TRACTEBEL

ENGIE

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

FEASIBILITY REPORT-PANCHAGANGAVALI (PANCHAGANGOLI) RIVER (23KM) - (NW-76)
Project No. P.009050
Document No. P.009050-W-10204-D09
Final Report

Karnataka and Kerala | INDIA

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

29 September 2016

Report

Rev.02

RESTRICTED

CATEGORY-II WATERWAYS: STAGE-I REPORTS

SALIENT FEATURES AT A GLANCE

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<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-VI & Karnataka</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW#</td><td>Panchagangavali (Panchagangoli) River (23 km), NW-76</td></tr>
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<tr><td>c)</td><td>Cross Structures
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ii) Bridges, Power cables etc. (total number; range of horizontal and vertical clearances)</td><td>Cross Structures
i) Barrage (1, with no navigation lock)
ii) 6 no. of Bridges, HC: 25.0m to 30.0m , VC: 3.0 m to 14.0m
5 no. HT line, HC: 25.0m to 70.0m , VC: 7.0m to 14.0m
6 no. LT line, HC: 20 m to 35 m , VC: 4 m to 7.0m
Out of 6 bridges, one bridge is under construction (Ch 6.02km).
Apart from above, last bridge is located at the end (Ch 22.90 km, VC: 6.0m).
(VC are above MHWS / HFL)</td></tr>
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Date: 29-09-2016

Consultant signature

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

PANCHAGANGAVALI (PANCHAGANGOLI) RIVER

(NW-76)

CLUSTER - VI

KARNATAKA AND KERALA, INDIA

			Arun Kumar	Shaloo Puri	Mithilesh Kumar
02	29.09.2016	For Acceptance	Arun Kumar	Shaloo Puri	Mithilesh Kumar
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
DMIC	Delhi Mumbai Industrial Corridor
DPR	Detailed Project Report
FRL	Full Reservoir Level
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
KIOCL	Kudremukh Iron Ore Company Limited
KP	Km Points
LAD	Least Available Depth
MDDL	Minimum Draw Down Level
MHWS	Mean High Water Spring
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
m/s	Meter/ second
NH	National Highway
NMPT	New Mangalore Port Trust
NW	National Waterway
OMPT	Old Mangalore Port Trust
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
UPCL	Udupi Power Corporation Ltd

VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

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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 of 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 Brahmaputra River, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the deltaic regions of the Godavari - Krishna Rivers.

Inland Waterways Authorities of India (IWAI), a statutory body under 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 includes five existing national waterway besides 106 newly declared waterways as national waterway 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 of 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 waterway to achieve navigation and to develop water transport facilities. This report presents study detail of stage-I of national waterway of Panchagangavali (Panchgangoli) River in the state of Karnataka. Panchagangavali (Panchgangoli) River has been designated as national waterway-76 with its description in the gazette notification as, Panchagangavali (Panchgangoli) River, 23km of the stretch from Gangoli Port at Lat 13°38'1.30"N, Long 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Long 74°39'15.13"E.

Sl No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Panchagangavali (Panchgangoli) River (NW-76)
2	State/ District through which river passes	The Panchagangavali (Panchgangoli) River originates from the Western Ghats, the south of Dharwad (Near Someshwara temple) as Shalmala and flows in the west direction to meet the Arabian sea.
3	Length of the river / canal	Out of the total length of 73 km of Panchagangavali (Panchgangoli) River, 23km of the stretch from Gangoli Port at Lat 13°38'1.30"N, Long 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Long 74°39'15.13"E has been declared as new national waterway and proposed to undertake the two stage DPR. The index map of Panchagangavali (Panchgangoli) River showing proposed waterway stretch, topographic features and road networks are shown in **Figure 1.1 & Figure1.2**.
4	Catchment Area	The total catchment area of Panchagangavali (Panchgangoli) River is 1125 sq. km.

B. Methodology Adopted

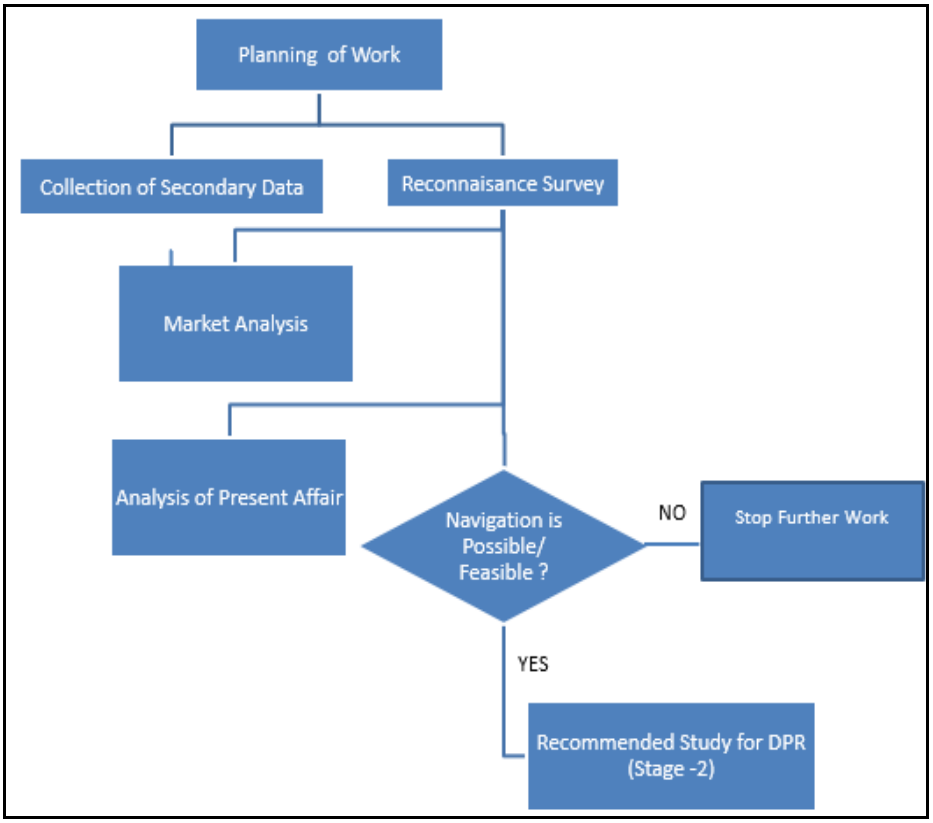
The feasibility of the navigation in the considered waterway has been examined from the following three perspectives:

a. The physical system: - It includes the study of hydrographic characteristics of the channel/stability of channel/water depth/width of river/ LAD/ port/ 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

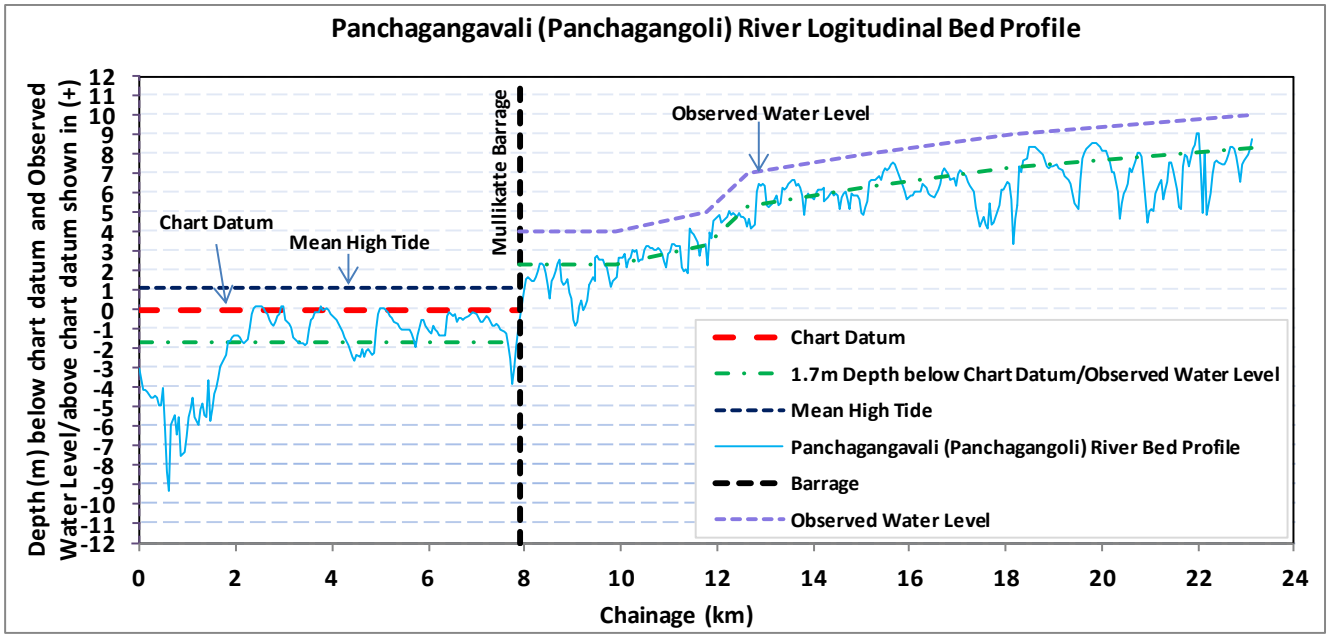
Reconnaissance survey has been conducted through expert agency for collection of primary data and various secondary data have also been collected from different sources e.g. benchmark, G & D data & chart datum from IWAI, Govt. of India, Govt. of Karnataka / MSME, Govt. of India/ Karnataka State Pollution Control Board, Bengaluru/ Cargo Movement Data for the Year 2014 and 2015 provided by IWAI, Govt. of India,WRD, Govt. of Karnataka/ WRD, Govt. of India undertaking/ KSIIDC, Govt. of Karnataka/ KSEB, Govt. of Karnataka, respective district authorities of State Govt. of Karnataka 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 23.0km, whereas the total surveyed length along the river to capture the thalweg is only 23.13km. The deepest channel route has been reckoned as 23.13km. All inferences derived for identifying the navigable length had been derived with reference to deepest channel length (23.13km).
2. 56.80% of the surveyed length has water depth more than 2m i.e. for 13.14km, however not continuous.
3. Vented barrage at Mullikatte exist at chainage 7.90km creating discontinuity for navigation.
4. The longitudinal Bed profile of Panchgangavali (Panchagangoli) River, as at Figure 3.13, is placed below:



5. Feasibility study suggests that the river is safely navigable between chainage 0.00km - 7.82km and chainage 7.90km – 23.13km. Mullikatte Barrage exists at 7.82km – 7.90km.
6. The lengths of the waterway, where a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart Datum / MDDL / Appropriate Level have been compiled in the main report. The brief of this is given in Table 3.7 and being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-5	9.33	-0.17	2.33	0.61	0.42	1.64
5-7.85	3.79	-0.10	1.81	0.76	0.14	0.14
Mullikate Barrage at Ch 7.90km						
Sub Total			**4.14**	**1.37**	**0.56**	**1.78**
7.85-10	4.80	1.18	0.00	0.26	0.34	1.55
10-15	3.87	0.86	2.91	1.75	0.30	0.04
15-23.13	6.65	0.95	6.11	1.64	0.28	0.10
Sub Total			**9.02**	**3.65**	**0.92**	**1.69**
Grand Total			**13.16**	**5.02**	**1.48**	**3.47**

7. Total Seven Nos. of Bridges is exists in the study stretch. Two Bridges are under construction for which the appropriate authorities are to be contacted to maintain the clearance standards. One Bridge at Ch 7.82km has been considered as the end of the first stretch. By limiting the operation at Ch21.13, there is no need of modification of Bridges, since the other Bridges are having required clearances.
8. Eleven Power Cables are crossing the study stretch of which six Power Cables are having clearances. Hence Five Power Cables may have to be modified.

The above 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 3.16** as reproduced below.

Criteria	Classification																			
Length of waterway from start (km)	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**20**	**21**	**22**	**23**
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-III																			
Raod Bridge Vert. Clearance	C-III																			
Raod Bridge Hor. Clearance	All Class																			
HT Line Vert. Clearance	All Class										Needs Raising of HT base									
Bend Radius																				
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

E. Cargo Feasibility

It is expected that the passenger volume using jetties at the waterway will increase to approximately 2.5 lakhs per annum in 2025. The same offers a potential for development of the Panchagangavali (Panchgangoli) River waterway. New ferry routes & jetties may have to be planned along the waterway.

F. SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objective 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. 56.80% of the 23.13km (13.14kn) has waterway having more than 2m water depth available for navigation, however not continuous.
2. Feasibility study suggests that the river is safely navigable between chainage 0.00km - 7.82km and chainage 7.90km – 23.13km.
3. Country Boats are being operated to cross the river at Marvanthe and at Gangoli Port and at some other locations.
4. Ferry points at ten (10) locations are being planned in the Souparnika River Catchment Area.
5. It is estimated that Passenger traffic may increase to 5.6 lacs per annum by 2025 considering the completion of ten (10) ferry routes assessed for Souparnika River Catchment Area by IWT.
6. Tourism potential may also exists in the River.

Weakness

1. Presently, there is no IWT cargo movement.
2. Vented barrage at Mullikatte exist at chainage 7.90km creating discontinuity for navigation.
3. Depth improvement at some locations is required for development of Class – III waterway.
4. No large and medium scale industries.
5. Two railway station viz. Kundapur and Senapur lies within 5km area.

Opportunity

1. 13.14km (of 23.13km) is having more than 2m water depth for safe navigation, though not continuous, which can be used advantageously for the mobility of hinterland cargo on provision of navigation lock at barrage location (at chainage 7.90km).
2. Alternatively, if Ro – Ro facility is provisioned connecting the downstream and upstream of the Barrage, throughput can be established.
3. The water level fluctuation during high tide up to chainage 7.90km (*Ref: Indian Tide Tables, 2016, Survey of India*), can be an opportunity for the safe mobility of vessels in the waterway.
4. The present road connectivity though may be competing with IWT may also be an opportunity for creating an efficient intermodal hub for IWT.

Threat

1. NH 66 (NH 17) and NH 48 may be a competing mode, if not effectively used for intermodal connectivity.
2. Habitation on both the banks of Panchagangavali (Panchagangoli) River may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.
3. Policies are to be firmed up for development of IWT in this stretch, which may get resistance from the line department.

G. Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable to the required standards. Henceforth the development of the proposed national water way 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. Nominal dredging may be required in the proposed waterway. The cost of terminal has been estimated @ INR 10.0 crore each for two Ro-Ro terminals. The cost of LT Lines has been estimated @ INR 44.0 Lacs at each location. The cost of bridge has been estimated @ INR 1.5 Cr at each location. No need of any modification for the Bridges in the study stretch. However, 5 Nos. Of Power Cables are to be modified to meet the clearance standards. The cost of navigational aids for day/night navigation has been considered as INR 150 lacs. 10% of the amount for dredging, terminal construction and night navigation 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 36.20 crore. (As at Table 5.1)

Sl. No.	Name of Waterway	Length of Waterway	Dredging Required (w. r. to 2m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Ro–Ro Terminal Proposed	Ro-Ro Terminal Cost @ INR 10 Cr each	Cost of Modification of Bridge / Transmission line	Night Navigation	Total cost including 10% unforeseen
		(km)	(km)	(INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Panchagangavali (Panchagangoli) River	23.00	10	9.2	2	20.00	2.2	1.50	36.20

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 Panchagangavali (Panchagangoli) River (NW 76) of 23.13km 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 Panchagangavali (Panchagangoli) River is described below. (As at 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 (Proposed)
0.0 – 23.13	-0.17	> 100.0	3.00 (Bridge)	20.00 (LT Line)	105.00	**Class – III**

The entire study stretch of the waterway of 23.13km is amenable for development as Class – III waterway with provision of navigational lock at barrage location at chainage 7.9km, for which viability may have to be established. Alternatively, if Ro – Ro service is provided, operational throughput can be achieved.

The above stretch of the waterway, hence, can be considered under Class - III, which is navigable with provision of navigational lock at barrage location at chainage 7.9km and shall be used for plying self-propelled vessel of carrying capacity up to 500 DWT (approximate size 58m overall length, 9m moulded breadth and 1.5m loaded draft) or one tug and four barges combination of 1000 DWT (approximate size 141m overall length, 9m breadth and 1.5m loaded draft).

I. Recommendation

The national waterway-76 of Panchagangavali (Panchagangoli) River has been identified having potential for development as waterway of Class - III for a distance of 23.13km (entire stretch with provision of navigational lock at barrage location at chainage 7.9km / provision of Ro – Ro service), as described above.

Accordingly, the national waterway NW-76 of Panchagangavali (Panchagangoli) River is proposed for development as **Class III** waterway in the stretch of the waterway as depicted below:

River Stretch	0.00km 7.82km	7.90km 23.13km
Classification	Class III	Class III
Horizontal clearance (m)	50	50
Vertical clearnce (m)	7	7
Minimum Depth(m)	1.7	1.7
Bottom Width (m)	50	50
Self Propelled Vessel		
Dead Weight Tonnage	500	500
Vessel size (m)	(58 x 9 x 1.5)	(58 x 9 x 1.5)
Tug + Barge		
Dead Weight Tonnage	1000	1000
Vessel size (m)	(141 x 9 x 1.5)	(141 x 9 x 1.5)

Though the stretch is amenable for Class III waterway, as explained, keeping in view the depleted cargo volumes in Gangoli Port and provision of lock structure at Barrage location at Ch 7.9km, the national waterway-76 of Panchagangavali (Panchagangoli) River is not recommended for stage-II study for preparation of Detailed Project Report (DPR).

Note:

1. All vertical clearances of cross over structures have been reckoned with MHWS of 2.13m and the corresponding Barrage levels and details are described in Para 3.3.5.
2. The depths have been reckoned in the tidal stretch (Ch 7.90km) with reference to the chart datum of 1.33m (below mean sea level).
3. MHWS –2.13m, HTL—2.13m, LTL—0.04m, Average Tidal Variation—1.10m and Port Name—Karwar 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 Ministry of Shipping. 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 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), 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 Brahmaputra River, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai 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 is just 0.1% of the total inland traffic in India. There now are 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, Gaighatt (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 of 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 waterways 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-6 & Cluster-7 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 Cluster-6 which consists of rivers/creeks of Karnataka and Kerala (length-487 km) and described in **Table 1.1** as shown below:-

Table 1.1: List of Rivers/Creeks Karnataka and Kerala under Cluster-6 (length-487.0 km)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length (km)	State
1.	West Coast Canal	3	160	Kerala
2.	Alappuzha- Changanassery Canal	8	28	Kerala
3.	Alappuzha- Kottayam – Athirampuzha Canal	9	38	Kerala
4.	Kottayam-Vaikom Canal	59	28	Kerala
5.	Gurupur River	43	10	Karnataka
6.	Kabini River	51	23	Karnataka

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length (km)	State
7.	Kali River	52	54	Karnataka
8.	Netravathi	74	78	Karnataka
9.	**Panchagangavali (Panchagangoli) River**	**76**	**23**	**Karnataka**
10.	Sharavati River	90	29	Karnataka
11.	Udayavara River	105	16	Karnataka
	Total		**487**	

The layout plan of the all eleven rivers/creeks covered in Cluster-6, showing the location and Index Map of Panchagangavali (Panchagangoli) River are shown in **Figure 1.1 & Figure 1.2** respectively.

Figure 1.1: Location Map of the Proposed Waterway of Cluster-6 in Karnataka and Kerala

Figure 1.2: Index Map of Panchagangavali (Panchagangoli) River

1.3 Objective 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 objective 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 – 6 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 assignment shall include the study in 2 stages:

1. **Stage-1** 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-2** 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 **Panchagangavali (Panchagangoli) River** for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-1 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:

the physical system

the current functions

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 the 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 river using satellite images, therefore, has been used as a basis for a first, but reliable appraisal of the physical potential of the river (for navigation) shall be carried out. Such analysis is, therefore, proposed as one of the methods in Stage 1.

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 a 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, hydro-power
  - ferry terminals: variations in water levels and terminal infrastructure
- fishery
- mining, occurs along certain rivers, and depends 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 train and railroad 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 as 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**.

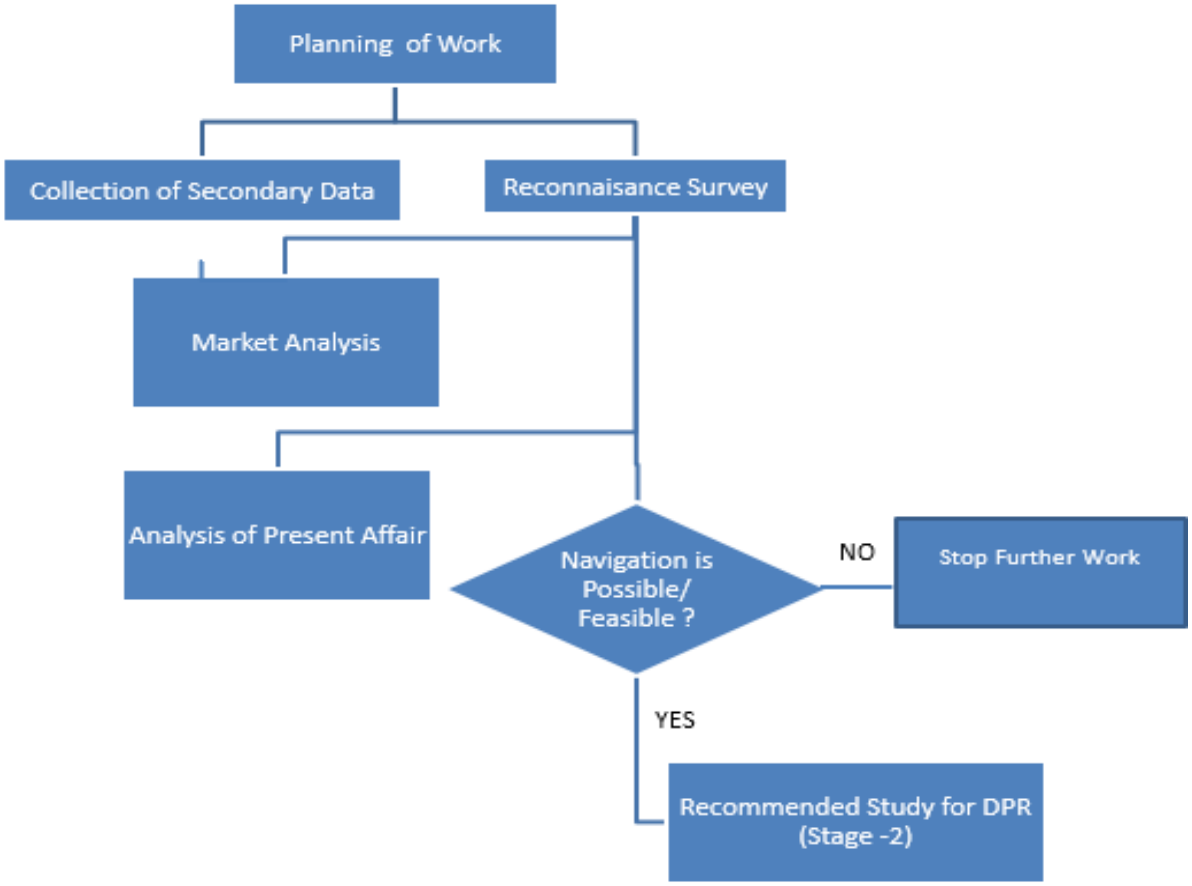


Figure 1.3: Execution Diagram of Stage I

1.6 Collection of Data

For evaluating the feasibility of the waterway in Panchagangavali (Panchagangoli) 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 Geoinfosys Technologies** 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 source of data is being enclosed as **Annexure 1.1**.

(B) **Secondary Data:** The following secondary data had been collected from concerned authorities as well as available on public domain.

