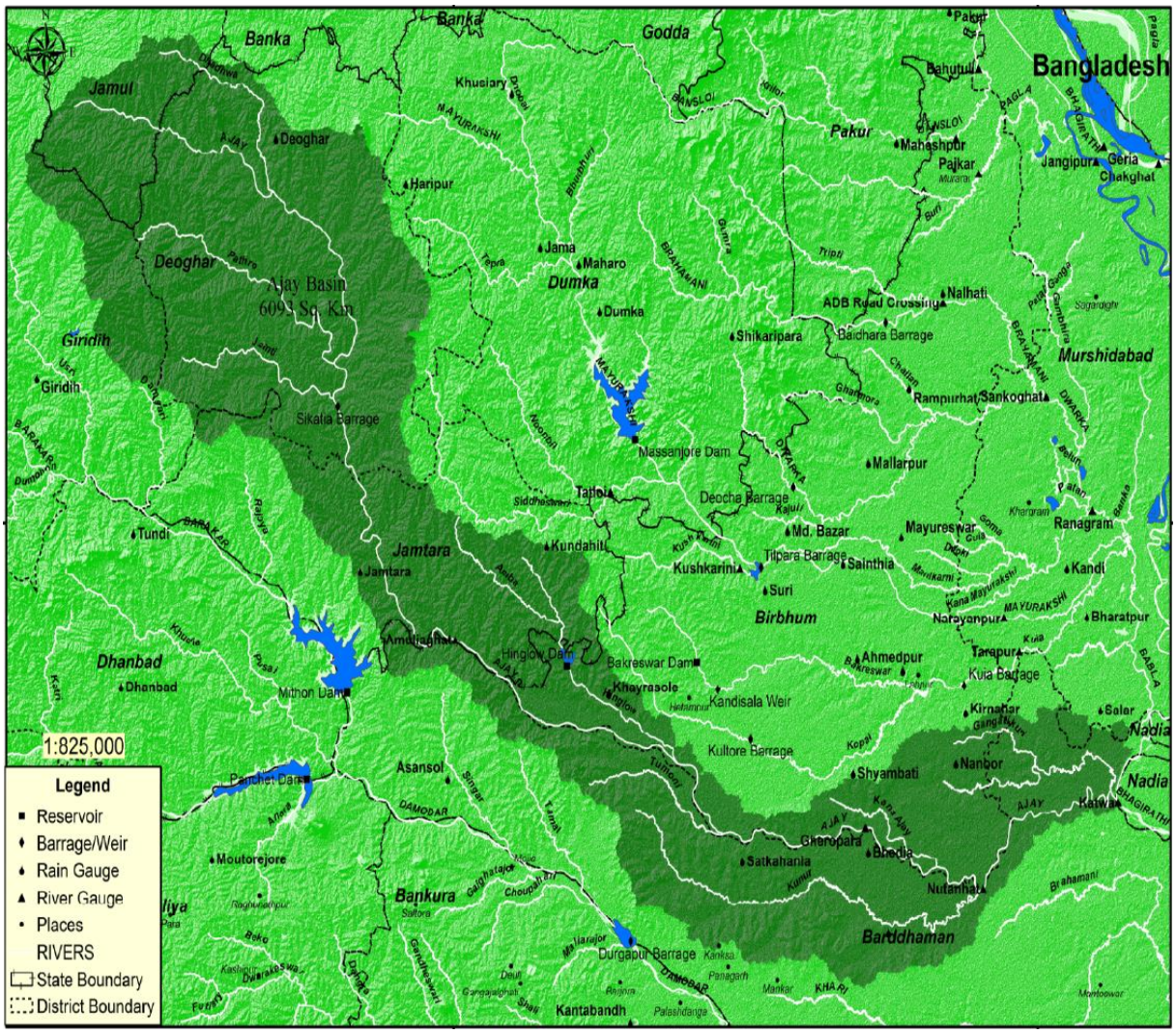
Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of National Waterway 7, Cluster - I: Ajoy River

FINAL FEASIBILTY REPORT



Inland Waterway Authority of India

Cluster – I : Ajoy River

Final Feasibility Report

Revision 0

October 2016

Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of National Waterway 7, Cluster - I: Ajoy River

FINAL FEASIBILITY REPORT

Project **IWAI Cluster-I, Ajoy River**
Owner **IWAI, Ministry of Shipping**
Consultant **Egis India Consulting Engineers**

<table>
<tr><td colspan="3">Authors

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PT/EIPTIWB003

Report No:
PT/EIPTIWB003/2016/FR/001

Approved by:

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<tr><td>0</td><td>Feasibility Report</td><td>Nov 2016</td><td>DM</td><td>AK</td><td>JKP</td></tr>
<tr><td>Revision</td><td>Description</td><td>Date</td><td>Prepared By</td><td>Checked By</td><td>Approved By</td></tr>
<tr><td colspan="2">Version :
Final</td><td>Report</td><td colspan="3">Classification: Restricted</td></tr>
<tr><td colspan="3">Distribution
IWAI</td><td>Digital</td><td colspan="2">Number of copies
3</td></tr>
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IWAI	Inland Waterways Authority of India
IWT	Inland Water Transportation
MOS	Ministry of Shipping
NW	National Waterway
DPR	Detailed Project Report
WW	Waterway
AtoN	Aid to Navigation
VC	Vertical Clearance
HC	Horizontal Clearance

ACKNOWLEDGEMENT

*Egis India Consulting Engineers Pvt Ltd (EIPL) express their gratitude to **Shri Amitabh Verma, IAS, Chairman,** for spending their valuable time and guidance for completing this Project of "Feasibility report of two stage detailed project report of National Waterway 07, Cluster – I, Ajoy River. EIPL would also like to thanks **Shri Pravir Pandey, Vice Chairman IA&AS**.*

*EIPL wishes to express their gratitude to **Cdr. P.K. Srivastava, Hydrographic Chief, IWAI** for his guidance and inspiration for this project. EIPL would also like to thank **Sh. Rajiv Singhal, A.H.S., IWAI** for their invaluable support and suggestions provided throughout the project duration. EIPL is pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation throughout the project duration.*

SALIENT FEATURES

<table>
<tr><th>Sl. No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>Egis India Consulting Engineers Pvt. Ltd.</td></tr>
<tr><td>2.</td><td>Cluster number</td><td>Cluster I</td></tr>
<tr><td>3.</td><td>Waterway stretch (from. To, total length)</td><td>Ajoy River (National Waterway 07)
(From Bridge on Morgram-Panagarh State Highway No 14 at Illambazar Lat 23°36'56.10"N, Long 87°31'58.07"E to confluence of river Ajay with river Bhagirathi at Katwa Lat 23°39'23.33"N, Long 88° 7'56.72"E);
Total Length: 96 Km</td></tr>
<tr><td>4.</td><td>Navigability status</td><td></td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions (from ... to, length, average tidal variation)</td><td>Tidal portion: Not Applicable
Non-tidal: 0 – 96 Km
Tidal variation: Not Applicable</td></tr>
<tr><td>b)</td><td>LAD status
Survey period (.. to ..)
< 1.0 m (km)
1.m to 1.5 m (km)
1.5 m to 2.0 m (km)
> 2.0 m (km)</td><td>
<table>
<tr><th></th><th>0- 20 Km</th><th>20 – 40 Km</th><th>40 – 60 Km</th><th>60 - 96 Km</th><th>Total Km</th></tr>
<tr><td>Survey Period</td><td colspan="5">23rd Jan to 28th Jan 2016</td></tr>
<tr><td>< 1.0 m (Km)</td><td>17.50</td><td>19.80</td><td>20.00</td><td>36.00</td><td>93.30</td></tr>
<tr><td>1 to 1.5 m (Km)</td><td>0.00</td><td>0.20</td><td>0.00</td><td>0.00</td><td>0.20</td></tr>
<tr><td>1.5 to 2.0 m (Km)</td><td>0.42</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.42</td></tr>
<tr><td>> 2.0 m (Km)</td><td>2.08</td><td>0.00</td><td>0.00</td><td>0.00</td><td>2.08</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross structures
i) Dams, wires, barrages etc (number, with navigation locks or not).
ii) Bridges, Power cables etc.</td><td>i) Dams, Weirs, Barrages, Locks = Not Available.
ii) Bridges = 5 numbers, HC (15m - 8m), VC (6.0 m)
iii) HT Line = 1 number, VC (8.0 m)
*Vertical clearance is above HFL on the basis of visual assessment.</td></tr>
</table>

Sl. No.	Particulars	Details
d)	Avg. discharge & no. of days	Request for discharge data was made to CWC, however the same is still awaited. Shall be provided in DPR Stage.
e)	Slope (1 in ..)	Approximate Slope of waterway is 1 in 2400.
f)	Consultants inference	➢ The horizontal and vertical clearance of existing cross-structures is in the range of 15.0 m to 8.0m and 6.0 m respectively. ➢ Taking in to account the water availability, 2.08 Km stretch of waterway have draft more than 2.0 m, 0.42 Km stretch have draft of 1.50 m to 2.0 m, 0.20 km have draft of 1.0 m to 1.50 m and remaining 93.30 km stretch of waterway have less than 1.0 m draft with respect to chart datum ➢ The waterway shall be used for coal transportation to proposed Katwa thermal power plant. Katwa thermal plant is proposed at about 4.5 Km from the waterway and thus the coal can be easily transported by conveyor belt directly from waterway to the site. ➢ The capacity of the waterway can be enhanced by constructing check dams and lockgates at suitable locations on the basis of detailed survey to be done in Stage – 2. ➢ Considering the availability of numerous minor and major industries and connectivity with rail and road network with 5km reach across the bank , the river has huge economic potential for development as a Waterway ➢ Also the connectivity of Ajoy waterway with National Waterway - 1 creates an added advantage for triggering new traffic.
5.	**Traffic potential**	
a)	Present IWT operations, ferry services, tourism, cargo, if any	Not Available

Sl. No.	Particulars	Details
b)	Important industries within 50 km	➢ Katwa Thermal Power Plant ➢ Vertech Valley Paper Products Pvt. Ltd. ➢ National Sugar Industry, ➢ Mayurakshi Cotton Mill Ltd. ➢ Mini Steel Plant ➢ Explosive Slurry Unit.
6.	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	Ajoy waterway is recommended for Stage – II DPR preparation in view of the following potential advantages: a) Connectivity of the waterway with proposed Katwa Thermal Power Plant. b) Direct connectivity with NW-1, Haldia and Kolkata port including their hinterland. c) Increasing cargo potential. d) Reduction in existing traffic load on rail and road infrastructure. In view of the above, it is recommended to develop the Ajoy waterway for large Cargo specially Coal transport for Katwa Thermal Power Plant and Passenger ferry services.

1.0 CONTEXT

IWAI, Ministry of Shipping, Government of India is exploring the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India. Upon completion of feasibility study, IWAI will select the stretches having potential for navigation to undertake a Detailed Project Report. The DPR stage would include detailed hydro-graphic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

There are 106 new waterways has been identified and declared as national waterways as per "The National Waterway Act, 2016", No. 17 of 2016, published in the Gazette of India, Part – II- Section 1 no. 18, New Delhi, Saturday, March 26/2016/Chaitra 6, 1938 (Saka), by Ministry of Law and Justice (Legislative Department).

Out of these 106 waterways, IWAI had invited international online bids for preparation of 2 stage Detailed Project Report (DPR) for National waterways, in a set of 8 Clusters from Cluster I to VIII through Tender No. IWAI/PR/40NW/2015/I. Egis Consulting Engineers was awarded the work for Cluster I and Cluster III respectively.

This feasibility report provides the technical viability of throughout the year inland navigation in the waterways, by taking into account the constraints and other functions of the rivers/canals such as water conveyance, tidal effects, floods, draughts, existing structures etc.

As stated above, 7 rivers out of 106 National waterways are clubbed in Cluster – I of two stages DPR studies for inland waterways project. The detail descriptions of these 7 waterways are presented in **Table 1**. The total length of stretches of 7 rivers under Cluster – I is 820 km. Among these 7 waterways, 5 are connected to the National Waterway 1 between Farakka to Haldia.

Table 1: National Waterways of Cluster - 1

S. No	River	National Waterway No.	Length (km)	Description
1.	Ajoy River	National Waterway 7	96	From Bridge on Morgram-Panagarh State Highway No 14 at Illambazar Lat 23°36'56.10"N, Long 87°31'58.07"E to confluence of river Ajay with river Bhagirathi at Katwa Lat 23°39'23.33"N, Long 88° 7'56.72"E
2.	Damodar River	National Waterway 29	130	From Krishak Setu, Bardhman on State Highway No 8 at Lat 23°12'39.83"N, Long 87°50'53.85"E to confluence with Hooghly river near Purbba Basudebpur at Lat 22°21'0.58"N, Long 88° 5'19.31"E
3.	Dwarekeswar River	National Waterway 35	113	From Bridge near Abantika Lat 23° 6'54.76"N, Long 87°18'46.99"E to confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E.
4.	Ichamati River	National Waterway 44	64	From Bridge on Border Main Road at Gobra near Bangladesh Border at Lat 22°53'49.64"N, Long 88°53'48.87"E to near Bangladesh Border at Bansjhari Mallikpur Lat 22°39'6.71"N, Long 88°55'35.35"E.
5.	Rupnarayan River	National Waterway 86	72	From confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E to confluence with Hooghly river at Geonkhali Lat 22°12'41.58"N, Long 88° 3'13.99"E
6.	Silabati River	National Waterway 92	26	From Barrage near Shimulia village at Lat 22°34'53.20"N, Long 87°38'30.54"E to confluence of Dwarakeswar and Silai rivers at Pratappur Lat 22°40'16.94"N, Long 87°46'42.57"E.
7.	Subarnarekha River	National Waterway 96	314	From Chandil Dam at Lat 22°58'29.39"N, Long 86° 1'14.03"E to confluence with Bay of Bengal at Lat 21°33'28.75"N, Long 87°22'58.60"E.

