FINAL FEASIBILITY REPORT

Consultancy Services for Preparation of Two-stage

Detailed Project Report (DPR) of Cluster 4 of Proposed 53 National Waterways

Birupa/Badi Genguti/Brahmani (NW 22)

FEEDBACK INFRA (P) LIMITED

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Abbreviations

BM	Bench Mark
CAD	Computer Aided Design
CD	Chart Datum
CH	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DF	Dual Frequency
DGLL	Directorate General of Lighthouses and Lightships
DGPS	Differential Global Positioning System
DPR	Detailed Project Report
DXF	Drawing Interchange Format
GPS	Global Positioning System
HFL	High Flood Level
HTL	High Tension Line
HC	Horizontal Clearance
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
km	kilometre
LAT.	Latitude
LONG.	Longitude
m	meter
m/s	meter per second
MSL	Mean Sea level
MTPA	Million Tonnes per Annum
MoEF	Ministry of Environment and Forest
NH	National Highways
NW	National waterways
PWD	Public Works Department
SBES	Single Beam Echo Sounder
SH	State Highways
UTM	Universal Transverse Mercator
VC	Vertical Clearance
WGS	World Geodetic System
PSU	Public Sector Undertaking
USA	United States of America

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CHAPTER 1
EXECUTIVE SUMMARY

1 Executive Summary

A total of 152 km of Birupa/Badi Genguti/Brahmani River system was studied. The study stretch consists of 77 km of Birupa River, additional 25 km of Badi Genguti, a tributary of Birupa and 54 km of Brahmani River. Single line bathymetry/topography survey was carried out from 23rd February 2016 to 11th March 2016. Major inventories like cross structures, dams, barrages and details of these structures in terms of vertical and horizontal clearances were collected. Out of the three stretches under study, only Birupa River was found to have a barrage without locks. Birupa was found to have 16 cross structures, Badi Genguti with 9 and Brahmani with two. During survey a lot of island formations were observed along the river stretches, mainly of sand.

As part of the present study, a preliminary market analysis was also carried out to ascertain the traffic potential along the study stretch. Cuttack district is the major industrial cluster along the study stretch that can generate the traffic. Steel industries and thermal plants dominate the industrial landscape. Sponge Iron, Ferro Alloy and Aluminum industries are other industries present in the cluster. The total traffic potential from the cluster is estimated at 1.69 MTPA and 3.2 MTPA in 2015 and 2025 respectively. As this river system also connects Mahanadi to NW5, traffic from Mahanadi can be routed to NW5 through this river system which further connects to Dhamra.

Salient features at a glance – Birupa River

<table>
<tr><th>S.No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1</td><td>Name of the Consultant</td><td>Feedback Infra Private Limited</td></tr>
<tr><td>2</td><td>Cluster number & States</td><td>Cluster 4, Odisha</td></tr>
<tr><td>3</td><td>Waterway stretch, NW#
From ….. to ; total length</td><td>Part of NW 22, Birupa River; total length of 67 km extends from Birupa Barrage to Upperkai Pada</td></tr>
<tr><td>4</td><td>Navigability Status</td><td>Presently, no navigation exists</td></tr>
<tr><td>a)</td><td>Tidal and non-tidal portions
(from ----- to ….. length, average tidal variation)</td><td>No tidal influence</td></tr>
<tr><td>b)</td><td>LAD Status (w.r.t.CD)
i) Survey period (23rd Feb 2016 to 27th Feb 2016)
ii) < 1.0 m (km)
iii) 1.0m to 1.5m (km)
iv) 1.5m to 2.0 m (km)
v) >2.0m (km)</td><td>
<table>
<tr><th rowspan="2">Depth (m)</th><th colspan="5">Length (km)</th></tr>
<tr><th>0-20</th><th>20-40</th><th>40-60</th><th>60-67</th><th>Total</th></tr>
<tr><td><1.0</td><td>18.83</td><td>17.63</td><td>5.25</td><td>18.83</td><td>60.24</td></tr>
<tr><td>1.0-1.5</td><td>1.17</td><td>1.18</td><td>0.88</td><td>1.17</td><td>3.76</td></tr>
<tr><td>1.5-2.0</td><td>0</td><td>0.59</td><td>0.58</td><td>0</td><td>1.67</td></tr>
<tr><td>>2.0</td><td>0</td><td>0.58</td><td>0.29</td><td>0</td><td>1.31</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross Structures
i) Dams, weirs, barrages etc. (total number; with navigational locks or not)
ii) Bridges, power cables etc. (total number ; range of horizontal and vertical clearance)</td><td>i) One barrage, Birupa; without navigational locks
ii) Bridges: 16; HT Lines: 24
iii) Range of horizontal Clearance: 16-48m
iv) Range of Vertical Clearance (w.r.t. HFL) : 2-7m</td></tr>
<tr><td>d)</td><td>Avg discharge & no. of days</td><td>Details not available</td></tr>
<tr><td>e)</td><td>Slope (1 in -----)</td><td>1 in 6400</td></tr>
<tr><td>5</td><td>Traffic potential</td><td>Traffic potential from Cuttack cluster is 3.2 MTPA for the year 2025</td></tr>
</table>

a)	Present IWT operations, ferry services, tourism, cargo, if any	No IWT operations such as ferry service, tourism, cargo, etc.
b)	Important industries within 50km	Aarti Steel, Bajrangabali Alloys Pvt. Ltd., OCL India Ltd(Captive Power Plant), Purvi Bharat Coke Pvt. Ltd
c)	Distance of rail and road from Industry	1.2 km to 5.0 km away from the main line
6	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	Mahanadi can be connected to NW-5 through this river and waterway navigation can be established to Dhamra port, recommended for next level studies.
7.	Any other information/comments	No additional information

Salient features at a glance - Badi Genguti

S.No.	Particulars	Details
1	Name of the Consultant	Feedback Infra Private Limited
2	Cluster number & States	Cluster 4, Odisha
3	Waterway stretch, NW# From ….. to ; total length	Part of NW 22, Badi Genguti River; total length of 36 km from Samaspur village to near Kharagpur village
4	Navigability Status	Presently, no navigation exists
a)	Tidal and non-tidal portions (from ----- to ….. length, average tidal variation)	No tidal influence
b)	LAD Status (w.r.t.CD) i) Survey period (25th Feb 2016 and 26th Feb 2016) ii) < 1.0 m (km) iii) 1.0m to 1.5m (km) iv) 1.5m to 2.0 m (km) v) >2.0m (km)	
c)	Cross Structures i) Dams, weirs, barrages etc. (total number; with navigational locks or not) ii) Bridges, power cables etc.(total number ; range of horizontal and vertical clearance)	i) No Barrage ii) Bridges: 09; HT Lines: 18 iii) Range of horizontal Clearance: 28-40m iv) Range of Vertical Clearance (w.r.t. HFL) : 0-5m
d)	Avg discharge & no. of days	Details not available
e)	Slope (1 in -----)	1 in 6400
5	Traffic potential	Traffic potential from Cuttack cluster is 3.2 MTPA for the 2025
a)	Present IWT operations, ferry services, tourism, cargo, if any	No IWT operations such as ferry service, tourism, cargo, etc. observed
b)	Important industries within 50km	Aarti Steel, Bajrangabali Alloys Pvt. Ltd., OCL India Ltd(Captive Power Plant), Purvi Bharat Coke Pvt. Ltd
c)	Distance of rail and road from Industry	1.2 km to 5.0 km from the mail line
6	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	Not recommended for Stage II (DPR preparation) because the river branches from Birupa and runs parallel to Birupa joining it at Kharagpur village. Travelling through Birupa is the shorter route.
7.	Any other information/comments	No additional information

Depth (m)	**Length (km)**				
	0-10	**10-20**	**20-30**	**30-36**	**Total**
<1.0	10.0	9.22	9.07	4.30	**32.59**
1.0-1.5	0.0	0.30	0.46	0.77	**1.53**
1.5-2.0	0.0	0.46	0.31	0.16	**0.93**
>2.0	0.0	0.23	0.16	0.46	**0.85**

Salient features at a glance - Brahmani River

<table>
<tr><th>S.No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1</td><td>Name of the Consultant</td><td>Feedback Infra Private Limited</td></tr>
<tr><td>2</td><td>Cluster number & States</td><td>Cluster 4, Odisha</td></tr>
<tr><td>3</td><td>Waterway stretch, NW#
From ….. to ; total length</td><td>Brahmani River; total length of 54 km from confluence of Birupa and Brahmani near Upperkai pada village to Brahmani river at Katana.</td></tr>
<tr><td>4</td><td>Navigability Status</td><td>Presently, no navigation exists</td></tr>
<tr><td>a)</td><td>Tidal and non-tidal portions
(from ----- to ….. length, average tidal variation)</td><td>28 km of river is under tidal influence from Karanpur at Ch 26.0km to Katana at Ch 54.0km
Tidal variation is from 2.8m to 0.7m</td></tr>
<tr><td>b)</td><td>LAD Status (w.r.t.CD)
i) Survey period (10th March 2016 and 11th March 2016)
ii) < 1.0 m (km)
iii) 1.0m to 1.5m (km)
iv) 1.5m to 2.0 m (km)
v) >2.0m (km)</td><td>
<table>
<tr><th rowspan="2">Depth (m)</th><th colspan="4">Length (km)</th></tr>
<tr><th>0-20</th><th>20-40</th><th>40-54</th><th>Total</th></tr>
<tr><td><1.0</td><td>10.0</td><td>9.22</td><td>9.07</td><td>28.29</td></tr>
<tr><td>1.0-1.5</td><td>0.0</td><td>0.30</td><td>0.46</td><td>0.76</td></tr>
<tr><td>1.5-2.0</td><td>0.0</td><td>0.46</td><td>0.31</td><td>0.77</td></tr>
<tr><td>>2.0</td><td>0.0</td><td>0.23</td><td>0.16</td><td>0.39</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross Structures
i) Dams, weirs, barrages etc. (total number; with navigational locks or not)
ii)Bridges, power cables etc. (total number ; range of horizontal and vertical clearance)</td><td>v) No Barrage
vi) Bridges: 02; HT Lines: 04
vii) Range of horizontal Clearance: 30-35 m
viii) Range of Vertical Clearance (w.r.t. HFL) : 3-7 m</td></tr>
<tr><td>d)</td><td>Avg discharge & no. of days</td><td>Details not available</td></tr>
<tr><td>e)</td><td>Slope (1 in -----)</td><td>1 in 6400</td></tr>
<tr><td>5</td><td>Traffic potential</td><td>Traffic potential from Cuttack cluster is 3.2 MTPA for the 2025</td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td>No IWT operations such as ferry service, tourism, cargo, etc. observed</td></tr>
<tr><td>b)</td><td>Important industries within 50km</td><td>No industries within 50 km radius</td></tr>
<tr><td>c)</td><td>Distance of rail and road from Industry</td><td>1.2 km to 5.0 km from the main line</td></tr>
<tr><td>6</td><td>Consultant’s recommendation for going ahead with Stage-II (DPR preparation)</td><td>Mahanadi can be connected to NW5 through this river and waterway navigation can be established to Dhamra port. Recommended for Stage 2 studies.</td></tr>
<tr><td>7.</td><td>Any other information/comments</td><td>No additional information</td></tr>
</table>

CHAPTER 2
INTRODUCTION

2 Introduction

2.1 Inland Waterways in India

Given India's long coastline and many waterways, coastal shipping and Inland Water Transport (IWT) segments have huge potential. India has about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc. However, its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the delta in regions of the Godavari-Krishna Rivers. There is a need to promote these environment-friendly and cost-effective modes of transport as these remain largely underutilized accounting for less than 0.5% of total traffic within India.

Realizing the potential of the IWT sector, Government of India has announced several initiatives to promote IWT in the country for developing a strong water transport network.

National Waterways Act 2016 – This act is one such initiative designating 106 new rivers and canals as National waterways which are to be developed for year round commercial navigability.

2.2 Project overview

Inland Waterways Authority of India (IWAI) is the nodal agency responsible for development and operation of IWT infrastructure in India. As a step towards achieving the objectives laid down by the Government, IWAI intends to develop key inland waterway routes which would boost the overall contribution of waterways in India's modal share and reduce logistics costs in key areas.

IWAI initiated the project for preparation of Detailed Project Report of 53 inland waterways (out of 106 designated waterways) in India. The project has been divided into eight clusters and FEEDBACK INFRA has been engaged for the preparation of Detailed Project Report for cluster 4 which includes the following four river stretches of Odisha:

S.No.	River Name	Total Length (km)	Length under project
1	Baitarani River	360	49
2	Birupa/Badi Genguti/ Brahmani River	799	152
3	Budha Balanga	198.75	56
4	Mahanadi	851 (494 km in Odisha)	425
5	Luna	75	75

Table 1: List of the river stretches under study

2.3 Objective of the study

Objective of present study is to explore the potential of rivers in cluster four for year round commercial navigation. To achieve this, the consultant needs to conduct a two stage study, stage-1 consisting of a feasibility Study and recommendations thereafter for a possibility of composite and integrated development of proposed waterways to achieve navigation and to develop water transport facilities in the study area. If feasibility study establishes the scope for navigation and potential to develop waterway transport facility, a Detailed Project Report needs to be prepared for identified feasible waterways and that would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

The present Draft Feasibility Report covers the review of data, reconnaissance survey, present state of affairs, traffic analysis and available navigable stretches for Birupa/Badi Genguti/Brahmani river system.

2.4 Scope

2.4.1 Scope of Work in Stage 1

Stage-I study consists of conducting feasibility study of the waterway for identifying the possibility of navigation. Broad scope of stage-1 activities are as mentioned below,

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

2.4.2 Scope of Work in Stage 2

Stage 2 study consists of preparation of detailed project report for feasible stretch of the river. Broad scope of stage 2 activities is as mentioned below:

2A. Detailed Hydrographic Survey & hydro-morphological survey

2B. Traffic Survey & Techno economic feasibility

2C. Preparation of Detailed Project Report

CHAPTER 3
APPROACH & METHODOLOGY

3 Approach & Methodology

3.1 Stage-1

To successfully deliver the project requirements, the Consultant prepared a stepwise delivery model. The approach and methodology used for Stage -1 studies are as mentioned below:

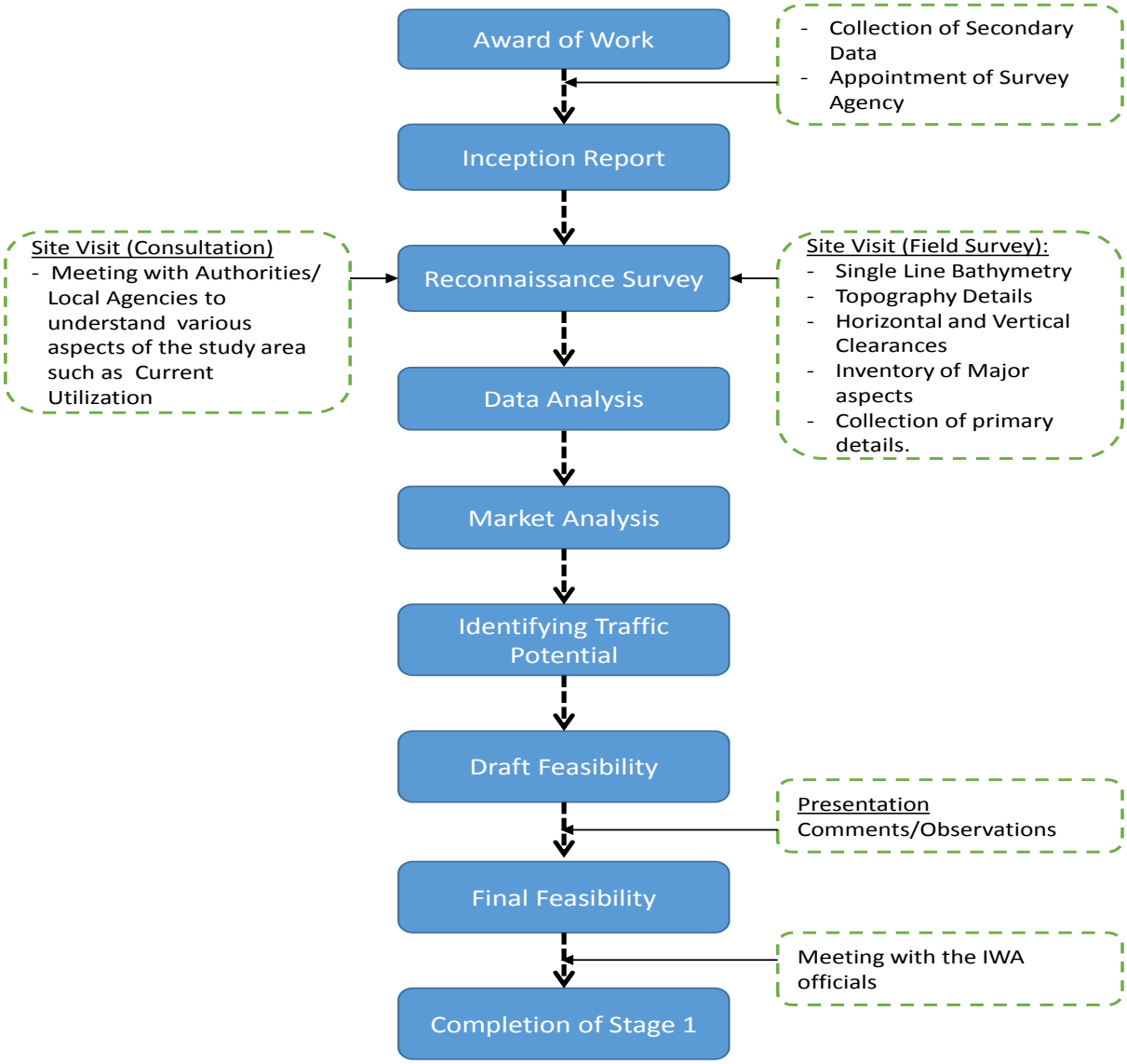


Figure 1: Stage-1 methodology flowchart

Subsequent to the award of the assignment, the consultant engaged a survey agency for the collection of the required primary and secondary data. Parallel to the submission of the Inception report, the consultant visited the site for reconnaissance survey to visually assess the present condition of the rivers and site supervision. Stakeholders were consulted in order to collect the secondary data. The data thus collected was analysed to determine the navigational feasibility of the earmarked river stretches along with the market analysis and traffic potential analysis.

CHAPTER 4
STUDY AREA PROFILE

4 Study area profile

Odisha is a state on the eastern seaboard of India, located between 17^0 49' and 22^0 36' North latitudes and between 81^0 36' and $87^0$18' East longitudes. It spreads over an area of 1, 55,707 sq. km. It is bounded by West Bengal in north-east, Bihar in the north, Madhya Pradesh in the west, Andhra Pradesh in the south and the Bay of Bengal in the east.

4.1 Physiography

On the basis of homogeneity, continuity and physiographical characteristics, Odisha has been divided into five major morphological regions: the Odisha Coastal Plain in the east, the Middle Mountainous and Highlands Region, the Central plateaus, the western rolling uplands and the major flood plains.

The Odisha Coastal Plains are the depositional landforms of recent origin and geologically belong to the post-tertiary period.

This region is the combination of several deltas of varied sizes and shapes formed by the major rivers of Odisha, such as the Subarnarekha, the Budha Balanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. Therefore, the coastal plain of Odisha is called the "Hexadeltaic region".

Middle Mountainous and Highlands Region covers about three-fourth of the entire State. Geologically it is a part of the Indian Peninsula which as a part of the ancient landmass of the Gondwanaland. The major rivers of Odisha with their tributaries have cut deep and narrow valleys. This region mostly comprises the hills and mountains of the Eastern Ghats which rise abruptly and steeply in the east and slope gently to a dissected plateau in the west running from north-east (Mayurbhanj) to north-west (Malkangirig).

The Central plateaus are mostly eroded plateaus forming the western slopes of the Eastern Ghats. The Panposh - Keonjhar -Pallahara plateau comprises the Upper Baitarani catchment basin.

The western rolling Uplands are lower in elevation than the plateaus having heights varying from 153 metres to 305 metres.

4.2 Rivers

4.2.1 River System of Odisha

The rivers of Odisha are divided into four river systems;

- Rivers with source outside the state (the Subarnarekha, the Brahmani and the Mahanadi)
- Rivers with source inside the state (the Budha Balanga, the Baitarani, the Salandi, and the Rusikulya)
- Rivers with source inside Odisha but flow through other states (the Bahudu the Vansadhara, and the Nagavali)
- Rivers with source inside Odisha, but tributary to rivers which flow through other states (the Machkund, the sileru, the Kolab and the Indravati)

4.2.2 Rivers under Study

The study area includes sections of four main river stretches namely Mahanadi, Baitarani, Brahmani, Badi Genguti, Birupa and Budha Balanga that forms part of an elaborate network of rivers flowing through the State of Odisha. Figure mentioned below shows the river stretches under study.

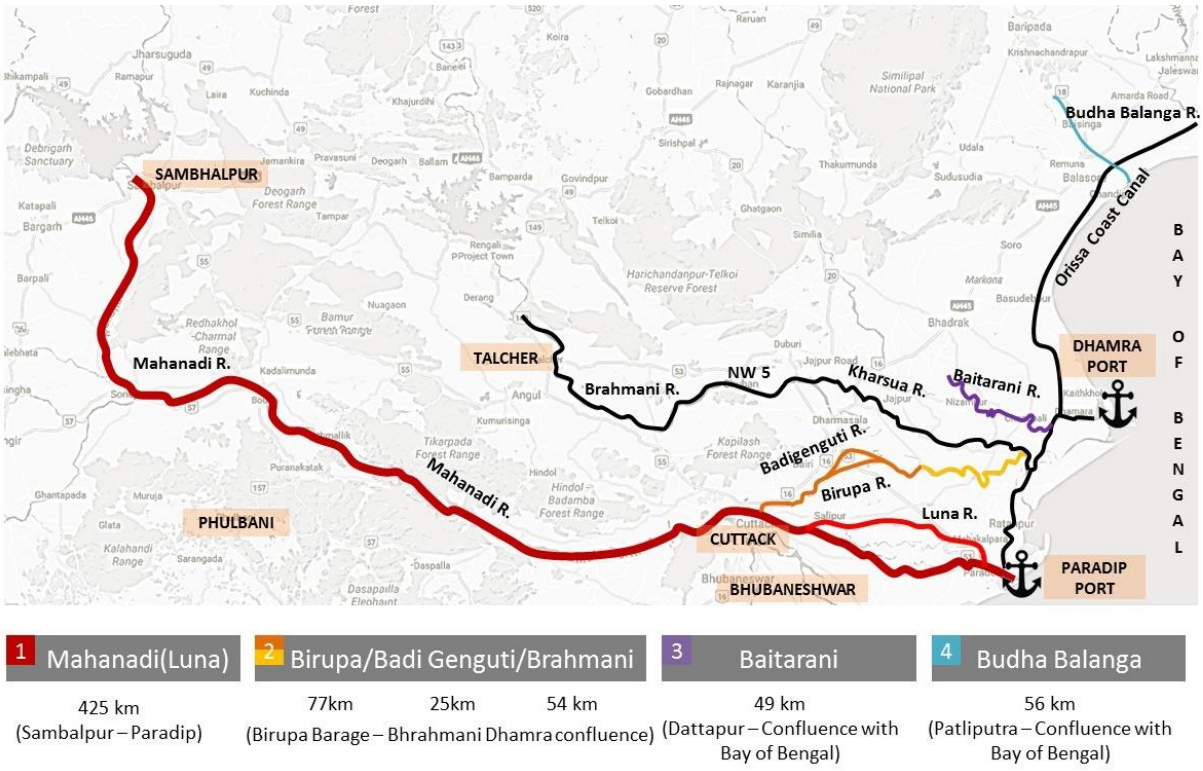


Figure 2: Rivers stretches under study

This report focuses on the review of data, reconnaissance survey, present state of affairs, traffic analysis, available navigable stretches for /Birupa/Badi Genguti/Brahmani river system.

4.2.3 Birupa/Badi Genguti/Brahmani river system

Considered as an important distributary of the Mahanadi, Birupa River originates near Cuttack and flows downstream joining the Brahmani River near Indupur in Kendrapada district. Another river called Badi Genguti branches out from Birupa at Samsarpur village and after flowing for 25 km re-joins Birupa at Kharagpur village.

Brahmani is the second largest river in Odisha. Two major rivers, the Sankh and the Koel, originate from the Chhotanagpur Plateau and join at Vedavyasa near Rourkela in Sundargarh district of Odisha to form a major river called the Brahmani. It flows through Sundargarh, Keonjhar, Dhenkanal, Cuttack and Jajpur districts in the coastal plains and enters into the Bay of Bengal at Dhamra.

Present study area consists of a 102 km stretch of the river from Birupa Barrage at Choudwar at Latitude 20°30'49.00"N, Longitude 85°55'20.17"E to confluence of Birupa & Brahmani rivers near Upperkai Pada village at Latitude 20°37'36.25"N, Longitude 86°24'19.13"E including alternative route of 25 km from Samaspur village at Latitude 20°35'40.59"N, Longitude 86° 6'31.50"E to near Kharagpur village at Latitude 20°38'27.77"N, Longitude 86°17'31.81"E. Additional 54 km length of Brahmani river from confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat

20°37'36.25"N, Long 86°24'19.13"E to Brahmani river at Katana Lat 20°39'26.28"N, Long 86°44'52.86"E has also been taken for study purpose. Figure 3 below shows the river stretches under study.

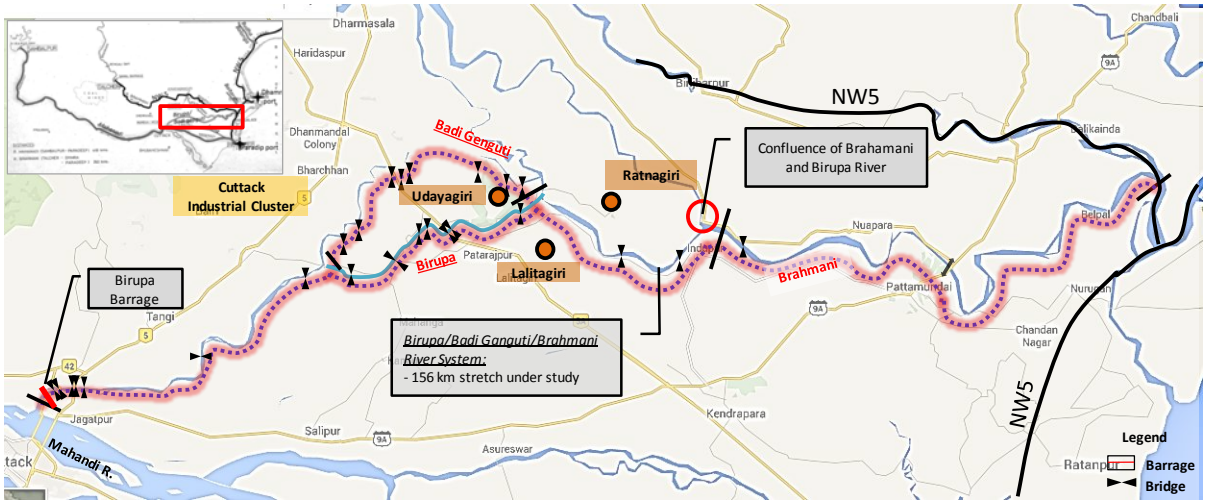


Figure 3: Birupa/Badi Genguti/Brahmani river stretches under study

4.3 Basin information of Birupa/Badi Genguti and Brahmani rivers

4.3.1 Birupa/ Badi Genguti Basin

Birupa and Badi Genguti are branches of Mahanadi and form part of Mahanadi basin. The catchment area of these rivers extends over lower part of Odisha covering districts of Kendrapara, Cuttack and Jagatsinghpur. Figure 4 shows the basin location of Briupa /Badi Genguti basin.

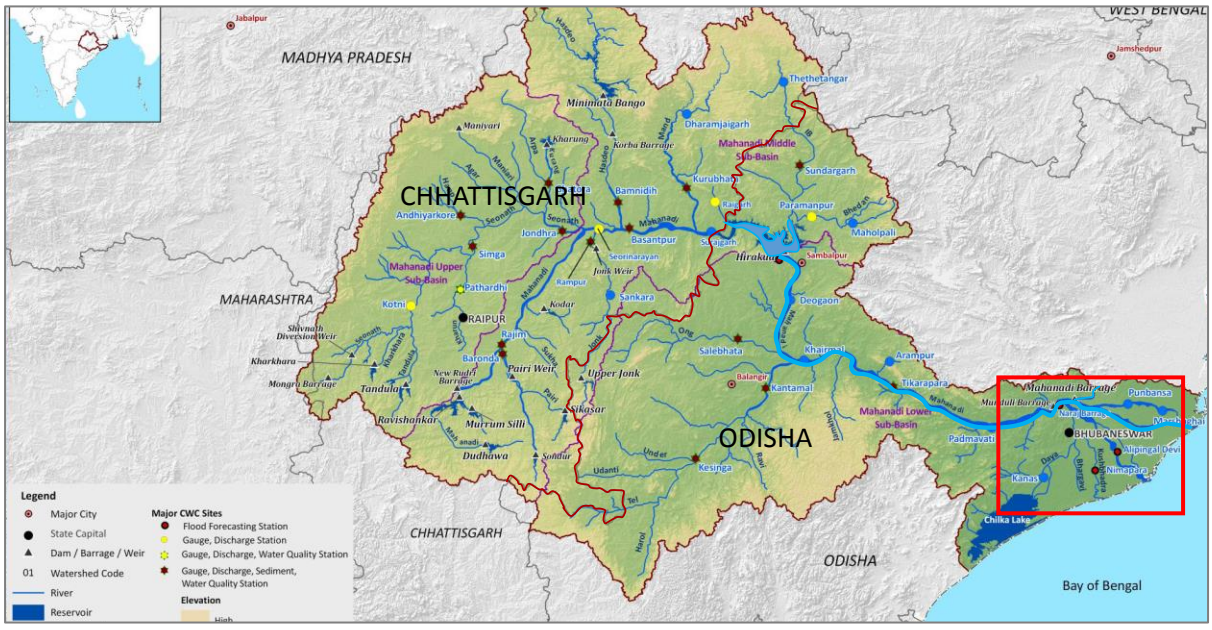


Figure 4: Map of Mahanadi Basin (Mahanadi basin report, Ministry of Water Resources)

I. Topography

The Mahanadi basin has varying topography with the lowest elevation in coastal reaches and highest elevation found in northern hills. Birupa and Badi Genguti lie in coastal plains of Lower Sub Basin of Mahanadi stretching over the districts of Cuttack, Kendrapara and Jagatsinghpur and with elevation from 10-50 m.

II. Landuse

Land use along the Birupa/Badi Genguti River

Around 50 percent of the land along the river stretches under study is being used for agricultural purpose followed by 14 percent under forest. Fallow land constitutes 5 percent of the total land available. The chart below shows the landuse pattern along the river.

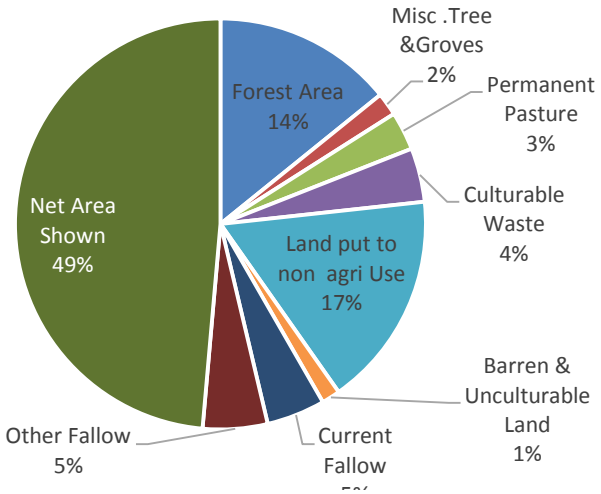


Figure 5: Chart showing landuse along Birupa/Badi Genguti study stretch

4.3.2 Brahmani River Basin

The Brahmani basin forms part of Brahmani/Baitarani river basin which is the 17th largest basin having total catchment area of 53,487 Sq.km which is nearly 1.7% of the total geographical area of the country. Out of the total area 67 percent lies within Odisha. Brahmani basin lies between Baitarani and Mahanadi basin.