(i) Benchmark Data from IWAI, Noida

(ii) Chart Datum data from Karwar Port

(iii) Industry Details from District Industry Centre, Dakshin Kannada, Udipi & North Kannada of Govt of Karnataka

(iv) Import Export data of commodities from Old Mangalore Port Trust Office

(v) Agriculture Data from Deptt of Agriculture, Govt of Karnataka

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 have 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 to the above criteria, the stretch of the proposed waterway of Panchagangavali (Panchagangoli) River under Cluster 6 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 shall be 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) 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 between 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 into 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 Panchagangavali (Panchagangoli) (NW-76)

Panchagangavali (Panchgangoli) river is flowing through Kundapur and Gangolli in western India. The five rivers namely Souparnika, Varahi, Kedaka, Chakra, and Kubja join and merge into Arabian Sea at Gangolli estuary. The total catchment area of Panchagangavali (Panchgangoli) River basin as obtained from Google earth is 1125 sq. km. The catchment receives an average annual rainfall of about 1700mm to 6000mm. The length of the Panchagangavali (Panchgangoli) main stream in the catchment from the origin to the outfall in the Arabian Sea is about 73km. The detail description of the Panchagangavali (Panchgangoli) River has been compiled in **Table 1.2**.

Table 1.2: Description of Panchagangavali (Panchagangoli) River (NW-76)

Sl. No.	Introductory Consideration	Description of the River
1.	Name of the river / canal	Panchagangavali (Panchgangoli) River (NW-76)
2.	State/ District through which river passes	The Panchagangavali (Panchgangoli) River originates from the Western Ghats, the south of Dharwad (Near Someshwara temple) as Shalmala and flows in the west direction to meet the Arabian sea.
3.	Length of the river / canal	Out of the total length of 73 km of Panchagangavali (Panchgangoli) River, 23km of the stretch from Gangoli Port at Lat 13°38'1.30"N, Long 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Long 74°39'15.13"E has been declared as new national waterway and proposed to undertake the two stage DPR.
4.	Map	The index map of Panchagangavali (Panchgangoli) River showing proposed waterway stretch, topographic features and road networks are shown in **Figure1.2**. The section of the Panchagangavali (Panchgangoli) River under feasibility study for inland waterway showing reconnaissance survey routes is presented in **Drawing No. P.009050-W-20201-009 (Sheet – 2)**.
Characteristic of River		
5.	River Course	The Panchagangavali (Panchgangoli) River originates from the Western Ghats, the south of Dharwad (Near Someshwara temple) as Shalmala and flows in the west direction to meet the Arabian sea. The total length of the river is about 73km from origin up to the Arabian Sea.
6.	Tributaries / Network of Rivers / Basin	River has a relatively Large catchment area and its tributaries are small feeder streams and canals. River Panchagangavali (Panchgangoli) has tidal effect.
7.	Catchment Area	The total catchment area of Panchagangavali (Panchgangoli) River is 1125 sq. km.

1.9 Structure of the Feasibility Study Report (FSR)

The Feasibility Study Report for proposed Inland Waterways of **Panchagangavali (Panchagangoli) River** has been prepared and emphasize that which stretches of proposed inland waterways has potential of possible navigation. Only for those stretches of proposed inland waterways, which have potential of possible navigation, Stage-II study for preparation of DPR shall be carried out.

The Feasibility Study Report starts with a comprehensive report in 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 and findings of Market Potential.

The executive summary concludes with Waterway Navigation Potential of the proposed waterway on Panchagangavali (Panchagangoli) River followed with recommendations for going ahead with classification of river. The structure of FSR shall be as below;

I. **Executive Summary:** Executive summary shall describe the suitability of the proposed waterway in terms of its navigability and market potential. It shall contain 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 shall form part of the document. It will help to understand the overall scenario and decide the suitability of development of a specific waterway.

II. **Introduction:** This chapter shall describe about the Project Background of the present study, objective of the assignment, scope of the assignment, methodology adopted, outcome of the assignment, River characteristics and structure of the feasibility study report is presented.

III. **Analysis of Present State of Affairs**: In which 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 done 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 (Full Supply Level) 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, it has been examined both the existing market and the potential future market. 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 various interconnected stakeholders.

VI. **Observations and Inferences**: Observations and Inferences of the feasibility study is presented in context of stretches of proposed inland waterways, which have potential of possible navigation for the approval of Stage 2. 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 of possible navigation have been categorized and classified between categories of 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 waterway, the state of affairs as existing today along proposed inland waterway on **Panchagangavali (Panchagangoli) River (NW-76)** is studied. Out of total 73 km length of the river, 23 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

The proposed water way is along the tributary viz. Souparnika River. Souparnika River originates from Kollur and for a distance of about 57 km out of total length 73km, the river is known as Kollur River. The total length of the river is about 73 km before joining the river Panchagangoli and then the Arabian sea. There is one vented dam viz. Mullikatte at chainage 7.90 km and river is under tidal effect of Arabian Sea up to Mullikatte vented dam.

There is Gangoli port on the right bank at mouth of sea. The port is used for fishing purpose only. There are total four (04) jetties, two (02) ferry routes and one (01) navigation lock existing along the proposed stretch of waterway. Details of existing structures along and across the Panchagangavali (Panchagangoli) waterway are presented in following sections.

2.1.1 Existing Waterway Structures

Existing waterway structures/ facilities in Panchagangavali (Panchagangoli) river include ports, jetties, ferry service and navigation lock. **Table 2.1** below provides the details of existing facilities along Panchagangavali (Panchagangoli) waterway with current utilization status.

Table 2.1: Existing Facilities on Panchagangavali (Panchagangoli) (NW 76)

Sl. No.	Existing Facility	Chainage (km)	Coordinates	Current Utilization
1.	Gangoli Port	0.00	13°38'08.13"N 74°40'07.16"E	Fishing
2.	Jetty 1	0. 40	13°38'25.70"N 74°40'16.56"E	Fishing & Local Travel
3.	Ferry 1	0.70	13°38'37.16"N 74°40'20.41"E	Ferry service to Maddugudde – Kundapura
4.	Jetty 2	1.50	13°39'00.66"N 74°40'26.85"E	Fishing & Local Travel
5.	Jetty 3	2.60	13°39'30.57"N 74°40'18.71"E	Fishing & Local Travel

Sl. No.	Existing Facility	Chainage (km)	Coordinates	Current Utilization
6.	Vented Dam at Mullikatte	7.90	13°41'57.16"N 74°41'00.63"E	
7.	Ferry 2	10.30	13°42'55.91"N 74°40'04.95"E	Ferry service between Movadi to Padukone Village
8.	Jetty 4	11.60	13°42'33.19"N 74°39'40.59"E	Fishing & Local Travel
9.	Navigation Lock, Maravanthe	15.70	13°42 '40.26" N 74°38 '35.03" E	Navigation Lock

Figures 2.1 to 2.3 show some of the above mentioned facilities.

Figure 2.1: Gangoli Port

Figure 2.2: Jetty At Chainage 1.50 km

Figure 2.3: Vented Dam Jetty At Chainage 7.90

2.1.2 Crossing Over Panchagangavali (Panchagangoli) (NW-76) Waterway

Apart from existing facilities on banks of the waterway as described in section 2.1.1 above, three Road Bridges and one Rail Bridge are existing in the study stretch. Further, two Road bridges are under construction in the study stretch of Panchagangoli River. **Table 2.2** shows details of the existing and under construction bridge structures.

Table 2.2: Details of Rail and Road Bridges across Panchagangavali (Panchagangoli)

Sl. No.	Name of Structure	Chainage (km)	Horizontal Clearance (m)	Vertical Clearance above MHWS / HFL (m)	Center Position	
					Latitude	Longitude
1	Bridge	5.99	30.00	14.00	13°41 '3.34"	74°40 '57.05"
2	Under Construction Bridge	6.02	30.00	-	13°41 '3.73"	74°40 '57.52"
3	Bridge	7.82	25.00	4.00	13°41 '56.74"	74°41 '0.45"
4	Mullikatte Vented Barrage	7.90	-	-	13°41 '58.34"	74°40 '58.62"
5	Maravanthe-Padukone Bridge (U/C)	15.76	-	-	13°42 '40.26"	74°38 '35.03"
6	Bridge Badakere	21.13	-	3.00	13°44 '21.15"	74°38 '33.87"
7	Railway Bridge	22.90	-	6.00	13°44 '50.15"	74°39 '14.85"

2.2 Connectivity of Waterway

Proposed stretch of Panchagangoli waterway lies in the coastal area of Udupi district which is well connected with the state capital and surrounding districts, tehsils and villages through road and rail. **Figure 2.4** shows road and rail connectivity of the area adjacent to the Panchagangoli River waterway.

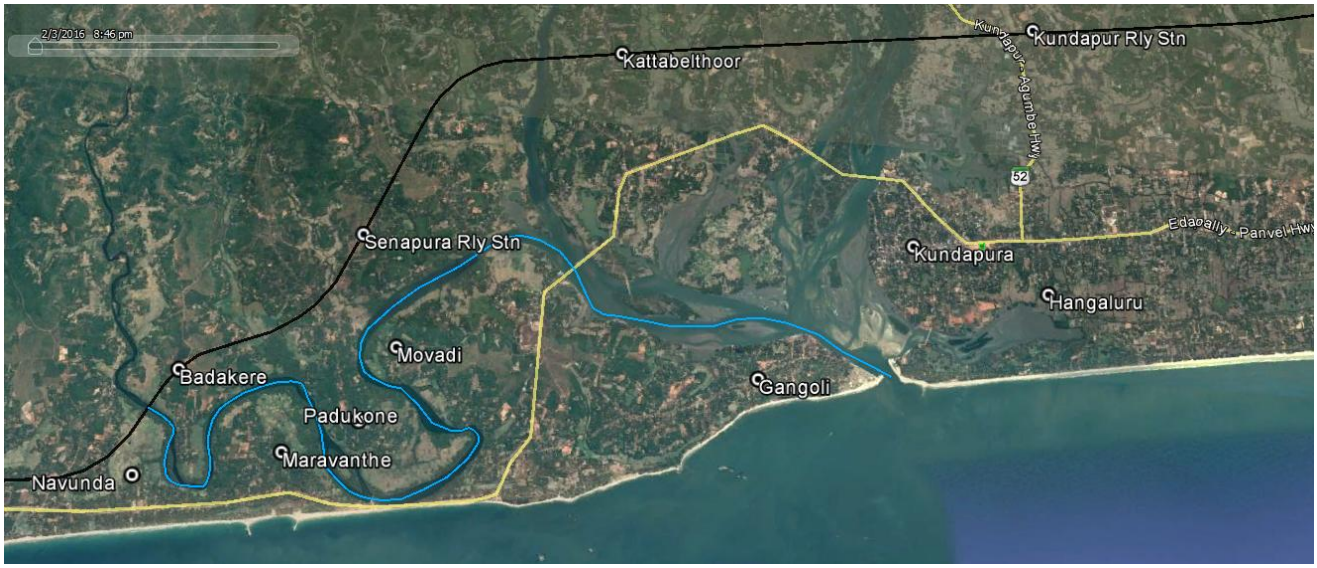


Figure 2.4: View of Rail and Road Network around Panchagangavali (Panchagangoli) River

In **Figure 2.4**, Panchagangavali (Panchagangoli) River waterway is shown in blue color whereas yellow and black colors represent the road and rail network respectively around the waterway. The area under study is well connected with highway and rail network.

2.2.1 Important Places

Many important places of Udupi district are situated in the vicinity of the waterway. These places are well connected with the waterway by road and rail transport. **Table 2.3** shows the distance of the waterway from nearby important places.

Table 2.3: List of Important Places of Panchagangavali (Panchagangoli) Waterway

Sl No.	Important Places	Category	Distance from Creek/River (km)	Bank
1.	Gangoli	Village	1.22	Right Bank
2.	Kundapura	Taluk	2.39	Left Bank
3.	Movadi	Village	0.70	Right Bank

Sl No.	Important Places	Category	Distance from Creek/River (km)	Bank
4.	Padukone	Village	0.50	Left Bank
5.	Maravanthe	Village	0.63	Right Bank
6.	Badaker	Village	0.71	Left Bank
7.	Kattabelthoor	Village	4.0	Left Bank
8.	Senapura	Village	1.36	Left Bank

2.2.2 Road Connectivity

Panchagangavali (Panchagangoli) River in the study stretch is well connected with Edapally – Panvel Highway (NH-66) and Badakere state highway (SH-52) and is surrounded by national highway & district road on right bank and left bank. The roads surrounding Panchagangavali (Panchagangoli) River connects to National Highway throughout the length of waterway on right bank.

2.2.3 Rail Connectivity

Railway transport in Panchagangavali (Panchagangoli) River catchment is developed under the Konkan Railways. The start and end point of study stretch of the river is connected to railway route. The nearest main railway station is at Kundapura on left bank. Kundapura railway station is about 46km from Udupi and 100km from Mangalore central railway station.

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 Panchagangavali (Panchagangoli) River is 73 km before joining the sea. The study stretch is only 23kms. The river is under tidal influence of Arabian Sea (backwater effect) up to vented dam at Mullikatte (about 7.9 km).
b) There are total four (04) jetties, two (02) ferry route, One (1) port and one (01) navigation lock existing along the proposed stretch of waterway
c) Panchagangavali (Panchagangoli) River in the study stretch is well connected with National Highway and is surrounded by national highway NH-66 and State highway SH-52 on right bank and left bank.

d) Railway transport in Panchagangavali (Panchagangoli) river catchment is developed under the Konkan Railways. Nearest railway station is at Kundapura which is about 46km from Udupi and 100km from Mangalore central railway station.

e) Three Road Bridges and one Rail Bridge exist in the study stretch. Further, two Road bridges are under construction in the study stretch of Panchagangoli River.

CHAPTER 3 RECONNAISSANCE SURVEY

3.1 River Profile

Panchagangavali (Panchgangoli) river is flowing through Kundapur and Gangolli in western India. The five rivers namely Souparnika, Varahi, Kedaka, Chakra, and Kubja join and merge into Arabian Sea at Gangolli estuary**.** The total catchment area of Panchagangavali (Panchgangoli) River basin as obtained from Google earth is 1125 sq. km. The catchment receives an average annual rainfall of about 1700mm to 6000mm. The length of the Panchagangavali (Panchgangoli) main stream in the catchment from the origin to the outfall in the Arabian Sea is about 73km. A map showing Panchagangavali (Panchgangoli) catchment basin is shown in **Figure 3.1.** Panchagangavali (Panchgangoli) River has a relatively small catchment area and its tributaries are small feeder streams.

Figure 3.1 indicates the significant part of the river flow close to the coastal region; thus the lower stretch of the river is expected to be tidal affected zone. Given the size of the river, some lower reaches may have navigation potential. IWAI expects the lower 23.00km, shown in green colour in **Figure 3.1**, to have potential for navigation and thus, the subject of study under this assignment.

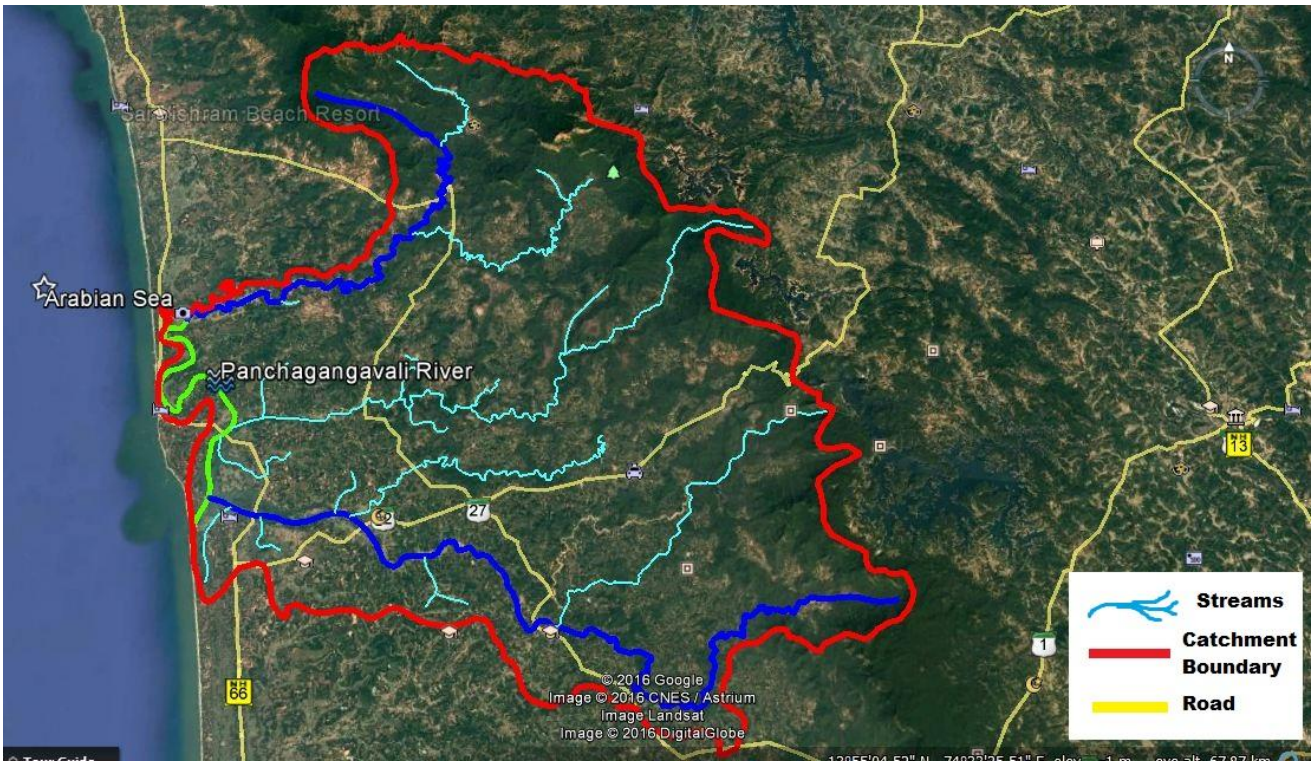


Figure 3.1: Catchment Area of Panchagangavali (Panchagangoli) River

The stretch of the Panchagangavali (Panchagangoli) River considered for assessment of navigation potential is defined as below:

23 km length of the river from Gangoli Port to Bridge at Badekere.	From: 13°38' 1.30"N, 74°40' 8.43"E	Up to: 13°44' 50.01"N, 74°39' 15.13"E	National Waterway: 76

3.2 Reconnaissance Survey

This section presents a stretch-wise description of Panchagangavali (Panchagangoli) River. It also covers the hydrological analysis of collected data viz maximum and minimum water depths. The route map of Panchagangavali (Panchagangoli) River is shown in **Figure 3.2** below.

Figure 3.2: Route Map of Panchagangavali (Panchagangoli) River

3.2.1 Methodology of Survey

Single line longitudinal survey (Bathymetric survey or Topographic survey) was carried out along the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System **(Figure 3.3)**. Bathymetric survey in the proposed waterway has been carried out in the deepest route. Deepest route has been accessed by taking two or three longitudinal line soundings at equal intervals. Topographic survey, wherever required, has been taken up at lowest ground levels, which can be decided on visual assessment.

Along with the bathymetry, other relevant data/information like horizontal and vertical clearances above high flood level of bridges, cross structures, 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 10.00km interval. Texture of the collected soil samples was analyzed visually.

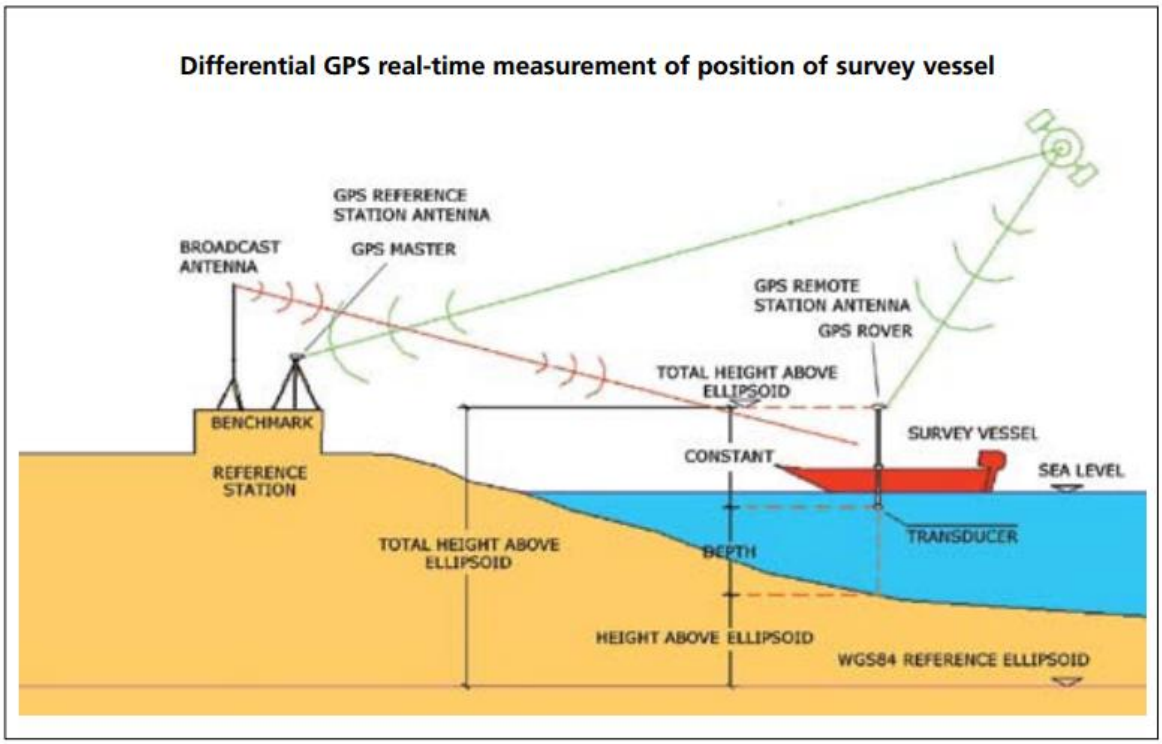


Figure 3.3: Differential GPS Real-time Measurement of Position of Survey Vessel

The survey was conducted in WGS84 datum; UTM Projection (Zone 43 N, CM 075^0 E). The specification of the Echo sounder (Bathy-500DF) used for carrying out the survey and other inter related details are tabulated in **Table 3.1.**

Table 3.1: Bathy-500DF

Particulars	Specification
Depth Ranges	Units of 0-15, 0-30, 0-60, 0-120, 0-240, 0-480, 0-960, 0-1920 feet or 0-5, 0-10, 0-20, 0-40, 0-80, 0-320, 0-640 m
Phasing	0-120, 60-180, 120-240, 180-300, etc. (displays 120ft range at 60 ft increments up to 1800-1920) feet, auto or 0-40, 20-60, 40-80, 60-100, 80-120, etc. (displays 40m range at 20m increments up to 600-640) m, auto
Chart Record	8.5 inch x 90 feet High Contrast Thermal Paper
Digital Display	LCD (4 lines x 16 characters) 0.25 inch characters (Depth Display: 0.75 inch characters) (Back-lighting: Electro-luminescent)
Resolution	0.01 units for depths less than 100 m;

Particulars	Specification
Depth Ranges	Units of 0-15, 0-30, 0-60, 0-120, 0-240, 0-480, 0-960, 0-1920 feet or 0-5, 0-10, 0-20, 0-40, 0-80, 0-320, 0-640 m
Phasing	0-120, 60-180, 120-240, 180-300, etc. (displays 120ft range at 60 ft increments up to 1800-1920) feet, auto or 0-40, 20-60, 40-80, 60-100, 80-120, etc. (displays 40m range at 20m increments up to 600-640) m, auto
Accuracy	Meets or exceeds all current IHO hydrographic requirements for single beam echo sounders At 33 Khz= 5 cm +/- 0.1% of depth At 200Khz= 1cm +/- 0.1% of depth
Frequency	Interleaved Dual Frequency Selections of: 33/210kHz or 50/210kHz or any single frequency (all user selectable & changeable via keypad) from these: 33kHz, 40kHz, 50kHz, 210kHz (Acoustic output = 600 watts)
Depth Alarms	Shallow and Deep (selected by keypad)
Sound Velocity	4,600-5,250 feet/second (1393-1590 meters/second) (user selected via keypad)
Offset	0 to +30 ft or m (allows the user, via keypad, to adjust for the net sum of transducer depth and tide)
Geographic Position	NMEA-0183 GGA or GLL Format from GPS/DGPS
Data I/O Compatibility	COM 1 provides bi-directional interface to PC or other peripheral device; This port accepts external annotation from external sources such as hydrographic software. COM 2 accepts GPS/DGPS inputs and provides additional (from COM 1) data outputs.
Data Outputs	-ODEC dt (Time, Lat, Long, Depth Hi, Depth Lo) -PMC dt (True Depth & Status) Atlas DESO-25 -Odom Digitrace -Odom Echotrac -NMEA DBT -NMEA DBS
Heave Compensation	Compatible with Teledyne TSS Format
Input Power	11-30 volts DC (1.5 amps @ 12v. 0.5 amp @ 30v.) or 115/230 volts AC 50/60 hertz (20 watts)
Dimensions	Height (including handle) 19 inches Width 17.5 inches Depth 9 inches
Weight	35lbs. (Recorder with P01540 Transducer)

The layout diagram of the equipment used for bathymetric survey has been shown in **Figure 3.4** below.