The detailed layout plan of the above waterways is shown in Drawing No. PT/EIPTIWB003/2016/FR/0001 attached with the report and also provided in **Figure 1**.

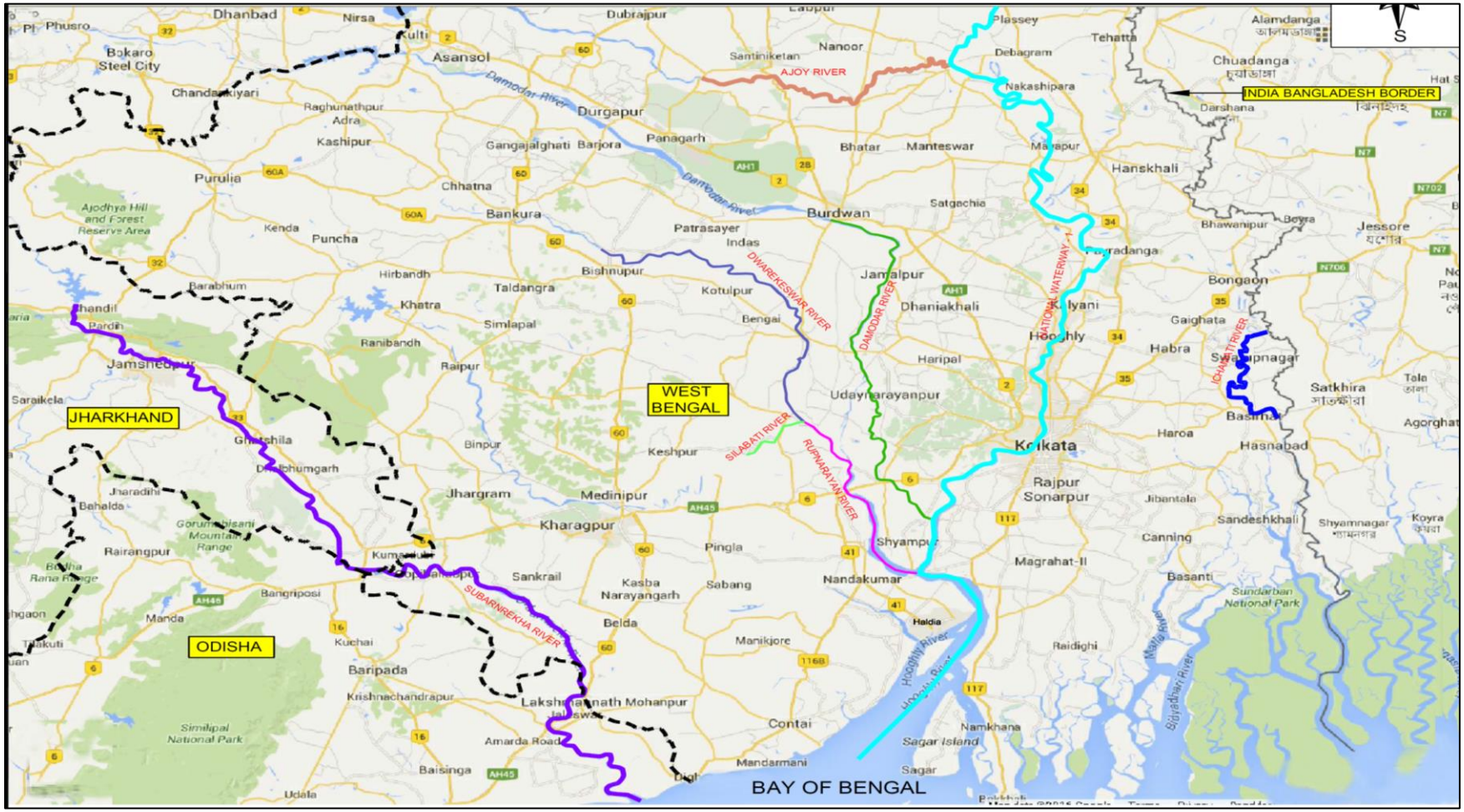

Figure 1: Layout Map of Cluster 1 National Waterways

2.0 OBJECTIVE

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India. The whole of study comprises of two stages, feasibility and DPR as Stage-I and Stage-II as presented below.

Stage-1

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

Stage-2

2A. Hydrographic Survey & hydro-morphological survey

2B. Traffic Survey & Techno economic feasibility

2C. Preparation of Detailed Project Report

The current scope for stage-I is executed as per following framework as per **Figure 2** .

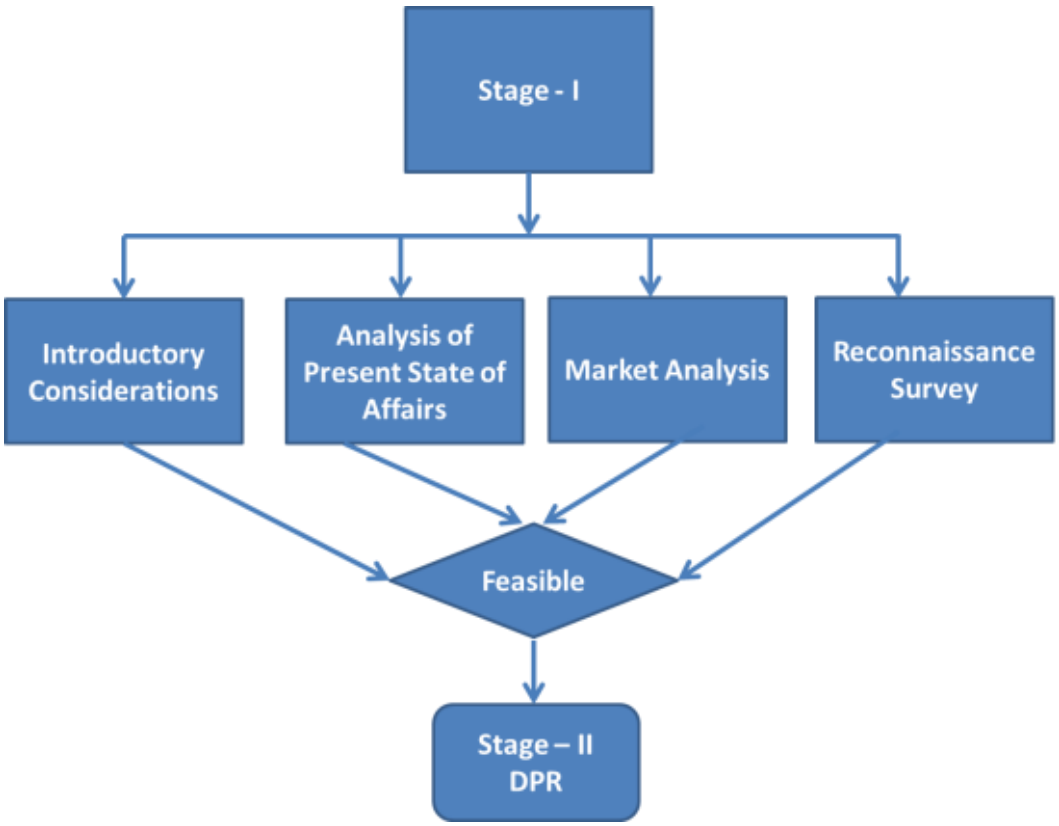

Figure 2: Framework of Studies

3.0 REPORT STRUCTURE

This report comprises of Feasibility Study for Ajoy River (length - 96 Km). The report is arranged in following main chapters,

I. **Introductory Consideration**: This section comprises of,
   1) Name of the river/canal;
   2) Length of the river/canal;
   3) State/ District through which river passes;
   4) Map;
   5) Characteristics of River;
      a. River Course: Background/Historical information, Origin, End
      b. Tributaries/ Network of Rivers/ Basin
   6) Methodology Adopted to undertake the Study;
      a. Primary Data
      b. Secondary Data

II. **Analysis of Present State of Affairs**: This section comprises of,
   1) Existing Dams, Barrages and Locks;
   2) Existing Bridges and Crossings over River;
   3) Other Cross structures, High Tension Lines, pipe-lines, cables;
   4) Hindrances/ Encroachment to the Waterway;
   5) Details of Protected Area- Wildlife, Defence;
   6) NH/SH/MDR along and/or in vicinity;
   7) Railway Line and Stations in the vicinity.

III. **Reconnaissance Survey**: This section provides the,
   1) Methodology adopted including resources and equipment;
   2) Description of Bench marks, reference levels, chart and sounding datum;
   3) Details of collected water levels, discharge data, HFL and FSL;
   4) Details and description of bathymetric and topographic survey including observations;
   5) Detail about Soil, Water and Bank characteristics.

IV. **Market Analysis**: This section comprises of,
   1) Land use pattern along Waterway;
   2) Crop/Agriculture in the region;

3) Availability of Bulk/Construction Material;
4) Existing industries along waterway;
5) Details of existing Jetties and Terminals;
6) Preliminary traffic identified;
7) Existing cargo movement;
8) Prominent City/ Town/ Places of worship/ Historical places for tourism;
9) Availability of passenger ferry services;
10) Available and probable water sport/recreational facilities.

V. **Observation and Inferences**: This section comprises of,
1) Observation on Waterway, Length, LAD, Cross-Structures;
2) Water availability for different periods and depths;
3) Cargo/Passenger/Tourism/RO-RO facility;
4) Suitability of waterway for navigation;
5) Proposed alternative methods for making waterway feasible;
6) SWOT analysis;
7) Way forward for Stage – 2 DPR studies.

In addition to the above, following digital data and charts shall also be submitted along with this report:

I. **Bathymetric Survey**: Hypack software output files with RAW, EDIT, SORT, TIDE extensions;
II. **Topographic Survey**: csv and xyz extension files;
III. **Survey Charts**: Geo-coded dxf and dwg files in scale as per width in AutoCAD formats;

4.0 INTRODUCTORY CONSIDERATIONS

The Consultant discussed here, the introductory considerations for feasibility and the scope of the assignment in subsequent phase of DPR for feasible stretches.

The present feasibility report provides the technical feasibility of Ajoy River, declared as National Waterway 7, clubbed under Cluster – I, as stated in earlier sections. The detail description of waterway analysed in this feasibility report are described in subsequent paragraphs.

4.1 DETAILS OF NATIONAL WATERWAY 7 (AJOY RIVER)

Details of the waterway are as follows:

Table 2: Description of River

Sl. No	Name of the River	Local Name	Length of waterway (km)	State/District through which river passes
1.	Ajoy River	Ajay River	96	**State: Jharkhand** *Deogarh District* *Jamtara District* **State: West Bengal** *Birbhum District* Bardhaman *(Burdwan) District*

Reconnaissance survey of the waterway is done from confluence of the Ajoy River with Bhagirathi River (Chainage 0.0 Km) towards upstream upto Illambazar (Chainage 96 Km).

4.2 CHARACTERISTICS OF AJOY RIVER

Characteristics of Ajoy River considered for waterway is described in subsequent paragraph.

River Course: The Ajoy River originates on a small hill about 300 metres high, southwest of Munger in Bihar. It then flows through Jharkhand and enters West Bengal at Simjuri, near Chittaranjan. It first forms the border between Bardhaman District and Jharkhand and then between Bardhaman District and Birbhum District, and finally it enters Katwa sub-division of Bardhaman district at Nareng village. It then joins the Bhagirathi River at Katwa Town. Total length of the Ajoy is 288 kilometres, out of which 152 kilometres is in West Bengal.

Catchment Area: The catchment area of Ajoy River is 6,093 square kilometres. The upper reaches of the Ajoy pass through hilly regions with laterite soil. It is only from Ausgram in Bardhaman district that the Ajoy flows through alluvial plains.

Tributaries: The important tributaries of the Ajoy are Pathro and Jayanti in Jharkhand, and Tumuni and Kunur in Bardhaman district of West Bengal.

The section of the Ajoy River under feasibility study for inland waterway is presented in Drawing No. PT/EIPTIWB003/2016/FR/0002A and is also presented as **Figure 3**. The detail layout maps of the waterway are shown in Drawing No. PT/EIPTIWB003/2016/FR/0002.