River	Total Basin Area (sq.km.)	Basin Area in Odisha (sq.km.)	Districts covered
Brahmani	39,269	22,516	Sundergarh, Deogarh, Sambalpur, Anugul, Dhenkanal, Kendujhar, Jajpur and Kendrapara

Table 2: Brahmani Basin details

The basin of study stretch spreads across Jajpur and Kendrapara districts. Below mentioned figure shows the basin area covered under Brahmani river study stretch.

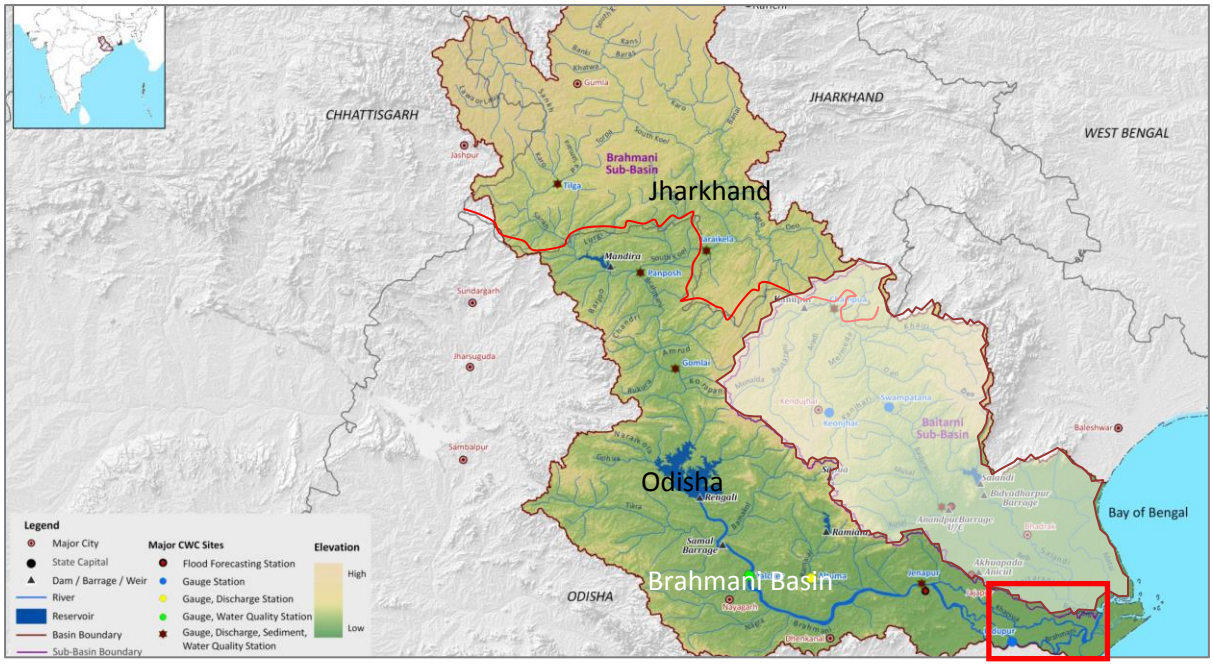


Figure 6: Map of Brahmani Basin

III. Topography

The upper parts of Brahmani river basin virtually consist of series of plateaus standing at different levels of elevation. The elevation of whole north-eastern cap of the basin is characterized by undulations and highly dissected. It slopes down towards south-east. The study stretch lies in coastal edge with nearly level and gentle slope.

IV. Landuse

Fifty Four percent of the land along the river stretch under study is being used for agricultural purpose followed by 18 percent forest area. Fallow land constitutes 5 percent of the total land available. The chart below shows the landuse pattern along the river.

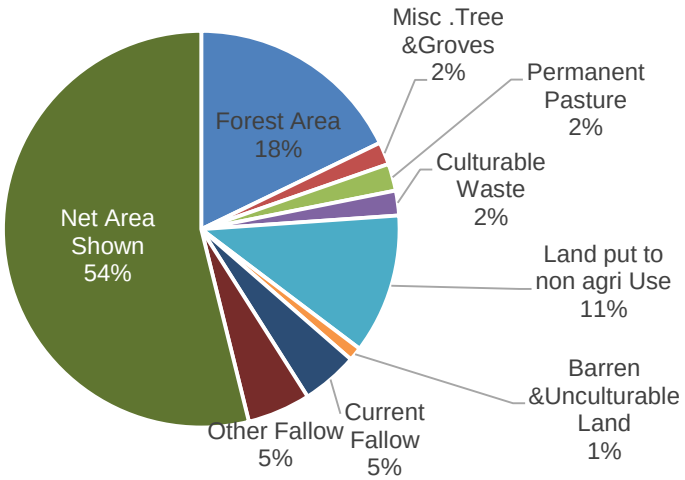


Figure 7: Chart showing landuse along Brahmani study stretch

The villages on both the banks are dependent on agriculture and the main crops grown are paddy and pulses namely black gram and ground nuts.

4.4 Climate

The state has tropical climate, characterized by high temperature, high humidity, medium to high rainfall and short and mild winters. The south-west monsoon normally sets in the first week of June in the coastal plain, and by first week of July, the whole of the state is under the full sway of the south-west monsoons. By mid-October, the south-west monsoon withdraws completely from Orissa.

4.4.1 Rainfall

The normal rainfall of the state is 1451.2 mm. About 75% to 80% of rainfall is received from June to September. The graph below shows the rainfall trend from 1961 to 2013.

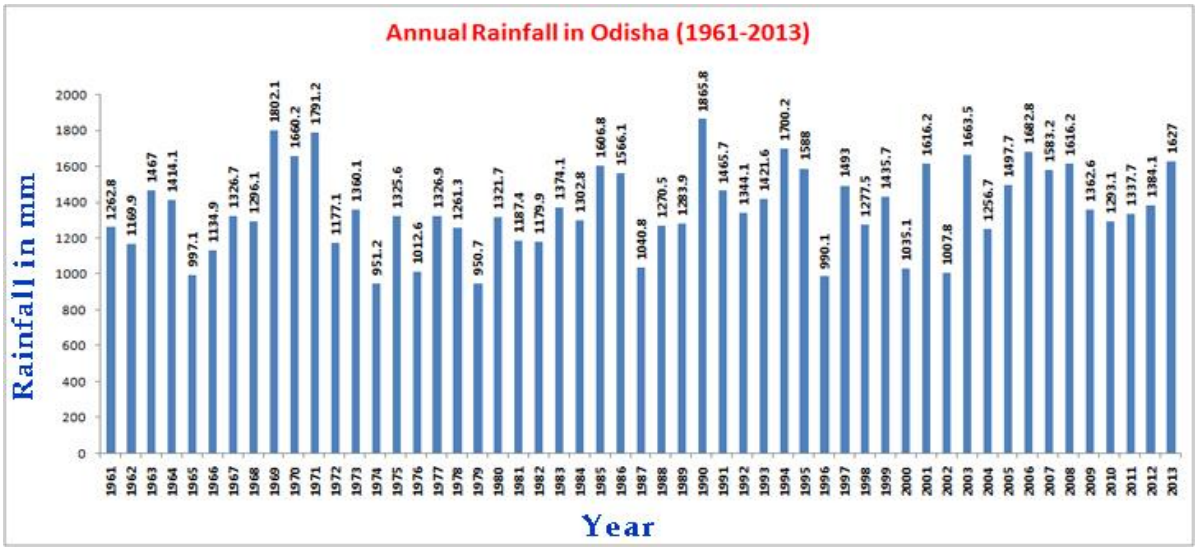


Figure 8: Rainfall trend from 1961-2013

CHAPTER 5

DATA COLLECTION AND SURVEY METHODOLOGY

5 Data Collection and Survey Methodology

5.1 Details of primary and secondary surveys for stage 1

In addition to the methodology flowcharts presented in Chapter 3, details of primary and secondary data collected for present study is as described in this chapter.

5.2 Secondary data collection

Consultant carried out secondary data collection from various stakeholders related to the waterway which included various government agencies, PSUs, Central Water Commission, etc. The list of stakeholders consulted is mentioned below.

Central Water Commission	**Pollution Control Boards**
River Boards	**Committees**
Survey of India	**Census of India**
Industry Boards	**Statistical Department**
MoEF	**MoS/ IWAI**

Table 3: List of Stakeholders to be consulted

5.3 Primary data collection (Reconnaissance survey)

As a part of the reconnaissance survey, the Consultant carried out the field surveys covering the inventory of major aspects including terrain, cross structures, existing facilities across the proposed waterways. Figure mentioned below shows the detailed flowchart of the reconnaissance survey.

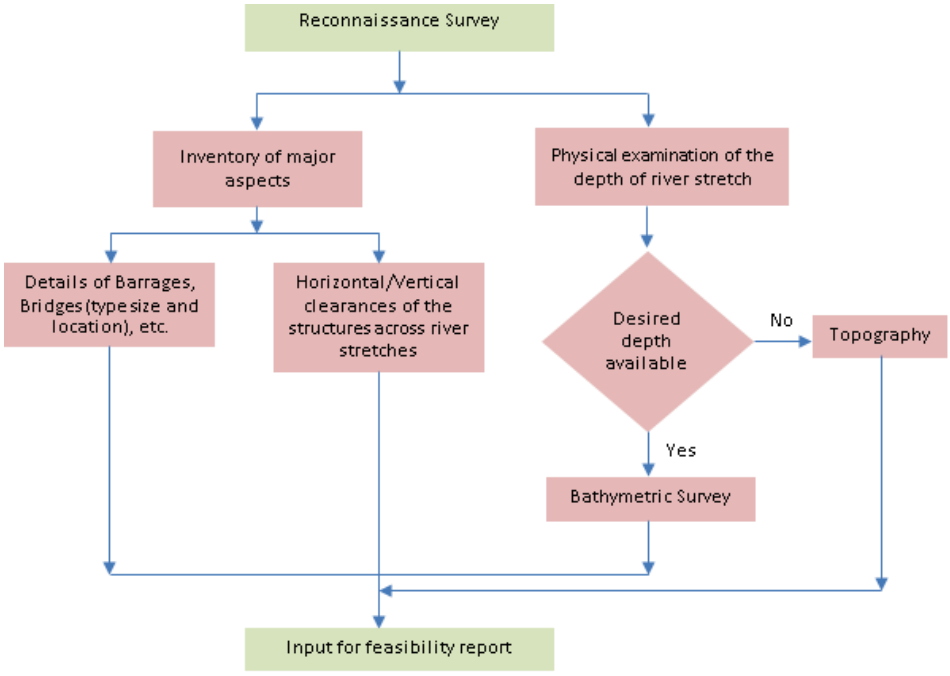


Figure 9: Flowchart showing Reconnaissance survey methodology

As a part of the reconnaissance survey, the Consultant carried out single line bathymetric/ topographic survey. In addition to the single line bathymetry, details of bridges, cross structures such as barrages, weirs, terrain details, vertical/horizontal clearances etc. were collected as part of the reconnaissance survey. External survey agency has been engaged to carry out the above mentioned reconnaissance task.

S.No.	Survey Agency	River	Total length
1	**GMI**	Birupa / Badi Genguti / Brahmani river system	156 km

Table 4 Survey agency appointed for Reconnaissance survey

The data received from the reconnaissance survey was analysed to identify the relevant river stretches for navigational potential and commercial viability.

5.4 Equipment details for reconnaissance survey

5.4.1 Bathymetric survey

The bathymetry survey was carried out using Bathy 500 portable shallow water echo sounder supported by DGPS Beacon Receiver and HYPACK data collection and processing software. The equipment was mounted on a fibre boat with safety equipment used for survey. The Bathy- 500 MF echo sounder is an electronic hydrographic survey instrument used for measuring depths with precision chart recordings and digital data output. The Bathy-500 echo sounding systems are based on the principle that when a sound signal is sent into the water it will be reflected back when it strikes an object. HYPACK survey software is used for bathymetry data collection and processing. The Echo sounder and DGPS receiver were interfaced through HYPACK software with on board PC. The position and depth will be recorded along the pre-planned transect at determined interval continuously. The bathymetry survey was conducted in the deepest route which was accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, wherever required, was taken up at lowest ground levels, which was decided on visual assessment.

Survey vessel

Locally hired survey vessel will be used for carrying out the survey. A small inflatable boat with draught of 0.2 metres is used for collecting bathymetry data.

Figure 10: Survey vessel

Position fixing

The position fixing was done by using differential global positioning system not less than 12 Channel receivers for sub-metre accuracy. Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that provides improved location accuracy.

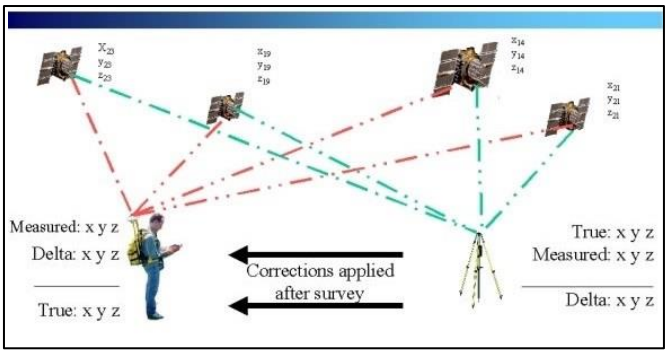


Figure 11: Position fixing using differential GPS

Other instruments

Hemisphere R110 DGPS system

For present study one Hemisphere R110 DGPS system (Receiver) will be used.

Navigation & data logging system

- To provide on-line route guidance, log navigation data, provide QC of navigation data, etc. The system comprises of the following equipment:
- One HP Laptop
- One HYPACK Version 2012 Navigation & Data Logging Software
- One Positioning & sensor interfaces
- Sufficient Paper Rolls

The survey was conducted in WGS-84 spheroid with no datum transformation.

Local Datum Geodetic Parameters	
Spheroid	WGS-84
Datum Transformation	None
Semi-major axis (a)	6378137.0000 m
Semi-minor axis (b)	6356752.3142 m
Eccentricity	0.0818 191909 28906
Inverse flattening (1/f)	298.257223563
Projection Parameters	
Grid Projection	Universal Transverse Mercator
Central Meridian (CM)	87 ° East (Zone 45)
Origin Latitude (False Lat)	0.0°
Hemisphere	North
False Easting (FE)	500000.0 m
False Northing (FN)	0.0 m
Scale Factor on CM	0.999600
Units	International Meters

Table 5: Local datum geodetic parameters

Single Beam Echo Sounder System

Single beam echo sounders are by far the most numerous sonar systems in use today. They are used on a wide range of vehicles from small pleasure boats, to huge cruise ships and tankers. They span a wide range of applications including:

- Water depth indicators, both for bottom avoidance and for navigation
- Fish finding, both sport and commercial
- Bottom classification, (rock, silt, eelgrass, etc.)
- Military, target localization
- Upward looking, for submarine ice avoidance
- Surveying, both for navigational charts and for resources exploration

Single beam sonars measure the time it takes for an acoustic pulse to travel from the sonar transducer to the bottom and back up to the sonar transducer.

The depth is given by the following equation.

$Z=t*c/2$

Where Z is the depth, t is the time, c is the average sound speed and the division by two accounts for the pulse having to travel the distance in both directions. Following are some of the instruments used for present study.

Bathy 500 dual frequency Echo Sounder

One Dual frequency transducer 33 kHz & 200 kHz + mounting bracket & base plate

Survey software (HYPACK)

Survey software was used for data collection and processing. It is integrated, first generation hydrographic survey software developed by Coastal Oceangraphical INC., USA. It works in MS Windows operating environment. The HYPACK's design program allows to import background map in CAD's DFX or Microsoft's DGN format. It enables to quickly create planned survey lines, plotting sheets and bottom coverage grids in a graphical environment. The survey tracks were planned using this software for accurate manoeuvring of the vessel and to keep the accuracy of the track. The post processing of the survey data and preparation of map were carried out using this software.

5.4.2 Topographic survey

Following are the instruments used for topographical survey

- Two Trimble SPS 855 RTK System with one Base and two Rover
- One Nikon Auto level with levelling stave
- Three Auto Level with levelling staves and tripod

Figure 12: Topographic Survey Instrument (Two Trimble SPS 855 RTK System)

CHAPTER 6
TECHNICAL ANALYSIS

6 Technical Analysis

In this section, various parameters like analysis of present state of affairs, details of single line bathymetry/topography survey, water depth details, details of bridges/cross structures, other salient features along the river, river bed profile, available navigable stretch, classification of waterways etc. are covered.

6.1 Analysis of present state of affairs

6.1.1 Birupa River

Considered as an important distributary of the Mahanadi, the river originating near Cuttack flows downstream joining the Brahmani River near Indupur in Kendrapada district. The river has a rich historical significance for coastal Orissa and tremendous religious significance since ancient times as pilgrims used to visit numerous Buddhist shrines thriving on its banks. The study stretch was surveyed from 23rd February 2016 to 27th February 2016. It was observed during survey that, there are ancient Buddhist site at three places named Lalitgiri, Ratnagiri and Udayagiri which is a pilgrimage for Buddhists. The river Birupa joins river Brahmani at position, Easting: 437828.52 and Northing: 2280692.77. Chaudwar is an industrial belt of Cuttack district and is dependent on the barrage for water intake. The famous Buddhist Complex is said to be ancient seat of Puspagiri, the Buddhist University of 7th century A.D. It was observed that cultivation land exists on either side of the bank with densely populated villages. The main cash crop of this region is paddy. There is no tidal impact in this river. The H.F.L. value of 76.18 m measured at Narrage gauge station has been taken for the study. It was observed that, sand quarries exist in this river. Since most of the water is being blocked by the barrage, very less water is available for navigation in this river. Below mentioned Figure 13 shows the river stretch under study.

Figure 13: River stretch under study - Birupa

I. Details of water Depth

Nearly, 90 percent of the river is found to have less than 1.0m of water depth when adjusted to chart datum. Stretch from Ch. 10km to 20km is found to be completely dry. However, the river bed is found to be favourable for dredging.

Chainage (km)	Draft Variation		Length of River (km)			
	Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1m	1-1.5m	1.5-2.0m	>2.0m
0-10	2.8	0	8.53	0.53	0.5	0.44
10-20	0	0	10	0	0	0
20-30	0.6	0	10	0	0	0
30-40	1.4	0	8.83	1.17	0	0
40-50	0.8	0	10	0	0	0
50-60	5	0	7.65	1.18	0.59	0.58
60-67	2.4	0	5.25	0.88	0.58	0.29
	Total		**60.26**	**3.76**	**1.67**	**1.31**

Table 6: Water Depth details of Birupa River

II. Bridge Details

Given below are the details of bridges within the study area.

S. No.	Name	Chain-age (km)	Easting	Northing	No. Of Span	Vertical Clearance (w.r.t. HFL)	Horizontal Clearance	Place
1	Birupa Barrage	0.0	387645.8	2268687.39	-	-	-	Choudwar
2	Rly Bridge	0.9	388224.02	2268572.16	15	6.0	28.5	Cuttack
3	Rly Bridge	0.9	388251.69	2268572.45	15	4.5	25.0	Cuttack
4	NH 5 Bridge	1.0	388577.66	2268604.34	16	7.0	29.5	Cuttack
5	NH 5 Bridge	1.0	388615.58	2268604.11	16	7.0	27.0	Cuttack
6	NH 5 Bridge	1.1	388640.50	2268600.72	16	7.0	28.0	Cuttack
7	Bhatimunda Bridge	12.5	398762.92	2269763.41	6	3.0	37.0	Bhatimunda
8	Dashrajpur Bridge	26.1	405900.09	2277259.49	10	2.5	27.0	Dashrajpur
9	Trivaniswar Bridge	32	408968.84	2275117.37	12	2.0	16.0	Tribeniswar
10	Kuanpala Bridge	38	413636.06	2277844.41	5	4.0	26.0	Kuanpal
11	Kusupur Bridge	43.5	417529.13	2280112.97	Under Construction			Kushupur
12	NH 5A Nanapur Bridge	44.5	418078.98	2280670.22	4	4.5	42.0	Nanapur
13	NH 5A Nanapur Bridge	44.5	418109.97	2280692.25	4	4.0	48.0	Nanapur
14	Nanpur Rly Bridge	45	418525.84	2281051.68	Under Construction			Nanpur
15	Gajendrapur Bridge	53	425561.72	2282112.67	6	8.0	32.0	Gajendrapur
16	Kampagad Bridge	57.6	429361.83	2280879.31	8	6.0	36.0	Pankagada

Table 7: Bridges across Birupa River

III. HTL/Cable Lines

Given below is the detailed account of the cross structures along the study stretch of Birupa River.

S.No.	Name	Easting	Northing	Vertical Clearance (m) w.r.t. to HFL
1	HTL	392759.23	2268549.80	12.0
2	Cable Line	402722.24	2273908.51	2.0
3	Cable Line	404253.13	2276088.98	3.0
4	HTL	408159.73	2279354.17	4.0
5	Cable Line	409054.70	2280565.40	5.0
6	Cable line	409864.29	2280906.26	5.0
7	Cable Line	409865.14	2280971.12	3.0
8	Cable Line	408673.78	2276960.30	3.5
9	HTL	409104.88	2275096.21	5.0
10	HTL	413303.70	2277192.17	5.5
11	Cable Line	414983.50	2278720.55	3.5
12	HTL	416574.32	2278667.50	5.5
13	HTL	417527.17	2280050.43	4.5
14	HTL	417896.21	2280540.52	10.0
15	HTL	418184.25	2280736.10	10.0
16	Cable Line	418240.02	2280780.85	5.0
17	HTL	418552.05	2281092.47	5.0
18	HTL	419633.18	2281033.81	5.0
19	HTL	420794.92	2280538.45	5.0
20	HTL	421254.86	2280601.39	5.0
21	HTL	424258.50	2281518.89	4.0
22	Cable Line	425556.72	2282094.32	8.0
23	HTL	425881.43	2282257.42	5.5
24	HTL	436744.64	2279416.9	5.5

Table 8: HTL/Cable lines across Birupa River

IV. Observed Islands/sand patches

In total eight islands and three sand patches were observed along the river stretch. The table below shows the details.

S.No.	Name	Easting	Northing
1	Island	388989.03	2268693.07
2	Island	396747.92	2269448.40
3	Island	398033.52	2269441.19
4	Island	398743.11	2271979.22
5	Island	399355.14	2272618.01
6	Sand Patch	405571.52	2276988.40
7	Island	432017.34	2279013.84
8	Island	432733.31	2278813.35
9	Island	434588.18	2277627.17
10	Sand Patch	435370.57	2277956.09
11	Sand Patch	436357.77	2279094.31

Table 9: Location of Islands/Sand patches along the survey stretch

V. Images of Structures across Birupa River

Given below are the images of structures across Birupa River.

Figure 14: Birupa Barrage (Ch. 0.0 km)

Figure 15: Manguli Railway bridge (Ch. 0.9 km)

Figure 16: Manguli NH5 bridge (Ch. 1.0 km)

Figure 17: Bhatamunda Bridge (Ch. 12.5 km)

Figure 18: Dashrajpur Bridge (Ch. 26.1km)

Figure 19: Triveniswar Bridge (Ch. 32.0 km)

Figure 20: Kuanpal Bridge (Ch. 38.0 km)

Figure 21: Kusupur Bridge (Ch. 43.5 km)

Figure 22: Nanapur Railway bridge (Ch. 45.0 km)

Figure 23 Gajendrapur Bridge (Ch. 53.0 km)

Figure 24 Kampagada Bridge (Ch. 57.6 km)

6.1.2 Badi Genguti

River Badi Genguti is a tributary of river Birupa and again re-joins with Birupa. The Badi Genguti River originates from Samsarpur village and re-joins the Birupa River at Kharagpur village. It is the northern portion of the stretch. This was confirmed from the locals. The survey was carried out from 25th February 2016 and 26th February 2016. It was observed that the maximum discharge of water from Birupa River passes through this stretch. The H.F.L. value of 76.18 m measured at Narrage gauge station has been taken for the study. The total distance of this river is 36 km. On either side of the banks it was found that, cultivation land exists and the main crop is paddy. There are no major industries in this stretch.

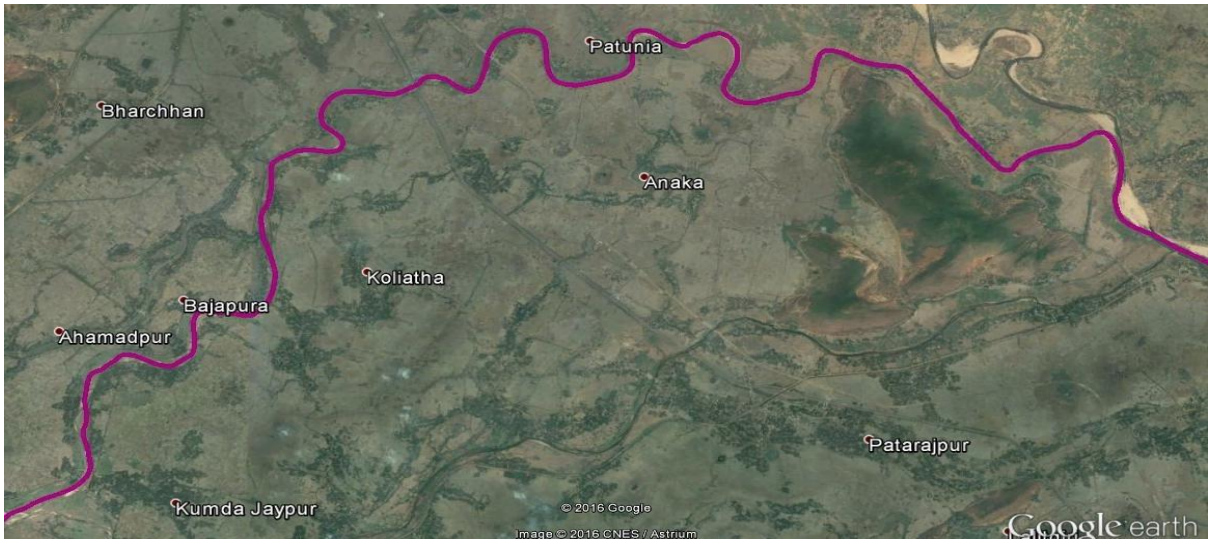


Figure 25: River stretch under study_Badi Genguti

The details of cross structures, Bridge details and river details are given in this section.

I. Details of water depth

More than 90 percent of the river stretch is found to have water depth of less than 1.0m. The details are given in the Table 10 below:

Chainage (km)	Draft Variation		Length of River (km)			
	Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1.0m	1.0-1.5m	1.5-2.0m	>2.0m
0-10	0.0	0	10	0	0	0
10-20	3.6	0	9.22	0.3	0.25	0.23
20-30	2.4	0	9.07	0.46	0.31	0.16
30-36	2.5	0	4.3	0.77	0.46	0.46
	Total		32.59	1.53	1.02	0.85

Table 10: Water Depth details of Badi Genguti River

II. Bridge Details

Given below are the details of bridges within the study area.

S.No.	Name	Chain-age (km)	Easting	Northing	No. of Span	V. Clearance (in m w.r.t. HFL)	H. Clearance (m)	Place
1	Jayapur Bridge	1.5	408211.30	2278351.58	6.0	2.0	36.0	Jayapur
2	Gopalpur/Bajpura Bridge	6.3	409866.74	2281318.85	Under Construction			Bajapur
3	Baisimauja/Radha-daipur Bridge	10.85	411305.14	2284550.80	Under Construction			Radhadaipur
4	NH5 A Bridge Benapur	14.8	413442.94	2286016.71	5.0	3.0	40.0	Benapur
5	NH5 A Benapur	14.8	413462.46	2286028.82	4.0	2.0	38.0	Benapur
6	Railwy Bridge	16.7	414740.61	2286621.66	Under Construction			Khadianga
7	Badanachipur Bridge	21.0	417256.86	2287073.87	Under Construction			Badanachipur
8	Araiikana Bridge	24.7	419419.95	2285671.35	4.0	2.5	33.0	Araiikana
9	Banapalipur Bridge	29.5	422864.12	2284864.69	3.0	3.0	28.0	Banapalipur
10	Balikuda Bridge	33.5	425351.12	2283959.07	8.0	5.0	35.0	Balikuda

Table 11: Bridges across Badi Genguti River

III. HTL/Cable Lines

Given below is the detailed account of the cross structures along the study stretch of Badi Genguti River.

S.No.	Name	Easting	Northing	V. Clearance (m) w.r.t. HFL
1	HTL	411203.96	2281922.73	5.5
2	Cable Line	411105.23	2283806.34	8.0
3	Cable Line	411208.99	2284475.68	4.0
4	HTL	411303.72	2284549.81	4.0
5	HTL	411744.19	2284668.03	5.0
6	Cable Line	412509.74	2285855.65	4.0
7	HTL	413378.39	2285885.78	5.0
8	HTL	413414.91	2286002.86	5.0

S.No.	Name	Easting	Northing	V. Clearance (m) w.r.t. HFL
9	NH 5A Benapur	413462.46	2286028.82	5.0
10	HTL	414624.20	2286089.17	7.0
11	Cable Line	415174.42	2287083.88	4.0
12	HTL	417209.18	2286552.81	4.0
13	Cable Line	417149.17	2286844.39	4.0
14	Cable Line	417770.44	2286901.48	4.5
15	HTL	418075.62	2286774.25	4.0
16	HTL	418914.72	2286307.28	4.5
17	HTL	421368.19	2286383.93	5.0
18	HTL	422874.59	2284852.36	4.0

Table 12: HTL/Cable Lines across Badi Genguti River

IV. Images of Structures across Badi Genguti

Given below are the images of structures across Badi Genguti River

Figure 26: Gopalpur Bridge (Ch 6.3 km)

Figure 27: Baishimauja Bridge (Ch 10.85 km)

Figure 28: Benapur NH 5A Bridge (Ch. 14.8km)

Figure 29: Khadianga Railway Bridge (Ch. 16.7 km)

Figure 30: Under construction Badanachhipur Bridge (Ch. 21.0km)

Figure 31: Arikana Bridge (Ch. 24.7km)

Figure 32: Banamalipur Bridge across Badi Genguti (Ch. 29.5km)

Figure 33: Balikuda Bridge across Badi Genguti (Ch. 33.5km)

6.1.3 Brahmani River

The survey area is from the confluence of river Birupa and Brahmani River near Upperkai pada village near Indupur. The basin in study area has an elevation of 5-10 m. The survey was conducted from 10th March 2016 and 11th March 2016. It was observed during the course of survey that, tidal stretch exists from Patrapur to Katana for a distance of 28 km and the H.F.L. value of 76.18 m measured at Narrage gauge station has been taken for the study. The villages on both the banks are dependent on Agriculture and the main crops grown are paddy and pulses namely black gram and ground nuts. There are no major industries lies in this stretch. It was observed that, fishing is also a major activities and revenue for the people in this stretch.

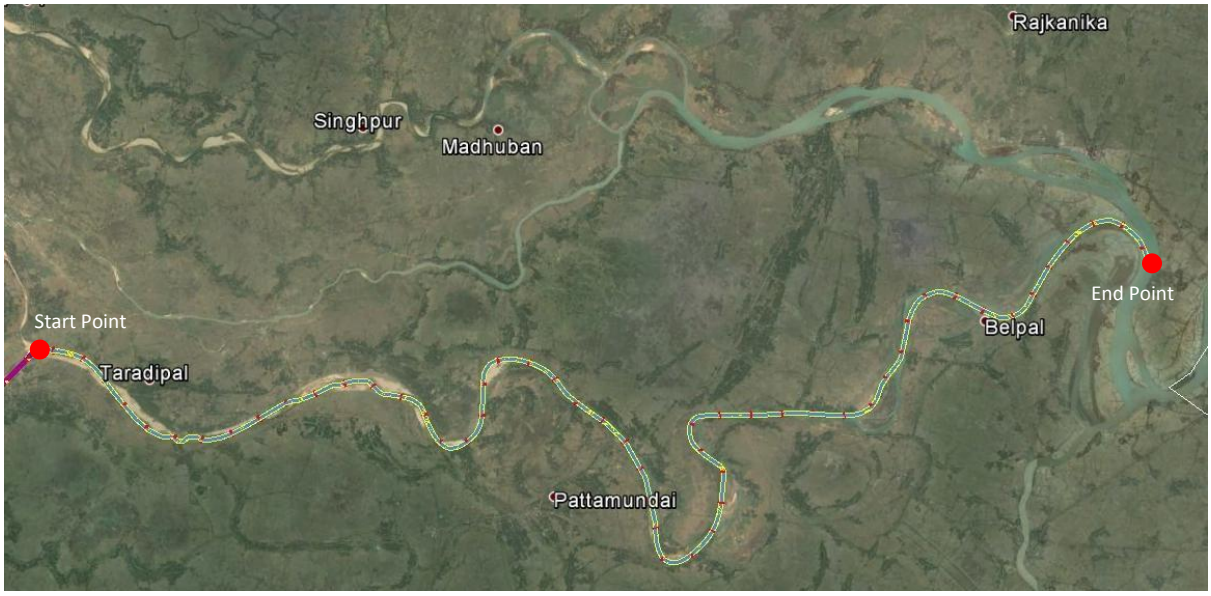


Figure 34: River stretch under study Brahmani River

I. Water Depth Details

It is observed from the survey that more than 60 percent of the river stretch has water depth of 1.5m or more. Rest of the stretch can be made navigable by technical interventions as the soil condition is favourable for dredging.