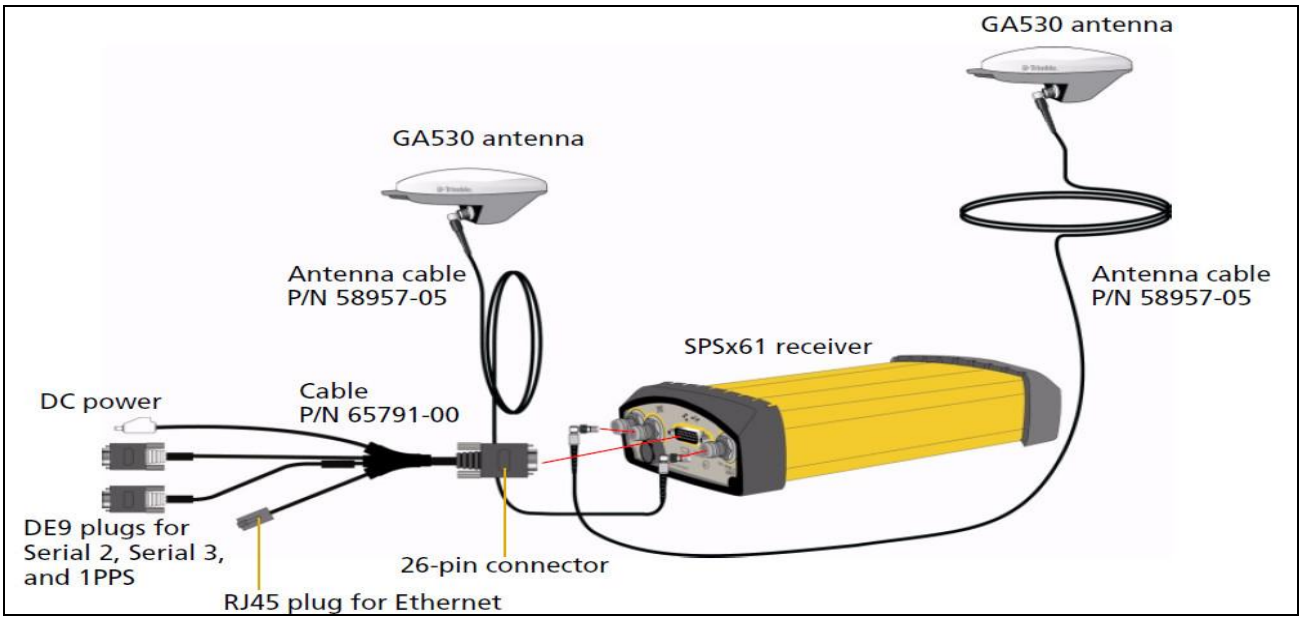


Figure 3.4: Equipment Diagram

Team surveying at site with equipment mounted on the boat is depicted in **Figure 3.5** as shown below:

Figure 3.5: Team Surveying at Site with Equipment Mounted on the Boat

The survey data has been processed using the latest version of "Hypack" software, thus to ensure a quality output of the survey.

An overview chart for Panchagangavali (Panchagangoli) 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 Karwar Port data were used to reduce the raw water depths to Chart Datum. The locations with coordinates of Chart Datum obtained from Karwar Port (*Ref. Indian Tide Table 2016, Survey of India*) have been used to reduce the soundings along the surveyed stretch as compiled in **Table 3.2**.

Table 3.2: Details of Chart Datum Used for Data Reduction upto Ch 7.90km

Sl. No.	Location	Latitude	Longitude	Z_0 *(m)
1	Karwar Port	14°47'58.17"N	74° 6'54.00"E	1.33

**- Below Mean Sea Level*

After Ch 7.90km to Ch 23.13km the data is reckoned w. r. to Observed Low Water Level.

3.2.3 Bathymetry and Site Data Collected

A. Panchagangavali (Panchagangoli) River from Ch -0.22km to Ch 0.00km

Panchagangavali (Panchagangoli) River waterway starts from the Arabian Sea at Vivi Beach, Udupi Karnataka. The start point (Lat 13° 38' 1.30" N, Lon 74° 40' 8.43" E) could not be approached by the survey boat due to the rough weather condition on the day of survey. The tide wave water gets enter into the boat as going closer to the start point. Therefore, the bathymetric survey was carried out from a point (Ch 0.00km, Lat 13° 38' 7.89" N, Lon 74° 40' 11.43" E) which is about 220m away from the waterway starting point. However, it is supposed to have sufficient water depth available for navigation in this stretch.

B. Panchagangavali (Panchagangoli) River from Ch 0.00km to Ch 5.00km

The survey starts from Gangoli Port at the mouth of Arabian Sea. Two Jetties are present on the right side of the river. Gangoli, Uppina Kudru and Kannada Kudru villages may be seen under this chainage. A shoal is present from Ch 1.00km to Ch 3.30km in the river. Sand and rock patches can be seen near the shoal at Ch 3.00km. At Ch 4.60km 11KV line is present. From Ch 0.00km to Ch 4.00km on the right side of the river residential area can be seen and from Ch 2.00km to Ch 3.80km and Ch 4.00km to Ch 5.00km agriculture and forest area can be seen on both the sides of the river. The minimum depth recorded is -0.17m at Ch 2.93km and the maximum depth is 9.33m at Ch 0.61km as given below in **Table 3.3.** The stretch is shown in **Figure 3.6** and **Figure 3.7**.

Table 3.3: Maximum – Minimum Depth in Panchagangavali (Panchagangoli) River from Ch 0.00km to Ch 5.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
0	5	9.33	-0.17

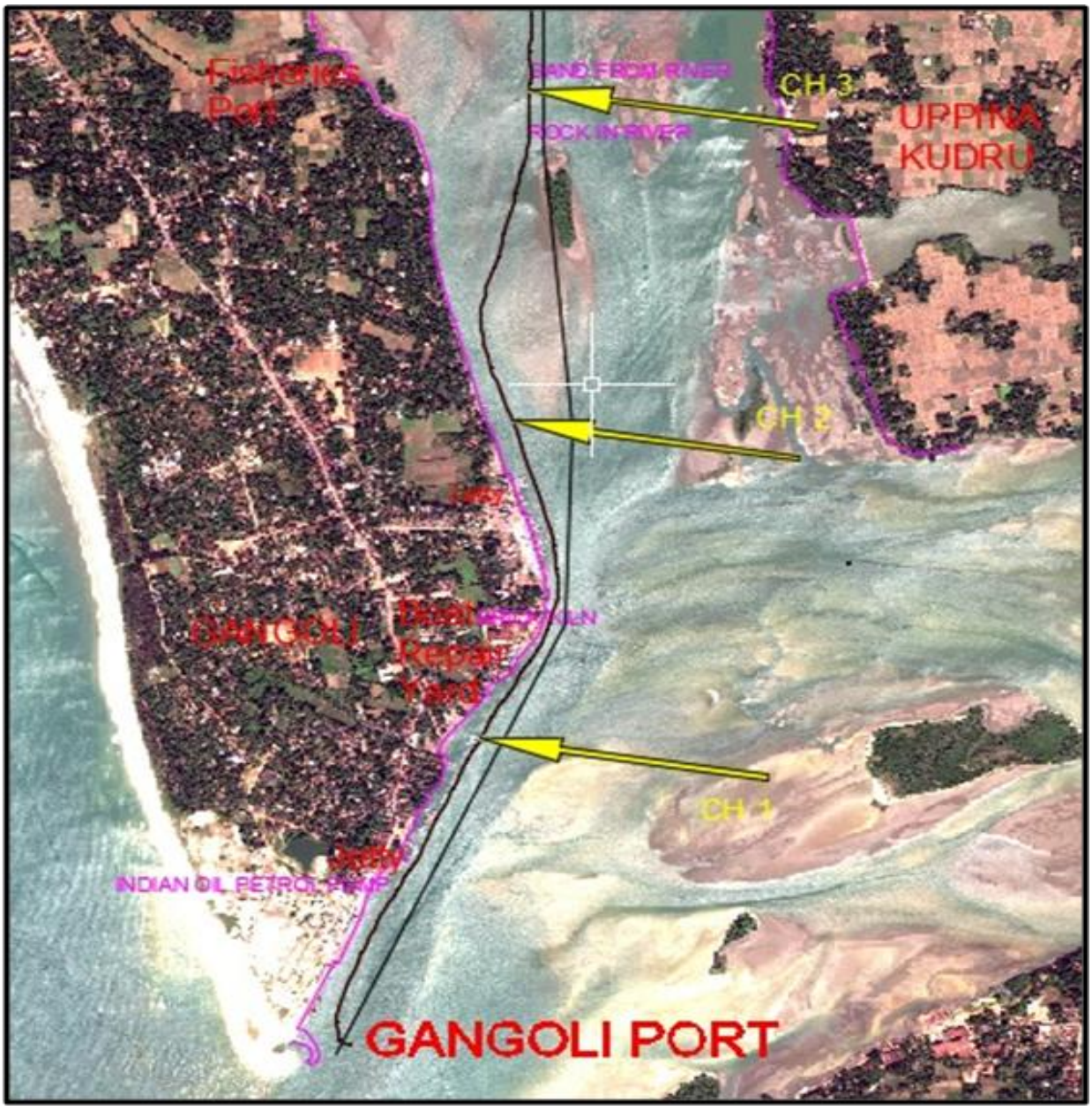


Figure 3.6: Route Chart of the Survey from Ch 0.00km to Ch 3.00km

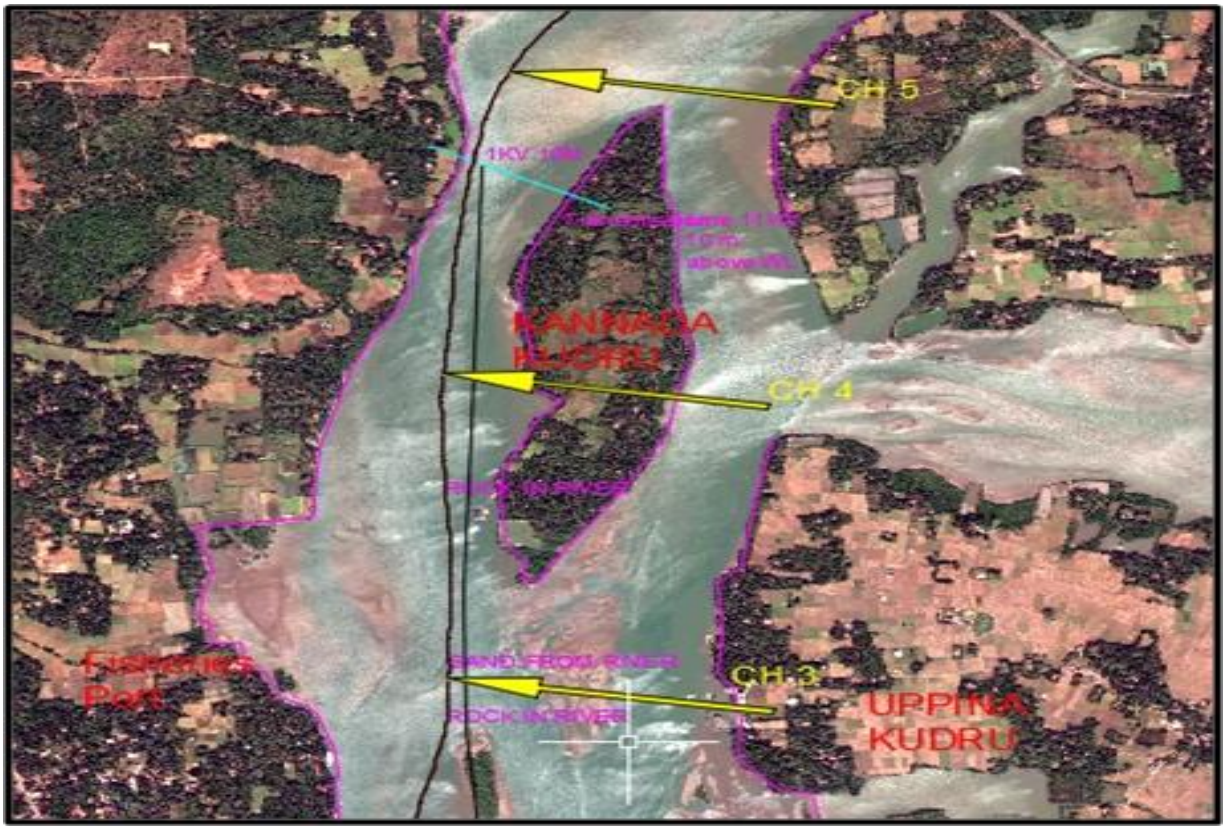


Figure 3.7: Route Chart of the Survey from Ch 3.00km to Ch 5.00km

C. Panchagangavali (Panchagangoli) River from Ch 5.00km to Ch 10.00km

In between these chainage Hosadu, Thoplu and Kelakali villages are present. A Bridge is present at Ch 5.90km and at Ch 7.82km. Under construction bridge can be seen at Ch 6.00km. At Ch 7.85km there is 132KV S/C Transmission line. Barrage is present at Ch 7.90km. From Ch 5.00km to Ch 10.00km on both the sides of the river Agricultures, residential and Plantation area can be seen. The minimum depth recorded is -0.10m at Ch 6.45km and the maximum depth is 4.80m at Ch 9.04km as given below in **Table 3.4.** The stretch is shown in **Figure 3.8** and **Figure 3.9**.

Table 3.4: Maximum – Minimum Depth in Panchagangavali (Panchagangoli) River from Ch 5.00km to Ch 10.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum/ Observed Low Water Level	
From	To	Max	Min
5	10	4.80	-0.10

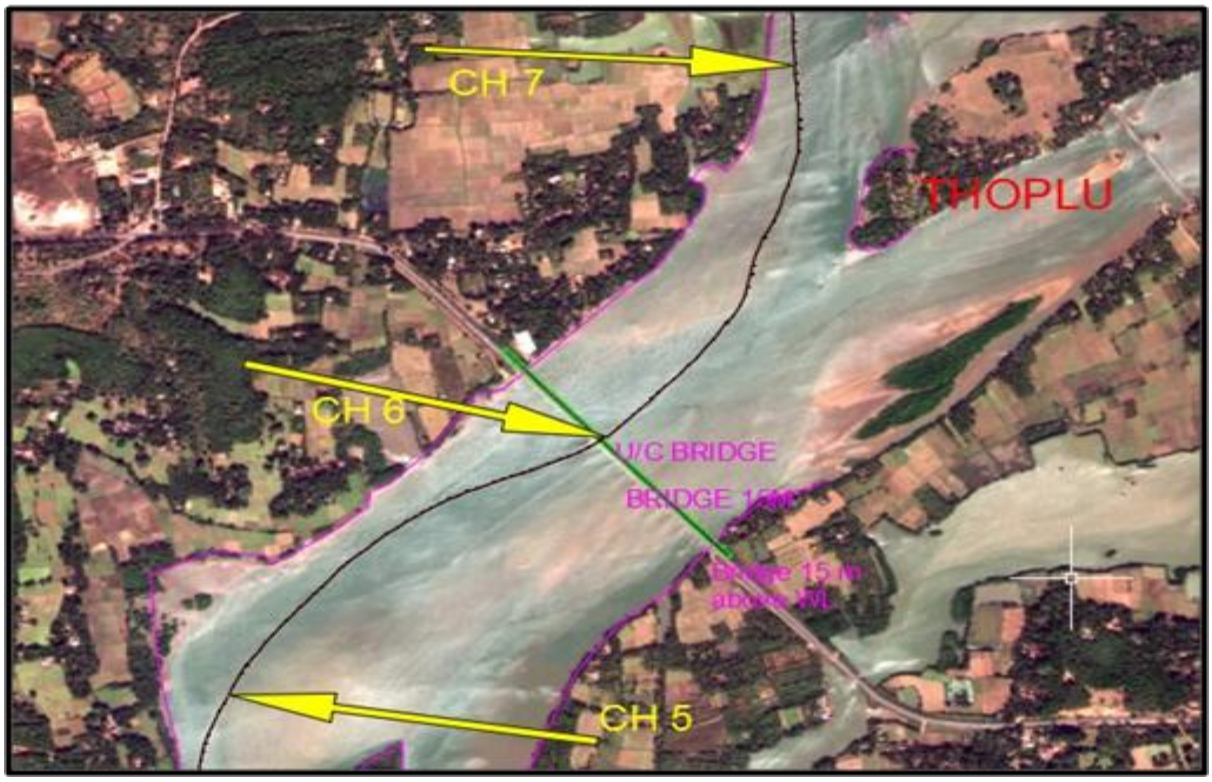


Figure 3.8: Route Chart of the Survey from Ch 5.00km to Ch 7.00km

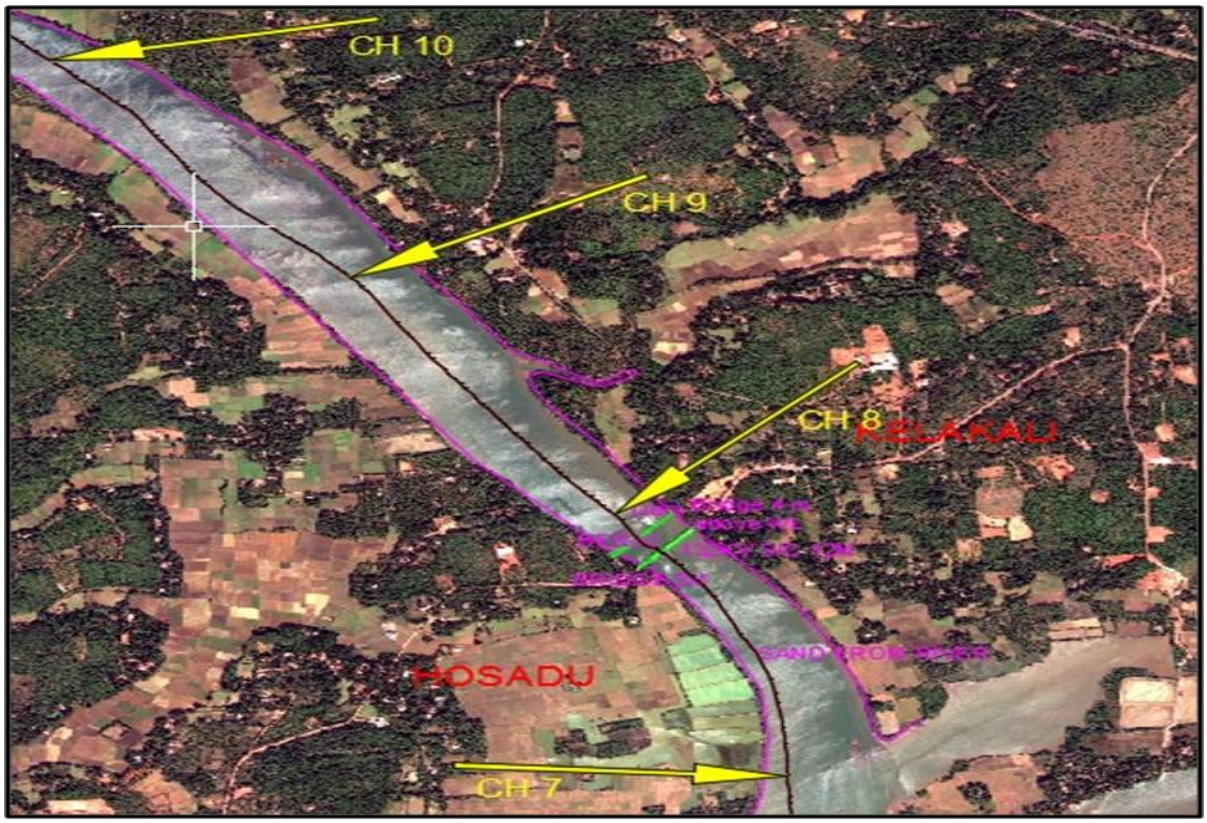


Figure 3.9: Route Chart of the Survey from Ch 7.0km to Ch 10.00km

D. Panchagangavali (Panchagangoli) River from Ch 10.00km to Ch 15.00km

In between these chainage Movadi, Hadayu and Padukone villages are present on both the sides of the river. On the right side of the river from Ch 10.00km to Ch 11.40km plantation and agriculture area is present. At Ch 11.12km there is a 11KV line. Plantation and Agriculture area may be seen from Ch 11.40km to Ch 12.00km and from Ch 12.00km to Ch 12.90km. Residential area is present from Ch 13.00km to Ch 14.00km and plantation is present from Ch 14.00km to Ch 15.00km. The minimum depth recorded is 0.86m at Ch 11.42km and the maximum depth is 3.87m at Ch 12.7km as given below in **Table 3.5.** The stretch is shown in **Figure 3.10**.