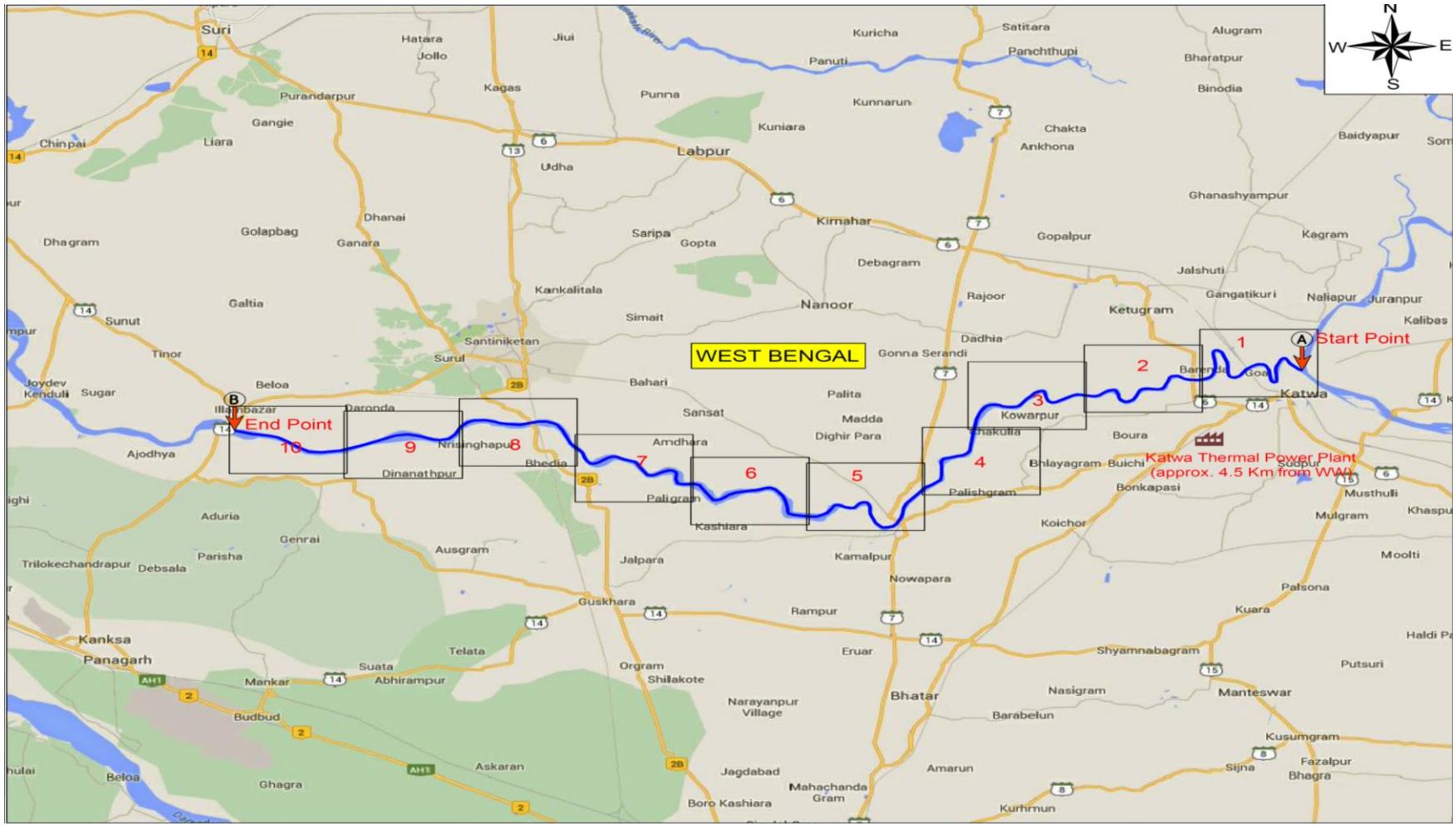

Figure 3: Layout Map of Ajoy River Waterway

4.3 METHODOLOGY ADOPTED FOR FEASIBILITY STUDIES AND CRITERIA FOR DPR STUDY

A detail description on Feasibility & DPR methodology and the expected outcome in fulfilling the assignment is presented.

The feasibility study shall be carried out in accordance with TOR in the following steps:

1. Conducting Reconnaissance survey as detailed in Chapter 5.
2. Collection and review of available primary and secondary data as detailed in Chapter 6 and 7.

On the basis of detailed analysis of collected primary and secondary data, throughout the year navigability potential of the waterway is assessed and submitted in the feasibility report.

4.3.1 Classification of Waterways

The classification of waterways by Inland Waterway Authority of India is discussed below and shall be adopted in the study.

1. The waterways shall be classified in the following categories for safe plying of self-propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000 tonne, namely:

    a. **Class I** - Waterways with the following configuration of navigable channel:-
        i. Rivers: Minimum of 1.2 meter depth, 30 meter bottom width, 300 meter bend radius, 4 meter vertical clearance and 30 meter horizontal clearance between piers, and
        ii. Canals: Minimum of 1.5 meter depth, 20 meter bottom width, 300 meter bends radius, 4 meter vertical clearance and 20 meter horizontal clearance between piers.

    b. **Class II -** Waterways with the following configuration of navigable channel:-
        i. Rivers: Minimum of 1.4 meter depth, 40 meter bottom width, 500 meter bend radius, 5 meter vertical clearance and 40 meter horizontal clearance between piers, and
        ii. Canals: Minimum of 1.8 meter depth, 30 meter bottom width, 500 meter bend radius, 5 meter vertical clearance and 30 meter horizontal clearance between piers.

    c. **Class III -** Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 1.7 meter depth, 50 meter bottom width, 700 meter bend radius, 7 meter vertical clearance and 50 meter horizontal clearance between piers, and

ii. Canals: Minimum of 2.2 meter depth, 40 meter bottom width, 700 meter bend radius, 7 meter vertical clearance and 40 meter horizontal clearance between piers.

d. Class IV - Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.0 meter depth, 50 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 50 meter horizontal clearance between piers, and

ii. Canals: Minimum of 2.5 meter depth, 50 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 50 meter horizontal clearance between piers.

e. Class V - Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.0 meter depth, 80 meter bottom width, 800 meter bend radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers.

f. Class VI - Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.75 meter depth, 80 meter bottom width, 900 meter bend radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers, and

ii. Canals: Minimum of 3.5 meter depth, 60 meter bottom width, 900 meter bend radius, 10 meter vertical clearance and 60 meter horizontal clearance between piers.

g. Class VII -Waterways with the following configuration of navigable channel:-

i. Rivers: Minimum of 2.75 meter and above depth, 100 meter and above bottom width, 900 meter bends radius, 10 meter vertical clearance and 80 meter horizontal clearance between piers.

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

a.	Low voltage transmission lines including telephone lines	-	16.5 meters
b.	High voltage transmission lines, not exceeding 110 kilo volt	-	19.0 meters
c.	High voltage transmission line, exceeding 110 kilo volt	-	19.0 meters
			+1 cm extra for each additional kilovolt

3. In case of underwater pipelines, power cables and other cables, norms to be followed shall be decided as per the site conditions and navigational requirement.

Provided that this classification shall be effective for:

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.

Reference level for vertical clearance in different types of channel shall be:

a. For rivers, over Navigational High Flood Level (NHFL), this is the highest flood level at a frequency of 5% in any year over a period of last twenty years.
b. For tidal canals, over the highest high water level.
c. For other canals, over designed full supply level.

4.3.2 Measures to Improve the Depth

The basic parameters considered for the fairway design are:

- Depth
- Width
- Side slopes
- Bends

As explained above, as the classification of waterways in India is based on the experience gained in various waterways, the characteristic features of the design waterways based on studies carried out by IWAI are furnished below and the same shall be followed.

Fairway Design

The fairway depth should be good enough to ensure steerability of the vessel and to prevent bottom feel. To meet this requirement, the minimum depth that is needed in a channel would commonly be the sum of the draught (draft) of the vessel and other tolerance factors. The tolerance factors to be considered are listed as:

- Factor of keel clearance to avoid touching of the vessel to the ground and minimum free water below the keel for maintaining control on manoeuvring,
- Wave tolerance for the heaving and pitching of the vessel due to wave motion,

- Squat, increase of draft due to ship motion,
- Tolerance for siltation and dredging,
- Increase of draught due to trim and heaving due to unequal loading and steering manoeuvre respectively, and
- Tolerance for the change of draught during the transition from salt water to fresh water.

The keel clearance factor is the prime concern of the all tolerance factors considered. As per the standards laid down by German Code of practice (EAU 80), a 0.3 m layer of water column below the keel of the loaded ship is sufficient for free manoeuvrability of the vessel.

IWAI's experience in inland waterways in India and sub-continent (Bangladesh and Myanmar) shows that the under keel clearance for free manoeuvrability of the vessel varies between 0.2 and 0.5 m depending upon the soil characteristics of the channel bed and other parameters.

Width of a Channel

The total width of a navigation waterway (W) in general is expressed in terms of a beam of a vessel (B). The design width for the proposed two-way navigation can be obtained as:

W = BM + BM1 + C + 2C1

Where: W = Navigation channel width for two-way navigation.

BM = Maneuvering zone for the design vessel which takes into account the directional stability of vessel.

BM1 = Maneuvering zone for the upcoming vessel which takes into account the directional stability of vessel.

C = Width of separating zone.

C1 = Width of the security area, between the maneuvering zone and the channel side which is accounted for environmental and human factors including bank suction.

Values recommended by various authorities for the above equation vary within wide limits. Some of the recommended values are presented here:

BM = 1.3 B to 3.0 B

BM = BM1

C = 0.5 B to 1.0 B

C1 = 0.3 B to 1.5 B

Where, B = Beam of a design vessel.

Based on the experience and recommendations of experts on Inland Waterways, the factors considered for the present design are:

BM = 1.8 B

BM = BM1

C = 0.5 B

C1 = 0.5 B

The designed channel width = 1.8B+1.8B+0.5B+2x0.5B for two way navigation at draft level = 5.1B. The bottom width of the channel for two-way navigation for the design vessel can generally be considered as 5 x B.

Slopes

The selection of slope is in accordance with the soil characteristics of the bed and banks, width of the waterway etc. The adopted channel slope shall be 1:5

Width Allowance at Bends

In bends, the width of the fairway should be more than the width of the canal that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The drift angle is larger for vessels traveling in the downstream than the upstream direction. The drift angle is inversely proportional to the bend radius 'R', that is, the larger the radius the smaller the value of drift angle. Unloaded ships normally subjected to more drift and consequently take up a greater width in bends than loaded ships and therefore the proposed allowance at the keel level of the unloaded ships is larger than the loaded ships.

Dredging of Navigational Channel

The dredging quantities for the above design channel shall be worked out based on the bathymetric surveys carried out. The system and different type of navigation marks shall be proposed in the DPR are given as follows:

- Lateral marks, to mark the left and right sides of the navigation route to be followed by navigator;
- Bifurcation marks, to mark the middle ground between the navigation channel, bifurcated channel and isolated dangers in the middle of the navigational channel;

- Shore marks;
- Bank wise marks, to indicate the channel at point where it approaches a bank;
- Crossing marks, to indicated crossing and alignment of the channel from one bank to another;
- Marks of prohibited areas, to indicate no permission of entry;
- Sound signal marks, to indicate use of horning or other sound signals;
- Marks for traffic control, to control up bound or down bound vessel in one way or sequence passage or to prohibit navigation;
- Marks on bridges, to indicate the passage through bridges;
- Depth indicator marks, to indicate shallow areas ahead in the navigation channel;
- Width indicator marks, to indicate the narrow stretches ahead in the navigational channel;
- River training marks, to indicate the ongoing river training works in the river to the navigators.

4.3.3 IWT Terminal Planning

The terminal planning and design includes selection of suitable sites in the vicinity of cargo potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of covered/open storage facility, cargo handling systems and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities shall be planned. The cost estimate including capital and operating costs shall be estimated for each of the proposed system considering the design. These above aspects are briefly explained in the following subsequent sections.

Planning Considerations

The terminal facilities proposed for this project shall include the following:

i) Berthing Facilities for vessels;
ii) Cargo Storage Facilities;
iii) Cargo Handling Facilities;
iv) Other ancillary Facilities.

Terminal Facilities

The type of cargo handling system required at the terminal is generally dependent on the type of cargo, the annual volume required to be handled and the size of the vessels. The various type of cargo foreseen to be handled at the proposed IWT Terminals are primarily grouped into:

i) Incoming Cargo, and

ii) Outgoing Cargo.

These above two groups are further subdivided into bulk, bagged and other miscellaneous general cargo for the purpose of planning the cargo handling equipment. The quantum and other cargo compositions shall be based on the traffic study. The same may be classified as below:

- Bulk Cargo - Construction materials such as Sand, stone, bricks, Marble, Iron steel, Machinery – Light, Heavy and ODC, Mineral Ore such as coal, lime stone, iron, fly ash, copper ore etc., bamboo, etc.
- Bagged Cargo - Cement, Fertilizer, wine and beverages, acids, cereals, cash crops, wheat, rice, Bajra, gram, pulses, cotton, etc.
- Misc. General Cargo – Consumer goods, animals, oil cake, edible oil, refined oil, paper products, jute products, etc
- Ferry – Passenger vessels for Tourists

4.3.4 Identification of IWT Terminals

Site selection is the most important as it decides the investment for establishing the terminal facilities. Hence, proper consideration has to be given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site shall be carried out with the view of following considerations:

- Water availability near the terminal land throughout the year especially during lean season;
- Stable river channel with sufficient depth;
- Favourable hydraulic conditions for berthing and cargo handling;
- Availability of terminal land for infrastructure, cargo storage and handling;
- Traffic potential and cargo characteristics; and
- Navigational safety.

The proposed IWT Terminals shall be planned with the following infrastructure facilities for operation:

i) Steel Gangway resting on a floating pontoon. The detailed engineering & design of gangway arrangement shall be carried out during the construction stage. The preliminary layout drawing shall be proposed in the DPR;
ii) Administration Building and Bank protection arrangement;
iii) Covered Storage Shed/Transit Shed;
iv) Open storage area;
v) Security Shed;

vi) Forklift Trucks, Pay loaders & Dumper tracks; and

vii) Weigh Bridge, Watch and ward, Compound wall, Firefighting arrangement, Electrical & PH Facilities including DG.

The terminal shall be proposed with suitable mooring facilities, firefighting water line, water supply pipeline, power line for shore connection to barges, fenders etc. Preliminary planning and master plan shall be prepared in the DPR stage as per the relevant IS codes. It is envisaged and proposed that to the extent possible, all shore/river bank based buildings / godown are prefabricated, pre-engineered type conforming to the best standards in vogue in logistic / supply chain industry.

Other Alternatives to Improve for Navigation

Based on our earlier study for Ganga River between the reach from Allahabad to Ghazipur, there are many methods available to improve river navigation. Bandalling work – it has to follow closely falling stage of river, closing minor channels and diverting river flow in single channel to increase depth in the navigable channel in mainly due done by bandalling. In some reaches this method becomes successful but some river stretches remain shallow and need other training measures including dredging. Channelization of river and Construction of barrages at suitable locations, creating ponding conditions with required depth and navigational locks for ships and vessel movement shall be studied. The examination of various options/measures to improve the water depth shall be studied. The most suitable method for development shall be identified with consideration on the likely morphological, sediment transport, and dredging aspects of different options. This task is expected to be fed back into from the financial and economic analysis providing refinement to the proposed development until a recommended solution is reached. The most appropriate type of river development including drudging option along the river shall be identified and likely impacts of these developments on river flow depths as well as sedimentation and morphology shall be investigated. This analysis will constitute an iterative process in which problems relating to LAD will be addressed to find more successful solutions where necessary. This will however, not be an open-ended process as the assessment of techno-economic feasibility updation only requires an indication of the likely costs of building and maintaining the structures which are shown to support achievement of LAD as intended.