Chainage (km)	Draft Variation		Length of River (km)			
	Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1m	1-1.5m	1.5-2.0m	>2.0m
0-10	1.9	0.0	9.05	0.63	0.32	0
10-20	9.3	0.0	1.78	1.79	1.69	4.74
20-30	8.6	0.0	0.74	0.84	1.05	7.37
30-40	16.4	0.0	1.89	1.58	1.79	4.74
40-50	8.7	0.0	0.95	1.47	2.11	5.47
50-54	8.3	1.5	0.0	0.0	0.63	3.37
	Total		**14.41**	**6.31**	**7.59**	**25.69**

Table 13: Water Depth details of Brahmani River

II. Bridge Details

Given below are the details of bridges in the study area.

S.No.	Name	Chainage (km)	Easting	Northing	No Of Span	Vertical Clearances (in meters w.r.t HFL)	Horizontal Clearance (m)	Location
1	Dandisahi Bridge	10.9	446734.75	2279450.18	06	6.0	35.0	Dandisahi
2	Patrapur Bridge	26.0	457268.17	2277729.25	04	10.0	36.0	Patrapur

Table 14: Details of Bridges across Brahmani River

III. HTL/ Cable Lines

Table 15 below gives the details of HTL/Cable lines:

S.No.	Name	Easting	Northing	Vertical Clearances (m) w.r.t. HFL
1	HTL	446962.83	2279530.29	10.0
2	Electric Line	452065.66	2278146.8	9.0
3	HTL	457159.1	2277881.1	9.0
4	Electric Line	465969.19	2280919.68	4.0

Table 15: Details of HTL/Cable Lines across Brahmani River

IV. Images of Structures across Brahmani River

Given below are the images of structures across Brahmani River

Figure 35: Dandisahi Bridge (Ch. 10.9km)

Figure 36: Patrapur Bridge (Ch. 26.0km)

6.2 Reconnaissance Survey

The survey for Birupa and Badi Genguti rivers was carried from 23rd February 2016 to 27th February 2016. Brahmani River was surveyed on 10th and 11th March 2016.

Tidal influence zone and tidal range

Tidal influence zone of 28 km was observed in case of Brahmani River. Tidal range in Odisha coast varies from 2.8 m during springs to 0.7 m during neaps.

6.2.1 Establishment of CD

I. Horizontal Control

The survey boat used for the survey operations throughout the project was positioned by the Differential Global Positioning System (DGPS). Differential corrections were received continuously from the nearest existing DGLL beacons at Paradeep which are capable of transmitting corrections up to range of 250 kilometres.

The Hemisphere DGPS Receiver was used for positioning of the depths. The position correction details were received from the nearest DGLL Beacon at Paradeep Port and position data were found to be in differential mode, and in order.

For topographic survey horizontal control was carried out from IWAI benchmark BM 4 for Birupa/ Badi Genguti/Brahmani River system.

II. Vertical Control

Chart Datum (CD) at the Tidal portion:

For the Birupa, Badi Genguti, Brahmani stretch, Datum values in tidal regions, i.e, 28kms in Brahmani, soundings observed were reduced to Chart datum using real time tidal observation and applying MSL~CD value of -1.511m for the already established IWAI Bench Mark BM4 of NW5 near Paradeep river mouth. The coordinates of Chart Datum(CD) used is given below.

SL No.	Location	Easting	Northing	Z_0(m)
1	IWAI Bench Mark BM4 of NW5	473357.9	2281979	--1.511m (below MSL)

Table 16: Coordinates of Chart Datum

Chart Datum / Sounding Datum at Non- tidal region:

- As instructed by IWAI, datum value in non-tidal region was fixed as average lowest water level for a period of last six years data at Naraj obtained from IWAI.
- The datum value for in between bench marks are derived by interpolation method.

Yearly Minimum and Maximum water levels

Below table shows yearly maximum and minimum water levels at Naraj gauging site:

S.No.	Year	Maximum Water Level(m)	Minimum Water Level(m)
1	2006-2007	26.680	20.360
2	2007-2008	25.800	20.500
3	2008-2009	27.150	20.180

S.No.	Year	Maximum Water Level(m)	Minimum Water Level(m)
4	2009-2010	26.100	20.140
5	2010-2011	26.260	20.280
6	2011-2012	27.540	20.680
7	2012-2013	26.020	20.360
8	2013-2014	26.100	20.800
9	2014-2015	26.840	20.320
10	2015-2016	22.570	20.400

Table 17: Yearly minimum and maximum water levels

As per the discussion with IWAI, Sounding datum in rivers is taken as average of minimum yearly water level for last six years at Naraj gauging site. The gauge discharge data of Naraj site was collected from CWC. Accordingly, the C.D at G.D site has been arrived as below:

C.D at Naraj G.D site = (20.400+20.320+20.800+20.360+20.680+20.280)/6 = 20.473m w.r.t. MSL

A straight line was drawn joining the CD level at this gauge station with the CD level at the river estuary. Thereafter, the CD levels at every 10km stretch of the river were interpolated for computing the height of the river bed with respect to these interpolated CD levels. The BM values of Badi Genguti River was derived with reference to value of BR10 and BR7. The map below show the location of benchmarks.

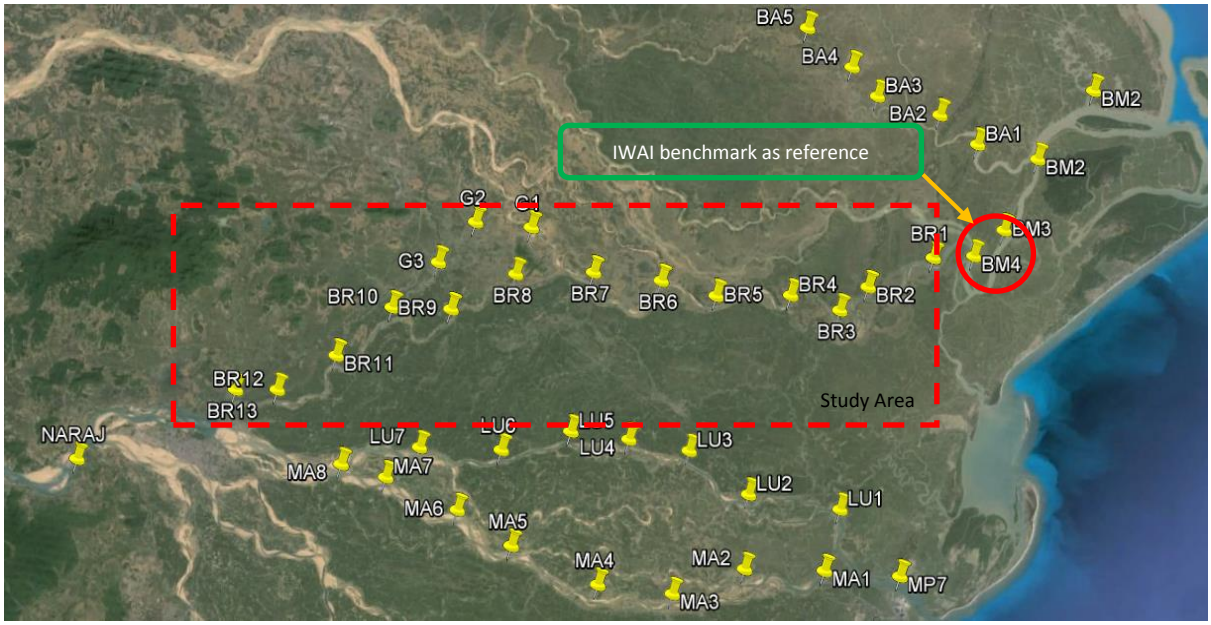


Figure 37: Bench Mark details

6.2.2 Hydrographic Surveys

A. Birupa

The survey stretch was found to have minimum depth of 0.7 m and maximum of 6.9 m. Minimum width of the water channel was found to be 12 m.

B. Badi Genguti

The survey was carried out along 25 km stretch and minimum depth of river was found to be 0.7 m and maximum depth 5.7m. Given below are the chainage wise details water depths along the stretch.

C. Brahmani

The river was surveyed from chainage zero to 54 km. The minimum depth of the river was observed at 0.7 m and minimum width observed was 30 m.

Topographic survey was not conducted along any of the stretches.

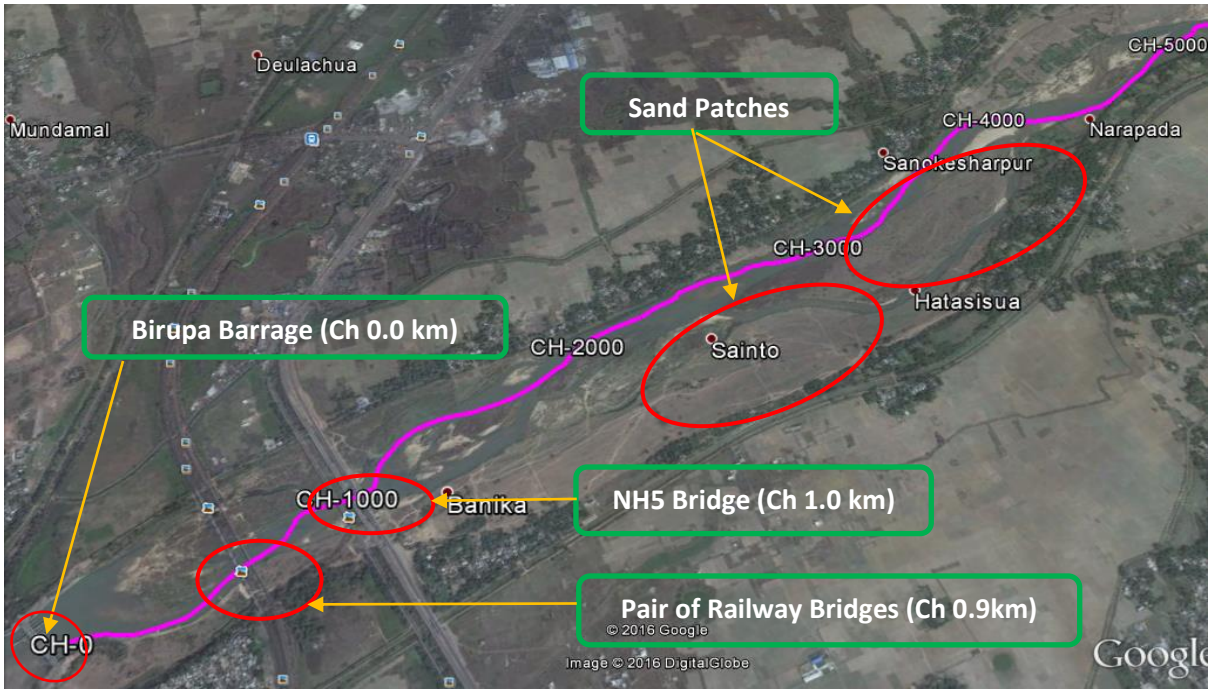
6.3 River Details

The study stretch of Birupa River starts from Ch 0.0km at Birupa Barrage and extends upto Ch 70.0km at Upperkai pada. The survey was conducted from 23rd February 2015 to 27th February 2015. The total stretch is found to be non-tidal.

6.3.1 Birupa River:

Birupa River (CH: 0km - 5km)

The survey starts at the Birupa Barrage. The survey was conducted from 23rd February 2016 to 27th February 2016. The figure below shows the stretch from Ch 0.0 km (Birupa Barrage) in Choudwar to Ch 5.0km in Naya Pada. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 5.3m. A pair of railway bridges and NH5 runs across the river at chainage 0.9 km and chainage 1.0 km respectively. The width of the river varies from 25 m to 130 m in this stretch. Sand deposits were also found at intervals.



Birupa River (CH: 5km - 10km)

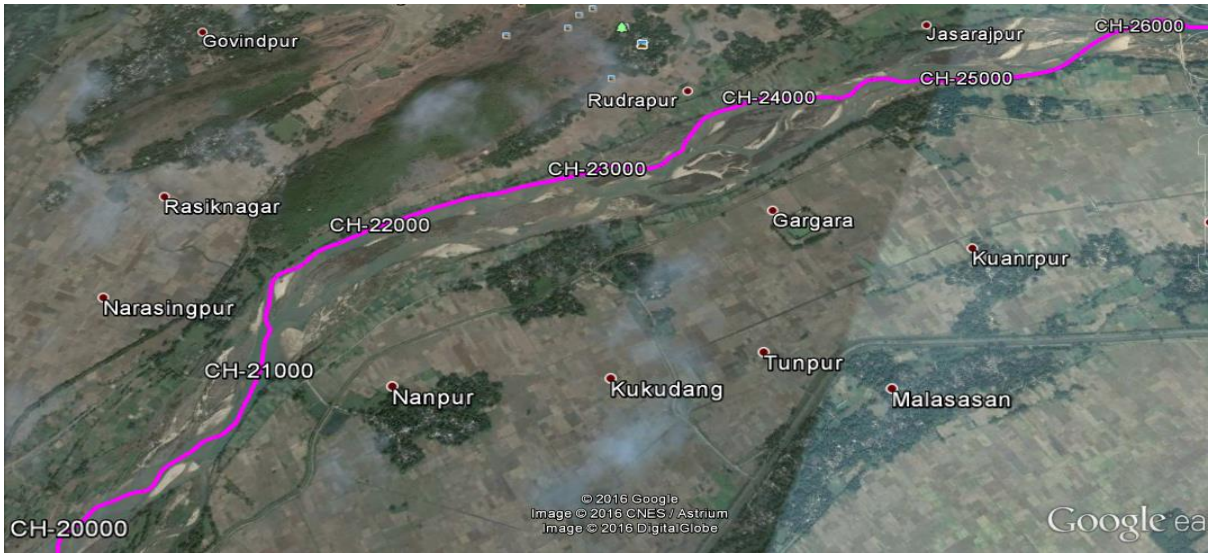
The figure below shows the section of river from Nayapada at Ch 5.0 km to Brahman Pada at Ch 10.0 km. Water depth recorded in this section varies from 0.7m to 5.3m. No cross structures were found in this section of the river. Agricultural land was found on both sides of the river. The width of the river varies from 68 m to 100 m in this stretch. Sand deposits were found at Ch 7.0 km and Ch 9.0 km.

Birupa River (CH: 10km - 20km)

This section extends from chainage 10 km in Bramhanpada to chainage 15 km in Narsinghpur. The minimum depth recorded in this section is 0.7m and the maximum recorded is 1.9m. The width of the river varies from 30m to 130m in this section. Bhatimunda Bridge crosses the river at chainage 12.5km and either side of the river stretch is found to be agricultural land. A sharp bend was found from Ch 14 km to Ch 17 km in this section of the river which as can pose difficulty for the vessels to navigate.

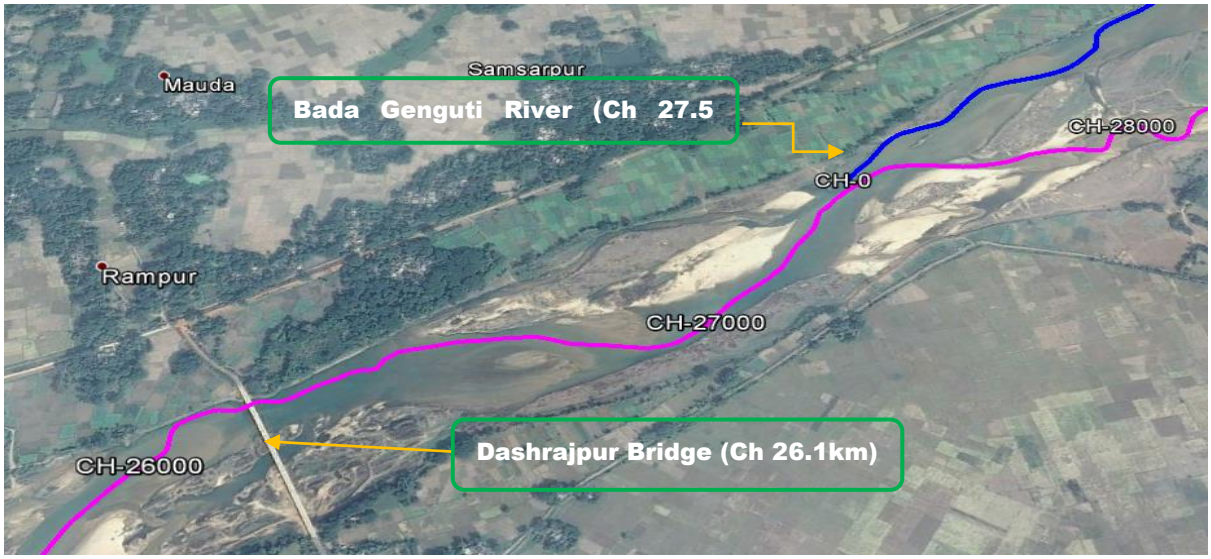
Birupa River (CH: 20 km - 26km)

This section extends at Ch 20km in Narsinghpur region to Ch 26 km in Samsarpur region. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 2.6m. The width of the river varies from 30m to 100m in this section. 2 cable line passes across the river in this section.



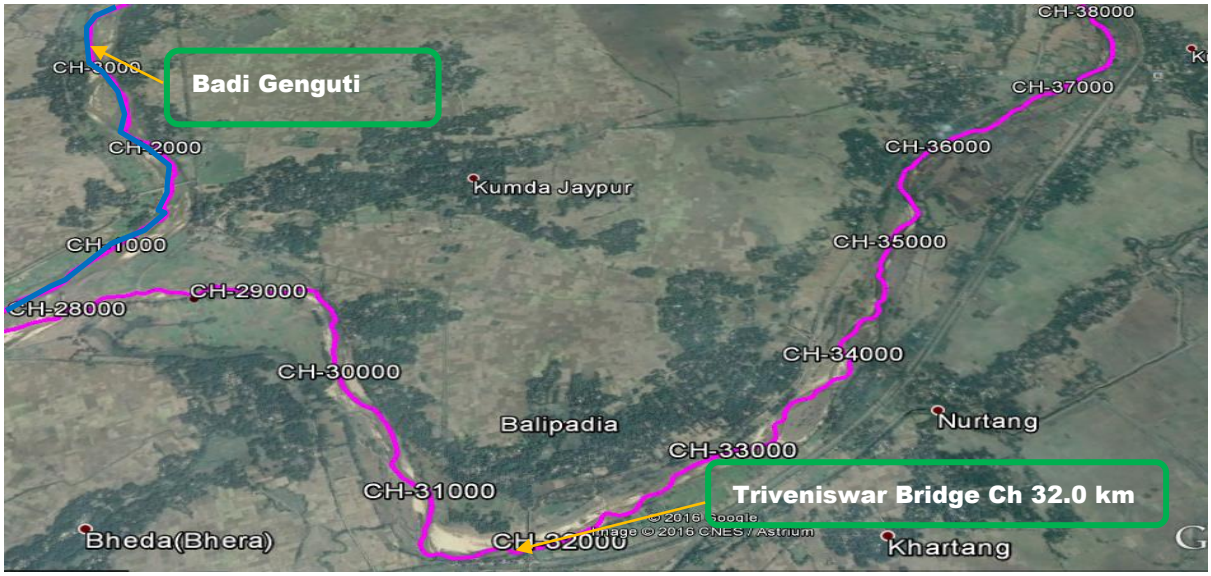
Birupa River from (CH: 26km - 28km)

Badi Genguti River starts at Ch 27.5 km at Samsarpur (blue line shown in figure below). The minimum depth recorded in this section is 0.7 m and the maximum depth recorded is 1.4 m. The width of the river varies from 50m to 100m in this section. Dashrajpur Bridge crosses the river at Ch 26.1 km and 2 cable line passes across the river at this section.



Birupa River (CH: 28km - 38km)

This section extends from Samsarpur at Ch 28.0 km to Kuanpal at Ch 38.0 km. The minimum depth recorded in this section is 0.7m with maximum depth 4.5m. The width of the river varies from 10m to 70m in this section. Triveniswar Bridge runs across the river at Ch 32.0 km, one cable line and one high tension line passes across the river at this section. A sharp bend of nearly 90 degrees was found at chainage 32 km. This can pose difficulty in navigation.

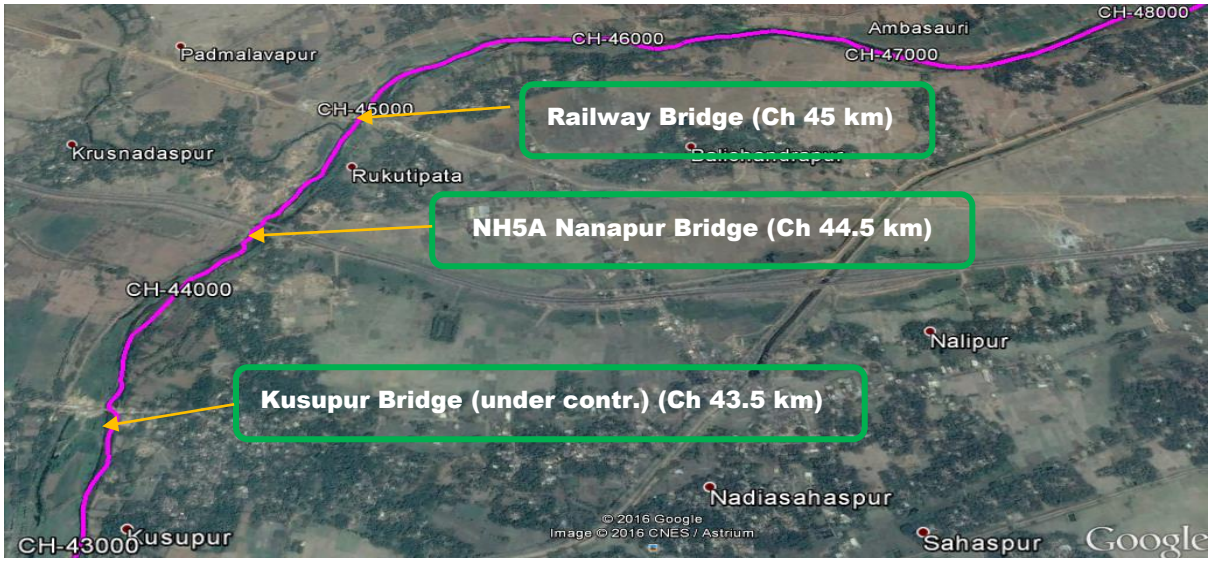


Birupa River (CH: 38km - 43km)

This section extends from Ch 38.0 km to Ch 43.0 km. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 3.2 m. The width of the river varies from 12 m to 50 m. Kaunpala bridge runs at Ch 38 km and one cable line passes across the river at this section.

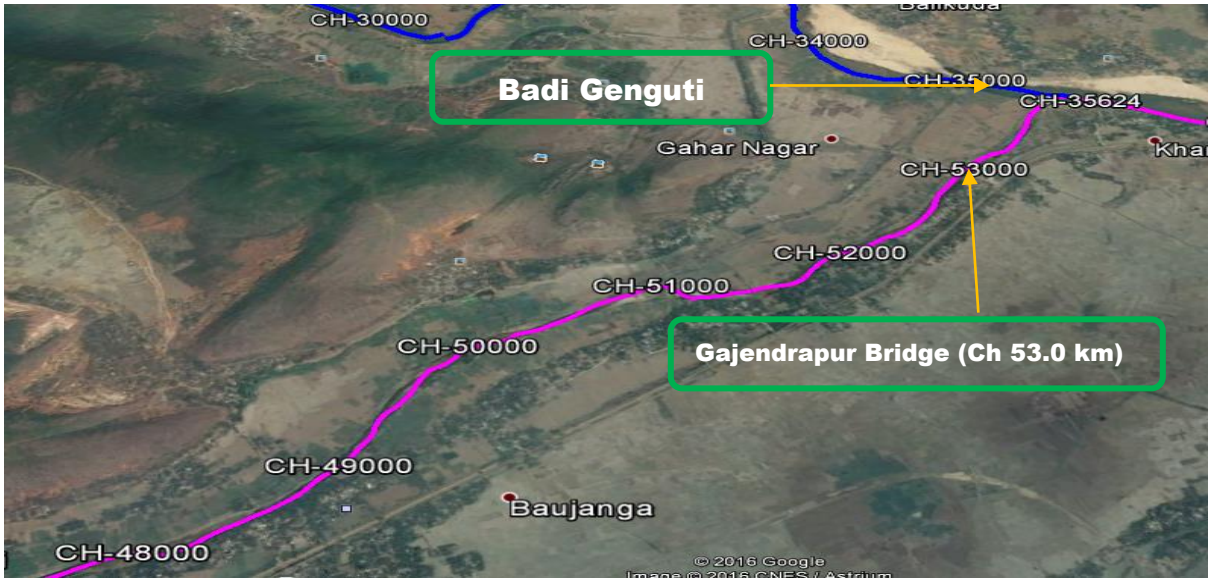
Birupa River (CH: 43km – 48km)

This section extends from Ch 43.0 km to Ch 48.0 km. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 3.2 m. The width of the river varies from 12 m to 50 m in this section. Kusupur bridge (under construction) runs at Ch 43.5km, NH 5A Bridge at Ch 44.5km, railway bridge at Ch 45 km and one cable line passes across the river at this section of Birupa River. The river in this stretch was found to have agricultural fields.



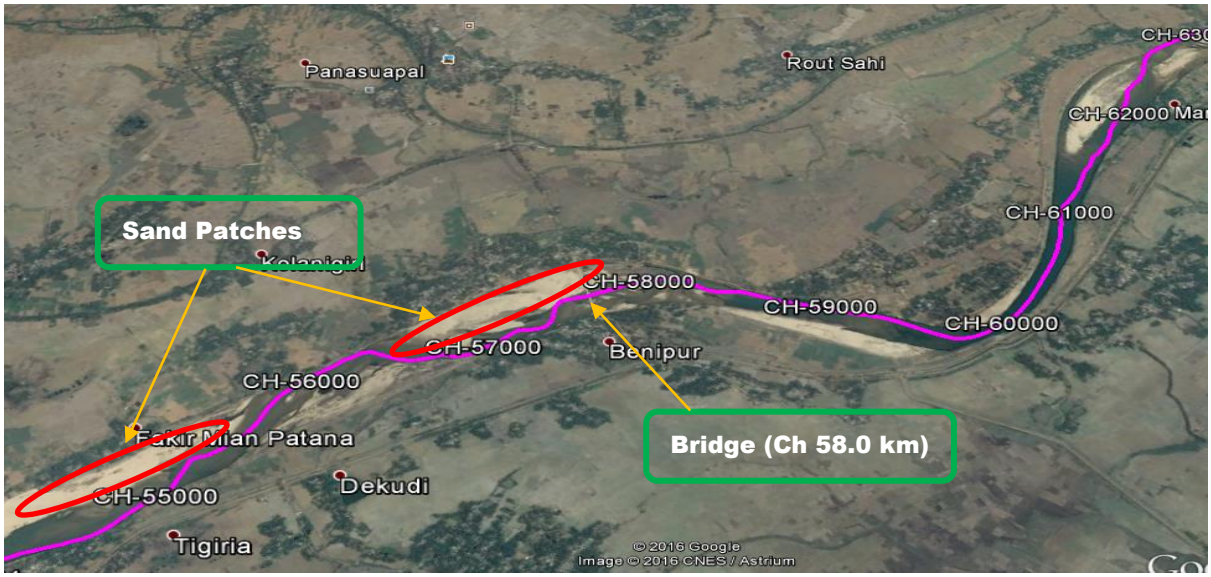
Birupa River (CH: 48km - 54km)

This section extends from Ch 48.0 km in Charinangal to Ch 54.0 km in Kharagpur. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 3.2m. The width of the river varies from 12m to 150m in this section. Gajendrapur Bridge passes across the river at Ch 53.0 km, 1 cable line and 2 High Tension line passes across the river at this section. Badi Genguti ends here at Ch 53.5 km of Birupa (shown in blue line in figure below).



Birupa River (CH: 54km - 63km)

This section extends from Ch 54.0 km in Kharagpur to Ch 63.0 km in Amathpur. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 6.9m. The width of the river varies from 23m to 170m in this section. A bridge at Ch 58.0 km, one cable line and two high tension line pass across the river at this section. Sand patches were observed at Ch 55.0 km, Ch 57.0 km and Ch 62.0 km.



Birupa River (CH: 63km - 70km)

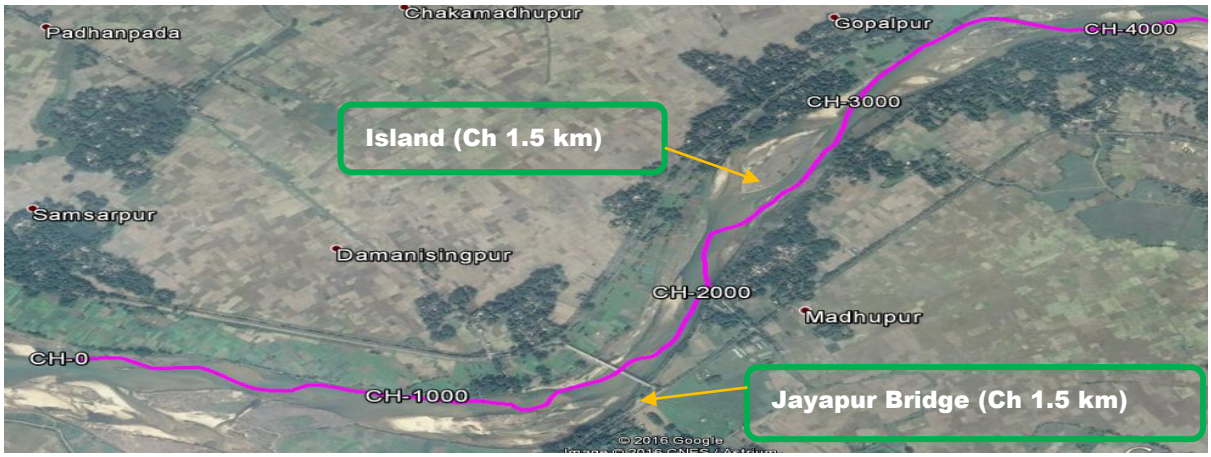
This section starts at Ch 63.0 km in Amathpur and ends at Ch 70.5 km in Upperkai Pada and here it meets Brahmani River. The minimum depth recorded in this section is 0.7m and the maximum 4.5m. The width of the river varies from 15m to 150m in this section. A bridge at Ch 68.8 km, a cable line and a high tension line runs across the river at this section. Sand bars were observed in this stretch of river.

6.3.2 Badi Genguti River:

The study stretch extends from Samarpur at Ch 0.0km where it branches out from Birupa to Pathapur at Ch 35.0km where it again meets Birupa. The survey was conducted from 25th February 2016 and 26th February 2016 and the total stretch is found to be non-tidal in nature Given below are the detailed observations of the survey.

Badi Genguti River (CH: 0km - 4km)

This section extends from Samsarpur at Ch 0.0km to Gopalpur at Ch 4.0 km. The minimum depth in this section is found to be 0.7m and maximum 2.8m. The width of the river varies from 36m to 100m in this section. Gopalpur Bridge crosses at Ch 1.5 km and a high tension line passes across the river at this section. Island was observed at Ch 2.8km and the both sides along the river is agricultural land.

