rail sectors. Promotion of waterways is a priority as it is a cheaper mode of transportation, being economical compared to roads and railways, and at the same time it is environment friendly too.

Feasibility study shall examine the viability of navigational routes and therefore potential to develop waterway transport facility is to be established. This shall be followed by preparation of Detailed Project Report (DPR) for those feasible waterways, which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc. Tractebel Engineering had been awarded two of the clusters i.e. Cluster-VI & Cluster-VII consisting of the rivers/canals/creeks for two stage studies, screen the rivers with respect to navigational feasibility and subsequently prepare a Detailed Project Report for the development of Inland Waterways. This report deals with the study of Chapora River which is one of the waterways of Cluster-VII which consists of rivers/creeks of Maharashtra and Goa (length-467 km) and described in **Table 1.1** as shown below:-

Table 1.1: List of Rivers/Creeks of Maharashtra and Goa under Cluster-VII (length-467.0 km)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length (km)	State
1.	**Chapora River**	**NW-25**	**33**	**Goa**
2.	Mapusa / Moide River	NW-71	27	Goa
3.	Sal River	NW-88	14	Goa
4.	Amba River	NW-10	45	Maharashtra
5.	Dabhol Creek/ Vashishti River	NW-28	45	Maharashtra
6.	Kalyan-Thane-Mumbai waterway, Vasai creek and Ulhas River	NW-53	145	Maharashtra
7.	Rajpuri Creek	NW-83	31	Maharashtra
8.	Revadanda creek / Kundalika River	NW-85	31	Maharashtra
9.	Savitri River (Bankot creek)	NW-89	44	Maharashtra
10.	Shastri River/ Jaigad creek	NW-91	52	Maharashtra
	Total		**467**	

The layout plan of all the ten rivers/creeks covered in Cluster-VII, showing the location and Index Map of Chapora River are shown in **Figure 1.1 & Figure 1.2** respectively.



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. (Surveyed Length-46.90km)
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. (Surveyed Length-31.30km)
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. (Surveyed Length-15.40km)
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. (Surveyed Length-51.20km)
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. (Surveyed Length-52.30km)
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. (Surveyed Length-155.50km)
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. (Surveyed Length-28.40km)
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. (Surveyed Length-46.30km)
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. (Surveyed Length-69.20km)
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. (Surveyed Length-50.50km)

Figure 1.1: Location Map of the Proposed Waterway of Cluster-VII in Goa and Maharashtra

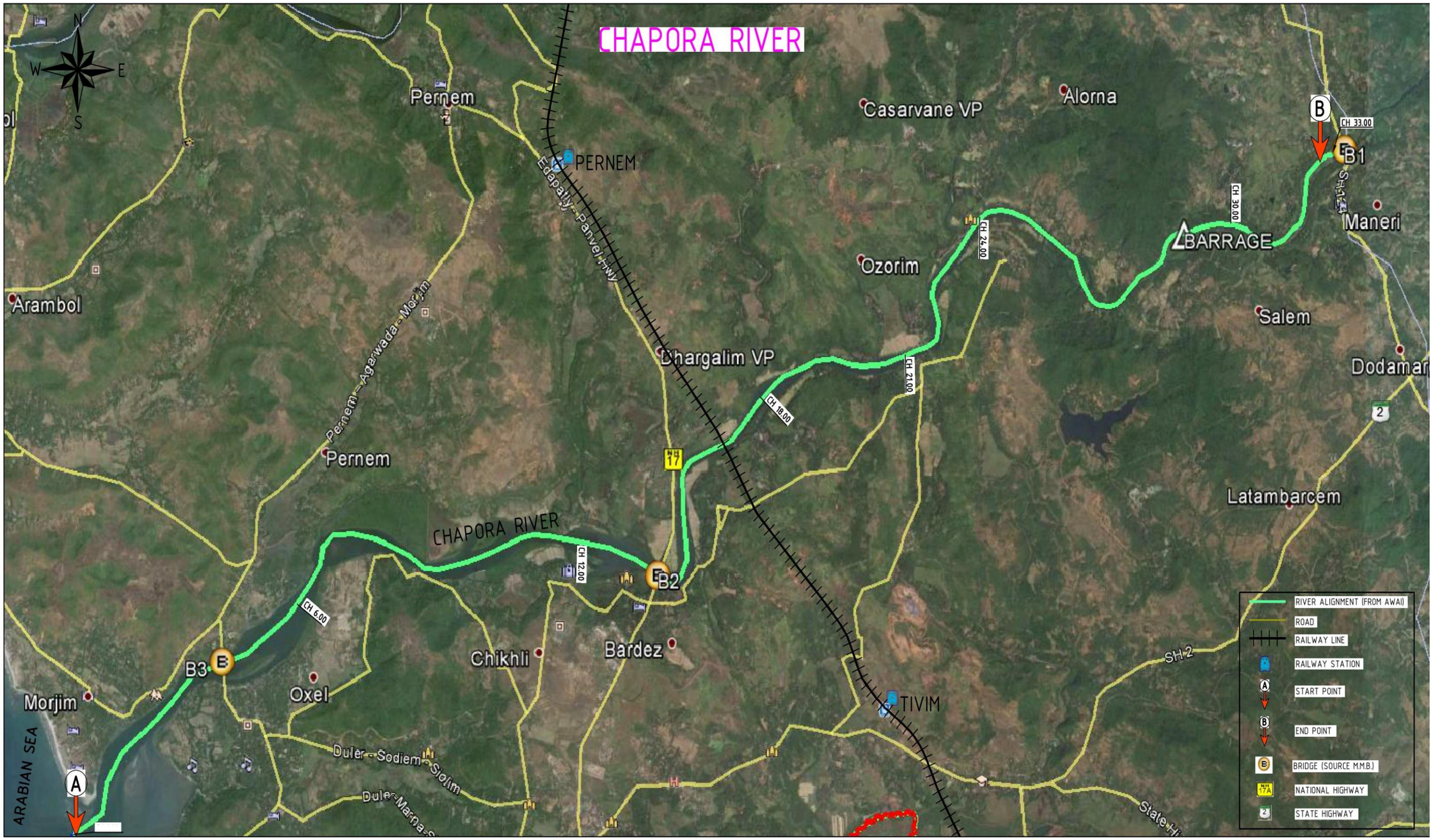


Figure 1.2: Index Map of Chapora River

1.3 Objectives of the Study

IWAI, Ministry of Shipping, Government of India intends to explore the potential of additional waterways across the country for commercial navigation.

The objectives of the study shall necessarily include:

1. To Explore the Potential of Year Round Commercial Navigation on the Proposed National Waterways by conducting Feasibility Studies.
2. Recommending thereafter the possibility of Composite and Integrated development of proposed waterways under cluster – VII consisting of Creeks/ Rivers to achieve navigation and to develop water transport facilities on these waterways.

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, viability etc.

1.4 Scope of the Assignment

The complete scope of the assignment shall include the study in 2 stages:

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.
2. **Stage-II** would consist of the detailed hydrographic survey, topographic survey, detailed traffic survey including the divertible traffic, selection of terminal locations and preparation of detailed project report including the returns /viability analysis for implementation as a project.

This report covers the activities of Stage-I only for feasibility of the **Chapora River** for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-I consists of the following activities:

A. Reconnaissance Survey
B. Collection and review of available data

C. Feasibility Report

1.5 Methodology Adopted

The Stage I Feasibility Study of the Inland Waterway stretches is based on three approaches:

1. The Physical System
2. The Current Functions and
3. The Market Potential

1.5.1 Physical System

The potential for inland navigation strongly depends on the physical environment. Success of navigation will depend on:

- The stability of the channel: frequent variations of channel positions requires river conservancy measures;
- The regime: in most cases good navigation conditions are required most of the time for fluvial navigation to develop as a competitive transport mode, if such conditions are not met, other – more reliable - modes of transportation will be used, making it difficult to get a return on the investments required for navigation (ships, maintenance, port infrastructure):
    - The regime which defines the variability of water depth, draught and water level (position of port infrastructure, vertical clearance at bridges).
    - Sediment supply: certain stretches are characterized by high sediment supply; developing such sections would require high maintenance efforts to keep the channels at depth; it must be economically and technically feasible to maintain a balance between dredging and sediment supply; therefore, the decision to construct barrages to increase the water depth, must be taken with care, as these may act as sediment traps.
- Hydrographic characteristics of the channel: depth and width of the channel. The fairway design shall conform to channel geometry. The discharge should guarantee sufficient water depth alternatively, weirs, canals could be constructed to allow required water depth for safe navigation.

From a quick scan of satellite images it becomes clear that the morphological and hydrological conditions of the different rivers vary strongly, even within the same river. Satellite images provide a complete, accessible and qualitative data source for a first appraisal of potential.

Morphological features can be easily derived from satellite images. The morphological analysis of satellite images, therefore, has been used as a basis for a first, but reliable appraisal of the physical potential of the river (for navigation). Such analysis is, therefore, proposed as one of the methods in stage I.

It should be pointed out, however, that the period in which the satellite images have been taken may strongly affect the appearance: otherwise dry sections may well be flooded in monsoon season. A careful evaluation shall be contemplated. Also, information obtained from water managers such as CWC, and local authorities will be useful complement to evaluate navigability.

1.5.2 Current Functions

Current functions of the river have also been taken into consideration:

- Navigation, present in certain areas – it's relevant to know why, how it's organized:
    - Transportation of people (including the tourism potential) and goods
- Structures aligned to rivers

- Crossing infrastructure
  - Bridges: vertical clearance, may even be absent for navigation.
  - Weirs, barrages: water supply, regulation, hydropower.
  - Ferry terminals: variations in water levels and terminal infrastructure.
- Fishery
- Mining, occurring along certain rivers, and depending on (the often) shallow channels for processing
- Irrigation/ water supply, the available water may be shared between different functions, barrages exist to tap water for supply – as Indian agriculture is important for the GDP and the employment of most of the population, equilibrium must be found between available water resources and additional uses such as use for navigation.

1.5.3 Market Potential

Historically, economic demand is a driving force behind waterway development. In several cases waterways were constructed and developed for specific industries. Also navigation was developed using existing irrigation or water supply canals. Further, the accessibility also was another driving force, when alternative mode development was difficult/ uneconomical.

In an emerging economy, such as India, the presence of waterways probably will also stimulate further economic development. While rail and road networks connect cities and industrial areas independently of the hydrographic network, now it must be analyzed where the hydrographic network can establish alternative and new links between cities. In navigable portions such links would be logical.

Environmental concerns viz. the emissions, consequences on air pollution and climate change, and social and economic pressure of congestion, led to a boost of inland navigation projects in all around the world. Such development can also be expected in India, as the development of waterways may be economically and socially more beneficial than the construction of the road and rail networks, not necessarily as a substitute, but to be developed in parallel, in a multi-modal transportation system.

The current scope for Stage I is executed as per following framework shown in **Figure 1.3**.

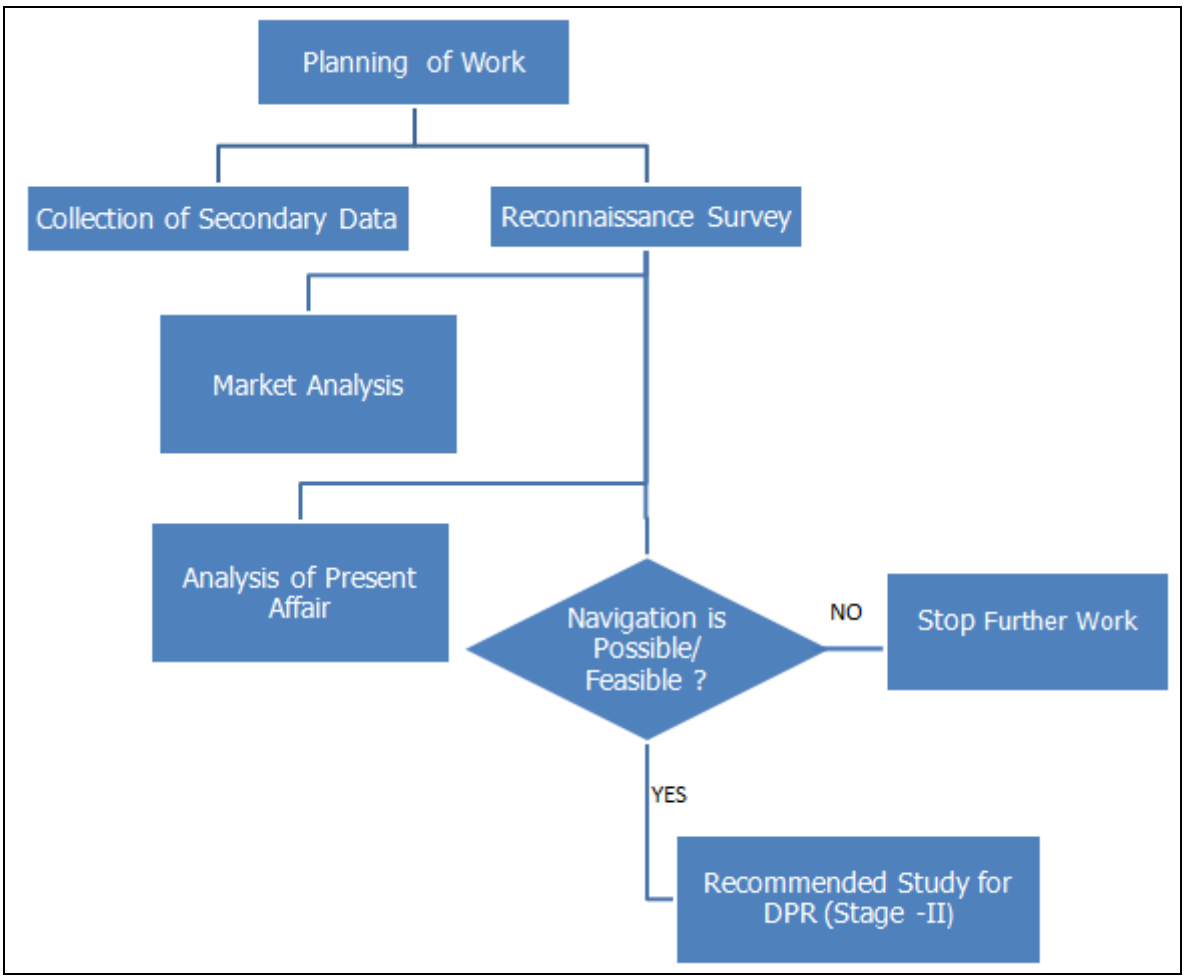


Figure 1.3: Execution Framework for Stage I

1.6 Collection of Data

For evaluating the feasibility of the waterway in Chapora River for year round navigation, the reconnaissance survey for collecting the Primary data has been taken up. Secondary data have also been collected from various sources. IWAI issued a letter in the name of M/s Tractebel, to all the concerned stakeholders for data collection from State/ Central Government.

(A) **Primary Data:** M/s Tractebel Engineering Pvt. Ltd. has appointed a separate survey agency M/s Fugro Survey (India) Pvt. Ltd. (FSINPVT) for carrying out the reconnaissance survey for collection of following primary data:

(i) Single line longitudinal survey (Bathymetric survey or Topographic survey);

(ii) Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route etc;)

(iii) Details of locations of permanent structures viz. Bridges, Barrages, Dams, Locks, Jetties, Ports etc;

(iv) Photographs of important structures along the route;
(v) Topographical features of the proposed Inland Waterways;
(vi) Typical physical features along the alignment i.e. land use pattern;
(vii) Preliminary identification of stretches having year round flow;
(viii) Critical depth for navigational purpose;
(ix) Preliminary traffic identification on the proposed Inland Waterways;
(x) Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways;
(xi) Urban areas (location & extent);
(xii) Geologically sensitive areas and environmental features;
(xiii) Critical areas requiring detailed investigations;
(xiv) Soil (textural classifications) (only visual inspection at every 10km);
(xv) Drainage conditions;
(xvi) Existing utility services along the alignment;
(xvii) Present Status of navigation on different sub stretches of the waterway;

All the data derived from the above reconnaissance surveys shall be utilized for planning and programming the detailed surveys and investigations. All reconnaissance field studies including the traffic surveys have been taken up and the classification of proposed waterway has been carried out as per IWAI guidelines on this matter. The list of data collected and sources of data are being enclosed as **Annexure 1.1**.

(B) **Secondary Data:** The following secondary data has been collected from the concerned authorities as well as from sources available in public domain.

(i) Benchmark Data from IWAI, Noida;
(ii) Chart Datum data and other related data from Captain of Ports, Goa;
(iii) Mormugao Port Trust, Goa;
(iv) District Industries Authorities, Goa;
(v) Fisheries Department, Government of Goa, Goa;
(vi) Goa Tourism, Goa;
(vii) Directorate of Mines & Geology, Government of Goa, Goa;
(viii) WRD, Govt. of Goa

All the data derived from the above reconnaissance surveys details shall be utilized for determining the navigability of the proposed national waterway. A review of the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways has been done for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Feasibility Report is to be prepared for the proposed national waterway based on the available data, reconnaissance survey and the market analysis. The structure of the report has been elaborated in succeeding section 1.9 of this chapter.

1.7 Expected Outcome of the Assignment

Combining knowledge on the physical constraints, actual and future uses of the river and the valley, economic potential and needs, or absence thereof, allows the characterization of the river for development as a waterway. The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. The potential of possible navigation in the stretches of proposed inland waterways has been determined using raw water depths reduced to the chart datum in the area of tide affected rivers. To define the navigability of river/creeks, several gradations can be distinguished:

- No or limited effort: navigable (for a specific draught) without measures;
- Limited to moderate effort: e.g. occasional dredging works at a limited number of location;
- Moderate to high: frequent dredging over a considerable length or large number of locations;
- High to very high: the construction of one or more weirs and or locks, or the construction of a canal;

In accordance with the above criteria, the stretch of the proposed waterway of Chapora River under Cluster VII has been defined in the context of availability of navigable depth (more than 2m). Taking into account for further development in the stretches of less than 2m depth, the solutions for the navigation have been proposed.

Combining economic potential and physical characteristics allows categorizing the river or specific stretches for navigation potential on the basis of following criteria:

(i) Water Availability
(ii) Flow Depth
(iii) Vertical & Horizontal Clearance
(iv) Nautical Continuity
(v) Cargo Availability
(vi) Economic & Social Parameters

The analyses of physical and economic parameters have been the basis of a suggestion for classification of Inland waterways for further study. The waterways shall be classified into categories of Class-I to Class VII as per description derived from the compilation of Inland Waterways Authority of India (Classification of Inland Waterways in India) Regulations, 2006. Referring the data derived from the reconnaissance single beam bathymetry survey, cargo traffic details, market potential, vertical and horizontal clearances with respect to existing cross over structures, the proposed waterway has been classified in to seven categories on the basis of IWAI guidelines for safe plying of self-propelled vessels up to 2000 Dead Weight Tonnage (DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000 DWT. A recommendation of a selection of proposed inland waterway stretch has been done (based on IWAI classification) for further analysis and preparation of DPR in Stage II.

1.8 Description of Chapora River (NW-25)

The Chapora River emerges at Ramghat at Maneri in the Indian state of Maharashtra and enters Goa. The total catchment area of Chapora River basin is 530 Sq. Km. The total length of the river from origin to its outfall in the Arabian Sea is about 65.0km. The Chapora River divides the Northern Goa towns of Pernem and Bardez. The detailed description of the river has been compiled in Table 1.2.

Table 1.2: Description of Chapora River (NW-25)

Sl. No.	Introductory Consideration	Description of the River
1.	Name of the river / canal	Chapora River (NW-25)
2.	State/ District through which river passes	Chapora River demarcates the border of Pernem, Bardez and Bicholim talukas in Goa
3.	Length of the river / canal	Out of the total 65km length, 33km length of the Chapora River starts from Arabian Sea at Morjim Lat 15°36'33.27"N, Long 73°44'0.93"E to Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E has been declared as new national waterway.
4.	Map	The index map of Chapora River showing proposed waterway stretch, topographic features and road networks is shown in **Figure1.2**. The section of the Chapora River under feasibility study for inland waterway showing reconnaissance survey routes is presented in **Drawing No. P. 009051-W-20201-A01 (Sheet – 1 to 4)**.
Characteristic of River		
5.	River Course	Chapora River emerges at Ramghat at Maneri in the Indian state of Maharashtra and enters Goa. The Chapora River follows zigzag course, demarcates the border of Pernem, Bardez and Bicholim talukas for approximately 21 kilometers. It flows westward and joins in to the Arabian Sea near Chapora in the northern most part of Goa. The total catchment area of Chapora River basin is 530 Sq. Km The catchment receives an average annual rainfall of about 3578mm. The total length of the river from origin to its outfall in the Arabian Sea is about 65.0km. Chapora River has a relatively small catchment area and its tributaries are small feeder streams and canals. The Chapora river divides the Northern Goa towns of Pernem and Bardez
6.	Tributaries / Network of Rivers / Basin	No Major tributaries
7.	Catchment Area	The total catchment area of Chapora River basin is 530 Sq. Km.

1.9 Structure of the Feasibility Study Report (FSR)

The Feasibility Study Report for proposed Inland Waterways of **Chapora River** has been prepared and emphasized with stretches of proposed inland waterways having the potential for navigation. Stage-II study for preparation of DPR shall be carried out only for those stretches of proposed inland waterways, which have the potential for navigation.

The Feasibility Study Report starts with a comprehensive report in the form of executive summary giving description of the methods used for the data collection, overview of the collected data followed by a description of the Present State of Affairs, Reconnaissance Survey, findings of Market Potential and observations & inferences thereof.

The executive summary concludes with Waterway Navigation Potential of the proposed waterway on Chapora River followed with recommendations for going ahead with classification of river. The structure of FSR is as below;

I. **Executive Summary:** Executive summary describes the suitability of the proposed waterway in terms of its navigability and market potential. It contains a brief statement of the characteristics of the river, present use of the river, data captured in the reconnaissance survey, hindrances, acceptability of the waterway, enhanced connectivity to the region, capability to decongest the existing mode of transport, important aspects for techno commercial viability etc. The background information, concise analysis and main conclusions form part of the document. It helps to understand the overall scenario and decide the suitability of development of a specific waterway.

II. **Introduction:** This chapter describes the Project background of the present study, objective of the assignment, scope of the assignment, methodology adopted, outcome of the assignment, river characteristics including the structure of the feasibility study report.

III. **Analysis of Present State of Affairs**: It provides the details about the existing town/ city/ taluka/ historical & tourist places, current utilization of proposed waterway, status of goods transport, road and rail transport as well as existing river facilities. The quantitative and qualitative description of the current utilization of proposed inland waterways are provided in the report. In addition, the descriptions about the status of goods transport, including utilization of road and transport services as well as river facilities have been covered.

IV. **Reconnaissance Survey:** The analysis of the data collected in the reconnaissance survey has been carried out to reflect the possibility of year round flow in the proposed Inland Waterways to achieve the commercial navigation. Bathymetry survey details, observed bed profiles and soil texture classification @ 10 km are compiled in this section. Observed waterway bed profile has been plotted with respect to existing Chart Datum in case of tidal affected rivers else the bed profile relates to CWC/ Irrigation water

level data or FSL in case of canal. Maps of proposed Inland Waterways have been generated and referred with at the relevant locations indicating existing cross structures viz. bridges, jetties, established chart datum locations, dams, barrages, HT line, LT line, water pipe line, cables etc.

V. **Market Analysis:** The analysis of the market and potential usage of proposed Inland Waterways have been carried out. In the analysis, both the existing market and the potential future market have been examined. The details of available existing industries along the waterway, type of production in these industries, ferry services, cargo movement, type of crop along the waterway, previous history of movement of cargo in the waterway etc. have been collected and included in the report. All the data have been collected after discussion with local people while conducting reconnaissance survey etc. and also after interaction with State Govt. Officials, Irrigation / Water Resources Departments and other stakeholders. The possible divertible cargo to IWT has been assessed.

VI. **Observations and Inferences**: The observations and Inferences of the feasibility study are presented in context of stretches of proposed inland waterways, which have potential for navigation and for which Stage-II studies may be conducted. Technical Feasibility has been discussed which shall establish the navigability and potential usage of proposed Inland Waterway. The stretches of proposed inland waterways which have potential for navigation have been categorized into Class-I to Class VII as per description derived from classification of rivers/canals by Inland Waterways Authority of India Regulations, 2006. SWOT Analysis of Proposed Waterway has also been described covering the overall aspect of the proposed waterway in terms of its Strength, Weakness, Opportunity and Threat to decide the suitability and the ranking of the waterway.

CHAPTER 2: ANALYSIS OF PRESENT STATE OF AFFAIRS

In order to establish the feasibility of waterways the present state of affairs as existing today along the proposed inland waterway on Chapora River (NW-25) is studied. Out of total 65 km length of the river, 33 km has been proposed by IWAI for feasibility study. This chapter provides details about the current affairs, status of goods transport including utilization of road and rail transport along or near by the waterway.

2.1 Current Utilization

Chapora River drains in the region of Vagator beach and meets Arabian Sea at Chapora. It flows through Goa district and the length of 33 km of proposed waterway traverses through Pernem, Bicholim and Bardez taluka of North Goa.

The total length of the river is about 65 km before joining the sea. The river is under tidal effect of the Arabian Sea (backwater effect) upto Maneri about 33 km from sea. The Chapora River waterway is being utilized for ferry services and fishing purpose. Ferry services are being operated connecting Pernem (Taulka) and Camoulim village. Details of existing structures along and across Chapora River waterway are presented in following sections.

2.1.1 Existing Waterway Structures

There are eight jetties existing in this waterway. Out of eight, two jetties are used for operating ferry service between Camoulim- Pernem **Table 2.1** below provides the details of existing facilities along Chapora River waterway with current utilization status.

Table 2.1: Existing Facilities on Chapora River (NW 25)

Sl. No.	Existing Facility	Coordinates	Chainage (km)	Current Utilization
1.	Chapora Jetty on Southern Bank	15° 36′ 31.57″ N 73° 44′ 19.39″ E	0.36	Used by mechanized trawlers and fishermen in the area.
2.	Wooden Jetty on Northern Bank	15° 37′ 31.63″ N 73° 44′ 36.64″ E	2.19	Fishing and local transport
3.	Wooden Jetty on Northern Bank	15° 37′ 38.75″ N 73° 44′ 48.95″ E	2.58	Fishing and local transport
4.	Slope Jetty on Southern Bank	15° 38′ 43.45″ N 73° 46′ 34.86″ E	6.23	Fishing and local transport
5.	Slope Jetty on Eastern Bank	15° 38′ 47.56″ N 73° 46′ 35.30″ E	6.33	Fishing and local transport
6.	Pernem Ferry Jetty on Northern Bank	15° 39′ 00.85″ N 73° 47′ 43.49″ E	9.07	Ferry Jetty between Camurlim- Pernem
7.	Camurlim Ferry Jetty on Southern Bank	15° 38′ 54.20″ N 73° 47′ 38.95″ E	9.07	

Sl. No.	Existing Facility	Coordinates	Chainage (km)	Current Utilization
8.	Jetty on Southern Bank	15° 41′ 24.91″ N 73° 54′ 47.36″ E	26.70	Fishing and local transport

Figures 2.1 to 2.8 show some of above mentioned facilities.

Figure 2.1: Chapora Jetty on South Bank of River at Chainage 0.36 km

Figure 2.3: Wooden Jetty on the Northern bank of the river at Chainage 2.58 km

Figure 2.2: Ferry Jetty from Pernem to Camoulim on the Northern bank of the river at Chainage 9.07 km

Figure 2.4: Ferry Jetty from Camoulim to Pernem on the Southern bank of the river at Chainage 9.07 km

Figure 2.5: Alorna Fort on the Northern Bank of the River at Chainage 25.40 km

2.1.2 Crossing Over Chapora River (NW-25)

Apart from the existing waterway facilities on the banks of the river as described in 2.1.1, six road bridges and one Railway bridge are crossing the stretch existing. **Table 2.2** shows the inventory of existing structures on Chapora River waterway.

Table 2.2: Inventory of existing structures on Chapora River

Sl. No.	Name of Structure	Chainage (km)	Horizontal Clearance (m)	Vertical Clearance above MHWS/HFL (m)	Coordinates
1.	Shivali Road Bridge	3.90	50	8.5	15°38'02.95"N 73°45'34.39"E
2.	Colvale Road Bridge	13.44	50	8.5	15°41'53.73"N 73°50'10.56"E
3.	Rail Bridge	16.49	30	6.5	15°40'59.51"N 73°50'49.97"E
4.	Revora Foot Bridge	17.06	20	8.5	15°40'11.73"N 73°51'07.52"E
5.	Pirna-Ozeri Road Bridge	21.14	50	8.5	15°40'05.40"N 73°52'59.24"E
6.	LMV Bridge over Bandhara	28.69	-	-	15°38'55.16"N 73°55'42.64"E
7.	Maneri Bridge	32.90	20	10.0	15°42'45.65"N 73°57'24.37"E

2.2 Connectivity of Waterway

Proposed stretch of Chapora River waterway lies in North Goa which is well connected with the state capital, surrounding district headquarters, tehsils and villages through road and rail. **Figure 2.9** shows road and rail connectivity of the area adjacent to Chapora River in the study stretch.