4.3.5 Rapid EIA

Suitable Rapid Environmental Impact Assessment shall be performed and report shall be included in final DPR. The Rapid EIA Studies can be broadly divided in to three phases.

- The first phase involves identification of significant environmental components in the area where the project is located and assessing their baseline (pre-project or existing) status within

the study zone. In case of existing projects, environmental performance of existing manufacturing / pollution control plants is also required to be covered.

- The second phase involves prediction of impacts on various identified significant environmental parameters due to proposed project.
- The third phase includes the evaluation of final impacts and delineation of an Environmental Management Plan to mitigate adverse impacts on the quality of surrounding environment.

4.3.6 Concept Design and Cost Estimates

Preliminary Design shall be performed for all the structures /developmental works proposed as per the above analysis and mathematical model studies carried out conforming to relevant IS Codes. Design drawings shall be prepared and submitted based on the preliminary design. Bill of quantities and cost estimates shall be prepared for all the proposed structures / developmental works. Based on the cargo potential and other considerations necessary for locating an IWT terminal, extent of land required for setting up of IWT terminals and other suitable locations shall be identified. Preliminary topographic survey shall be carried out and layout plan for all suggested locations shall be prepared clearly indicating all facilities e.g jetty, approach to jetty, bank protection, covered and open storage, roads, office, sentry hut, boundary wall, bank protection, bunkering facility, water facility, turning circle for IWT vessels location of depth contours of 2m and 2.5m in the river near the terminal sites. Preliminary engineering design and drawings for setting up of terminals with related facilities including mechanical loading/ unloading at the proposed sites shall be prepared. Also inter modal cargo transfer facilities required at these terminals shall be indicated.

4.3.7 Financial and Economic Analysis

Financial and economic analysis through FIRR and EIRR of the project including SWOT analysis shall be carried out for the project. For the Financial Internal Rate of Return shall be computed as follows:

- Costs shall be calculated as total capital investment for the Project components, net rate of interest charges during construction and operations & maintenance costs for the Project;
- Income flows shall be calculated based on gross revenues of projected goods to be transported through private operators with permissible assumptions such as project life etc.;
- Economic Internal Rate of Return shall be computed taking into account the following factors;
- The assumed life of the project as per norms;
- Costs shall be calculated as Government contribution and other sources. A standard conversion factor shall be used to reduce financial costs to economic costs;

- Benefits shall be estimated as Government revenues, calculated as net profit share, royalties and tax;
- Social Benefits like fuel saving, reduction in environment pollution and carbon emission, accident reduction, decongestion of rail and roads, etc.

The financial viability and sustainability of this project depend upon the adaptation to the prevailing context in which they operate. In working out the Financial Viability and sustainability, the following factors shall be considered.

- budgeting and cost accounting systems,
- resource mobilization for capital investments,
- cost recovery and operational financing,
- cost reduction and control.

The Profitability projections and financial analysis for each of the project components shall be worked out in detail and presented in the report. The financial statements shall be prepared on the basis of the suitable assumptions. The cost benefit analysis for the proposed project shall be calculated. The Net Present Value (NPV) with interest and depreciation, IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

4.3.8 Implementation & Monitoring Mechanism

Project financial structuring shall be worked out in detail which will examine the sources and composition of funding for the project. The Project financial structuring can involve a combination of equity, grant, debt and finance from private participation (and in some cases, contribution from user communities). The scope and options for possible debt and private sector financing shall be reviewed elaborately and presented in the report. The suitable monitoring mechanism shall be evolved.

5.0 COLLECTION AND REVIEW OF DATA

5.1 PRIMARY DATA

In order to collect primary data and to access the latest hydro-morphological condition of the National waterways reconnaissance survey was done. Following aspects is covered in the reconnaissance survey as per TOR:

a) Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the national waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

b) Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks en-route are also to be collected horizontal and vertical clearance is to be given as approximate on visual assessment.

c) Photographs are required to be submitted in the report.

d) Topographical features of the Inland Waterways.

e) Typical physical features along the alignment i.e. land use pattern:

f) Preliminary identification of stretches having year round flow and critical depth for navigational purpose.

g) Inventory of major aspects including Inland Waterway width, Terrain, Bridges and structures across the Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features

h) Critical areas requiring detailed investigations and

i) Requirements for carrying out supplementary investigations

j) Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.

k) Type and extent of existing utility services along the alignment.

All the above details are collected during field survey as well as by interaction with the concerned authorities from 23rd January to 28th January 2016 by the Consultant.

5.2 REVIEW OF SECONDARY DATA

River Ajay originates on a small hill about 300 m high, southwest of Munger in Bihar. It then flows through Jharkhand and enters West Bengal at Simjuri, near Chittaranjan. It forms the border between Burdwan and Birbhum districts and finally joins the Bhagirathi River near Katwa of Burdwan. Total length of the Ajay is 288 km out of which 152 km is in West Bengal. The important tributaries of the Ajay are Pathro and Jayanti in Jharkhand, and Tumuni and Kunur in Burdwan district of West Bengal.

There is a Barrage across river Ajay constructed by Govt. of Jharkhand at Sikatia. Sikatia barrage is located about 200 Km upstream of the Illambazar, (End Chainage of 96 Km – Point B as shown in Figure 3). The floods of this river are flashy and of short duration. There are some pockets in the Ajay-Kunur catchment which suffer from frequent inundation. Large areas of Burdwan and Birbhum districts face inundation whenever floods of the Ajay coincide with that of the Mayurakshi, Dwarka and the Bhagirathi. The total catchment area of this Sub-basin is 6,093 sq.km.

Details of catchment area of Ajoy River Sub Basin:

Catchment Area in sq. Km			Total Catchment Area in sq. Km	Tributaries
Bihar	Jharkhand	West Bengal		
385	3203	2505	6093	Pathro, Jayanti, Hinglow, Kunur, Tumoni

Status of river gauges established in Ajoy sub-basin is given as below:

Name of the River	Gauge Station	District	Danger Level (DL) (m amsl)	Extreme Danger Level (EDL) (m amsl)
Ajoy	Amuliaghat	Burdwan	Discharge measuring Gauge	
Jamuna	Geropara	Birbhum	39.42	40.42

Source: Annual Flood Report 2014
DL is considered as HFL for assessing the Minimum Vertical Clearance

6.0 ANALYSIS OF PRESENT STATE OF AFFAIRS

6.1 EXISTING DAMS, BARRAGE & LOCKS

No Dam, Barrage and Locks are located en-route the National waterway on Ajoy River.

6.2 EXISTING BRIDGES ALONG THE WATERWAY

The existing bridges and crossings encountered during survey are listed in **Table 3**.

Table 3: Details of existing Major Road bridges en-route Ajoy Waterway

Sl. No	Location	Chainage (km)	Easting	Northing	Vertical Clearance w.r.t HFL (m)	Horizontal Clearance b/w piers (m)
Major Road Bridges						
1.	Charkhi	14.71	609329.90	2615782.10	6.0	8.0
2.	Nutanghat	43.70	592678.50	2604266.70	6.0	8.0
3	Gheropara	75.28	571653.00	2612047.00	6.0	8.0
Rail Bridges						
1.	Nabagram	6.82	612491.00	2616745.40	8.0	8.0
2.	Gheropara	74.93	571911.98	2612211.25	8.0	15.0

Vertical Clearances are on the basis of visual assessment s per Ref No. 2, page 2 of 27, replies to Pre-bid queries raised by Prospective bidders in Pre-bid meeting held on 23.04.2015, wherein it was clarified by IWAI that, "In Stage –I, horizontal and vertical clearance is to be given as approximate on visual assessment."

It can be inferred from the above table that the horizontal clearance is in the range of **15.0 m to 8.0 m**. Similarly the maximum and minimum vertical clearance is **6.0 m** respectively.

6.3 EXISTING HIGH TENSION LINES AND OTHER CROSS STRUCTURES

High tension wires located en-route the waterway is provided in **Table 4**.

Table 4: Details of Existing High Tension Lines

Sl. No	Location	Chainage	Easting	Northing	Vertical Clearance w.r.t HFL (m)
1	Majkhanra	66.5	577557.70	2608898.40	8.00

Vertical Clearances are on the basis of visual assessment s per Ref No. 2, page 2 of 27, replies to Pre-bid queries raised by Prospective bidders in Pre-bid meeting held on 23.04.2015, wherein it was clarified by IWAI that, "In Stage –I, horizontal and vertical clearance is to be given as approximate on visual assessment."

6.4 HINDRANCES/ ENCROACHMENT ALONG THE WATERWAY

Hindrances/encroachments for waterway are defined as any natural or manmade structure, which can cause obstruction or danger to navigation. In order to start navigation in the waterway, these structures are either to be removed or taken care adequately. These hindrances/encroachments are may be rock outcrop from the river bed, wooden or sand bridges, etc. Major hindrances/encroachments identified en-route the Ajoy waterway are wooden and bamboo bridges which are to be dismantled or re-located as per the navigational requirements. Photographs of the hindrances are provided in **Annexure 4**.

The list of these hindrances is provided in **Table 5**.

Table 5: Details of Hindrances / Encroachment along the Waterway

Sr. No.	Location	Chainage (km)	Easting	Northing
1	Sudharpur Gaon	39.0	585987.40	2606347.30
2	Batuwa Gaon	52.8	594721.60	2607318.70

6.5 FOREST AREA / PROTECTED AREA / DEFENCE AREA

No defence protected or restricted area is located along the waterway.

6.6 ROAD AND RAIL INFRASTRUCTURE

Ajoy waterway is well connected with rail and road network. The details of Railway station located within 5.0 Km radius of the waterway are presented in **Table 6** below.

Table 6: Railway station within 5.0 Km radius of Ajoy Waterway

Sl. No.	Railway Station	Sl. No.	Railway Station
1.	Bolpur - Shantiniketan Railway Station	4.	Shiblun Railway Station
2.	Bhedia Railway Station	5.	Nabagram Kakurhati Railway Station
3.	Ambalgram Railway Station	6.	Katwa Railway Station

Detail of major roads connecting to the Ajoy waterway is provided in **Table 7**.

Table 7: Major Road crossing or within 5.0 Km radius of Ajoy Waterway

National/State Highway	Other Major Roads
a) **National Highway 2B** b) **State Highway 6** c) **State Highway 7** d) **State Highway 13** e) **State Highway 14**	a) Churpuni Majigram Road b) Katwa Natunhat Road c) Natunhat Guskara Road d) Morgram Panagarh Road

7.0 RECONNAISSANCE SURVEY

Egis, India carried out the reconnaissance survey as required for the feasibility studies and detailed as per TOR as below.

- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System.
- Horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be charted.
- Details about Barrages and Dams en-route are also to be reported.
- Topographical features of the Inland Waterways are to be reported.
- Typical physical features along the alignment i.e. land use pattern are to be reported
- Stretches having year round flow and critical depth for navigational purpose are to be reported.
- Preliminary Traffic on the Inland Waterways is to be identified.
- Inventory of major aspects including Inland Waterway width, Terrain, Bridges and structures across the Inland Waterways (Type, size and location) will be reported.
- Urban areas (location extent) are to be reported.
- Geologically sensitive areas environmental features are to be reported
- Hydrological features are to be reported.
- Critical areas requiring detailed investigations are to be reported.
- Requirements for carrying out supplementary investigations are to be reported.
- Visual inspection of Soil (textural classifications) are to be reported
- Major Drainage conditions are to be reported.
- Type and extent of existing utility services along the alignment are to be identified.
- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

7.1 DETAIL METHODOLOGY FOR SURVEY

The team of experienced and qualified surveyors were deployed to carry out the reconnaissance survey; the detailed methodology is described in following sub sections.

7.1.1 Resource for Survey Work

Off shore Key Personal:

- Project in-charge: 1 no.
- Senior Surveyor: 4 nos.
- Survey Engineer: 3 nos.

On shore Key Personal:

- Project manager: 1 no.
- Survey manager: 2 nos.
- Reports Coordinator: 1 no.

Survey Equipment and Software:

Table 8: List of Equipment Mobilised for Survey

Equipment/System	Description/Make/Model
Software / Navigation	HYPACK 2015 computer acquisition and data logging Software
Positioning System	Trimble SPS 351(DGPS) & 855 RTK DGPS (One Base & Two Rover)
Single beam Echo Sounder	Sonar Mite
Tidal Observation	Valeport Automatic Tide Gauge/ Manual Tide Gauge
Levelling	Sokkia B40 Auto Level
Total Station	Trimble TS 635
Data Acquisition System	Dell laptop/ HP laptop

Survey Vessel

Inflatable Zodiac Boat "Aqua Marina-1", "Aqua Marina 2" were used to carry out bathymetric survey. The names and specifications of the survey boats are provided in **Table 9**.

Table 9: Details of Survey Boats Used

Name of the Boat	Length (m)	Width (m)	Draft (m)
Aqua Marina - 1	3.0	1.5	0.020
Aqua Marina – 2	2.5	1.29	0.020

7.1.2 Geodetic Parameters

The geodetic parameters used for survey were as follows:-

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Inverse Flattening:	$^1/_f$ = 298.257 223 563
Local Datum Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Inverse Flattening:	$^1/_f$ = 298.257 223 563

Datum Transformation Parameters from WGS84 to WGS84						
Shift dX:	0.0 m	Rotation rX:	0.000	arcsec	Delta Scale :	0.0000 ppm
Shift dY:	0.0 m	Rotation rY:	0.000	arcsec		
Shift dZ:	0.0 m	Rotation rZ:	0.000	arcsec		

Local Projection and Grid Parameters [2)]	
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 45 N
Central Meridian:	087° 00’ 00” West
Latitude of Origin:	0° 00’ 00” North
False Easting:	500 000 m
False Northing:	0.0000
Scale factor on Central Meridian:	0.9996
Units:	metres

Notes:

1) Hypack navigation software always uses WGS84 geodetic parameters as a primary datum for any geodetic calculations.
2) This is the right-handed coordinate frame rotation convention used by the Hypack navigation software.