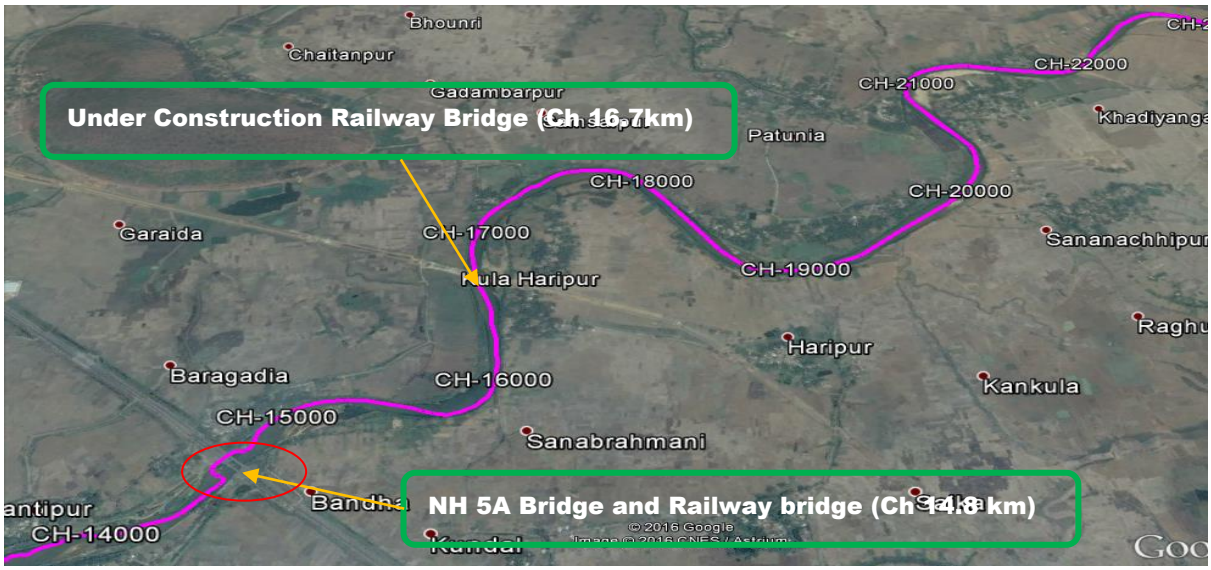


Badi Genguti River (CH: 4km - 14km)

This section extends from Ch 4.0km in Gopalpur to 14.0 km in Shantipur. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 2.9m. The width of the river varies from 15m to 80m in this section. Gopalpur Bridge at Ch 6.3km, two high tension lines and 6 cable lines pass across the river at this section.

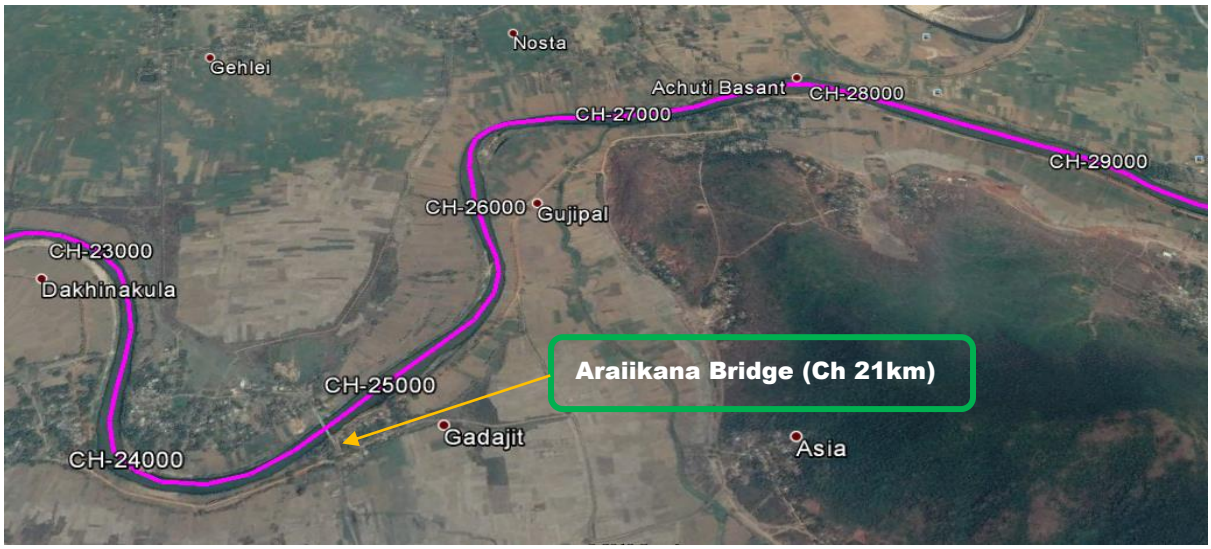
Badi Genguti River (CH: 14km - 23km)

This section extends from Shantipur (Ch 14.0 km) to Ariekana (Ch 23km). The minimum and minimum depth recorded in this section is 0.7m and 5.7m respectively. The width of the river varies from 15m to120m in this section. The section consists of NH 5A Bridge at Ch 14.8 km, an under construction railway bridge near Badanasipur at Ch 16.7km and five high tension lines and 3 cable lines passing across the river. Sharp bends were observed at Ch 16.0 km and Ch 21.0 km making it difficult for navigation at these points.



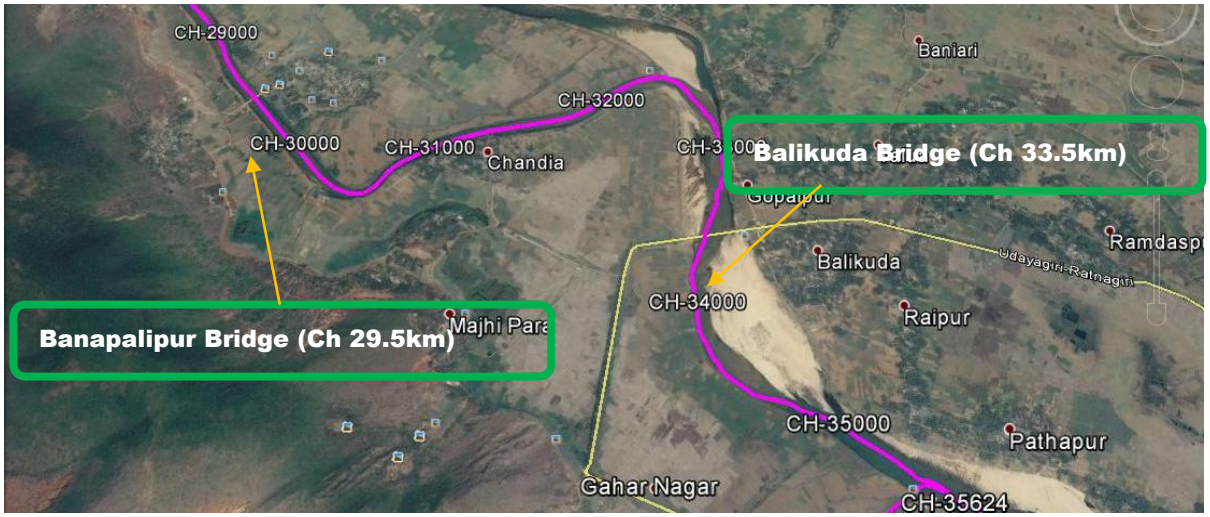
Badi Genguti River (CH: 23 km - 29 km)

This section extends from Ch 23.0 km to Ch 29.0 km. The minimum depth recorded in this section is 0.7m and the maximum 4.3m. The width of the river varies from 25m to 150m. Araiikana Bridge at Ch 21 km and 2 High Tension lines run across the river in this stretch. A sharp bend was observed at Ch 24.0 km.



Badi Genguti River (CH: 29 km – 35 km)

This section extends from Ch 29.0 km to Ch 35.0 km. The minimum and maximum depth recorded in this section is 0.7m and 4.3m respectively. The width of the river varies from 25m to 150m. Banamalipur Bridge (Ch 29.5 km) and Balikuda Bridge (Ch 33.5km) runs across the river. Banamalipur village lies to the North Badi Genguti at Ch 29.5 km. Sharp bends were also observed at Ch 30.5 km and 32.5 km.

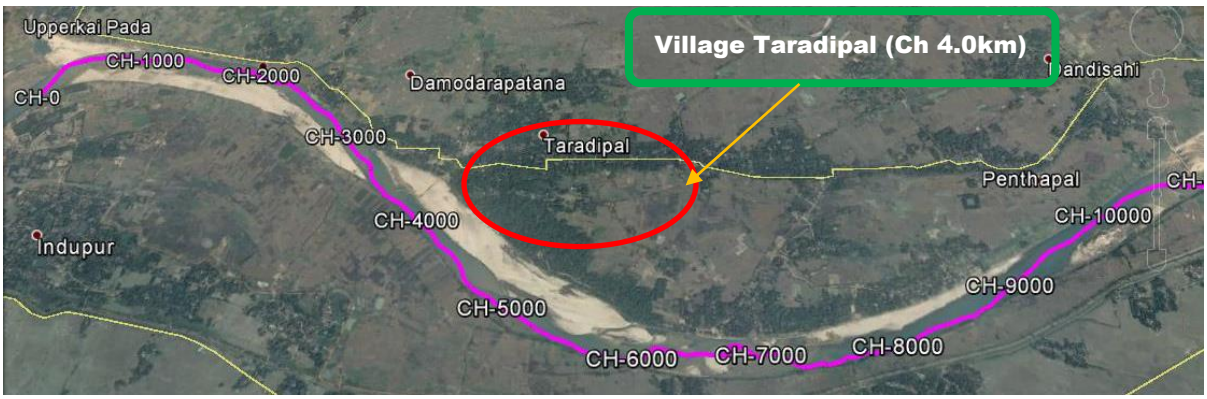


6.3.3 Brahmani River

The survey stretch extends from Upperkai Pada at Ch 0.0km to Katana at Ch 54.0km. Here the southern branch of Brahmani River meets its northern branch which also is part of National Waterway 5. The survey was conducted from 10th March 2016 and 11th March 2016. The river was found to be under the tidal influence from Ch. 28.0 km of river is under tidal influence from Karanpur at Ch 26.0km to Katana at Ch 54.0km.Given below are the detailed observations of the survey.

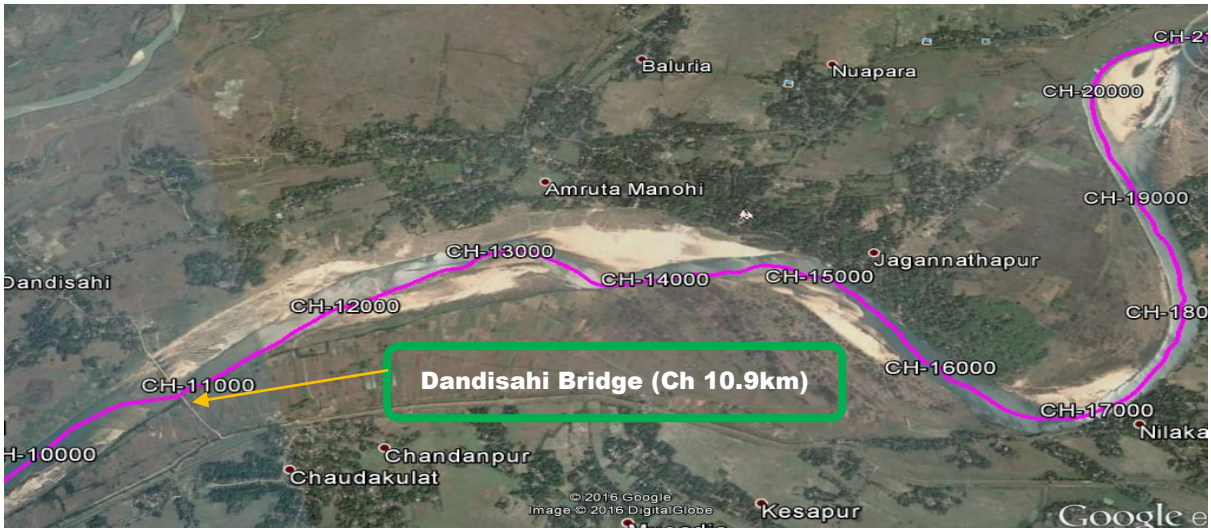
Brahmani River (CH: 0km - 10km)

This section extends from Ch 0.0 km at UppeKai Pada to Ch 10.0 km at Penthapal. The minimum depth recorded in this section is 0.7m and the maximum depth recorded is 3.6m. The width of the river varies from 50m to200m in this section. Taradipal village is located on the northern bank at Ch 4.0km.



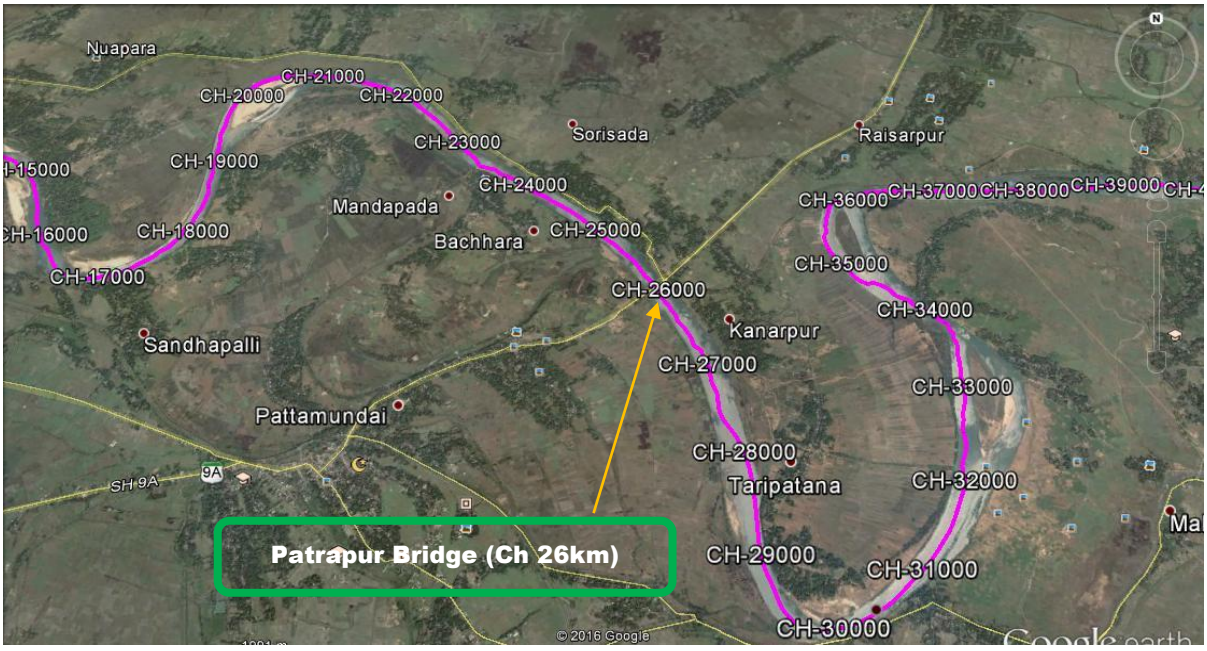
Brahmani River (CH: 10km - 20km)

This section extends from Ch 10 km at Panthapala to Ch 20 km at Gangadharpur. The minimum and maximum depth in this section is 0.7m and 10m respectively. The width of the river varies from 35m to 200m in this section. Dandisahi Bridge at Ch 10.9 km and two high tension lines pass across the river at this section.



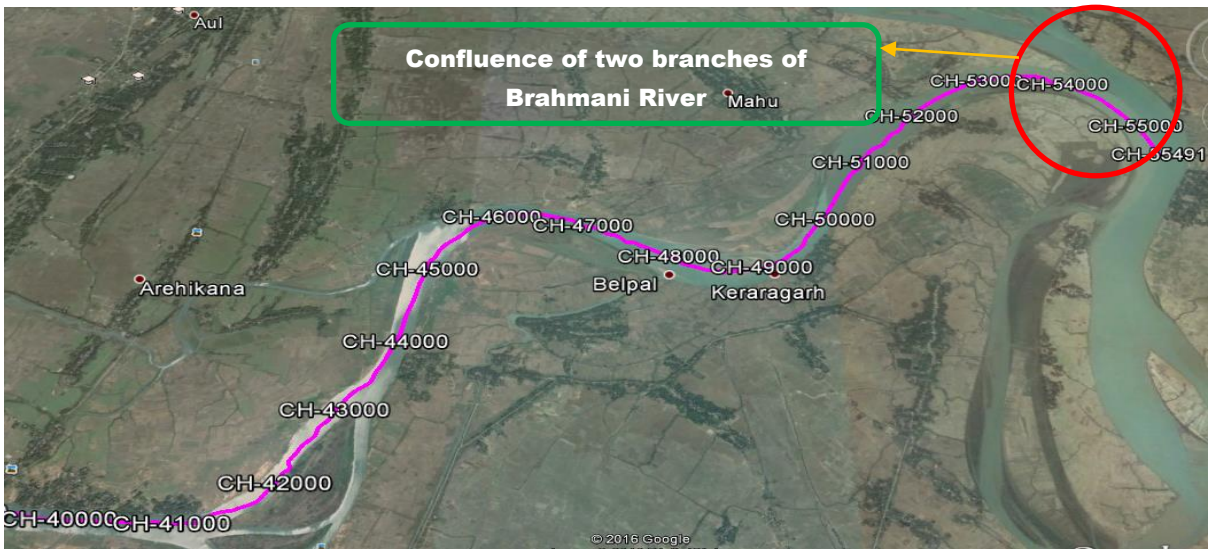
Brahmani River from (CH: 20km - 40km)

This section extends from Ch 20 km to Ch 30 km. The minimum depth recorded in this section is 0.7m and the maximum 10m. The width of the river varies from 30m to200m in this section. Patrapur Bridge at Ch 26km and an electric line runs across the river at this section. Sharp bends were observed at Ch 30.0 km and 36.0 km making the river difficult to navigate at these points.



Brahmani River from (CH: 40km - 54km)

This section extends from Ch 40 km at Manikapatana to Ch 54 km at Katana. Here the southern branch of Brahmani River meets its northern branch which also is part of National Waterway 5. The observed water depth varies from 1.6m to 10.6m. The width of the river varies from 100m to640m in this section. An electric line passes across the river at this section and land along the river is being used for agricultural purpose.



6.4 Bed Profile of Proposed Waterway

All soundings were reduced to chart datum in the area chainage vs water depth and soil texture at 100m interval is shown in Annexure-I.

6.4.1 Birupa

River bed profile is shown in Figure 38 mentioned below.

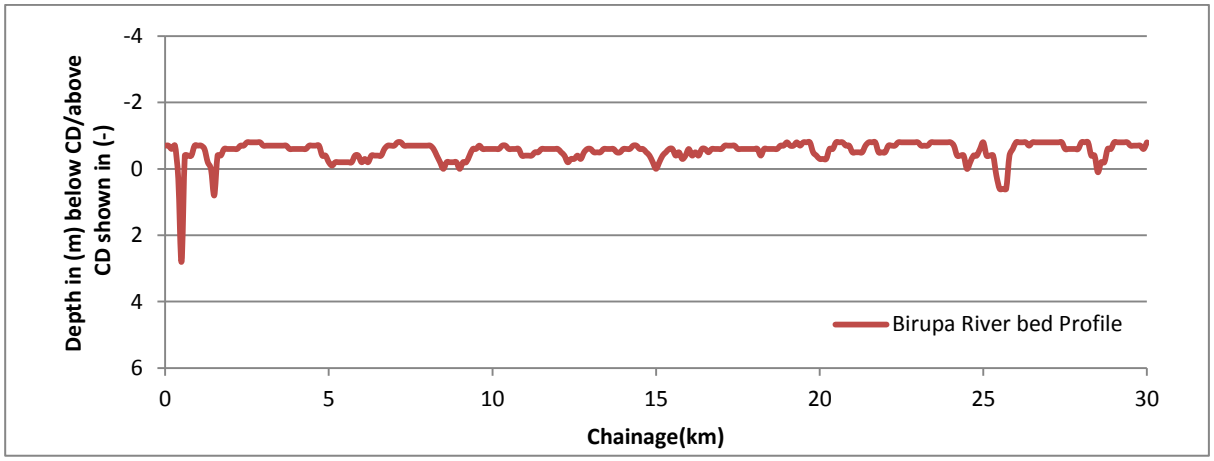


Figure 38: Longitudinal River bed profile of Birupa River (w.r.t. CD) from Chainage 0.0 km to 30.0 km

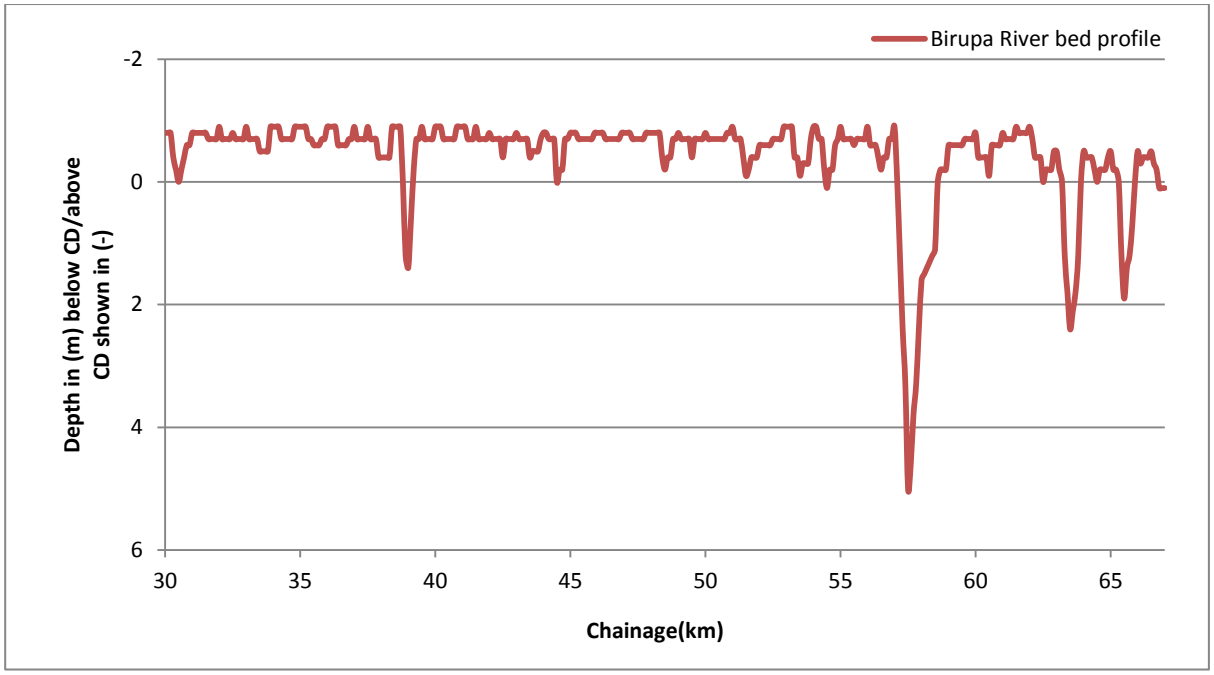


Figure 39: Longitudinal River bed profile of Birupa River (w.r.t. CD) from chain-age 30.0 km to 67.0 km

6.4.2 Badi Genguti

The observed bed profile of Badi Genguti River is presented below.

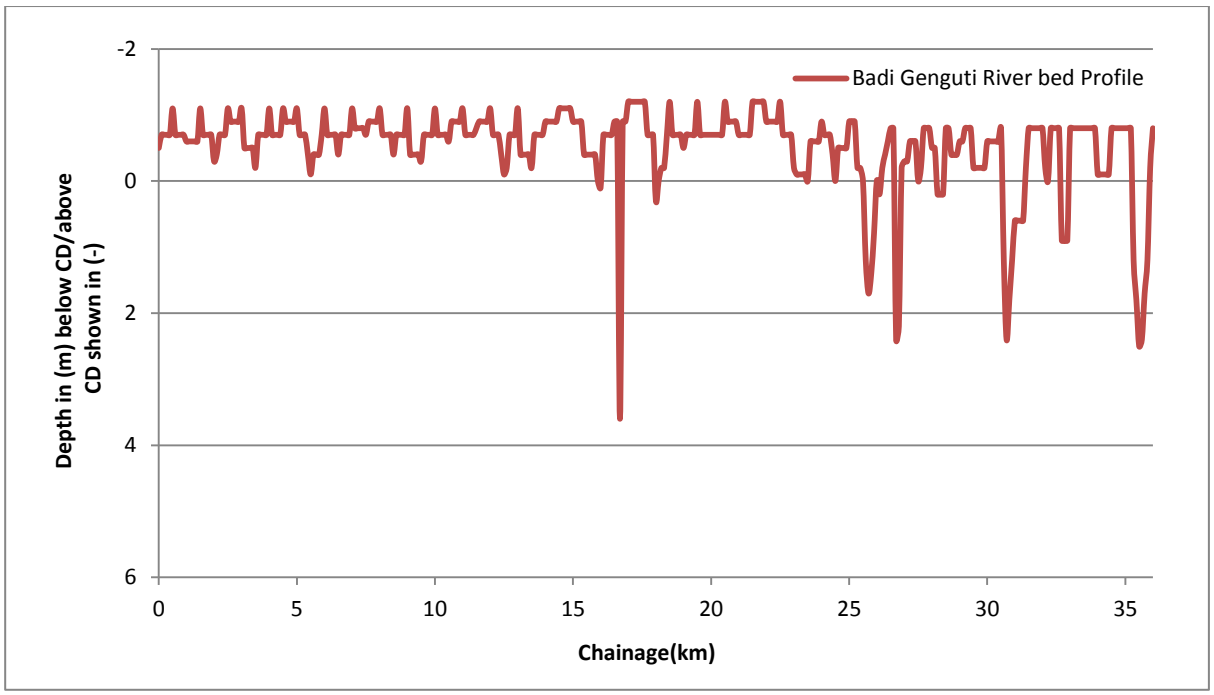


Figure 40: Longitudinal River bed profile of Badi Genguti River (w.r.t. CD) from chainage 0.0 km to 36.0 km

6.4.3 Brahmani

The observed bed profile of Brahmani river waterways are presented below mentioned in Figure 41.

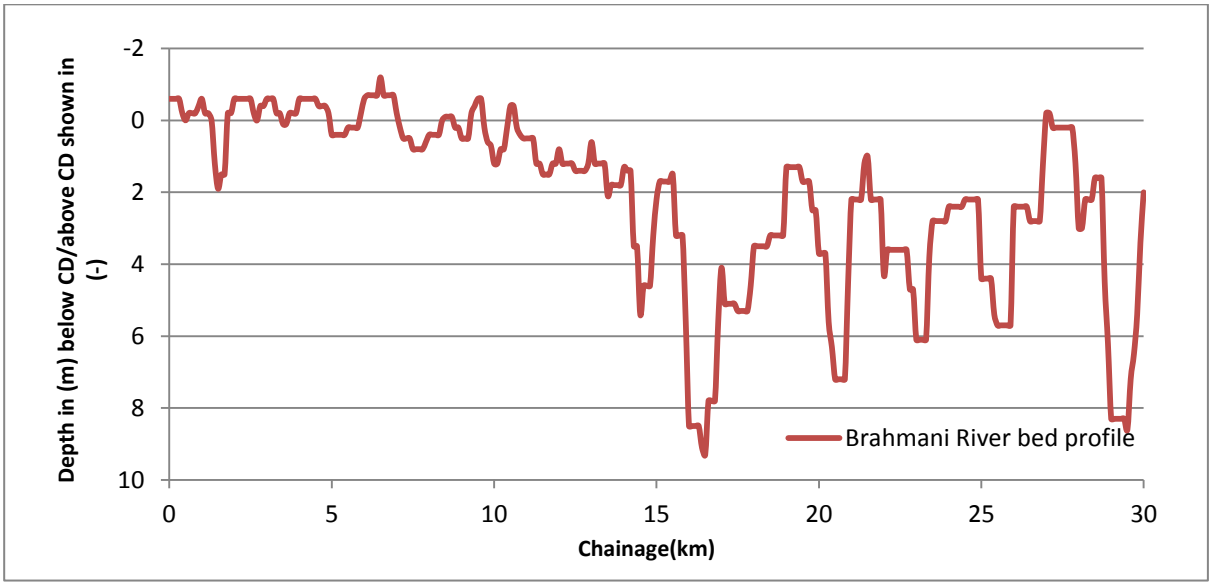


Figure 41: Longitudinal River bed profile of Brahmani River (w.r.t. to CD) from chainage 0.0 km to 30.0 km

As evident from figure below, majority of the river bed from chainage 30.0 km to chainage 54.0 km was found to be below CD.

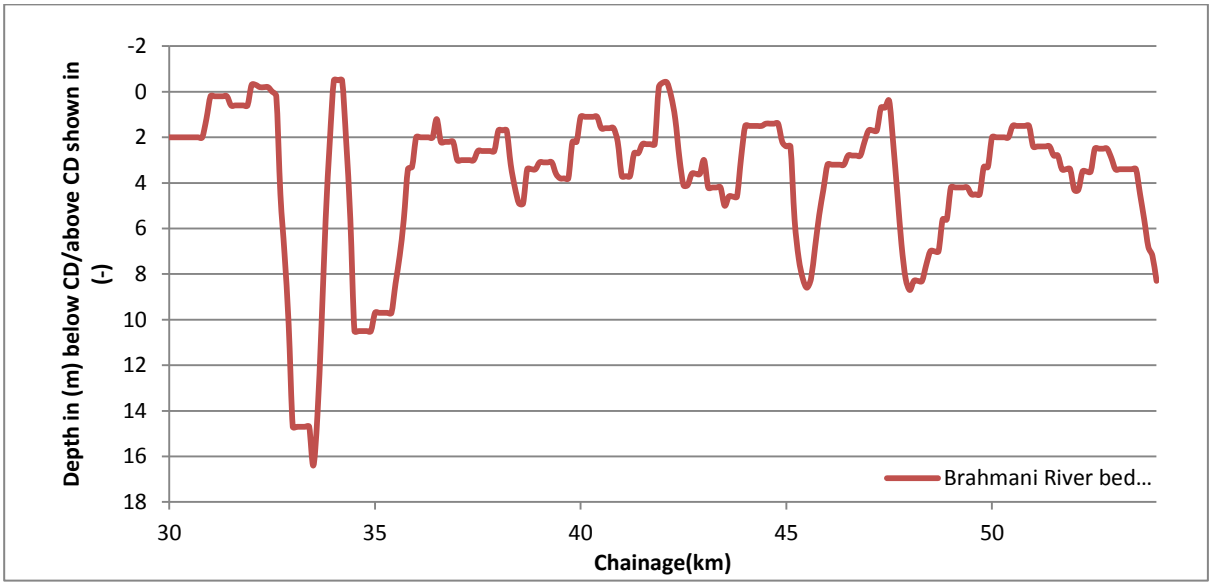


Figure 42: Longitudinal River bed profile of Brahmani River from Chainage 30.0km to 54.0km

6.5 Available Navigable Stretch

The table below shows the representation of available navigable stretch for – 1.0m, 1.5m & 2.0m LAD at chainage of 10 km along with draft variation for Birupa, Badi genguti and Brahmani Rivers under cluster IV.