Figure 2.6: View of Rail and Road Network around Chapora River

In **Figure 2.9**, Chapora River is shown in green color whereas yellow and black colors represent the road and rail network respectively around the Chapora River.

2.2.1 Important Places

Chapora River is in the vicinity of various important places of North Goa district. **Table 2.3** shows the distance of Chapora River from nearby important places.

Table 2.3: List of Important Places from Chapora River NW-25 (Length-33.0kms)

Sl. No.	Important Places	Category	Distance from Creek/River (Kms)	Bank
	District-North Goa			
1.	Bicholim	Taluka, City, Municipal Council	12.0	Left Bank
2.	Pernem (Taluka)	Taluka, City, Municipal Council	8.0	Right Bank
3.	Bardez	Taulka	1.0	Left Bank
4.	Maneri	Village	1.0	Left Bank
5.	Dodamarg	Taulka	3.0	Right Bank
6.	Salem	Village	1.0	Left Bank
7.	Alorna	Village	3.0	Right Bank
8.	Ozorim	Village	1.5	Right Bank
9.	Dhargalim VP	Village	2.0	Right Bank
10.	Chikhil	Village	1.5	Left Bank
11.	Oxel	Village	1.5	Left Bank
12.	Sodiem Siolim	Village	2.5	Left Bank
14.	Vagator	Beach	1.2	Left Bank

Sl. No.	Important Places	Category	Distance from Creek/River (Kms)	Bank
15.	Chapora	Village	0.2	Left Bank
16.	Anjuna	Town	2.5	Left bank
17.	Morjim	Town	0.5	Right Bank
18.	Camurlim	Village	1.0	Left Bank

2.2.2 Road Connectivity

Chapora River in the study stretch is well connected with Mumbai Goa National Highway and is surrounded by State Highway SH-2, SH-124 and SH-130 on right bank and left bank respectively. The roads surrounding Chapora River connects to Mumbai Goa National Highway at middle of study stretch 13.80 km.

2.2.3 Rail Connectivity

Railway transport in Chapora River catchment is developed under the Konkan Railway Project. The main trunk route of the railway is aligned almost parallel to the coast line. The end point of the study stretch of the river is at Maneri. Nearest railway station is 6.1 km from Bardez i.e. at Tivim. Tivim railway station is located on Konkan railway route about 46 km from Madgaon Railway station. Madgaon is the busiest railway station in the state of Goa and has direct rail connection with several major cities in India.

2.3 Status of Goods Transport

Status of goods transport through River waterway is detailed in **Chapter 4 on Market Analysis of this report**.

2.4 Conclusion

a) Total length of Chapora River is 44 km before joining the sea. The river is under tidal influence of Arabian Sea (backwater effect) upto Maneri (about 33 km), thus total study stretch (33km) of National Waterway (NW-25) is under tidal effect

b) There are eight (8) jetties existing in the study stretch of the river.

c) Chapora River in the study stretch is well connected with Mumbai Goa National Highway and is surrounded by state highway number SH-2, SH-124 and SH-130 on right bank and left bank respectively.

d) Railway transport in Chapora river catchment is developed under the Konkan Railway Project. The nearest railway station is at Tivim about 6.1 km from water way. Tivim railway station is 46km from Madgaon the main junction of Konkan railway.

e) Five Road Bridges, One Railway Bridge and One LMV Bridge are existing in the study stretch of the River.

f) Chapora Jetty is being used by mechanized trawlers and fishermen in the area.

CHAPTER 3: RECONNAISSANCE SURVEY

3.1 River Profile

Chapora River originates at Ramghat at Maneri in the Indian state of Maharashtra and enters Goa. The Chapora River follows zigzag course, demarcates the border of Pernem, Bardez and Bicholim talukas for approximately 21 kilometers. It flows westward and joins in to the Arabian Sea near Chapora in the northern most part of Goa. The total catchment area of Chapora River basin is 530 sqkm. The catchment receives an average annual rainfall of about 3578mm. The total length of the river from origin to its outfall in the Arabian Sea is about 65.0km. A map showing Chapora catchment basin is shown in **Figure 3.1**. Chapora River has a relatively small catchment area and its tributaries are small feeder streams and canals. The Chapora river divides the Northern Goa towns of Pernem and Bardez.

Figure 3.1 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. IWAI expects the lower 33.00km, shown in green colour in the Figure 3.1, to have potential for navigation and thus, the subject of study under this assignment.

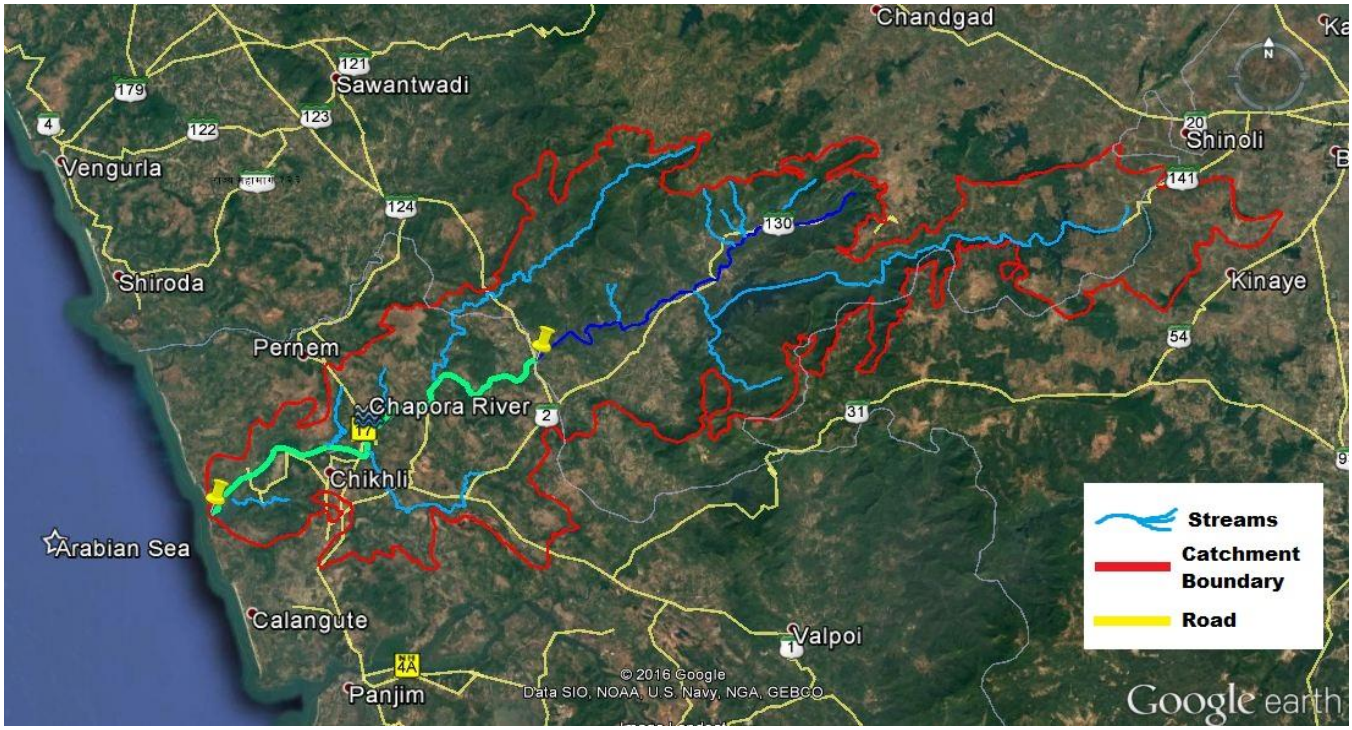


Figure 3.1: Catchment Area of Chapora River

The stretch of the Chapora River considered for assessment of navigation potential is defined as below:

33 km length of the river from Confluence of Chapora river with Arabian Sea at Morjim to Bridge at State highway # 124 (1Km from Maneri village).	From: 15°36'33.27"N, 73°44'0.39"E	Up to: 15°42'47.31"N, 73°57'23"E	National Waterway: 25

3.2 Reconnaissance Survey

This section presents a stretch-wise description about Chapora River. It also covers the Hydrological analysis of collected data viz maximum and minimum water depths. The route map of Chapora River is in **Figure 3.2** as placed below.

Figure 3.2: Route Map of Chapora River

3.2.1 Methodology of Survey

Single beam bathymetry survey was carried out to determine the river profile along its deepest route (single line survey) along the proposed waterway by deploying DGPS positioning system and single beam echo sounder. Wherever bathymetry survey was not feasible due to shallow water depths, survey was continued using topography survey method.

Along with the river bathymetry, other relevant data/information like horizontal and vertical clearances above high flood level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route were collected along with their coordinates and locations. Soil samples were also collected along the survey area at about 10.0km interval. Texture of the collected soil samples was analyzed visually.

The survey was conducted in WGS84 datum; UTM Projection (Zone 43 N, CM 075° E). The geodetic parameters used during the survey are mentioned in **Table 3.1.**

Table 3.1: Geodetic Datum and Projection Parameters

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984
Spheroid:	World Geodetic System 1984
Semi Major Axis:	a = 6 378 137.000m
Inverse Flattening:	1/f = 298.257 223 563
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 43 N;
Central Meridian:	075° 00′ 00″ East
Latitude of Origin:	0° 00′ 00″ North
False Easting:	500 000m
False Northing:	0m
Scale Factor on Central Meridian:	0.9996
Units:	Metre

The layout diagram of the equipment used for bathymetric survey has been shown in **Figure 3.3** below.

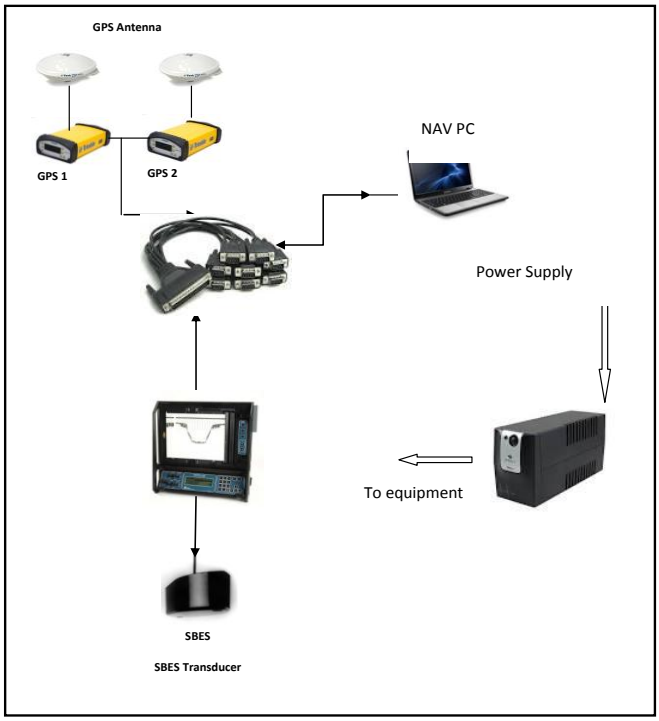


Figure 3.3: Equipment Diagram

Boat setup at site with equipment mounted on the boat is depicted in **Figure 3.4** as shown below.

Figure 3.4: Boat Setup with Equipment Mounted on the Boat

An overview chart for Chapora River bathymetry is enclosed as **Annexure 3.1**.

3.2.2 Chart Datum of the Proposed Waterway

The water depths have been determined as a result of all soundings reduced to Chart Datum (the lowest tide level observed for a considerable period at specific location) in the area. Tidal heights predicted using Mormugao Port data were used to reduce the raw water depths to Chart Datum. The locations with coordinates of Chart Datum obtained from Mormugao Port have been used to reduce the soundings along the surveyed stretch as compiled in **Table 3.2**. Also, daily data of heights of high and low waters at Marmagao for the year 2015, obtained from Captain of Ports department, Panaji, Goa has been given in **Annexure 3.2**.

Table 3.2: Details of Chart Datum Used for Data Reduction

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

**- Below Mean Sea Level*

3.2.3 Bathymetry and Site Data Collected

A. Chapora River (Ch 0.00km – Ch 4.00km)

Chapora jetty is located on the South (left) bank at Ch 0.32km. Settlements are seen along both sides of the river along this section. A shallow patch is found from Ch 0.60km upto Ch 2.00km. A delta is observed near the estuary of the river (Lat. 15° 36′ 33.27″ N, Long. 73° 44′ 00.93″ E). Two wooden jetties are on the North (right) bank at Ch 1.96km and Ch 2.34km. Fishing stakes from the middle of the river to the South (left) bank are seen at Ch 3.20km. The Chopdem-Siolem Road Bridge crosses the river at Ch 3.90km. An island is seen at Ch 3.90km.

The minimum depth recorded in this section is 0.5m at Ch 0.85km and the maximum depth is 5.8m at Ch 0.00km as tabulated in **Table 3.3.** The stretch is shown in **Figure 3.5**.

Table 3.3: Maximum – Minimum Depth in Chapora River from Ch 0.00km – Ch 4.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
0.00	4.00	5.8	0.5

Figure 3.5: Route Chart of the Survey from Ch 0.00km to Ch 4.00km

B. Chapora River (Ch 4.00km – Ch 10.00km)

Vegetation is seen along the right bank of the river. Two jetties are seen at Ch 6.20km and Ch 6.30km on the left bank. Shallow patches have been observed between Ch 6.80km and Ch 7.10km in the middle of the river. Small right bank tributary join the Chapora River at Ch 6.30km and at Ch 6.90km. Two ferry jetties are seen on both banks of the river at Ch 8.70km. Small Island with trees is observed in the middle of river from Ch 9.70km to Ch 10.30km. The minimum depth recorded in this section is 0.10m at Ch 4.59km and the maximum depth is 9.7m at Ch 6.40km as tabulated in **Table 3.4**. The Stretch is shown in **Figure 3.6**.

Table 3.4: Maximum – Minimum Depth in Chapora River from Ch 4.00km to Ch 10.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
4.00	10.00	9.7	0.1

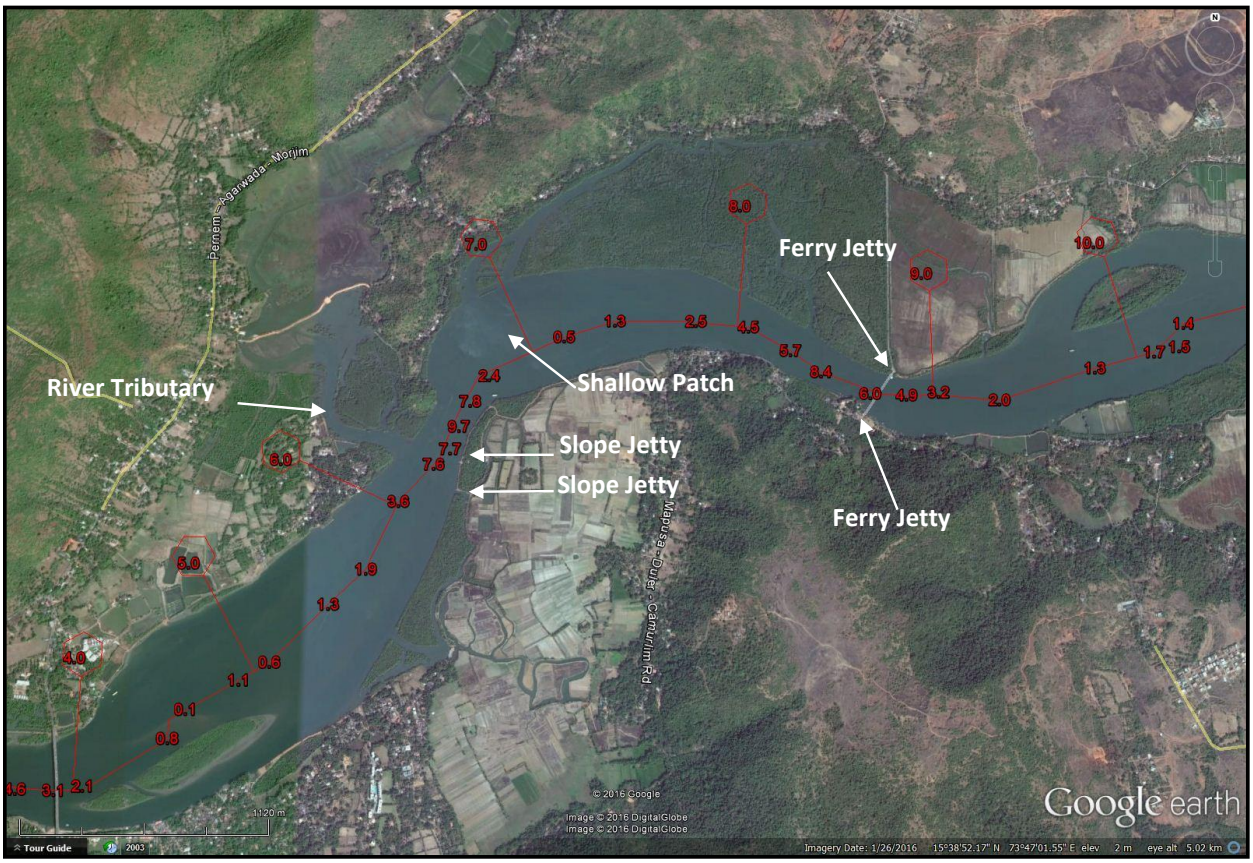


Figure 3.6: Route Chart of the Survey from Ch 4.00km to Ch 10.00km

C. Chapora River (Ch 10.00km – Ch 17.00km)

Open fields are seen on the right bank (from Ch 10.20km to Ch 11.00km) and on the left bank (from Ch 10.70km to Ch 11.60km). Arabo village is located on the North (left) bank at Ch 11.50km. A tree is seen in the middle of the river at Ch 11.86km. Islands are observed between Ch 11.60km and Ch 12.30km. Colvale Road Bridge crosses the river at Ch 13.44km. High Tension Lines crosses the river at Ch 13.47km and Ch 16.33km. Settlement of Bardez is observed from Ch 14.80km to Ch 15.50km. Open fields are seen from Ch 13.90km to Ch 16.20km. Rail Bridge crosses the river at Ch 16.49km which connects Revora with Dargolim. Open fields are seen from Ch 16.65km to Ch 16.90km. The minimum depth recorded in this section is 1.3 m at Ch 16.97km and the maximum depth is 13.1 m at Ch 15.42km as tabulated in **Table 3.5.** The stretch is shown in **Figure 3.7**.

Table 3.5: Maximum – Minimum Depth in Chapora River from Ch 10.00km to Ch 17.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
10.00	17.00	13.1	1.3

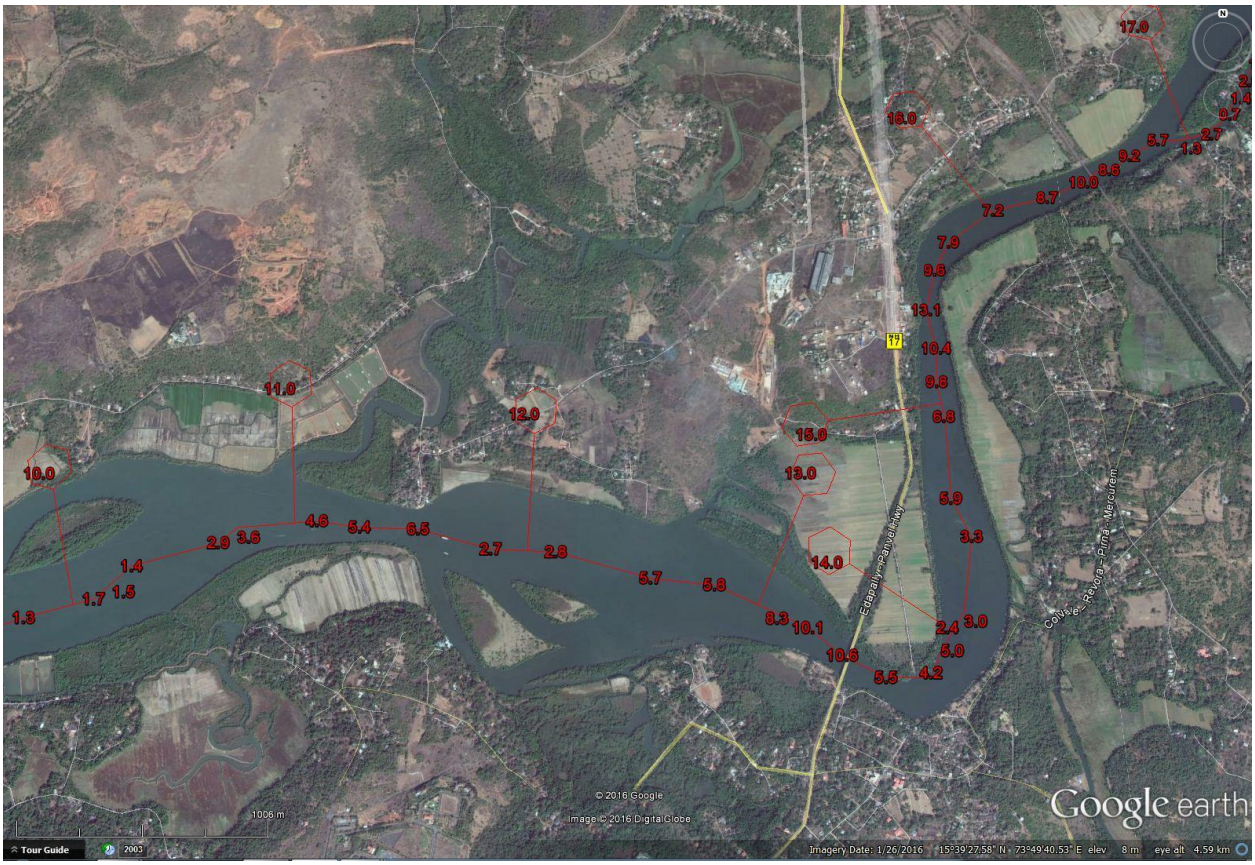


Figure 3.7: Route Chart of the Survey from Ch 10.00km to Ch 17.00km

D. Chapora River (Ch 17.00km – Ch 23.00Km)

Agricultural fields are found on both the banks of the river. Patches of vegetation are also seen along the river banks. An Island is seen from Ch 17.00km to Ch 17.80km. Settlements are observed on this Island. A foot bridge crosses the river from the South (left) bank to the island at Ch 17.06km. Orozim village is located on the North (right) bank at Ch 19.80km. Open fields are found on the right bank from Ch 20.20km to Ch 21.10km. Settlements near Ozorim village are seen on the right bank between Ch 20.90km and Ch 21.10km. Pirna - Ozeri Road Bridge crosses the river at Ch 21.14km. The minimum depth recorded in this section is 0.7 m at Ch 17.16km and the maximum depth is 14.3 m at Ch 21.81km as tabulated in **Table 3.6.** The route chart has been displayed in **Figure 3.8**.

Table 3.6: Maximum – Minimum Depth in Chapora River from Ch 17.00km to Ch 23.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
17.00	23.00	14.3	0.7

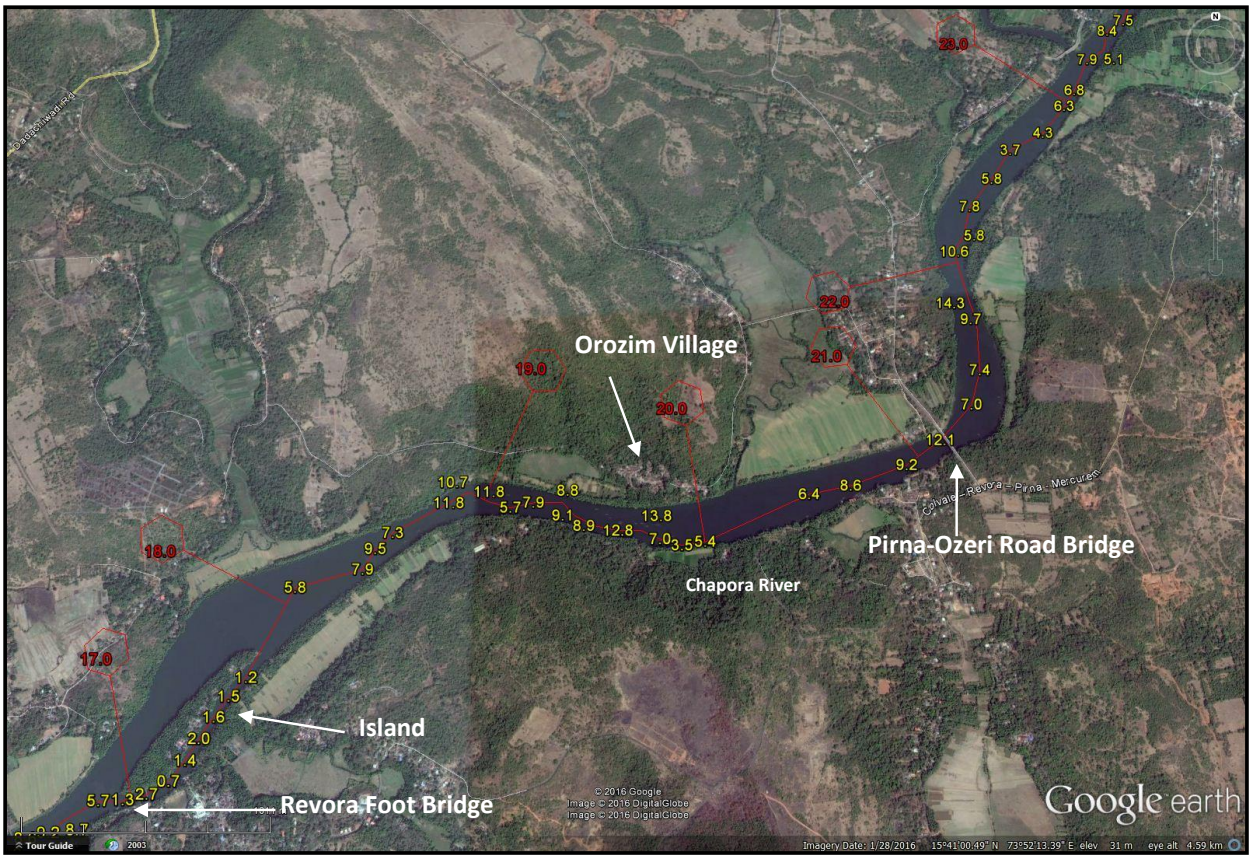


Figure 3.8: Route Chart of the Survey from Ch 17.00km to Ch 23.00km

E. Chapora River (Ch 23.0km – Ch 29.00Km)

A small right bank tributary meets the Chapora River at Ch 23.2km. A road bridge, which is parallel to the Chapora River, crosses the tributary just upstream of the confluence location. Islands are observed between Ch 25.10km and Ch 26.30km. Alorna Fort is located on the right bank of the river at Ch 25.2km. An island is present from Ch 28.40km to Ch 29.00km. Two dams near Salem are located at Ch 28.7km. These dams (Lat. 15°41'54.42"N, Long. 73°55'46.86"E and Lat. 15°41'54.42"N, Long. 73°55'46.86"E) are connected with island to left bank and another one to the right bank. A Water Treatment Plant is situated near the dam site at the left bank. The bathymetric survey along the Chapora River ends upto the dam near Salem (Ch 28.7Km). Vegetation and Aagricultural land are seen in this stretch. There are few settlements with the immediate proximity to the river. The minimum water depth recorded in this section is 0.1 m at Ch 28.67km and the maximum depth is 8.4 m at Ch 23.43km as tabulated in **Table 3.7.** The stretch is shown in **Figure 3.9**.