Table 3.5: Maximum – Minimum Depth in Panchagangavali (Panchagangoli) River from Ch 10.00km to Ch 15.00km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Observed Low Water Level	
From	To	Max	Min
10	15	3.87	0.86

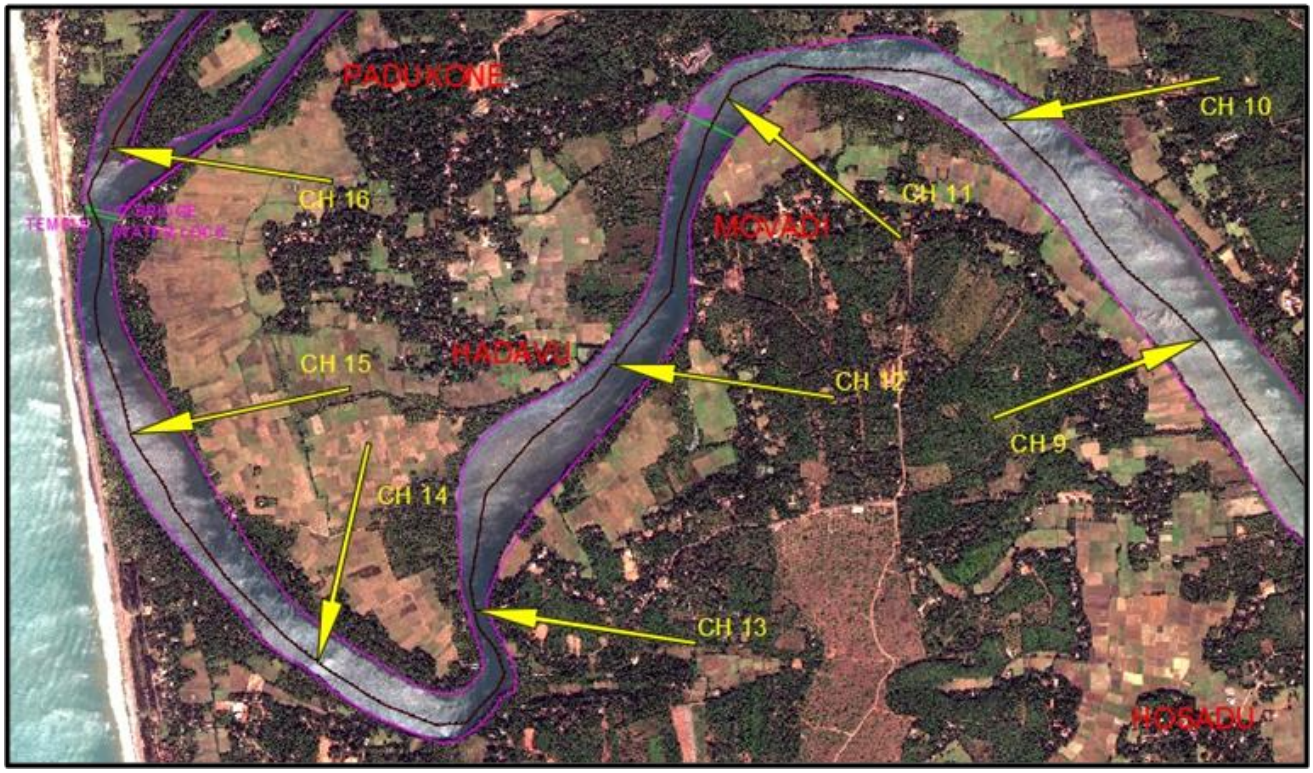


Figure 3.10: Route Chart of the Survey from Ch 10.00km to Ch 15.00km

E. Panchagangavali (Panchagangoli) River from Ch 15.00km to Ch 23.13km

Plantation and agriculture land are present on the left side of the river from Ch 15.00km to Ch 21.50km. Hadavu, Padukone, Vidyanagar, Maravanthe, Chikkali, Badakere and Navunda villages can be seen on the left

side at Ch 15.70km. An island is present in the river at Ch 15.95km, Ch 18.20km and Ch 21.45km. A bridge is present at Ch 21.23km. LT lines are present at Ch 21.57km, Ch 21.63km, Ch 21.68km, Ch 21.83km, Ch 21.91km and Ch 22.86km respectively. From Ch 21.50km to Ch 22.30km residential area on the left side of the river may be seen. Agricultural and Plantation land is present from Ch 22.30km to Ch 23.13km. At Ch 22.90km there is a railway bridge. At Ch 22.94km there is 11KV line and at Ch 23.03km there is 132KV S/C Transmission Line. Survey ends at Ch 23.13km at Badakere. The minimum depth recorded is 0.95m at Ch 22.01km and the maximum depth is 6.65m at Ch 18.18km as given below in **Table 3.6.** The stretch is shown in **Figure 3.11** and **Figure 3.12.**

Table 3.6: Maximum – Minimum Depth in Panchagangavali (Panchagangoli) River from Ch 15.00km to Ch 23.13km

Maximum –Minimum Depth			
Chainage (km)		Reduced Water Depth (m) w. r. t. Observed Low Water Level	
From	To	Max	Min
15	**23.13**	6.65	0.95

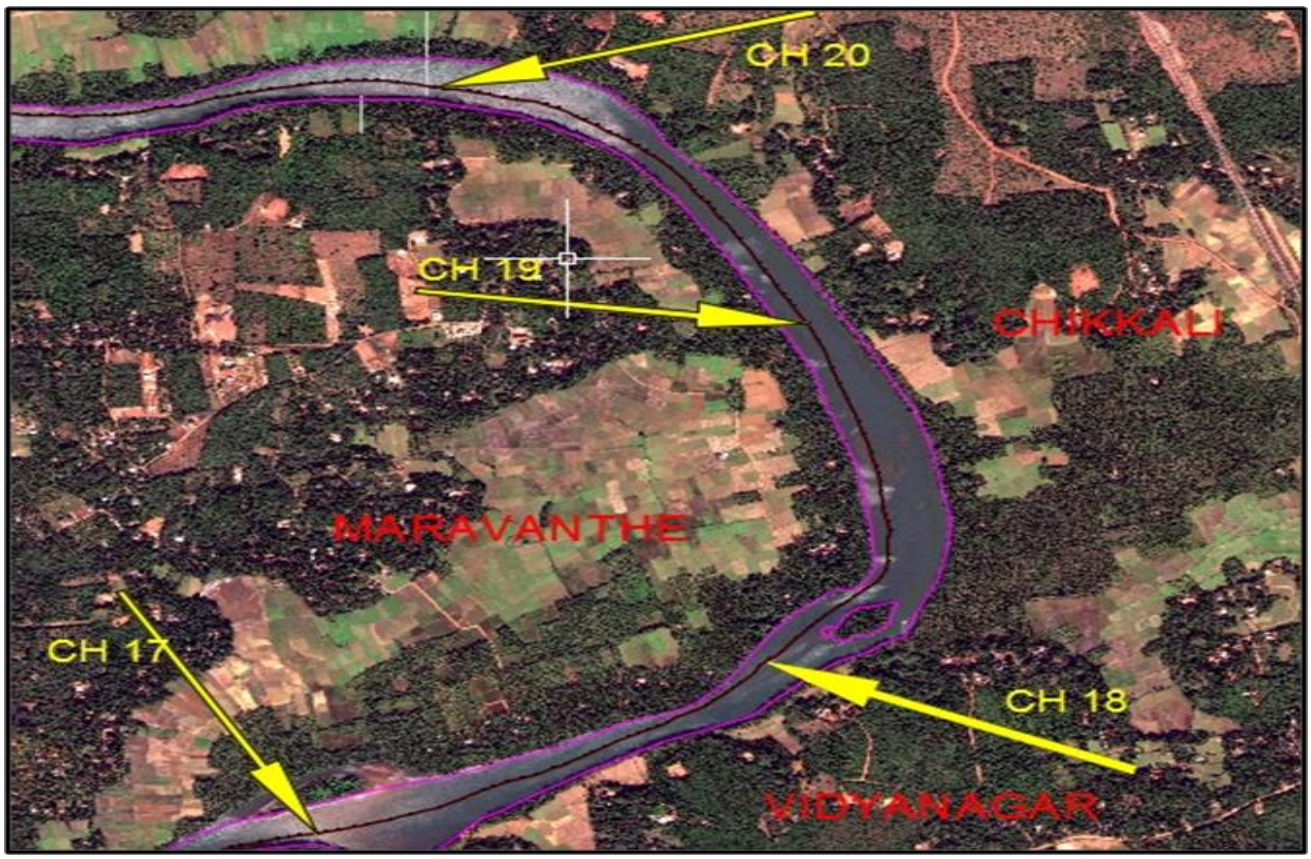


Figure 3.11: Route Chart of the Survey from Ch 15.00km to Ch 20.00km

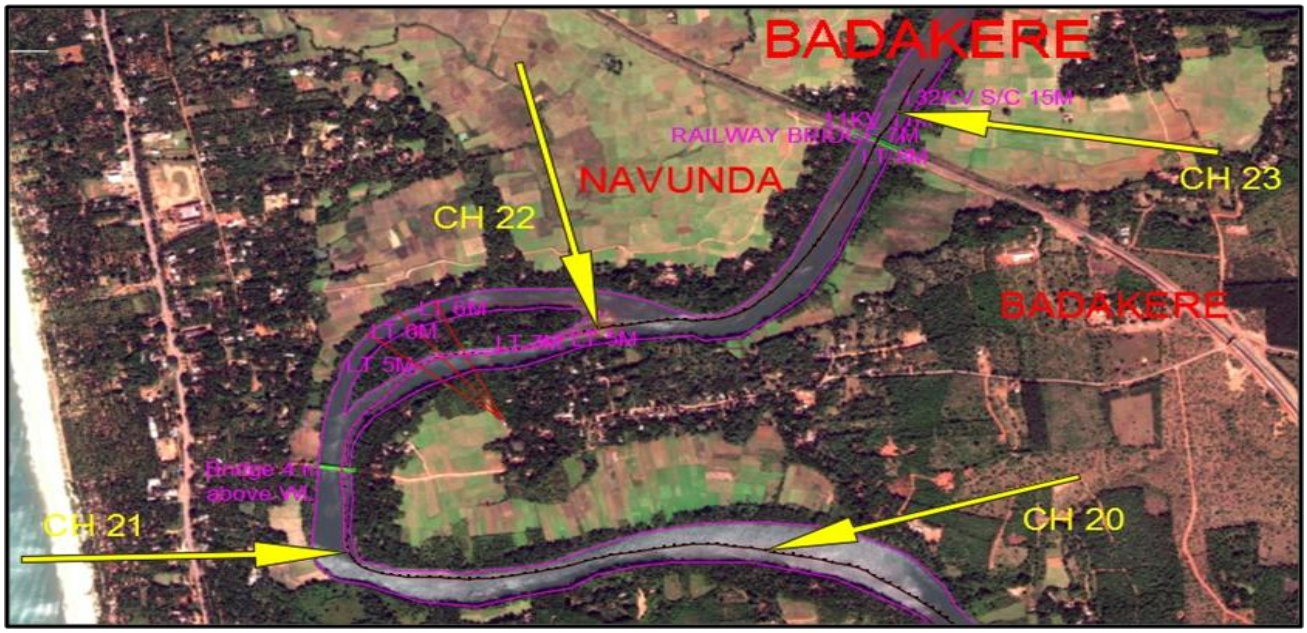


Figure 3.12: Route Chart of the Survey from Ch 20.0km to Ch 23.13km

Keeping in view the Mullikatte Barrage at Ch 7.90km, the river stretch may have to be separated into two parts- from Ch 0.00km to Ch 7.90km as first part and from Ch 7.90km to Ch 23.13km as second part. The tidal effect can be considered upto barrage at Ch 7.90km. Water depths have been reckoned with respect to Chart Datum upto barrage at Ch 7.90km and after that the depths have been reckoned with respect to Observed Water level on the upstream of Barrage.

The maximum and minimum depths with reference to the Chart Datum in the small intervals have been summarized in **Table 3.7** describing the length of stretch showing various ranges of water depth available.

Table 3.7: Maximum – Minimum Depth in Panchagangavali (Panchagangoli) River from Ch 0.00km to Ch 23.13km

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-5	9.33	-0.17	2.33	0.61	0.42	1.64
5-7.85	3.79	-0.10	1.81	0.76	0.14	0.14
Mullikate Barrage at Ch 7.90km						
Sub Total			**4.14**	**1.37**	**0.56**	**1.78**
7.85-10	4.80	1.18	0.00	0.26	0.34	1.55
10-15	3.87	0.86	2.91	1.75	0.30	0.04
15-23.13	6.65	0.95	6.11	1.64	0.28	0.10
Sub Total			**9.02**	**3.65**	**0.92**	**1.69**
Grand Total			**13.16**	**5.02**	**1.48**	**3.47**

The above data indicates that water depth of 2.0m and above is available up to 13.14km of the waterway under study. It may be noted that the depths upto Ch 7.90km have been reckoned with CD. Since the study stretch of Panchagangavali River from Arabian Sea to Mullikatte Barrage (Ch 7.90km) is under tidal influence, the available effective depths would be advantageous for safe navigation, however, for limited period. The reach of the river on the upstream of the Barrage is pond and hence, the water depth greater than 2m in the reach as indicated in the above table is reasonable. It confirms the availability of 2.0m and above water in 56.80% of river in the proposed stretch under study. However, due to the existence of Mullikatte Barrage in the Panchagangavali River, there is discontinuity in the navigation at Ch 7.90km. The detailed hydrographic survey information indicating location, observed water depth at each point of data reading has been given in **Annexure 3.2**

3.2.4 Soil Texture Classification

The soil texture has been observed during the reconnaissance survey. The visually observed soil texture at 10km interval has been given in **Table 3.8**.

Table 3.8: Soil Texture in Panchagangavali (Panchagangoli) River at 10.0km Interval

Chainage (Km)	Latitude	Longitude	Depth (m)	Soil Texture
0	13°38 '8"	74°40 '12"	4.33	Coastal alluvial
10.02	13°42 '51"	74°40 '14"	2.28	Red soil
23.13	13°44 '56.55"	74°39 '18.38"	1.24	Red soil

From the above table, it is observed that Red soil is present in most parts of the river under study stretch. However, at some places in the initial stretch Coastal alluvial soil is found.

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 2000 Dead Weight Tonnage (DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000 DWT (Ref: IWAI, Gazette Notification 2006). The classification criteria of waterways are mentioned in **Table 3.9**for Rivers and in **Table 3.10** for canals.

Table 3.9: 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 3.10: 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 are described in **Table 3.11**

Table 3.11: 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 here in above and conclusions have been made with regard to the class of navigation channel that the relevant stretch of Panchagangavali (Panchagangoli) River falls into. Furthermore, it is to be determined whether the entire 23.00km 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, Low Tension lines, Bridges and Barrages crossing the Panchagangavali (Panchagangoli) River are given below in **Table 3.12** and **Table 3.13**.

Table 3.12: Details of High Tension Line and Low Tension Line across Panchagangavali (Panchagangoli) River

Sl. No.	Cross-Structure Name	Chainage (km)	Position (Above vessel track)		Vertical Clearance above MHWS / HFL (m)	Horizontal Clearance (m)
			Latitude	Longitude		
1.	HT Line	4.70	13°40 '34.3"	74°40 '29.19"	9.00	25.00
2.	HT Line	7.85	13°41 '57.24"	74°41 '0.07"	11.00	70.00
3.	HT Line	11.12	13°42 '50.05"	74°39 '42.36"	7.00	25.00

Sl. No.	Cross-Structure Name	Chainage (km)	Position (Above vessel track)		Vertical Clearance above MHWS / HFL (m)	Horizontal Clearance (m)
			Latitude	Longitude		
4.	LT Line	21.57	13°44 '30.14"	74°38 '39.88"	4.00	30.00
5.	LT Line	21.63	13°44 '31.02"	74°38 '41.31"	5.00	30.00
6.	LT Line	21.68	13°44 '31.29"	74°38 '42.98"	5.00	35.00
7.	LT Line	21.83	13°44 '31.88"	74°38 '48.1"	6.00	25.00
8.	LT Line	21.91	13°44 '32.76"	74°38 '50.8"	4.00	20.00
9.	LT Line	22.86	13°44 '49.04"	74°39 '14.35"	7.00	20.00
10.	HT Line	22.94	13°44 '51.12"	74°39 '15.51"	10.00	30.00
11.	HT Line(S/C)	23.03	13°44 '53.57"	74°39 '16.88"	14.00	50.00

Table 3.13: Details of Bridges across Panchagangavali (Panchagangoli) River

Sl. No.	Name of Structure	Chainage (km)	Horizontal Clearance (m)	Vertical Clearance above MHWS / HFL (m)	Center Position	
					Latitude	Longitude
1.	Bridge	5.99	30.00	14.00	13°41 '3.34"	74°40 '57.05"
2.	Under Construction Bridge	6.02	30.00	-	13°41 '3.73"	74°40 '57.52"
3.	Bridge	7.82	25.00	4.00	13°41 '56.74"	74°41 '0.45"
4.	Mullikatte Vented Barrage	7.90	-	-	13°41 '58.34"	74°40 '58.62"
5.	Maravanthe-Padukone Bridge (U/C)	15.76	-	-	13°42 '40.26"	74°38 '35.03"
6.	Bridge Badakere	21.13	-	3.00	13°44 '21.15"	74°38 '33.87"
7.	Railway Bridge	22.90	-	6.00	13°44 '50.15"	74°39 '14.85"

From the above information, waterway from Ch 0.00km to Ch 23.03km, sufficient vertical clearance is available from HT line which fulfills the criteria for **Class III** and for LT line the base shall have to be raised in the range of 3m - 5m to make suitable for **Class-III.**

Bridge at chainage 7.82km and 21.23km needs to raise in range between 3m – 4m to obtain the vertical clearance to fulfills the criteria for **Class III**.

Photos of important structures such as port, bridges, barrage, transmission lines and plants as taken during site visit are shown in **Annexure 3.3**.

3.3.2 Dams, Barrages and Reservoirs

One barrage is there at Ch 7.90km. However, no dams or reservoirs exist along the surveyed route.

3.3.3 Bends along the Route

On the proposed waterway route, there are many bends in Panchagangavali (Panchagangoli) River, which are given below in **Table 3.14.**

Table 3.14: River Bend Radius in Panchagangavali (Panchagangoli) River

Sl. No.	Chainage (Km)	Radius (m)
1.	1.35	505
2.	6.90	475
3.	10.96	105
4.	13.75	230
5.	15.56	235
6.	18.50	485
7.	21.82	430

In the study stretch, based on the river radius criteria, it may not be fit for **Any Class.** The study stretch can be considered for development as **Class III** with depth improvement at some locations and with improvement to the cross structures Vessels with depth improvement at some locations, however on the 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 P.009050-W-20201-009** (Sheet 1 to 2).

3.3.4 Gauge & Discharge data

In the Panchagangavali (Panchagangoli) 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 and Observed Water level in the area. Tidal heights are predicted using Karwar Port to reduce the raw water depths to Chart Datum. The observed bed profile of

Panchagangavali (Panchagangoli) River waterways is shown below in **Figure 3.13** and presented in **Annexure 3.4**.

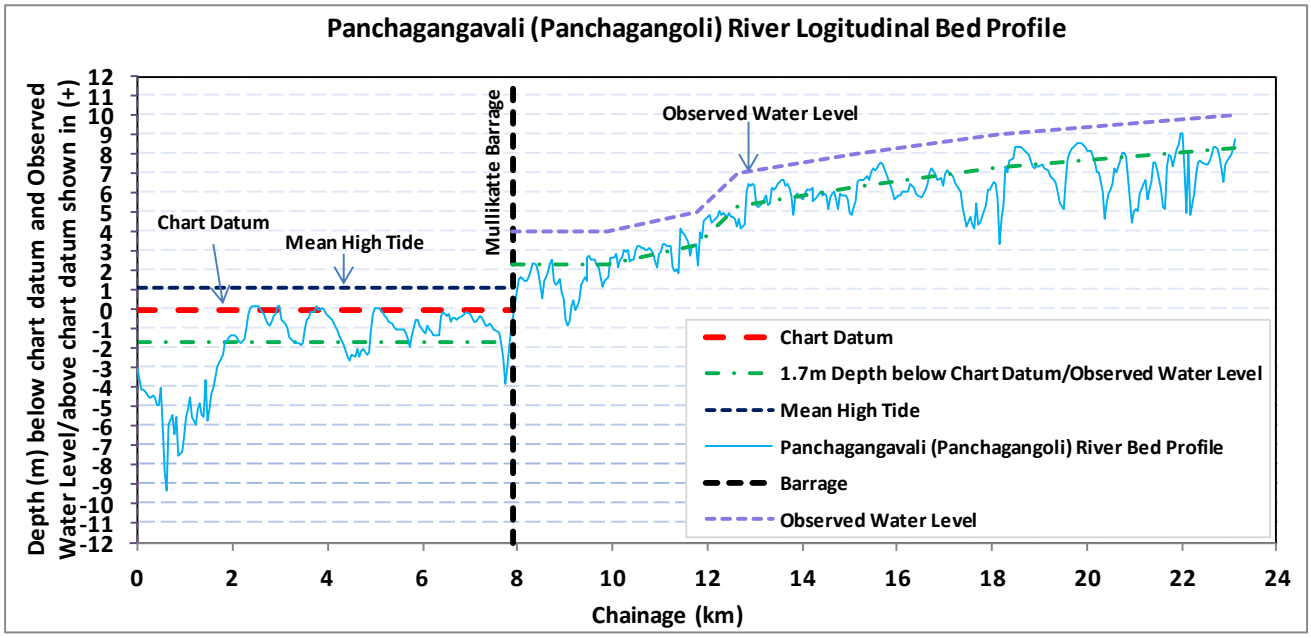


Figure 3.13: Longitudinal River Bed Depth Profile of Panchagangavali (Panchagangoli) River from Ch 0.00km to Ch 23.13km

Figures 3.13 also shows the Chart Datum line, depth line 1.7m below the Chart Datum, mean high tide 1.1m above Chart Datum, Observed Water Level line, and depth line 1.7m below Observed Water Level line. However, high tides in this region were observed in the range of about 0.04m to 2.13m (MHWS). The tidal effect has been considered up to barrage at Ch 7.90km. Thereafter; the depth is reckoned with respect to the Observed Water Level as per the survey on the upstream of Barrage. The following key observations have been illustrated below:

(i) The tidal effect of the Arabian Sea in the Panchagangavali (Panchagangoli) River is affected up to the Barrage at 7.90km from the sea.

(ii) As observed at the site, the study stretch generally has the soil texture as Red soil in upper reaches and Coastal alluvial in the initial stretch.

(iii) The initial one third of the river stretch from the mouth is under tidal influence and the bed exhibits very flat slope, which becomes steeper on the upstream of barrage having an average slope of 1 in 2500 in 23.00km of the river stretch under study.

(iv) Water depth of 1.70m is available naturally up to Ch 23.13km with minimum to moderate dredging required at some places.

(v) There is discontinuity in navigation at Ch 7.90km due to barrage in the river stretch.

3.4 Tidal Effect on Navigability of Panchagangavali (Panchagangoli) 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 Panchagangavali (Panchagangoli) River

With the information gathered during the reconnaissance survey, presently, no vessels are plying upstream of the Karwar Port area. Tide dependent water level in the Panchagangavali (Panchagangoli) River can be used advantageously for the smooth movement of the vessels in the study stretch.

3.4.2 Chart Datum & Variation in Navigation Draft

The depth variation in the Panchagangavali (Panchagangoli) River has been established from -0.17m to 9.33m with respect to Chart Datum during the reconnaissance survey. The tide tables are available for the region. 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 1.1m with it maximum depth of 2.13m in Panchagangavali (Panchagangoli) 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 with respect 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 Panchagangavali (Panchagangoli) 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 the Vessels is normally 8 knots in a still river and the travel time of the Vessels in the study stretch may be about 2.0 hours inclusive of the docking time etc. 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-76 Panchagangavali (Panchagangoli) River has been given in **Table 3.15**.

Table 3.15: 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 Panchagangavali (Panchagangoli) River. The consolidated data shall be useful in deriving basic information about each of the waterway in IWAI format as enclosed as **Annexure 3.5**.

3.6 Conclusion

Based on the survey observation, the classification of proposed waterways based on various criteria has been summarized in below **Table 3.16**.

Table 3.16: Classification of Proposed Waterway

Criteria	Classification																			
Length of waterway from start (km)	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	18	20	21	22	23
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-III																			
Raod Bridge Vert. Clearance	C-III																			
Raod Bridge Hor. Clearance	All Class																			
HT Line Vert. Clearance	All Class										Needs Raising of HT base									
Bend Radius																				
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

Finally, with due consideration of all aspects, the classification of the proposed Panchagangavali (Panchagangoli) River Waterway in light of technical navigability may be adopted as shown in **Table 3.17** below:

Table 3.17: Final Conclusion for Possible Navigation

River Stretch	0.00km 7.82km	7.90km 23.13km
Classification		
	Class III	**Class III**
Horizontal clearance (m)	50	50
Vertical clearnce (m)	7	7
Minimum Depth(m)	1.7	1.7
Bottom Width (m)	50	50
Self Propelled Vessel		
Dead Weight Tonnage	500	500
Vessel size (m)	(58 x 9 x 1.5)	(58 x 9 x 1.5)
Tug + Barge		
Dead Weight Tonnage	1000	1000
Vessel size (m)	(141 x 9 x 1.5)	(141 x 9 x 1.5)

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.

Accordingly, the present waterway is navigable in two reaches of the NW-76 stretch. The first stretch shall be from (Ch 0.00km to Ch 7.82km), and the second stretch shall be (Ch 7.90km to Ch 23.00km). Both the stretches will be possible for navigation with **Class III**. The first stretch is under tidal influence. The observed depths from survey have been recorded during the lean period. However, from the study it has been found that during high and moderate tides the water depths are significant for navigation. The existing bridges with their horizontal clearances are to be considered for single lane operation.