6.5.1 Birupa

S.No.	Chainage (km)	Draft Variation		Length of River (km)			
		Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1m	1-1.5m	1.5-2.0m	>2.0m
1	0-10	2.8	0	8.53	0.53	0.5	0.44
2	10-20	0	0	10	0	0	0
3	20-30	0.6	0	10	0	0	0
4	30-40	1.4	0	8.83	1.17	0	0
5	40-50	0.8	0	10	0	0	0
6	50-60	5	0	7.65	1.18	0.59	0.58
7	60-67	2.4	0	5.25	0.88	0.58	0.29
		Total		60.26	3.76	1.67	1.31

Table 18: Available Navigable Stretch- Birupa River

6.5.2 Badi Genguti

S.No.	Chainage (km)	Draft Variation		Length of River (km)			
		Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1m	1-1.5m	1.5-2.0m	>2.0m
1	0-10	0.0	0	10	0	0	0
2	10-20	3.6	0	9.22	0.3	0.25	0.23
3	20-30	2.4	0	9.07	0.46	0.31	0.16
4	30-36	2.5	0	4.3	0.77	0.46	0.46
		Total		32.59	1.53	1.02	0.85

Table 19: Available navigable stretch - Badi Genguti

6.5.3 Brahmani

S.No.	Chainage (km)	Draft Variation		Length of River (Km)			
		Max. Available w.r.t. CD (m)	Min. Available w.r.t. CD (m)	<1m	1-1.5m	1.5-2.0m	>2.0m
1	**0-10**	1.9	0.0	9.05	0.63	0.32	0
2	**10-20**	9.3	0.0	1.78	1.79	1.69	4.74
3	**20-30**	8.6	0.0	0.74	0.84	1.05	7.37
4	**30-40**	16.4	0.0	1.89	1.58	1.79	4.74
5	**40-50**	8.7	0.0	0.95	1.47	2.11	5.47
6	**50-54**	8.3	1.5	0	0	0.63	3.37
			Total	14.41	6.31	7.59	25.69

Table 20: Available navigable stretch – Brahmani

6.6 Classification of Waterways

The Inland waterways in India are classified into seven categories for rivers as well as canals as per the 'The Inland waterways Authority of India Act, 1985' for safe plying of self-propelled vessels upto 2000 dead weight tonnage(DWT) and tug-barge formation in push-tow units of carrying capacity upto 8000tonnes.The classification of waterways is discussed below:

For Rivers:

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

Table 21: Classification of Inland Waterways for rivers

For Canals:

Class of Waterways	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
Class I	1.5	20	300	4	20
Class II	1.8	30	500	5	30
Class III	2.2	40	700	7	40
Class IV	2.5	50	800	10	50
Class VI	3.50	60	900	10	60

Table 22: Classification of Inland Waterways for canals

Provided that this classification shall be effective only if:

a) Minimum depth of channel should normally be available for about 330 days of the year.
b) Vertical clearance at cross structure over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway.
c) Reference level for vertical clearance in different types of channel shall be :
    i. For rivers, over Navigational High Flood Level (NHFL), which is the highest flood level at a frequency of 5% in any year over a period of last twenty years.
    ii. For tidal canals, over the highest high water level.
    iii. For other canals, over designed full supply level.

Different types of vessels can be used in different class waterways as per 'The Inland Waterways Authority of India Act, 1985'. Given below is the list of different class of waterways.

Class of Waterways	Self-propelled Vessel	Tug with barges
Class I	Carrying capacity -100DWT (Size - 32m LOA, 5m moulded breadth and 1m loaded draft)	1 Tug + 2 barges – 200DWT (Size – 80m LOA, 5m moulded breadth and 1m loaded draft)
Class II	Carrying capacity -300DWT (Size - 45m LOA, 8m moulded breadth and 1.2m loaded draft)	1 Tug + 2 barges – 600DWT (Size – 110m LOA, 8m moulded breadth and 1.2m loaded draft)
Class III	Carrying capacity -500DWT (Size - 58m LOA, 9m moulded breadth and 1.5m loaded draft)	1 Tug + 2 barges – 1000DWT (Size – 141m LOA, 9m moulded breadth and 1.5m loaded draft)
Class IV	Carrying capacity -1000DWT (Size - 70m LOA, 12m moulded breadth and 1.8m loaded draft)	1 Tug + 2 barges – 2000DWT (Size – 170m LOA, 12m moulded breadth and 1.8m loaded draft)
Class V	Carrying capacity -1000DWT (Size - 70m LOA, 12m moulded breadth and 1.8m	1 Tug + 4 barges – 4000DWT (Size – 170m LOA, 24m moulded breadth and

Class of Waterways	Self-propelled Vessel	Tug with barges
	loaded draft)	1.8m loaded draft)
Class VI	Carrying capacity -2000DWT (Size - 86m LOA, 14m moulded breadth and 2.5m loaded draft)	1 Tug + 2 barges – 4000DWT (Size – 210m LOA, 14m moulded breadth and 2.5m loaded draft)
Class VII	Carrying capacity -2000DWT (Size - 86m LOA, 14m moulded breadth and 2.5m loaded draft)	1 Tug + 4 barges – 8000DWT and above (Size – 210m LOA, 28m moulded breadth and 2.5m loaded draft or with higher dimensions)

Table 23: Types of vessels to be used in different Class waterways

All new structures to be constructed across the national waterways classified under these regulations shall conform to the respective criteria of horizontal and vertical clearances of the appropriate class of waterway as provided.

6.7 Dredging

Generally, dredging works in river areas are carried out to create depth in case of new developments and to maintain the dredged depths in the already existing developments for the safe movement of barges / vessels. Dredging quantity has been worked out for a channel width of 40m and a depth of 1.4m with a side slope of 1:5 and the preliminary dredging quantity is found to be 10 million cubic meter.

CHAPTER 7

MARKET ANALYSIS & TRAFFIC POTENTIAL

7 Market Analysis and Traffic Potential

7.1 Market Overview

Odisha has an agriculture-based economy which is in transition towards an industry and service-based economy. According to the 2011 Census of India, 61.8% of the working is engaged in agricultural activities. However, the agricultural contribution to the GSDP was 16.3% in the fiscal year 2013-14 and it was estimated to be 15.4% in 2014-15. The area under cultivation was 5,691 hectare in 2005-06 and it dropped to 5,424 hectare in 2013-14. Rice is the dominant crop in Odisha.

During 2013-14, the state exported 4.13 lakh tonnes and ₹1,800 crore worth of seafood. In 2014-15, the value of exports rose by 26% to ₹2,300 crore with 4.67 lakh tonnes being exported. Odisha is the fourth largest shrimp producing state in India.

Since the state is rich in mineral resources like bauxite, iron ore, lime stone, dolomite, chromite etc., more of mineral based industries came up. Orissa being a rich repository of major minerals like Coal, iron ore, Chromite ore, Manganese ore, Bauxite, Dolomite and lime stone etc., has become a prime destination for primary metallurgical industries.

Odisha has oldest coal mines at Talcher and Ib valley and after nationalization of coal in 1975 and the national policy on energy sector, many power plants have come up in Odisha.

7.1.1 Industrial setup of Odisha

Major industries in Odisha are concentrated in clusters of Rourkela, Kalinganagar, Jharsuguda, Angul, Dhenkanal, Cuttack, Sundargarh, Kendujhar, Khorda, Paradip and Koraput.

S. No.	Region	Type of Industries
1	Rourkela- Rajganpur	Iron & Steel, Sponge Iron, Cement, Secondary Steel melting and rooling Mill, Refractories, Chemicals and Engineering
2	Ib valley & Jharsuguda area	Thermal Power, Sponge Iron, Refractories and Coal Mines (Aluminium, Coal Washeries)
3	Sambalpur region	Thermal Power, Sponge Iron, Steel
4	Hirakud	Aluminium, Rolling Mill
5	Talchar - Angul	Thermal Power, Aluminium, Coal Washeries, Ferro Alloys, Coal Mines
6	Choudwar	Ferro Alloys, Thermal power, Pulp and Paper, Coke Oven
7	Balasore	Pulp and Paper, Ferro Alloys, Rubber Industries
8	Chandikol	Stone crusher, Coke oven
9	Duburi	Integrated Steel, Ferro Alloys, Mineral Processing
10	Paradeep	Fertilizer, Sea Food Processing, Petroleum Coke
11	Khurda- Tapang	Stone Crusher
12	Joda - Barbil	Pig Iron, Sponge Iron, Ferro Alloys, Iron Ore Crusher, Mineral Processing
13	Rayagada	Pulp and Paper, Ferro Alloys

Table 24: Region wise major industrial clusters

Location of industrial clusters is given in figure below. The clusters highlighted in red are the relevant clusters for the whole study i.e. Jharsuguda, Sambalpur and Cuttack. These clusters are situated along the waterway. For the purpose of this report, Cuttack cluster is discussed in detail.

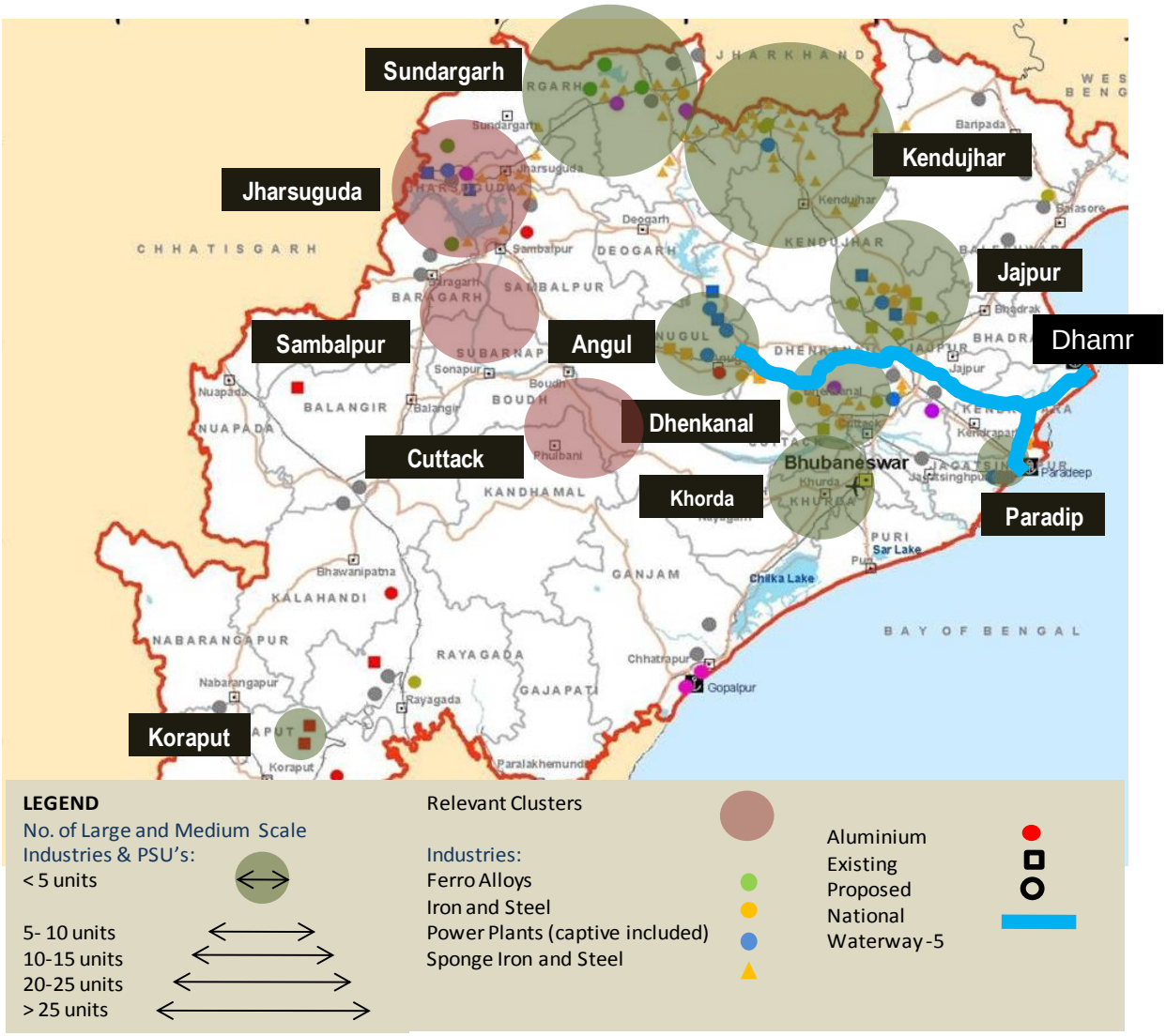


Figure 43: Industrial Clusters in Odisha

7.1.2 Existing Tourism Scenario in Odisha

Odisha is also enriched with enormous potentialities of tourism like: eco-tourism, rural tourism and agri- tourism. Day by day more and more tourists are attracted to come Odisha to witness and inculcate especially tribal culture, car festivals/ratha yatra, Konark sculpture, historical importance of Dhauli, Odishi dance, Chilika and other local festivals that strengthen the state economy as well as national economy by inflow of foreign currency.

The graph below shows the trend of tourist influx in Odisha from 2002-03 to 2011-12. Odisha has seen nearly linear growth in tourist traffic for this period.

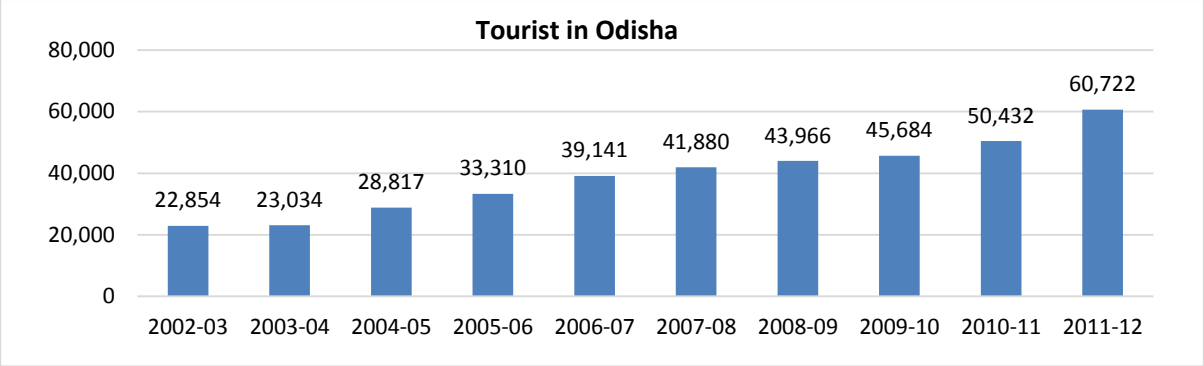


Figure 44: Tourist growth in Odisha

7.2 Market setup along the Waterway

7.2.1 Industries along the study stretch

Major industries along Birupa/Badi Genguti/ Brahmani are in Cuttack district. The type of industries includes steel, power, automobile, alloys, fireclay, etc.

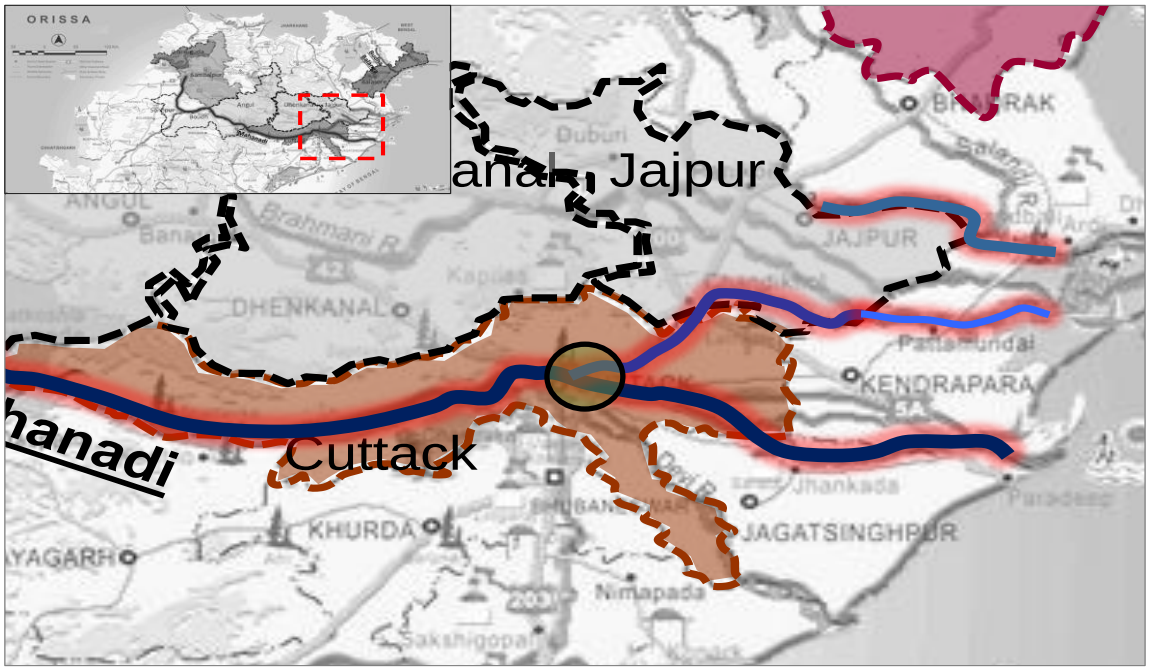


Figure 45: Industrial cluster along Birupa/Badi Genguti/Brahmani stretch

Cuttack District

Given below is the table showing industries at a glance.

S.No.	Head	Particulars (Units)
1	Registered Industrial Unit	5776
2	Total industrial unit	13126
3	Registered medium & large units	19
4	Total employment in small scale industries	78215
5	Employment in large & medium industries	2708
6	No. of industrial area	8

Table 25: Industries at a glance

There are 19 medium and large scale industries. The Table 26 below shows the existing large scale industries and PSUs with their installed capacity.

S.No.	Name of the Unit	Major Item of Production	Installed Capacity
1	Arati Steel, Athagarh	Sponge Iron	0.4 MTPA
2	Indian Charge Chrome ltd, Chaudwar	Ferro Alloys	0.1 MTPA
3	Bajrangabali Alloys pvt ltd,	Ferro Alloys	0.2 MTPA
4	Maheswary Ispat ltd, Athagarh	Ferro Alloys	0.4 MTPA
5	Raw Met Industries ltd, Athagarh	Steel	0.4 MTPA
6	OCL India ltd, Tangi captive power plant	Electricity	150 MW
7	Sri Hardev Steel pvt ltd, Athagarh	Steel	0.2 MTPA
8	Biraja Steel and Power pvt ltd, Athagarh	Steel, Electricity	2.5 MTPA, 100 MW
9	COS Board pvt ltd, Jagatpur	Paper Board and news print	
10	Purvi Bharat Coke pvt ltd, Kuspangi	Coke	
11	Badamba Sugar India ltd	Sugar and Spirit	

Table 26: Large and Medium Scale Units and PSU's in Cuttack Cluster

7.2.2 Mineral reserves along the study stretch

The direct contribution of mineral to the economy of the district is less so far as only mines of fire clay and quartz & quartzite are found in the district.

7.2.3 Agricultural scenario along the study stretch

Kharif is the main cropping season and rice is the principal crop of during kharif season. Cropping during Rabi season is mainly confined to the irrigated areas. Other important crops produced are pulses (Arhar, Mung, Biri, Kulthi), oil seeds (Groundnut, Til, Mustard and Nigar), Fibres (Jute, Mesta, Cotton), Sugarcane, Vegetables and Spices. In 2011-12, rice production in Cuttack, Jajpur and Kendrapara combined occupied 386040 Ha in the Kharif season and 8500 Ha in the Rabi season. The table below gives details of the other produces during 2011-12.

Name of the district	Rice	Other cereals	Total cereals	Total pulses	Total foodgrains	Total oilseeds	Total vegetables	Total fibres	Total Spices	Total cropped area
Cuttack	134.33	1.47	135.8	2.72	138.52	1.84	7.92	2.09	2.73	153.1
Kendrapara	132.19	0.07	132.26	0.03	132.29		8.68	2.46	1.22	144.65
Jajpur	119.52	3.06	122.58	3.7	126.28	1.78	12.98	2.46	2.01	145.51

Table 27: District wise Kharif cropped area (Birupa/Badi enguti/Brahmani) in '000 Ha

Name of the district	Rice	Other cereals	Total cereals	Total pulses	Total food grains	Total Oilseeds	Total vegetables	Total spices	Sugarcane	Total cropped area
Cuttack	4.29	0.69	4.98	111.85	116.83	15.01	17.33	4.35	3.11	278.44
Kendrapara	2.8	0.39	3.19	78.1	81.29	12.65	10.9	4.3	0.47	194.09
Jajpur	1.41	0.48	1.89	59.54	61.43	35.44	11.04	3.84	1.34	176.41

Table 28: District wise Rabi cropped area (Birupa/Badi Genguti/Brahmani) in '000 Ha

7.2.4 Tourist places along the study stretch

No major tourist spots were identified in the vicinity of present study stretch.

7.3 Rail/Road Connectivity

Industries in the districts of Jharsuguda, Sambalpur, Cuttack and Jagatsinghpur are well connected to coal and iron ore mines and to Paradip and Dhamra port via rail and road.

Rail Connectivity: Cuttack is part of the East Coast Railway zone and is well connected to various cities of Odisha such as Puri and Bhubaneswar

Paradip Port is connected by a double, electrified line section with Cuttack which connects to the Howrah Chennai Trunk Line. The 155 km Daitari- Banspani rail line is also under construction. The 78 km Haridaspur-Paradip Rail Link to provide a dedicated corridor from the Port to the iron ore mines and steel plants is also under construction.

Dhamra port has acquired a 125 meter wide corridor from Dhamra to Bhadrak which can accommodate two rail tracks and a four lane road along with service lines viz. transmission line and pipe lines. Sambalpur and Jharsuguda clusters have a well-established rail connectivity to Vizag and Gangavaram Port in Tamil Nadu.

Road Connectivity: Paradip port is connected to NH-5 through a 2-lane road up to Chandikol and 4-laning of the road is in process. The two lane SH-12 from Paradip port to Cuttack provides network between the port and the mines. Jharsuguda and Sambalpur clusters connected to Paradip port through NH 200. Dhamra port is connected to NH5 through Jamujhadi Dhamra road which is proposed to be widenen to four lanes.

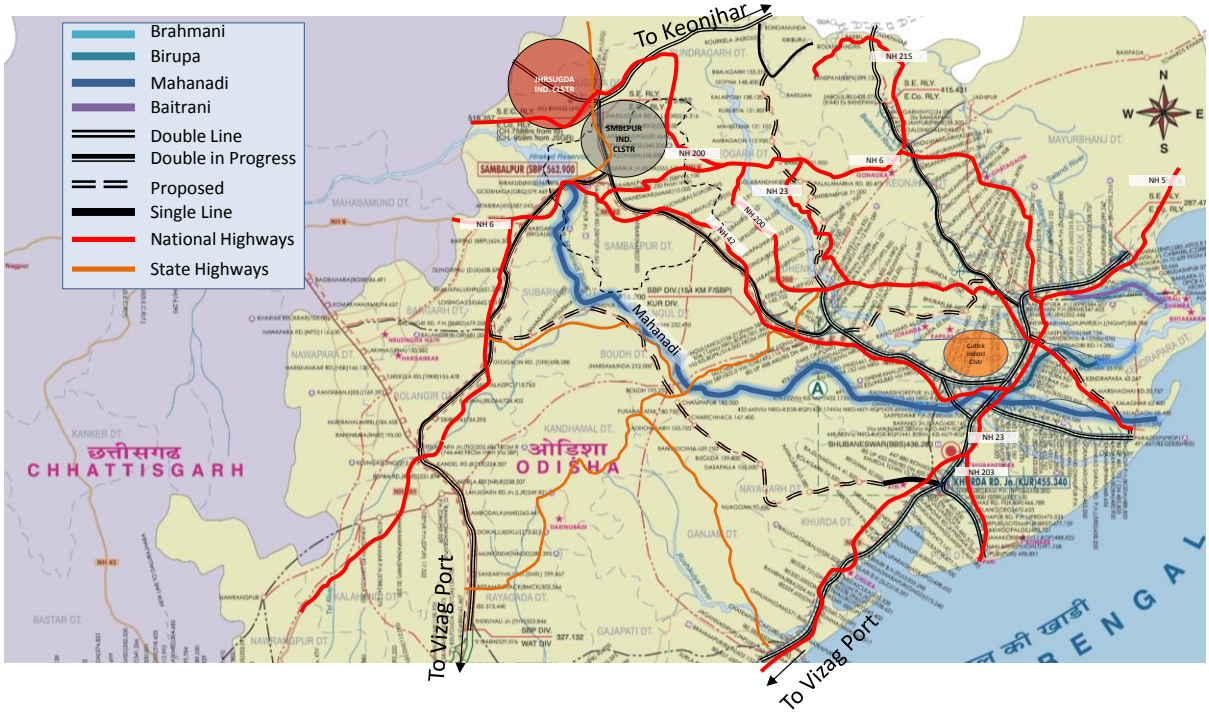


Figure 46: Rail-Road connectivity map

7.4 Traffic Potential

The **total traffic potential** in the hinterland of Birupa/Badi Genguti/Brahmani River stretches include the inbound and outbound traffic of all the industries in the Cuttack cluster , EXIM traffic at Paradip and Dhamra ports and possible passenger movement along the waterway. Of the total traffic in the region, the **relevant traffic potential** for these stretches is considered to be the portion of total traffic whose origin and/or destination points are in the vicinity of the river stretches, and whose direction of movement (or a part thereof) corresponds to the alignment of the waterway.

7.4.1 Approach & Methodology

The Consultants carried out preliminary analysis of the expected traffic for the waterway. The proposed approach and methodology has been depicted in the flowchart below

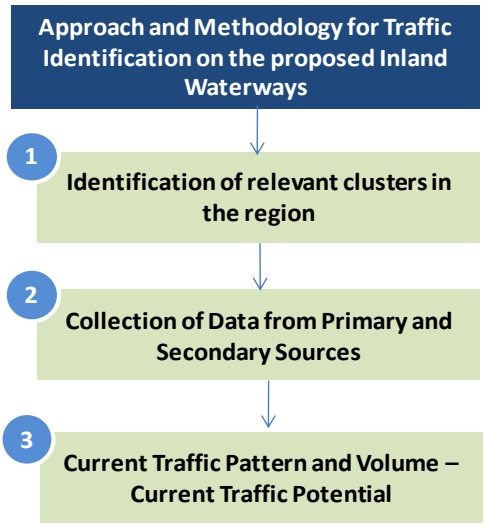


Figure 47: Flowchart showing approach and methodology for traffic identification

Each of the steps mentioned in the flowchart above have been described in detail as follows

Step 1: Identification of relevant clusters in the region

The relevant clusters include major industrial clusters and tourism locations such as temples, waterfalls, etc.

Major industries in Odisha are concentrated in the clusters of Rourkela, Jaipur, Jharsuguda, Angul, Dhenkanal, Sundargarh, Sambalpur, Cuttack, Keonjhar, Khorda, Paradip and Koraput. Out of these industrial clusters, traffic study was conducted for the relevant clusters along the waterway i.e. Angul, Dhenkanal, Jaipur, Jharsuguda Sambalpur and Cuttack. It is assumed that traffic from these clusters currently moving along the railway and roadway may shift onto the waterway. The clusters would be delineated according to district boundaries.

Odisha is also enriched with enormous potentialities of tourism like: eco-tourism, rural tourism and agri- tourism. Day by day more and more tourists are attracted to come Odisha to witness and inculcate especially tribal culture. Tourist spots along the waterway can be utilized for water tourism.

Step 2: Collection of data from primary and secondary sources

This step involves carrying out interviews with the industries like steel plants, thermal power plants and related industrial associations to get estimates on quantum of inflow of raw materials and outflow of finished products, proposed expansion plans, probability of shifting cargo from existing modes i.e. rail and road to waterways

This step also includes collection of information about the major tourist spots along the waterway. Secondary data collection for industries was carried out from related websites and review of reports like

- Brief Industrial Profile of Districts, Ministry of MSME (Ministry of Micro, Small and Medium Enterprises)
- Orissa state Economic Survey Report
- Official websites of relevant districts
- Department of Steel and Mines, Govt. of Odisha
- Orissa Power Generation Company
- National Thermal Power Corporation
- Mahanadi Coal Fields Ltd

For tourism related information, the data was collected from the following sources.

- Orrisa Tourism web portal
- District websites
- Published literature to identify tourist places along the study stretch

Step 3: Study and analysis of the current and future traffic potential

Based on the data collected from primary and secondary sources, a preliminary traffic potential was worked out.

Thermal power plants and Steel plants are likely to be the key traffic generators, considering the first cut profile of existing industrial clusters.

For steel plants, current finished product offtake would be estimated based on the installed capacity of steel plants and their current utilization levels. Assumptions like requirement of raw material per tonne of finished product would be made to estimate the raw material intake.

Similarly, coal requirement for thermal power plants would be estimated based on the installed capacity, current utilization levels and coal required per 1000 megawatt of power generated.

7.4.2 Cargo Potential

I. Existing traffic through the waterway

Presently, no cargo is moving through the study stretch.

II. Traffic potential

A. Total raw material requirement

For the purpose of stage-1 raw material requirement of the industries is taken as the prime traffic generator as its bulk nature. This type of cargo is considered to be suitable for movement through

waterway. As most of the traffic estimated through Birupa/Badi Genguti/Brahmani stretch is coming from Mahanadi, the Cargo Potential for Mahanadi and Birupa / Brahmani stretch has been collectively considered from Jharsuguda, Sambalpur and Cuttack clusters. Depending upon the presence of major type of industries, total traffic is divided into raw materials for steel and iron industry; raw material for thermal power plants; finished goods. The traffic commodities mainly include coke, coking coal, thermal coal, iron ore, chrome ore, limestone, dolomite/quartzite and finished products of steel and aluminium industry.

Odisha being rich in minerals, large number of mineral based industries have come up. The industrial clusters of Jharsuguda, Sambalpur and Cuttack accommodate thermal plants, sponge iron plants, steel industries and ferro alloy industries.

As the bulk cargo is suited for movement through waterway, Coal, Iron Ore, Limestone, Dolomite, Chrome Ore and Thermal coal qualify as the potential cargo. The raw material requirement for the industries in relevant clusters is shown in the graph below:

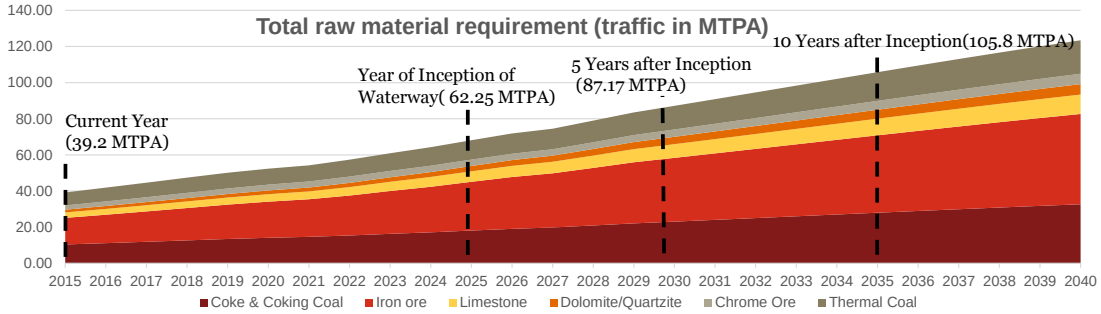


Figure 48: Total raw material requirement (traffic) [1]

In 2015, the total raw material requirement for the industries comes out to be approximately 39 MTPA. Considering 2025 as the year of operation, the total industrial requirement of raw material is estimated at 62.25 MTPA with Iron Ore requirement being highest at 26.98 MTPA.

B. Relevant traffic potential (potential cargo movement)

The cargo that has origin or destination at Paradip or Dhamra Port has been taken as 'divertible cargo' as this has the potential to be diverted from rail or road to the proposed waterway. Cargo OD patterns of the industries located in the relevant cluster were analysed using the East Coast Railways data and telephonic interviews with the industries. Coke, coking coal, Iron ore and Thermal coal are commodities found to be moving to and from ports.

The total divertible traffic for the 2015 comes out to be 13.72 MTPA. Considering 2025 as the year of inception of the waterway, the total divertible cargo is estimated at 24.10 Million tonnes per annum.

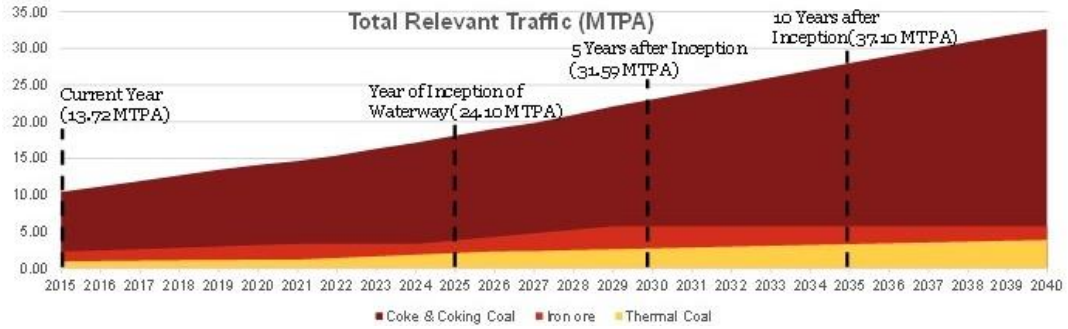


Figure 49: Potential cargo traffic

Further, cluster wise analysis reveal that Jharsuguda has the highest traffic generating potential followed by Sambalpur and Cuttack. According to 2015 figures, Jharsuguda has traffic generating potential of 6.37 Million tonnes and Sambalpur and Cuttack can generate 5.66 Million tonnes and 1.64 Million tonnes of traffic respectively.