Table 3.7: Maximum – Minimum Depth in Chapora River from Ch 23.00km to Ch 28.7km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
23.00	28.7	8.4	0.1

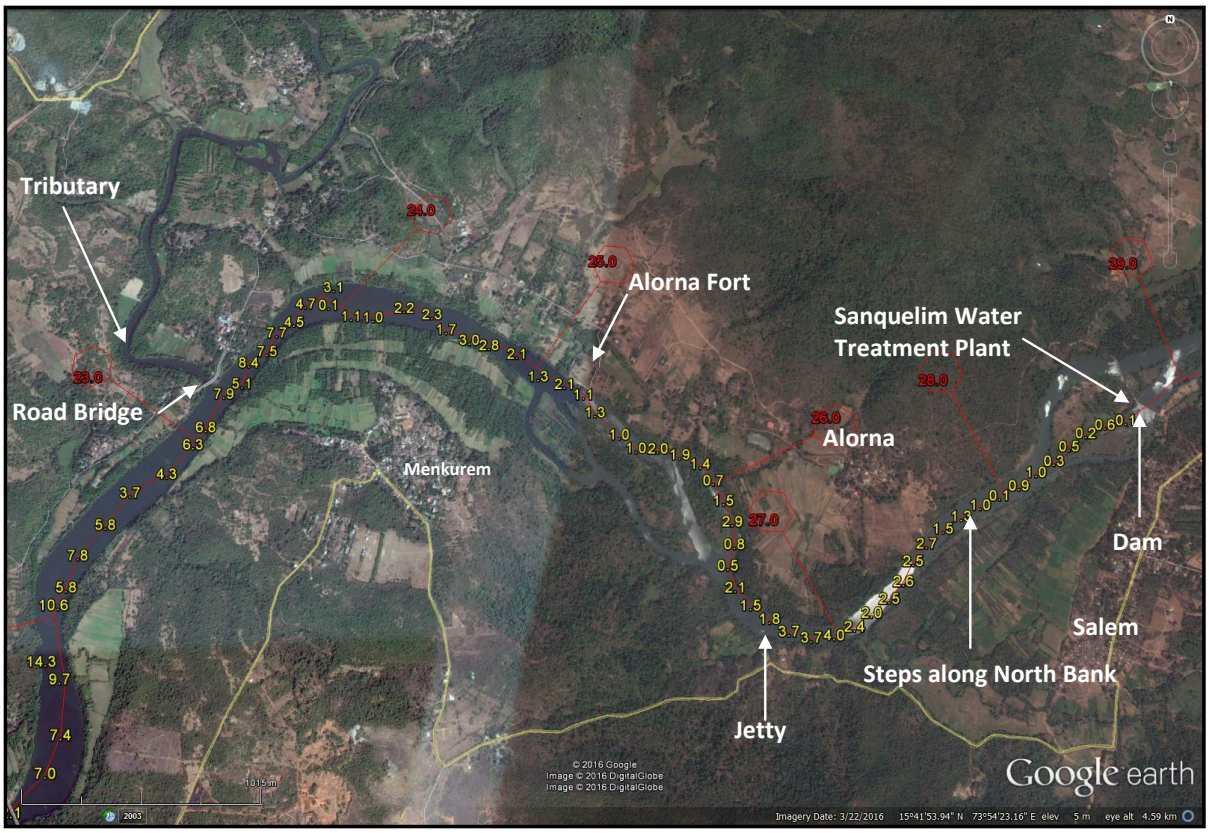


Figure 3.9: Route Chart of the Survey from Ch 23.00km to Ch 29.00km

F. Chapora River (Ch 29.00km – 33.00km)

Topographic survey has been carried out from CH 28.81 to CH 33.00km (near Sanquelim Dam to Maneri Bridge), as the stretch is shallow depth and boat navigation was not possible. Water depths in this section are taken manually. There is a walkway near to Maneri Bridge. The route chart has been displayed in **Figure 3.10**.

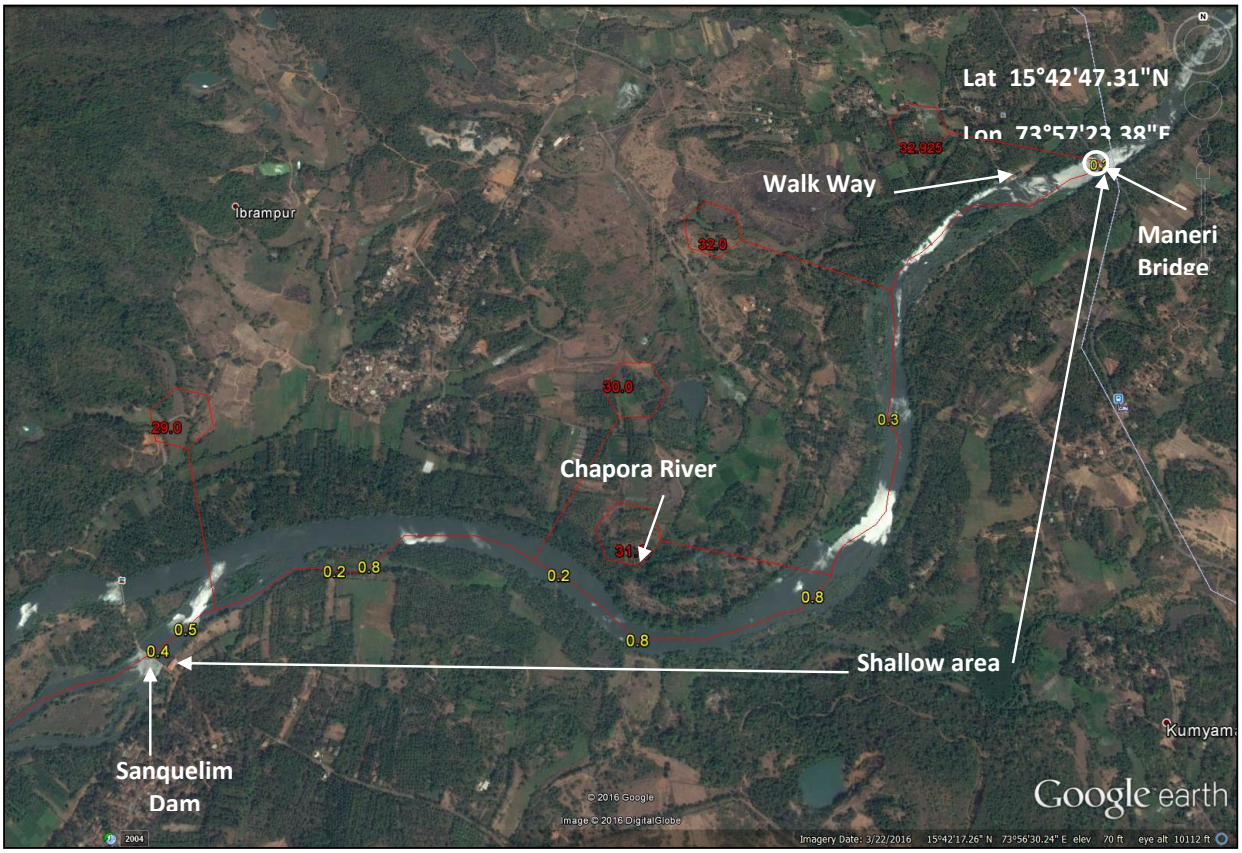


Figure 3.10: Route Chart of the Survey from Ch 29.00km to 33.00km

The maximum and minimum depths with reference to the Chart Datum in the small intervals have been summarized in **Table 3.8** describing the length of stretch showing various ranges of water depth available.

Table 3.8: Maximum – Minimum Depth in Chapora River from Ch 0.00km to Ch 33.00km

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-4	5.8	0.5	3.48	0.17	-	0.35
4-10	9.7	0.1	3.50	0.50	1.00	1.00
10-17	13.1	1.3	6.22	0.39	0.39	-
17-23	14.3	0.7	5.08	0.46	0.31	0.15
23-28.7	8.4	0.1	2.70	0.60	1.20	1.20
Total			**20.98**	**2.12**	**2.90**	**2.70**
28.7-33	Topographic survey due to shallow water depth, 0.2m to 0.8m.					

The above data indicates that water depth of 2.0m and above is available up to 24.00km of the waterway under study, except in two or three locations where marginal dredging requirement has been observed. It may be noted that the above depths have been reckoned with CD. Since, about 29km (88%) study stretch of Chapora River is under tidal influence, the available effective depths would be more than 1.15m (average tide height) which will

be advantageous for safe navigation. It confirms the availability of 2.0m and above water in 73% of river in the proposed stretch under study. The detailed hydrographic survey information from Ch 00.km up to Ch 28.7km, indicating location and observed water depth at each point of data reading has been given in **Annexure 3.3.** The detailed topographic survey information from Ch 28.81km upto Maneri Bridge (Ch 33.00km), indicating location, observed water depth and river bed elevation at each point of data reading has been given in **Annexure 3.4.**

3.2.4 Soil Texture Classification

The soil texture has been observed during the reconnaissance survey. The observed soil texture at 10km interval has been given in **Table 3.9**.

Table 3.9: Soil Texture in Chapora River at 10.0km Interval

Chainage (Km)	Latitude	Longitude	Depth (m)	Soil Texture
6.50	15°38'55.738"	73°46'38.135"	1.00	Sand
13.00	15°38'57.359"	73°49'31.217"	0.90	Sand
20.39	15°40'46.497"	73°52'11.969"	12.80	Sand
30.00	15°41'53.386"	73°55'42.125"	0.10	Pebbles

From the above table, it is observed that sandy soil is present in most part of the river under study stretch. Rocky patches (Pebbles) in the upper most stretch under study area are observed beyond Ch 30.00km.

3.3 Classification of Waterways

The 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 2000tonne Dead Weight Tonnage (DWT) and tug-barge formation in push-two units of carrying capacity up to 8000tonne (Ref: IWAI, Gazette Notification 2006). The classification criteria of waterways are mentioned in **Table 3.10** for Rivers and in **Table 3.11** for canals.

Table 3.10: 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 3.11: Classification of Inland Waterways for Canals

Class of Waterways	Rivers				
	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	-	-	-	-	-

The vessel sizes for self propelled or tug and barge combination for different classes of waterways is described in **Table 3.12**.

Table 3.12: 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)

Vertical Clearance for power cables or telephone lines or cables for any transmission purpose for all classes:

- Low Voltage Transmission lines and Telephone line 16.5m
- High Voltage Transmission line not exceeding 110 kV 19.0m
- High Voltage Transmission line exceeding 110 kv 19.0m +1 cm per each additional kv

In case of underwater pipelines, power cables and other cables, norms are to be decided as per site condition and navigational requirement.

Reference level for vertical clearance for different types of channels:

- For Rivers:- Over the Navigational High Flood Level (NHFL), which is the highest flood level at frequency of 5 % in any year over a period of last twenty years;
- For Tidal Canals:- Over the highest high water level;

- For Other Canal:- Over designed full supply level (FSL);

The above classification for rivers and channels shall be effective if:

- Minimum depth of channel is available for about 330 days in a year (about 90% days in a year).
- Vertical clearance at cross structure over the waterways is available at least in central 75% portion of each of the spans in the entire width of the waterways.

The data gathered through the reconnaissance study has been analyzed from the parameters mentioned hereinabove and conclusions have been made with regard to the class of navigation channel that the relevant stretch of Chapora River falls into. Furthermore, it is to be determined whether the entire 33.00km stretch can be classified under one class of channel or there is a possibility and advantage of developing sub-reaches under different classes of navigation channel.

3.3.1 Cross Over Structures

The details of High Tension lines and Bridges crossing the Chapora River are given below in **Table 3.13** and **Table 3.14**.

Table 3.13: Details of High Tension and Electric Lines across Chapora River

Sl. No.	Cross-Structure Name	Chainage (km)	Position (Above vessel track)		Vertical Clearance above MHWS (m)
			Latitude	Longitude	
1.	HT Line	13.47	15°38'55.88"N	73°50'12.01"E	13.0
2.	HT Line	16.33	15°40'02.05"N	73°50'45.75"E	20.0

Table 3.14: Details of Bridges across Chapora River

Sl. No.	Name of Structure	Chainage (km)	Horizontal Clearance (m)	Vertical Clearance above MHWS/HFL (m)	Center Position	
					Latitude	Longitude
1.	Shivali Road Bridge	3.90	50	8.5	15°38'02.95"N	73°45'34.39"E
2.	Colvale Road Bridge	13.44	50	8.5	15°41'53.73"N	73°50'10.56"E
3.	Rail Bridge	16.49	30	6.5	15°40'59.51"N	73°50'49.97"E
4.	Revora Foot Bridge	17.06	20	8.5	15°40'11.73"N	73°51'07.52"E
5.	Pirna-Ozeri Road Bridge	21.14	50	8.5	15°40'05.40"N	73°52'59.24"E
6.	LMV Bridge over Bandhara	28.69	-	-	15°38'55.16"N	73°55'42.64"E
7.	Maneri Bridge	32.90	20	10.0	15°42'45.65"N	73°57'24.37"E

From the above information, waterway Ch 0.00km to Ch 13.47km, sufficient vertical clearance is available from HT line. Support base of electric line at Ch 13.47km will have to be raised upto 6.0m to get the required clearance.

The vertical clearance at the bridges fulfills the criteria for **Class III** except at Ch 16.49km which fall under Class II. Revora Foot Bridge is located across the right branch river flow, separated due to island and ignoring the waterway bifurcated its vertical clearance has not been considered for analysis. LMV Bridge is at the Barrage site at Ch 28.69km. Shallow depths were observed in the upstream of barrage up to the Meneri Bridge (End location). Therefore, waterway could be ended upto this chainage due to the obstruction of barrage. Rail Bridge is located at Ch 16.49km. Prior to this bridge, the stretch can be classified for class III. Thereafter, the vertical clearance at bridge is falling in **Class II**. Maneri Bridge at Ch 32.9km is located at the upstream end of the proposed waterway and hence its vertical clearance has not been considered for analysis.

The horizontal clearance on the classification has been provisioned for two lane navigation. With due caution considering the provision of single lane mobility under the Railway Bridge at Ch 16.49km (without any change in the structure modification), the class of the waterway can be elevated to **Class II**.
Photos of important structures such as port, bridges, jetties, transmission lines and plants as taken during the site visit are shown in **Annexure 3.5**.

3.3.2 Dams, Barrages and Reservoirs

One barrage is located at Ch 28.67km under Light Motor Vehicle Bridge over Bandhara, Sal-Ibrampur. No dams & reservoirs exist along the surveyed route.

3.3.3 Bends along the Route

On the proposed waterway route, there are many bends in Chapora River, which are given below in **Table 3.15.**

Table 3.15: River Bend Radius in Chapora River

Sl. No.	Chainage (Km)	Radius (m)
1.	3.50	1150.00
2.	7.25	670.00
3.	9.10	630.00
4.	11.25	1340.00
5.	14.00	350.00
6.	15.75	360.00

Sl. No.	Chainage (Km)	Radius (m)
7.	19.20	700.00
8.	21.40	350.00
9.	22.25	410.00
10.	24.00	380.00
11.	27.00	390.00
12.	30.50	320.00
13.	32.10	690.00

The existing river bend radius is sufficient for class I. River takes mild and sharp bends at various locations and needs smoothening of bends. In the study stretch based on the river radius criteria it may be fit for **Class II** vessels with depth improvement at some locations and by smoothening of the bends, however on confirmation of cargo.

The pictorial detailed information showing the proposed waterway indicating various cross-structures (i.e. bridges, transmission lines etc.), major industrial locations and important places along the waterway have been shown in **Drawing No P009051-W-20201-A01** (Sheet 1 to 4). Drawing also depicts various information such as Jetties, Rail and Road location along the waterway.

3.3.4 Gauge & Discharge data

In the Chapora River catchment, no gauge and discharge site as established by Central Water Commission was observed. For the Stage II study, the gauge data will be analyzed if the same is available within a reasonable reach and if found relevant.

3.3.5 Bed Profile of Waterway

All soundings were reduced to Chart Datum in the area which lies under the tidal effect. Tidal heights are predicted using Marmagao data to reduce the raw water depths to Chart Datum. The observed bed profile of Chapora River waterways using bathymetric and topographic survey is shown below in **Figure 3.11** and presented in **Annexure 3.6**.

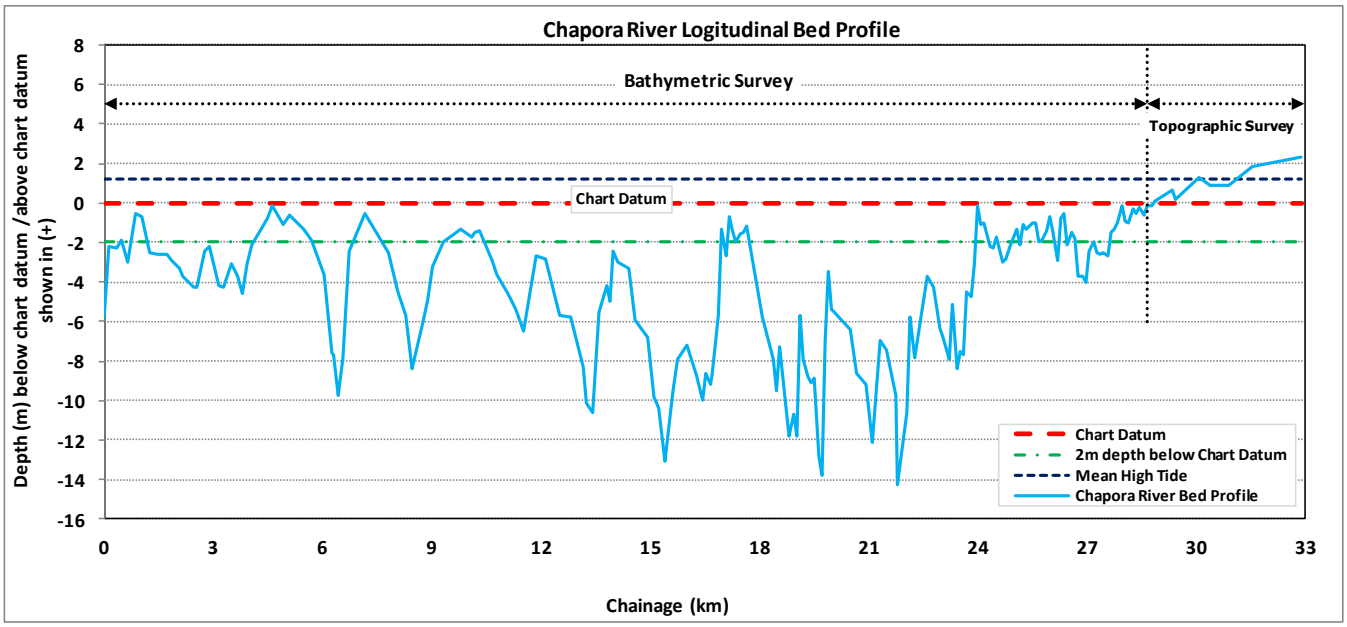


Figure 3.11: Longitudinal River Bed Depth Profile of Chapora River from Ch 0.00km to Ch 33.00km

Figures 3.11 also shows the Chart Datum line, 2.0m below the Chart Datum line and mean tide variation 1.15m above Chart Datum. However, high tides in this region were observed in the range of about 0.00m to 2.30m (MHWS) *(Ref: Indian Tide Tables, 2016, Survey of India)*. The following key observations are made from Figure 3.11:

(i) The tidal effect of the Arabian Sea in the Chapora River is affected up to the up to the Alorna Fort and upstream (*Ref: Information as gathered from the office of Captain of Ports Department, Goa*). It has been observed that the study stretch is under tidal affect up to the barrage Site (Ch 28.67km). The tide in the region is Semi-Diurnal characteristics.

(ii) As observed from the site, the study stretch has the soil texture as sandy.

(iii) The initial half of the river stretch from the mouth is flatter which gradually becomes mild steeper having an overall average slope of 1 in 4715 in 33km of the river stretch under study.

(iv) Minimum 2.0m depth is available naturally upto 24.0km with minimum dredging required at some places (**Class V**).

(v) With minimum to moderate dredging in the stretch from Ch 24.0km up to Ch 28.7km, a minimum depth of 1.4m for **Class II** may be achieved.

3.4 Tidal Effect on Navigability of Chapora River

The tidal effect on the river navigability may be put to an advantage in order to optimize the cargo movement from import ships and taking bulk cargo to a jetty located upstream of the river bank near the industrial units for planned bulk consumption of the cargo. Industrial units e.g. Steel plants/ Thermal & Gas based plants/ Cement

plants/ Oil terminals are either operational or have been planned near the coast line as a preferred location either on the river banks near the mouth of the river or in creeks meeting high sea.

Shallow waterways in these rivers and creeks put a restriction on movement of large ships which calls for unloading of the cargo from ships at high sea into smaller vessels. These vessels transport the cargo to smaller jetties of the plants. Normally, there is a travel restriction of the movement of vessels by variation in the available draft in the river/creek due to tide. If the available draft in the river is adequate to sail a particular type of vessel, the vessel can move into the river/creeks or vice versa; else they wait for the high tide. Thus, movements of the vessels through the river depend upon the draft available which is affected by the tide.

3.4.1 Present Usability of Chapora River

With the information gathered during the reconnaissance survey, the study stretch is being used for fishing. Tide dependent water level in the Chapora River is being used advantageously for the smooth movement of the vessels in the River.

3.4.2 Chart Datum & Variation in Navigation Draft

The draft variation in the Chapora River has been established from 0.1m to 14.3m with respect to Chart Datum during the reconnaissance survey. The tide tables are available for the region and water level in the creek can be forecasted at any point of time. It helps in knowing that a particular type of vessel can sail in the creek at a given point of time. The tidal variation is of the order of 1.15m with it maximum depth of 2.30m in Chapora River as per the records available for this region *(Ref: Indian Tide Tables, 2016, Survey of India)*. Hence, it is noted that if the high tide is considered for navigation, a higher water depth is actually available for navigation along the waterway although water depth with respect to Chart Datum shall depict a lower depth corresponding to the Least Available Depth (LAD). So, conceptually, navigation in a tidal river is more effective considering the tidal effect which is observed in such cases elsewhere. Arabian Sea at the confluence location of Chapora River has a semidiurnal tide having two high and two low water each tidal day, with relatively small differences in the respective highs and lows effect which provides a tidal cycle of 6.0 hours.

The speed of these vessels is normally 8 knots in a still river and the travel time of these vessels may be about 2.0 hours inclusive of the docking time. Hence, a six hour tidal window shall be advantageously used for optimization of vessel movement from sea to destined location as well as for unloading the material and the low tide shall be made use of to sail from local jetty to the high sea with a lower draft requirement of empty vessel which is again available during the low tide. Similar considerations shall be effective for other industrial units that are either already planned or that may be planned in future on this waterway. This shall also facilitate the classification of the water way either in one category or into various categories with a consideration of river length being actively used currently, and future possibilities for cargo movement beyond the present use.

3.4.3 Benefits of Tidal Effect

The above contention for using tidal window using high tide for facilitating navigation shall help to decide many other logistics which may consist of exact vessel size, loading time, unloading time, facilities available at loading and unloading locations etc. A better insight into tidal information shall help to decide the following:

(i) Classification of the waterway;
(ii) Vessel Size;
(iii) Scheduling of vessel movement;
(iv) Number of vessels for defined quantity of the cargo;
(v) Flotilla Combination;
(vi) Different size of vessels instead of only one size;
(vii) Handling facilities at the terminal location;
(viii) Desirability and quantum of dredging required;
(ix) Vessel allocation decision;

The benefits of tidal effect will be more useful in operation of vessels and in improving the efficiency of vessel operation.

3.5 Agencies to be approached for Clearances, if any

Based on the reconnaissance survey, interaction with local people and consultation with government officials, the information regarding clearances and approvals required from the concerned authorities for operation of National Waterway NW-25 (Chapora River) has been given in **Table 3.16**.

Table 3.16: List of Clearances and Approvals Required

Environment Clearance	Forest Clearance	Wildlife Clearance	Coastal Regulation Zone (CRZ) Clearance	Consent to Establish/ Operate	No Objection Certificate from Directorate of Fisheries	NOC from WRD/PWD/ Railways
√	To be ascertained at DPR Stage-II	To be ascertained at DPR Stage-II	√	√	√	√

3.5.1 Compilation of Data in Feasibility Format

The field information gathered through single line bathymetry survey, data collection from IWAI, data collection from various agencies, site visit and information derived from web has been compiled in the format as provided by IWAI for the Chapora River. The consolidated data shall be useful in deriving basic information about each of the waterway in IWAI format as enclosed as **Annexure 3.7**.

3.6 Conclusion

Based on the survey observation, the classification of proposed waterways up to Ch 28.7km based on various criteria has been summarized in below **Table 3.17**. As mentioned above, the navigable stretch is confined upto stretch of 28.7km due to barrage structure.

Table 3.17: Classification of Proposed Waterway

Criteria	Classification																			
Length of waterway from start (km)	1	3	4	6	7	9	10	11	13	14	16	17	19	20	22	23	24	26	27	28.7
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V																	C-II		
Raod Bridge Vert. Clearance	C-III												C-II							
Raod Bridge Hor. Clearance	C-III												C-II							
HT Line Vert. Clearance	All Class										Needs Raising of HT Base									
Bend Radius	C-II																			
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

Finally, with due consideration of all aspects and obstruction due to important structure (rail Bridge) the classification of the proposed Chapora River Waterway in light of technical navigability may be adopted as shown in **Table 3.18** below:

Table 3.18: Final Conclusion for Possible Navigation

River Stretch	0.0 km 16.49km	28.70km
Classification		
	Class- III	**Class-II**
Horizontal clearance (m)	50	40
Vertical clearnce (m)	7	5
Minimum Depth (m)	1.7	1.4
Bottom Width (m)	50	40
Self Propelled Vessel		
Dead Weight Tonnage	500	300
Vessel size (m)	(58 x 9 x 1.5)	45 x 8 x 1.2
Tug + Barge		
Dead Weight Tonnage	1000	600
Vessel size (m)	(141 x 9 x 1.5)	110 x 8 x 1.2

The conclusion has been drawn keeping in view the present river condition and linking the same with various characteristics of classification viz., available draft; vertical clearance under Rail Bridge / Road Bridge/ HT Line and Bend Radius etc.

The stretch from Ch 0.00km to Ch 16.49km can be developed as **Class III** waterway and the balance stretch can be considered as a **Class II** waterway with required modifications.

CHAPTER 4: MARKET ANALYSIS

4.1 Background

Market analysis for Chapora 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.

The methodology that has been adopted for conducting the market analysis for various river basins is as shown in **Figure 4.1**.

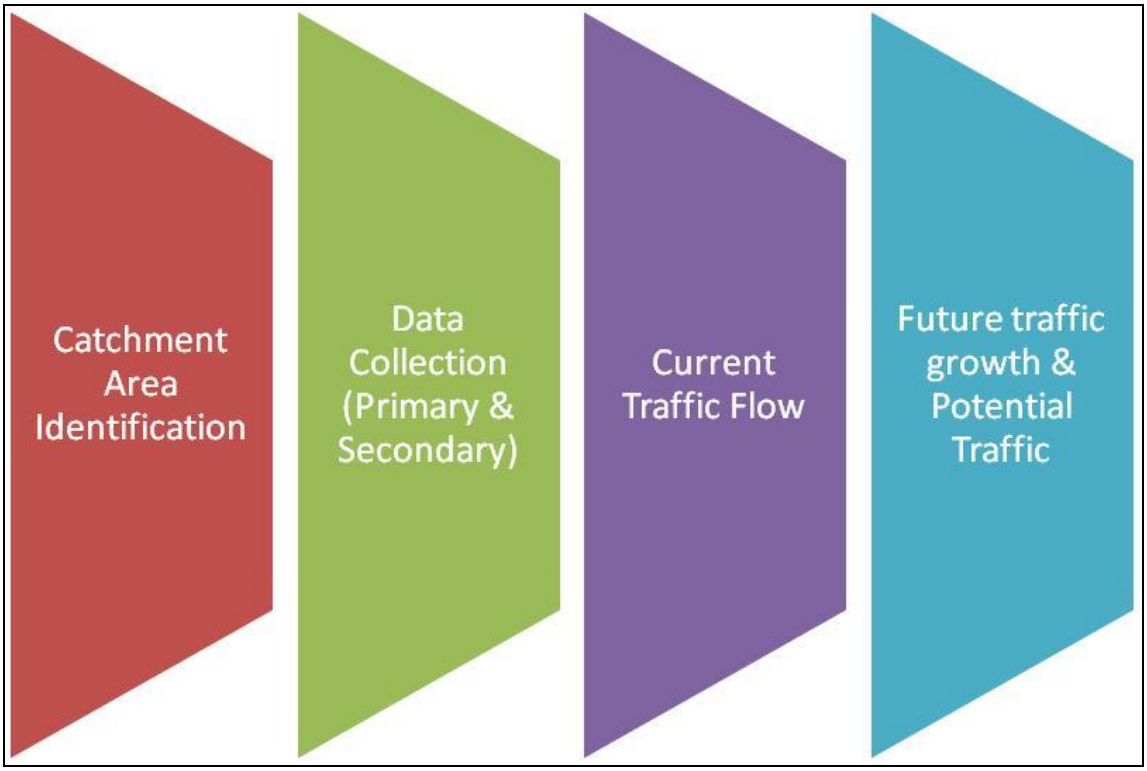


Figure 4.1: Methodology for Market Analysis

4.2 Existing Profile

Chapora river waterway falls under North Goa district of the State and the district headquarters of North Goa district is at Panaji. Panaji is also the state capital of Goa. The North Goa district is further divided into six (6) talukas namely Tiswadi, Bardez, Pernem, Bicholim, Sattari and Ponda, with a total geographical area of 354.48 sq. km.

River Chapora falls under Bardez & Pernem taluka. The catchment of Chapora river has a total population of 3,13,187 (Census 2011).

The study stretch of the waterway has a total length of 33 km from State Highway SH 124 to Morjim. **Figure 4.2** shows the location of Chapora River.