7.1.3 Survey Data Processing

General

The survey data was logged in HYPACK On-line Survey Software, and was processed using the HYPACK Processing, AUTOCAD and Spectra Precision Survey Office. The data was processed, checked and verified to ensure good quality data. Single Beam (SB) Editor was used for the automated and manual processing of logged data sets.

Navigation and Positioning

The DGPS Receiver Antenna was mounted exactly above the echo sounder transducer. The echo sounder transducer was mounted on the side of the boat, without any offset to ensure accuracy in the position of soundings. The bar-checks were carried out before/after each sounding session. Transducer draft was measured and recorded, and the same was used while processing. On all such occasions the error observed was zero or near zero. Therefore, no corrections were necessary.

Bathymetry

HYPACK Processing suite was used to import quality check and process the navigation, bathymetry and tidal data. The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set.

7.2 DESCRIPTION OF BENCH MARKS/ REFERENCE LEVELS

Due to non-availability of any permanent BM near the project area during reconnaissance survey, benchmarks was established by DGPS observation for 12 hours using Trimble SPS 855 positioning system and post processing through AUSPOS and Spectra Precision Survey Office to get the value of the TBMs with respect to MSL. The final co-ordinates of the BM and height above MSL and other details are provided in **Table 10** as below.

Table 10 : Temporary Benchmark established along Ajoy waterway

TBM No.	TBM	Latitude	Longitude	Chainage (Km)	Chart Datum (m)	Ht above MSL in m
1.	Sankhai	23°39'20.75"N	88°07'55.97"E	0.00	8.12	13.67
2.	Rajua	23°38'21.46"N	88°02'35.48"E	18.40	11.73	18.553
3.	Nutanhat	23°32'45.22"N	87°54'30.66"E	41.10	19.84	35.656

7.3 LEVELLING OF TEMPORARY BENCH MARKS

Three Temporary Bench Marks were established in between the course of survey at different places by using Trimble RTK SPS 855. Auto level SOKIA B-30 was used to establish the zero of the tide gauge with reference the TBMs. The observed readings in Auto Level are provided in **Annexure 1**. The water levels observed on the tide poles during reconnaissance survey are provided in **Annexure 2**. The CD/SD adopted for obtaining reduced depth along the waterway is given in **Figure 4**. Chart datum established at Sagar Island is used for establishing CD along the waterway.

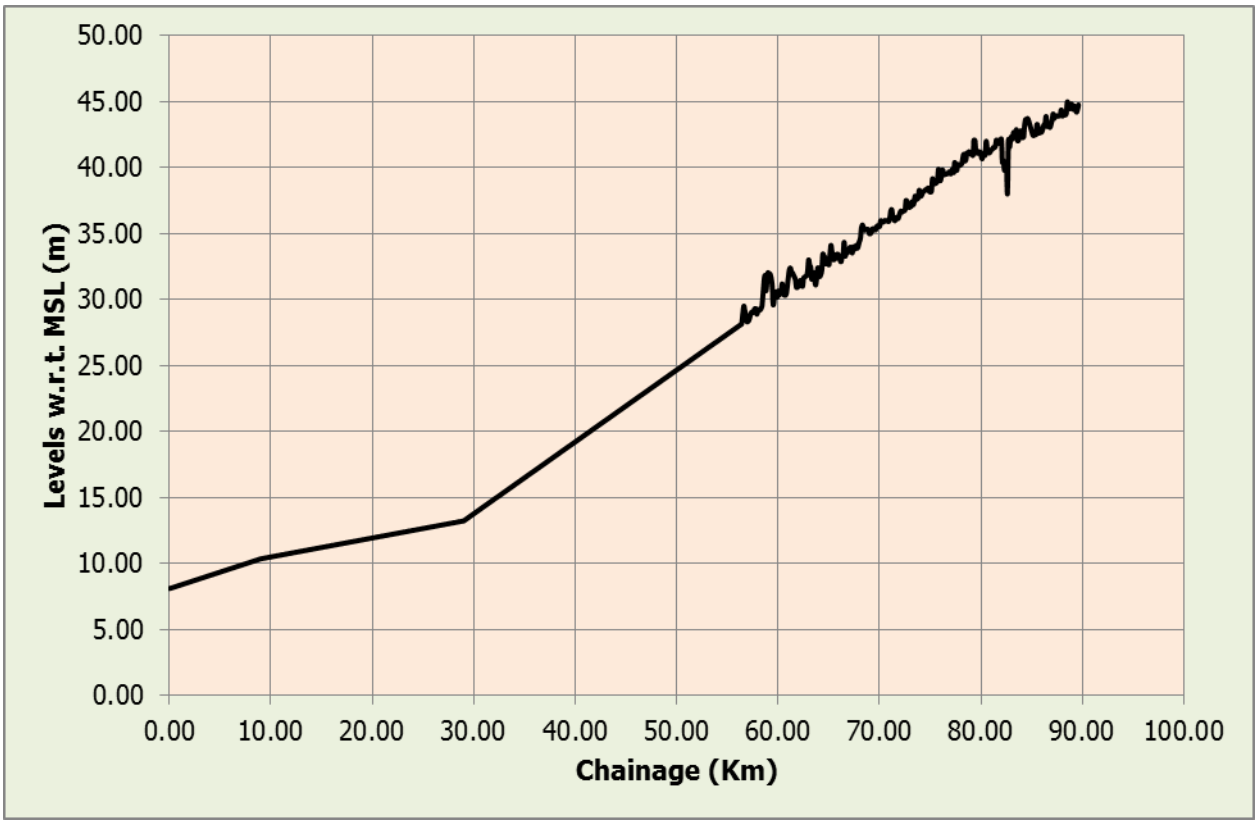

Figure 4: Graph showing Chart Datum/Sounding Datum w.r.t. MSL along Ajoy River

7.4 HYDROGRAPHIC SURVEY

Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System has been carried out for the length as carried out for the length as shown in

Table 11.

Table 11: Survey Length of Waterway

Total Length of Waterway as per TOR	Length of Bathymetric Survey	Length of Topographic Survey
96 Km	56.3 Km	39.7 Km

7.5 WATER DEPTH

Water depths along the waterway have been observed during Reconnaissance survey as per the scope of works and requirement for feasibility studies. Single line longitudinal bathymetric/topographic survey has been carried out for obtaining the water depth along the deepest route or lowest height lands of waterway. The observed depth are then corrected by applying a reduction factor as provided above for different stretches to calculate the reduced water depths available for navigation. The reduced water depths at every 10 km interval are presented in **Table 12**. Detailed Water depths along the Ajoy waterway is also provided in **Annexure 3**.

Table 12: Reduced Water Depth along the Waterway

Chainage (Km)	Draft Variation		Length of River (Km) with following draft			
	Max. Available (m)	Min. Available (m)	<1m	1.0 -1.5m	1.5 -2.0 m	>2.0m
0 – 10	4.62	0.00	7.50	0.00	0.42	2.08
10 – 20	0.02	0.00	10.00	0.00	0.00	0.00
20 – 30	0.69	0.00	10.00	0.00	0.00	0.00
30 – 40	1.27	0.06	9.80	0.20	0.00	0.00
40 – 50	0.54	0.13	10.00	0.00	0.00	0.00
50 – 60	0.51	0.17	10.00	0.00	0.00	0.00
60 – 70	Topographic Survey done		10.00	0.00	0.00	0.00
70 – 80			10.00	0.00	0.00	0.00
80 – 90			10.00	0.00	0.00	0.00

Chainage (Km)	Draft Variation		Length of River (Km) with following draft			
	Max. Available (m)	Min. Available (m)	<1m	1.0 -1.5m	1.5 -2.0 m	>2.0m
90 – 96			10.00	0.00	0.00	0.00
Total			**93.30**	**0.20**	**0.42**	**2.08**

It can be inferred from the above table that **2.08 Km stretch of waterway have draft more than 2.0 m, 0.42 Km stretch have draft of 1.50 m to 2.0 m, 0.20 km have draft of 1.0 m to 1.50 m and remaining 93.30 km stretch of waterway have less than 1.0 m draft with respect to chart datum** respectively.

7.6 SOIL CHARACTERISTICS

On the basis of visual assessment done during longitudinal survey, the characteristics of soil on both banks of the waterway are provided in **Table 13**.

Table 13: Soil Characteristics along Ajoy Waterway

S. No.	Chainage (km)	Latitude	Longitude	Easting (m)	Northing (m)	Soil Type
1.	0.0	23°39'23.58"N	88°07'56.34"E	615477.73	2616660.69	Muddy sand
2.	10.0	23°39'56.01"N	88°05'26.96"E	611238.00	2617625.00	Sand
3.	20.0	23°37'58.92"N	88°02'12.87"E	605766.00	2613983.00	Sand
4.	30.0	23°37'45.11"N	87°58'1.14"E	598636.00	2613508.00	Sand
5.	40.0	23°34'19.30"N	87°55'28.69"E	594357.00	2607150.00	Sand
6.	50.0	23°33'14.42"N	87°52'13.61"E	588839.00	2605120.00	Sand
7.	60.0	23°33'20.28"N	87°50'42.02"E	586241.07	2605284.62	Sand
8.	70.0	23°35'00.55"N	87°46'33.69"E	579183.83	2608328.59	Sand
9.	80.0	23°37'05.95"N	87°42'26.78"E	572166.25	2612148.61	Sand
10.	90.0	23°36'22.95"N	87°3713.73"E	563301.01	2610785.28	Sand
11.	96.0	23°36'56.47"N	87°31'57.85"E	554345.50	2611779.95	Sand

7.7 TIDAL WATERWAY SECTION

No tidal influence is observed along the waterway length.

8.0 MARKET ANALYSIS

Preliminary market analysis has been done on the basis of reconnaissance survey, consultants site visit, available secondary informations and published literature at the feasibility stage of the project.

8.1 LAND USE PATTERN

Land use pattern along the Ajoy waterway can be characterized as Agricultural and Residential as presented in **Table 14**.

Table 14: Land Use Pattern along Waterway

Agricultural		Residential	
Length (km)	%	Length (km)	%
63.90	71.0 %	26.10	29.0 %

8.2 CROPS /AGRICULTURE PRODUCTS

Ajoy waterway is located along the border of Birbhum and Bardhaman districts of west Bengal in the North 24 Parganas district of West Bengal.

Birbhum: Birbhum is primarily an agricultural district with around 75% of the people dependent on agriculture. While 159.3 km^2 of land is occupied by forests, 3,329.05 km^2 of land is used for agricultural purposes. 91.02% of the population live in villages. Out of total 4,50,313 farmers (holding 3,20,610 hectares of land), 3,59,404 are marginal farmers (holding 1,41,813 hectares altogether), 63,374 are small farmers (holding 95,144 hectares altogether), 26,236 are semi-medium farmers (holding 76,998 hectares altogether), 1,290 are medium farmers (holding 6,215 hectare altogether), and 9 are large farmers (holding 440 hectares of land). The average size of land holding per farmer is 0.71 hectares. 6,07,172 people work as agricultural labourers in Birbhum. Major crops produced in the district include rice, legumes, wheat, corn (maize), potatoes and sugar cane.

Table 15: Average Production and Productivity of major crops in Birbhum district (2004-08)

Name of Crop	Kharif		Rabi		Summer		Total	
	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)
Major Field Crops								
Rice	13.8	2568	955.8	3043	209.2	3331	1178.8	2981
Pulses			16.2	859			16.2	859
Wheat			84.8	2702			84.8	2702
Oilseeds			25.7	1025			25.7	1025
Potato			272.6	17053			272.6	17053
Major Horticultural Crops								
Brinjal	-	-	-	-	-	-	182.5	18525
Cucurbits	-	-	-	-	-	-	145.5	15681
Okra							34.2	8746
Cabbage							67.2	26356
Cauliflower	-	-	-	-	-	-	34.2	15751

Source: Agriculture Contingency Plan

Bardhhaman: Bardhhaman is the only district in the state of West Bengal that is fortunate both in industry and agriculture. On an average about 58 percent of the total population belongs to the agricultural population while the non-agricultural sector accounts for the remaining 42 percent.

The eastern, northern, southern and central areas of the district are extensively cultivated but the soil of the western portion being of extreme lateritic type is unfit for cultivation except in the narrow valleys and depressions having rich soil and good moisture. The cultivation in the district has improved since 1953 with the implementation of the irrigation projects undertaken by the Damodar Valley Corporation. Up to 1953 the cultivation was entirely dependent on the monsoon, and irrigation facilities were rather inadequate and more or less primitive. The position has since been changed and an all-round agricultural development has become possible. Though agriculture is largely regulated by

rainfall as in the other districts of the state, the developing irrigation system has been very helpful in minimizing the effects of the vagaries of nature.

Rice is the most important crop of the district and in the alluvial plains to the east little else is grown. The rice grown with its numerous varieties can broadly grouped under the three primary classes distinguished from one another by distinct characteristics and there are: The Aus or autumn, the Aman or winter and the Boro or the summer rice. Paddy covers maximum of the gross cropped area. Among commercial crops Jute, Mesta and Sugarcane, potato, oil seeds are cultivated in marginal area

Table 16: Average Production and Productivity of major crops in Bardhhaman district (2004-08)

Name of Crop	Kharif		Rabi		Summer		Total	
	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)	Production ('000 t)	Productivity (kg/ha)
Major Field Crops								
Rice	48.1	3069	1231.1	2953	642.5	3129	1921.7	3021
Wheat	-	-	6.7	2313	-	-	6.7	2313
Pulses	-	-	1.2	849	-	-	1.2	849
Oilseeds	-	-	43.1	850	-	-	43.1	850
Jute	233.0	3019	-	-	-	-	233.0	3019
Potato	-	-	1058.0	21674	-	-	1058.0	21674

Source: Agriculture Contingency Plan

8.3 AVAILABILITY OF PASSENGER FERRY SERVICES

No ferry services are located along the waterway during Reconnaissance survey.