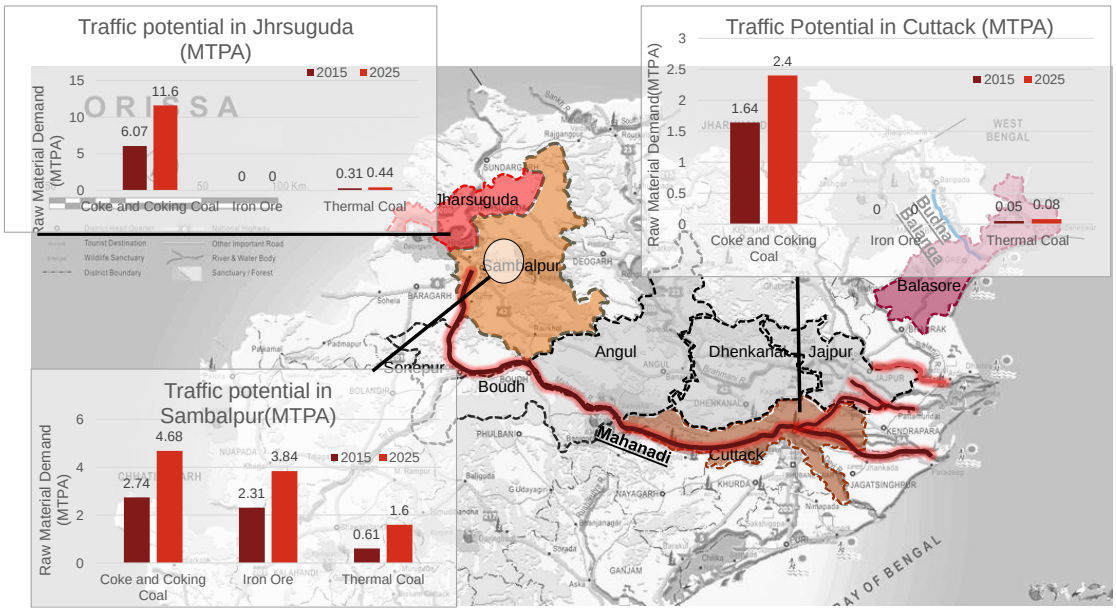


Figure 50: Cluster wise traffic potential

The estimated figures of 2025 (start of waterway operations) reveal that traffic generating potential of Jharsuguda cluster is 12 million tonnes. The figure above shows the commodity wise traffic potential for the relevant clusters.

7.4.3 Passenger traffic potential

I. Existing passenger movement through the waterway

The waterway is not being utilized for any passenger movement.

II. Traffic potential

The following water based tourism options have been explored, and suitable ones then narrowed upon, considering the catchment area and current tourist profile

- River Cruise
- Riverfront development
- Riverside Wildlife sanctuaries

- Waterfalls

As there are no major passenger generation points along the study stretch, potential for passenger movement may not be established. This needs to be further studied in stage 2 of the study.

7.5 Summary

The table below shows the relevant traffic potential for the discussed river stretch.

Name of the River	Relevant Clusters (District)	Type of Industries	Potential commodities (anchor commodity)	Total raw material requirement (MTPA)		Relevant Traffic (Potential in MTPA)	
				2015	2025	2015	2025
Mahanadi/ Luna/Birupa/ Brahmani	Jharsuguda	Thermal Plants, Sponge Iron, Steel, Ferro Alloys	Coking coal and Coke	10.45	18.14	10.45	18.14
	Sambalpur		Iron Ore	14.72	26.98	2.31	3.84
			Limestone	3.00	5.80	--	--
			Dolomite	1.52	2.95	--	--
			Chrome Ore	2.37	3.52	--	--
	Cuttack		Thermal Coal (Imported)	0.97	2.12	0.97	2.12
			Thermal coal (Domestic)	6.19	8.63	--	--
			Total	**39.2**	**62.25**	**13.72**	**24.10**

Table 29: Summary of Traffic potential

CHAPTER 8
SWOT ANALYSIS

8 SWOT analysis of proposed waterway

8.1 Birupa/Badi Genguti/Brahmani River system

	Helpful	Harmful
Internal	*STRENGTHS* - Traffic from Sambalpur through Mahanadi can be routed to this river system and connectivity to NW-5 can be achieved.	*WEAKNESSES* - Slower than other modes of transport - Birupa, the main river branching from Mahanadi has maximum no. of cross structures compared to any other stretch.
External	*OPPORTUNITIES* - Location of the stretch can act as an opportunity to attract traffic - Lesser transport cost can make industries shift to this mode - This can also be used as a dedicated transport corridor for small industries - Connectivity to NW-5 and Dhamra port	*THREATS* - Shift to waterway may require strong driving force because of well-connected railway network available. - Maintenance dredging will be more at Brahmani as river is close to mouth of sea. - Increase in irrigational requirement may affect the water levels - Constraints in navigation in terms of size of the barges due to cross structures

Figure 51: SWOT Analysis

CHAPTER 9
OBSERVATIONS & SUGGESTIONS

9 Observations and Suggestions

9.1 Observations

River	Waterway	Length	Cross Structures	Cargo/Passenger/ Tourism/RO RO
Birupa/Badi Genguti/Brahmani	The river stretches are found to be without any show stoppers such as rapids, waterfalls and rocky strata. Out of three river stretches, only Brahmani is found to be under tidal influence for 28km. From survey it was found that 60 km of the Birupa stretch and 28km of Brahmani is found to have <1m of water but can be made navigable through technical interventions such as dredging, construction of Barrages/Locks Turning radius issues were also observed along the study stretches	Total length of 152 km was surveyed as part of the study stretch Birupa River has 77 km of length under study and 54 km of Brahmani is under study.	*Birupa:* 17 bridges &35 other cross structures *Badi Genguti:* 9 bridges& 18 other cross structures *Brahmani:* 2 bridges & 4 other cross structures	No cargo or passenger service was observed along the study stretch.

Table 30: Observations

9.2 Suggestions

Following points are suggested for the navigability of the rivers

- Birupa and Brahmani River to be considered for interlinking Mahanadi with NW-5 which can further improve connectivity to Dhamra port can be achieved. In view of this Birupa and Brahmani River system shall be taken further for Stage-2 studies.

CHAPTER 10
ANNEXURE

10 Annexure 1

Birupa river

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
0	0.5	1.152	-0.7	Coarse Sand
0.1	0.5	1.152	-0.7	Coarse Sand
0.2	0.6	1.152	-0.6	Coarse Sand
0.3	0.5	1.152	-0.7	Coarse Sand
0.4	1.5	1.152	0.3	Coarse Sand
0.5	4.0	1.152	2.8	Coarse Sand
0.6	0.8	1.152	-0.4	Coarse Sand
0.7	0.8	1.152	-0.4	Coarse Sand
0.8	0.8	1.152	-0.4	Coarse Sand
0.9	0.5	1.152	-0.7	Coarse Sand
1	0.5	1.152	-0.7	Coarse Sand
1.1	0.5	1.152	-0.7	Coarse Sand
1.2	0.6	1.152	-0.6	Coarse Sand
1.3	1.0	1.152	-0.2	Coarse Sand
1.4	1.2	1.152	0	Coarse Sand
1.5	2.0	1.152	0.8	Coarse Sand
1.6	0.8	1.152	-0.4	Coarse Sand
1.7	0.8	1.152	-0.4	Coarse Sand
1.8	0.6	1.152	-0.6	Coarse Sand
1.9	0.6	1.152	-0.6	Coarse Sand
2	0.6	1.152	-0.6	Coarse Sand
2.1	0.6	1.152	-0.6	Coarse Sand
2.2	0.6	1.152	-0.6	Coarse Sand
2.3	0.5	1.152	-0.7	Coarse Sand
2.4	0.5	1.152	-0.7	Coarse Sand
2.5	0.4	1.152	-0.8	Coarse Sand
2.6	0.4	1.152	-0.8	Coarse Sand
2.7	0.4	1.152	-0.8	Coarse Sand
2.8	0.4	1.152	-0.8	Coarse Sand
2.9	0.4	1.152	-0.8	Fine Sand
3	0.5	1.152	-0.7	Fine Sand
3.1	0.5	1.152	-0.7	Fine Sand
3.2	0.5	1.152	-0.7	Fine Sand
3.3	0.5	1.152	-0.7	Fine Sand
3.4	0.5	1.152	-0.7	Fine Sand
3.5	0.5	1.152	-0.7	Fine Sand
3.6	0.5	1.152	-0.7	Fine Sand
3.7	0.5	1.152	-0.7	Fine Sand
3.8	0.6	1.152	-0.6	Fine Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
3.9	0.6	1.152	-0.6	Fine Sand
4	0.6	1.152	-0.6	Fine Sand
4.1	0.6	1.152	-0.6	Fine Sand
4.2	0.6	1.152	-0.6	Fine Sand
4.3	0.6	1.152	-0.6	Fine Sand
4.4	0.5	1.152	-0.7	Fine Sand
4.5	0.5	1.152	-0.7	Fine Sand
4.6	0.5	1.152	-0.7	Fine Sand
4.7	0.5	1.152	-0.7	Fine Sand
4.8	0.8	1.152	-0.4	Fine Sand
4.9	0.8	1.152	-0.4	Fine Sand
5	1.0	1.152	-0.2	Fine Sand
5.1	1.1	1.152	-0.1	Fine Sand
5.2	1.0	1.152	-0.2	Fine Sand
5.3	1.0	1.152	-0.2	Fine Sand
5.4	1.0	1.152	-0.2	Fine Sand
5.5	1.0	1.152	-0.2	Fine Sand
5.6	1.0	1.152	-0.2	Fine Sand
5.7	1.0	1.152	-0.2	Fine Sand
5.8	0.8	1.152	-0.4	Fine Sand
5.9	0.8	1.152	-0.4	Fine Sand
6	0.9	1.144	-0.2	Fine Sand
6.1	0.8	1.144	-0.3	Fine Sand
6.2	0.9	1.144	-0.2	Fine Sand
6.3	0.7	1.144	-0.4	Fine Sand
6.4	0.7	1.144	-0.4	Fine Sand
6.5	0.7	1.144	-0.4	Fine Sand
6.6	0.7	1.144	-0.4	Fine Sand
6.7	0.5	1.144	-0.6	Fine Sand
6.8	0.4	1.144	-0.7	Fine Sand
6.9	0.4	1.144	-0.7	Fine Sand
7	0.4	1.144	-0.7	Fine Sand
7.1	0.3	1.144	-0.8	Fine Sand
7.2	0.3	1.144	-0.8	Fine Sand
7.3	0.4	1.144	-0.7	Fine Sand
7.4	0.4	1.144	-0.7	Fine Sand
7.5	0.4	1.144	-0.7	Fine Sand
7.6	0.4	1.144	-0.7	Fine Sand
7.7	0.4	1.144	-0.7	Fine Sand
7.8	0.4	1.144	-0.7	Fine Sand
7.9	0.4	1.144	-0.7	Fine Sand
8	0.4	1.144	-0.7	Fine Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
8.1	0.4	1.144	-0.7	Fine Sand
8.2	0.5	1.144	-0.6	Fine Sand
8.3	0.7	1.144	-0.4	Fine Sand
8.4	0.9	1.144	-0.2	Fine Sand
8.5	1.1	1.144	0	Fine Sand
8.6	0.9	1.144	-0.2	Fine Sand
8.7	0.9	1.144	-0.2	Fine Sand
8.8	0.9	1.144	-0.2	Fine Sand
8.9	0.9	1.144	-0.2	Fine Sand
9	1.1	1.144	0	Fine Sand
9.1	0.9	1.144	-0.2	Fine Sand
9.2	0.9	1.144	-0.2	Fine Sand
9.3	0.7	1.144	-0.4	Fine Sand
9.4	0.5	1.144	-0.6	Fine Sand
9.5	0.5	1.144	-0.6	Fine Sand
9.6	0.4	1.144	-0.7	Fine Sand
9.7	0.5	1.144	-0.6	Fine Sand
9.8	0.5	1.144	-0.6	Fine Sand
9.9	0.5	1.144	-0.6	Fine Sand
10	0.5	1.144	-0.6	Fine Sand
10.1	0.5	1.144	-0.6	Fine Sand
10.2	0.5	1.144	-0.6	Fine Sand
10.3	0.4	1.144	-0.7	Fine Sand
10.4	0.4	1.144	-0.7	Fine Sand
10.5	0.5	1.144	-0.6	Fine Sand
10.6	0.5	1.144	-0.6	Fine Sand
10.7	0.5	1.144	-0.6	Fine Sand
10.8	0.5	1.144	-0.6	Fine Sand
10.9	0.7	1.144	-0.4	Fine Sand
11	0.7	1.144	-0.4	Fine Sand
11.1	0.7	1.144	-0.4	Fine Sand
11.2	0.7	1.144	-0.4	Fine Sand
11.3	0.6	1.144	-0.5	Fine Sand
11.4	0.6	1.144	-0.5	Fine Sand
11.5	0.5	1.144	-0.6	Fine Sand
11.6	0.5	1.144	-0.6	Fine Sand
11.7	0.5	1.144	-0.6	Fine Sand
11.8	0.5	1.144	-0.6	Fine Sand
11.9	0.5	1.144	-0.6	Fine Sand
12	0.5	1.144	-0.6	Fine Sand
12.1	0.6	1.144	-0.5	Fine Sand
12.2	0.7	1.144	-0.4	Fine Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
12.3	0.9	1.144	-0.2	Fine Sand
12.4	0.8	1.144	-0.3	Fine Sand
12.5	0.8	1.144	-0.3	Fine Sand
12.6	0.7	1.144	-0.4	Fine Sand
12.7	0.8	1.144	-0.3	Fine Sand
12.8	0.6	1.144	-0.5	Fine Sand
12.9	0.5	1.144	-0.6	Fine Sand
13	0.5	1.144	-0.6	Fine Sand
13.1	0.6	1.144	-0.5	Fine Sand
13.2	0.6	1.144	-0.5	Fine Sand
13.3	0.6	1.144	-0.5	Fine Sand
13.4	0.5	1.144	-0.6	Fine Sand
13.5	0.5	1.144	-0.6	Fine Sand
13.6	0.5	1.144	-0.6	Fine Sand
13.7	0.5	1.144	-0.6	Fine Sand
13.8	0.6	1.144	-0.5	Fine Sand
13.9	0.6	1.144	-0.5	Fine Sand
14	0.5	1.144	-0.6	Fine Sand
14.1	0.5	1.144	-0.6	Fine Sand
14.2	0.5	1.144	-0.6	Fine Sand
14.3	0.4	1.144	-0.7	Fine Sand
14.4	0.4	1.144	-0.7	Fine Sand
14.5	0.5	1.144	-0.6	Fine Sand
14.6	0.5	1.144	-0.6	Fine Sand
14.7	0.6	1.144	-0.5	Fine Sand
14.8	0.7	1.144	-0.4	Fine Sand
14.9	0.9	1.144	-0.2	Fine Sand
15	1.1	1.144	0	Fine Sand
15.1	0.9	1.144	-0.2	Fine Sand
15.2	0.7	1.144	-0.4	Fine Sand
15.3	0.6	1.144	-0.5	Fine Sand
15.4	0.5	1.144	-0.6	Fine Sand
15.5	0.5	1.144	-0.6	Fine Sand
15.6	0.7	1.144	-0.4	Fine Sand
15.7	0.6	1.144	-0.5	Coarse Sand
15.8	0.8	1.144	-0.3	Coarse Sand
15.9	0.7	1.144	-0.4	Coarse Sand
16	0.7	1.279	-0.6	Coarse Sand
16.1	0.9	1.279	-0.4	Coarse Sand
16.2	0.8	1.279	-0.5	Coarse Sand
16.3	0.9	1.279	-0.4	Coarse Sand
16.4	0.7	1.279	-0.6	Coarse Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
16.5	0.7	1.279	-0.6	Coarse Sand
16.6	0.8	1.279	-0.5	Coarse Sand
16.7	0.7	1.279	-0.6	Coarse Sand
16.8	0.7	1.279	-0.6	Coarse Sand
16.9	0.7	1.279	-0.6	Coarse Sand
17	0.7	1.279	-0.6	Coarse Sand
17.1	0.6	1.279	-0.7	Coarse Sand
17.2	0.6	1.279	-0.7	Coarse Sand
17.3	0.6	1.279	-0.7	Coarse Sand
17.4	0.6	1.279	-0.7	Coarse Sand
17.5	0.7	1.279	-0.6	Coarse Sand
17.6	0.7	1.279	-0.6	Coarse Sand
17.7	0.7	1.279	-0.6	Coarse Sand
17.8	0.7	1.279	-0.6	Coarse Sand
17.9	0.7	1.279	-0.6	Coarse Sand
18	0.7	1.279	-0.6	Coarse Sand
18.1	0.7	1.279	-0.6	Coarse Sand
18.2	0.9	1.279	-0.4	Coarse Sand
18.3	0.7	1.279	-0.6	Coarse Sand
18.4	0.7	1.279	-0.6	Coarse Sand
18.5	0.7	1.279	-0.6	Coarse Sand
18.6	0.7	1.279	-0.6	Coarse Sand
18.7	0.7	1.279	-0.6	Coarse Sand
18.8	0.6	1.279	-0.7	Coarse Sand
18.9	0.6	1.279	-0.7	Coarse Sand
19	0.5	1.279	-0.8	Coarse Sand
19.1	0.6	1.279	-0.7	Coarse Sand
19.2	0.6	1.279	-0.7	Coarse Sand
19.3	0.5	1.279	-0.8	Coarse Sand
19.4	0.6	1.279	-0.7	Coarse Sand
19.5	0.5	1.279	-0.8	Coarse Sand
19.6	0.5	1.279	-0.8	Coarse Sand
19.7	0.5	1.279	-0.8	Coarse Sand
19.8	0.8	1.279	-0.5	Coarse Sand
19.9	0.9	1.279	-0.4	Coarse Sand
20	1.0	1.279	-0.3	Coarse Sand
20.1	1.0	1.279	-0.3	Coarse Sand
20.2	1.0	1.279	-0.3	Coarse Sand
20.3	0.7	1.279	-0.6	Coarse Sand
20.4	0.7	1.279	-0.6	Coarse Sand
20.5	0.5	1.279	-0.8	Coral Sand
20.6	0.5	1.279	-0.8	Coral Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
20.7	0.5	1.279	-0.8	Coral Sand
20.8	0.6	1.279	-0.7	Coral Sand
20.9	0.6	1.279	-0.7	Coral Sand
21	0.8	1.279	-0.5	Coral Sand
21.1	0.8	1.279	-0.5	Coral Sand
21.2	0.8	1.279	-0.5	Coral Sand
21.3	0.8	1.279	-0.5	Coral Sand
21.4	0.6	1.279	-0.7	Coral Sand
21.5	0.5	1.279	-0.8	Coral Sand
21.6	0.5	1.279	-0.8	Coral Sand
21.7	0.5	1.279	-0.8	Coral Sand
21.8	0.8	1.279	-0.5	Coral Sand
21.9	0.8	1.279	-0.5	Coral Sand
22	0.8	1.279	-0.5	Coral Sand
22.1	0.6	1.279	-0.7	Coral Sand
22.2	0.6	1.279	-0.7	Coral Sand
22.3	0.6	1.279	-0.7	Coral Sand
22.4	0.5	1.279	-0.8	Coral Sand
22.5	0.5	1.279	-0.8	Coral Sand
22.6	0.5	1.279	-0.8	Coral Sand
22.7	0.5	1.279	-0.8	Coral Sand
22.8	0.5	1.279	-0.8	Coral Sand
22.9	0.5	1.279	-0.8	Coral Sand
23	0.5	1.279	-0.8	Coral Sand
23.1	0.6	1.279	-0.7	Coral Sand
23.2	0.6	1.279	-0.7	Coral Sand
23.3	0.6	1.279	-0.7	Coral Sand
23.4	0.5	1.279	-0.8	Coral Sand
23.5	0.5	1.279	-0.8	Coral Sand
23.6	0.5	1.279	-0.8	Coral Sand
23.7	0.5	1.279	-0.8	Coral Sand
23.8	0.5	1.279	-0.8	Coral Sand
23.9	0.5	1.279	-0.8	Coral Sand
24	0.5	1.279	-0.8	Coral Sand
24.1	0.6	1.279	-0.7	Coral Sand
24.2	0.9	1.279	-0.4	Coral Sand
24.3	0.9	1.279	-0.4	Coral Sand
24.4	0.9	1.279	-0.4	Coral Sand
24.5	1.3	1.279	0	Coral Sand
24.6	1.1	1.279	-0.2	Coral Sand
24.7	0.9	1.279	-0.4	Coral Sand
24.8	0.9	1.279	-0.4	Coral Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
24.9	0.7	1.279	-0.6	Coral Sand
25	0.5	1.279	-0.8	Coral Sand
25.1	0.9	1.279	-0.4	Coral Sand
25.2	0.9	1.279	-0.4	Coral Sand
25.3	0.9	1.279	-0.4	Coral Sand
25.4	1.5	1.279	0.2	Coral Sand
25.5	1.9	1.279	0.6	Coral Sand
25.6	1.9	1.279	0.6	Coral Sand
25.7	1.9	1.279	0.6	Coral Sand
25.8	0.9	1.279	-0.4	Coral Sand
25.9	0.7	1.279	-0.6	Coral Sand
26	0.4	1.236	-0.8	Coral Sand
26.1	0.4	1.236	-0.8	Coarse Sand
26.2	0.4	1.236	-0.8	Coarse Sand
26.3	0.4	1.236	-0.8	Coarse Sand
26.4	0.5	1.236	-0.7	Coarse Sand
26.5	0.4	1.236	-0.8	Coarse Sand
26.6	0.4	1.236	-0.8	Coarse Sand
26.7	0.4	1.236	-0.8	Coarse Sand
26.8	0.4	1.236	-0.8	Coarse Sand
26.9	0.4	1.236	-0.8	Coarse Sand
27	0.4	1.236	-0.8	Coarse Sand
27.1	0.4	1.236	-0.8	Coarse Sand
27.2	0.4	1.236	-0.8	Coarse Sand
27.3	0.4	1.236	-0.8	Coarse Sand
27.4	0.4	1.236	-0.8	Coarse Sand
27.5	0.6	1.236	-0.6	Coarse Sand
27.6	0.6	1.236	-0.6	Coarse Sand
27.7	0.6	1.236	-0.6	Coarse Sand
27.8	0.6	1.236	-0.6	Coarse Sand
27.9	0.6	1.236	-0.6	Coarse Sand
28	0.4	1.236	-0.8	Coarse Sand
28.1	0.4	1.236	-0.8	Coarse Sand
28.2	0.4	1.236	-0.8	Coarse Sand
28.3	0.8	1.236	-0.4	Coarse Sand
28.4	0.8	1.236	-0.4	Coarse Sand
28.5	1.3	1.236	0.1	Coarse Sand
28.6	1.0	1.236	-0.2	Coarse Sand
28.7	1.0	1.236	-0.2	Coarse Sand
28.8	0.6	1.236	-0.6	Coarse Sand
28.9	0.6	1.236	-0.6	Coarse Sand
29	0.4	1.236	-0.8	Coarse Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
29.1	0.4	1.236	-0.8	Coarse Sand
29.2	0.4	1.236	-0.8	Coarse Sand
29.3	0.4	1.236	-0.8	Coarse Sand
29.4	0.4	1.236	-0.8	Coarse Sand
29.5	0.5	1.236	-0.7	Coarse Sand
29.6	0.5	1.236	-0.7	Coarse Sand
29.7	0.5	1.236	-0.7	Coarse Sand
29.8	0.5	1.236	-0.7	Coarse Sand
29.9	0.6	1.236	-0.6	Coarse Sand
30	0.4	1.236	-0.8	Coarse Sand
30.1	0.4	1.236	-0.8	Coarse Sand
30.2	0.4	1.236	-0.8	Coarse Sand
30.3	0.8	1.236	-0.4	Coarse Sand
30.4	1.0	1.236	-0.2	Coarse Sand
30.5	1.2	1.236	0	Coarse Sand
30.6	1.0	1.236	-0.2	Coarse Sand
30.7	0.8	1.236	-0.4	Coarse Sand
30.8	0.6	1.236	-0.6	Coarse Sand
30.9	0.6	1.236	-0.6	Coarse Sand
31	0.4	1.236	-0.8	Coarse Sand
31.1	0.4	1.236	-0.8	Coarse Sand
31.2	0.4	1.236	-0.8	Coarse Sand
31.3	0.4	1.236	-0.8	Coarse Sand
31.4	0.4	1.236	-0.8	Coarse Sand
31.5	0.4	1.236	-0.8	Coarse Sand
31.6	0.5	1.236	-0.7	Coarse Sand
31.7	0.5	1.236	-0.7	Coarse Sand
31.8	0.5	1.236	-0.7	Coarse Sand
31.9	0.5	1.236	-0.7	Coarse Sand
32	0.3	1.236	-0.9	Coarse Sand
32.1	0.5	1.236	-0.7	Coarse Sand
32.2	0.5	1.236	-0.7	Coarse Sand
32.3	0.5	1.236	-0.7	Coarse Sand
32.4	0.5	1.236	-0.7	Coarse Sand
32.5	0.4	1.236	-0.8	Coarse Sand
32.6	0.5	1.236	-0.7	Coarse Sand
32.7	0.5	1.236	-0.7	Coarse Sand
32.8	0.5	1.236	-0.7	Coarse Sand
32.9	0.5	1.236	-0.7	Coarse Sand
33	0.3	1.236	-0.9	Coarse Sand
33.1	0.5	1.236	-0.7	Coarse Sand
33.2	0.5	1.236	-0.7	Coarse Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
33.3	0.5	1.236	-0.7	Coarse Sand
33.4	0.5	1.236	-0.7	Coarse Sand
33.5	0.7	1.236	-0.5	Coarse Sand
33.6	0.7	1.236	-0.5	Coarse Sand
33.7	0.7	1.236	-0.5	Coarse Sand
33.8	0.7	1.236	-0.5	Coarse Sand
33.9	0.3	1.236	-0.9	Coarse Sand
34	0.3	1.236	-0.9	Coarse Sand
34.1	0.3	1.236	-0.9	Coarse Sand
34.2	0.3	1.236	-0.9	Coarse Sand
34.3	0.5	1.236	-0.7	Coarse Sand
34.4	0.5	1.236	-0.7	Coarse Sand
34.5	0.5	1.236	-0.7	Coarse Sand
34.6	0.5	1.236	-0.7	Coarse Sand
34.7	0.5	1.236	-0.7	Coarse Sand
34.8	0.3	1.236	-0.9	Coarse Sand
34.9	0.3	1.236	-0.9	Coarse Sand
35	0.3	1.236	-0.9	Coarse Sand
35.1	0.3	1.236	-0.9	Coarse Sand
35.2	0.3	1.236	-0.9	Coarse Sand
35.3	0.5	1.236	-0.7	Coarse Sand
35.4	0.5	1.236	-0.7	Coarse Sand
35.5	0.6	1.236	-0.6	Coarse Sand
35.6	0.6	1.236	-0.6	Coarse Sand
35.7	0.6	1.236	-0.6	Coarse Sand
35.8	0.5	1.236	-0.7	Coarse Sand
35.9	0.5	1.236	-0.7	Coarse Sand
36	0.3	1.236	-0.9	Coarse Sand
36.1	0.3	1.236	-0.9	Coarse Sand
36.2	0.3	1.236	-0.9	Coarse Sand
36.3	0.3	1.236	-0.9	Coarse Sand
36.4	0.6	1.236	-0.6	Silt Sand
36.5	0.6	1.236	-0.6	Silt Sand
36.6	0.6	1.236	-0.6	Silt Sand
36.7	0.6	1.236	-0.6	Silt Sand
36.8	0.5	1.236	-0.7	Silt Sand
36.9	0.5	1.236	-0.7	Silt Sand
37	0.4	1.299	-0.9	Silt Sand
37.1	0.6	1.299	-0.7	Silt Sand
37.2	0.6	1.299	-0.7	Silt Sand
37.3	0.6	1.299	-0.7	Silt Sand
37.4	0.6	1.299	-0.7	Silt Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
37.5	0.4	1.299	-0.9	Silt Sand
37.6	0.6	1.299	-0.7	Silt Sand
37.7	0.6	1.299	-0.7	Silt Sand
37.8	0.6	1.299	-0.7	Silt Sand
37.9	0.9	1.299	-0.4	Silt Sand
38	0.9	1.299	-0.4	Silt Sand
38.1	0.9	1.299	-0.4	Silt Sand
38.2	0.9	1.299	-0.4	Silt Sand
38.3	0.9	1.299	-0.4	Silt Sand
38.4	0.4	1.299	-0.9	Silt Sand
38.5	0.4	1.299	-0.9	Silt Sand
38.6	0.4	1.299	-0.9	Silt Sand
38.7	0.4	1.299	-0.9	Silt Sand
38.8	1.3	1.299	0	Silt Sand
38.9	2.5	1.299	1.2	Silt Sand
39	2.7	1.299	1.4	Silt Sand
39.1	1.9	1.299	0.6	Silt Sand
39.2	1.1	1.299	-0.2	Silt Sand
39.3	0.6	1.299	-0.7	Silt Sand
39.4	0.6	1.299	-0.7	Silt Sand
39.5	0.4	1.299	-0.9	Silt Sand
39.6	0.6	1.299	-0.7	Silt Sand
39.7	0.6	1.299	-0.7	Silt Sand
39.8	0.6	1.299	-0.7	Silt Sand
39.9	0.6	1.299	-0.7	Silt Sand
40	0.4	1.299	-0.9	Silt Sand
40.1	0.4	1.299	-0.9	Silt Sand
40.2	0.4	1.299	-0.9	Silt Sand
40.3	0.6	1.299	-0.7	Silt Sand
40.4	0.6	1.299	-0.7	Silt Sand
40.5	0.6	1.299	-0.7	Silt Sand
40.6	0.6	1.299	-0.7	Silt Sand
40.7	0.6	1.299	-0.7	Silt Sand
40.8	0.4	1.299	-0.9	Silt Sand
40.9	0.4	1.299	-0.9	Silt Sand
41	0.4	1.299	-0.9	Silt Sand
41.1	0.4	1.299	-0.9	Silt Sand
41.2	0.6	1.299	-0.7	Silt Sand
41.3	0.6	1.299	-0.7	Silt Sand
41.4	0.6	1.299	-0.7	Silt Sand
41.5	0.4	1.299	-0.9	Fine Sand
41.6	0.6	1.299	-0.7	Fine Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
41.7	0.6	1.299	-0.7	Fine Sand
41.8	0.6	1.299	-0.7	Fine Sand
41.9	0.6	1.299	-0.7	Fine Sand
42	0.5	1.299	-0.8	Fine Sand
42.1	0.6	1.299	-0.7	Fine Sand
42.2	0.6	1.299	-0.7	Fine Sand
42.3	0.6	1.299	-0.7	Fine Sand
42.4	0.6	1.299	-0.7	Fine Sand
42.5	0.9	1.299	-0.4	Fine Sand
42.6	0.6	1.299	-0.7	Fine Sand
42.7	0.6	1.299	-0.7	Fine Sand
42.8	0.6	1.299	-0.7	Fine Sand
42.9	0.6	1.299	-0.7	Fine Sand
43	0.5	1.299	-0.8	Fine Sand
43.1	0.6	1.299	-0.7	Fine Sand
43.2	0.6	1.299	-0.7	Fine Sand
43.3	0.6	1.299	-0.7	Fine Sand
43.4	0.6	1.299	-0.7	Fine Sand
43.5	0.9	1.299	-0.4	Fine Sand
43.6	0.8	1.299	-0.5	Fine Sand
43.7	0.8	1.299	-0.5	Fine Sand
43.8	0.8	1.299	-0.5	Fine Sand
43.9	0.6	1.299	-0.7	Fine Sand
44	0.5	1.299	-0.8	Fine Sand
44.1	0.5	1.299	-0.8	Fine Sand
44.2	0.6	1.299	-0.7	Fine Sand
44.3	0.6	1.299	-0.7	Fine Sand
44.4	0.6	1.299	-0.7	Fine Sand
44.5	1.3	1.299	0	Fine Sand
44.6	1.1	1.299	-0.2	Fine Sand
44.7	1.1	1.299	-0.2	Fine Sand
44.8	0.6	1.299	-0.7	Fine Sand
44.9	0.6	1.299	-0.7	Fine Sand
45	0.5	1.299	-0.8	Coarse Sand
45.1	0.5	1.299	-0.8	Coarse Sand
45.2	0.5	1.299	-0.8	Coarse Sand
45.3	0.6	1.299	-0.7	Coarse Sand
45.4	0.6	1.299	-0.7	Coarse Sand
45.5	0.6	1.299	-0.7	Coarse Sand
45.6	0.6	1.299	-0.7	Coarse Sand
45.7	0.6	1.299	-0.7	Coarse Sand
45.8	0.6	1.299	-0.7	Coarse Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
45.9	0.5	1.299	-0.8	Coarse Sand
46	0.5	1.299	-0.8	Coarse Sand
46.1	0.5	1.299	-0.8	Coarse Sand
46.2	0.5	1.299	-0.8	Coarse Sand
46.3	0.6	1.299	-0.7	Coarse Sand
46.4	0.6	1.299	-0.7	Coarse Sand
46.5	0.6	1.299	-0.7	Coarse Sand
46.6	0.6	1.299	-0.7	Coarse Sand
46.7	0.6	1.299	-0.7	Coarse Sand
46.8	0.6	1.299	-0.7	Coarse Sand
46.9	0.5	1.299	-0.8	Coarse Sand
47	0.5	1.299	-0.8	Coarse Sand
47.1	0.5	1.299	-0.8	Coarse Sand
47.2	0.5	1.299	-0.8	Coarse Sand
47.3	0.6	1.299	-0.7	Coarse Sand
47.4	0.6	1.299	-0.7	Coarse Sand
47.5	0.6	1.299	-0.7	Coarse Sand
47.6	0.6	1.299	-0.7	Coarse Sand
47.7	0.6	1.299	-0.7	Coarse Sand
47.8	0.5	1.299	-0.8	Coarse Sand
47.9	0.5	1.299	-0.8	Coarse Sand
48	0.3	1.135	-0.8	Mud Sand
48.1	0.3	1.135	-0.8	Mud Sand
48.2	0.3	1.135	-0.8	Mud Sand
48.3	0.3	1.135	-0.8	Mud Sand
48.4	0.7	1.135	-0.4	Mud Sand
48.5	0.9	1.135	-0.2	Mud Sand
48.6	0.7	1.135	-0.4	Mud Sand
48.7	0.7	1.135	-0.4	Mud Sand
48.8	0.4	1.135	-0.7	Mud Sand
48.9	0.4	1.135	-0.7	Mud Sand
49	0.3	1.135	-0.8	Mud Sand
49.1	0.4	1.135	-0.7	Mud Sand
49.2	0.4	1.135	-0.7	Mud Sand
49.3	0.4	1.135	-0.7	Mud Sand
49.4	0.4	1.135	-0.7	Mud Sand
49.5	0.7	1.135	-0.4	Mud Sand
49.6	0.4	1.135	-0.7	Mud Sand
49.7	0.4	1.135	-0.7	Mud Sand
49.8	0.4	1.135	-0.7	Mud Sand
49.9	0.4	1.135	-0.7	Mud Sand
50	0.3	1.135	-0.8	Mud Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
50.1	0.4	1.135	-0.7	Mud Sand
50.2	0.4	1.135	-0.7	Mud Sand
50.3	0.4	1.135	-0.7	Mud Sand
50.4	0.4	1.135	-0.7	Mud Sand
50.5	0.4	1.135	-0.7	Mud Sand
50.6	0.4	1.135	-0.7	Mud Sand
50.7	0.4	1.135	-0.7	Mud Sand
50.8	0.3	1.135	-0.8	Mud Sand
50.9	0.3	1.135	-0.8	Mud Sand
51	0.2	1.135	-0.9	Mud Sand
51.1	0.4	1.135	-0.7	Mud Sand
51.2	0.4	1.135	-0.7	Mud Sand
51.3	0.4	1.135	-0.7	Mud Sand
51.4	0.7	1.135	-0.4	Mud Sand
51.5	1.0	1.135	-0.1	Mud Sand
51.6	0.9	1.135	-0.2	Mud Sand
51.7	0.7	1.135	-0.4	Mud Sand
51.8	0.7	1.135	-0.4	Mud Sand
51.9	0.7	1.135	-0.4	Mud Sand
52	0.5	1.135	-0.6	Mud Sand
52.1	0.5	1.135	-0.6	Mud Sand
52.2	0.5	1.135	-0.6	Mud Sand
52.3	0.5	1.135	-0.6	Mud Sand
52.4	0.5	1.135	-0.6	Mud Sand
52.5	0.4	1.135	-0.7	Mud Sand
52.6	0.4	1.135	-0.7	Mud Sand
52.7	0.4	1.135	-0.7	Mud Sand
52.8	0.4	1.135	-0.7	Mud Sand
52.9	0.2	1.135	-0.9	Mud Sand
53	0.2	1.135	-0.9	Mud Sand
53.1	0.2	1.135	-0.9	Mud Sand
53.2	0.2	1.135	-0.9	Mud Sand
53.3	0.7	1.135	-0.4	Mud Sand
53.4	0.7	1.135	-0.4	Mud Sand
53.5	1.0	1.135	-0.1	Mud Sand
53.6	0.8	1.135	-0.3	Mud Sand
53.7	0.8	1.135	-0.3	Mud Sand
53.8	0.8	1.135	-0.3	Mud Sand
53.9	0.4	1.135	-0.7	Mud Sand
54	0.2	1.135	-0.9	Mud Sand
54.1	0.2	1.135	-0.9	Mud Sand
54.2	0.4	1.135	-0.7	Mud Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
54.3	0.4	1.135	-0.7	Mud Sand
54.4	0.9	1.135	-0.2	Mud Sand
54.5	1.2	1.135	0.1	Mud Sand
54.6	0.9	1.135	-0.2	Mud Sand
54.7	0.9	1.135	-0.2	Mud Sand
54.8	0.5	1.135	-0.6	Mud Sand
54.9	0.4	1.135	-0.7	Mud Sand
55	0.2	1.135	-0.9	Mud Sand
55.1	0.4	1.135	-0.7	Mud Sand
55.2	0.4	1.135	-0.7	Mud Sand
55.3	0.4	1.135	-0.7	Mud Sand
55.4	0.4	1.135	-0.7	Mud Sand
55.5	0.5	1.135	-0.6	Mud Sand
55.6	0.4	1.135	-0.7	Mud Sand
55.7	0.4	1.135	-0.7	Mud Sand
55.8	0.4	1.135	-0.7	Mud Sand
55.9	0.4	1.135	-0.7	Mud Sand
56	0.2	1.135	-0.9	Mud Sand
56.1	0.5	1.135	-0.6	Mud Sand
56.2	0.5	1.135	-0.6	Mud Sand
56.3	0.5	1.135	-0.6	Mud Sand
56.4	0.7	1.135	-0.4	Mud Sand
56.5	0.9	1.135	-0.2	Mud Sand
56.6	0.7	1.135	-0.4	Mud Sand
56.7	0.7	1.135	-0.4	Mud Sand
56.8	0.4	1.135	-0.7	Mud Sand
56.9	0.4	1.135	-0.7	Mud Sand
57	0.2	1.135	-0.9	Mud Sand
57.1	1.1	1.135	0	Mud Sand
57.2	2.3	1.135	1.2	Mud Sand
57.3	3.5	1.135	2.4	Mud Sand
57.4	4.4	1.135	3.3	Mud Sand
57.5	6.1	1.135	5	Mud Sand
57.6	5.7	1.135	4.6	Mud Sand
57.7	4.9	1.135	3.8	Mud Sand
57.8	4.4	1.135	3.3	Mud Sand
57.9	3.5	1.135	2.4	Mud Sand
58	2.5	0.876	1.6	Mud Sand
58.1	2.4	0.876	1.5	Mud Sand
58.2	2.3	0.876	1.4	Mud Sand
58.3	2.2	0.876	1.3	Mud Sand
58.4	2.1	0.876	1.2	Mud Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
58.5	2.0	0.876	1.1	Mud Sand
58.6	0.9	0.876	0	Mud Sand
58.7	0.7	0.876	-0.2	Mud Sand
58.8	0.7	0.876	-0.2	Mud Sand
58.9	0.7	0.876	-0.2	Mud Sand
59	0.3	0.876	-0.6	Mud Sand
59.1	0.3	0.876	-0.6	Mud Sand
59.2	0.3	0.876	-0.6	Mud Sand
59.3	0.3	0.876	-0.6	Mud Sand
59.4	0.3	0.876	-0.6	Mud Sand
59.5	0.3	0.876	-0.6	Mud Sand
59.6	0.2	0.876	-0.7	Mud Sand
59.7	0.2	0.876	-0.7	Mud Sand
59.8	0.2	0.876	-0.7	Mud Sand
59.9	0.2	0.876	-0.7	Mud Sand
60	0.1	0.876	-0.8	Mud Sand
60.1	0.5	0.876	-0.4	Mud Sand
60.2	0.5	0.876	-0.4	Mud Sand
60.3	0.5	0.876	-0.4	Mud Sand
60.4	0.5	0.876	-0.4	Mud Sand
60.5	0.8	0.876	-0.1	Mud Sand
60.6	0.3	0.876	-0.6	Mud Sand
60.7	0.3	0.876	-0.6	Mud Sand
60.8	0.3	0.876	-0.6	Mud Sand
60.9	0.3	0.876	-0.6	Mud Sand
61	0.1	0.876	-0.8	Mud Sand
61.1	0.2	0.876	-0.7	Mud Sand
61.2	0.2	0.876	-0.7	Mud Sand
61.3	0.2	0.876	-0.7	Mud Sand
61.4	0.2	0.876	-0.7	Mud Sand
61.5	0.0	0.876	-0.9	Mud Sand
61.6	0.1	0.876	-0.8	Mud Sand
61.7	0.1	0.876	-0.8	Mud Sand
61.8	0.1	0.876	-0.8	Mud Sand
61.9	0.1	0.876	-0.8	Mud Sand
62	0.0	0.876	-0.9	Mud Sand
62.1	0.2	0.876	-0.7	Mud Sand
62.2	0.5	0.876	-0.4	Mud Sand
62.3	0.5	0.876	-0.4	Mud Sand
62.4	0.5	0.876	-0.4	Mud Sand
62.5	0.9	0.876	0	Mud Sand
62.6	0.7	0.876	-0.2	Mud Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
62.7	0.7	0.876	-0.2	Mud Sand
62.8	0.7	0.876	-0.2	Mud Sand
62.9	0.4	0.876	-0.5	Mud Sand
63	0.4	0.876	-0.5	Mud Sand
63.1	0.7	0.876	-0.2	Mud Sand
63.2	0.9	0.876	0	Mud Sand
63.3	2.1	0.876	1.2	Mud Sand
63.4	2.7	0.876	1.8	Mud Sand
63.5	3.3	0.876	2.4	Mud Sand
63.6	3.0	0.876	2.1	Mud Sand
63.7	2.7	0.876	1.8	Mud Sand
63.8	2.1	0.876	1.2	Mud Sand
63.9	0.9	0.876	0	Mud Sand
64	0.4	0.876	-0.5	Mud Sand
64.1	0.5	0.876	-0.4	Mud Sand
64.2	0.5	0.876	-0.4	Mud Sand
64.3	0.5	0.876	-0.4	Mud Sand
64.4	0.7	0.876	-0.2	Mud Sand
64.5	0.9	0.876	0	Mud Sand
64.6	0.7	0.876	-0.2	Mud Sand
64.7	0.7	0.876	-0.2	Mud Sand
64.8	0.7	0.876	-0.2	Mud Sand
64.9	0.5	0.876	-0.4	Mud Sand
65	0.4	0.876	-0.5	Mud Sand
65.1	0.7	0.876	-0.2	Mud Sand
65.2	0.7	0.876	-0.2	Mud Sand
65.3	0.9	0.876	0	Mud Sand
65.4	2.1	0.876	1.2	Mud Sand
65.5	2.8	0.876	1.9	Mud Sand
65.6	2.3	0.876	1.4	Mud Sand
65.7	2.1	0.876	1.2	Mud Sand
65.8	1.6	0.876	0.7	Mud Sand
65.9	0.9	0.876	0	Mud Sand
66	0.4	0.876	-0.5	Mud Sand
66.1	0.6	0.876	-0.3	Mud Sand
66.2	0.5	0.876	-0.4	Mud Sand
66.3	0.5	0.876	-0.4	Mud Sand
66.4	0.5	0.876	-0.4	Mud Sand
66.5	0.4	0.876	-0.5	Mud Sand
66.6	0.6	0.876	-0.3	Mud Sand
66.7	0.7	0.876	-0.2	Mud Sand
66.8	1.0	0.876	0.1	Mud Sand