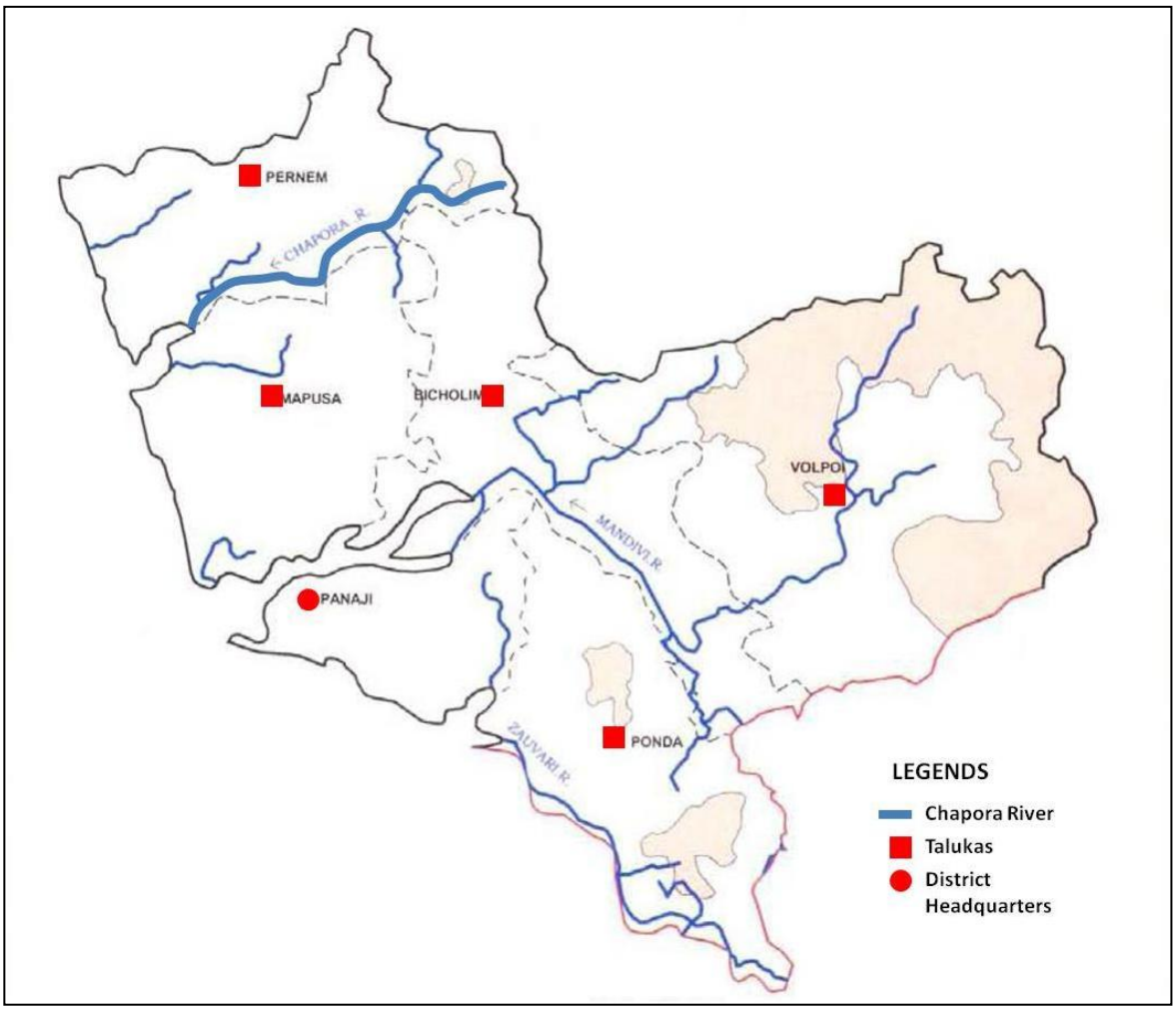


Figure 4.2: Location of Chapora River

4.2.1 Industrial Profile

North Goa district has seen a continuous increase in industrial investments over the past years. The details of total no. of units registered and related information is given in **Table 4.1**.

Table 4.1: Industrial Units in North Goa District

S. No.	Profile of Industries	Quantity (No.)
1	Registered Industrial Units	4,595
2	Total Industrial Units (Goa)	51,492
3	Registered Medium & Large Units	60
4	No. of Industrial Areas	12

Source: Industrial Profile of North Goa District, MSME, Govt. of India

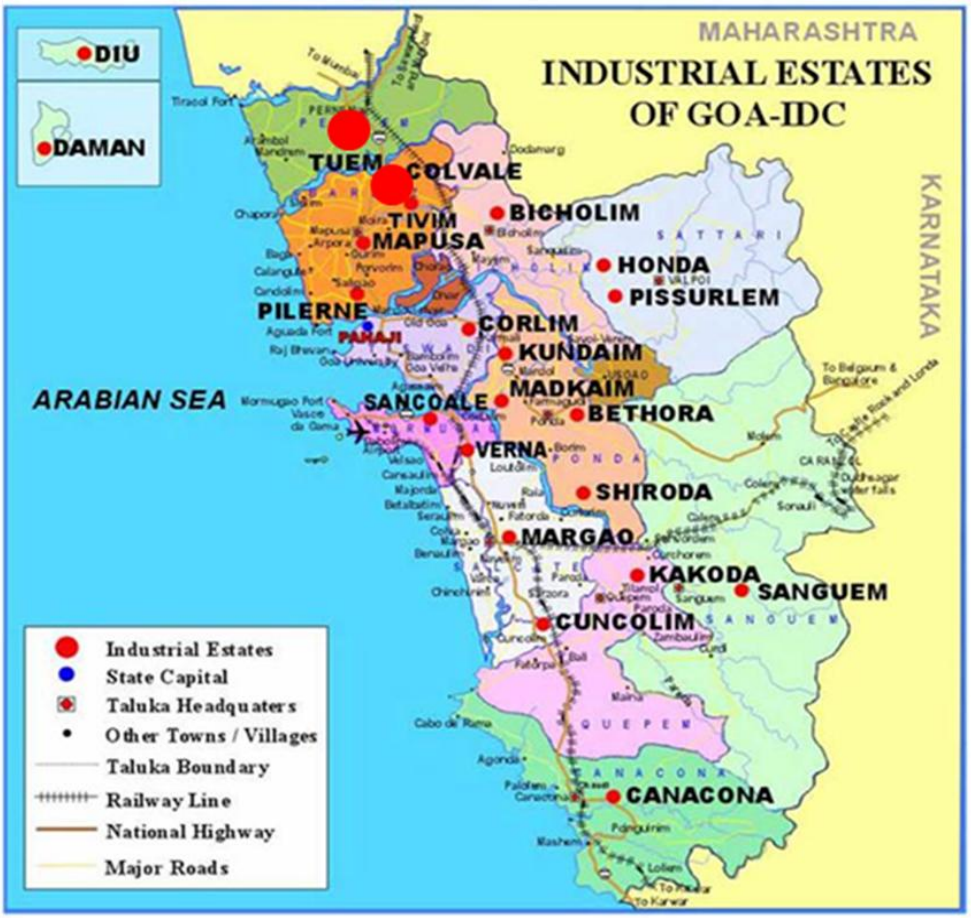
These registered units include various types of industries; the details of the same are given in **Table 4.2**.

Table 4.2: Industrial Profile of North Goa District

S. No.	Type of Industry
1	Food Products
2	Beverages & Tobacco Products
3	Jute, Hemp & Mesta Textile
4	Textile Products & Garments
5	Wood Products & Wooden Furniture, Fixture
6	Paper Products including Printing/Publishing
7	Leather & Leather Products
8	Rubber, Plastic, Petroleum and Coal Products
9	Chemical Products (except Petroleum and Coal Products)
10	Non Metallic Minerals
11	Basic Metal & Alloys
12	Metal Products & parts (except M/c. & Transport eqpt.)
13	Machinery, Tools & Parts (except Electrical m/c.)
14	Electrical Machinery & Apparatus & Supplier Parts
15	Transport Equipment & Parts
16	Other Mfg. Industries
17	Repair/Services

Source: Industrial Profile of North Goa District, MSME, Govt. of India

These industries are located in various industrial clusters, the location of the same is shown in **Figure 4.3**. Out of all the clusters, two (2) clusters fall in vicinity of the Chapora River, namely Tuem Industrial Estate & Colvale Industrial Estate.



Source: GDITC, Govt. of Goa

Figure 4.3: Industrial Estates of Goa

4.2.2 Connectivity

The Industrial Clusters & Mining Areas in the catchment of Chapora River are well connected with other parts of Goa as well as other regional centers by an efficient Road & Rail network. **Figure 4.4** shows Road & Rail connectivity of major industrial clusters it the catchment of Chapora River.

Road Connectivity

Industrial Clusters of both Tuem & Colvale are well connected by the extensive road network of National & State Highways. The Colvale Cluster is directly accessible from National highway 66. The Cluster at Tuem is also connected to National Highway No. 66 for regional connectivity. The existing road network also ensures good connectivity of these Industrial Clusters with the Mormugao Port Trust.

Figure 4.4: Road/Rail Connectivity of Chapora River Catchment Area

Rail Connectivity

Chapora river basin & the industries in its vicinity are also connected to Indian Railway network by Konkan Railway. Konkan Railway connects the area with South Western railway at Majorda. Both the Railway sections are Single line sections with Diesel traction of locomotives. Railway connectivity to Mormugao port Trust is also available.

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

4.3 Existing Cargo Traffic

In the existing scenario, it has been observed that the waterway currently is not being used for any cargo shipping. However, passenger ferry service is available in this waterway from Camurlim to Tuem.

4.4 Future Cargo Potential

Keeping in view the Industrial Estates and Mining Areas located along the waterway, some potential for movement of cargo through IWT exists for Chapora River. Further, the Port traffic, Fish traffic and Passenger/Tourism traffic are also discussed in the following sections:

Industrial Traffic

Two Industrial estates viz. Tuem & Colvale are located within a distance of 5kms of the waterway corridor. Most of the industries in these estates are either small scale which have very limited potential of utilising waterways or produce commodities which do not require inland shipping.

However, the possibility of shipping the raw materials & commodities of these industries via Inland navigation & coastal shipping will be studied at DPR stage.

Annexure 4.1 and **Map 4.1** show various industries that are located within the hinterland of Chapora River.

Mineral Traffic

A number of mining sites are located in the catchment of Chapora River. These sites are located in Bardez, Pernem & Bicholim taluka. The mineral reserves of this river catchment include Laterite, Manganese, Iron Ore, Murram and Basalt. The location of these mines is shown in **Figure 4.6, Figure 4.7 & Figure 4.8**. Mines that are located within a distance of 5 km from river banks are given in **Table 4.3.**

Table 4.3: Mines in Vicinity of Chapora River

S. No.	Mine Location	Mineral
1	Nadora	Iron Ore & Laterite
2	Colvale	Laterite
3	Mencurem	Laterite
4	Tuem	Laterite
5	Agarvado	Laterite
6	Chopdem	Laterite
7	Dargalim	Iron Ore, Laterite & Manganese
8	Siolim	Manganese
9	Ozorim	Basalt & Manganese
10	Salem	Basalt
11	Dumacem	Basalt
12	Ibrampur	Basalt
13	Alorna	Basalt & Murram

It has been observed that some of the mines in these talukas are located in the vicinity of Chapora River. **Figure 4.5** shows various mining areas located in the vicinity of Chapora River.

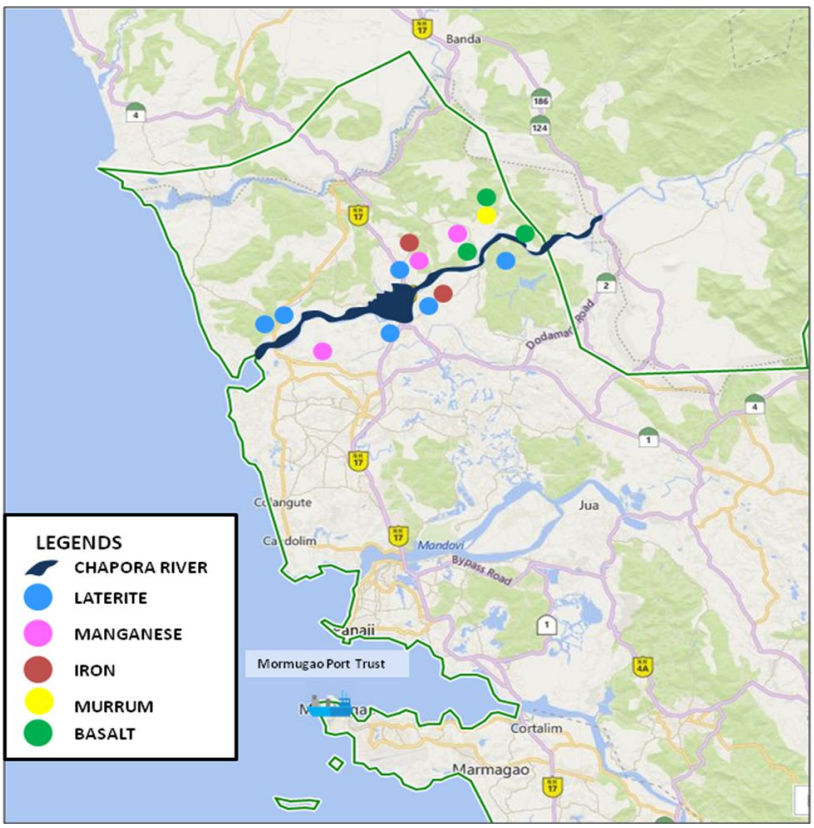
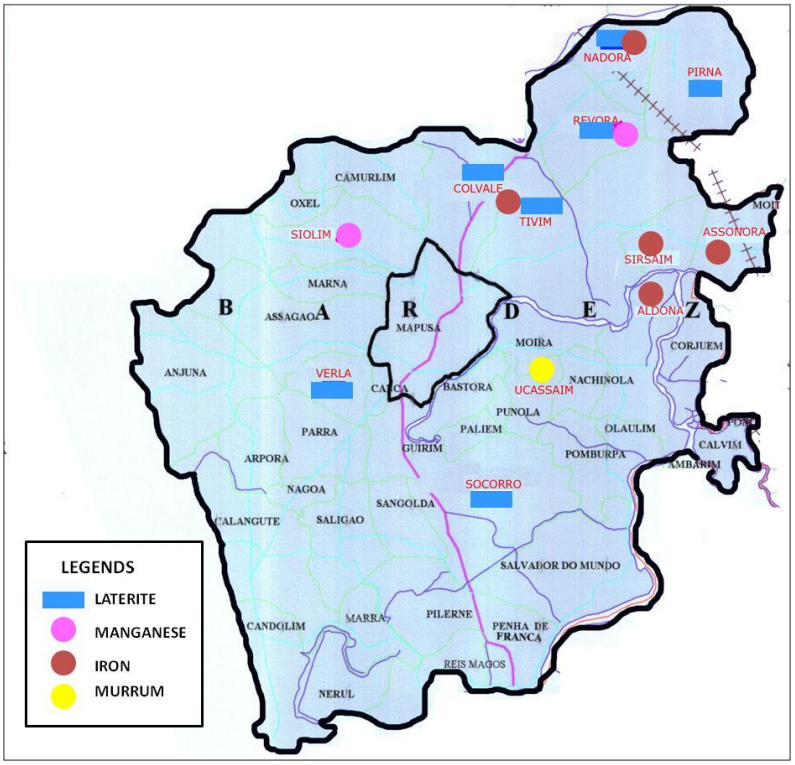
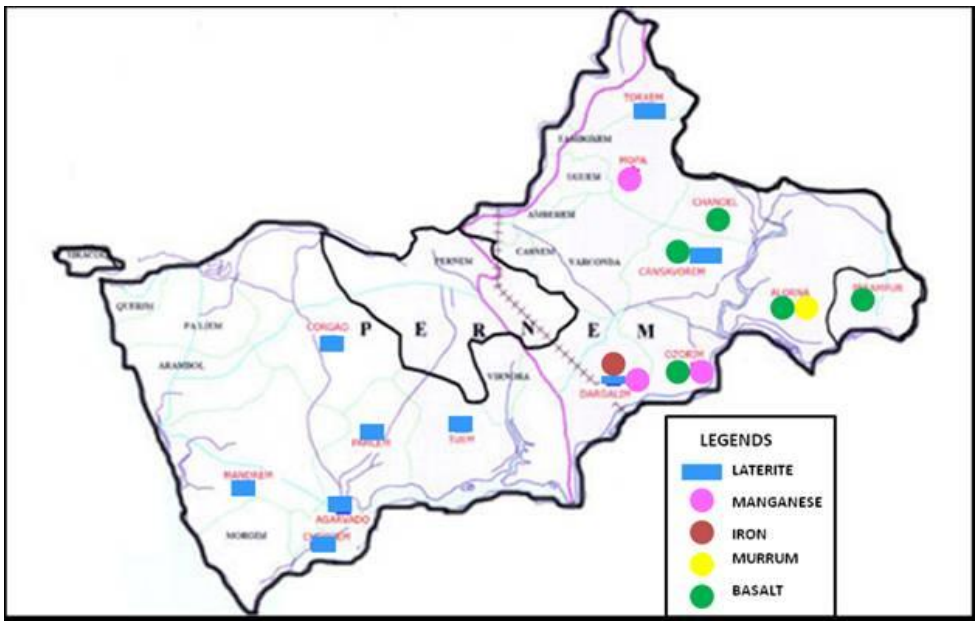


Figure 4.5: Mining Areas in catchment of Chapora River



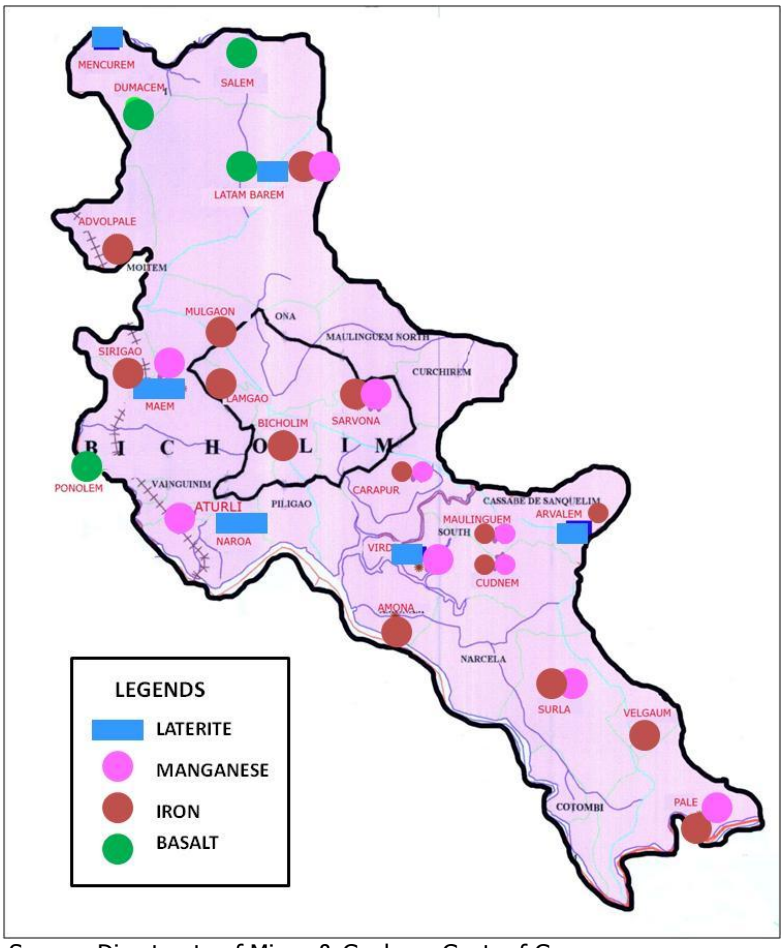
Source: Directorate of Mines & Geology, Govt. of Goa

Figure 4.6: Mining Areas in Bardez



Source: Directorate of Mines & Geology, Govt. of Goa

Figure 4.7: Mining Areas in Pernem



Source: Directorate of Mines & Geology, Govt. of Goa

Figure 4.8: Mining Areas in Bicholim

Although, most of the mines in vicinity of Chapora River are currently not in operations, keeping in view the upliftment of ban on mining, mining traffic is expected to come in future. This traffic will can have a positive impact on the feasibility of IWT. The detailed analysis of the same will be done at DPR stage.

Port Traffic

Mormugao Port is one of the major ports of India located in the South of Chapora River. The Port is well connected by both Road & Rail network. There has been a continuous increase in traffic at Mormugao port. **Figure 4.9** shows the growth of traffic at Mormugao Port. A dip in exports is observed in 2012-13 due to the ban on extraction of Iron Ore & Minerals. However, a steady increase has been observed in the same, thereafter.

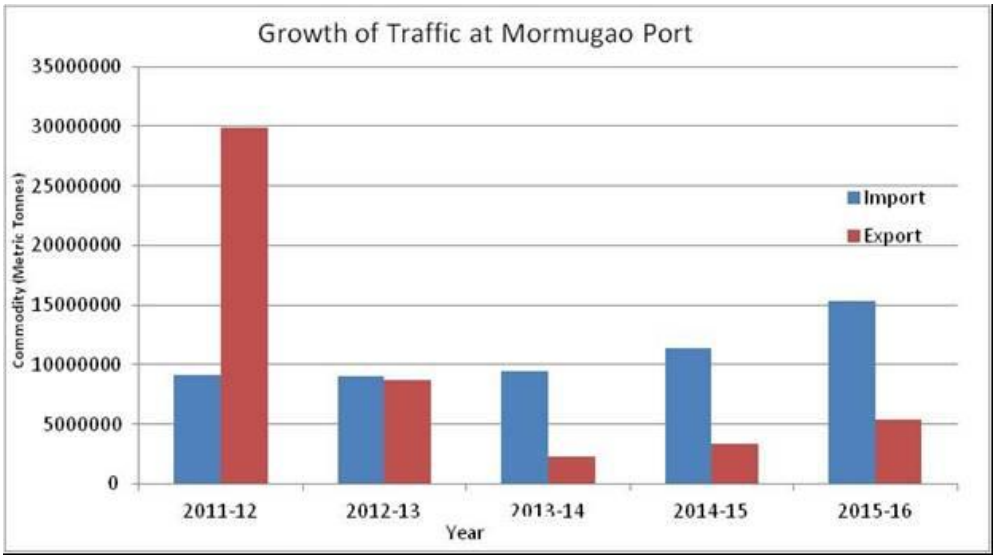


Figure 4.9: Traffic Growth at Mormugao Port

Mormugao Port handled 20.77 MMTPA cargo in 2015-16, which is 41% higher than the preceding year.

Chapora Port is also located at the end of Chapora River. The port currently is not handling any major cargo. However, the growth & development of the same can also play a vital role in the growth of traffic at Chapora River.

It is observed that at Mormugao port, Iron Ore & Coal are the major commodities that are being shipped. A dip in Iron Ore exports has been observed from 2011-12 to 2012-13 because of the ban on Iron Ore production imposed by the Courts. However, as the ban has now been lifted, growth in traffic of the same will be observed at Mormugao Port. The same has been observed in the cargo movement of 2015-16, where the Iron Ore and Pellets movement has increased to 3.57 MMTPA as compared to 0.6 MMTPA in 2014-15. **Figure 4.10** shows the growth of mineral traffic at Mormugao Port.

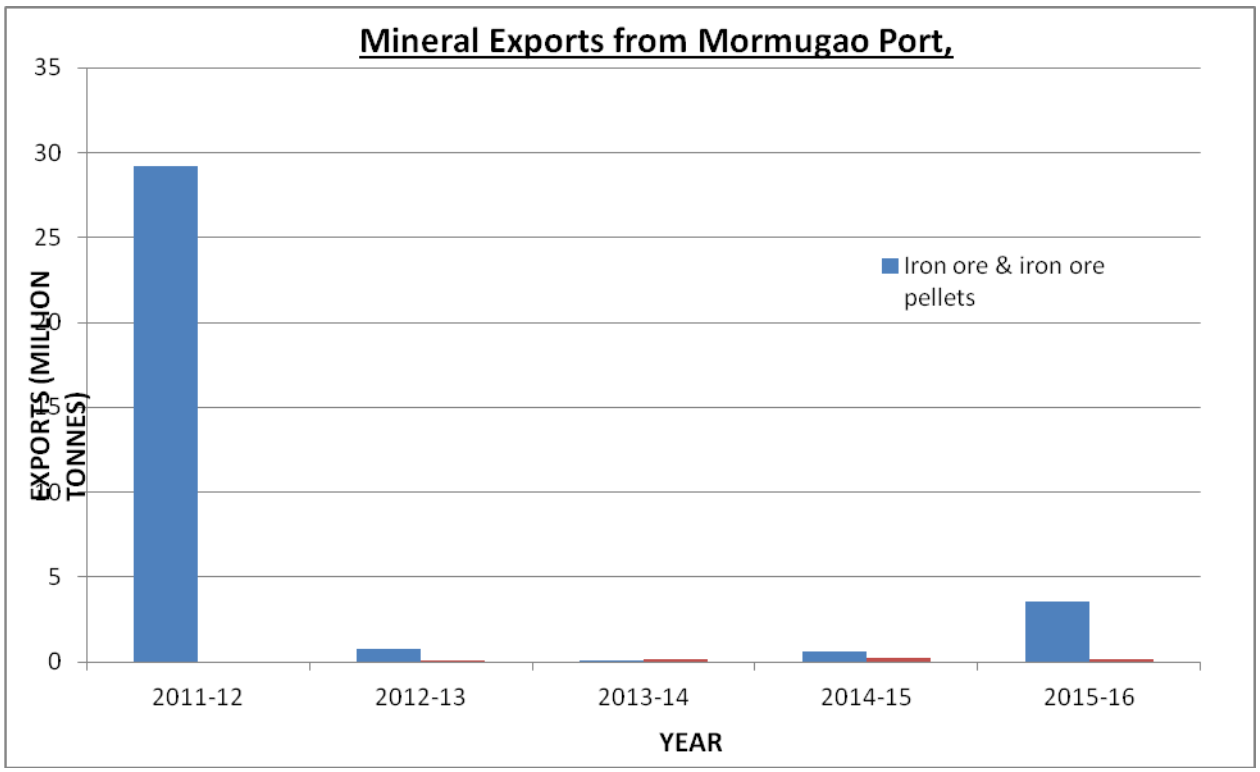


Figure 4.10: Mineral Export at Mormugao Port

The catchment area of Chapora River also has Iron Ore mines located in its hinterland. The growth in Iron Ore production and possibility of shipping it to Mormugao port via inland and coastal shipping will be studied at DPR stage.

Passenger Ferry

A passenger ferry route is located along the waterway from Camurlim to Tuem. 3.13 lakh people reside in the catchment area of Chapora River. Keeping this in view, a possibility for development of river navigation will be studied in detail at DPR stage.

4.4.1 Fish Production

During site visits & analysis, Inland Fish Production was observed along Chapora river waterway.

There has been a steady growth in fish production in Goa at a CAGR of 3.15% (2001-2015), which includes both Inland & Marine Fish production. **Figure 4.11** & **Table 4.4** shows the growth in annual Fish Production in Goa from 2001 to 2015.

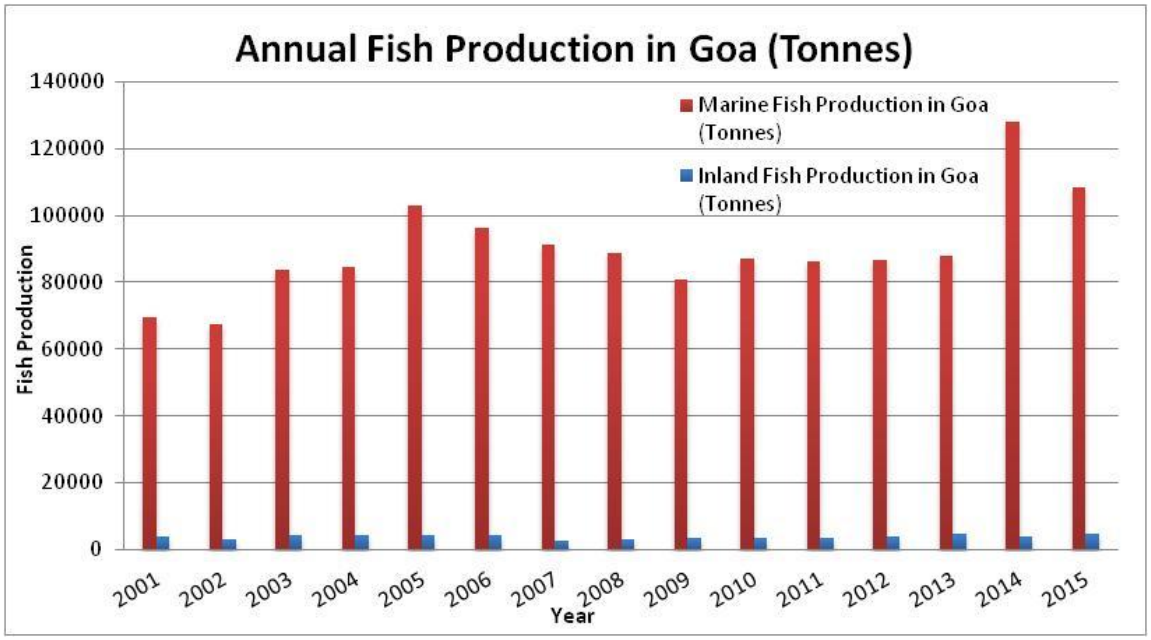


Figure 4.11: Annual Fish Production in Goa

It has been observed that growth in Marine Fish Production has been greater than the Inland Fish Production. Marine Fish Production has grown at a CAGR of 3.23% from 2001-2015 as compared to 1.62% for Inland Fish Production for the same period.

Table 4.4: Fish Production in Goa

Year	Marine Fish Production in Goa (Tonnes)	Inland Fish Production in Goa (Tonnes)
2001	69,386	3,713
2002	67,563	3,148
2003	83,756	4,285
2004	84,394	4,397
2005	1,03,087	4,194
2006	96,326	4,131
2007	91,185	2,447
2008	88,771	3,077
2009	80,687	3,283
2010	87,062	3,311
2011	86,185	3,538
2012	86,628	3,887
2013	87,984	4,678
2014	1,28,107	3,718
2015	1,08,240	4,648
CAGR	**3.23%**	**1.62%**

Inland fish production is also done along the inland portion of Chapora river basin. Five Inland fish landing centers are also located along the river:

a. Chapora Jetty (1 Jetty),
b. Wooden Jetty (2 Jetties),
c. Slope Jetty (2 Jetties).