CHAPTER 4 MARKET ANALYSIS

Five Rivers – Varahi, Kubja, Chakra, Kedaka and Souparnika merge in to Arabian Sea and this confluence of five Rivers is known as Panch Gangavali. The River in study is Souparnika, which meanders from North West (NW) to South East (SE) starting from Badkeri village and ends at the river sea confluence near Kodi village. It runs a length of approximately 23 km and covers Naunda, Badkeri, Padukone, Trasi, Senapur, Muvadi, Gudamani, Guntode, Arante, Ujaddi, Kundapur, Marvante, Kannarpur, Padukone, Gudiangdi, Kodukone, Channapur, Tapala, Mavatmudi, Gangoli and Kodi villages on either banks of the River.

The navigable length of the River is 23 km (**Refer Map 4.1**).

Gangoli Port is in the vicinity of the South bank of the River and there are 04 jetties along the River which includes fishing and passenger jetties.

In the year 2014-15, off 0.65 MMTPA of cargo handled at all nine Non-Major Ports in Karnataka. Cargo handled at Gangoli Port was negligible **(Figure 4.1)**.

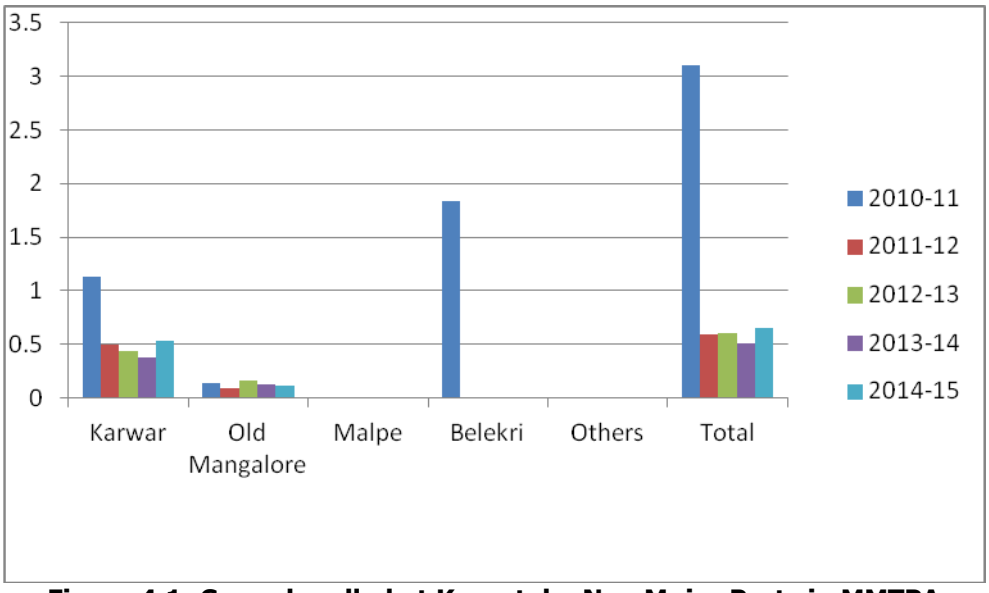


Figure 4.1: Cargo handled at Karnataka Non Major Ports in MMTPA

4.1 Existing Traffic

- **Cargo:** Gangoli Port is at about Chainage 0.4 km in the River. It is riverine Port which was handling coastal and overseas cargo since pre-independence, however, now the cargo is moving by Road. Huge deposition of sand in the river mouth has also diverted vessels to other Ports. The Port has been developed as a minor fishing Harbour to cater to the demands of local community. The cargo handled at the Port during last 5 years is (**Table 4.1**)

Table 4.1: Cargo Handled at Gangoli Port

Sl. No.	Year	Import MTPA	Export MTPA	Remarks
1.	2011-12	Nil	Nil	
2.	2012-13	Nil	Nil	
3.	2013-14	439	439	Dumb Barge
4.	2014-15	Nil	Nil	
5.	2015-16	152	Nil	Dumb Barge

Total land available in the port is 65 Acres, out of which about 35.5 Acres have been leased to Fisheries for construction of fishing Harbour, and 1.5 Acres to Coastal security Police for Jetty construction. The land allotted to M/S Good Earth Maritime for iron ore handling is proposed for lease cancellation.

- **Passengers:** There are no Passenger Ferry services operating on this River, However, there are country Boats running to cross the river at Marvanthe and at Gangoli Port and at some other locations.

4.2 Future Cargo Potential

- **District Profile:** Udupi District covers a total area of 3,880 Sq. Km. The district comprises of 3 taluks namely: Udupi, Kundapura, and Karkala, with Byndoor and Brahmmavar getting the special Taluka Status. The total number of Grama panchayaths is 146 with 248 Inhabited Villages. There is one City Municipality, two Town Municipalities and one Town Panchayath in the District. Udupi District has a total population of 11.8 lakh. The Souparnika River stretch lies in Kundapura Taluka which has an area of 1,571 sq km and a population of about 4 lakhs.

- **Connectivity**: The District has two National Highways passing through it with the length of NH 66 (NH 17) being 107 Km and NH 48 is 32 Km. NH 66 is the major Road passing through the catchment area of Kundapura and provides a link to Mangalore and Karwar via Kundapura. The District has a total Railway line of 100.86 km with 8 Railway Stations.

- **Industries:** There are no large and medium scale industries in Kundapura Taluka.

The possibilities of moving the cargo are examined as follows:

- **Cargo from Industries:** As there are no large and medium scale industries in the catchment area of Souparnika River, there is no potential of cargo diversion at present.

- **Cargo from Gangoli Port:** As the cargo handled at Gangoli Port is negligible, there is no potential to move the unloaded//loaded cargo from/to the Port through the River.

- **Food grains:** About 91,000 MT of Food grains, Rice, Pulses and oil seeds and 94,000 MT of Horticulture products (**Table 4.2**) is produced in Kundapura Taluka of Udipi District. As quantity is small and the distance to be travelled is also small (as there is a vented Dam at Bantwady at a length of 8.1 km), it is unlikely that this cargo will move through the River.

Table 4.2: Major Food Grains/Horticulture Productions in Souparnika Attachment Area in MTPA (2014-15)

Sl. No.	Taluk	Rice	Pulses (Blackgram, horse gram)	Oil seeds Ground nut, Sesamum	Sugarcane	Coconut	Areca nut	Cashew	Fruit crops	Total
1.	Udupi	81,929	1490	1013	12036	61,800	8901	2873	7828	177,870
2.	Kundapur	84,215	912	3623	2714	49,398	25,213	7324	12,469	185,868
3.	Karkala	49,423	125	8	0	30,612	28,353	4643	7997	121,161
	Total	215,567	2,527	4,644	147,50	1,41,810	62,467	14,840	28,294	484,899

- **Fisheries:** About 25,000 MT of fishes (**Table 4.3**) are caught in Kundapura Taluka; and proportionately the fish caught in the River catchment area is smaller. As both the quantity and the distance to be travelled in River are small, it is unlikely that this cargo will move through River.

Table 4.3: Fisheries in Souparnika Catchment Area (2014-15)

Fish Production				
Sl. No.	**Taluk**	**Fish Catch (Tonnes)**	**Ice Plants (No/MT)**	**Cold Storage (No/MT)**
1.	Kundapura	25,379	28/685	3/95
2.	Karkala	2,005	0/0	0/0
3.	Udupi	1,18,101	62/1,752	5/470
Total		1,45,485	90/2,437	8/565

- **Mining:** In Kundapura Taluka, Bauxite Mines in Byndoor village (25 km from Bantwadi) and Lime shell in Kasaba village in Kundapura Taluka exists, however, it is far away from the River and the possibility of moving cargo from these mines is nill.

- **Other possibilities:** Varahi River which is also merging with Souparnika River at Panchgangavali is running parallel to NH 27 and 52 from Halady to Gangoli port (**Figure 4.2**). There may be a possibility to move cargo through Ro-Ro services through Varahai-Souparnika combination from Halady to the vented Dam location at Bantwady on Souparnika River (about 35-40 km), however, the navigability of Varahi has

to be established first and cargo potential examined in detail. As this was outside the scope of work, this has not been examined. This may be examined at the DPR stage if required.

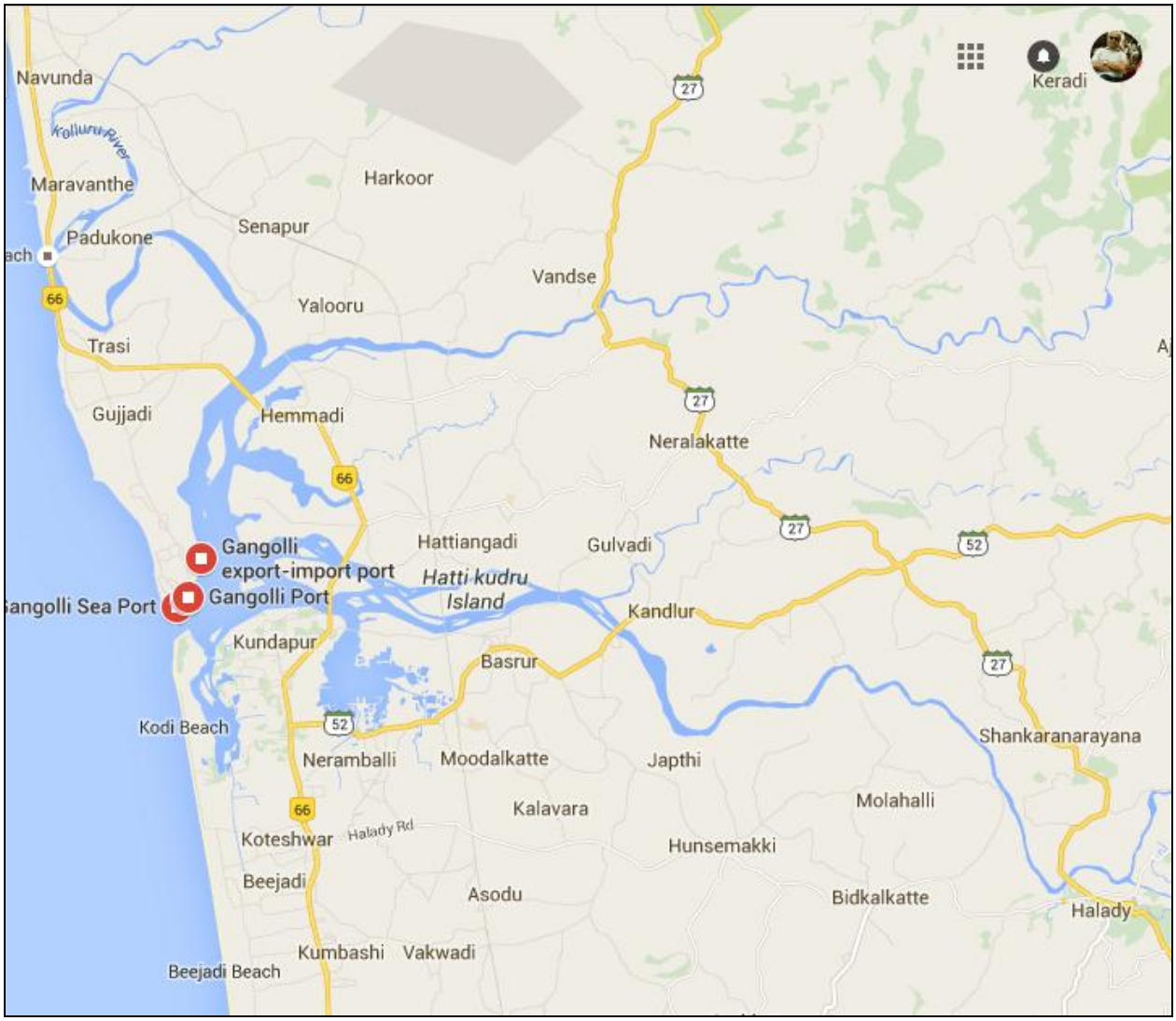


Figure 4.2: Possibility of Ro-Ro Cargo

- **Passenger Ferry Services**

The current population of Kundapura taluka is about 4 lakhs (Census 2011) **(Table 4.4)**.

Table 4.4: Population of Udipi District

Sl. No.	Taluk	Area (sq. km)	Population	
			2001 (No.)	2011 (No.)
1.	Kundapura	1,571	3,98,471	3,98,971
2.	Karkala	1,083	2,16,091	2,23,719
3.	Udupi	928	5,62,799	7,03,363
Total		3,582	11,77,361	13,26,053

The study on Development of IWT by Directorate of Ports & IWT assessed that for Souparnika River Catchment Area, there is a potential to develop five Ferry routes as follows:

1. Navunda-Badakere,
2. Maharajswamy-Padukbane,
3. Kundapur-Gangolli,
4. Mavattumudi-Kannadakudru,
5. Guwadi-Khaodahar.

As per the study, about 5.6 lakh Passengers are likely to use these Ferry services in next 10 years, if the facilities are provided for.

A total of 10 ferry points have been proposed in the Panchagangavali (Panchagangoli) River area to cater to the forecasted passenger demand. The proposed locations of the same are:

1. Naunda,
2. Badakere,
3. Gangoli,
4. Maharajswamy,
5. Padukbane,
6. Kundapura,
7. Mavattumudi,
8. Kannadakudru,
9. Khodahar,
10. Guwadi.

The possibility of operating the Ferry services will be examined in detail at the DPR stage.

- **Tourist Traffic**

Tourism potential in this river exists. The potential of the same will be studied at DPR stage.

4.3 Conclusions

Based on preliminary assessment a possibility of moving cargo through Souparnika River is negligible.

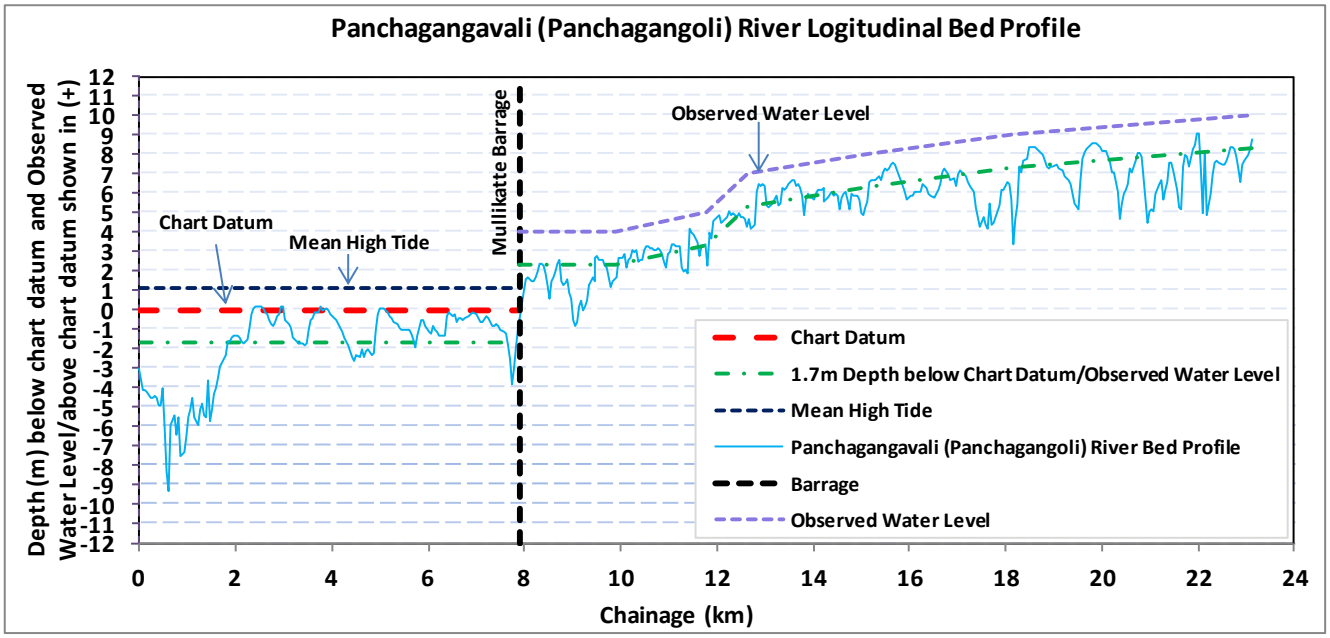
Potential of Passenger movement exists in the catchment area and is expected to be significant. The same will require for the provision of facilities such as Ferry points, Fleet and dredging.
Tourism potential also exists in the River.
These are very preliminary observations and will be studied in detail at DPR stage.

CHAPTER 5 OBSERVATIONS AND INFERENCES

5.1 Waterway Feasibility

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

1. The river length as given by IWAI is 23.0km, whereas the total surveyed length along the river to capture the thalweg is only 23.13km. The deepest channel route has been reckoned as 23.13km. All inferences derived for identifying the navigable length had been derived with reference to deepest channel length (23.13km).
2. 56.80% of the surveyed length has water depth more than 2m i.e. for 13.14km, however not continuous.
3. Vented barrage at Mullikatte exist at chainage 7.90km creating discontinuity for navigation.
4. The longitudinal Bed profile of Panchgangavali (Panchagangoli) River, as at **Figure 3.13**, is placed below:



5. Feasibility study suggests that the river is safely navigable between chainage 0.00km - 7.82km and chainage 7.90km – 23.13km. Mullikatte Barrage exists at 7.82km – 7.90km.
6. The lengths of the waterway, where a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart Datum / MDDL / Appropriate Level have been compiled in the main report. The brief of this is given in **Table 3.7** and being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-5	9.33	-0.17	2.33	0.61	0.42	1.64
5-7.85	3.79	-0.10	1.81	0.76	0.14	0.14
Mullikate Barrage at Ch 7.90km						
Sub Total			**4.14**	**1.37**	**0.56**	**1.78**
7.85-10	4.80	1.18	0.00	0.26	0.34	1.55
10-15	3.87	0.86	2.91	1.75	0.30	0.04
15-23.13	6.65	0.95	6.11	1.64	0.28	0.10
Sub Total			**9.02**	**3.65**	**0.92**	**1.69**
Grand Total			**13.16**	**5.02**	**1.48**	**3.47**

7. Total Seven Nos. of Bridges is existing in the study stretch. Two Bridges are under construction for which the appropriate authorities are to be contacted to maintain the clearance standards. One Bridge at Ch 7.82km has been considered as the end of the first stretch. By limiting the operation at Ch21.13, there is no need of modification of Bridges, since the other Bridges are having required clearances.
8. Eleven Power Cables are crossing the study stretch of which six Power Cables are having clearances. Hence Five Power Cables may have to be modified.

The above 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 3.16** as reproduced below.

Criteria	Classification																			
Length of waterway from start (km)	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**20**	**21**	**22**	**23**
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-III																			
Raod Bridge Vert. Clearance	C-III																			
Raod Bridge Hor. Clearance	All Class																			
HT Line Vert. Clearance	All Class										Needs Raising of HT base									
Bend Radius																				
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

5.2 Cargo Feasibility

It is expected that the passenger volume using jetties at the waterway will increase to approximately 2.5 lakhs per annum in 2025. The same offers a potential for development of the Panchagangavali (Panchgangoli) River waterway. New ferry routes & jetties may have to be planned along the waterway.

5.3 SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objective 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. 56.80% of the 23.13km (13.14km) has waterway having more than 2m water depth available for navigation, however not continuous.
2. Feasibility study suggests that the river is safely navigable between chainage 0.00km - 7.82km and chainage 7.90km – 23.13km.
3. Country Boats are being operated to cross the river at Marvanthe and at Gangoli Port and at some other locations.
4. Ferry points at ten (10) locations are being planned in the Souparnika River Catchment Area.
2. It is estimated that Passenger traffic may increase to 5.6 lacs per annum by 2025 considering the completion of ten (10) ferry routes assessed for Souparnika River Catchment Area by IWT.
3. Tourism potential may also exist in the River.

Weakness

1. Presently, there is no IWT cargo movement.
2. Vented barrage at Mullikatte exist at chainage 7.90km creating discontinuity for navigation.
3. Depth improvement at some locations is required for development of Class – III waterway.
1. No large and medium scale industries.
2. Two railway station viz. Kundapur and Senapur lies within 5km area.

Opportunity

1. 13.14km (of 23.13km) is having more than 2m water depth for safe navigation, though not continuous, which can be used advantageously for the mobility of hinterland cargo on provision of navigation lock at barrage location (at chainage 7.90km).
2. Alternatively, if Ro – Ro facility is provisioned connecting the downstream and upstream of the Barrage, throughput can be established.
3. The water level fluctuation during high tide up to chainage 7.90km (*Ref: Indian Tide Tables, 2016, Survey of India*), can be an opportunity for the safe mobility of vessels in the waterway.
4. The present road connectivity though may be competing with IWT may also be an opportunity for creating an efficient intermodal hub for IWT.

Threat

1. NH 66 (NH 17) and NH 48 may be a competing mode, if not effectively used for intermodal connectivity.
2. Habitation on both the banks of Panchagangavali (Panchagangoli) River may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.
3. Policies are to be firmed up for development of IWT in this stretch, which may get resistance from the line department.

5.4 Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable to the required standards. Henceforth the development of the proposed national water way 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. Nominal dredging may be required in the proposed waterway. The cost of terminal has been estimated @ INR 10.0 crore each for two Ro-Ro terminals. The cost of LT Lines has been estimated @ INR 44.0 Lacs at each location. The cost of bridge has been estimated @ INR 1.5 Cr at each location. No need of any modification for the Bridges in the study stretch. However, 5 Nos. Of Power Cables are to be modified to meet the clearance standards. The cost of navigational aids for day/night navigation has been considered as INR 150 lacs. 10% of the amount for dredging, terminal construction and night navigation 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 36.20 crore.

Table 5.1: Tentative Development Cost of Panchagangavali (Panchagangoli) River Waterway (NW-76)

Sl. No.	Name of Waterway	Length of Waterway	Dredging Required (w. r. to 2m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Ro–Ro Terminal Proposed	Ro-Ro Terminal Cost @ INR 10 Cr each	Cost of Modification of Bridge / Transmission line	Night Navigation	Total cost including 10% unforeseen
		(km)	(km)	(INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Panchaganga vali (Panchagangoli) River	23.00	10	9.2	2	20.00	2.2	1.50	36.20

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 Panchagangavali (Panchagangoli) River (NW 76) of 23.13km 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 Panchagangavali (Panchagangoli) River is described below.

Table 5.2: Classification of Panchagangavali (Panchagangoli) River (NW-76)

Chainage (km)	Minimum Depth (m)	Bottom Width (m)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)	Bend Radius (m)	Classification of Waterway (Proposed)
0.0 – 23.13	-0.17	> 100.0	3.00 (Bridge)	20.00 (LT Line)	105.00	**Class – III**

The entire study stretch of the waterway of 23.13km is amenable for development as Class – III waterway with provision of navigational lock at barrage location at chainage 7.9km, for which viability may have to be established. Alternatively, if Ro – Ro service is provided, operational throughput can be achieved.

The above stretch of the waterway, hence, can be considered under **Class III**, which is navigable with provision of navigational lock at barrage location at chainage 7.9km and shall be used for plying self-propelled vessel of carrying capacity up to 500 DWT (approximate size 58m overall length, 9m moulded breadth and 1.5m loaded draft) or one tug and four barges combination of 1000 DWT (approximate size 141m overall length, 9m breadth and 1.5m loaded draft).

5.6 Recommendation

The national waterway-76 of Panchagangavali (Panchagangoli) River has been identified having potential for development as waterway of Class - III for a distance of 23.13km (entire stretch with provision of navigational lock at barrage location at chainage 7.9km / provision of Ro – Ro service), as described above.

Accordingly, the national waterway NW-76 of Panchagangavali (Panchagangoli) River is proposed for development as **Class III** waterway in the stretch of the waterway as depicted below:

River Stretch	0.00km 7.82km	7.90km 23.13km
Classification	Class III	Class III
Horizontal clearance (m)	50	50
Vertical clearnce (m)	7	7
Minimum Depth(m)	1.7	1.7
Bottom Width (m)	50	50
Self Propelled Vessel		
Dead Weight Tonnage	500	500
Vessel size (m)	(58 x 9 x 1.5)	(58 x 9 x 1.5)
Tug + Barge		
Dead Weight Tonnage	1000	1000
Vessel size (m)	(141 x 9 x 1.5)	(141 x 9 x 1.5)

Though the stretch is amenable for Class III waterway, as explained, keeping in view the depleted cargo volumes in Gangoli Port and provision of lock structure at Barrage location at Ch 7.9km, the national waterway-76 of Panchagangavali (Panchagangoli) River is not recommended for stage-II study for preparation of Detailed Project Report (DPR).