8.4 EXISTING JETTIES AND TERMINALS

One RCC jetty is located at the confluence of river Ajoy with river Bhagirathi at Katwa, namely Sankhai Ghat (Photograph of the jetty is provided in **Annexure 4**)

The jetty is used by locals for transporting small cargo, passengers across and along river Bhagirathi.

8.5 HISTORICAL AND TOURIST PLACE ALONG AJOY WATERWAY

Jaydev Kenduli, claimed to be the birthplace of the 13th-century Sanskrit poet Jayadeva of Gita Govinda fame, and Churulia, birthplace of Kazi Nazrul Islam are located on the banks of the Ajay.

8.6 AVAILABILITY OF CONSTRUCTION MATERIAL

Major construction materials available along the Ajoy waterway are Sand and Bricks.

8.7 INDUSTRIES ALONG THE WATERWAY

Katwa Super Thermal Power Station is proposed near Srikhanda Village, 8 km from Katwa town in West Bengal. The power plant is one of the coal based power plants of NTPC. Initially, NTPC had planned for a super critical (800MW x 2) 1,600 MW power plant but land scarcity and other factors led to it being scaled down to (660MW x 2) 1,320 MW project. The project will require seven million tonne of coal annually. The power plant is located about 4.5 Km from the nearest alignment of Ajoy waterway (about 18.0 Km from the confluence of Ajoy river with river Bhagirathi).

Birbhum is a major centre of cottage industries. Perhaps the most notable cottage industry is a non-profit rural organization named Amar Kutir. Other main industries in Birbhum are agriculture-based industries, textiles, forestry, arts and crafts. Sriniketan is noted for its dairy industry and as a forestry centre. Some of the notable forms of cottage industries of Birbhum include textile—especially cotton and locally harvested tussar silk, jute works, batik, kantha stitch, macramé (weaving by knotting threads), leather, pottery and terracotta, solapith, woodcarving, bamboo and cane craft, metal works and tribal crafts. There are 8,883 small and medium scale industries. Principal industries of the district include cotton and silk harvesting and weaving, rice and oilseed milling, lac harvesting, and metalware and pottery manufacture.

Bardhaman is known for Modern Rice Mill, Rice Bran Oil, Cold Storage, Oil Mill, Chira Mill, Bakery, L.P.G Gas Filling Plant. Transformer manufacturing/repairing Automobile Spare Parts etc. This district is rich in handicrafts also. The degree of excellence of products like, Sola Craft of Bonkapasi Village and Dokra of Dariapur is now acceptable to European markets. There are rural wood carving artisans who are maintaining the continuity of their traditional art.

Major Industries along 50 km radius of waterway are:

1) Katwa Super Thermal Power Plant.
2) Vertech Valley Paper Products Pvt. Ltd.

3) National Sugar Industry,
4) Mayurakshi Cotton Mill Ltd.
5) Mini Steel Plant
6) Explosive Slurry Unit.

The likely exportable items are follows:

1) Engineering goods,
2) Plastic Based items,
3) Jute and Jute diversified products,
4) Foods and Beverages,
5) Cotton Textiles,
6) Hosiery and Garments,
7) Wood products,
8) Leather products,
9) Rubber & Plastic products,
10) Basic metal products,
11) Construction material like bricks and sand.
12) Fresh water Fish and poultry,
13) Agriculture products including Bittle,

8.8 EXISTING WATER SPORT AND RECREATIONAL ACTIVITIES AND FUTURE PROBABILITY

Water recreational activities are currently not available along the waterway.

8.9 ESTIMATED CARGO MOVEMENT

Ajoy waterway has huge potential for economic development considering its connectivity with major Super Thermal power plant having coal need of about 7.0 million tonne annually, other various industrial and commercial places. Its connection with National Waterway - 1 adds to its commercial advantage. Forecasted cargo potential has been estimated on the basis of last 13 year growth pattern of Cargo movement from 2002-2003 to 2014 – 2015 for National waterway-1, as provided in the IWAI Annual reports (Refer **Table 17**). Linear correlation between existing and declared National Waterways has been done, to estimate the forecasted cargo potential. In stage – 1 of the studies a base figure of 0.0 tonnes cargo movement is assumed for estimating the forecasted figures as shown in **Figure 5**. However, after the start of Katwa thermal power plant, cargo movement through waterway shall be much more than the project figures, considering the 7.0 MTPA coal demand of power plant.

Table 17: Cargo Movement in National Waterway – 1 from 2002 – 2015

Sl. No.	Year	Cargo Movement for NW-1 (tonnes)
1.	2002-03	632,037
2.	2003-04	786,159
3.	2004-05	887,328
4.	2005-06	1,001,450
5.	2006-07	1,317,387
6.	2007-08	1,497,964
7.	2008-09	1,348,385
8.	2009-10	1,811,070
9.	2010-11	1,871,178
10.	2011-12	3,309,839
11.	2012-13	2,716,437
12.	2013-14	3,349,138
13.	2014-15	5,050,209

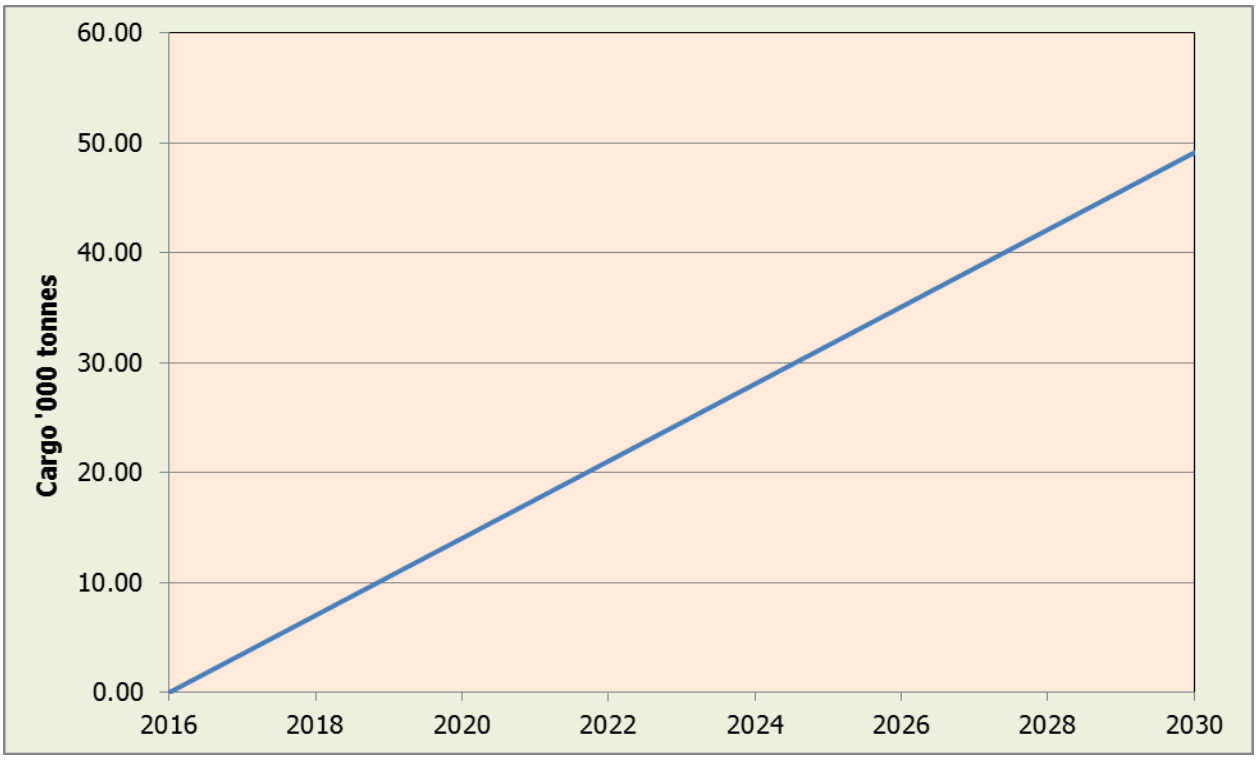

Figure 5: Forecasted Cargo Potential

Prima facie Ajoy waterway has huge economical potential for development of Inland waterway. Extent of development and prioritisation of inland waterways will be prepared in subsequent phase of the DPR study on the basis of detailed survey and investigations.

9.0 OBSERVATION AND INFERENCE

On the basis of reconnaissance survey as well as primary and secondary data collected from IWAI, central and state government departments and other stakeholders, following observations and inferences are made on the Ajoy Waterway (National Waterway 7).

9.1 WATERWAY

River Ajay originates on a small hill about 300 m high, southwest of Munger in Bihar. It then flows through Jharkhand and enters West Bengal at Simjuri, near Chittaranjan. It forms the border between Burdwan and Birbhum districts and finally joins the Bhagirathi River near Katwa of Burdwan. Total length of the Ajay is 288 km out of which 152 km is in West Bengal. The important tributaries of the Ajay are Pathro and Jayanti in Jharkhand, and Tumuni and Kunur in Burdwan district of West Bengal.

9.2 LEAST AVAILABLE DEPTH (LAD)

LAD of the Ajoy waterway is estimated on the basis of applying exceedance probability approach on the reduced water depth. Reduced water depth is calculated after applying corrections on the water depths observed during single line hydrographic survey with reference to Chart/Sounding datums. Navigable stretch available for least available depth (LAD) of <1.0 m, 1.0 m to 1.5 m, 1.5 m to 2.0 m and >2.0 m for the waterway is presented in **Table 18**.

Table 18: Waterway length with varying LAD

Features	Results
Waterway Length	96.0 Km
Length with Topographic Survey	39.70 Km
Length with Bathymetric Survey	56.30 Km
Maximum available draft	4.62 m
Minimum available draft	0.00 m
Waterway length with <1.0 m draft	93.30 Km
Waterway length with 1.0 – 1.5 m draft	0.20 Km
Waterway length with 1.5 – 2.0 m draft	0.42 Km

Features	Results
Waterway length with >2.0 m draft	2.08 Km

9.3 CROSS - STRUCTURES

During reconnaissance survey, details of cross-structures have been collected and their minimum horizontal and vertical clearance has been evaluated on the basis of visual assessment as shown in **Table 19** below. The detailed list of cross-structures is provided in **Table 3** and **Table 4**.

Table 19: Minimum Horizontal and Vertical Clearance along Waterways

Dams/ Barrages/Locks	Bridges/ Crossing	Min Ver. /Hor. Clearance (m)	High-Tension Lines	Min Ver. Clearance (m)
Not Available	5	8.0 / 8.0	1	8.0

Vertical clearance is with reference to the HFL.
Horizontal Clearance is the minimum distance between the bridge piers.

9.4 SWOT ANALYSIS

SWOT analysis is a technique commonly used to assist in identifying strategic direction for an organization or practice. It helps to make an assessment of internal environment and scrutiny of external environment, with an objective to take maximum benefits by having an appropriate proposition. It is preferred for the present work as it yields useful information about the future viability of the considered inland waterway system. The predictive capabilities in the technique come about from the consideration of system's strengths and weaknesses in the context of the development of Inland Waterway System, which may present opportunities and threats.

The strengths and weaknesses of a system are determined by the internal elements, whereas external forces dictate opportunities and threats. Strengths can be defined as any available resource that can be used to improve its performance. Weaknesses are flaws/shortcomings of any system that may cause to lose a competitive advantage, efficiency or resources. Sometimes it is recommended to identify opportunities and threats first in order to more quickly ring to light the system's strengths and weaknesses. Many of the threats are based on weaknesses.

POSITIVE	**INTERNAL**	**NEGATIVE**
	STRENGTH	**WEAKNESS**
	➢ Commitment of Govt. of India for Developing Inland Waterways Sector. ➢ Environmental friendly mode of Transport ➢ Increase in Infrastructure Facilities as alternative mode of transport. ➢ Comparatively high level of transport safety. ➢ Reliable services under predictable weather conditions. ➢ Low transport costs (per km) for bulk shipments. ➢ Long term effective cost control measures (O&M). ➢ Capable of bringing down decongestion from the Road Transport.	➢ Huge Initial Investment ➢ High Maintenance Cost ➢ High tariff structure for Inland Transport. ➢ Limited knowledge of IWT among shippers. ➢ Dependence on inter-modality for door-to door services. ➢ Substantial cost differentials w.r.t other transports. ➢ Dredging capability of GoI is 16% of National requirement. ➢ Water availability.
	➢ Location of Katwa Thermal Power Plant near the waterway. ➢ Connectivity with NW-1 and its hinterland. ➢ Trigger new traffic in the hinterland ➢ Boost International and National trade of commodities. ➢ Improvement of the capacity/quality of the Infrastructure. ➢ Integration of Ports with Roads & Railways. ➢ Enhance inter-modality. ➢ Implementation of infrastructure links. ➢ Improved Supply-Demand logistic chains ➢ Creation of reliable employment for the people.	➢ Lack of Skilled Man-power. ➢ Environmental policy restrictions on transport infrastructure policies. ➢ Limited financial means. ➢ Fast growing economic sectors often road oriented: low IWT affinity. ➢ Priority of investments in road/ rail infrastructure as per the present scenario. ➢ Land Acquisition.
	OPPORTUNITY	**THREAT**
	EXTERNAL	

Figure 6: SWOT Analysis

Further, SWOT analysis helps in categorizing the key internal and external factors that are important to achieving the objective. With regards to assessing the feasibility of national waterway for

navigation, this exercise will help us identify the important factors to be considered while designing the future action for DPR study in Stage 2 and strategic plan for its development.