Possibility of shipping fish through the study stretch will be analyzed at the DPR stage.

4.4.2 Tourist Traffic

The catchment area of Chapora River includes a number of tourist places which includes Chaopra Fort and other popular Beaches. The region currently has a number of tourist resorts along the coastline. **Table 4.5** shows the growth in tourists from 2001 to 2015. It has been observed that the overall growth in tourist traffic has been at a CAGR of 10.08% from 2001 to 2015.

Table 4.5: Tourist Growth in Goa

Year	Domestic	Foreign	Total
2001	11,20,242	2,60,071	13,80,313
2002	13,25,296	2,71,645	15,96,941
2003	17,25,140	3,14,357	20,39,497
2004	20,85,729	3,63,230	24,48,959
2005	19,65,343	3,36,803	23,02,146
2006	20,98,654	3,80,414	24,79,068
2007	22,08,986	3,88,457	25,97,443
2008	20,20,416	3,51,123	23,71,539
2009	21,27,063	3,76,640	25,03,703
2010	22,01,752	4,41,053	26,44,805
2011	22,25,002	4,45,935	26,70,937
2012	23,37,499	4,50,530	27,88,029
2013	26,29,151	4,92,322	31,21,473
2014	35,44,634	5,13,592	40,58,226
2015	47,56,422	5,41,480	52,97,902
CAGR	**10.88%**	**5.38%**	**10.08%**

Source: Department of Tourism, Govt. of Goa

The total number of tourists that visited Chaopra river catchment (Bicholim, Pernem & Bardez taluka) was 10,30,623 during 2013-14. The growth in Domestic Tourist traffic has been comparatively higher as compared to Foreign Tourist traffic. **Table 4.6** & **Figure 4.12** shows the growth in International & Domestic Tourists in Bicholim, Pernem & Bardez taluka.

Table 4.6: Tourist Growth in Chapora Catchment Area

Year	Bicholim		Pernem		Bardez		Total		Total
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign	
2008-09	25,153	135	11,793	19,467	4,93,494	1,16,716	5,30,440	1,36,318	6,66,758
2009-10	27,943	415	36,111	6,389	5,07,196	1,09,066	5,71,250	1,15,870	6,87,120
2010-11	31,975	458	40,572	18,382	5,15,883	1,16,033	5,88,430	1,34,873	7,23,303
2011-12	2,447	1,707	45,679	16,719	6,53,801	1,04,975	7,01,927	1,23,401	8,25,328
2012-13	5,103	1,801	69,970	16,999	6,99,887	1,05,881	7,74,960	1,24,681	8,99,641
2013-14	5,803	2,546	84,814	17,651	8,01,455	1,18,354	8,92,072	1,38,551	10,30,623
CAGR	-25.42%	79.93%	48.38%	-1.94%	10.18%	0.28%	10.96%	0.33%	9.10%

Source: Statistical Handbook, Govt. of Goa.

The overall growth rate in number of tourists in the catchment of Chapora during the period of 2008 to 2013 has been observed to be 9.10%.

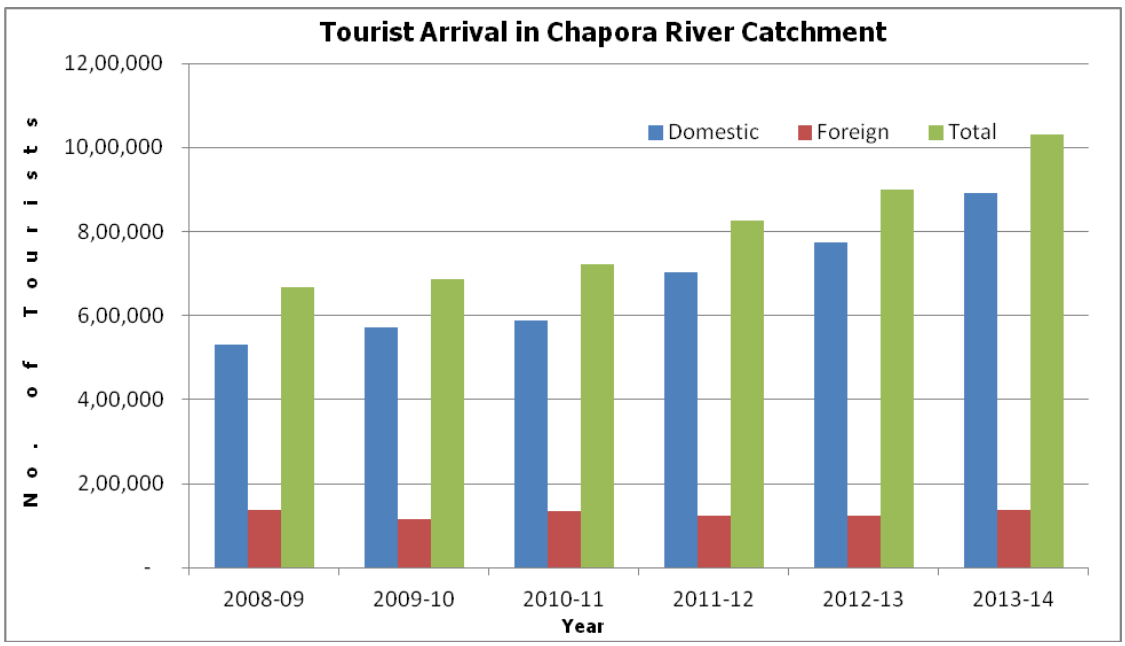


Figure 4.12: Tourist Growth in Chapora Catchment Area

The possibility for development of tourism potential along the waterway will be studied at DPR stage.

4.5 Conclusion

Iron Ore & other Mineral Mines are located in the vicinity of Chapora River and with the upliftment of ban on mining in Goa, movement of the same via Chapora River offers a potential for development of IWT. The direct connectivity of Chapora River with Chapora Port also provides a positive outlook for development of Inland & Coastal Shipping. However, the volumes etc. that would be diverted to IWT will be studied in detail at DPR stage.

Two Industrial Estates viz. Tuem & Colvale are located within a distance of 5 km from waterway. The possibility of diverting the cargo of these estates via inland shipping will be studied at DPR stage.

The development of Ferry Services for Passenger/Tourist traffic will be studied at DPR stage.
The mobility of Fish through Inland and Coastal Shipping also offers a potential for growth in cargo traffic along the waterway. Economics of the same will be studied in detail at DPR stage.

CHAPTER 5: OBSERVATIONS AND INFERENCES

5.1 Waterway Feasibility

Based on the details presented in the Chapter-3, following conclusions have been derived for establishing the navigability of the proposed waterway;

1. The river length as given by IWAI is 33km, whereas the total surveyed length along the river to capture the thalweg is 28.70km. The deepest channel route has been reckoned as 28.70km. All inferences derived for identifying the navigable length have been derived with reference to the deepest channel length (28.70km).
2. The river is tidal affected for a majority of length under study and relevant chart datum has been used. 73% of the surveyed length (starting from 0.00km - confluence of river with sea near Chapora) has water depth more than 2.0m, however not continuous. The average tidal variation is 1.15m with maximum high tide of 2.3m and low tide of 0.00m as per the records available for this region. The average tide height of 1.15m would be an added advantage for the safe navigation.
3. It has been observed that the feasibility study suggests that the river is navigable without any significant obstructions up to the Rail Bridge (at Ch. 16.49km) and it can traverse up to the end of the stretch i.e., up to Ch 28.70 with different class where a Barrage exists. Accordingly, the stretch has been classified as Class III up to Ch 16.49km and the balance stretch as Class II.
4. The lengths of the waterway, with a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart datum have been compiled in the main report. This is given in Table 3.8 of the report and is being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-4	5.8	0.5	3.48	0.17	-	0.35
4-10	9.7	0.1	3.50	0.50	1.00	1.00
10-17	13.1	1.3	6.22	0.39	0.39	-
17-23	14.3	0.7	5.08	0.46	0.31	0.15
23-28.7	8.4	0.1	2.70	0.60	1.20	1.20
Total			**20.98**	**2.12**	**2.90**	**2.70**
28.7-33	Topographic survey due to shallow water depth, 0.2m to 0.8m.					

5. Two H. T. Lines are crossing the study stretch with the vertical clearance of 13.0m and 20.0m MHWS. The minimum vertical clearance required shall be 20.1m corresponding to 220kVA transmission line.
6. The Rail Bridge at Ch 16.49km is to be considered with single lane operation.

The description & classification of the waterway has been presented schematically based on the survey observation and duly keeping in view the river classification criteria in Table 3.17 as reproduced below.

Criteria	Classification																			
Length of waterway from start (km)	1	3	4	6	7	9	10	11	13	14	16	17	19	20	22	23	24	26	27	28.7
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V																	C-II		
Raod Bridge Vert. Clearance	C-III												C-II							
Raod Bridge Hor. Clearance	C-III												C-II							
HT Line Vert. Clearance	All Class										Needs Raising of HT Base									
Bend Radius	C-II																			
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

5.2 Cargo Feasibility

Iron Ore & other Mineral Mines are located in the vicinity of Chapora River and with the upliftment of ban on mining in Goa, movement of the same via Chapora River offers a potential for development of IWT. The direct connectivity of Chapora River with Chapora Fishing Port also provides a positive outlook for development of Inland & Coastal Shipping. However, the volumes etc. that would be diverted to IWT will be studied in detail at DPR stage.

Two Industrial Estates viz. Tuem & Colvale are located within a distance of 5 km from waterway. The possibility of diverting the cargo of these estates via inland shipping will be studied at DPR stage.

The development of Ferry Services for Passenger/Tourist traffic will be studied at DPR stage.

The mobility of Fish through Inland and Coastal Shipping also offers a potential for growth in cargo traffic along the waterway. Economics of the same will be studied in detail at DPR stage.

5.3 SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objectives of the study for development of the waterway for year round commercial navigation and identifying the internal & external factors that are favorable and unfavorable in the development of the waterway.

Strength

1. 73% of the surveyed length has water depth more than 2 m and is safe for navigation.
2. The above depth of more than 2m is almost available, in the 73% of the study stretch up to the Barrage at Ch 28.69km, however not continuous. Certain patches may be required to be attended with a moderate conservancy activity involving dredging.
3. The entire study stretch is tidal affected (27.69km). The maximum water level fluctuation of 2.3m has been observed and this will strengthen the safe mobility of vessels in the waterway.
4. Approximately 3.1 lacs of population are residing in the region of Pernem, Bardez and Bicholim talukas.

5. The Existing Fish movement will have some influence on IWT, with the river stretch development.
6. A considerable Iron Ore and Mineral cargo are divertible from / to hinterland, on upliftment of mining policy in the region, as per the preliminary study.
7. The nearby Industrial Estates (two nos) may be an additional strength for IWT.
8. Ferry service with Passenger / Tourism potential is in existence.
9. Fish mobility is in existence.

Weakness

1. Presently, there is no IWT movement. However, the traffic estimations present an optimistic picture for IWT.
2. The waterway clearances available at Rail Bridge at Ch 16.49km and Road bridge at Ch 17.06km are alarming for future IWT development.

Opportunity

1. 73% of the surveyed length has water depth more than 2 m, which can be used advantageously for the mobility of hinterland cargo.
2. The entire stretch is in tidal zone and the tidal effect can be used advantageously.
3. Approximately 3.1 lacs of population is residing in the region of Pernem, Bardez and Bicholim talukas, which will have direct or indirect benefits from the IWT and related projects coming up in the area.
4. A considerable Iron Ore and Mineral cargo are divertible from the hinterland, on upliftment of mining policy in the region, as per the preliminary study.
5. The nearby Industrial Estates (two nos) are an opportunity for better utilization of the stretch to mobilise IWT cargo.
6. The Existing Fish movement will have some influence on IWT, on its development.
7. The existing Ferry service with Passenger / Tourism potential will support IWT, if developed.
8. The present Rail and Road connectivity though may be competing with IWT may also be an opportunity for creating an efficient intermodal hub for IWT.
9. Policies are to be firmed up for development of IWT in this stretch.

Threat

1. The Mumbai – Goa Highway and State Highways SH-2; SH-124 and SH-130 in the study area may create competing modes of transport especially with respect to cargo traffic for the proposed waterway.
2. The present rail network also may pose some threats as an alternative mode of transport.
3. The scattered marginal mangrove trees in certain places may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.

5.4 Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. Henceforth, the development of the proposed national waterway involves physical interference in the form of dredging, construction of terminals at the identified locations, modification of HT Lines at crossing locations to provide a minimum vertical clearance of 20.1m (with respect to 220 kVA) or the case may be combined with some unforeseen expenses. Moderate dredging effort has been envisaged with an average dredging of 1.0m required in 7.7km of the length of proposed waterway reckoned with reference to ascertained data. The cost of dredging has been considered @ INR 230 per cum. The cost of terminal has been estimated @ INR 20.0 crore each for two terminals. HT line crossing shall need modification which shall require two towers at the bank of requisite height and the stringing over pair of poles crossing the Chapora River. The cost of transmission tower has been estimated to be INR 20.00 lacs each and the stringing cost across the towers shall be INR 4.0 lacs per pair of towers. The total estimated cost for modification to two HT Lines shall be INR 2 x 44.0 lacs = INR 132.0 lacs. The cost of navigational aids for day/night navigation has been considered as INR 350 lacs. 10% of the amount for dredging, terminal construction, tower / bridge modification and night navigational aids has been envisaged as unforeseen. The tentative total cost of development to make the river navigable round the year to achieve safe navigation for the required classification of vessel mobility has been estimated to INR 56.60 crore.

Table 5.1: Tentative Development Cost of Chapora River Waterway (NW 25)

Sl. No.	Name of Waterway	Length of Water way	Dredging Required (w. r. to 2 m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Terminal Proposed	Terminal Cost @ INR 20 Cr each	Cost of Modification of Transmission line	Night Navigation	Total cost incld. 10% unforeseen
		(km)	(km)	INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Chapora River	28.70 / 33.00	7.70	7.10	2.00	40.00	0.88	3.5	56.60

5.5 Classification of Waterway

The 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 DWT and tug-barge formation in push tug + four barge units of carrying capacity up to 8000 DWT (Ref: IWAI, Gazette Notification dated 26th January 2007).

As per the above Classification of Inland Waterways, the entire waterway of Chapora River (NW 25) of 33.00km length has been classified based on available minimum water depth, bottom width, minimum vertical and horizontal clearances of cross over structures and bend radius in the river. The classification of Chapora River Waterway is described below.

Table 5.2: Classification of Chapora River (NW 25)

Chainage (km)	Minimum Depth (m)	Bottom Width (m)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)	Bend Radius (m)	Classification of Waterway
0.0 – 16.49	0.1	150.0	8.5 (Bridge) 13.0 (H. T. Line)	30 (Bridge)	350	**Class – III**
16.49 – 28.70	0.1	100.0	6.5 (Bridge)	20 (Bridge)	320	**Class – II**

The study stretch of the waterway is amenable for development as Class III / Class II waterway as explained above. Marginal Dredging may be required. Bridge at Ch 16.49 is to be considered with single lane operation. Further smoothening of bends is essential.

The above stretch of the waterway, hence, can be considered under Class III, which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 500 DWT (approximate size 58m overall length, 9m moulded breadth and 1.5m loaded draft) or one tug and two barges combination of 1000 DWT (approximate size 141m overall length, 9m breadth and 1.5m loaded draft). Further, partial stretch can be considered under Class II, which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 300 DWT (approximate size 45m overall length, 8m moulded breadth and 1.2m loaded draft) or one tug and two barges combination of 600 DWT (approximate size 110m overall length, 8m breadth and 1.2m loaded draft).

5.6 Recommendation

The national waterway-25 of Chapora River has been identified having potential for development as waterway of Class-III / Class II in the study stretch, as described above. This stretch of the river is, therefore, recommended for stage-II study for preparation of Detailed Project Report (DPR) to establish the viability for implementation as a project.

Accordingly, the national waterway NW-25 of Chapora River is proposed for development as **Class III / Class II** waterway in the stretch of the waterway as depicted below:

River Stretch	0.0 km 16.49km	28.70km
Classification		
	Class- III	**Class-II**
Horizontal clearance (m)	50	40
Vertical clearnce (m)	7	5
Minimum Depth (m)	1.7	1.4
Bottom Width (m)	50	40
Self Propelled Vessel		
Dead Weight Tonnage	500	300
Vessel size (m)	(58 x 9 x 1.5)	45 x 8 x 1.2
Tug + Barge		
Dead Weight Tonnage	1000	600
Vessel size (m)	(141 x 9 x 1.5)	110 x 8 x 1.2

ANNEXURE 1.1

DATA COLLECTION & SOURCE OF DATA

Annexure 1.1: Data Collection Source of Data

(Cluster-7)

Sl. no	Name of Authority, place	Contacted Person	Designation	Required Data	Collected Data	Date of Receiving Data	Remarks
MAHARASHTRA							
1	Office of Hydrographer, Maharashtra Maritime Board, Khar (West), Mumbai	Mr. Sandip Dhuraji	Hydrographer	Chart Datum & Structure Detail in Water Way	Yes	3/4/2016	Official Letter Submitted to the Department. Data Received
2	Office of Hydrographer, Maharashtra Maritime Board, Khar (West), Mumbai	Mr. Anil Kadam	Assistant Hydrographer	River Gauge & Discharge Data/ Structure Detail	Yes	3/4/2016	Official Letter Submitted to the Department. Data Received
3	Kolkewadi Dam Maintainance Division, Alore, WRD, Maharashtra	Mr.K M Mane	Sectional Engineer (Admin)	River Gauge & Discharge Data/ Structure Detail/ Chart Datum	---	---	Official Letter Submitted to the Department. Data is Awaited
4	Indian Oil Corporation Ltd. (IOCL), Indian Oil Bhawan, G-9, Ali Yavar Jung Marg, Bandra (East), Mumbai	Mr. R. D. Kherdekar	GM (Consumer)	POL Data	Yes	7/6/2016	Discussion
5	Maharashtra Maritime Board, Main Office, Ramji Bhai Kamani Marg Ballard Estate, Mumbai	Mr. Atul Patane	Chief Executive Officer	existing traffic data on Cluster-7 Inland waterways and associated ports in Maharashtra	Yes	8/6/2016	Official Letter Submitted to the Department. Data Received
6	Maharashtra Industrial Development Corporation, Udyog Sarathi, Andheri (E), Mumbai	Mr. Yuvraj Poman	OSD (Markering)	Industries along the Cluster-7 Inland waterways in Maharashtra	Yes	8/6/2016	Official Letter Submitted to the Department. Maharashtra MIDC Industrial Area Map Received
7	Maharashtra Tourism Development Corporation Ltd. Opp. LIC (Yogakshema) Building, Madame Cama Road, Mumbai	Mr. Satish Soni	Director of Tourism & Jt. MD	Existing Tourism Development and Future Plan on Cluster-7 Inland waterways in Maharashtra	Yes	8/6/2016	Discussion
8	Direcorate of Industries, Government of Maharashtra	Mr. S. B. Patil	Jt. Director	Industries along the Cluster-7 Inland waterways in Maharashtra	To be Provided	---	Data is Awaited
9	Collectorate & DM Office, Raigarh, Maharashtra	Mr. Sagar Pathak	District Disaster Management Officer	Population data along the Cluster-7 Inland waterways in Ragarh district	Yes	9/6/2016	Population Data Received

Annexure 1.1: Data Collection Source of Data

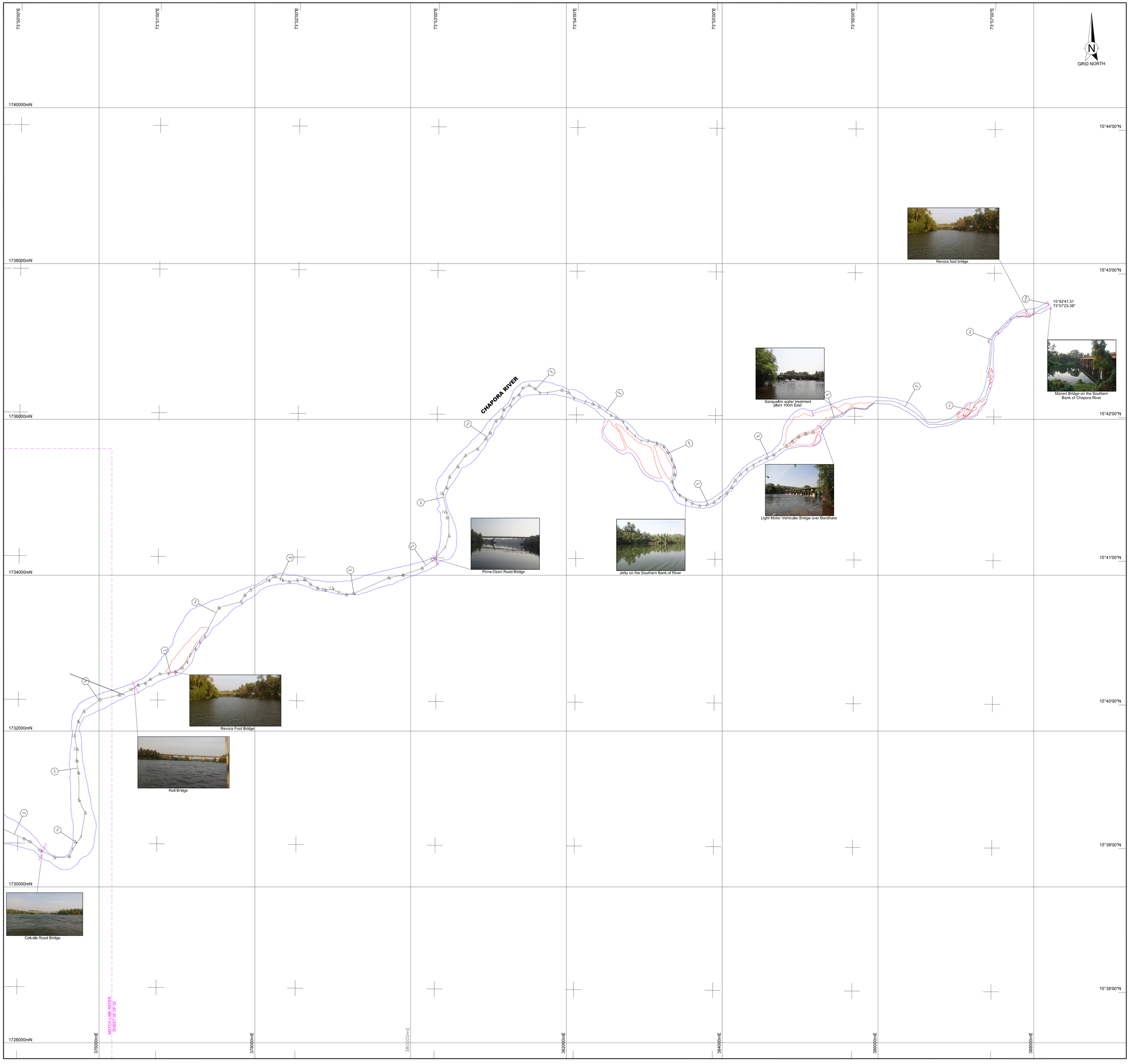
(Cluster-7)

Sl. no	Name of Authority, place	Contacted Person	Designation	Required Data	Collected Data	Date of Receiving Data	Remarks
10	District Industrial Centre, Raigarh, Maharashtra	Mr. Lohnde	GM	Industries along the Cluster-7 Inland waterways in Raigarh district	Yes	9/6/2016	Industrial Data Received
11	Collectorate & DM Office, Raigarh, Maharashtra	Mr. K. Shinde	Superintendent of Agriculture	Crops/Fruits along the Cluster-7 Inland waterways in Raigarh district	Yes	9/6/2016	Agriculture/Horticulture Data Received
12	Collectorate & DM Office, Ratnagiri, Maharashtra	Mr. Suryavanshi	District Disaster Management Officer	Population data along the Cluster-7 Inland waterways in Ratnagiri district	To be Provided	10/6/2016	Data is Awaited
13	Collectorate & DM Office, Ratnagiri, Maharashtra	Mr. Vidyadhar Vaidya	Superintendent of Agriculture	Crops/Fruits along the Cluster-7 Inland waterways in Ratnagiri district	Yes	10/6/2016	Agriculture/Horticulture Data Received
14	District Industrial Centre, Ratnagiri, Maharashtra	Mrs. Ranjana Basantrao Pol	Manager	Industries along the Cluster-7 Inland waterways in Ratnagiri district	Yes	10/6/2016	Industrial Data Received
GOA							
1	Works Division - III, Water Resource Department, Goa	Mr. R. B. Ghanti,	Executive Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
2	Water Resource Department, Goa	Mr. S T Nandkarni	Chief Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
3	Water Resource Department, Works Division-III, Goa	Mr. P. B. Badami	Executive Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
4	Water Resource Department, Works Division-III, Goa	Mr. Rajan	Section Engineer, WRD. Goa	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
5	Captain of Ports Department, Govt. of Goa.	Mr. Sagar Chandra Rai	Captain	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited

ANNEXURE 3.1

OVERVIEW CHART FOR CHAPORA RIVER BATHYMETRY

BATHYMETRY



LEGEND:

FEATURES IDENTIFIED FROM CURRENT SURVEY

GENERAL

- GEOGRAPHICAL GRATICULE INTERSECTION
- CHAINAGE ALONG CENTER LINE

BATHYMETRY

FEATURES OBTAINED FROM OTHER SOURCES (AS INDICATED)

- RIVER BOUNDARY (DRAWN FROM GOOGLE)
- SHALLOW PATCHES
- BRIDGE
- BUOY
- JETTY

NOTES:

1) SURVEY VESSEL JIJAI WAS DEPLOYED FOR THIS SURVEY IN FEBRUARY 2016.
2) THE COORDINATES OF THE SURVEY CORRIDOR WERE PROVIDED BY THE CLIENT.
3) FUGRO'S STARFIX SYSTEM WAS USED FOR POSITIONING AND CONTROL OF SURVEY.
4) REFER TO FSINPVT SURVEY REPORT NO. J-MAR-16-012 FOR DETAILS ON THE RESOURCES MOBILISED AND METHODOLOGY ADOPTED FOR THIS SURVEY.
5) SOUNDINGS WERE REDUCED TO CHART DATUM USING REAL TIME TIDAL HEIGHTS OBSERVED IN THE SURVEY AREA APPLYING MSL-CD RELATIONSHIP 1.3m of Mormugao from ATT.
6) THE RESULTS OF SURVEY ARE PLOTTED IN WGS84 DATUM, UTM PROJECTION. ZONE 43N: CENTRAL MERIDIAN 075° E.