Chainage(km)	Observed Depth (m)	Reduction Factor	Water depth(m) w.r.t. CD	Texture
66.9	1.0	0.876	0.1	Mud Sand
67	1.0	0.876	0.1	Mud Sand

Badi Genguti River

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
0	1.0	1.534	-0.5	Coral Sand
0.1	0.8	1.534	-0.7	Coral Sand
0.2	0.8	1.534	-0.7	Coral Sand
0.3	0.8	1.534	-0.7	Coral Sand
0.4	0.8	1.534	-0.7	Coral Sand
0.5	0.4	1.534	-1.1	Coral Sand
0.6	0.8	1.534	-0.7	Coral Sand
0.7	0.8	1.534	-0.7	Coral Sand
0.8	0.8	1.534	-0.7	Coral Sand
0.9	0.8	1.534	-0.7	Coral Sand
1	0.9	1.534	-0.6	Coral Sand
1.1	0.9	1.534	-0.6	Coral Sand
1.2	0.9	1.534	-0.6	Coral Sand
1.3	0.9	1.534	-0.6	Coral Sand
1.4	0.9	1.534	-0.6	Coral Sand
1.5	0.4	1.534	-1.1	Coral Sand
1.6	0.8	1.534	-0.7	Coral Sand
1.7	0.8	1.534	-0.7	Coral Sand
1.8	0.8	1.534	-0.7	Coral Sand
1.9	0.8	1.534	-0.7	Coral Sand
2	1.2	1.534	-0.3	Coral Sand
2.1	1.1	1.534	-0.4	Coral Sand
2.2	0.8	1.534	-0.7	Coral Sand
2.3	0.8	1.534	-0.7	Coral Sand
2.4	0.8	1.534	-0.7	Coral Sand
2.5	0.4	1.534	-1.1	Coral Sand
2.6	0.6	1.534	-0.9	Coral Sand
2.7	0.6	1.534	-0.9	Coral Sand
2.8	0.6	1.534	-0.9	Coral Sand
2.9	0.6	1.534	-0.9	Coral Sand
3	0.4	1.534	-1.1	Coral Sand
3.1	1.0	1.534	-0.5	Coral Sand
3.2	1.0	1.534	-0.5	Coral Sand
3.3	1.0	1.534	-0.5	Coral Sand
3.4	1.0	1.534	-0.5	Coral Sand
3.5	1.3	1.534	-0.2	Coral Sand
3.6	0.8	1.534	-0.7	Coral Sand
3.7	0.8	1.534	-0.7	Coral Sand
3.8	0.8	1.534	-0.7	Coral Sand
3.9	0.8	1.534	-0.7	Coral Sand
4	0.4	1.534	-1.1	Coral Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
4.1	0.8	1.534	-0.7	Coral Sand
4.2	0.8	1.534	-0.7	Coral Sand
4.3	0.8	1.534	-0.7	Coral Sand
4.4	0.8	1.534	-0.7	Coral Sand
4.5	0.4	1.534	-1.1	Coral Sand
4.6	0.6	1.534	-0.9	Coral Sand
4.7	0.6	1.534	-0.9	Coral Sand
4.8	0.6	1.534	-0.9	Coral Sand
4.9	0.6	1.534	-0.9	Coral Sand
5	0.4	1.534	-1.1	Coral Sand
5.1	0.8	1.534	-0.7	Coral Sand
5.2	0.8	1.534	-0.7	Coral Sand
5.3	0.8	1.534	-0.7	Coral Sand
5.4	1.1	1.534	-0.4	Coral Sand
5.5	1.4	1.534	-0.1	Coral Sand
5.6	1.1	1.534	-0.4	Coral Sand
5.7	1.1	1.534	-0.4	Coral Sand
5.8	1.1	1.534	-0.4	Coral Sand
5.9	0.8	1.534	-0.7	Coral Sand
6	0.6	1.652	-1.1	Coral Sand
6.1	1.0	1.652	-0.7	Coral Sand
6.2	1.0	1.652	-0.7	Coral Sand
6.3	1.0	1.652	-0.7	Coral Sand
6.4	1.0	1.652	-0.7	Coral Sand
6.5	1.3	1.652	-0.4	Coral Sand
6.6	1.0	1.652	-0.7	Coral Sand
6.7	1.0	1.652	-0.7	Coral Sand
6.8	1.0	1.652	-0.7	Coral Sand
6.9	1.0	1.652	-0.7	Coral Sand
7	0.6	1.652	-1.1	Coral Sand
7.1	0.9	1.652	-0.8	Coral Sand
7.2	0.9	1.652	-0.8	Coral Sand
7.3	0.9	1.652	-0.8	Coral Sand
7.4	0.9	1.652	-0.8	Coral Sand
7.5	1.0	1.652	-0.7	Coral Sand
7.6	0.8	1.652	-0.9	Coral Sand
7.7	0.8	1.652	-0.9	Coral Sand
7.8	0.8	1.652	-0.9	Coral Sand
7.9	0.8	1.652	-0.9	Coral Sand
8	0.6	1.652	-1.1	Coral Sand
8.1	1.0	1.652	-0.7	Coral Sand
8.2	1.0	1.652	-0.7	Coral Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
8.3	1.0	1.652	-0.7	Coral Sand
8.4	1.0	1.652	-0.7	Coral Sand
8.5	1.3	1.652	-0.4	Coral Sand
8.6	1.0	1.652	-0.7	Coral Sand
8.7	1.0	1.652	-0.7	Coral Sand
8.8	1.0	1.652	-0.7	Coral Sand
8.9	1.0	1.652	-0.7	Coral Sand
9	0.6	1.652	-1.1	Coral Sand
9.1	1.3	1.652	-0.4	Coral Sand
9.2	1.3	1.652	-0.4	Coral Sand
9.3	1.3	1.652	-0.4	Coral Sand
9.4	1.3	1.652	-0.4	Coral Sand
9.5	1.4	1.652	-0.3	Coarse Sand
9.6	1.0	1.652	-0.7	Coarse Sand
9.7	1.0	1.652	-0.7	Coarse Sand
9.8	1.0	1.652	-0.7	Coarse Sand
9.9	1.0	1.652	-0.7	Coarse Sand
10	0.6	1.652	-1.1	Coarse Sand
10.1	1.0	1.652	-0.7	Coarse Sand
10.2	1.0	1.652	-0.7	Coarse Sand
10.3	1.0	1.652	-0.7	Coarse Sand
10.4	1.0	1.652	-0.7	Coarse Sand
10.5	1.1	1.652	-0.6	Coarse Sand
10.6	0.8	1.652	-0.9	Coarse Sand
10.7	0.8	1.652	-0.9	Coarse Sand
10.8	0.8	1.652	-0.9	Coarse Sand
10.9	0.8	1.652	-0.9	Coarse Sand
11	0.6	1.652	-1.1	Coarse Sand
11.1	1.0	1.652	-0.7	Coarse Sand
11.2	1.0	1.652	-0.7	Coarse Sand
11.3	1.0	1.652	-0.7	Coarse Sand
11.4	1.0	1.652	-0.7	Coarse Sand
11.5	0.9	1.652	-0.8	Coarse Sand
11.6	0.8	1.652	-0.9	Coarse Sand
11.7	0.8	1.652	-0.9	Coarse Sand
11.8	0.8	1.652	-0.9	Coarse Sand
11.9	0.8	1.652	-0.9	Coarse Sand
12	0.6	1.652	-1.1	Coarse Sand
12.1	1.0	1.652	-0.7	Coarse Sand
12.2	1.0	1.652	-0.7	Coarse Sand
12.3	1.0	1.652	-0.7	Coarse Sand
12.4	1.3	1.652	-0.4	Coarse Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
12.5	1.6	1.652	-0.1	Coarse Sand
12.6	1.5	1.652	-0.2	Coarse Sand
12.7	1.0	1.652	-0.7	Coarse Sand
12.8	1.0	1.652	-0.7	Coarse Sand
12.9	1.0	1.652	-0.7	Coarse Sand
13	0.6	1.652	-1.1	Coarse Sand
13.1	1.3	1.652	-0.4	Coarse Sand
13.2	1.3	1.652	-0.4	Coarse Sand
13.3	1.3	1.652	-0.4	Coarse Sand
13.4	1.3	1.652	-0.4	Coarse Sand
13.5	1.5	1.652	-0.2	Coarse Sand
13.6	1.0	1.652	-0.7	Coarse Sand
13.7	1.0	1.652	-0.7	Coarse Sand
13.8	1.0	1.652	-0.7	Coarse Sand
13.9	1.0	1.652	-0.7	Coarse Sand
14	0.8	1.652	-0.9	Coarse Sand
14.1	0.8	1.652	-0.9	Coarse Sand
14.2	0.8	1.652	-0.9	Coarse Sand
14.3	0.8	1.652	-0.9	Coarse Sand
14.4	0.8	1.652	-0.9	Coarse Sand
14.5	0.6	1.652	-1.1	Coarse Sand
14.6	0.6	1.652	-1.1	Coarse Sand
14.7	0.6	1.652	-1.1	Coarse Sand
14.8	0.6	1.652	-1.1	Coarse Sand
14.9	0.6	1.652	-1.1	Coarse Sand
15	0.8	1.652	-0.9	Coarse Sand
15.1	0.8	1.652	-0.9	Coarse Sand
15.2	0.8	1.652	-0.9	Coarse Sand
15.3	0.8	1.652	-0.9	Coarse Sand
15.4	1.3	1.652	-0.4	Coarse Sand
15.5	1.3	1.652	-0.4	Coarse Sand
15.6	1.3	1.652	-0.4	Coarse Sand
15.7	1.3	1.652	-0.4	Coarse Sand
15.8	1.3	1.652	-0.4	Coarse Sand
15.9	1.7	1.652	0	Coarse Sand
16	1.3	1.162	0.1	Coarse Sand
16.1	0.5	1.162	-0.7	Coarse Sand
16.2	0.5	1.162	-0.7	Coarse Sand
16.3	0.5	1.162	-0.7	Coarse Sand
16.4	0.5	1.162	-0.7	Coarse Sand
16.5	0.3	1.162	-0.9	Coarse Sand
16.6	0.3	1.162	-0.9	Coarse Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
16.7	4.8	1.162	3.6	Coarse Sand
16.8	0.3	1.162	-0.9	Coarse Sand
16.9	0.3	1.162	-0.9	Coarse Sand
17	0.0	1.162	-1.2	Coarse Sand
17.1	0.0	1.162	-1.2	Coarse Sand
17.2	0.0	1.162	-1.2	Coarse Sand
17.3	0.0	1.162	-1.2	Coarse Sand
17.4	0.0	1.162	-1.2	Coarse Sand
17.5	0.0	1.162	-1.2	Coarse Sand
17.6	0.0	1.162	-1.2	Coarse Sand
17.7	0.5	1.162	-0.7	Coarse Sand
17.8	0.5	1.162	-0.7	Coarse Sand
17.9	0.5	1.162	-0.7	Coarse Sand
18	1.5	1.162	0.3	Coarse Sand
18.1	1.2	1.162	0	Coarse Sand
18.2	1.0	1.162	-0.2	Coarse Sand
18.3	1.0	1.162	-0.2	Coarse Sand
18.4	0.5	1.162	-0.7	Coarse Sand
18.5	0.0	1.162	-1.2	Coarse Sand
18.6	0.5	1.162	-0.7	Coarse Sand
18.7	0.5	1.162	-0.7	Coarse Sand
18.8	0.5	1.162	-0.7	Coarse Sand
18.9	0.5	1.162	-0.7	Coarse Sand
19	0.7	1.162	-0.5	Coarse Sand
19.1	0.5	1.162	-0.7	Coarse Sand
19.2	0.5	1.162	-0.7	Coarse Sand
19.3	0.5	1.162	-0.7	Coarse Sand
19.4	0.5	1.162	-0.7	Coarse Sand
19.5	0.0	1.162	-1.2	Coarse Sand
19.6	0.5	1.162	-0.7	Coarse Sand
19.7	0.5	1.162	-0.7	Coarse Sand
19.8	0.5	1.162	-0.7	Coarse Sand
19.9	0.5	1.162	-0.7	Coarse Sand
20	0.5	1.162	-0.7	Coarse Sand
20.1	0.5	1.162	-0.7	Coarse Sand
20.2	0.5	1.162	-0.7	Coarse Sand
20.3	0.5	1.162	-0.7	Coarse Sand
20.4	0.5	1.162	-0.7	Coarse Sand
20.5	0.0	1.162	-1.2	Coarse Sand
20.6	0.3	1.162	-0.9	Coarse Sand
20.7	0.3	1.162	-0.9	Coarse Sand
20.8	0.3	1.162	-0.9	Mud Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
20.9	0.3	1.162	-0.9	Mud Sand
21	0.5	1.162	-0.7	Mud Sand
21.1	0.5	1.162	-0.7	Mud Sand
21.2	0.5	1.162	-0.7	Mud Sand
21.3	0.5	1.162	-0.7	Mud Sand
21.4	0.5	1.162	-0.7	Mud Sand
21.5	0.0	1.162	-1.2	Mud Sand
21.6	0.0	1.162	-1.2	Mud Sand
21.7	0.0	1.162	-1.2	Mud Sand
21.8	0.0	1.162	-1.2	Mud Sand
21.9	0.0	1.162	-1.2	Mud Sand
22	0.3	1.162	-0.9	Mud Sand
22.1	0.3	1.162	-0.9	Mud Sand
22.2	0.3	1.162	-0.9	Mud Sand
22.3	0.3	1.162	-0.9	Mud Sand
22.4	0.3	1.162	-0.9	Mud Sand
22.5	0.0	1.162	-1.2	Mud Sand
22.6	0.5	1.162	-0.7	Mud Sand
22.7	0.5	1.162	-0.7	Mud Sand
22.8	0.5	1.162	-0.7	Mud Sand
22.9	0.5	1.162	-0.7	Mud Sand
23	1.0	1.162	-0.2	Mud Sand
23.1	1.1	1.162	-0.1	Mud Sand
23.2	1.1	1.162	-0.1	Mud Sand
23.3	1.1	1.162	-0.1	Mud Sand
23.4	1.1	1.162	-0.1	Mud Sand
23.5	1.2	1.162	0	Mud Sand
23.6	0.6	1.162	-0.6	Mud Sand
23.7	0.6	1.162	-0.6	Mud Sand
23.8	0.6	1.162	-0.6	Mud Sand
23.9	0.6	1.162	-0.6	Mud Sand
24	0.3	1.162	-0.9	Mud Sand
24.1	0.5	1.162	-0.7	Mud Sand
24.2	0.5	1.162	-0.7	Mud Sand
24.3	0.5	1.162	-0.7	Mud Sand
24.4	0.8	1.162	-0.4	Mud Sand
24.5	1.2	1.162	0	Mud Sand
24.6	0.7	1.162	-0.5	Mud Sand
24.7	0.7	1.162	-0.5	Mud Sand
24.8	0.7	1.162	-0.5	Mud Sand
24.9	0.7	1.162	-0.5	Mud Sand
25	0.3	1.162	-0.9	Mud Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
25.1	0.3	1.162	-0.9	Mud Sand
25.2	0.3	1.162	-0.9	Mud Sand
25.3	1.0	1.162	-0.2	Mud Sand
25.4	1.0	1.162	-0.2	Mud Sand
25.5	1.2	1.162	0	Mud Sand
25.6	2.4	1.162	1.2	Mud Sand
25.7	2.9	1.162	1.7	Mud Sand
25.8	2.6	1.162	1.4	Mud Sand
25.9	2.0	1.162	0.8	Mud Sand
26	1.2	1.162	0	Mud Sand
26.1	1.4	1.162	0.2	Mud Sand
26.2	1.0	1.162	-0.2	Mud Sand
26.3	0.8	1.162	-0.4	Mud Sand
26.4	0.6	1.162	-0.6	Mud Sand
26.5	0.4	1.162	-0.8	Mud Sand
26.6	0.4	1.162	-0.8	Mud Sand
26.7	3.6	1.162	2.4	Mud Sand
26.8	3.4	1.162	2.2	Mud Sand
26.9	1.0	1.162	-0.2	Mud Sand
27	0.9	1.162	-0.3	Mud Sand
27.1	0.9	1.162	-0.3	Mud Sand
27.2	0.6	1.162	-0.6	Mud Sand
27.3	0.6	1.162	-0.6	Mud Sand
27.4	0.6	1.162	-0.6	Mud Sand
27.5	1.2	1.162	0	Mud Sand
27.6	1.0	1.162	-0.2	Mud Sand
27.7	0.4	1.162	-0.8	Mud Sand
27.8	0.4	1.162	-0.8	Mud Sand
27.9	0.4	1.162	-0.8	Mud Sand
28	0.7	1.162	-0.5	Mud Sand
28.1	0.7	1.162	-0.5	Mud Sand
28.2	1.4	1.162	0.2	Mud Sand
28.3	1.4	1.162	0.2	Mud Sand
28.4	1.4	1.162	0.2	Mud Sand
28.5	0.4	1.162	-0.8	Mud Sand
28.6	0.4	1.162	-0.8	Mud Sand
28.7	0.8	1.162	-0.4	Mud Sand
28.8	0.8	1.162	-0.4	Mud Sand
28.9	0.8	1.162	-0.4	Mud Sand
29	0.6	1.162	-0.6	Mud Sand
29.1	0.6	1.162	-0.6	Mud Sand
29.2	0.4	1.162	-0.8	Mud Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
29.3	0.4	1.162	-0.8	Mud Sand
29.4	0.4	1.162	-0.8	Mud Sand
29.5	1.0	1.162	-0.2	Mud Sand
29.6	1.0	1.162	-0.2	Mud Sand
29.7	1.0	1.162	-0.2	Mud Sand
29.8	1.0	1.162	-0.2	Mud Sand
29.9	1.0	1.162	-0.2	Mud Sand
30	0.6	1.162	-0.6	Mud Sand
30.1	0.6	1.162	-0.6	Mud Sand
30.2	0.6	1.162	-0.6	Mud Sand
30.3	0.6	1.162	-0.6	Mud Sand
30.4	0.6	1.162	-0.6	Mud Sand
30.5	0.4	1.162	-0.8	Mud Sand
30.6	2.4	1.162	1.2	Mud Sand
30.7	3.6	1.162	2.4	Mud Sand
30.8	3.0	1.162	1.8	Mud Sand
30.9	2.4	1.162	1.2	Mud Sand
31	1.8	1.162	0.6	Mud Sand
31.1	1.8	1.162	0.6	Mud Sand
31.2	1.8	1.162	0.6	Mud Sand
31.3	1.8	1.162	0.6	Mud Sand
31.4	1.0	1.162	-0.2	Mud Sand
31.5	0.4	1.162	-0.8	Mud Sand
31.6	0.4	1.162	-0.8	Mud Sand
31.7	0.4	1.162	-0.8	Mud Sand
31.8	0.4	1.162	-0.8	Mud Sand
31.9	0.4	1.162	-0.8	Mud Sand
32	0.4	1.162	-0.8	Mud Sand
32.1	1.0	1.162	-0.2	Mud Sand
32.2	1.2	1.162	0	Mud Sand
32.3	0.4	1.162	-0.8	Mud Sand
32.4	0.4	1.162	-0.8	Mud Sand
32.5	0.4	1.162	-0.8	Mud Sand
32.6	0.4	1.162	-0.8	Mud Sand
32.7	2.1	1.162	0.9	Mud Sand
32.8	2.1	1.162	0.9	Mud Sand
32.9	2.1	1.162	0.9	Mud Sand
33	0.4	1.162	-0.8	Mud Sand
33.1	0.4	1.162	-0.8	Mud Sand
33.2	0.4	1.162	-0.8	Mud Sand
33.3	0.4	1.162	-0.8	Fine Sand
33.4	0.4	1.162	-0.8	Fine Sand