ANNEXURE 1.1

DATA COLLECTION & SOURCE OF DATA

Annexure 1.1: Data Collection Source of Data

(Cluster-6)

Sl. no	Name of Authority, place	Contacted Person	Designation	Contact Number	Required Data	Collected Data	Date of Receiving Data	Remarks
KARNATAKA								
1	Water Resources Deparment, Vikas Soudha, Banagalore	---	Additional Chief Secretary	---	River Gauge & Discharge Data/ Structure Detail	----	---	Official Letter Submitted to the Department. Data is Awaited
2	Public Works Ports and Inland Water Transport, Vikas Soudha, Bangalore	---	Principal Secretary	---	River Gauge & Discharge Data/ Structure Detail	Yes	3/4/2016	Official Letter Submitted to the Department. PS suggested to contact Director, Karwar for data collection.
3	Public Works Ports and Inland Water Transport, Karwar	Mr. Captain R Mohan	Director	---	River Gauge & Discharge Data/ Structure Detail/ Chart Datum	---	---	
4	Public Works Ports and Inland Water Transport, Karwar	Mr. Narayanappa	Inland water transport Engineer	9480431148	River Gauge & Discharge Data/ Structure Detail/ Chart Datum	Yes	3/3/2016	Official Letter Submitted to the Department. Data Received in the form of historical reports and studies.
5	public works ports and inland water transport, Karwar	Mr. YaganaKumar	Hydrographic Surveyor	9242850078	River Gauge & Discharge Data/ Structure Detail/ Chart Datum	Yes	3/4/2016	Official Letter Submitted to the Department. Data Received in the form of historical reports and studies.

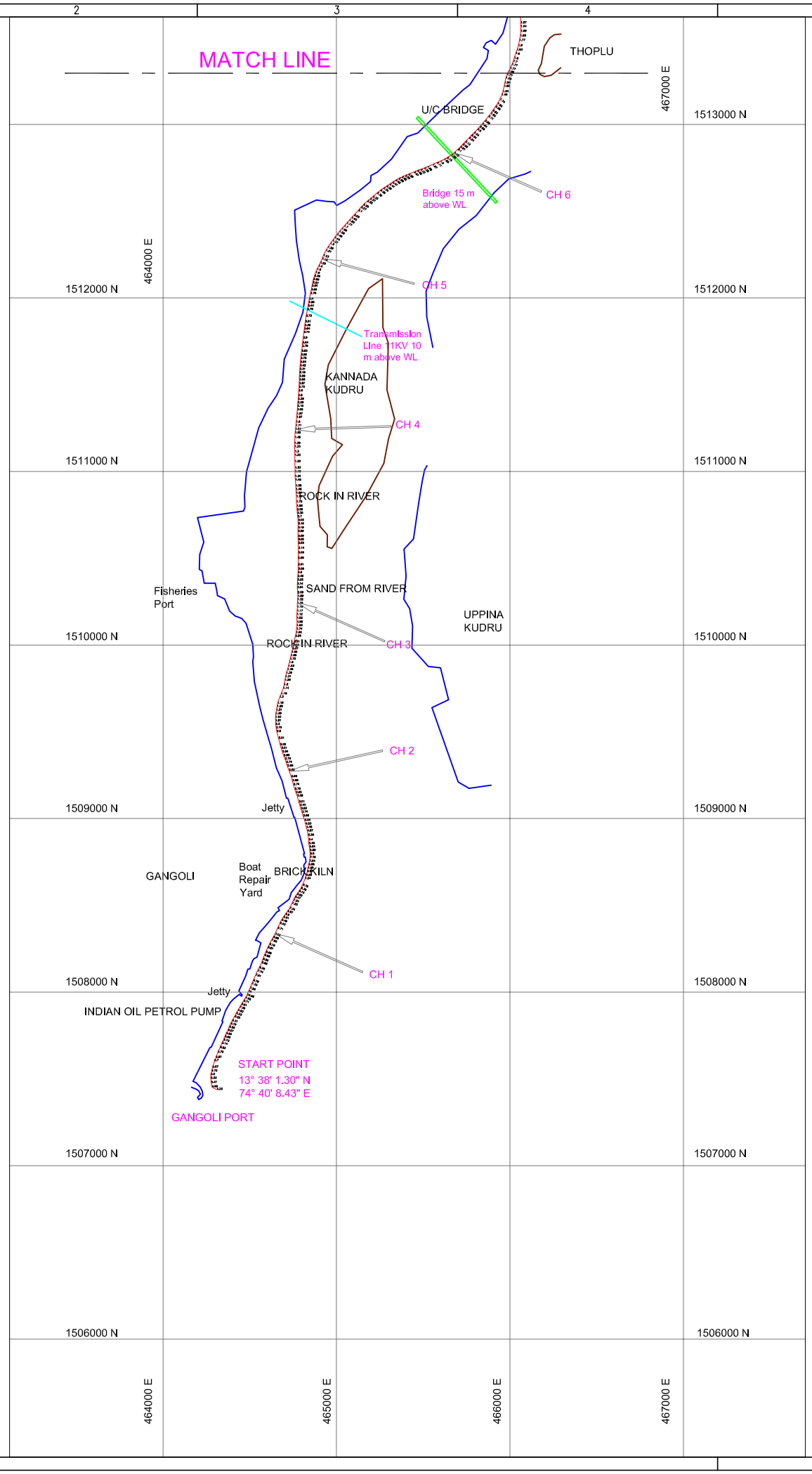
Annexure 1.1: Data Collection Source of Data

(Cluster-6)

KERALA								
1	Planing and Economics Affairs, Annex Building, Secretariat, Thiruvanathapuram	Mr. Alok Sheel	Additioan Chief Secretary	0471-2518444	Data on Urban Infrastructure & Transportation	---	---	Official Letter Submitted to the Department. Data is Awaited
2	LSGD - Urban Affairs, Secretariat, Thiruvanathapuram	Mr. APM Mohammed Hanish	Secretary	0471-2327451	Data on Urban Infrastructure & Transportation	---	---	Official Letter Submitted to the Department. Data is Awaited
3	Directorate of industries and commerce, Vikas Bhavan, Thiruvananathapuram	Mr. PM Francis	Director	---	District Industrial Production Data	---	---	Official Letter Submitted to the Department. Data is Awaited
4	Directorate of industries and commerce, Vikas Bhavan, Thiruvananathapuram	Mr. Ramesh Baskar	Additional Direcotor	9495940863	District Industrial Production Data	---	---	Official Letter Submitted to the Department. Data is Awaited
5	Revenue and Disaster Management	Mr. Viswas Mehta	principal Secretary	0471-2518113, 0471-2517162	District Gross Production Data	---	---	Official Letter Submitted to the Department. Data is Awaited
6	Deparment of Transport	Mr. Elaias George	Additional Chief Secretary	---	Transport Related data/ Current Use	---	---	Official Letter Submitted to the Department. Data is Awaited
7	Water Resources Secretariat Thiruvanathapuram	Mr. VJ Kurain	Additional Chief Secretary	---	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
8	Water ResourcesDeptt.Public Offiece, Thiruvanthapuram	Mr. Hari Narayanan	Chief Engineer	---	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
9	Water ResourcesDeptt.Public Offiece, Thiruvanthapuram	Mr. Srileka	Executive Engneer	9895324906	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited

ANNEXURE 3.1

OVERVIEW CHART FOR PANCHAGANGAVALI (PANCHAGANGOLI) RIVER BATHYMETRY



LEGEND:

1.4	Sounding		RIVER BOUNDARY
1642000 N	UTM Grid		SHOALS/BARS/ISLAND
	BRIDGE	CH 2	CHAINAGE
	HT/LT CABLE		

GEODETIC INFORMATION

GEODETIC DATUM	:	WGS 1984
ELLIPSOID	:	WGS 1984
SEMI MAJOR AXIS	:	6378137.000 M
SEMI MINOR AXIS	:	6356752.314 M
INVERSE FLATTENING	:	298.257223563
FALSE NORTHING	:	0 M
SCALE FACTOR	:	0.9996 ON CM
UNIT OF MEASUREMENT	:	INTERNATIONAL METRES
PROJECTION	:	UNIVERSAL TRANSVERSE MERCATOR
GRID SYSTEM	:	UTM ZONE 43 N
CENTRAL MERIDIAN	:	75 DEGREE EAST
LATITUDE OF ORIGIN	:	0 DEGREE NORTH
FALSE EASTING	:	500000 M

NOTES:

1. Position Fixing was controlled by Trimble SPS 351 DGPS System.
2. Dual Frequency Echo Sounder Bathy 500 DF working on 200 kHz was used for recording water depths.
3. Depths are in Metres and Decimetres.

REVISION STATUS

Rev	Date	Description	Surveyed by	Processing & Charting by	Checked by	Approved by
0	11 Feb 2016	Final Drawing	AVS	JA	DKV	BS

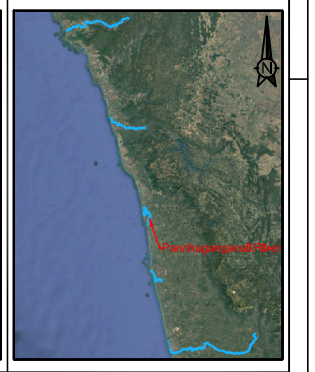
REFERENCE DRAWINGS

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

GEOINFOSYS TECHNOLOGIES
201, Tara Bhavan, Old MB Road,
Lado Sarai, New Delhi - 30

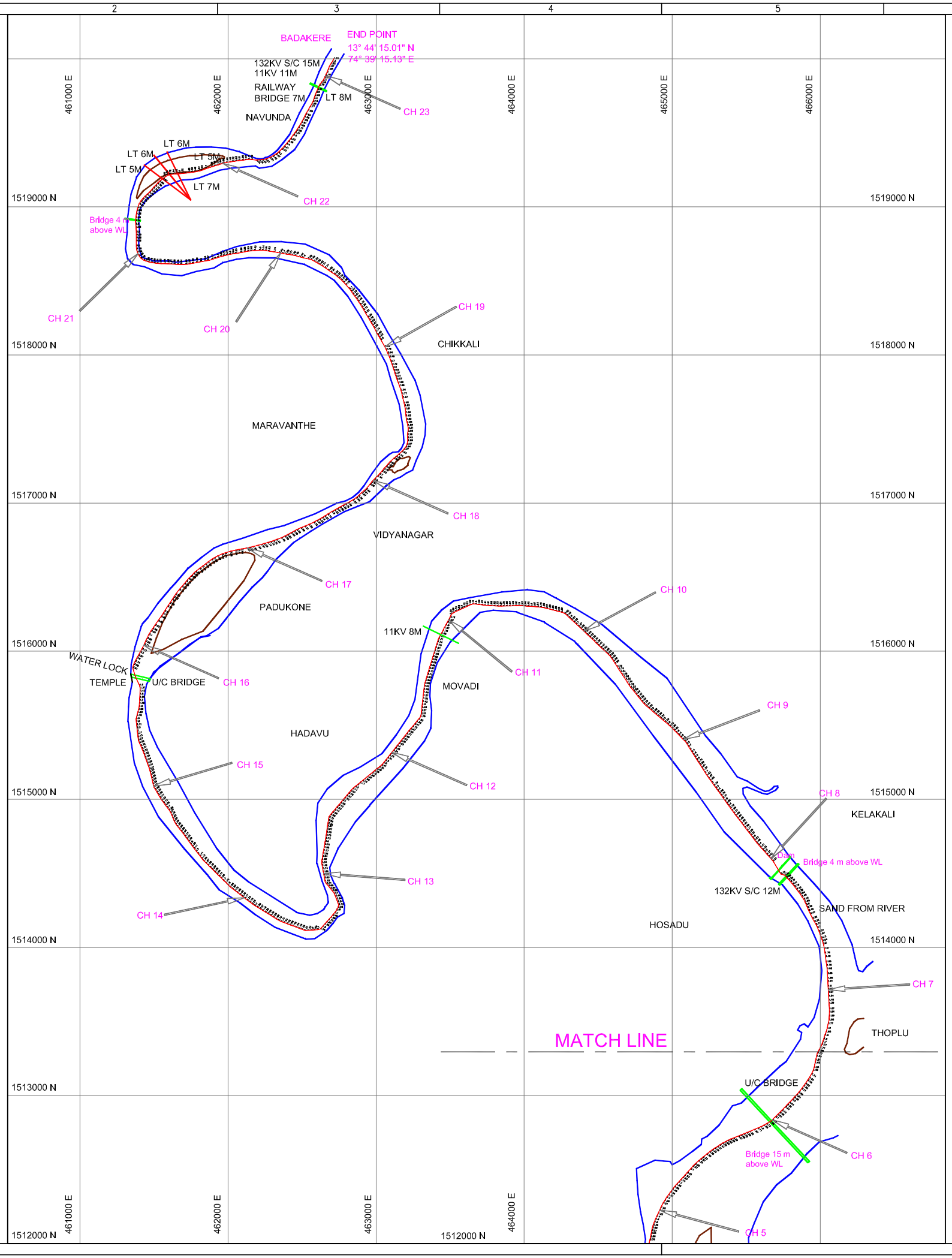
PROJECT TITLE

CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DETAILDED REPORT OF PROPOSED 53 INLAND WATERWAYS (CLUSTER-VI (KARNATAKA AND KERALA) PROPOSED NATIONAL WATERWAY(NW-52)

CHART SHOWING

ANNEXURE 3.1
OVERVIEW CHART OF PANCHAGANGAVALI RIVER BATHYMETRY

SCALE 0 0.30 0.60 0.80 1.20 1.50KM



LEGEND:

1.4	Sounding		RIVER BOUNDARY
1642000 N	UTM Grid		SHOALS/BARS/ISLAND
	BRIDGE		CHAINAGE
	HT/LT CABLE		

GEODETIC INFORMATION

GEODETIC DATUM	:	WGS 1984
ELLIPSOID	:	WGS 1984
SEMI MAJOR AXIS	:	6378137.000 M
SEMI MINOR AXIS	:	6356752.314 M
INVERSE FLATTENING	:	298.257223563
FALSE NORTHING	:	0 M
SCALE FACTOR	:	0.9996 ON CM
UNIT OF MEASUREMENT	:	INTERNATIONAL METRES
PROJECTION	:	UNIVERSAL TRANSVERSE MERCATOR
GRID SYSTEM	:	UTM ZONE 43 N
CENTRAL MERIDIAN	:	75 DEGREE EAST
LATITUDE OF ORIGIN	:	0 DEGREE NORTH
FALSE EASTING	:	500000 M

NOTES:

1. Position Fixing was controlled by Trimble SPS 351 DGPS System.
2. Dual Frequency Echo Sounder Bathy 500 DF working on 200 kHz was used for recording water depths.
3. Depths are in Metres and Decimetres.

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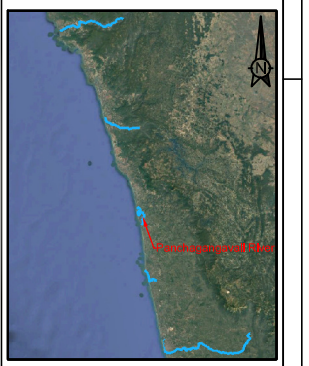
0	11 Feb 2016	Final Drawing	AVS	JA	DKV	BS

REFERENCE DRAWINGS

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

OVERVIEW PLAN

LAYOUT PLAN INDIA - WEST COAST



NOT TO SCALE

CLIENT

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SURVEY CONTRACTOR

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CHART SHOWING

ANNEXURE 3.1
OVERVIEW CHART OF PANCHAGANGAVALI RIVER BATHYMETRY

SCALE 0 0.30 0.60 0.80 1.20 1.50KM

Sheet: 2 of 2

ANNEXURE 3.2

BATHYMETRIC SURVEY AS RECEIVED FROM HYDROGRAPHIC SURVEYOR

Annexure 3.2: Bathymetric Survey as Received from Hydrographic Surveyor

Digital Data, Chainage vs Water Depth

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
0.00	74°40 '12.07"	13°38 '7.75"	4.33	3.00
0.06	74°40 '11"	13°38 '9.05"	5.47	4.14
0.10	74°40 '10.93"	13°38 '10.55"	5.50	4.17
0.15	74°40 '11.26"	13°38 '11.92"	5.57	4.24
0.21	74°40 '11.9"	13°38 '13.76"	5.87	4.54
0.27	74°40 '12.67"	13°38 '15.66"	5.83	4.50
0.32	74°40 '13.35"	13°38 '17.04"	5.73	4.40
0.36	74°40 '13.84"	13°38 '18.26"	5.84	4.51
0.40	74°40 '14.43"	13°38 '19.48"	6.26	4.93
0.44	74°40 '14.99"	13°38 '20.66"	6.31	4.98
0.48	74°40 '15.76"	13°38 '22.02"	5.33	4.00
0.53	74°40 '16.41"	13°38 '23.19"	7.39	6.06
0.57	74°40 '17.17"	13°38 '24.35"	9.71	8.38
0.61	74°40 '17.82"	13°38 '25.49"	10.66	9.33
0.65	74°40 '18.39"	13°38 '26.76"	7.26	5.93
0.70	74°40 '19.01"	13°38 '28.18"	6.79	5.46
0.76	74°40 '19.83"	13°38 '29.99"	7.74	6.41
0.81	74°40 '20.64"	13°38 '31.57"	6.88	5.55
0.86	74°40 '21.16"	13°38 '32.94"	8.88	7.55
0.91	74°40 '21.78"	13°38 '34.4"	8.67	7.34
0.95	74°40 '22.5"	13°38 '35.75"	7.82	6.49
1.00	74°40 '23.19"	13°38 '36.92"	6.82	5.49
1.06	74°40 '24.1"	13°38 '38.94"	6.43	5.10
1.10	74°40 '24.79"	13°38 '40.1"	5.91	4.58
1.15	74°40 '25.57"	13°38 '41.18"	6.87	5.54
1.20	74°40 '26.43"	13°38 '42.68"	7.23	5.90
1.24	74°40 '27.01"	13°38 '43.87"	6.47	5.14
1.28	74°40 '27.77"	13°38 '44.98"	6.15	4.82
1.32	74°40 '28.49"	13°38 '46.15"	6.75	5.42
1.38	74°40 '29.16"	13°38 '47.92"	6.83	5.50
1.42	74°40 '29.48"	13°38 '49.27"	4.98	3.65
1.46	74°40 '29.8"	13°38 '50.56"	7.04	5.71
1.51	74°40 '29.95"	13°38 '51.93"	6.50	5.17
1.55	74°40 '29.78"	13°38 '53.25"	5.64	4.31
1.59	74°40 '29.65"	13°38 '54.58"	5.40	4.07
1.64	74°40 '29.38"	13°38 '56.26"	4.87	3.54
1.68	74°40 '29.06"	13°38 '57.56"	4.23	2.90
1.73	74°40 '28.6"	13°38 '59.08"	3.88	2.55
1.77	74°40 '28.16"	13°39 '0.43"	3.63	2.30
1.81	74°40 '27.77"	13°39 '1.69"	3.01	1.68
1.87	74°40 '27.2"	13°39 '3.44"	2.92	1.59
1.92	74°40 '26.74"	13°39 '4.95"	2.74	1.41
1.97	74°40 '26.3"	13°39 '6.44"	2.65	1.32
2.03	74°40 '25.55"	13°39 '8.44"	2.69	1.36
2.07	74°40 '25.1"	13°39 '9.74"	2.76	1.43
2.12	74°40 '24.6"	13°39 '11.08"	2.94	1.61
2.16	74°40 '24.15"	13°39 '12.42"	3.05	1.72
2.24	74°40 '23.51"	13°39 '14.9"	2.90	1.57
2.28	74°40 '23.28"	13°39 '16.24"	2.30	0.97

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
2.32	74°40 '23.24"	13°39 '17.56"	1.53	0.20
2.36	74°40 '23.41"	13°39 '18.89"	1.31	-0.02
2.40	74°40 '23.65"	13°39 '20.21"	1.18	-0.15
2.46	74°40 '24.32"	13°39 '21.95"	1.18	-0.15
2.52	74°40 '24.9"	13°39 '23.67"	1.20	-0.13
2.56	74°40 '25.16"	13°39 '25.17"	1.31	-0.02
2.61	74°40 '25.52"	13°39 '26.51"	1.46	0.13
2.65	74°40 '25.87"	13°39 '27.82"	1.60	0.27
2.69	74°40 '26.17"	13°39 '29.12"	1.85	0.52
2.73	74°40 '26.48"	13°39 '30.4"	2.07	0.74
2.77	74°40 '26.79"	13°39 '31.7"	2.21	0.88
2.82	74°40 '27.18"	13°39 '33.43"	1.92	0.59
2.87	74°40 '27.32"	13°39 '34.74"	1.65	0.32
2.91	74°40 '27.32"	13°39 '36.15"	1.52	0.19
2.95	74°40 '27.37"	13°39 '37.48"	1.17	-0.16
2.99	74°40 '27.4"	13°39 '38.93"	1.16	-0.17
3.03	74°40 '27.5"	13°39 '40.25"	1.89	0.56
3.09	74°40 '27.4"	13°39 '41.89"	2.04	0.71
3.13	74°40 '27.44"	13°39 '43.31"	2.22	0.89
3.17	74°40 '27.53"	13°39 '44.69"	2.80	1.47
3.22	74°40 '27.56"	13°39 '46.17"	2.91	1.58
3.29	74°40 '27.58"	13°39 '48.41"	3.09	1.76
3.34	74°40 '27.57"	13°39 '50.21"	3.08	1.75
3.38	74°40 '27.53"	13°39 '51.51"	3.09	1.76
3.43	74°40 '27.52"	13°39 '53.09"	3.19	1.86
3.47	74°40 '27.52"	13°39 '54.51"	3.03	1.70
3.51	74°40 '27.39"	13°39 '55.84"	2.36	1.03
3.55	74°40 '27.28"	13°39 '57.16"	1.86	0.53
3.61	74°40 '27.19"	13°39 '58.94"	1.74	0.41
3.65	74°40 '27.1"	13°40 '0.28"	1.45	0.12
3.71	74°40 '27.01"	13°40 '2.05"	1.45	0.12
3.75	74°40 '26.95"	13°40 '3.61"	1.18	-0.15
3.81	74°40 '26.88"	13°40 '5.52"	1.33	0.00
3.87	74°40 '26.88"	13°40 '7.36"	1.30	-0.03
3.92	74°40 '26.86"	13°40 '8.95"	1.36	0.03
3.98	74°40 '26.93"	13°40 '10.9"	1.52	0.19
4.02	74°40 '27.07"	13°40 '12.24"	1.71	0.38
4.07	74°40 '27.22"	13°40 '13.81"	1.87	0.54
4.11	74°40 '27.35"	13°40 '15.23"	2.02	0.69
4.15	74°40 '27.45"	13°40 '16.56"	2.29	0.96
4.19	74°40 '27.55"	13°40 '17.91"	2.50	1.17
4.24	74°40 '27.67"	13°40 '19.5"	2.72	1.39
4.28	74°40 '27.73"	13°40 '20.85"	2.96	1.63
4.32	74°40 '27.76"	13°40 '22.18"	3.19	1.86
4.37	74°40 '27.87"	13°40 '23.5"	3.42	2.09
4.41	74°40 '27.99"	13°40 '24.87"	3.75	2.42
4.45	74°40 '28.16"	13°40 '26.23"	3.93	2.60
4.50	74°40 '28.34"	13°40 '27.79"	3.64	2.31
4.56	74°40 '28.57"	13°40 '29.75"	3.74	2.41
4.60	74°40 '28.75"	13°40 '31.05"	3.39	2.06
4.65	74°40 '29"	13°40 '32.81"	3.73	2.40