REFERENCE DRAWINGS

Rev. No:	Date:	Drawing No.	Source	Description:
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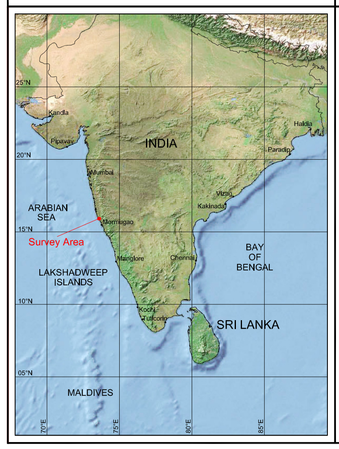
OVERVIEW PLAN



LAYOUT PLAN — INDIA - WEST COAST

NOT TO SCALE

CLIENT

TRACTEBEL ENGINEERING PVT. LTD.
2nd FLOOR, BUILDING NO-10C,
DLF CYBER CITY,
GURGAON - 122002
HARYANA (INDIA)

SURVEY CONTRACTOR

FUGRO SURVEY (INDIA) PVT. LTD.
FUGRO HOUSE
D-222/30, TTC INDUSTRIAL AREA, MIDC, NERUL, NAVI
MUMBAI - 400 706, INDIA
TEL : +91 22 2762 9500 FAX : +91 22 2762 9140
(AN ISO 9001:2008 COMPANY)

PROJECT TITLE

RECONNAISSANCE SURVEY AND FEASIBILITY REPORT FOR STAGE-1 IN MAHARASHTRA AND GOA WEST COAST OF INDIA

FEBRUARY 2016

CHART SHOWING

OVERVIEW CHART FOR CHAPORA RIVER

BATHYMETRY

SHEET 01 OF 02

HORIZONTAL SCALE 1 : 20,000

400m 0m 400m 800m 1200m 1600m 2000m

Vessel:- JIJAI — Project Ref: J-MAR-16-012

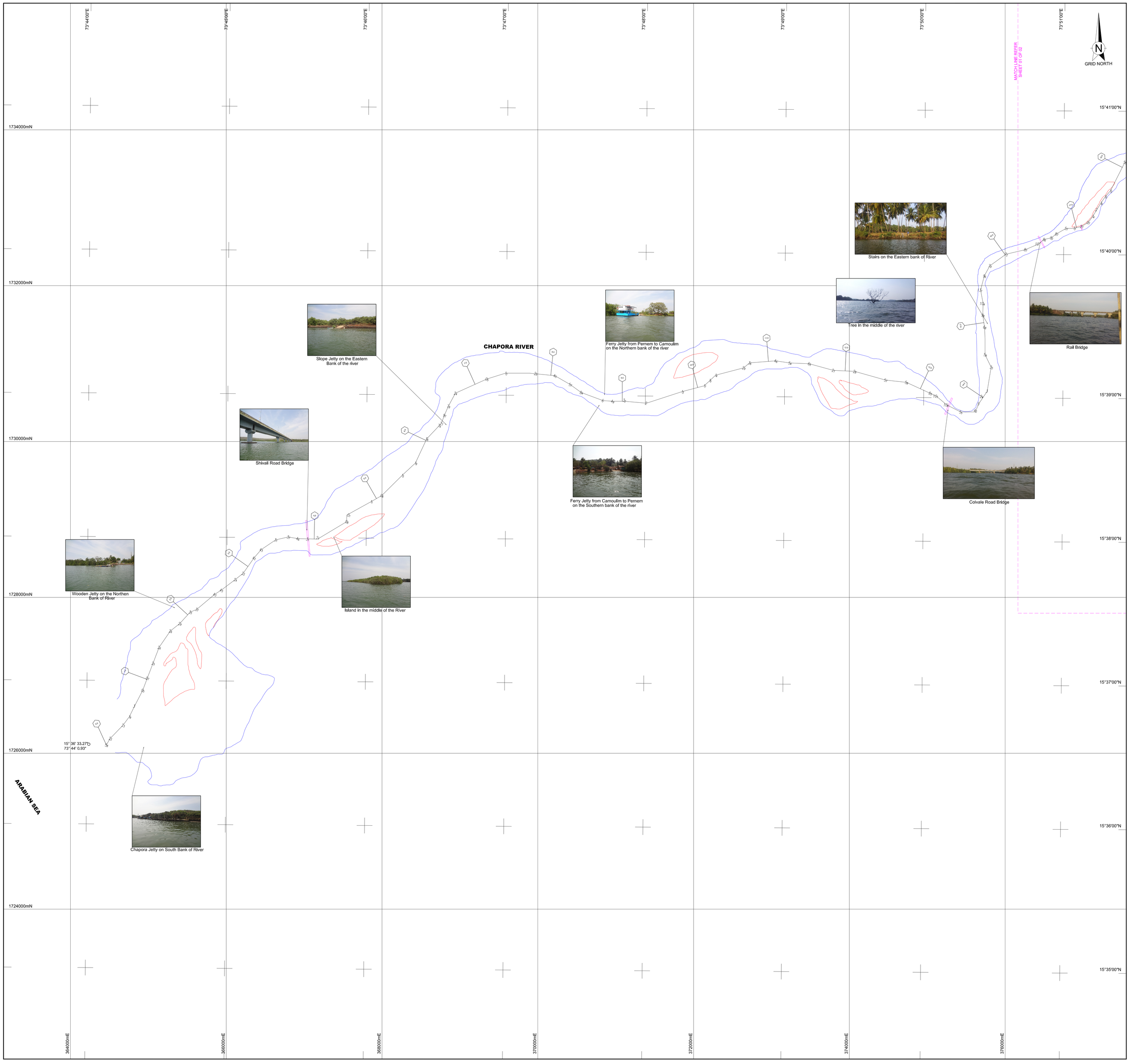
Rev. No:	Date:	Description:	Surveyed :	Interpr:	Drawn:	Chkd:	Appr:
0	13/06/2016	ISSUED FOR APPROVAL	SD	–	RP/SG	KS/PM	MI

Drawing File No: 7442-01R0

Drawing No: J-MAR-16-012D/TRACTEBELENGINEERING/GOA/B/B/01/7442

Encl: 01 OF 02

BATHYMETRY



LEGEND:

FEATURES IDENTIFIED FROM CURRENT SURVEY

GENERAL

- GEOGRAPHICAL GRATICULE INTERSECTION
- CHAINAGE ALONG CENTER LINE

BATHYMETRY

- DEPTHS IN METRES BELOW CHART DATUM
- HEIGHTS IN METRES ABOVE CHART DATUM

FEATURES OBTAINED FROM OTHER SOURCES (AS INDICATED)

- RIVER BOUNDARY (DRAWN FROM GOOGLE)
- SHALLOW PATCHES
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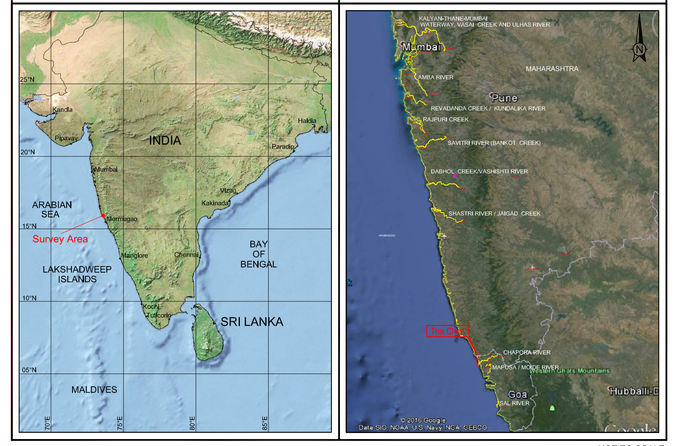
Rev. No:	Date:	Drawing No.	Source	Description:
-	-	-	-	-

OVERVIEW PLAN

LAYOUT PLAN — INDIA - WEST COAST



NOT TO SCALE

CLIENT

TRACTEBEL ENGINEERING PVT. LTD.
2nd FLOOR, BUILDING NO-10C,
DLF CYBER CITY,
GURGAON - 122002
HARYANA (INDIA)

SURVEY CONTRACTOR

FUGRO SURVEY (INDIA) PVT. LTD.
FUGRO HOUSE
D-222/30, TTC INDUSTRIAL AREA, MIDC, NERUL, NAVI
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(AN ISO 9001:2008 COMPANY)

PROJECT TITLE

RECONNAISSANCE SURVEY AND FEASIBILITY REPORT FOR STAGE-1 IN MAHARASHTRA AND GOA WEST COAST OF INDIA

FEBRUARY 2016

CHART SHOWING

OVERVIEW CHART FOR CHAPORA RIVER

BATHYMETRY

SHEET 02 OF 02

HORIZONTAL SCALE 1 : 20,000

400m 0m 400m 800m 1200m 1600m 2000m

Vessel:- JIJAI — Project Ref: J-MAR-16-012

Rev. No:	Date:	Description:	Surveyed :	Interpr:	Drawn:	Chkd:	Appr:
0	13/06/2016	ISSUED FOR APPROVAL	SD	–	RP/SG	KS/PM	MI

Drawing File No: 7442-02R0

Drawing No: J-MAR-16-012D/TRACTEBELENGINEERING/GOA/B/B/02/7442

Encl: 02 OF 02

ANNEXURE 3.2

DAILY HEIGHTS OF HIGH AND LOWE WATERS AT MARMAGAO OBTAINED FROM CAPTAIN OF PORTS, PANAJI, GOA

MARMAGAO – INDIA, WEST COAST

LAT. 15° 25′ N. LONG. 73° 48′ E.

TIME ZONE -0530 — TIMES AND HEIGHTS OF HIGH AND LOW WATERS — YEAR 2015

JANUARY

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 F	0307	2.14	16 SA	0256	2.33
	0959	0.98		0945	0.71
	1531	1.58		1542	1.81
	2051	1.07		2122	1.01
2 SA	0342	2.06	17 SU	0336	2.23
	1048	0.96		1044	0.66
	1645	1.53		1732	1.78
	2142	1.23		2233	1.21
3 SU	0420	1.98	18 M	0426	2.12
	1140	0.91		1144	0.59
	1829	1.58		1857	1.86
	2308	1.36		2351	1.35
4 M	0506	1.92	19 TU	0526	2.02
	1234	0.83		1250	0.51
	1945	1.69		2012	1.99
5 TU	0028	1.43	20 W	0114	1.39
	0601	1.88		0655	1.96
	1328	0.72		1354	0.41
	2057	1.84		2118	2.12
6 W	0152	1.44	21 TH	0233	1.34
	0706	1.87		0759	1.96
	1418	0.59		1450	0.32
	2145	1.99		2210	2.23
7 TH	0300	1.39	22 F	0332	1.25
	0802	1.89		0853	1.97
	1501	0.47		1538	0.27
	2224	2.12		2252	2.31
8 F	0350	1.32	23 SA	0423	1.14
	0851	1.92		0943	1.99
	1542	0.37		1623	0.25
	2302	2.23		2329	2.35
9 SA	0433	1.25	24 SU	0509	1.05
	0935	1.96		1033	2.00
	1620	0.29		1702	0.28
	2339	2.32			
10 SU	0512	1.18	25 M	0001	2.36
	1019	2.00		0553	0.97
	1657	0.25		1119	1.99
				1739	0.36
11 M	0012	2.38	26 TU	0031	2.36
	0549	1.10		0632	0.92
	1102	2.03		1203	1.96
	1733	0.25		1808	0.46
12 TU	0042	2.42	27 W	0100	2.33
	0628	1.00		0709	0.88
	1147	2.05		1245	1.90
	1811	0.30		1838	0.59
13 W	0110	2.45	28 TH	0128	2.29
	0710	0.91		0742	0.86
	1238	2.02		1326	1.83
	1853	0.41		1906	0.73
14 TH	0141	2.45	29 F	0157	2.23
	0758	0.84		0819	0.86
	1334	1.97		1409	1.75
	1940	0.58		1937	0.89
15 F	0216	2.41	30 SA	0222	2.15
	0850	0.77		0858	0.85
	1434	1.89		1457	1.68
	2027	0.79		2011	1.04
			31 SU	0247	2.07
				0943	0.85
				1553	1.62
				2051	1.20

FEBRUARY

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 M	0321	1.99	16 TU	0357	2.02
	1034	0.84		1118	0.54
	1712	1.59		1838	1.87
	2143	1.34		2340	1.35
2 TU	0409	1.90	17 W	0502	1.88
	1132	0.81		1225	0.55
	1849	1.65		1958	1.95
	2318	1.45			
3 W	0505	1.83	18 TH	0107	1.36
	1231	0.75		0648	1.81
	2005	1.78		1335	0.52
				2105	2.05
4 TH	0100	1.48	19 F	0227	1.28
	0610	1.79		0758	1.82
	1333	0.65		1436	0.47
	2111	1.92		2156	2.13
5 F	0234	1.42	20 SA	0327	1.15
	0727	1.81		0854	1.86
	1429	0.53		1527	0.44
	2156	2.07		2235	2.19
6 SA	0329	1.31	21 SU	0414	1.03
	0829	1.87		0945	1.90
	1517	0.41		1612	0.43
	2235	2.20		2308	2.22
7 SU	0413	1.19	22 M	0455	0.92
	0921	1.95		1031	1.94
	1559	0.32		1649	0.46
	2311	2.31		2334	2.23
8 M	0451	1.06	23 TU	0532	0.83
	1007	2.02		1115	1.96
	1640	0.27		1722	0.51
	2342	2.39			
9 TU	0529	0.91	24 W	0000	2.24
	1055	2.09		0603	0.76
	1719	0.27		1156	1.96
				1749	0.59
10 W	0010	2.45	25 TH	0027	2.23
	0607	0.76		0631	0.71
	1144	2.14		1234	1.94
	1800	0.33		1817	0.69
11 TH	0038	2.48	26 F	0052	2.20
	0649	0.63		0700	0.68
	1236	2.14		1312	1.90
	1843	0.45		1843	0.80
12 F	0110	2.48	27 SA	0112	2.15
	0734	0.54		0730	0.67
	1333	2.10		1349	1.85
	1928	0.63		1913	0.91
13 SA	0147	2.42	28 SU	0130	2.09
	0823	0.50		0804	0.68
	1429	2.02		1430	1.79
	2018	0.84		1945	1.04
14 SU	0225	2.31	29 M	0154	2.02
	0917	0.49		0842	0.70
	1532	1.92		1518	1.73
	2112	1.06		2026	1.16
15 M	0308	2.17			
	1014	0.52			
	1708	1.85			
	2223	1.24			

MARCH

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 TU	0226	1.93	16 W	0339	1.85
	0927	0.73		1049	0.55
	1614	1.68		1812	1.89
	2119	1.29		2332	1.26
2 W	0310	1.83	17 TH	0451	1.71
	1023	0.75		1158	0.64
	1742	1.68		1928	1.92
	2233	1.39			
3 TH	0419	1.74	18 F	0100	1.23
	1133	0.75		0652	1.66
	1907	1.76		1313	0.67
				2037	1.97
4 F	0019	1.41	19 SA	0218	1.11
	0532	1.70		0805	1.71
	1242	0.70		1418	0.66
	2009	1.88		2127	2.02
5 SA	0202	1.34	20 SU	0312	0.98
	0704	1.72		0907	1.77
	1348	0.61		1510	0.65
	2103	2.02		2203	2.05
6 SU	0303	1.20	21 M	0356	0.86
	0815	1.81		0955	1.83
	1446	0.51		1553	0.65
	2148	2.14		2230	2.07
7 M	0346	1.02	22 TU	0431	0.76
	0910	1.94		1034	1.89
	1535	0.43		1630	0.67
	2224	2.25		2254	2.08
8 TU	0424	0.82	23 W	0501	0.67
	1000	2.06		1112	1.94
	1619	0.39		1701	0.70
	2255	2.34		2319	2.09
9 W	0502	0.62	24 TH	0527	0.59
	1051	2.16		1149	1.98
	1702	0.40		1730	0.75
	2326	2.41		2343	2.08
10 TH	0542	0.44	25 F	0554	0.53
	1143	2.23		1225	1.99
	1746	0.46		1800	0.82
11 F	0000	2.43	26 SA	0003	2.06
	0624	0.31		0621	0.50
	1236	2.25		1300	1.98
	1832	0.58		1829	0.89
12 SA	0036	2.41	27 SU	0024	2.02
	0709	0.24		0650	0.49
	1328	2.22		1335	1.95
	1920	0.73		1900	0.98
13 SU	0117	2.33	28 M	0046	1.97
	0757	0.25		0721	0.51
	1422	2.14		1411	1.91
	2011	0.91		1935	1.06
14 M	0159	2.20	29 TU	0116	1.91
	0849	0.32		0757	0.55
	1519	2.02		1453	1.86
	2110	1.08		2019	1.15
15 TU	0246	2.03	30 W	0149	1.83
	0946	0.44		0842	0.61
	1640	1.92		1542	1.81
	2219	1.21		2114	1.24
			31 TH	0230	1.73
				0935	0.67
				1644	1.79
				2228	1.30

APRIL

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 F	0346	1.64	16 SA	0042	1.06
	1041	0.73		0650	1.56
	1812	1.81		1238	0.83
	2354	1.28		1941	1.91
2 SA	0509	1.60	17 SU	0155	0.95
	1157	0.74		0808	1.62
	1917	1.90		1347	0.86
				2027	1.92
3 SU	0120	1.18	18 M	0246	0.84
	0655	1.65		0908	1.70
	1306	0.71		1442	0.87
	2008	2.01		2101	1.93
4 M	0227	0.99	19 TU	0325	0.73
	0806	1.78		0950	1.79
	1411	0.66		1527	0.87
	2051	2.11		2129	1.94
5 TU	0312	0.78	20 W	0357	0.63
	0901	1.94		1027	1.87
	1507	0.61		1603	0.87
	2129	2.20		2157	1.95
6 W	0353	0.54	21 TH	0424	0.53
	0955	2.09		1102	1.95
	1557	0.59		1637	0.89
	2206	2.28		2224	1.95
7 TH	0434	0.33	22 F	0451	0.45
	1047	2.22		1139	2.01
	1645	0.60		1711	0.91
	2244	2.32		2251	1.94
8 F	0515	0.14	23 SA	0519	0.39
	1142	2.30		1215	2.04
	1732	0.65		1746	0.95
	2323	2.33		2318	1.92
9 SA	0558	0.04	24 SU	0549	0.36
	1234	2.34		1250	2.05
	1821	0.73		1819	0.99
				2344	1.90
10 SU	0005	2.29	25 M	0618	0.35
	0643	0.03		1323	2.03
	1323	2.31		1853	1.04
	1910	0.84			
11 M	0050	2.19	26 TU	0014	1.86
	0730	0.11		0648	0.38
	1412	2.23		1357	2.01
	2005	0.95		1931	1.09
12 TU	0137	2.04	27 W	0048	1.82
	0822	0.25		0726	0.43
	1503	2.11		1434	1.97
	2105	1.05		2016	1.14
13 W	0229	1.87	28 TH	0126	1.74
	0918	0.43		0812	0.51
	1604	1.99		1519	1.94
	2212	1.11		2112	1.17
14 TH	0328	1.70	29 F	0215	1.66
	1021	0.61		0904	0.61
	1733	1.92		1612	1.91
	2320	1.12		2220	1.18
15 F	0444	1.57	30 SA	0334	1.58
	1127	0.74		1007	0.71
	1842	1.90		1716	1.90
				2332	1.11

MARMAGAO – INDIA, WEST COAST

LAT. 15° 25′ N. LONG. 73° 48′ E.

TIME ZONE -0530 — TIMES AND HEIGHTS OF HIGH AND LOW WATERS — YEAR 2015

MAY

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 SU	0458	1.55	16 M	0116	0.85
	1120	0.78		0740	1.54
	1826	1.94		1255	1.01
				1919	1.85
2 M	0041	0.98	17 TU	0206	0.75
	0649	1.63		0843	1.64
	1229	0.82		1358	1.04
	1921	2.01		1957	1.84
3 TU	0145	0.78	18 W	0244	0.65
	0757	1.76		0928	1.74
	1335	0.83		1450	1.04
	2005	2.08		2032	1.84
4 W	0237	0.54	19 TH	0317	0.55
	0853	1.95		1009	1.85
	1439	0.83		1534	1.04
	2046	2.14		2104	1.84
5 TH	0322	0.31	20 F	0346	0.44
	0949	2.11		1047	1.95
	1536	0.82		1613	1.03
	2127	2.19		2138	1.84
6 F	0406	0.11	21 SA	0417	0.35
	1045	2.25		1125	2.02
	1628	0.82		1652	1.03
	2209	2.21		2210	1.84
7 SA	0449	-0.04	22 SU	0451	0.29
	1137	2.33		1203	2.07
	1718	0.83		1730	1.04
	2252	2.20		2242	1.83
8 SU	0533	-0.09	23 M	0523	0.26
	1225	2.37		1238	2.08
	1808	0.85		1807	1.06
	2340	2.14		2316	1.82
9 M	0619	-0.05	24 TU	0554	0.26
	1312	2.34		1312	2.08
	1900	0.89		1843	1.07
				2350	1.81
10 TU	0029	2.04	25 W	0627	0.29
	0706	0.07		1344	2.07
	1357	2.27		1921	1.08
	1957	0.94			
11 W	0120	1.91	26 TH	0029	1.78
	0755	0.26		0706	0.35
	1442	2.16		1418	2.05
	2056	0.97		2008	1.08
12 TH	0215	1.75	27 F	0116	1.72
	0849	0.46		0752	0.45
	1531	2.05		1457	2.03
	2157	0.99		2103	1.06
13 F	0312	1.60	28 SA	0213	1.64
	0948	0.66		0843	0.57
	1630	1.96		1542	2.01
	2259	0.98		2203	1.01
14 SA	0424	1.49	29 SU	0329	1.58
	1049	0.82		0942	0.71
	1740	1.90		1630	1.99
				2305	0.92
15 SU	0008	0.93	30 M	0451	1.56
	0625	1.48		1048	0.83
	1151	0.94		1725	1.98
	1835	1.87			
			31 TU	0007	0.77
				0639	1.64
				1157	0.93
				1825	2.00

JUNE

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 W	0107	0.58	16 TH	0157	0.62
	0745	1.79		0857	1.68
	1304	0.99		1408	1.16
	1920	2.03		1942	1.75
2 TH	0204	0.36	17 F	0234	0.51
	0846	1.95		0945	1.80
	1415	1.01		1503	1.14
	2008	2.06		2022	1.76
3 F	0254	0.16	18 SA	0312	0.39
	0945	2.09		1027	1.91
	1518	0.99		1550	1.12
	2054	2.09		2101	1.77
4 SA	0342	0.01	19 SU	0350	0.30
	1041	2.21		1108	2.00
	1613	0.96		1633	1.09
	2142	2.10		2141	1.79
5 SU	0428	-0.08	20 M	0427	0.23
	1129	2.29		1146	2.05
	1704	0.93		1713	1.07
	2230	2.08		2217	1.80
6 M	0513	-0.10	21 TU	0502	0.20
	1214	2.32		1222	2.08
	1754	0.90		1750	1.05
	2320	2.03		2255	1.81
7 TU	0558	-0.03	22 W	0536	0.20
	1256	2.30		1255	2.10
	1846	0.88		1827	1.03
				2336	1.82
8 W	0012	1.94	23 TH	0611	0.23
	0643	0.11		1326	2.11
	1337	2.25		1906	0.98
	1941	0.88			
9 TH	0106	1.83	24 F	0021	1.80
	0728	0.29		0650	0.29
	1416	2.17		1357	2.11
	2037	0.88		1952	0.93
10 F	0158	1.70	25 SA	0112	1.75
	0815	0.48		0735	0.41
	1457	2.08		1430	2.10
	2132	0.88		2044	0.87
11 SA	0253	1.58	26 SU	0213	1.68
	0905	0.68		0825	0.55
	1541	1.99		1508	2.08
	2227	0.87		2139	0.80
12 SU	0353	1.47	27 M	0321	1.62
	1002	0.85		0918	0.72
	1627	1.91		1550	2.04
	2322	0.84		2238	0.70
13 M	0532	1.43	28 TU	0441	1.59
	1101	0.98		1020	0.89
	1722	1.84		1635	2.00
				2336	0.58
14 TU	0019	0.80	29 W	0627	1.65
	0650	1.48		1129	1.02
	1158	1.09		1727	1.96
	1815	1.79			
15 W	0113	0.72	30 TH	0036	0.43
	0755	1.57		0735	1.77
	1302	1.14		1242	1.10
	1900	1.76		1835	1.95

JULY

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 F	0138	0.28	16 SA	0157	0.51
	0839	1.91		0919	1.74
	1358	1.11		1434	1.20
	1941	1.95		1944	1.69
2 SA	0234	0.13	17 SU	0243	0.39
	0941	2.04		1006	1.85
	1504	1.07		1528	1.15
	2034	1.96		2033	1.72
3 SU	0325	0.03	18 M	0327	0.29
	1033	2.14		1045	1.95
	1600	1.00		1613	1.09
	2127	1.97		2118	1.77
4 M	0413	-0.03	19 TU	0407	0.21
	1118	2.20		1123	2.02
	1651	0.92		1652	1.02
	2217	1.97		2200	1.81
5 TU	0458	-0.02	20 W	0444	0.17
	1158	2.23		1158	2.08
	1742	0.85		1730	0.95
	2308	1.94		2244	1.85
6 W	0542	0.05	21 TH	0519	0.16
	1236	2.23		1228	2.12
	1831	0.80		1807	0.87
	2358	1.88		2329	1.87
7 TH	0622	0.17	22 F	0556	0.20
	1312	2.20		1256	2.15
	1920	0.78		1846	0.78
8 F	0049	1.80	23 SA	0017	1.87
	0702	0.33		0636	0.27
	1348	2.15		1324	2.17
	2009	0.77		1930	0.70
9 SA	0138	1.69	24 SU	0110	1.83
	0737	0.50		0720	0.40
	1423	2.08		1358	2.16
	2057	0.78		2019	0.63
10 SU	0227	1.59	25 M	0209	1.77
	0815	0.68		0806	0.57
	1500	1.99		1434	2.12
	2145	0.78		2112	0.57
11 M	0321	1.49	26 TU	0311	1.70
	0900	0.85		0858	0.76
	1536	1.90		1514	2.05
	2233	0.77		2209	0.51
12 TU	0426	1.43	27 W	0427	1.64
	0956	1.00		1000	0.94
	1616	1.81		1559	1.96
	2322	0.75		2309	0.45
13 W	0558	1.44	28 TH	0612	1.67
	1104	1.12		1113	1.08
	1658	1.73		1654	1.87
14 TH	0012	0.69	29 F	0012	0.38
	0709	1.51		0724	1.76
	1211	1.19		1231	1.15
	1749	1.68		1811	1.81
15 F	0104	0.61	30 SA	0117	0.29
	0818	1.62		0833	1.88
	1324	1.22		1351	1.13
	1849	1.66		1931	1.81
			31 SU	0219	0.20
				0934	1.99
				1457	1.04
				2029	1.84

AUGUST

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 M	0312	0.13	16 TU	0301	0.34
	1023	2.07		1013	1.93
	1552	0.94		1552	1.01
	2121	1.86		2104	1.77
2 TU	0400	0.10	17 W	0343	0.26
	1104	2.12		1049	2.02
	1641	0.84		1630	0.89
	2210	1.88		2150	1.85
3 W	0444	0.12	18 TH	0423	0.22
	1139	2.15		1120	2.10
	1726	0.75		1706	0.76
	2259	1.88		2235	1.92
4 TH	0525	0.18	19 F	0501	0.21
	1211	2.16		1147	2.16
	1810	0.69		1743	0.63
	2347	1.85		2323	1.97
5 F	0601	0.28	20 SA	0539	0.24
	1242	2.14		1215	2.20
	1850	0.66		1821	0.51
6 SA	0032	1.80	21 SU	0012	1.98
	0632	0.40		0619	0.33
	1314	2.10		1246	2.22
	1928	0.65		1904	0.42
7 SU	0117	1.73	22 M	0106	1.96
	0703	0.55		0704	0.47
	1345	2.03		1321	2.19
	2006	0.66		1952	0.36
8 M	0202	1.65	23 TU	0202	1.90
	0735	0.70		0752	0.65
	1416	1.94		1359	2.11
	2046	0.68		2043	0.36
9 TU	0249	1.57	24 W	0301	1.82
	0813	0.86		0847	0.84
	1444	1.85		1443	2.00
	2129	0.69		2141	0.38
10 W	0341	1.50	25 TH	0413	1.74
	0857	1.00		0952	1.01
	1517	1.75		1532	1.87
	2219	0.70		2242	0.41
11 TH	0449	1.47	26 F	0556	1.73
	0955	1.13		1108	1.12
	1600	1.67		1634	1.74
	2313	0.68		2350	0.42
12 F	0624	1.50	27 SA	0712	1.79
	1123	1.22		1227	1.15
	1654	1.60		1814	1.67
13 SA	0012	0.63	28 SU	0100	0.40
	0735	1.59		0822	1.88
	1245	1.25		1351	1.08
	1757	1.58		1935	1.69
14 SU	0113	0.55	29 M	0206	0.36
	0843	1.70		0919	1.97
	1412	1.20		1454	0.95
	1913	1.61		2033	1.75
15 M	0211	0.45	30 TU	0301	0.31
	0934	1.82		1004	2.03
	1508	1.12		1545	0.83
	2013	1.68		2125	1.81
			31 W	0349	0.29
				1041	2.06
				1628	0.72
				2212	1.85

MARMAGAO – INDIA, WEST COAST

LAT. 15° 25′ N. LONG. 73° 48′ E.