9.5 SUMMARY

The salient features of the feasibility study for 96 km (90 km as per survey according to the co-ordinates given in TOR) stretch of Ajoy waterway are,

- The horizontal and vertical clearance of existing cross-structures is in the range of 15.0 m to 8.0m and 6.0 m respectively.
- Taking in to account the water availability, 2.08 Km stretch of waterway have draft more than 2.0 m, 0.42 Km stretch have draft of 1.50 m to 2.0 m, 0.20 km have draft of 1.0 m to 1.50 m and remaining 93.30 km stretch of waterway have less than 1.0 m draft with respect to chart datum
- Availability of Katwa Super Thermal power plant gives an additional economic advantage to the waterway, as the waterway can be used for coal transportation to the power plant located about 4.5 Km from the waterway. The project will require seven million tonne of coal annually which can be easily transported by conveyor belt directly from waterway to the site.
- The capacity of the waterway can be enhanced by constructing check dams and lockgates at suitable locations on the basis of detailed survey to be done in Stage – 2.
- Considering the availability of Katwa Super Thermal power plant and other minor and major industries and connectivity with rail and road network within 5km reach across the bank , the river has huge economic potential for development as a Waterway
- Also the connectivity of Ajoy waterway with National Waterway - 1 creates an added advantage for triggering new traffic.

9.6 CRITICAL AREAS REQUIRING DETAILED INVESTIGATIONS

Critical areas along the waterways, requiring detailed investigations during Stage – II, are identified on the basis of draft availability, location of hindrances, areas requiring clearances etc. On the basis of above, following locations require detailed investigations during stage –II of the study:

Table 20: Locations requiring Detail Investigation along the Waterway

Sr. No.	Location	Chainage (km)
1	Sudharpur Gaon	39.0
2	Batuwa Gaon	52.8

In addition to the above, the length of the waterway having flow depth of less than 1 m w.r.t Chart Datum also requires detail investigation during DPR stage studies.

9.7 SURVEY AND INVESTIGATIONS REQUIRED FOR STAGE – II STUDIES

Following survey and investigations are required to be done during Stage – II studies:

i) Hydrographic and Hydro morphological Survey, as per TOR, comprising of:

   a) Erection of bench mark pillars and water level gauges and observing reading.
   b) Detailed bathymetric and topographic survey.
   c) Current velocity and discharge measurement.
   d) Collection of water and bottom samples and testing.
   e) Collection of topographical features.

ii) Traffic Survey.

iii) Geo-tech investigation on proposed locations for Jetties and Terminal structures.

iv) Environmental impact assessment (EIA).

9.8 WAY FORWARD: WATERWAY DEVELOPMENT

The combining knowledge on the physical constraints, actual and future uses of the river and the valley, economic potential and needs, or absence thereof, allows the characterization of the river for development as a waterway. The reconnaissance survey data collected with regard to physical constraints can be turned into cost to make a river navigable; however the same shall be verified in detail during DPR stage. Although several challenges do exist to make Ajoy River as National waterway, but with respect to long-term economic interest of the nation the financial investment is advisable.

Economic Interest / **Financial Investment**	Local	Regional	National	International
Low				
Moderate				
High			Ajoy Waterway	
Very High				

Ajoy waterway is recommended for Stage – II DPR preparation in view of the following potential advantages:

a) Connectivity of the waterway with proposed Katwa Thermal Power Plant.
b) Direct connectivity with NW-1, Haldia and Kolkata port including their hinterland.
c) Increasing cargo potential.
d) Reduction in existing traffic load on rail and road infrastructure.

In view of the above, it is recommended to develop the Ajoy waterway for large Cargo specially Coal transport for Katwa Thermal Power Plant and Passenger ferry services.

Annexure 1: Levelling Results

LEVELLING BETWEEN TEMPORARY BENCH MARK 1 & TIDE POLE

BS	FS	HI	RL	REMARK
1.219		14.889	13.67	TBM 1
1.121	2.421	13.589	12.468	CP 1
1.043	2.104	12.528	11.485	CP 2
1.221	1.985	11.764	10.543	CP 3
1.004	1.842	10.926	9.922	CP 4
	1.572		9.354	TIDE POLE

BS	FS	HI	RL	REMARK
2.138		11.492	9.354	TIDE POLE
2.561	1.025	13.028	10.467	CP 1
2.117	1.198	13.947	11.83	CP 2
1.996	1.096	14.847	12.851	CP 3
1.234	1.283	14.798	13.564	CP 4
	1.128		13.67	TBM 1

LEVELLING BETWEEN TEMPORARY BENCH MARK 2 & TIDE POLE

BS	FS	HI	RL	REMARK
0.983		19.536	18.553	TBM 2
0.99	3.981	16.545	15.555	CP 1
	3.696		12.849	TIDE POLE

BS	FS	HI	RL	REMARK
3.896		16.745	12.849	TIDE POLE
3.597	1.034	19.308	15.711	CP 2
	0.755		18.553	TBM 2

LEVELLING BETWEEN TEMPORARY BENCH MARK 3 & TIDE POLE

BS	FS	HI	RL	REMARK
0.672		36.328	35.656	TBM 3
0.513	3.896	32.945	32.432	CP 1
0.678	2.987	30.636	29.958	CP 2
0.431	3.332	27.735	27.304	CP 3
0.237	3.871	24.101	23.864	CP 4
	3.036		21.065	TIDE POLE

BS	FS	HI	RL	REMARK
3.643		24.708	21.065	TIDE POLE
3.721	0.212	28.217	24.496	CP 1
3.211	0.651	30.777	27.566	CP 2
3.012	0.672	33.117	30.105	CP 3
3.771	0.684	36.204	32.433	CP 4
	0.547		35.657	TBM 3

Annexure 2: Water levels Observed on Tide Poles

Sankhai Ghat TBM - 1 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w. r. t. MSL.		
TIME	DATE	WATER LEVEL
13:00	24-Jan-16	9.624
15:00	24-Jan-16	9.624
17:00	24-Jan-16	9.624
17:45	24-Jan-16	9.624

Rajua TBM - 2 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w. r. t. MSL.		
TIME	DATE	WATER LEVEL
11:00	25-Jan-16	21.245
12:00	25-Jan-16	21.245
14:00	25-Jan-16	21.245
15:00	25-Jan-16	21.245
15:45	25-Jan-16	21.245

Nutanhat TBM - 3 Time (IST) in hh:mm & Hts are in Mtrs. Water Level are w. r. t. MSL.		
TIME	DATE	WATER LEVEL
11:00	28-Jan-16	13.169
12:00	28-Jan-16	13.169
14:00	28-Jan-16	13.169
15:00	28-Jan-16	13.169
15:45	28-Jan-16	13.169

Annexure 3: Water Depth along Ajoy Waterway

(Start Chainage - 0.0 Km is at confluence of Ajoy River with Bhagirathi River)

(End Chainage – 96.0 Km is at Bridge on Morgram-Panagarh State Highway no. 14 at Illambazar)

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
0.00	0.55	8.12	9.63	1.51	0.00
0.10	1.71	8.14	9.65	1.50	0.21
0.20	2.01	8.17	9.66	1.50	0.51
0.30	2.20	8.19	9.68	1.49	0.71
0.40	1.96	8.22	9.70	1.48	0.48
0.50	2.01	8.24	9.72	1.48	0.53
0.60	2.34	8.27	9.74	1.47	0.87
0.70	1.54	8.29	9.76	1.46	0.08
0.80	1.74	8.32	9.78	1.46	0.28
0.90	2.17	8.34	9.79	1.45	0.72
1.00	3.40	8.37	9.81	1.44	1.96
1.10	6.06	8.39	9.83	1.44	4.62
1.20	6.03	8.42	9.85	1.43	4.60
1.30	5.22	8.44	9.87	1.42	3.80
1.40	2.35	8.47	9.89	1.42	0.93
1.50	1.44	8.49	9.91	1.41	0.03
1.60	1.38	8.52	9.92	1.41	0.00
1.70	1.33	8.54	9.94	1.40	0.00
1.80	1.48	8.57	9.96	1.39	0.09
1.90	2.46	8.59	9.98	1.39	1.07
2.00	0.36	8.62	10.00	1.38	0.00
2.10	0.33	8.64	10.02	1.37	0.00
2.30	1.06	8.69	10.05	1.36	0.00
2.40	1.12	8.72	10.07	1.35	0.00
2.50	0.00	8.74	10.09	1.35	0.00
2.60	0.30	8.77	10.11	1.34	0.00
2.80	0.00	8.82	10.15	1.33	0.00
2.90	0.39	8.84	10.16	1.32	0.00
3.00	0.72	8.87	10.18	1.31	0.00
3.10	1.11	8.90	10.20	1.31	0.00
3.20	1.68	8.92	10.22	1.30	0.38

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
3.30	1.90	8.95	10.24	1.29	0.61
3.40	3.42	8.97	10.26	1.29	2.13
3.50	3.97	9.00	10.28	1.28	2.69
3.60	0.75	9.02	10.29	1.27	0.00
3.70	0.60	9.05	10.31	1.27	0.00
3.80	0.76	9.07	10.33	1.26	0.00
3.90	0.51	9.10	10.35	1.25	0.00
4.00	0.55	9.12	10.37	1.25	0.00
4.10	0.57	9.15	10.39	1.24	0.00
4.20	0.42	9.17	10.41	1.23	0.00
4.30	0.54	9.20	10.42	1.23	0.00
4.40	0.97	9.22	10.44	1.22	0.00
4.50	1.35	9.25	10.46	1.22	0.14
4.60	0.00	9.27	10.48	1.21	0.00
4.70	1.17	9.30	10.50	1.20	0.00
4.80	0.25	9.32	10.52	1.20	0.00
5.00	0.20	9.37	10.55	1.18	0.00
5.20	0.12	9.42	10.59	1.17	0.00
5.30	0.09	9.45	10.61	1.16	0.00
5.40	0.00	9.47	10.63	1.16	0.00
5.50	0.00	9.50	10.65	1.15	0.00
5.60	0.00	9.52	10.67	1.14	0.00
5.70	0.00	9.55	10.68	1.14	0.00
5.80	0.00	9.57	10.70	1.13	0.00
5.90	0.00	9.60	10.72	1.12	0.00
6.00	0.00	9.62	10.74	1.12	0.00
6.10	0.00	9.65	10.76	1.11	0.00
6.20	0.00	9.67	10.78	1.10	0.00
6.30	0.00	9.70	10.80	1.10	0.00
6.40	0.30	9.72	10.81	1.09	0.00
6.50	0.42	9.75	10.83	1.08	0.00

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
6.60	0.30	9.77	10.85	1.08	0.00
6.70	0.18	9.80	10.87	1.07	0.00
6.80	0.15	9.82	10.89	1.06	0.00
6.90	0.14	9.85	10.91	1.06	0.00
7.00	0.14	9.87	10.93	1.05	0.00
7.20	0.14	9.92	10.96	1.04	0.00
7.30	0.14	9.95	10.98	1.03	0.00
7.40	0.14	9.97	11.00	1.02	0.00
7.50	0.14	10.00	11.02	1.02	0.00
7.60	0.13	10.02	11.04	1.01	0.00
7.80	0.13	10.07	11.07	1.00	0.00
7.90	0.13	10.10	11.09	0.99	0.00
8.00	0.13	10.13	11.11	0.99	0.00
8.10	0.13	10.15	11.13	0.98	0.00
8.20	0.13	10.18	11.15	0.97	0.00
8.30	0.13	10.20	11.17	0.97	0.00
8.40	0.13	10.23	11.18	0.96	0.00
8.50	0.12	10.25	11.20	0.95	0.00
8.60	0.10	10.28	11.22	0.95	0.00
8.70	0.21	10.30	11.24	0.94	0.00
8.80	0.22	10.33	11.26	0.93	0.00
8.90	0.26	10.35	11.28	0.93	0.00
9.00	0.22	10.38	11.30	0.92	0.00
9.10	0.34	10.39	11.31	0.92	0.00
9.20	0.24	10.40	11.31	0.91	0.00
9.40	0.27	10.43	11.33	0.90	0.00
9.50	0.24	10.45	11.34	0.90	0.00
9.60	0.20	10.46	11.35	0.89	0.00
9.70	0.20	10.48	11.36	0.89	0.00
9.80	0.25	10.49	11.37	0.88	0.00
9.90	0.27	10.51	11.38	0.88	0.00

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
10.10	0.29	10.53	11.40	0.87	0.00
10.20	0.12	10.55	11.41	0.86	0.00
10.30	0.18	10.56	11.42	0.86	0.00
10.50	0.10	10.59	11.44	0.84	0.00
10.60	0.10	10.61	11.45	0.84	0.00
10.70	0.10	10.62	11.46	0.84	0.00
10.80	0.10	10.63	11.46	0.83	0.00
10.90	0.00	10.65	11.47	0.82	0.00
11.00	0.00	10.66	11.48	0.82	0.00
11.10	0.00	10.68	11.49	0.82	0.00
11.30	0.04	10.71	11.51	0.81	0.00
11.40	0.10	10.72	11.52	0.80	0.00
11.50	0.11	10.74	11.53	0.80	0.00
11.60	0.17	10.75	11.54	0.79	0.00
11.70	0.10	10.76	11.55	0.79	0.00
11.80	0.10	10.78	11.56	0.78	0.00
12.00	0.05	10.81	11.58	0.77	0.00
12.10	0.05	10.82	11.59	0.77	0.00
12.20	0.06	10.84	11.60	0.76	0.00
12.30	0.13	10.85	11.61	0.76	0.00
12.50	0.19	10.88	11.62	0.74	0.00
12.60	0.20	10.89	11.63	0.74	0.00
12.70	0.20	10.91	11.64	0.74	0.00
12.80	0.20	10.92	11.65	0.73	0.00
12.90	0.25	10.94	11.66	0.73	0.00
13.00	0.25	10.95	11.67	0.72	0.00
13.10	0.22	10.97	11.68	0.72	0.00
13.20	0.20	10.98	11.69	0.71	0.00
13.30	0.24	10.99	11.70	0.71	0.00
13.40	0.10	11.01	11.71	0.70	0.00
13.50	0.24	11.02	11.72	0.70	0.00