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
4.71	74°40 '29.38"	13°40 '34.71"	3.44	2.11
4.75	74°40 '29.61"	13°40 '36.01"	3.40	2.07
4.81	74°40 '29.99"	13°40 '37.72"	3.66	2.33
4.85	74°40 '30.25"	13°40 '39.09"	3.57	2.24
4.89	74°40 '30.59"	13°40 '40.37"	2.39	1.06
4.93	74°40 '31.08"	13°40 '41.62"	1.60	0.27
4.97	74°40 '31.66"	13°40 '42.81"	1.23	-0.10
5.02	74°40 '32.29"	13°40 '44.21"	1.23	-0.10
5.07	74°40 '33.13"	13°40 '45.75"	1.26	-0.07
5.12	74°40 '34.02"	13°40 '47.01"	1.37	0.04
5.16	74°40 '34.87"	13°40 '48.15"	1.49	0.16
5.21	74°40 '35.79"	13°40 '49.26"	1.66	0.33
5.25	74°40 '36.74"	13°40 '50.29"	1.77	0.44
5.29	74°40 '37.67"	13°40 '51.3"	1.93	0.60
5.35	74°40 '38.98"	13°40 '52.7"	2.10	0.77
5.39	74°40 '39.94"	13°40 '53.75"	2.28	0.95
5.44	74°40 '41.22"	13°40 '54.85"	2.37	1.04
5.50	74°40 '42.58"	13°40 '55.97"	2.32	0.99
5.54	74°40 '43.8"	13°40 '56.9"	2.34	1.01
5.59	74°40 '44.96"	13°40 '57.61"	2.41	1.08
5.63	74°40 '46.12"	13°40 '58.37"	2.52	1.19
5.67	74°40 '47.32"	13°40 '58.96"	2.82	1.49
5.71	74°40 '48.57"	13°40 '59.49"	3.29	1.96
5.77	74°40 '50.31"	13°41 '0.19"	2.68	1.35
5.81	74°40 '51.61"	13°41 '0.69"	2.28	0.95
5.86	74°40 '53.23"	13°41 '1.35"	1.87	0.54
5.91	74°40 '54.71"	13°41 '1.97"	1.90	0.57
5.95	74°40 '55.99"	13°41 '2.62"	2.13	0.80
6.00	74°40 '57.31"	13°41 '3.5"	2.48	1.15
6.05	74°40 '58.53"	13°41 '4.65"	2.61	1.28
6.09	74°40 '59.48"	13°41 '5.61"	2.13	0.80
6.14	74°41 '0.66"	13°41 '6.84"	2.34	1.01
6.19	74°41 '1.82"	13°41 '7.95"	2.50	1.17
6.23	74°41 '2.71"	13°41 '8.94"	2.64	1.31
6.29	74°41 '3.92"	13°41 '10.37"	2.71	1.38
6.33	74°41 '4.74"	13°41 '11.47"	2.63	1.30
6.38	74°41 '5.64"	13°41 '12.76"	1.64	0.31
6.43	74°41 '6.49"	13°41 '14.34"	1.49	0.16
6.49	74°41 '6.94"	13°41 '15.96"	1.62	0.29
6.54	74°41 '7.26"	13°41 '17.53"	1.56	0.23
6.58	74°41 '7.76"	13°41 '18.77"	1.95	0.62
6.62	74°41 '8.42"	13°41 '20.05"	1.77	0.44
6.66	74°41 '8.86"	13°41 '21.3"	1.80	0.47
6.71	74°41 '9.38"	13°41 '22.78"	1.83	0.50
6.77	74°41 '9.87"	13°41 '24.59"	1.77	0.44
6.82	74°41 '10.12"	13°41 '26.29"	1.69	0.36
6.87	74°41 '10.14"	13°41 '27.87"	1.57	0.24
6.93	74°41 '10.02"	13°41 '29.79"	1.46	0.13
6.98	74°41 '9.91"	13°41 '31.48"	1.57	0.24
7.02	74°41 '9.83"	13°41 '32.84"	1.80	0.47
7.08	74°41 '9.76"	13°41 '34.6"	1.98	0.65

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
7.14	74°41 '9.62"	13°41 '36.67"	1.92	0.59
7.19	74°41 '9.42"	13°41 '38.23"	1.65	0.32
7.25	74°41 '9.16"	13°41 '40.18"	1.76	0.43
7.31	74°41 '8.77"	13°41 '42.15"	2.20	0.87
7.35	74°41 '8.36"	13°41 '43.46"	2.13	0.80
7.40	74°41 '7.82"	13°41 '44.84"	2.07	0.74
7.45	74°41 '7.14"	13°41 '46.41"	2.19	0.86
7.50	74°41 '6.34"	13°41 '47.76"	2.32	0.99
7.56	74°41 '5.51"	13°41 '49.48"	2.42	1.09
7.60	74°41 '4.94"	13°41 '50.75"	2.60	1.27
7.64	74°41 '4.36"	13°41 '51.94"	3.15	1.82
7.68	74°41 '3.6"	13°41 '53.08"	3.84	2.51
7.72	74°41 '2.79"	13°41 '54.16"	5.12	3.79
7.77	74°41 '1.87"	13°41 '55.28"	4.41	3.08
7.81	74°41 '0.96"	13°41 '56.28"	3.26	1.93
7.85	74°41 '0.06"	13°41 '57.27"	2.34	1.01
Mullikatte Vented Barrage at Ch 7.90km				
7.98	74°40 '57.49"	13°42 '0.32"	3.07	3.07
8.02	74°40 '56.56"	13°42 '1.34"	2.42	2.42
8.06	74°40 '55.63"	13°42 '2.35"	2.30	2.30
8.10	74°40 '54.71"	13°42 '3.37"	2.41	2.41
8.14	74°40 '53.79"	13°42 '4.39"	2.48	2.48
8.18	74°40 '52.94"	13°42 '5.47"	2.50	2.50
8.23	74°40 '52.1"	13°42 '6.55"	2.28	2.28
8.27	74°40 '51.25"	13°42 '7.64"	1.99	1.99
8.31	74°40 '50.41"	13°42 '8.72"	1.63	1.63
8.35	74°40 '49.56"	13°42 '9.8"	1.64	1.64
8.39	74°40 '48.72"	13°42 '10.88"	1.77	1.77
8.44	74°40 '47.89"	13°42 '11.97"	2.13	2.13
8.48	74°40 '47.07"	13°42 '13.08"	2.68	2.68
8.52	74°40 '46.26"	13°42 '14.18"	3.41	3.41
8.56	74°40 '45.44"	13°42 '15.29"	2.56	2.56
8.60	74°40 '44.63"	13°42 '16.39"	2.30	2.30
8.64	74°40 '43.82"	13°42 '17.5"	2.00	2.00
8.69	74°40 '43"	13°42 '18.6"	1.67	1.67
8.73	74°40 '42.21"	13°42 '19.72"	1.40	1.40
8.77	74°40 '41.46"	13°42 '20.87"	2.51	2.51
8.81	74°40 '40.72"	13°42 '22.02"	2.74	2.74
8.85	74°40 '39.97"	13°42 '23.17"	2.60	2.60
8.90	74°40 '39.22"	13°42 '24.31"	2.40	2.40
8.94	74°40 '38.47"	13°42 '25.46"	3.10	3.10
8.98	74°40 '37.7"	13°42 '26.59"	3.40	3.40
9.02	74°40 '36.73"	13°42 '27.57"	4.50	4.50
9.06	74°40 '35.75"	13°42 '28.54"	4.80	4.80
9.10	74°40 '34.78"	13°42 '29.51"	4.65	4.65
9.15	74°40 '33.74"	13°42 '30.42"	3.80	3.80
9.19	74°40 '32.68"	13°42 '31.3"	3.50	3.50
9.23	74°40 '31.61"	13°42 '32.18"	3.99	3.99
9.27	74°40 '30.55"	13°42 '33.06"	3.88	3.88
9.31	74°40 '29.49"	13°42 '33.94"	3.54	3.54
9.35	74°40 '28.45"	13°42 '34.84"	2.76	2.76

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
9.40	74°40 '27.57"	13°42 '35.9"	2.32	2.32
9.44	74°40 '26.7"	13°42 '36.95"	2.54	2.54
9.48	74°40 '25.82"	13°42 '38.01"	1.33	1.33
9.52	74°40 '24.98"	13°42 '39.1"	1.18	1.18
9.56	74°40 '24.22"	13°42 '40.24"	1.45	1.45
9.61	74°40 '23.46"	13°42 '41.38"	1.45	1.45
9.65	74°40 '22.7"	13°42 '42.52"	1.74	1.74
9.69	74°40 '21.94"	13°42 '43.66"	1.86	1.86
9.73	74°40 '21.18"	13°42 '44.8"	2.36	2.36
9.77	74°40 '20.27"	13°42 '45.82"	2.82	2.82
9.81	74°40 '19.26"	13°42 '46.75"	2.52	2.52
9.86	74°40 '18.24"	13°42 '47.68"	2.41	2.41
9.90	74°40 '17.22"	13°42 '48.61"	2.34	2.34
9.94	74°40 '16.21"	13°42 '49.54"	2.32	2.32
9.98	74°40 '15.19"	13°42 '50.47"	2.37	2.37
10.02	74°40 '14.18"	13°42 '51.4"	2.28	2.28
10.07	74°40 '13.16"	13°42 '52.33"	2.10	2.10
10.11	74°40 '12.14"	13°42 '53.26"	2.87	2.87
10.15	74°40 '11.13"	13°42 '54.2"	2.43	2.43
10.19	74°40 '10.02"	13°42 '54.97"	2.29	2.29
10.23	74°40 '8.67"	13°42 '55.29"	1.88	1.88
10.27	74°40 '7.32"	13°42 '55.62"	1.98	1.98
10.32	74°40 '5.97"	13°42 '55.95"	1.92	1.92
10.36	74°40 '4.6"	13°42 '56.15"	2.54	2.54
10.40	74°40 '3.21"	13°42 '56.25"	2.40	2.40
10.44	74°40 '1.82"	13°42 '56.34"	2.44	2.44
10.48	74°40 '0.43"	13°42 '56.44"	1.90	1.90
10.53	74°39 '59.04"	13°42 '56.41"	1.69	1.69
10.57	74°39 '57.65"	13°42 '56.36"	1.68	1.68
10.61	74°39 '56.26"	13°42 '56.31"	1.81	1.81
10.65	74°39 '54.87"	13°42 '56.36"	1.82	1.82
10.69	74°39 '53.48"	13°42 '56.45"	1.91	1.91
10.73	74°39 '52.09"	13°42 '56.59"	1.91	1.91
10.78	74°39 '50.71"	13°42 '56.76"	1.80	1.80
10.82	74°39 '49.37"	13°42 '56.65"	1.92	1.92
10.86	74°39 '48.11"	13°42 '56.07"	2.12	2.12
10.90	74°39 '46.85"	13°42 '55.49"	2.56	2.56
10.94	74°39 '45.59"	13°42 '54.9"	2.86	2.86
10.98	74°39 '44.72"	13°42 '53.92"	2.15	2.15
11.03	74°39 '44.07"	13°42 '52.72"	2.02	2.02
11.07	74°39 '43.42"	13°42 '51.52"	1.67	1.67
11.11	74°39 '42.76"	13°42 '50.32"	1.65	1.65
11.15	74°39 '42.11"	13°42 '49.12"	1.71	1.71
11.19	74°39 '41.69"	13°42 '47.82"	1.73	1.73
11.23	74°39 '41.29"	13°42 '46.52"	1.72	1.72
11.28	74°39 '40.88"	13°42 '45.21"	2.85	2.85
11.32	74°39 '40.48"	13°42 '43.91"	3.05	3.05
11.36	74°39 '40.08"	13°42 '42.61"	2.97	2.97
11.40	74°39 '39.67"	13°42 '41.3"	3.12	3.12
11.44	74°39 '39.27"	13°42 '40"	0.86	0.86
11.49	74°39 '38.93"	13°42 '38.69"	1.03	1.03

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
11.53	74°39 '38.78"	13°42 '37.33"	1.16	1.16
11.57	74°39 '38.63"	13°42 '35.98"	1.35	1.35
11.61	74°39 '38.48"	13°42 '34.63"	1.50	1.50
11.65	74°39 '38.32"	13°42 '33.27"	2.27	2.27
11.69	74°39 '38.09"	13°42 '31.95"	1.75	1.75
11.74	74°39 '37.2"	13°42 '30.91"	1.62	1.62
11.78	74°39 '36.31"	13°42 '29.86"	2.72	2.72
11.82	74°39 '35.41"	13°42 '28.82"	3.25	3.25
11.86	74°39 '34.55"	13°42 '27.75"	2.98	2.98
11.90	74°39 '33.68"	13°42 '26.68"	3.36	3.36
11.94	74°39 '32.82"	13°42 '25.61"	2.40	2.40
11.99	74°39 '31.96"	13°42 '24.54"	2.24	2.24
12.03	74°39 '31.1"	13°42 '23.48"	2.15	2.15
12.07	74°39 '30.24"	13°42 '22.41"	2.50	2.50
12.11	74°39 '29.35"	13°42 '21.36"	2.41	2.41
12.15	74°39 '28.27"	13°42 '20.5"	2.36	2.36
12.20	74°39 '27.19"	13°42 '19.64"	2.18	2.18
12.24	74°39 '26.11"	13°42 '18.78"	1.97	1.97
12.28	74°39 '25.03"	13°42 '17.92"	2.13	2.13
12.32	74°39 '23.95"	13°42 '17.07"	2.00	2.00
12.36	74°39 '22.87"	13°42 '16.21"	2.11	2.11
12.40	74°39 '21.96"	13°42 '15.17"	2.18	2.18
12.45	74°39 '21.07"	13°42 '14.13"	1.98	1.98
12.49	74°39 '20.17"	13°42 '13.09"	2.26	2.26
12.53	74°39 '19.27"	13°42 '12.05"	2.23	2.23
12.57	74°39 '18.37"	13°42 '11.01"	2.36	2.36
12.61	74°39 '17.53"	13°42 '9.95"	2.73	2.73
12.66	74°39 '17.32"	13°42 '8.6"	3.28	3.28
12.70	74°39 '17.12"	13°42 '7.26"	3.87	3.87
12.74	74°39 '16.91"	13°42 '5.91"	3.73	3.73
12.78	74°39 '16.7"	13°42 '4.56"	3.60	3.60
12.82	74°39 '16.47"	13°42 '3.22"	1.95	1.95
12.86	74°39 '16.23"	13°42 '1.88"	1.56	1.56
12.91	74°39 '15.99"	13°42 '0.54"	1.62	1.62
12.95	74°39 '16.07"	13°41 '59.2"	1.49	1.49
12.99	74°39 '16.31"	13°41 '57.86"	1.64	1.64
13.03	74°39 '16.55"	13°41 '56.52"	2.63	2.63
13.07	74°39 '17.01"	13°41 '55.27"	2.71	2.71
13.11	74°39 '17.9"	13°41 '54.23"	2.64	2.64
13.16	74°39 '18.79"	13°41 '53.18"	2.50	2.50
13.20	74°39 '19.29"	13°41 '51.91"	2.34	2.34
13.24	74°39 '19.76"	13°41 '50.63"	2.13	2.13
13.28	74°39 '19.24"	13°41 '49.45"	2.61	2.61
13.32	74°39 '18.4"	13°41 '48.38"	2.48	2.48
13.36	74°39 '17.47"	13°41 '47.35"	1.75	1.75
13.41	74°39 '16.55"	13°41 '46.33"	1.86	1.86
13.45	74°39 '15.63"	13°41 '45.31"	1.76	1.76
13.49	74°39 '14.29"	13°41 '45.12"	1.56	1.56
13.53	74°39 '12.91"	13°41 '45.03"	1.43	1.43
13.57	74°39 '11.56"	13°41 '45.21"	1.33	1.33
13.61	74°39 '10.25"	13°41 '45.69"	1.34	1.34

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
13.65	74°39 '8.95"	13°41 '46.16"	1.58	1.58
13.70	74°39 '7.64"	13°41 '46.64"	1.54	1.54
13.74	74°39 '6.36"	13°41 '47.15"	1.72	1.72
13.78	74°39 '5.17"	13°41 '47.86"	2.09	2.09
13.82	74°39 '3.99"	13°41 '48.58"	3.09	3.09
13.86	74°39 '2.8"	13°41 '49.29"	2.18	2.18
13.91	74°39 '1.62"	13°41 '50.01"	1.98	1.98
13.95	74°39 '0.43"	13°41 '50.73"	2.26	2.26
13.99	74°38 '59.33"	13°41 '51.55"	2.23	2.23
14.03	74°38 '58.23"	13°41 '52.38"	2.36	2.36
14.07	74°38 '57.12"	13°41 '53.21"	1.98	1.98
14.11	74°38 '56.02"	13°41 '54.04"	1.83	1.83
14.16	74°38 '54.96"	13°41 '54.93"	1.80	1.80
14.20	74°38 '53.97"	13°41 '55.88"	1.70	1.70
14.24	74°38 '52.98"	13°41 '56.84"	2.41	2.41
14.28	74°38 '51.99"	13°41 '57.79"	2.36	2.36
14.32	74°38 '50.99"	13°41 '58.75"	2.18	2.18
14.37	74°38 '50"	13°41 '59.71"	1.97	1.97
14.41	74°38 '49.06"	13°42 '0.7"	2.13	2.13
14.45	74°38 '48.21"	13°42 '1.78"	2.00	2.00
14.49	74°38 '47.36"	13°42 '2.86"	2.11	2.11
14.53	74°38 '46.53"	13°42 '3.95"	2.80	2.80
14.57	74°38 '45.71"	13°42 '5.05"	2.22	2.22
14.62	74°38 '44.88"	13°42 '6.15"	2.04	2.04
14.66	74°38 '44.03"	13°42 '7.22"	1.89	1.89
14.70	74°38 '43.17"	13°42 '8.3"	2.36	2.36
14.74	74°38 '42.56"	13°42 '9.51"	2.82	2.82
14.78	74°38 '42.02"	13°42 '10.77"	2.07	2.07
14.83	74°38 '41.26"	13°42 '11.89"	2.10	2.10
14.87	74°38 '40.43"	13°42 '12.99"	2.13	2.13
14.91	74°38 '39.64"	13°42 '14.11"	2.17	2.17
14.95	74°38 '38.92"	13°42 '15.27"	2.32	2.32
14.99	74°38 '38.2"	13°42 '16.44"	3.07	3.07
15.03	74°38 '37.87"	13°42 '17.75"	3.09	3.09
15.08	74°38 '37.55"	13°42 '19.07"	2.68	2.68
15.12	74°38 '37.2"	13°42 '20.39"	2.47	2.47
15.16	74°38 '36.74"	13°42 '21.67"	2.39	2.39
15.20	74°38 '36.25"	13°42 '22.95"	2.35	2.35
15.24	74°38 '35.76"	13°42 '24.22"	2.33	2.33
15.29	74°38 '35.23"	13°42 '25.48"	2.32	2.32
15.33	74°38 '34.68"	13°42 '26.73"	2.27	2.27
15.37	74°38 '34.49"	13°42 '28.08"	2.11	2.11
15.41	74°38 '34.34"	13°42 '29.43"	2.30	2.30
15.45	74°38 '34.2"	13°42 '30.78"	1.90	1.90
15.49	74°38 '34.31"	13°42 '32.12"	1.75	1.75
15.54	74°38 '34.66"	13°42 '33.44"	1.86	1.86
15.58	74°38 '34.9"	13°42 '34.77"	1.76	1.76
15.62	74°38 '34.96"	13°42 '36.13"	1.56	1.56
15.66	74°38 '35.03"	13°42 '37.49"	1.43	1.43
15.70	74°38 '34.93"	13°42 '38.82"	1.50	1.50
15.86	74°38 '33.63"	13°42 '43.46"	2.58	2.58

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
15.90	74°38 '34.29"	13°42 '44.85"	2.90	2.90
15.95	74°38 '35.06"	13°42 '46.13"	3.30	3.30
16.01	74°38 '35.99"	13°42 '47.88"	3.11	3.11
16.05	74°38 '36.58"	13°42 '49.19"	3.08	3.08
16.11	74°38 '37.44"	13°42 '50.75"	2.94	2.94
16.16	74°38 '38.36"	13°42 '52.05"	2.92	2.92
16.23	74°38 '39.72"	13°42 '53.93"	2.88	2.88
16.27	74°38 '40.5"	13°42 '55.13"	2.50	2.50
16.34	74°38 '41.7"	13°42 '56.92"	2.68	2.68
16.38	74°38 '42.57"	13°42 '58.21"	3.02	3.02
16.45	74°38 '43.77"	13°42 '59.84"	3.12	3.12
16.50	74°38 '44.92"	13°43 '1.15"	3.22	3.22
16.54	74°38 '45.9"	13°43 '2.24"	3.07	3.07
16.59	74°38 '46.96"	13°43 '3.34"	2.82	2.82
16.65	74°38 '48.39"	13°43 '4.53"	2.48	2.48
16.70	74°38 '49.72"	13°43 '5.51"	1.91	1.91
16.74	74°38 '51.03"	13°43 '6.47"	1.74	1.74
16.79	74°38 '52.4"	13°43 '7.26"	1.99	1.99
16.85	74°38 '54.14"	13°43 '7.98"	2.31	2.31
16.92	74°38 '56.5"	13°43 '8.56"	2.24	2.24
16.96	74°38 '57.84"	13°43 '8.82"	2.64	2.64
17.02	74°38 '59.61"	13°43 '9.15"	2.02	2.02
17.07	74°39 '1.33"	13°43 '9.56"	1.84	1.84
17.12	74°39 '2.84"	13°43 '9.99"	2.05	2.05
17.16	74°39 '4.32"	13°43 '10.44"	2.15	2.15
17.21	74°39 '5.62"	13°43 '10.88"	2.43	2.43
17.27	74°39 '7.51"	13°43 '11.64"	2.59	2.59
17.32	74°39 '8.95"	13°43 '12.4"	2.93	2.93
17.36	74°39 '10.19"	13°43 '13.09"	3.68	3.68
17.42	74°39 '11.97"	13°43 '13.8"	4.21	4.21
17.48	74°39 '13.98"	13°43 '14.7"	4.75	4.75
17.53	74°39 '15.29"	13°43 '15.39"	4.24	4.24
17.57	74°39 '16.47"	13°43 '16.05"	4.61	4.61
17.63	74°39 '18.1"	13°43 '17.05"	4.80	4.80
17.67	74°39 '19.27"	13°43 '17.7"	3.51	3.51
17.71	74°39 '20.5"	13°43 '18.37"	4.59	4.59
17.75	74°39 '21.7"	13°43 '19.01"	4.49	4.49
17.82	74°39 '23.55"	13°43 '20.11"	3.95	3.95
17.87	74°39 '24.79"	13°43 '21.2"	3.67	3.67
17.91	74°39 '25.81"	13°43 '22.07"	2.84	2.84
17.97	74°39 '27.04"	13°43 '23.56"	2.81	2.81
18.02	74°39 '28.35"	13°43 '24.85"	2.44	2.44
18.07	74°39 '29.33"	13°43 '25.96"	2.53	2.53
18.11	74°39 '30.23"	13°43 '26.97"	3.37	3.37
18.15	74°39 '31.12"	13°43 '27.97"	6.65	6.65
18.20	74°39 '32.54"	13°43 '29.19"	5.34	5.34
18.26	74°39 '33.81"	13°43 '30.27"	4.64	4.64
18.30	74°39 '34.71"	13°43 '31.25"	2.64	2.64
18.34	74°39 '35.17"	13°43 '32.61"	2.89	2.89
18.38	74°39 '35.06"	13°43 '33.92"	2.28	2.28
18.43	74°39 '35.28"	13°43 '35.36"	2.21	2.21