TIME ZONE -0530 — TIMES AND HEIGHTS OF HIGH AND LOW WATERS — YEAR 2015

SEPTEMBER

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 TH	0431	0.31	16 F	0400	0.37
	1111	2.08		1027	2.14
	1708	0.63		1638	0.53
	2255	1.88		2230	2.04
2 F	0508	0.36	17 SA	0440	0.37
	1137	2.08		1059	2.21
	1742	0.57		1715	0.36
	2337	1.88		2319	2.11
3 SA	0539	0.45	18 SU	0522	0.41
	1207	2.06		1132	2.25
	1812	0.53		1756	0.23
4 SU	0019	1.87	19 M	0008	2.15
	0607	0.55		0605	0.50
	1235	2.02		1208	2.25
	1841	0.51		1838	0.15
5 M	0059	1.83	20 TU	0102	2.14
	0636	0.67		0653	0.62
	1259	1.96		1248	2.19
	1910	0.52		1924	0.15
6 TU	0140	1.77	21 W	0154	2.09
	0707	0.79		0744	0.78
	1319	1.88		1330	2.08
	1944	0.54		2013	0.22
7 W	0219	1.70	22 TH	0249	1.99
	0741	0.92		0842	0.93
	1338	1.81		1416	1.92
	2020	0.58		2111	0.33
8 TH	0304	1.64	23 F	0355	1.89
	0823	1.04		0950	1.06
	1408	1.72		1512	1.76
	2105	0.63		2217	0.45
9 F	0359	1.58	24 SA	0534	1.83
	0915	1.15		1104	1.12
	1454	1.63		1621	1.62
	2203	0.67		2326	0.55
10 SA	0515	1.56	25 SU	0650	1.85
	1037	1.24		1224	1.10
	1607	1.55		1829	1.58
	2315	0.68			
11 SU	0646	1.61	26 M	0039	0.59
	1210	1.25		0759	1.91
	1722	1.52		1347	0.99
				1947	1.65
12 M	0025	0.65	27 TU	0149	0.58
	0748	1.71		0854	1.96
	1344	1.18		1444	0.85
	1852	1.57		2049	1.73
13 TU	0131	0.58	28 W	0247	0.57
	0837	1.83		0935	1.99
	1443	1.05		1529	0.73
	2001	1.68		2136	1.82
14 W	0229	0.49	29 TH	0334	0.56
	0919	1.95		1004	2.00
	1525	0.89		1607	0.62
	2053	1.80		2217	1.88
15 TH	0318	0.41	30 F	0414	0.58
	0955	2.05		1030	2.01
	1603	0.71		1641	0.53
	2142	1.93		2254	1.94

OCTOBER

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 SA	0448	0.63	16 SU	0421	0.63
	1055	2.00		1017	2.25
	1708	0.46		1648	0.14
	2332	1.97		2315	2.28
2 SU	0519	0.69	17 M	0506	0.65
	1122	1.99		1057	2.27
	1734	0.42		1729	0.02
3 M	0010	1.98	18 TU	0005	2.33
	0547	0.76		0554	0.71
	1144	1.95		1137	2.25
	1801	0.39		1812	-0.01
4 TU	0046	1.96	19 W	0055	2.33
	0618	0.85		0643	0.80
	1205	1.91		1221	2.17
	1829	0.40		1857	0.05
5 W	0121	1.93	20 TH	0144	2.27
	0649	0.93		0735	0.90
	1227	1.86		1307	2.04
	1859	0.44		1948	0.19
6 TH	0157	1.87	21 F	0233	2.17
	0723	1.02		0836	0.99
	1255	1.80		1359	1.88
	1933	0.50		2043	0.37
7 F	0234	1.81	22 SA	0329	2.05
	0805	1.10		0942	1.06
	1327	1.73		1500	1.71
	2016	0.58		2149	0.56
8 SA	0322	1.76	23 SU	0455	1.96
	0858	1.18		1052	1.09
	1409	1.63		1612	1.57
	2110	0.67		2258	0.71
9 SU	0420	1.72	24 M	0615	1.93
	1012	1.24		1210	1.04
	1527	1.54		1832	1.56
	2216	0.75			
10 M	0542	1.73	25 TU	0010	0.82
	1139	1.22		0716	1.94
	1657	1.50		1328	0.92
	2336	0.78		1952	1.65
11 TU	0655	1.80	26 W	0124	0.86
	1303	1.12		0806	1.95
	1841	1.56		1423	0.79
				2054	1.76
12 W	0046	0.76	27 TH	0225	0.88
	0745	1.90		0842	1.95
	1409	0.95		1505	0.67
	1951	1.70		2139	1.86
13 TH	0149	0.71	28 F	0312	0.88
	0827	2.01		0910	1.95
	1453	0.75		1539	0.57
	2044	1.87		2216	1.95
14 F	0247	0.66	29 SA	0353	0.90
	0905	2.11		0938	1.95
	1532	0.53		1609	0.48
	2135	2.03		2249	2.02
15 SA	0335	0.63	30 SU	0428	0.92
	0942	2.19		1007	1.95
	1610	0.32		1634	0.41
	2224	2.17		2325	2.08
			31 M	0501	0.94
				1034	1.94
				1702	0.35

NOVEMBER

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 TU	0000	2.11	16 W	0000	2.47
	0533	0.98		0543	0.91
	1101	1.92		1112	2.22
	1730	0.33		1750	-0.05
2 W	0035	2.11	17 TH	0045	2.48
	0605	1.02		0634	0.93
	1126	1.90		1200	2.14
	1758	0.35		1836	0.05
3 TH	0107	2.08	18 F	0130	2.43
	0639	1.07		0727	0.97
	1154	1.87		1250	2.02
	1828	0.39		1924	0.22
4 F	0138	2.05	19 SA	0215	2.34
	0713	1.11		0826	1.01
	1227	1.82		1345	1.87
	1900	0.47		2015	0.44
5 SA	0212	2.01	20 SU	0303	2.22
	0755	1.16		0929	1.03
	1303	1.76		1444	1.72
	1941	0.56		2117	0.67
6 SU	0253	1.97	21 M	0356	2.11
	0847	1.20		1033	1.02
	1348	1.67		1553	1.59
	2032	0.68		2223	0.87
7 M	0342	1.93	22 TU	0509	2.02
	0955	1.21		1139	0.98
	1501	1.57		1810	1.56
	2132	0.80		2327	1.02
8 TU	0440	1.92	23 W	0614	1.97
	1109	1.16		1250	0.90
	1635	1.53		1933	1.64
	2245	0.90			
9 W	0551	1.94	24 TH	0036	1.12
	1218	1.04		0702	1.94
	1827	1.59		1348	0.80
				2042	1.76
10 TH	0001	0.96	25 F	0147	1.17
	0655	2.00		0741	1.93
	1324	0.86		1432	0.68
	1938	1.76		2128	1.87
11 F	0109	0.97	26 SA	0243	1.18
	0741	2.08		0818	1.92
	1416	0.64		1505	0.58
	2034	1.95		2204	1.98
12 SA	0213	0.96	27 SU	0328	1.17
	0823	2.15		0853	1.92
	1500	0.40		1535	0.49
	2129	2.13		2238	2.07
13 SU	0312	0.93	28 M	0407	1.16
	0903	2.20		0925	1.92
	1542	0.19		1604	0.40
	2223	2.29		2313	2.15
14 M	0404	0.91	29 TU	0444	1.15
	0943	2.24		0957	1.92
	1624	0.03		1637	0.35
	2312	2.41		2349	2.20
15 TU	0454	0.90	30 W	0519	1.14
	1027	2.25		1030	1.91
	1706	-0.06		1708	0.33

DECEMBER

	TIME	Ht.		TIME	Ht.
	h m	m		h m	m
1 TH	0024	2.22	16 W	0034	2.64
	0554	1.15		0622	0.98
	1101	1.91		1146	2.12
	1737	0.34		1818	0.10
2 F	0055	2.21	17 TH	0114	2.60
	0629	1.16		0716	0.96
	1133	1.89		1236	2.03
	1807	0.38		1903	0.28
3 SA	0124	2.20	18 F	0154	2.43
	0704	1.16		0811	0.95
	1208	1.87		1333	1.90
	1839	0.45		1948	0.50
4 SU	0155	2.18	19 SA	0233	2.34
	0745	1.16		0907	0.96
	1250	1.81		1427	1.77
	1919	0.54		2036	0.73
5 M	0230	2.16	20 SU	0314	2.23
	0834	1.16		1002	0.95
	1340	1.73		1528	1.64
	2005	0.68		2132	0.96
6 TU	0311	2.14	21 M	0359	2.11
	0934	1.13		1058	0.93
	1450	1.65		1709	1.57
	2058	0.83		2234	1.15
7 W	0356	2.11	22 TU	0448	2.01
	1037	1.06		1157	0.89
	1614	1.60		1845	1.61
	2200	0.98		2339	1.29
8 TH	0445	2.09	23 W	0546	1.93
	1139	0.93		1257	0.82
	1805	1.65		2011	1.71
	2315	1.11			
9 F	0542	2.08	24 TH	0048	1.37
	1239	0.76		0642	1.88
	1924	1.81		1347	0.73
				2107	1.83
10 SA	0029	1.19	25 F	0205	1.39
	0645	2.10		0728	1.86
	1337	0.55		1427	0.63
	2026	2.00		2148	1.96
11 SU	0144	1.21	26 SA	0301	1.36
	0740	2.13		0809	1.86
	1430	0.34		1504	0.53
	2125	2.18		2224	2.07
12 M	0254	1.19	27 TU	0348	1.32
	0829	2.16		0850	1.87
	1518	0.15		1541	0.44
	2220	2.34		2301	2.17
13 TU	0350	1.14	28 W	0427	1.26
	0917	2.19		0929	1.89
	1603	0.02		1616	0.37
	2309	2.46		2336	2.23
14 W	0442	1.08	29 TH	0506	1.22
	1006	2.20		1006	1.91
	1648	-0.04		1651	0.34
	2353	2.52			
15 TH	0532	1.02	30 F	0010	2.28
	1055	2.18		0543	1.19
	1733	-0.01		1042	1.93
				1722	0.33
			31 SA	0041	2.30
				0617	1.16
				1120	1.93
				1753	0.36

ANNEXURE 3.3

BATHYMETRIC SURVEY AS RECEIVED FROM HYDROGRAPHIC SURVEYOR

Annexure 3.3: Digital Data, Chainage vs Water Depth, Bathymetric Survey				
Chainage (km)	**Northing(m)**	**Easting(m)**	**Raw Depth(m)**	**Reduced Depth w.r.t. CD (m)**
0.00	15° 36' 33.00658"	73° 44' 08.50142"	7.41	5.80
0.10	15° 36' 35.77369"	73° 44' 10.18509"	3.86	2.20
0.33	15° 36' 41.28392"	73° 44' 15.66122"	3.96	2.30
0.47	15° 36' 44.87981"	73° 44' 18.36529"	3.63	1.90
0.62	15° 36' 49.27580"	73° 44' 20.55011"	4.78	3.00
0.85	15° 36' 55.89226"	73° 44' 24.03055"	2.31	0.50
1.02	15° 37' 00.99330"	73° 44' 25.97608"	2.55	0.70
1.22	15° 37' 07.24723"	73° 44' 28.43269"	4.36	2.50
1.44	15° 37' 13.87598"	73° 44' 30.99585"	4.46	2.60
1.69	15° 37' 20.74268"	73° 44' 35.79257"	4.48	2.60
1.85	15° 37' 23.85650"	73° 44' 39.84329"	4.74	2.90
2.05	15° 37' 28.67717"	73° 44' 44.31983"	5.15	3.30
2.14	15° 37' 29.82592"	73° 44' 47.12640"	5.59	3.70
2.44	15° 37' 36.12764"	73° 44' 54.77261"	6.18	4.30
2.54	15° 37' 37.91318"	73° 44' 57.63983"	6.14	4.30
2.76	15° 37' 42.34986"	73° 45' 03.61419"	4.32	2.40
2.89	15° 37' 45.01162"	73° 45' 07.04465"	4.03	2.20
3.13	15° 37' 51.43127"	73° 45' 11.65420"	6.10	4.20
3.27	15° 37' 54.88936"	73° 45' 14.70180"	6.14	4.30
3.50	15° 37' 59.04872"	73° 45' 20.96922"	4.92	3.10
3.67	15° 38' 00.27266"	73° 45' 26.38636"	5.53	3.70
3.79	15° 37' 59.61885"	73° 45' 30.45182"	6.43	4.60
3.91	15° 37' 59.45534"	73° 45' 34.67954"	4.92	3.10
4.05	15° 38' 00.04586"	73° 45' 39.04241"	3.96	2.10
4.48	15° 38' 06.82545"	73° 45' 51.53724"	2.63	0.80
4.59	15° 38' 09.55498"	73° 45' 52.41612"	1.99	0.10
4.92	15° 38' 15.22663"	73° 46' 02.00169"	2.98	1.10
5.08	15° 38' 17.80919"	73° 46' 06.60799"	2.45	0.60
5.45	15° 38' 26.27694"	73° 46' 15.33890"	3.16	1.30
5.68	15° 38' 31.46405"	73° 46' 21.01112"	3.76	1.90
6.02	15° 38' 41.56380"	73° 46' 25.82838"	5.41	3.60
6.26	15° 38' 47.17260"	73° 46' 31.21518"	9.35	7.60
6.29	15° 38' 48.01496"	73° 46' 32.07122"	9.44	7.70
6.40	15° 38' 51.43152"	73° 46' 33.38413"	11.48	9.70
6.53	15° 38' 55.27533"	73° 46' 35.10421"	9.55	7.80
6.72	15° 39' 00.71542"	73° 46' 38.08158"	4.13	2.40
7.17	15° 39' 06.72341"	73° 46' 51.59343"	2.23	0.50
7.42	15° 39' 09.19989"	73° 46' 59.64552"	3.09	1.30
7.80	15° 39' 09.14191"	73° 47' 12.60510"	4.24	2.50
8.05	15° 39' 08.26545"	73° 47' 20.93227"	6.18	4.50
8.28	15° 39' 04.61686"	73° 47' 27.56129"	7.47	5.70
8.45	15° 39' 01.31369"	73° 47' 32.34146"	10.16	8.40
8.75	15° 38' 57.97183"	73° 47' 41.80634"	7.69	6.00
8.87	15° 38' 57.72643"	73° 47' 45.82433"	6.58	4.90
9.02	15° 38' 58.17810"	73° 47' 50.86286"	4.84	3.20
9.31	15° 38' 57.00482"	73° 48' 00.50607"	3.71	2.00

Annexure 3.3: Digital Data, Chainage vs Water Depth, Bathymetric Survey				
Chainage (km)	**Northing(m)**	**Easting(m)**	**Raw Depth(m)**	**Reduced Depth w.r.t. CD (m)**
9.79	15° 39' 01.91576"	73° 48' 15.79854"	2.95	1.30
10.09	15° 39' 04.40836"	73° 48' 25.35302"	3.33	1.70
10.19	15° 39' 06.71793"	73° 48' 27.71702"	3.09	1.50
10.29	15° 39' 08.86500"	73° 48' 30.23781"	3.02	1.40
10.66	15° 39' 11.99751"	73° 48' 42.31258"	4.47	2.90
10.76	15° 39' 14.10274"	73° 48' 44.86927"	5.19	3.60
11.09	15° 39' 14.98718"	73° 48' 56.10847"	6.17	4.60
11.28	15° 39' 14.13756"	73° 49' 02.19612"	6.96	5.40
11.53	15° 39' 13.86191"	73° 49' 10.57830"	8.04	6.50
11.85	15° 39' 11.15235"	73° 49' 20.93907"	4.07	2.70
12.12	15° 39' 10.77545"	73° 49' 30.13923"	4.12	2.80
12.53	15° 39' 07.21772"	73° 49' 43.50043"	6.95	5.70
12.80	15° 39' 06.30089"	73° 49' 52.49103"	7.02	5.80
13.14	15° 39' 01.82861"	73° 50' 02.77627"	9.52	8.30
13.23	15° 39' 00.60214"	73° 50' 05.46689"	11.30	10.10
13.40	15° 38' 56.97683"	73° 50' 10.00978"	11.85	10.60
13.60	15° 38' 54.07697"	73° 50' 15.99094"	6.67	5.50
13.80	15° 38' 54.68652"	73° 50' 22.26694"	5.40	4.20
13.90	15° 38' 57.55464"	73° 50' 23.79897"	6.19	5.00
14.00	15° 39' 00.60403"	73° 50' 24.90482"	3.58	2.40
14.10	15° 39' 02.78600"	73° 50' 27.38612"	4.14	3.00
14.41	15° 39' 12.84164"	73° 50' 29.02514"	4.44	3.30
14.59	15° 39' 18.06859"	73° 50' 26.36402"	7.03	5.90
14.94	15° 39' 29.54352"	73° 50' 26.07096"	7.85	6.80
15.10	15° 39' 34.54080"	73° 50' 25.27032"	10.92	9.80
15.25	15° 39' 39.38819"	73° 50' 25.41562"	11.46	10.40
15.42	15° 39' 45.01834"	73° 50' 24.29971"	14.17	13.10
15.61	15° 39' 50.93182"	73° 50' 25.86975"	10.68	9.60
15.76	15° 39' 55.16470"	73° 50' 28.20094"	8.91	7.90
16.01	15° 40' 00.03923"	73° 50' 35.13930"	8.26	7.20
16.27	15° 40' 01.99832"	73° 50' 43.48864"	9.72	8.70
16.45	15° 40' 04.36725"	73° 50' 49.09910"	10.95	10.00
16.54	15° 40' 06.29439"	73° 50' 51.58715"	9.61	8.60
16.64	15° 40' 06.99391"	73° 50' 54.65877"	10.18	9.20
16.72	15° 40' 08.64385"	73° 50' 56.84746"	9.67	8.70
16.87	15° 40' 10.96552"	73° 51' 01.03553"	6.70	5.70
16.97	15° 40' 11.11522"	73° 51' 04.38634"	2.25	1.30
17.07	15° 40' 11.81703"	73° 51' 07.65582"	3.67	2.70
17.16	15° 40' 13.45741"	73° 51' 10.51097"	1.68	0.70
17.26	15° 40' 16.07201"	73° 51' 12.48676"	2.35	1.40
17.36	15° 40' 18.85941"	73° 51' 14.21709"	2.99	2.00
17.46	15° 40' 21.62584"	73° 51' 15.98247"	2.52	1.60
17.56	15° 40' 24.32351"	73° 51' 17.85506"	2.45	1.50
17.66	15° 40' 26.77756"	73° 51' 20.05885"	2.12	1.20
18.08	15° 40' 38.74938"	73° 51' 26.23086"	6.74	5.80
18.37	15° 40' 41.19632"	73° 51' 35.68618"	8.82	7.90

Annexure 3.3: Digital Data, Chainage vs Water Depth, Bathymetric Survey				
Chainage (km)	**Northing(m)**	**Easting(m)**	**Raw Depth(m)**	**Reduced Depth w.r.t. CD (m)**
18.47	15° 40' 44.01264"	73° 51' 37.35603"	10.48	9.50
18.56	15° 40' 46.20341"	73° 51' 39.75286"	8.24	7.30
18.83	15° 40' 50.32534"	73° 51' 47.63012"	12.77	11.80
18.93	15° 40' 51.82918"	73° 51' 50.41137"	11.66	10.70
19.02	15° 40' 50.49273"	73° 51' 53.42229"	12.76	11.80
19.12	15° 40' 49.69728"	73° 51' 56.53098"	6.69	5.70
19.22	15° 40' 50.37911"	73° 51' 59.81424"	8.82	7.90
19.32	15° 40' 50.68269"	73° 52' 03.13989"	9.73	8.80
19.42	15° 40' 48.59741"	73° 52' 05.70785"	10.05	9.10
19.52	15° 40' 47.14594"	73° 52' 08.70056"	9.87	8.90
19.62	15° 40' 46.49736"	73° 52' 11.96930"	13.73	12.80
19.72	15° 40' 47.14480"	73° 52' 15.22151"	14.80	13.80
19.81	15° 40' 45.33255"	73° 52' 17.98912"	8.01	7.00
19.90	15° 40' 44.49509"	73° 52' 21.11177"	4.48	3.50
20.00	15° 40' 44.99279"	73° 52' 24.42526"	6.39	5.40
20.50	15° 40' 51.58973"	73° 52' 39.53779"	7.43	6.40
20.68	15° 40' 52.79442"	73° 52' 45.57156"	9.56	8.60
20.94	15° 40' 55.66012"	73° 52' 53.73729"	10.00	9.20
21.12	15° 40' 59.17382"	73° 52' 58.81402"	12.84	12.10
21.34	15° 41' 04.27414"	73° 53' 03.69039"	7.79	7.00
21.50	15° 41' 09.30062"	73° 53' 05.25658"	8.15	7.40
21.74	15° 41' 16.77647"	73° 53' 04.39838"	10.53	9.70
21.81	15° 41' 19.16431"	73° 53' 03.69142"	15.06	14.30
22.05	15° 41' 26.91354"	73° 53' 02.45816"	11.35	10.60
22.14	15° 41' 29.37051"	73° 53' 04.07497"	6.60	5.80
22.28	15° 41' 33.86080"	73° 53' 05.27596"	8.59	7.80
22.45	15° 41' 38.20902"	73° 53' 08.92991"	6.59	5.80
22.63	15° 41' 42.81373"	73° 53' 12.15052"	4.49	3.70
22.80	15° 41' 45.55247"	73° 53' 17.40956"	5.09	4.30
22.97	15° 41' 49.85952"	73° 53' 21.03934"	7.14	6.30
23.07	15° 41' 52.39425"	73° 53' 22.78819"	7.68	6.80
23.24	15° 41' 57.36693"	73° 53' 25.17186"	8.79	7.90
23.33	15° 41' 58.88139"	73° 53' 27.86482"	6.00	5.10
23.43	15° 42' 02.03369"	73° 53' 28.64224"	9.25	8.40
23.52	15° 42' 03.75907"	73° 53' 31.34653"	8.40	7.50
23.62	15° 42' 06.63656"	73° 53' 32.60515"	8.53	7.70
23.71	15° 42' 08.27358"	73° 53' 35.21353"	5.41	4.50
23.81	15° 42' 11.13320"	73° 53' 36.80114"	5.63	4.70
23.90	15° 42' 12.27566"	73° 53' 39.48813"	3.99	3.10
23.99	15° 42' 10.88832"	73° 53' 42.03994"	1.04	0.10

Annexure 3.3: Digital Data, Chainage vs Water Depth, Bathymetric Survey				
Chainage (km)	**Northing(m)**	**Easting(m)**	**Raw Depth(m)**	**Reduced Depth w.r.t. CD (m)**
24.07	15° 42' 09.17608"	73° 53' 43.98714"	2.01	1.10
24.17	15° 42' 08.98312"	73° 53' 47.33773"	1.94	1.00
24.36	15° 42' 10.41523"	73° 53' 53.65222"	3.08	2.20
24.45	15° 42' 09.44377"	73° 53' 56.47253"	3.21	2.30
24.54	15° 42' 07.13314"	73° 53' 58.69299"	2.63	1.70
24.71	15° 42' 05.50439"	73° 54' 03.91835"	3.97	3.00
24.80	15° 42' 04.68406"	73° 54' 06.96860"	3.80	2.80
24.89	15° 42' 03.39432"	73° 54' 09.72877"	3.13	2.10
25.07	15° 42' 00.00080"	73° 54' 14.56745"	2.29	1.30
25.15	15° 41' 58.83271"	73° 54' 17.06324"	3.09	2.10
25.25	15° 41' 57.24795"	73° 54' 19.92101"	2.11	1.10
25.35	15° 41' 54.61072"	73° 54' 21.65971"	2.30	1.30
25.50	15° 41' 51.28866"	73° 54' 25.31815"	2.00	1.00
25.59	15° 41' 49.30194"	73° 54' 27.84344"	2.02	1.00
25.69	15° 41' 49.21518"	73° 54' 31.19136"	3.10	2.00
25.79	15° 41' 48.33967"	73° 54' 34.42186"	2.91	1.90
25.89	15° 41' 46.98904"	73° 54' 37.45434"	2.49	1.40
25.99	15° 41' 44.56897"	73° 54' 39.41956"	1.80	0.70
26.09	15° 41' 41.65871"	73° 54' 40.84049"	2.61	1.50
26.19	15° 41' 38.66391"	73° 54' 42.14361"	4.02	2.90
26.28	15° 41' 35.43064"	73° 54' 42.34686"	1.87	0.80
26.38	15° 41' 32.40686"	73° 54' 41.29368"	1.62	0.50
26.48	15° 41' 29.33726"	73° 54' 42.34424"	3.25	2.10
26.58	15° 41' 26.84761"	73° 54' 44.45622"	2.61	1.50
26.68	15° 41' 24.99074"	73° 54' 47.19298"	2.93	1.80
26.78	15° 41' 23.25225"	73° 54' 49.98385"	4.83	3.70
26.88	15° 41' 22.40648"	73° 54' 53.19056"	4.89	3.70
26.98	15° 41' 22.73474"	73° 54' 56.51903"	5.16	4.00
27.08	15° 41' 23.91723"	73° 54' 59.52757"	3.64	2.40
27.18	15° 41' 25.82835"	73° 55' 02.14733"	3.26	2.00
27.28	15° 41' 27.76683"	73° 55' 04.83952"	3.72	2.50
27.37	15° 41' 30.19612"	73° 55' 07.02594"	3.89	2.60
27.47	15° 41' 33.03465"	73° 55' 08.65864"	3.80	2.50
27.57	15° 41' 35.51711"	73° 55' 10.80617"	3.97	2.70
27.67	15° 41' 37.64128"	73° 55' 13.34863"	2.84	1.50
27.77	15° 41' 39.40070"	73° 55' 16.16309"	2.59	1.30
27.87	15° 41' 41.01319"	73° 55' 19.07845"	2.28	1.00
27.97	15° 41' 42.36859"	73° 55' 22.12450"	1.40	0.10
28.07	15° 41' 43.80366"	73° 55' 25.09556"	2.26	0.90
28.17	15° 41' 45.74597"	73° 55' 27.78887"	2.36	1.00
28.27	15° 41' 47.38109"	73° 55' 30.68131"	1.71	0.30
28.37	15° 41' 49.52245"	73° 55' 33.15827"	1.90	0.50
28.47	15° 41' 51.48156"	73° 55' 35.83003"	1.60	0.20
28.57	15° 41' 52.71972"	73° 55' 38.87206"	2.00	0.60
28.67	15° 41' 53.38651"	73° 55' 42.12503"	1.55	0.10

Note: Reduced depth has been reckoned by applying tide variation Min 0.74m & Max 1.92m

ANNEXURE 3.4

DIGITAL DATA, CHAINAGE VS WATER DEPTH, TOPOGRAPHIC SURVEY

Annexure 3.4: Digital Data, Chainage vs Water Depth, Topographic Survey

Chainage (km)	Northing(m)	Easting(m)	Water Depth (m)	Water Surface wrt MSL	River Bed wrt MSL
28.806	15°42'1.54"N	73°55'43.00"E	0.4	-1.00	-1.40
28.899	15°42'3.65"N	73°55'49.13"E	0.5	-0.72	-1.22
29.366	15°42'6.02"N	73°56'0.76"E	0.2	-0.45	-0.65
29.469	15°42'6.99"N	73°56'9.73"E	0.8	-0.33	-1.13
30.086	15°42'2.69"N	73°56'24.17"E	0.2	0.16	-0.04
30.38	15°41'56.47"N	73°56'32.72"E	0.8	0.37	-0.43
30.913	15°42'1.73"N	73°56'47.81"E	0.8	0.42	-0.38
31.565	15°42'16.41"N	73°56'58.29"E	0.3	0.82	0.52
32.908	15°42'46.75"N	73°57'23.35"E	0.2	1.23	1.03

ANNEXURE 3.5

PHOTOS CAPTURED BY SURVEY TEAM DURING RECONNAISSANCE SURVEY

Annexure 3.5: Site Photo

Photo 1: Chapora Jetty on South Bank of River at Ch 0.32km (15˚36'32.40"N, 73˚44'24.70"E)

Photo 2: Wooden Jetty on the Northen Bank of River at Ch 1.96km (15˚37'30.40"N, 73˚44'37.80"E)

Photo 3: Wooden Jetty on the Northern bank of the river 2.34 km (15˚37'38.10"N, 73˚44'48.90"E)

Photo 4: Fishing stakes from the middle to the Southern bank of the at Ch 3.59km (15˚38'00.06"N, 73˚45'23.73"E)

Photo 5: Shivali Road Bridge at Ch 3.90km (15˚38'02.95"N, 73˚45'34.39"E)

Photo 6: Island in the middle of the River at Ch 4.24km (15˚38'00.62"N, 73˚45'45.90"E)

Photo 7: Slope Jetty on the Southern Bank of the river at Ch 6.21km (15˚38'42.90”N, 73˚46'33.70”E)

Photo 8: Slope Jetty on the Eastern Bank of the river at Ch 6.30km (15˚38'47.40”N, 73˚46'34.40”E)

Photo 9: Ferry Jetty from Camoulim to Pernem on the Southern bank of the river at Ch 8.73km (15˚38'56.20"N, 73˚47'40.26"E)

Photo 10: Ferry Jetty from Pernem to Camoulim on the Northern bank of the river at Ch 8.77km (15˚39'00.20"N, 73˚47'42.41"E)

Photo 11: Tree in the middle of the river at Ch 11.86km (15˚39'10.16"N, 73˚49'21.43"E)

Photo 12: Colvale Road Bridge at Ch 13.44km (15˚38'55.16"N, 73˚50'10.56"E)

Photo 13: High Tension Line crossing River at Ch 13.47km (15˚38'55.88"N, 73˚50'12.01"E)

Photo 14: Stairs on the Eastern bank of River at Ch 14.97km (15˚39'30.80"N, 73˚50'27.50"E)

Photo 15: High Tension Power Line crossing River at Ch 16.33km (15˚40'02.05"N, 73˚50'45.75"E)

Photo 16: Rail Bridge at Ch 16.49km (15˚40'05.40"N, 73˚50'49.97"E)

Photo 17: Revora Foot Bridge at Ch 17.06km (15˚40'11.73"N, 73˚51'07.52"E)

Photo 18: Pirna-Ozeri Road Bridge at Ch 21.14km (15˚40'59.51"N, 73˚52'59.24"E)

Photo 19: Alorna Fort on the Northern Bank of the River at Ch 25.13km (15˚41'58.87"N, 73˚54'16.26"E)

Photo 20: Jetty on the Southern Bank of River at Ch 26.69km (15˚41'24.91"N, 73˚54'47.36"E)

Photo 21: Stairs connecting River on the Northern Bank at Ch 27.60km (15˚41'36.00"N, 73˚55'11.50"E)