Chainage(km)	Observed water depth	Reduction factor	Water Depth (m) w.r.t. CD	Texture
33.5	0.4	1.162	-0.8	Fine Sand
33.6	0.4	1.162	-0.8	Fine Sand
33.7	0.4	1.162	-0.8	Fine Sand
33.8	0.4	1.162	-0.8	Fine Sand
33.9	0.4	1.162	-0.8	Fine Sand
34	1.1	1.162	-0.1	Fine Sand
34.1	1.1	1.162	-0.1	Fine Sand
34.2	1.1	1.162	-0.1	Fine Sand
34.3	1.1	1.162	-0.1	Fine Sand
34.4	1.1	1.162	-0.1	Fine Sand
34.5	0.4	1.162	-0.8	Fine Sand
34.6	0.4	1.162	-0.8	Fine Sand
34.7	0.4	1.162	-0.8	Fine Sand
34.8	0.4	1.162	-0.8	Fine Sand
34.9	0.4	1.162	-0.8	Fine Sand
35	0.4	1.162	-0.8	Fine Sand
35.1	0.4	1.162	-0.8	Fine Sand
35.2	0.4	1.162	-0.8	Fine Sand
35.3	2.4	1.162	1.2	Fine Sand
35.4	3.0	1.162	1.8	Fine Sand
35.5	3.7	1.162	2.5	Fine Sand
35.6	3.6	1.162	2.4	Fine Sand
35.7	2.9	1.162	1.7	Fine Sand
35.8	2.4	1.162	1.2	Fine Sand
35.9	1.0	1.162	-0.2	Fine Sand
36	0.4	1.162	-0.8	Fine Sand

Brahmani River

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
0	0.2	0.812	-0.6	Fine Sand
0.1	0.2	0.812	-0.6	Fine Sand
0.2	0.2	0.812	-0.6	Fine Sand
0.3	0.2	0.812	-0.6	Fine Sand
0.4	0.6	0.812	-0.2	Fine Sand
0.5	0.8	0.812	0	Fine Sand
0.6	0.6	0.812	-0.2	Fine Sand
0.7	0.6	0.812	-0.2	Fine Sand
0.8	0.6	0.812	-0.2	Fine Sand
0.9	0.4	0.812	-0.4	Fine Sand
1	0.2	0.812	-0.6	Fine Sand
1.1	0.6	0.812	-0.2	Fine Sand
1.2	0.6	0.812	-0.2	Fine Sand
1.3	0.8	0.812	0	Fine Sand
1.4	2.0	0.812	1.2	Fine Sand
1.5	2.7	0.812	1.9	Fine Sand
1.6	2.3	0.812	1.5	Fine Sand
1.7	2.3	0.812	1.5	Fine Sand
1.8	0.6	0.812	-0.2	Fine Sand
1.9	0.6	0.812	-0.2	Fine Sand
2	0.2	0.812	-0.6	Fine Sand
2.1	0.2	0.812	-0.6	Fine Sand
2.2	0.2	0.812	-0.6	Fine Sand
2.3	0.2	0.812	-0.6	Fine Sand
2.4	0.2	0.812	-0.6	Fine Sand
2.5	0.2	0.812	-0.6	Fine Sand
2.6	0.6	0.812	-0.2	Fine Sand
2.7	0.8	0.812	0	Fine Sand
2.8	0.4	0.812	-0.4	Fine Sand
2.9	0.4	0.812	-0.4	Fine Sand
3	0.2	0.812	-0.6	Fine Sand
3.1	0.2	0.812	-0.6	Fine Sand
3.2	0.2	0.812	-0.6	Fine Sand
3.3	0.6	0.812	-0.2	Fine Sand
3.4	0.6	0.812	-0.2	Fine Sand
3.5	0.9	0.812	0.1	Fine Sand
3.6	0.9	0.812	0.1	Fine Sand
3.7	0.6	0.812	-0.2	Fine Sand
3.8	0.6	0.812	-0.2	Fine Sand
3.9	0.6	0.812	-0.2	Fine Sand
4	0.2	0.812	-0.6	Fine Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
4.1	0.2	0.812	-0.6	Fine Sand
4.2	0.2	0.812	-0.6	Fine Sand
4.3	0.2	0.812	-0.6	Fine Sand
4.4	0.2	0.812	-0.6	Fine Sand
4.5	0.2	0.812	-0.6	Fine Sand
4.6	0.4	0.812	-0.4	Fine Sand
4.7	0.4	0.812	-0.4	Fine Sand
4.8	0.4	0.812	-0.4	Fine Sand
4.9	0.6	0.812	-0.2	Fine Sand
5	1.2	0.812	0.4	Fine Sand
5.1	1.2	0.812	0.4	Fine Sand
5.2	1.2	0.812	0.4	Fine Sand
5.3	1.2	0.812	0.4	Fine Sand
5.4	1.2	0.812	0.4	Fine Sand
5.5	1.0	0.812	0.2	Fine Sand
5.6	1.0	0.812	0.2	Fine Sand
5.7	1.0	0.812	0.2	Fine Sand
5.8	1.0	0.812	0.2	Fine Sand
5.9	0.6	0.812	-0.2	Fine Sand
6	0.2	0.812	-0.6	Fine Sand
6.1	0.1	0.812	-0.7	Fine Sand
6.2	0.1	0.812	-0.7	Fine Sand
6.3	0.1	0.812	-0.7	Fine Sand
6.4	0.1	0.812	-0.7	Fine Sand
6.5	0.4	0.812	-1.2	Fine Sand
6.6	0.1	0.812	-0.7	Fine Sand
6.7	0.1	0.812	-0.7	Fine Sand
6.8	0.1	0.812	-0.7	Fine Sand
6.9	0.1	0.812	-0.7	Fine Sand
7	0.4	0.26	-0.2	Fine Sand
7.1	0.4	0.26	0.2	Fine Sand
7.2	0.2	0.26	0.5	Fine Sand
7.3	0.2	0.26	0.5	Fine Sand
7.4	0.2	0.26	0.5	Fine Sand
7.5	0.5	0.26	0.8	Fine Sand
7.6	0.5	0.26	0.8	Fine Sand
7.7	0.5	0.26	0.8	Fine Sand
7.8	0.5	0.26	0.8	Mud Sand
7.9	0.3	0.26	0.6	Mud Sand
8	0.1	0.26	0.4	Mud Sand
8.1	0.1	0.26	0.4	Mud Sand
8.2	0.1	0.26	0.4	Mud Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
8.3	0.1	0.26	0.4	Mud Sand
8.4	0.4	0.26	0	Mud Sand
8.5	0.4	0.26	-0.1	Mud Sand
8.6	0.4	0.26	-0.1	Mud Sand
8.7	0.4	0.26	-0.1	Mud Sand
8.8	0.1	0.26	0.2	Mud Sand
8.9	0.1	0.26	0.2	Mud Sand
9	0.2	0.26	0.5	Mud Sand
9.1	0.2	0.26	0.5	Mud Sand
9.2	0.2	0.26	0.5	Mud Sand
9.3	0.5	0.26	-0.2	Mud Sand
9.4	0.7	0.26	-0.4	Mud Sand
9.5	0.9	0.26	-0.6	Mud Sand
9.6	0.9	0.26	-0.6	Mud Sand
9.7	0.1	0.26	0.2	Mud Sand
9.8	0.3	0.26	0.6	Mud Sand
9.9	0.4	0.26	0.7	Mud Sand
10	0.9	0.26	1.2	Mud Sand
10.1	0.9	0.26	1.2	Mud Sand
10.2	0.5	0.26	0.8	Mud Sand
10.3	0.5	0.26	0.8	Mud Sand
10.4	0.4	0.26	0.2	Mud Sand
10.5	0.7	0.26	-0.4	Mud Sand
10.6	0.7	0.26	-0.4	Mud Sand
10.7	0.1	0.26	0.2	Mud Sand
10.8	0.1	0.26	0.4	Mud Sand
10.9	0.2	0.26	0.5	Mud Sand
11	0.2	0.26	0.5	Mud Sand
11.1	0.2	0.26	0.5	Mud Sand
11.2	0.2	0.26	0.5	Mud Sand
11.3	0.9	0.26	1.2	Mud Sand
11.4	0.9	0.26	1.2	Mud Sand
11.5	1.2	0.26	1.5	Mud Sand
11.6	1.2	0.26	1.5	Mud Sand
11.7	1.2	0.26	1.5	Mud Sand
11.8	0.9	0.26	1.2	Mud Sand
11.9	0.9	0.26	1.2	Mud Sand
12	0.5	0.26	0.8	Mud Sand
12.1	0.9	0.26	1.2	Mud Sand
12.2	0.9	0.26	1.2	Mud Sand
12.3	0.9	0.26	1.2	Mud Sand
12.4	0.9	0.26	1.2	Mud Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
12.5	1.1	0.26	1.4	Mud Sand
12.6	1.1	0.26	1.4	Mud Sand
12.7	1.1	0.26	1.4	Mud Sand
12.8	1.1	0.26	1.4	Mud Sand
12.9	0.9	0.26	1.2	Mud Sand
13	0.3	0.26	0.6	Mud Sand
13.1	0.9	0.26	1.2	Mud Sand
13.2	0.9	0.26	1.2	Mud Sand
13.3	0.9	0.26	1.2	Mud Sand
13.4	0.9	0.26	1.2	Mud Sand
13.5	1.8	0.26	2.1	Mud Sand
13.6	1.5	0.26	1.8	Mud Sand
13.7	1.5	0.26	1.8	Mud Sand
13.8	1.5	0.26	1.8	Mud Sand
13.9	1.5	0.26	1.8	Mud Sand
14	1.0	0.26	1.3	Mud Sand
14.1	1.1	0.26	1.4	Mud Sand
14.2	1.1	0.26	1.4	Mud Sand
14.3	3.2	0.26	3.5	Mud Sand
14.4	3.2	0.26	3.5	Mud Sand
14.5	5.1	0.26	5.4	Mud Sand
14.6	4.3	0.26	4.6	Mud Sand
14.7	4.3	0.26	4.6	Mud Sand
14.8	4.3	0.26	4.6	Mud Sand
14.9	2.9	0.26	3.2	Mud Sand
15	1.9	0.26	2.2	Mud Sand
15.1	1.4	0.26	1.7	Mud Sand
15.2	1.4	0.26	1.7	Mud Sand
15.3	1.4	0.26	1.7	Mud Sand
15.4	1.4	0.26	1.7	Mud Sand
15.5	1.2	0.26	1.5	Mud Sand
15.6	2.9	0.26	3.2	Mud Sand
15.7	2.9	0.26	3.2	Mud Sand
15.8	2.9	0.26	3.2	Mud Sand
15.9	5.3	0.26	5.6	Mud Sand
16	8.2	0.26	8.5	Mud Sand
16.1	8.2	0.26	8.5	Mud Sand
16.2	8.2	0.26	8.5	Mud Sand
16.3	8.2	0.26	8.5	Mud Sand
16.4	8.8	0.26	9.1	Mud Sand
16.5	9.0	0.26	9.3	Mud Sand
16.6	7.5	0.26	7.8	Mud Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
16.7	7.5	0.26	7.8	Mud Sand
16.8	7.5	0.26	7.8	Mud Sand
16.9	5.3	0.26	5.6	Mud Sand
17	3.8	0.26	4.1	Mud Sand
17.1	4.8	0.26	5.1	Mud Sand
17.2	4.8	0.26	5.1	Mud Sand
17.3	4.8	0.26	5.1	Mud Sand
17.4	4.8	0.26	5.1	Mud Sand
17.5	5.0	0.26	5.3	Mud Sand
17.6	5.0	0.26	5.3	Mud Sand
17.7	5.0	0.26	5.3	Mud Sand
17.8	5.0	0.26	5.3	Mud Sand
17.9	4.3	0.26	4.6	Mud Sand
18	3.2	0.26	3.5	Mud Sand
18.1	3.2	0.34	3.5	Mud Sand
18.2	3.2	0.34	3.5	Mud Sand
18.3	3.2	0.34	3.5	Mud Sand
18.4	3.2	0.34	3.5	Mud Sand
18.5	2.9	0.34	3.2	Mud Sand
18.6	2.9	0.34	3.2	Mud Sand
18.7	2.9	0.34	3.2	Mud Sand
18.8	2.9	0.34	3.2	Mud Sand
18.9	2.9	0.34	3.2	Mud Sand
19	1.0	0.34	1.3	Mud Sand
19.1	1.0	0.34	1.3	Mud Sand
19.2	1.0	0.34	1.3	Mud Sand
19.3	1.0	0.34	1.3	Mud Sand
19.4	1.0	0.34	1.3	Mud Sand
19.5	1.4	0.34	1.7	Mud Sand
19.6	1.4	0.34	1.7	Mud Sand
19.7	1.4	0.34	1.7	Mud Sand
19.8	2.2	0.34	2.5	Mud Sand
19.9	2.2	0.34	2.5	Mud Sand
20	3.4	0.34	3.7	Mud Sand
20.1	3.4	0.34	3.7	Mud Sand
20.2	3.4	0.34	3.7	Mud Sand
20.3	5.3	0.34	5.6	Mud Sand
20.4	6.0	0.34	6.3	Coarse Sand
20.5	6.9	0.34	7.2	Coarse Sand
20.6	6.9	0.34	7.2	Coarse Sand
20.7	6.9	0.34	7.2	Coarse Sand
20.8	6.9	0.34	7.2	Coarse Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
20.9	4.2	0.34	4.5	Coarse Sand
21	1.9	0.34	2.2	Coarse Sand
21.1	1.9	0.34	2.2	Coarse Sand
21.2	1.9	0.34	2.2	Coarse Sand
21.3	1.9	0.34	2.2	Coarse Sand
21.4	0.9	0.34	1.2	Coarse Sand
21.5	0.7	0.34	1	Coarse Sand
21.6	1.9	0.34	2.2	Coarse Sand
21.7	1.9	0.34	2.2	Coarse Sand
21.8	1.9	0.34	2.2	Coarse Sand
21.9	1.9	0.34	2.2	Coarse Sand
22	4.0	0.34	4.3	Coarse Sand
22.1	3.3	0.34	3.6	Coarse Sand
22.2	3.3	0.34	3.6	Coarse Sand
22.3	3.3	0.34	3.6	Coarse Sand
22.4	3.3	0.34	3.6	Coarse Sand
22.5	3.3	0.34	3.6	Coarse Sand
22.6	3.3	0.34	3.6	Coarse Sand
22.7	3.3	0.34	3.6	Coarse Sand
22.8	4.4	0.34	4.7	Coarse Sand
22.9	4.4	0.34	4.7	Coarse Sand
23	5.8	0.34	6.1	Coarse Sand
23.1	5.8	0.34	6.1	Coarse Sand
23.2	5.8	0.34	6.1	Coarse Sand
23.3	5.8	0.34	6.1	Coarse Sand
23.4	3.5	0.34	3.8	Coarse Sand
23.5	2.5	0.34	2.8	Coarse Sand
23.6	2.5	0.34	2.8	Coarse Sand
23.7	2.5	0.34	2.8	Coarse Sand
23.8	2.5	0.34	2.8	Coarse Sand
23.9	2.5	0.34	2.8	Coarse Sand
24	2.1	0.34	2.4	Coarse Sand
24.1	2.1	0.34	2.4	Coarse Sand
24.2	2.1	0.34	2.4	Coarse Sand
24.3	2.1	0.34	2.4	Coarse Sand
24.4	2.1	0.34	2.4	Coarse Sand
24.5	1.9	0.34	2.2	Coarse Sand
24.6	1.9	0.34	2.2	Coarse Sand
24.7	1.9	0.34	2.2	Coarse Sand
24.8	1.9	0.34	2.2	Coarse Sand
24.9	1.9	0.34	2.2	Coarse Sand
25	4.1	0.34	4.4	Coarse Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
25.1	4.1	0.34	4.4	Coarse Sand
25.2	4.1	0.34	4.4	Coarse Sand
25.3	4.1	0.34	4.4	Coarse Sand
25.4	5.1	0.34	5.4	Coarse Sand
25.5	5.4	0.34	5.7	Coarse Sand
25.6	5.4	0.34	5.7	Coarse Sand
25.7	5.4	0.34	5.7	Coarse Sand
25.8	5.4	0.34	5.7	Coarse Sand
25.9	5.4	0.34	5.7	Coarse Sand
26	2.1	0.34	2.4	Coarse Sand
26.1	2.1	0.34	2.4	Coarse Sand
26.2	2.1	0.34	2.4	Coarse Sand
26.3	2.1	0.34	2.4	Coarse Sand
26.4	2.1	0.34	2.4	Coarse Sand
26.5	2.5	0.34	2.8	Coarse Sand
26.6	2.5	0.34	2.8	Coarse Sand
26.7	2.5	0.34	2.8	Coarse Sand
26.8	2.5	0.34	2.8	Coarse Sand
26.9	0.9	0.34	1.2	Coarse Sand
27	0.5	0.34	-0.2	Coarse Sand
27.1	0.5	0.34	-0.2	Coarse Sand
27.2	0.4	0.34	0.2	Coarse Sand
27.3	0.4	0.34	0.2	Coarse Sand
27.4	0.4	0.34	0.2	Coarse Sand
27.5	0.4	0.34	0.2	Coarse Sand
27.6	0.4	0.34	0.2	Coarse Sand
27.7	0.4	0.34	0.2	Coarse Sand
27.8	0.4	0.34	0.2	Coarse Sand
27.9	0.9	0.34	1.2	Coarse Sand
28	2.7	0.3	3	Coarse Sand
28.1	2.7	0.3	3	Coarse Sand
28.2	1.9	0.3	2.2	Coarse Sand
28.3	1.9	0.3	2.2	Coarse Sand
28.4	1.9	0.3	2.2	Coarse Sand
28.5	1.3	0.3	1.6	Coarse Sand
28.6	1.3	0.3	1.6	Coarse Sand
28.7	1.3	0.3	1.6	Coarse Sand
28.8	4.2	0.3	4.5	Coarse Sand
28.9	5.9	0.3	6.2	Coarse Sand
29	8.0	0.3	8.3	Coarse Sand
29.1	8.0	0.3	8.3	Coarse Sand
29.2	8.0	0.3	8.3	Coarse Sand

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
29.3	8.0	0.3	8.3	Coarse Sand
29.4	8.0	0.3	8.3	Coarse Sand
29.5	8.3	0.3	8.6	Coarse Sand
29.6	6.9	0.3	7.2	Coarse Sand
29.7	6.2	0.3	6.5	Coarse Sand
29.8	5.1	0.3	5.4	Coarse Sand
29.9	3.1	0.3	3.4	Coarse Sand
30	1.7	0.3	2	Coarse Sand
30.1	1.7	0.3	2	Coarse Sand
30.2	1.7	0.3	2	Coarse Sand
30.3	1.7	0.3	2	Coarse Sand
30.4	1.7	0.3	2	Coarse Sand
30.5	1.7	0.3	2	Coarse Sand
30.6	1.7	0.3	2	Coarse Sand
30.7	1.7	0.3	2	Coarse Sand
30.8	1.7	0.3	2	Coarse Sand
30.9	0.9	0.3	1.2	Coarse Sand
31	0.4	0.3	0.2	Coarse Sand
31.1	0.4	0.3	0.2	Coarse Sand
31.2	0.4	0.3	0.2	Coarse Sand
31.3	0.4	0.3	0.2	Coarse Sand
31.4	0.4	0.3	0.2	Coarse Sand
31.5	0.3	0.3	0.6	Coarse Sand
31.6	0.3	0.3	0.6	Coarse Sand
31.7	0.3	0.3	0.6	Coarse Sand
31.8	0.3	0.3	0.6	Coarse Sand
31.9	0.3	0.3	0.6	Coarse Sand
32	0.6	0.3	-0.3	Coarse Sand
32.1	0.6	0.3	-0.3	Coarse Sand
32.2	0.5	0.3	-0.2	Coarse Sand
32.3	0.5	0.3	-0.2	Coarse Sand
32.4	0.5	0.3	-0.2	Coarse Sand
32.5	0.3	0.3	0	Mud Silt
32.6	0.4	0.3	0.2	Mud Silt
32.7	4.2	0.3	4.5	Mud Silt
32.8	6.8	0.3	7.1	Mud Silt
32.9	9.9	0.3	10.2	Mud Silt
33	14.4	0.3	14.7	Mud Silt
33.1	14.4	0.3	14.7	Mud Silt
33.2	14.4	0.3	14.7	Mud Silt
33.3	14.4	0.3	14.7	Mud Silt
33.4	14.4	0.3	14.7	Mud Silt

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
33.5	16.1	0.3	16.4	Mud Silt
33.6	13.9	0.3	14.2	Mud Silt
33.7	9.9	0.3	10.2	Mud Silt
33.8	5.3	0.3	5.6	Mud Silt
33.9	1.9	0.3	2.2	Mud Silt
34	0.8	0.3	-0.5	Mud Silt
34.1	0.8	0.3	-0.5	Mud Silt
34.2	0.8	0.3	-0.5	Mud Silt
34.3	1.9	0.3	2.2	Mud Silt
34.4	5.3	0.3	5.6	Mud Silt
34.5	10.2	0.3	10.5	Mud Silt
34.6	10.2	0.3	10.5	Mud Silt
34.7	10.2	0.3	10.5	Mud Silt
34.8	10.2	0.3	10.5	Mud Silt
34.9	10.2	0.3	10.5	Mud Silt
35	9.4	0.3	9.7	Mud Silt
35.1	9.4	0.3	9.7	Mud Silt
35.2	9.4	0.3	9.7	Mud Silt
35.3	9.4	0.3	9.7	Mud Silt
35.4	9.4	0.3	9.7	Mud Silt
35.5	8.1	0.3	8.4	Mud Silt
35.6	6.9	0.3	7.2	Mud Silt
35.7	5.3	0.3	5.6	Mud Silt
35.8	3.1	0.3	3.4	Mud Silt
35.9	3.0	0.3	3.3	Mud Silt
36	1.7	0.3	2	Mud Silt
36.1	1.7	0.3	2	Mud Silt
36.2	1.7	0.3	2	Mud Silt
36.3	1.7	0.3	2	Mud Silt
36.4	1.7	0.3	2	Mud Silt
36.5	0.9	0.3	1.2	Mud Silt
36.6	1.9	0.3	2.2	Mud Silt
36.7	1.9	0.3	2.2	Mud Silt
36.8	1.9	0.3	2.2	Mud Silt
36.9	1.9	0.3	2.2	Mud Silt
37	2.7	0.3	3	Mud Silt
37.1	2.7	0.3	3	Mud Silt
37.2	2.7	0.3	3	Mud Silt
37.3	2.7	0.3	3	Mud Silt
37.4	2.7	0.3	3	Mud Silt
37.5	2.3	0.3	2.6	Mud Silt
37.6	2.3	0.3	2.6	Mud Silt

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
37.7	2.3	0.3	2.6	Mud Silt
37.8	2.3	0.3	2.6	Mud Silt
37.9	2.3	0.3	2.6	Mud Silt
38	1.3	0.37	1.7	Mud Silt
38.1	1.3	0.37	1.7	Mud Silt
38.2	1.3	0.37	1.7	Mud Silt
38.3	2.8	0.37	3.2	Mud Silt
38.4	3.8	0.37	4.2	Mud Silt
38.5	4.5	0.37	4.9	Mud Silt
38.6	4.5	0.37	4.9	Mud Silt
38.7	3.0	0.37	3.4	Mud Silt
38.8	3.0	0.37	3.4	Mud Silt
38.9	3.0	0.37	3.4	Mud Silt
39	2.7	0.37	3.1	Mud Silt
39.1	2.7	0.37	3.1	Mud Silt
39.2	2.7	0.37	3.1	Mud Silt
39.3	2.7	0.37	3.1	Mud Silt
39.4	3.2	0.37	3.6	Mud Silt
39.5	3.4	0.37	3.8	Mud Silt
39.6	3.4	0.37	3.8	Mud Silt
39.7	3.4	0.37	3.8	Mud Silt
39.8	1.8	0.37	2.2	Mud Silt
39.9	1.8	0.37	2.2	Mud Silt
40	0.7	0.37	1.1	Mud Silt
40.1	0.7	0.37	1.1	Mud Silt
40.2	0.7	0.37	1.1	Mud Silt
40.3	0.7	0.37	1.1	Mud Silt
40.4	0.7	0.37	1.1	Mud Silt
40.5	1.2	0.37	1.6	Mud Silt
40.6	1.2	0.37	1.6	Mud Silt
40.7	1.2	0.37	1.6	Mud Silt
40.8	1.2	0.37	1.6	Mud Silt
40.9	1.8	0.37	2.2	Mud Silt
41	3.3	0.37	3.7	Mud Silt
41.1	3.3	0.37	3.7	Mud Silt
41.2	3.3	0.37	3.7	Mud Silt
41.3	2.3	0.37	2.7	Mud Silt
41.4	2.3	0.37	2.7	Mud Silt
41.5	1.9	0.37	2.3	Mud Silt
41.6	1.9	0.37	2.3	Mud Silt
41.7	1.9	0.37	2.3	Mud Silt
41.8	1.9	0.37	2.3	Mud Silt

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
41.9	0.6	0.37	-0.2	Mud Silt
42	0.8	0.37	-0.4	Mud Silt
42.1	0.8	0.37	-0.4	Mud Silt
42.2	0.2	0.37	0.2	Mud Silt
42.3	0.8	0.37	1.2	Mud Silt
42.4	2.5	0.37	2.9	Mud Silt
42.5	3.7	0.37	4.1	Mud Silt
42.6	3.7	0.37	4.1	Mud Silt
42.7	3.2	0.37	3.6	Mud Silt
42.8	3.2	0.37	3.6	Mud Silt
42.9	3.2	0.37	3.6	Mud Silt
43	2.6	0.37	3	Mud Silt
43.1	3.8	0.37	4.2	Mud Silt
43.2	3.8	0.37	4.2	Mud Silt
43.3	3.8	0.37	4.2	Mud Silt
43.4	3.8	0.37	4.2	Mud Silt
43.5	4.6	0.37	5	Mud Silt
43.6	4.2	0.37	4.6	Mud Silt
43.7	4.2	0.37	4.6	Mud Silt
43.8	4.2	0.37	4.6	Mud Silt
43.9	2.5	0.37	2.9	Mud Silt
44	1.1	0.37	1.5	Mud Silt
44.1	1.1	0.37	1.5	Mud Silt
44.2	1.1	0.37	1.5	Mud Silt
44.3	1.1	0.37	1.5	Mud Silt
44.4	1.1	0.37	1.5	Mud Silt
44.5	1.0	0.37	1.4	Mud Silt
44.6	1.0	0.37	1.4	Mud Silt
44.7	1.0	0.37	1.4	Mud Silt
44.8	1.0	0.37	1.4	Mud Silt
44.9	1.8	0.37	2.2	Mud Silt
45	2.0	0.37	2.4	Mud Silt
45.1	2.0	0.37	2.4	Mud Silt
45.2	5.2	0.37	5.6	Mud Silt
45.3	6.9	0.37	7.3	Mud Silt
45.4	7.8	0.37	8.2	Mud Silt
45.5	8.2	0.37	8.6	Mud Silt
45.6	7.8	0.37	8.2	Mud Silt
45.7	6.4	0.37	6.8	Mud Silt
45.8	5.0	0.37	5.4	Mud Silt
45.9	3.9	0.37	4.3	Mud Silt
46	2.8	0.37	3.2	Mud Silt

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
46.1	2.8	0.37	3.2	Mud Silt
46.2	2.8	0.37	3.2	Mud Silt
46.3	2.8	0.37	3.2	Mud Silt
46.4	2.8	0.37	3.2	Mud Silt
46.5	2.4	0.37	2.8	Mud Silt
46.6	2.4	0.37	2.8	Mud Silt
46.7	2.4	0.37	2.8	Mud Silt
46.8	2.4	0.37	2.8	Mud Silt
46.9	1.8	0.37	2.2	Mud Silt
47	1.3	0.37	1.7	Mud Silt
47.1	1.3	0.37	1.7	Mud Silt
47.2	1.3	0.37	1.7	Mud Silt
47.3	0.3	0.37	0.7	Mud Silt
47.4	0.3	0.37	0.7	Mud Silt and Clay
47.5	0.0	0.37	0.4	Mud Silt and Clay
47.6	1.9	0.37	2.3	Mud Silt and Clay
47.7	4.1	0.37	4.5	Mud Silt and Clay
47.8	6.3	0.37	6.7	Mud Silt and Clay
47.9	7.8	0.37	8.2	Mud Silt and Clay
48	8.4	0.35	8.7	Mud Silt and Clay
48.1	8.0	0.35	8.3	Mud Silt and Clay
48.2	8.0	0.35	8.3	Mud Silt and Clay
48.3	8.0	0.35	8.3	Mud Silt and Clay
48.4	7.3	0.35	7.6	Mud Silt and Clay
48.5	6.7	0.35	7	Mud Silt and Clay
48.6	6.7	0.35	7	Mud Silt and Clay
48.7	6.7	0.35	7	Mud Silt and Clay
48.8	5.3	0.35	5.6	Mud Silt and Clay
48.9	5.3	0.35	5.6	Mud Silt and Clay
49	3.9	0.35	4.2	Mud Silt and Clay
49.1	3.9	0.35	4.2	Mud Silt and Clay
49.2	3.9	0.35	4.2	Mud Silt and Clay
49.3	3.9	0.35	4.2	Mud Silt and Clay
49.4	3.9	0.35	4.2	Mud Silt and Clay
49.5	4.2	0.35	4.5	Mud Silt and Clay
49.6	4.2	0.35	4.5	Mud Silt and Clay
49.7	4.2	0.35	4.5	Mud Silt and Clay
49.8	3.0	0.35	3.3	Mud Silt and Clay
49.9	3.0	0.35	3.3	Mud Silt and Clay
50	1.7	0.35	2	Mud Silt and Clay
50.1	1.7	0.35	2	Mud Silt and Clay
50.2	1.7	0.35	2	Mud Silt and Clay

Chainage(km)	Observed Water depth	Reduction Factor	Water Depth(m) w.r.t. CD	Texture
50.3	1.7	0.35	2	Mud Silt and Clay
50.4	1.7	0.35	2	Mud Silt and Clay
50.5	1.2	0.35	1.5	Mud Silt and Clay
50.6	1.2	0.35	1.5	Mud Silt and Clay
50.7	1.2	0.35	1.5	Mud Silt and Clay
50.8	1.2	0.35	1.5	Mud Silt and Clay
50.9	1.2	0.35	1.5	Mud Silt and Clay
51	2.1	0.35	2.4	Mud Silt and Clay
51.1	2.1	0.35	2.4	Mud Silt and Clay
51.2	2.1	0.35	2.4	Mud Silt and Clay
51.3	2.1	0.35	2.4	Mud Silt and Clay
51.4	2.1	0.35	2.4	Mud Silt and Clay
51.5	2.5	0.35	2.8	Mud Silt and Clay
51.6	2.5	0.35	2.8	Mud Silt and Clay
51.7	3.1	0.35	3.4	Mud Silt and Clay
51.8	3.1	0.35	3.4	Mud Silt and Clay
51.9	3.1	0.35	3.4	Mud Silt and Clay
52	4.0	0.35	4.3	Mud Silt and Clay
52.1	4.0	0.35	4.3	Mud Silt and Clay
52.2	3.2	0.35	3.5	Mud Silt and Clay
52.3	3.2	0.35	3.5	Mud Silt and Clay
52.4	3.2	0.35	3.5	Mud Silt and Clay
52.5	2.2	0.35	2.5	Mud Silt and Clay
52.6	2.2	0.35	2.5	Mud Silt and Clay
52.7	2.2	0.35	2.5	Mud Silt and Clay
52.8	2.2	0.35	2.5	Mud Silt and Clay
52.9	2.6	0.35	2.9	Mud Silt and Clay
53	3.1	0.35	3.4	Mud Silt and Clay
53.1	3.1	0.35	3.4	Mud Silt and Clay
53.2	3.1	0.35	3.4	Mud Silt and Clay
53.3	3.1	0.35	3.4	Mud Silt and Clay
53.4	3.1	0.35	3.4	Mud Silt and Clay
53.5	3.1	0.35	3.4	Mud Silt and Clay
53.6	4.2	0.35	4.5	Mud Silt and Clay
53.7	5.3	0.35	5.6	Mud Silt and Clay
53.8	6.5	0.35	6.8	Mud Silt and Clay
53.9	6.9	0.35	7.2	Mud Silt and Clay
54	8.0	0.35	8.3	Mud Silt and Clay

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