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
18.47	74°39 '35.01"	13°43 '36.65"	1.64	1.64
18.51	74°39 '34.75"	13°43 '38.06"	1.63	1.63
18.56	74°39 '34.61"	13°43 '39.62"	1.61	1.61
18.60	74°39 '34.32"	13°43 '40.95"	1.61	1.61
18.66	74°39 '33.84"	13°43 '42.9"	1.77	1.77
18.72	74°39 '33.28"	13°43 '44.71"	1.95	1.95
18.77	74°39 '32.72"	13°43 '46.16"	2.07	2.07
18.81	74°39 '32.26"	13°43 '47.46"	2.37	2.37
18.85	74°39 '31.86"	13°43 '48.73"	2.60	2.60
18.89	74°39 '31.39"	13°43 '50.08"	2.70	2.70
18.95	74°39 '30.64"	13°43 '51.9"	2.64	2.64
19.00	74°39 '29.98"	13°43 '53.28"	2.64	2.64
19.07	74°39 '28.79"	13°43 '55.33"	2.53	2.53
19.12	74°39 '28.05"	13°43 '56.6"	2.74	2.74
19.17	74°39 '27.29"	13°43 '57.99"	2.81	2.81
19.21	74°39 '26.6"	13°43 '59.12"	3.16	3.16
19.26	74°39 '25.68"	13°44 '0.65"	3.22	3.22
19.31	74°39 '24.9"	13°44 '1.94"	3.28	3.28
19.35	74°39 '24.07"	13°44 '3.23"	3.48	3.48
19.40	74°39 '23.27"	13°44 '4.32"	4.01	4.01
19.44	74°39 '22.49"	13°44 '5.39"	4.57	4.57
19.50	74°39 '21.27"	13°44 '6.88"	4.79	4.79
19.54	74°39 '20.27"	13°44 '7.89"	3.37	3.37
19.58	74°39 '19.22"	13°44 '8.76"	2.25	2.25
19.63	74°39 '17.98"	13°44 '9.63"	1.91	1.91
19.68	74°39 '16.63"	13°44 '10.57"	1.77	1.77
19.72	74°39 '15.36"	13°44 '11.34"	1.65	1.65
19.76	74°39 '14.17"	13°44 '12.04"	1.52	1.52
19.81	74°39 '12.79"	13°44 '12.58"	1.38	1.38
19.87	74°39 '10.88"	13°44 '13.01"	1.44	1.44
19.92	74°39 '9.13"	13°44 '13.39"	1.48	1.48
19.96	74°39 '7.74"	13°44 '13.63"	1.58	1.58
20.00	74°39 '6.4"	13°44 '13.87"	1.84	1.84
20.08	74°39 '4"	13°44 '14.26"	1.83	1.83
20.12	74°39 '2.64"	13°44 '14.46"	2.14	2.14
20.17	74°39 '0.83"	13°44 '14.42"	2.43	2.43
20.22	74°38 '59.39"	13°44 '14.28"	2.93	2.93
20.26	74°38 '57.8"	13°44 '14"	2.88	2.88
20.32	74°38 '55.99"	13°44 '13.68"	3.94	3.94
20.36	74°38 '54.53"	13°44 '13.44"	5.31	5.31
20.40	74°38 '53.23"	13°44 '13.09"	4.53	4.53
20.44	74°38 '51.95"	13°44 '12.71"	4.00	4.00
20.49	74°38 '50.35"	13°44 '12.22"	3.87	3.87
20.54	74°38 '48.77"	13°44 '11.97"	3.50	3.50
20.60	74°38 '46.94"	13°44 '11.6"	2.72	2.72
20.64	74°38 '45.45"	13°44 '11.37"	2.95	2.95
20.70	74°38 '43.63"	13°44 '11.31"	2.35	2.35
20.74	74°38 '42.11"	13°44 '11.38"	1.97	1.97
20.79	74°38 '40.59"	13°44 '11.46"	1.94	1.94
20.84	74°38 '38.99"	13°44 '11.53"	2.14	2.14
20.88	74°38 '37.65"	13°44 '11.7"	3.18	3.18

Chainage(KM)	Easting	Northing	Depth(M)	Reduced Depth (M) w.r.t CD/Observed Low Water Depth
20.94	74°38 '35.72"	13°44 '12.22"	5.51	5.51
20.98	74°38 '34.74"	13°44 '13.12"	4.89	4.89
21.03	74°38 '34.1"	13°44 '14.7"	4.78	4.78
21.09	74°38 '34.03"	13°44 '16.42"	4.92	4.92
21.13	74°38 '34.04"	13°44 '17.73"	4.03	4.03
21.18	74°38 '33.97"	13°44 '19.43"	3.56	3.56
21.22	74°38 '33.84"	13°44 '20.86"	3.34	3.34
21.27	74°38 '34.02"	13°44 '22.35"	4.35	4.35
21.31	74°38 '34.32"	13°44 '23.72"	3.80	3.80
21.36	74°38 '35.02"	13°44 '25.23"	3.44	3.44
21.40	74°38 '35.9"	13°44 '26.25"	2.42	2.42
21.45	74°38 '36.94"	13°44 '27.17"	2.42	2.42
21.49	74°38 '37.83"	13°44 '28.16"	2.78	2.78
21.53	74°38 '38.76"	13°44 '29.14"	3.35	3.35
21.58	74°38 '39.96"	13°44 '30.2"	3.87	3.87
21.62	74°38 '41.11"	13°44 '30.9"	4.75	4.75
21.66	74°38 '42.53"	13°44 '31.16"	4.84	4.84
21.70	74°38 '43.87"	13°44 '31.27"	2.60	2.60
21.74	74°38 '45.21"	13°44 '31.4"	2.00	2.00
21.79	74°38 '46.72"	13°44 '31.6"	2.09	2.09
21.83	74°38 '48.26"	13°44 '31.87"	2.61	2.61
21.89	74°38 '49.89"	13°44 '32.44"	1.70	1.70
21.95	74°38 '51.78"	13°44 '33.03"	1.48	1.48
21.99	74°38 '53.07"	13°44 '33.41"	0.96	0.96
22.03	74°38 '54.63"	13°44 '33.79"	0.95	0.95
22.07	74°38 '55.96"	13°44 '33.98"	2.72	2.72
22.12	74°38 '57.34"	13°44 '34.19"	5.01	5.01
22.16	74°38 '58.79"	13°44 '34.37"	1.84	1.84
22.20	74°39 '0.17"	13°44 '34.34"	5.12	5.12
22.25	74°39 '1.67"	13°44 '34.34"	4.04	4.04
22.29	74°39 '3.07"	13°44 '34.51"	3.07	3.07
22.34	74°39 '4.73"	13°44 '35.2"	2.42	2.42
22.39	74°39 '5.96"	13°44 '36.03"	2.30	2.30
22.44	74°39 '7.21"	13°44 '37.23"	2.41	2.41
22.49	74°39 '8.19"	13°44 '38.37"	2.48	2.48
22.54	74°39 '9.27"	13°44 '39.76"	2.50	2.50
22.58	74°39 '10.07"	13°44 '40.88"	2.28	2.28
22.62	74°39 '10.8"	13°44 '42.01"	1.99	1.99
22.67	74°39 '11.47"	13°44 '43.19"	1.63	1.63
22.71	74°39 '12.1"	13°44 '44.36"	1.64	1.64
22.76	74°39 '13.03"	13°44 '45.99"	1.77	1.77
22.80	74°39 '13.72"	13°44 '47.15"	2.13	2.13
22.85	74°39 '14.16"	13°44 '48.41"	2.68	2.68
22.89	74°39 '14.7"	13°44 '49.74"	3.41	3.41
22.94	74°39 '15.55"	13°44 '51.26"	2.56	2.56
22.98	74°39 '16.31"	13°44 '52.37"	2.30	2.30
23.03	74°39 '16.86"	13°44 '53.59"	2.00	2.00
23.07	74°39 '17.37"	13°44 '54.83"	1.67	1.67
23.13	74°39 '18.38"	13°44 '56.55"	1.24	1.24

Note: The Observed depth has been worked out after duly applying the tidal correction, wherever applicable.

ANNEXURE 3.3

PHOTOS CAPTURED BY SURVEY TEAM DURING RECONNAISSANCE SURVEY

ANNEXURE 3.3: SITE PHOTO

Photo 1: Indian Oil Petrol Pump at Ch 0.50km

Photo 2: Gangoli Fishing Harbor

Photo 3: Brick Kiln at Ch 2.00km

Photo 4: Fishing Boat

Photo 5: Stone in River at Ch 3.00km

Photo 6: Sand in River at Ch 4.00km

Photo 7: River Bank at Ch 5.00km

Photo 8: 11KV at Ch 5.00km

Photo 9: Panchagangavali River

Photo 10: Bridge at Ch 5.99km

Photo 11: Sand Store at Ch 6.50km

Photo 12: Bridge at Ch 7.80km

Photo 13: Barrage at Ch 7.90km

Photo 14: Boat Service for Padukone Village at Ch 15.50km

Photo 15: Mullikatte-Padukone Bridge at Ch 15.76km

Photo 16: Marvanthe-Padukone Bridge at Ch 15.76km

Photo 17: Sand from River at Ch 20.00km

Photo 18: Bridge at Ch 21.00km

Photo 19: Stone in River at Ch 22.00km

Photo 20: Railway Bridge at Ch 22.90km

Photo 21: Ending Point near Badakere

ANNEXURE 3.4

PANCHAGANGAVALI (PANCHAGANGOLI) RIVER LONGITUDINAL BED PROFILE

ANNEXURE 3.4

OBSERVED BED PROFILE OF PANCHGANGAVALI/PANCHAGANGOLI RIVER WATERWAY

ANNEXURE 3.5

COMPILATION OF FIELD INFORMATION OF PANCHAGANGAVALI (PANCHAGANGOLI) RIVER IN IWAI FORMAT

Annexure 3.5: Format for Submission of Initial Field Information Report

SL#	DESCRIPTION	DETAILS	REMARKS
	NAME OF THE FIRM	**GeoInfosys**	
	REGION / CLUSTER NO.	**Cluster-6/ Stage-1/ Karnataka**	
1	NAME OF THE WATERWAY	Panchagangavali(Panchagangoli) River	
2	LENGTH OF THE WATERWAY (km)	23	
3	WATERWAY IN THE STATES OF	Karnataka	
4	FIELD WORK COMPLETED FOR THE LENGTH OF THE WATERWAY (km)	23.13	
TIDAL WATERWAYS			
5	Length of the waterway having tidal effects (km)	7.9	
6	Start & end location name having tidal effects	Gangoli port & Mullikatte Barrage	
7	Tidal variation (m)	1.1	
DEPTH INFORMATION			
8	Length of the waterway, where depths more than 2m is observed	13.14	
9	Length of the waterway, where depths more than 1.5m is observed	4.51	
10	Existing Water level (m)		
11	Minimum Water Level (m)	CD at 1.33m	
12	Highest Flood level (m)	NA	
CROSS-STRUCTURE INFORMATION			
13	Existing list of Dam, Barrages, Locks	Mullikatte Barrage	at Ch 7.90km from Arabian Sea
14	Existing Bridges (nos.)	6	
15	Minimum Vertical and Horizontal clearances (m) as per visual estimation	V.C-4.00m to 14.00m H.C-25.00m to 30.00m	Vertical Clearance is taken w.r.t HFL
16	High Tension lines/LT lines	V.C-4.00m to 14.00m H.C-25.00m to 70.00m	
NAVIGATIONAL OBSTRUCTION			
17	Rocks	yes	At some places
18	Steep gradients	No	
ENVIRONMENTAL & OTHER ISSUES			
19	Details of wildlife /forest area	Nagarhole National Park	
20	Protected areas		
21	Security clearances		
CARGO AND OTHER DETAILS			
22	Availability of passenger ferry services.along the waterway	Not Available	
23	Estimated cargo movement through proposed waterway, road and rail		

SL#	DESCRIPTION	DETAILS	REMARKS
24	Type of crops (in different seasons) and industries along the waterway	Paddy, Vegitable , Jowar, Maize	
25	Availability of Prominent towns / City along the waterway.	Beechanhalli, Jeeyara, Machare, Kandegala, Singapatna, Kanakahalli, Beeramballi	Near Sargur
26	Historical and tourist places along waterway	Kabini Dam, Nagarhole National Park	
27	Existing water sport and recreational activities and future probability		
28	Existing Jetties and Terminals	Not Available ,	Only one Forest Department Jetty Available

ANNEXURE 4.1

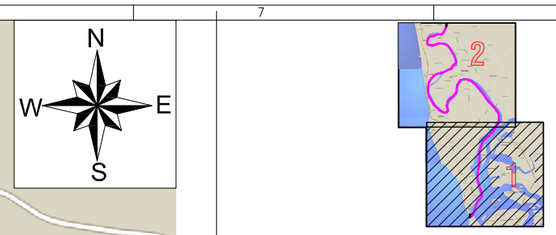
MEETINGS AND DISCUSSIONS

Annexure 4.1: Meeting and Discussions

District	S. No.	Department	Persons met
Dakshina Kannada District	1	Old Mangalore Port Office	Port Conservator
	2	Directorate of Industries	Jt. Director
	3	Association of Industries	Treasurer
	4	District Collector Office Dakshina Kannada	JD Agriculture, DFO Forest, Fisheries, Disaster Management Unit
Udipi District	1	Malpe Port Office	Ports Officer
	2	Hannover Port	Ports officer
	3	Directorate of Industries	Jt. Director
	4	District Collector Office Udipi District	JD Agriculture, DFO Forest, Fisheries, Disaster Management Unit, Department of Economics and Statistics
North Kannada District	1	Directorate of Ports and Inland Water Transport	Director Port, Ports Engineer, Superintending Engineer
	2	Directorate of Industries	Jt. Director
	3	District Collector Office Uttar Kannada District	JD Agriculture, DFO Forest, Fisheries, Disaster Management Unit, Department of Economics and Statistics

DRAWINGS

P.009050-W-20201-009 R0 (SHEET-2): PANCHAGANGAVALI RIVER (KARNATAKA) – PROPOSED NATIONAL WATERWAY NUMBER 76 – LAYOUT PLAN



LEGEND

	BUS STOP
	FUEL STATION/PUMP
	JETTY
	INDUSTRY
	PORT
	PLACE NAME
	RAILWAY STATION
	RESORT
	NATIONAL/STATE HIGHWAY (Hwy)
	ROAD
	FERRY LINE
	ROUTE PROVIDED BY IWAI
	SURVEY VESSEL TRACK (THALWEG) (ABOUT 40m WIDE)
	DREDGING REQUIRED
	RAILWAY LINE
A	START POINT FROM GANGOLI PORT AT LAT. 13°38'1.30" N LON. 74°40'8.43" E
A1	START POINT FROM GANGOLI PORT AT LAT. 13°38'7.68" N LON. 74°40'12.05" E
B	END POINT BRIDGE AT BADAKERE LAT. 13°44'50.01" N LON. 74°39'15.13" E
B1	END POINT BRIDGE AT BADAKERE LAT. 13°44'56.14" N LON. 74°39'18.60" E

BRIDGE DETAILS

BRIDGE No.	CHAINAGE (Km)
B1	6.215
B2	6.245

PROPOSED WATERWAY LENGTH 23.0Km (AS PER TENDER)
TOTAL WATERWAY LENGTH FROM POINT 'A' TO POINT 'B' 23.13Km

SCALE 0 0.5 1.25KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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

TITLE: PANCHAGANGAVALI RIVER (KARANATAKA)
PROPOSED NATIONAL WATERWAY NUMBER 76
LAYOUT PLAN

CLIENT: **INLAND WATERWAYS AUTHORITY OF INDIA**
MINISTRY OF SHIPPING

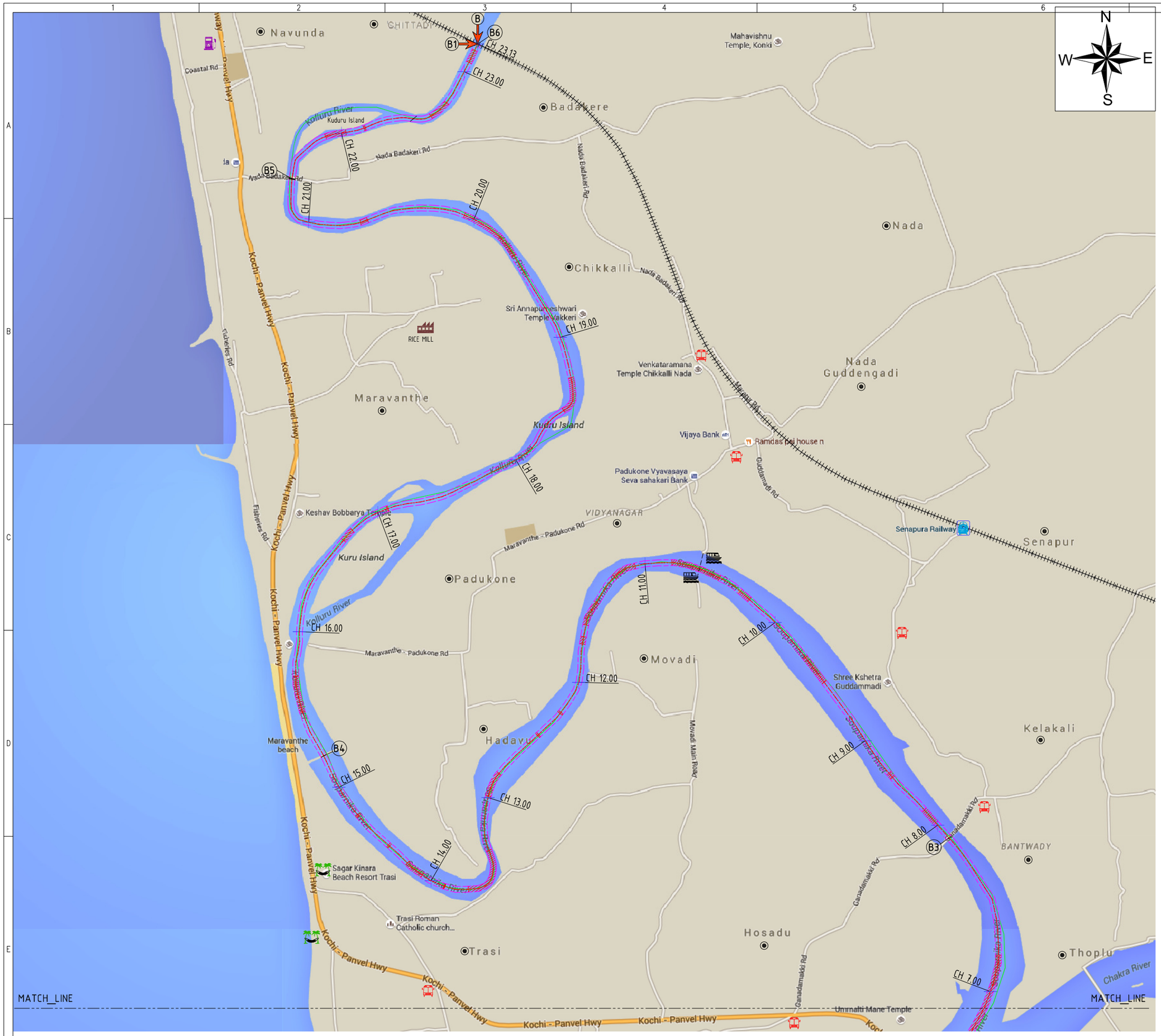
PROJECT: CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 6 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 – FEASIBILITY REPORT

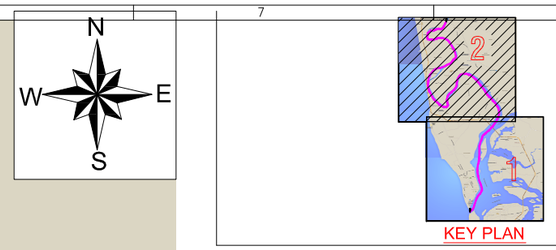
PROJECT NO. **P.009050**

TRACTEBEL Engineering GDF SUEZ

SIZE: A3 | SCALE: 1:25000 | SHEET: 1–2

DRAWING NUMBER: P.009050-W-202201-009 REV 0





LEGEND

	BUS STOP
	FUEL STATION/PUMP
	JETTY
	INDUSTRY
	PORT
	PLACE NAME
	RAILWAY STATION
	RESORT
	NATIONAL/STATE HIGHWAY (Hwy)
	ROAD
	FERRY LINE
	ROUTE PROVIDED BY IWAI
	SURVEY VESSEL TRACK (THALWEG) (ABOUT 40m WIDE)
	DREDGING REQUIRED
	RAILWAY LINE
A	START POINT FROM GANGOLI PORT AT LAT. 13°38'1.30" N LON. 74°40'8.43" E
A1	START POINT FROM GANGOLI PORT AT LAT. 13°38'7.68" N LON. 74°40'12.05" E
B	END POINT BRIDGE AT BADAKERE LAT. 13°44'50.01" N LON. 74°39'15.13" E
B1	END POINT BRIDGE AT BADAKERE LAT. 13°44'56.14" N LON. 74°39'18.60" E

BRIDGE DETAILS

BRIDGE No.	CHAINAGE (Km)	BRIDGE No.	CHAINAGE (Km)
B3	7.82	B5	21.23
B4	15.76	B6	23.13

PROPOSED WATERWAY LENGTH 23.0Km (AS PER TENDER)

TOTAL WATERWAY LENGTH FROM POINT 'A' TO POINT 'B' 23.13Km

SCALE 0 0.5 1.25KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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

TITLE: PANCHAGANGAVALI RIVER (KARANATAKA)
PROPOSED NATIONAL WATERWAY NUMBER 76
LAYOUT PLAN

CLIENT: **INLAND WATERWAYS AUTHORITY OF INDIA**
MINISTRY OF SHIPPING

PROJECT: CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 6 OF PROPOSED 53 NATIONAL WATERWAYS. STAGE 1 - FEASIBILITY REPORT

PROJECT NO. **P.009050**

SIZE: A3 | SCALE: 1:25000 | SHEET: 2-2

TRACTEBEL Engineering GDF SUEZ

DRAWING NUMBER P.0090501-W-2020101-0090 REV 0

MAPS

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

MAP 4.1

LEGEND

- BUS STOP
- FUEL STATION/PUMP
- JETTY
- INDUSTRY
- PORT
- PLACE NAME
- RAILWAY STATION
- RESORT
- NATIONAL/STATE HIGHWAY (Hwy)
- ROAD
- FERRY LINE
- ROUTE PROVIDED BY IWAI
- SURVEY (VESSEL TRACK)/THALWEG
- RAILWAY LINE
- (A) START POINT FROM GANGOLI PORT AT LAT. 13°38'1.30" N LON. 74°40'8.43" E
- (A1) START POINT FROM GANGOLI PORT AT LAT. 13°38'7.68" N LON. 74°40'12.05" E
- (B) END POINT BRIDGE AT BADAKERE LAT. 13°44'50.01" N LON. 74°39'15.13" E
- (B1) END POINT BRIDGE AT BADAKERE LAT. 13°44'56.14" N LON. 74°39'18.60" E

BRIDGE DETAILS

BRIDGE No.	CHAINAGE (Km)	BRIDGE No.	CHAINAGE (Km)
B1	6.215	B4	15.76
B2	6.245	B5	21.23
B3	7.82	B6	23.13

PROPOSED WATERWAY LENGTH 23.0Km (AS PER TENDER)

TOTAL WATERWAY LENGTH FROM POINT 'A' TO POINT 'B' 23.13Km

SCALE 0 1.20 3.0KM

LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	GANGOLI PORT	J1
2	JETTY 1	J2
3	FERRY 1	J3
4	JETTY 2	J4
5	JETTY 3	J5
6	VENTED DAM AT MULLIKATTE	J6
7	FERRY	J7
8	JETTY 4	J8
9	NAVIGATION LOCK MARAVANTHE	J9

SL. NO.	DESCRIPTION	NUMBER
1	INDUSTRY	NIL

TITLE: LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF PANCHAGANGAVALI RIVER (KARANATAKA) (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 6 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. P.009050

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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