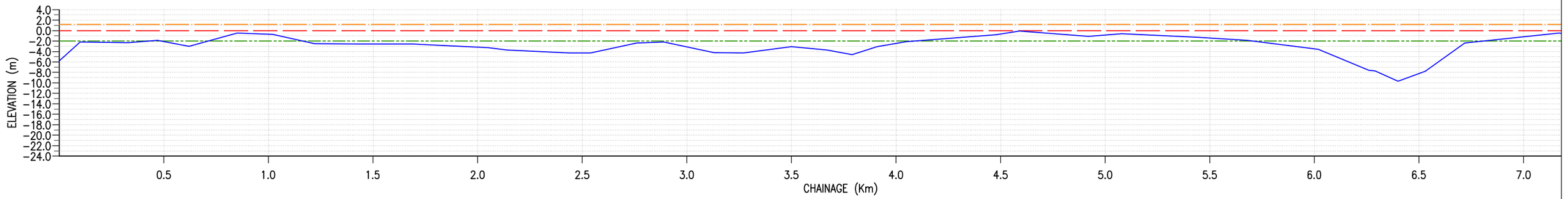
Photo 22: Light Motor Vehicular Bridge over Bandhara, SAL-IBRAMPUR

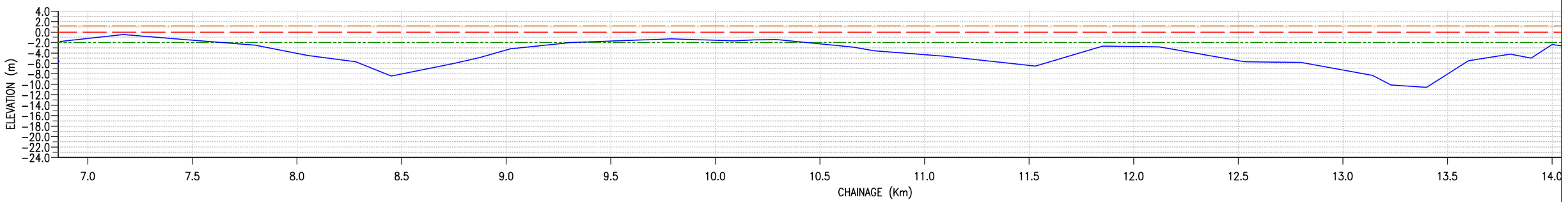
Photo 23: Light Motor Vehicular Bridge over Bandhara, SAL-IBRAMPUR at Ch 28.67km (15˚41'53.73”N, 73˚55'42.64”E)

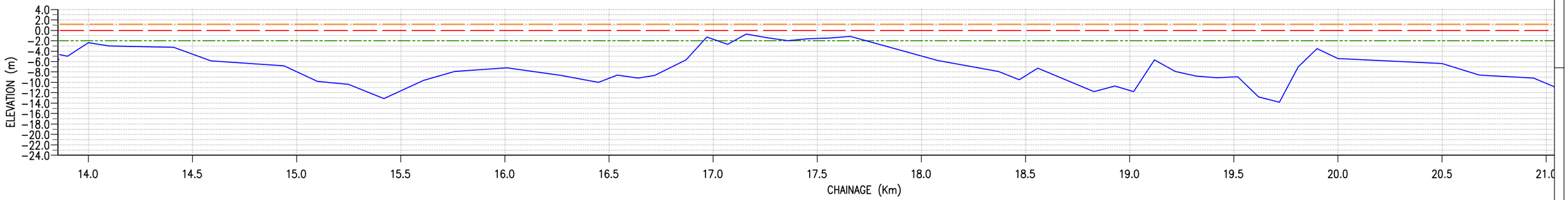
Photo 24: Maneri Bridge on the Southern Bank of Chapora River at Ch 32.90km (15˚42'45.65"N, 73˚57'24.37”E)

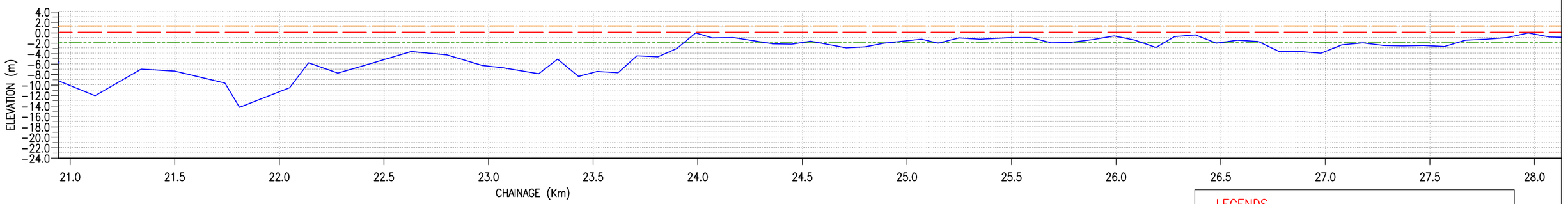
ANNEXURE 3.6

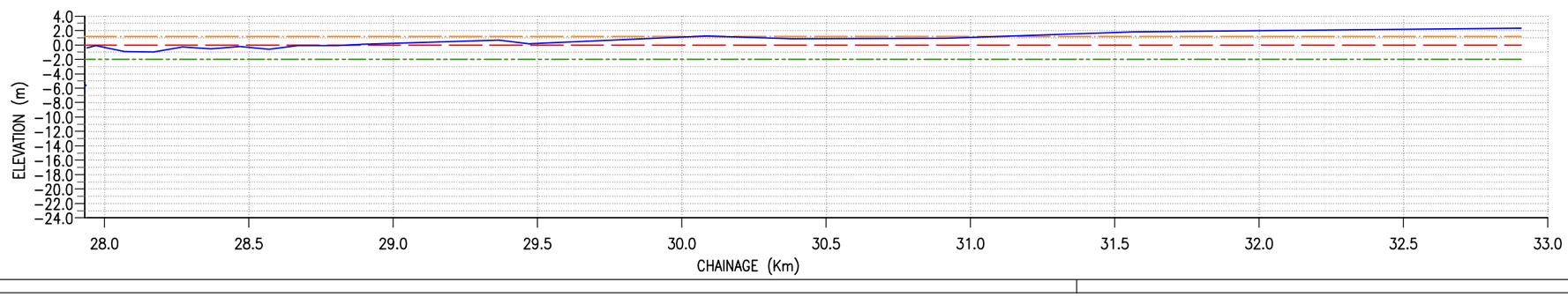
OBSERVED BED PROFILE OF CHAPORA RIVER WATERWAY











LEGENDS

- MEAN HIGH TIDE
- CHART DATUM
- 2m DEPTH BELOW CHART DATUM
- CHAPORA RIVER BED PROFILE

ANNEXURE 3.6

CHAPORA RIVER LONGITUDINAL BED PROFILE

ANNEXURE 3.7

COMPILATION OF FIELD INFORMATION OF CHAPORA RIVER IN IWAI FORMAT

Annexure 3.7: Format for Submission of Initial Field Information Report

SL#	DESCRIPTION	DETAILS	REMARKS
	NAME OF THE FIRM	**Fugro Survey(India) Pvt Ltd.**	
	REGION / CLUSTER NO.	**Cluster-7/ Stage-1/ Maharashtra**	
1	NAME OF THE WATERWAY	Chapora River	
2	LENGTH OF THE WATERWAY (km)	33 Km	
3	WATERWAY IN THE STATES OF	Goa	
4	FIELD WORK COMPLETED FOR THE LENGTH OF THE WATERWAY (km)	33 km(data acquisition on 25 & 26.02.2016)	
TIDAL WATERWAYS			
5	Length of the waterway having tidal effects (km)	28.7 Km	
6	Start & end location name having tidal effects	Till Chainage 28.7 km	
7	Tidal variation (m)	-	Tide variation measurement scope is not in Stage-1, we have not carried out the same at site
DEPTH INFORMATION			
8	Length of the waterway, where depths more than 2m is observed	20.98 Km	
9	Length of the waterway, where depths more than 1.5m is observed	23.1 Km	
10	Length of the waterway, where depths more than 1.0m is observed	26.00 Km	
11	Existing Water level (m)	Dry height to 14.3m	
12	Minimum Water Level (m)	Dry height	
13	Highest Flood level (m)	We have not seen HFL marking in any Bridges	
CROSS-STRUCTURE INFORMATION			
13	Existing list of Dam, Barrages, Locks	Nil	
14	Existing Bridges (nos.)	7	
15	Minimum Vertical and Horizontal clearances (m) as per visual estimation	1)Shivali Road Bridge - Ch 3.9 km, VC: 8.5m, HC: 50m 2) Colvale Road Bridge - Ch 13.44 km, VC: 8.5m, HC: 50m 3) Rail Bridge -Ch 16.49 km, VC: 6.5m, HC: 30m 4) Revora Foot Bridge - Ch 17.06 km, VC: 8.5m, HC: 20m 5) Pirna-Ozeri Road Bridge- Ch 21.14 km, VC: 8.5m, HC: 50m 6) LMV Bridge over Bandhara - Ch 28.69 km, No VC 7) Maneri Bridge - Ch32.9 km, VC: 8.5m, HC: 20m	Vertical clearance above MHWS
16	High Tension lines	2	
NAVIGATIONAL OBSTRUCTION			
17	Rocks	Found in upper stretches	
18	Steep gradients	Nil	
ENVIRONMENTAL & OTHER ISSUES			
19	Details of wildlife /forest area	Nil	
20	Protected areas	Nil	
21	Security clearances	Nil	
CARGO AND OTHER DETAILS			
22	Availability of passenger ferry services along the waterway	Camoulim-Pernem - at Chainage 9.07 Km	
23	Estimated cargo movement through proposed waterway, road and rail	Nil	
24	Type of crops (in different seasons) and industries along the waterway	Nil	
25	Availability of prominent towns / City along the waterway.	Bicholim, Pernem, Bardez, Dodamarg, Anjuna & Morjim	
26	Historical and tourist places along waterway	Alnora & Chapora Fort	
27	Existing water sport and recreational activities and future probability	Nil	
28	Existing Jetties and Terminals	8 Jetty, No Terminals	

ANNEXURE 4.1

LARGE SCALE INDUSTRIES IN CHAPORA RIVER CATCHMENT REGION

Annexure 4.1: List of Industries in Chapora River Catchment Region

List of Existing Industries, Mapusa River		
Sl.No.	**Description**	**Symbol**
1	VIRONIK MICRONUTRIENTS.	I1
2	CROMPTON GREAVES LTD.	I2
3	PAI KANE GROUP	I3

DRAWINGS

P.009051-W-20201-A01 R0 (SHEET-1 TO 4): LAYOUT PLAN – CHAPORA RIVER

53NW CLUSTER-7
STATE OF GOA
CHAPORA RIVER

N
W E
S

Agarvado
Chopdem
Camurlim
Oxel
Morjim
KUDAL
Siolim
Marna
Morgim Beach
Sodie

18
18
19
19
5
6

CHOPDEM-SIOLEM BRIDGE

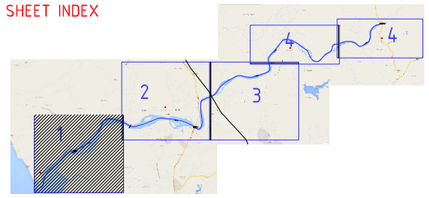
CHAPORA RIVER

CH 8.00
CH 7.00
CH 6.00
CH 5.00
CH 4.00
CH 3.00
CH 2.00
CH 1.00
CH 0.00

MATCH LINE

B1
B

SHEET INDEX



LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	BARRAGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
	SURVEY (VESSEL TRACK)
	ROUTE PROVIDED BY IWAI
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	DREDGED CHANNEL / RIVER LENGTH
	RAILWAY LINE
A	START FROM BRIDGE AT SH124(1KM FOR MANERI VILLAGE AS PROVIDED BY IWAI LAT. 15°42'47.32" LON. 73°57'23.38"
A1	START POINT OF RECONNAISSANCE SURVEY FROM BRIDGE AT SH124(1KM FOR MANERI VILLAGE LAT. 15°41'53.46" LON. 73°55'42.11"
B	END POINT AT CONFLUENCE OF CHAPORA RIVER WITH ARABIAN SEA AT MORJIM AS PROVIDED BY IWAI LAT. 15°36'33.27" LON. 73°44'00.93"
B1	END POINT OF RECONNAISSANCE SURVEY AT CONFLUENCE OF CHAPORA RIVER WITH ARABIAN SEA AT MORJIM LAT. 15°36'41.07", LONG. 73°43'58.68"

PROPOSED WATERWAY LENGTH 33.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

REV.	DATE	SIGN	SIGN	SIGN	SIGN	
REVISION		DRAWN	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
–	–	–	–	–	–	–
–	–	–	–	–	–	–
–	–	–	–	–	–	–
–	–	–	–	–	–	–

TITLE
LAYOUT PLAN
CHAPORA RIVER

CLIENT
INLAND WATERWAYS AUTHORITY INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

SIZE: A3 | SCALE: 1:20000 | SHEET: 1–4

DRAWING NUMBER
P.0090051-W-20201-A01 REV 0

53NW CLUSTER-7
STATE OF GOA
CHAPORA RIVER

N
W
E
S

Virnora
Oshalbag
Dargalim
Tuem
PALYEM
Shirghalim
Arabo
Power Grid Corporation

Kochi - Panvel Hwy
Kochi - Panvel Hwy
Kochi - Panvel Hwy

CHAPORA RIVER

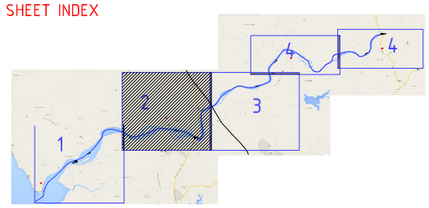
FERRY LINE
CH 9.00
CH 10.00
CH 11.00
CH 12.00
CH 13.00
CH 14.00
CH 15.00
CH 16.00

COLVALE BRIDGE

15

MATCH LINE
MATCH LINE

SHEET INDEX



LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	BARRAGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
	SURVEY (VESSEL TRACK)
	ROUTE PROVIDED BY IWAI
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	DREDGED CHANNEL / RIVER LENGTH
	RAILWAY LINE
A	START FROM BRIDGE AT SH124(1KM FOR MANERI VILLAGE AS PROVIDED BY IWAI LAT. 15°42'47.32" LON. 73°57'23.38"
A1	START POINT OF RECONNAISSANCE SURVEY FROM BRIDGE AT SH124(1KM FOR MANERI VILLAGE LAT. 15°41'53.46" LON. 73°55'42.11"
B	END POINT AT CONFLUENCE OF CHAPORA RIVER WITH ARABIAN SEA AT MORJIM AS PROVIDED BY IWAI LAT. 15°36'33.27" LON. 73°44'00.93"
B1	END POINT OF RECONNAISSANCE SURVEY AT CONFLUENCE OF CHAPORA RIVER WITH ARABIAN SEA AT MORJIM LAT. 15°36'41.07", LONG. 73°43'58.68"

PROPOSED WATERWAY LENGTH 33.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

REV.	DATE	SIGN	SIGN	SIGN	SIGN	
REVISION		DRAWN	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
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TITLE
LAYOUT PLAN
CHAPORA RIVER

CLIENT
INLAND WATERWAYS AUTHORITY INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO.
P.009051

SIZE: A3 | SCALE: 1:20000 | SHEET: 2–4

TRACTEBEL Engineering
GDF SUEZ

DRAWING NUMBER
P.0090 51-W-2020 1-A01 REV 0

53NW CLUSTER-7
STATE OF GOA
CHAPORA RIVER

MATCH LINE

CH 22.00

CH 21.00

CH 20.00

CH 19.00

CH 18.00

CH 17.00

CHAPORA RIVER

Colvale – Revora – Pirna – Mercure

Nadora

Pirna

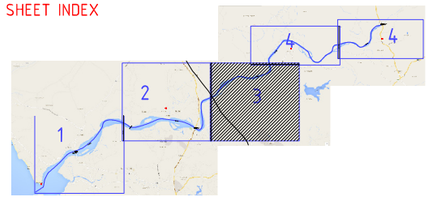
TANODIWADA

Revora

15

MATCH LINE

SHEET INDEX



LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
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PROPOSED WATERWAY LENGTH 33.0Km

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TITLE
LAYOUT PLAN
CHAPORA RIVER

CLIENT
INLAND WATERWAYS AUTHORITY INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 – FEASIBILITY REPORT

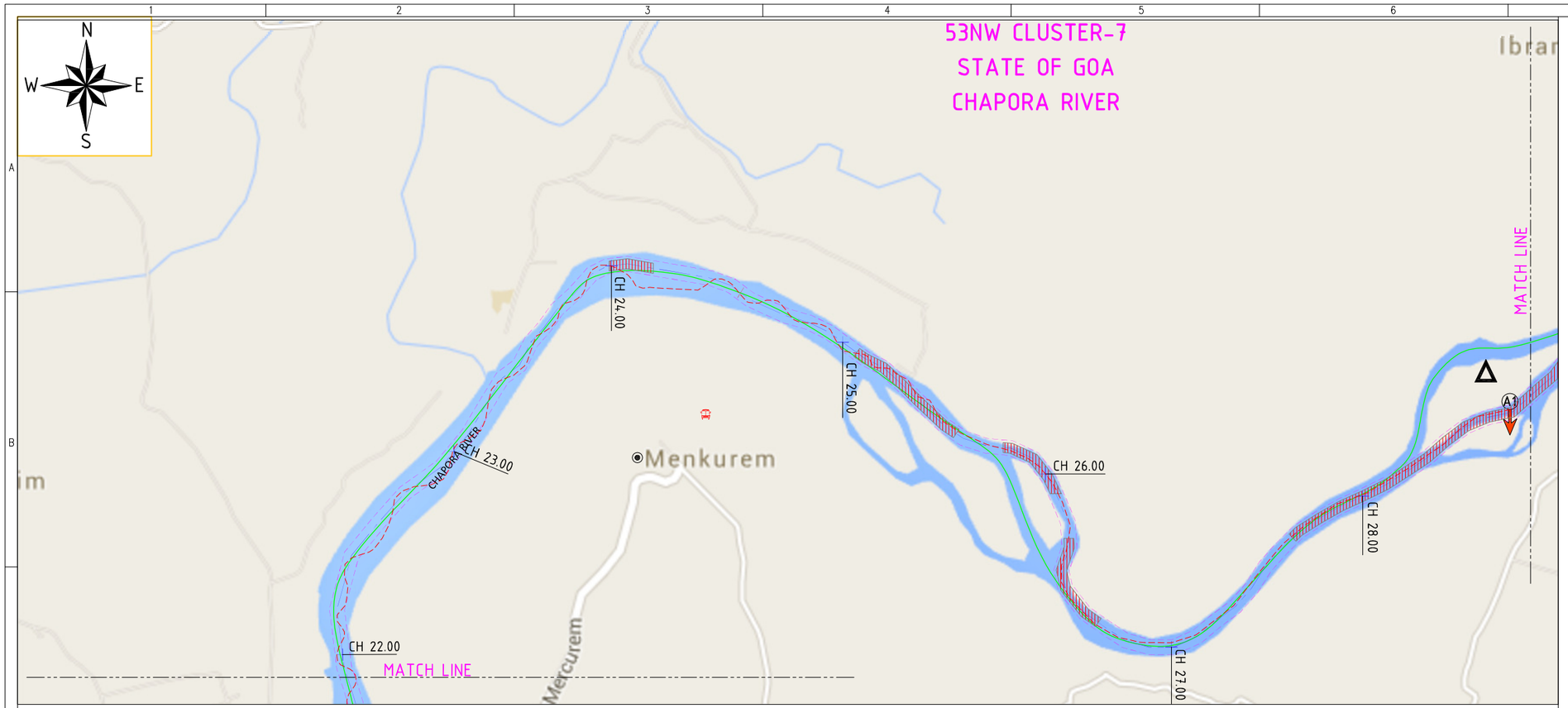
PROJECT NO.
P.009051

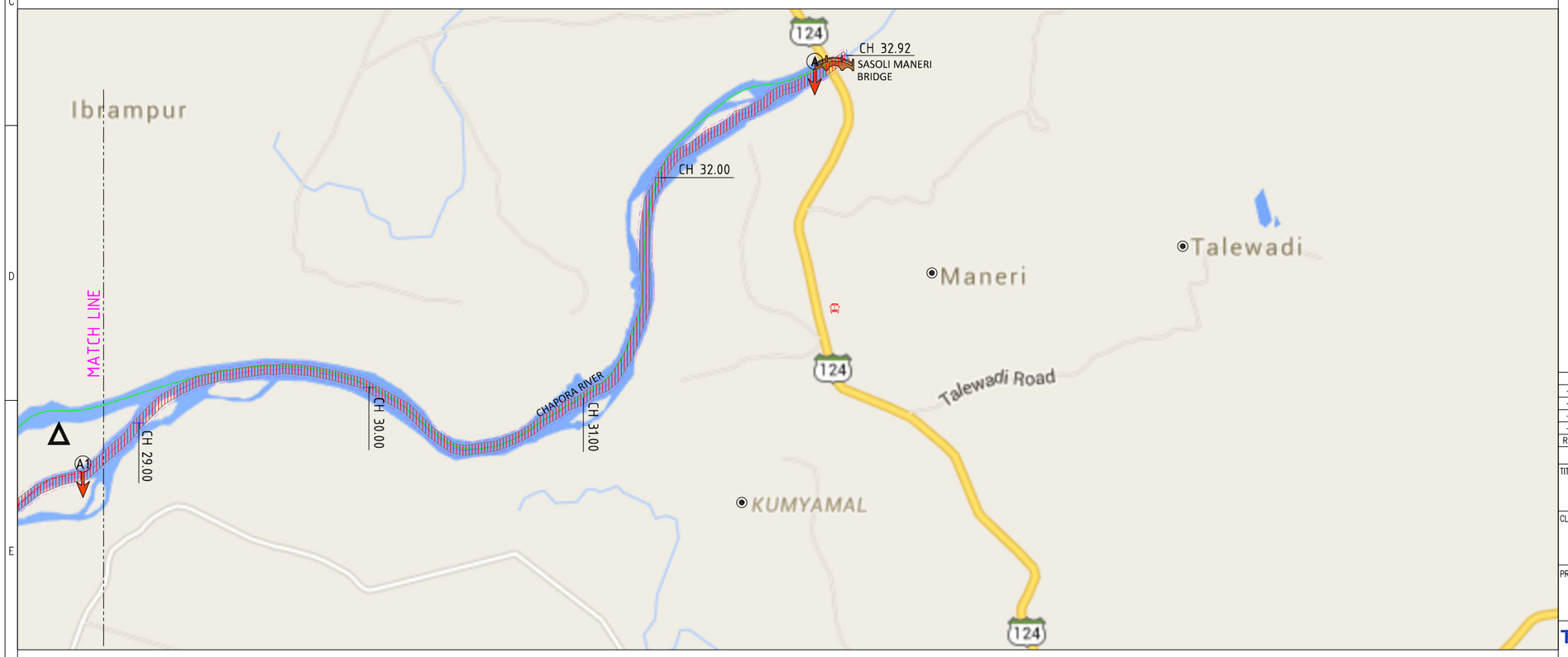
SIZE: A3 | SCALE: 1:20000 | SHEET: 3–4

TRACTEBEL Engineering
GDF SUEZ

DRAWING NUMBER
P.009051-W-20201-A01 REV 0

53NW CLUSTER-7
STATE OF GOA
CHAPORA RIVER





SHEET INDEX

LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
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PROPOSED WATERWAY LENGTH 33.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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	REVISION	DRAWN	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
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TITLE
LAYOUT PLAN
CHAPORA RIVER

CLIENT
INLAND WATERWAYS AUTHORITY INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

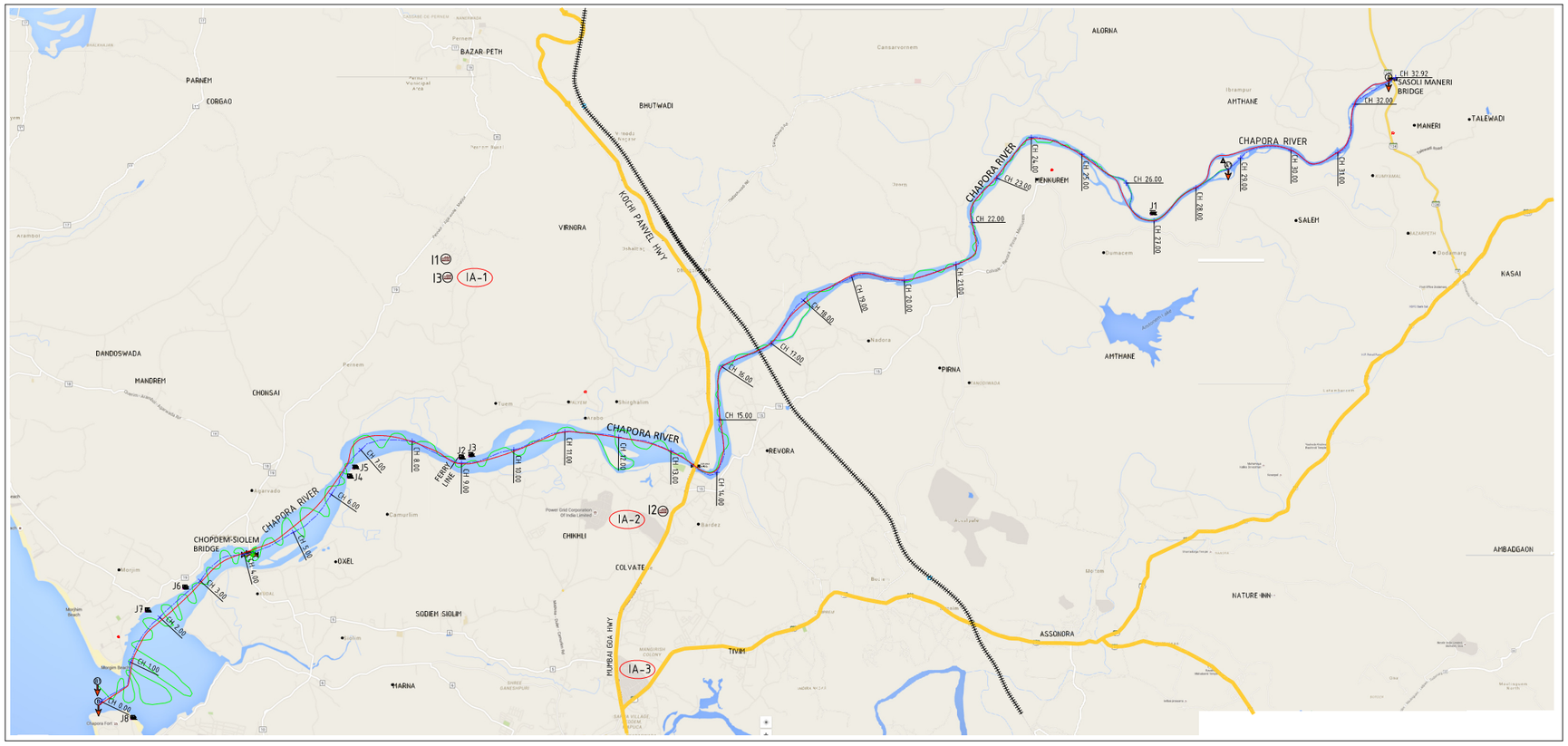
SIZE: A3 | SCALE: 1:20000 | SHEET: 4–4

DRAWING NUMBER P.009051-W-20201-A01 REV 0

MAPS

MAP 4.1 – LAYOUT MAP SHOWING EXISTING JETTIES AND INDUSTRIES IN VICINITY OF CHAPORA RIVER

MAP 4.1



LIST OF JETTIES		
SL.	DESCRIPTION	SYMB.
1	CHAPORA JETTY ON SOUTHERN BANK	J1
2	WOODEN JETTY ON NORTHERN BANK	J2
3	WOODEN JETTY ON NORTHERN BANK	J3
4	SLOPE JETTY ON SOUTHERN BANK	J4
5	SLOPE JETTY ON EASTERN BANK	J5
6	PERNEM FERRY JETTY ON NORTHERN BANK	J6
7	CAMURLIM FERRY JETTY ON SOUTHERN BANK	J7
8	JETTY ON SOUTHERN BANK	J8

LIST OF EXISTING INDUSTRY		
SL.	DESCRIPTION	SYMB.
1	VERONIK MICRONUTRIENTS.	I1
2	CROMPTION GREAVES LTD.	I2
3	PAI KANE GROUP.	I3

LIST OF EXISTING INDUSTRIAL AREAS		
SL.	DESCRIPTION	SYMB.
1	TUEM INDUSTRIAL AREA	IA-1
2	COLVALE INDUSTRIAL AREA	IA-2
3	TIVIM INDUSTRIAL AREA	IA-3

LEGEND

- BUS STOP
- HISTORICAL PLACE
- PORT
- INDUSTRY
- RAILWAY STATION
- PLACE NAME
- JETTY
- CHART DATUM
- ROAD BRIDGE
- BARRAGE
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- ROAD
- NALA/SUB CREEK/SMALL RIVER
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PROPOSED WATERWAY LENGTH 33.0Km

SCALE 0 2.0 5.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

TITLE: LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF CHAPORA RIVER (MAP 4.1)

CLIENT: INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT: CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. P.009051

TRACTEBEL Engineering GDF SUEZ

At the helm of the Energy Transition, Tractebel provides a full range of engineering and consulting services throughout the life cycle of its clients' projects, including design and project management. As one of the world's largest engineering consultancy companies and with more than 150 years of experience, it's our mission to actively shape the world of tomorrow. With about 4,400 experts and offices in 33 countries, we are able to offer our customers multidisciplinary solutions in energy, water and infrastructure.

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