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
13.60	0.15	11.04	11.73	0.69	0.00
13.80	0.16	11.07	11.75	0.68	0.00
13.90	0.10	11.08	11.76	0.67	0.00
14.00	0.24	11.09	11.76	0.67	0.00
14.10	0.20	11.11	11.77	0.66	0.00
14.20	0.15	11.12	11.78	0.66	0.00
14.30	0.34	11.14	11.79	0.65	0.00
14.40	0.50	11.15	11.80	0.65	0.00
14.50	0.34	11.17	11.81	0.65	0.00
14.60	0.30	11.18	11.82	0.64	0.00
14.70	0.40	11.20	11.83	0.64	0.00
14.80	0.41	11.21	11.84	0.63	0.00
14.90	0.30	11.22	11.85	0.63	0.00
15.00	0.40	11.24	11.86	0.62	0.00
15.10	0.26	11.25	11.87	0.62	0.00
15.20	0.30	11.27	11.88	0.61	0.00
15.30	0.43	11.28	11.89	0.61	0.00
15.40	0.59	11.30	11.90	0.60	0.00
15.50	0.31	11.31	11.91	0.59	0.00
15.60	0.20	11.32	11.91	0.59	0.00
15.70	0.23	11.34	11.92	0.59	0.00
15.80	0.30	11.35	11.93	0.58	0.00
15.90	0.21	11.37	11.94	0.57	0.00
16.00	0.20	11.38	11.95	0.57	0.00
16.10	0.00	11.40	11.96	0.57	0.00
16.20	0.00	11.41	11.97	0.56	0.00
16.30	0.00	11.43	11.98	0.56	0.00
16.40	0.10	11.44	11.99	0.55	0.00
16.50	0.20	11.45	12.00	0.55	0.00
16.60	0.29	11.47	12.01	0.54	0.00
16.70	0.16	11.48	12.02	0.54	0.00

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
16.80	0.10	11.50	12.03	0.53	0.00
16.90	0.20	11.51	12.04	0.53	0.00
17.00	0.10	11.53	12.05	0.52	0.00
17.10	0.10	11.54	12.05	0.51	0.00
17.20	0.10	11.55	12.06	0.51	0.00
17.30	0.10	11.57	12.07	0.51	0.00
17.40	0.10	11.58	12.08	0.50	0.00
17.50	0.00	11.60	12.09	0.49	0.00
17.60	0.16	11.61	12.10	0.49	0.00
17.70	0.15	11.63	12.11	0.48	0.00
17.80	0.00	11.64	12.12	0.48	0.00
17.90	0.02	11.65	12.13	0.48	0.00
18.00	0.03	11.67	12.14	0.47	0.00
18.10	0.25	11.68	12.15	0.47	0.00
18.20	0.20	11.70	12.16	0.46	0.00
18.30	0.20	11.71	12.17	0.46	0.00
18.40	0.27	11.73	12.18	0.45	0.00
18.50	0.30	11.74	12.19	0.45	0.00
18.60	0.25	11.76	12.20	0.44	0.00
18.70	0.26	11.77	12.20	0.43	0.00
18.80	0.25	11.78	12.21	0.43	0.00
18.90	0.16	11.80	12.22	0.43	0.00
19.00	0.10	11.81	12.23	0.42	0.00
19.10	0.15	11.83	12.24	0.41	0.00
19.20	0.30	11.84	12.25	0.41	0.00
19.30	0.13	11.86	12.26	0.41	0.00
19.40	0.15	11.87	12.27	0.40	0.00
19.50	0.15	11.88	12.28	0.40	0.00
19.60	0.27	11.90	12.29	0.39	0.00
19.70	0.40	11.91	12.30	0.39	0.02
19.80	0.30	11.93	12.31	0.38	0.00

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
19.90	0.19	11.94	12.32	0.38	0.00
20.00	0.10	11.96	12.33	0.37	0.00
20.10	0.10	11.97	12.34	0.37	0.00
20.20	0.10	11.99	12.35	0.36	0.00
20.40	0.15	12.01	12.36	0.35	0.00
20.50	0.11	12.03	12.37	0.35	0.00
20.60	0.17	12.04	12.38	0.34	0.00
20.70	0.10	12.06	12.39	0.33	0.00
20.90	0.20	12.09	12.41	0.33	0.00
21.00	0.77	12.10	12.42	0.32	0.45
21.10	1.00	12.11	12.43	0.32	0.69
21.20	1.00	12.13	12.44	0.31	0.69
21.30	0.71	12.14	12.45	0.31	0.41
21.40	0.45	12.16	12.46	0.30	0.15
21.50	0.21	12.17	12.47	0.30	0.00
21.60	0.17	12.19	12.48	0.29	0.00
21.70	0.20	12.20	12.49	0.29	0.00
21.90	0.30	12.23	12.50	0.28	0.02
22.00	0.25	12.24	12.51	0.27	0.00
22.10	0.21	12.26	12.52	0.27	0.00
22.30	0.21	12.29	12.54	0.26	0.00
22.40	0.24	12.30	12.55	0.25	0.00
22.50	0.20	12.32	12.56	0.25	0.00
22.60	0.25	12.33	12.57	0.24	0.01
22.70	0.24	12.34	12.58	0.23	0.01
22.80	0.16	12.36	12.59	0.23	0.00
22.90	0.15	12.37	12.60	0.23	0.00
23.00	0.19	12.39	12.61	0.22	0.00
23.10	0.20	12.40	12.62	0.22	0.00
23.20	0.27	12.42	12.63	0.21	0.06
23.30	0.29	12.43	12.64	0.20	0.09

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
23.40	0.31	12.45	12.65	0.20	0.11
23.50	0.40	12.46	12.65	0.20	0.21
23.60	0.40	12.47	12.66	0.19	0.21
23.70	0.33	12.49	12.67	0.19	0.15
23.80	0.27	12.50	12.68	0.18	0.09
23.90	0.34	12.52	12.69	0.17	0.17
24.10	0.26	12.55	12.71	0.16	0.10
24.20	0.17	12.56	12.72	0.16	0.01
24.30	0.30	12.57	12.73	0.15	0.15
24.40	0.20	12.59	12.74	0.15	0.05
24.50	0.15	12.60	12.75	0.15	0.00
24.60	0.27	12.62	12.76	0.14	0.13
24.70	0.20	12.63	12.77	0.14	0.07
24.80	0.20	12.65	12.78	0.13	0.07
24.90	0.20	12.66	12.79	0.13	0.08
25.00	0.20	12.68	12.80	0.12	0.08
25.10	0.23	12.69	12.80	0.12	0.12
25.20	0.16	12.70	12.81	0.11	0.05
25.30	0.10	12.72	12.82	0.11	0.00
25.40	0.10	12.73	12.83	0.10	0.00
25.50	0.12	12.75	12.84	0.10	0.02
25.60	0.15	12.76	12.85	0.09	0.06
25.70	0.19	12.78	12.86	0.08	0.11
25.80	0.20	12.79	12.87	0.08	0.12
25.90	0.25	12.80	12.88	0.07	0.18
26.00	0.30	12.82	12.89	0.07	0.23
26.10	0.25	12.83	12.90	0.06	0.19
26.20	0.13	12.85	12.91	0.06	0.07
26.30	0.10	12.86	12.92	0.05	0.05
26.40	0.15	12.88	12.93	0.05	0.10
26.50	0.23	12.89	12.94	0.04	0.19

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
26.60	0.20	12.91	12.95	0.04	0.16
26.70	0.20	12.92	12.95	0.04	0.17
26.80	0.16	12.93	12.96	0.03	0.13
26.90	0.14	12.95	12.97	0.03	0.12
27.00	0.25	12.96	12.98	0.02	0.23
27.10	0.10	12.98	12.99	0.02	0.08
27.20	0.10	12.99	13.00	0.01	0.09
27.30	0.10	13.01	13.01	0.00	0.10
27.40	0.20	13.02	13.02	0.00	0.20
27.50	0.10	13.03	13.03	0.00	0.10
27.60	0.10	13.05	13.04	-0.01	0.11
27.70	0.10	13.06	13.05	-0.01	0.11
27.80	0.10	13.08	13.06	-0.02	0.12
27.90	0.20	13.09	13.07	-0.03	0.23
28.00	0.20	13.11	13.08	-0.03	0.23
28.10	0.25	13.12	13.09	-0.04	0.29
28.20	0.21	13.14	13.10	-0.04	0.25
28.30	0.20	13.15	13.10	-0.04	0.25
28.40	0.20	13.16	13.11	-0.05	0.25
28.50	0.25	13.18	13.12	-0.05	0.31
28.60	0.25	13.19	13.13	-0.06	0.31
28.70	0.21	13.21	13.14	-0.06	0.27
28.80	0.16	13.22	13.15	-0.07	0.23
29.00	0.15	13.25	13.17	-0.08	0.23
29.10	0.13	13.30	13.22	-0.08	0.21
29.20	0.14	13.36	13.28	-0.08	0.22
29.30	0.20	13.41	13.33	-0.08	0.28
29.40	0.10	13.47	13.39	-0.08	0.18
29.50	0.10	13.52	13.44	-0.08	0.18
29.60	0.10	13.58	13.50	-0.08	0.18
29.70	0.15	13.63	13.55	-0.08	0.23

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
29.80	0.10	13.69	13.61	-0.08	0.18
29.90	0.10	13.74	13.66	-0.08	0.18
30.00	0.10	13.79	13.72	-0.08	0.18
30.10	0.10	13.85	13.77	-0.08	0.18
30.20	0.15	13.90	13.83	-0.08	0.23
30.30	0.15	13.96	13.88	-0.08	0.23
30.40	0.15	14.01	13.94	-0.08	0.23
30.50	0.13	14.07	13.99	-0.08	0.21
30.60	0.10	14.12	14.05	-0.08	0.18
30.70	0.15	14.18	14.10	-0.08	0.23
30.80	0.15	14.23	14.16	-0.07	0.22
30.90	0.15	14.28	14.21	-0.07	0.22
31.00	0.15	14.34	14.26	-0.07	0.22
31.10	0.20	14.39	14.32	-0.07	0.27
31.20	0.25	14.45	14.37	-0.07	0.32
31.30	0.25	14.50	14.43	-0.07	0.32
31.40	0.23	14.56	14.48	-0.07	0.30
31.50	0.25	14.61	14.54	-0.07	0.32
31.60	0.20	14.67	14.59	-0.07	0.27
31.70	0.20	14.72	14.65	-0.07	0.27
31.80	0.15	14.77	14.70	-0.07	0.22
31.90	0.18	14.83	14.76	-0.07	0.25
32.00	0.20	14.88	14.81	-0.07	0.27
32.10	0.20	14.94	14.87	-0.07	0.27
32.20	0.20	14.99	14.92	-0.07	0.27
32.30	0.29	15.05	14.98	-0.07	0.36
32.40	0.30	15.10	15.03	-0.07	0.37
32.50	0.24	15.16	15.09	-0.07	0.31
32.60	0.20	15.21	15.14	-0.07	0.27
32.70	0.20	15.26	15.20	-0.07	0.27
32.80	0.20	15.32	15.25	-0.07	0.27

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
32.90	0.20	15.37	15.31	-0.07	0.27
33.00	0.25	15.43	15.36	-0.07	0.32
33.10	0.25	15.48	15.41	-0.07	0.32
33.20	0.24	15.54	15.47	-0.07	0.31
33.30	0.10	15.59	15.52	-0.07	0.17
33.40	0.10	15.65	15.58	-0.07	0.17
33.50	0.11	15.70	15.63	-0.07	0.18
33.60	0.20	15.75	15.69	-0.07	0.27
33.70	0.24	15.81	15.74	-0.07	0.31
33.80	0.30	15.86	15.80	-0.07	0.37
33.90	0.29	15.92	15.85	-0.07	0.36
34.00	0.20	15.97	15.91	-0.07	0.27
34.10	0.20	16.03	15.96	-0.07	0.27
34.20	0.21	16.08	16.02	-0.06	0.27
34.30	0.22	16.14	16.07	-0.06	0.28
34.40	0.24	16.19	16.13	-0.06	0.30
34.50	0.19	16.24	16.18	-0.06	0.25
34.60	0.15	16.30	16.24	-0.06	0.21
34.70	0.10	16.35	16.29	-0.06	0.16
34.80	0.10	16.41	16.35	-0.06	0.16
34.90	0.00	16.46	16.40	-0.06	0.06
35.00	0.00	16.52	16.45	-0.06	0.06
35.10	0.00	16.57	16.51	-0.06	0.06
35.20	0.00	16.63	16.56	-0.06	0.06
35.30	0.13	16.68	16.62	-0.06	0.19
35.40	0.15	16.73	16.67	-0.06	0.21
35.50	0.16	16.79	16.73	-0.06	0.22
35.60	0.15	16.84	16.78	-0.06	0.21
35.70	0.10	16.90	16.84	-0.06	0.16
35.80	0.10	16.95	16.89	-0.06	0.16
35.90	0.10	17.01	16.95	-0.06	0.16

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
36.00	0.10	17.06	17.00	-0.06	0.16
36.10	0.10	17.12	17.06	-0.06	0.16
36.20	0.15	17.17	17.11	-0.06	0.21
36.30	0.14	17.23	17.17	-0.06	0.20
36.40	0.10	17.28	17.22	-0.06	0.16
36.50	0.16	17.33	17.28	-0.06	0.22
36.60	0.10	17.39	17.33	-0.06	0.16
36.70	0.20	17.44	17.39	-0.06	0.26
36.80	0.42	17.50	17.44	-0.06	0.48
36.90	0.38	17.55	17.49	-0.06	0.44
37.00	0.29	17.61	17.55	-0.06	0.35
37.10	0.27	17.66	17.60	-0.06	0.33
37.20	0.20	17.72	17.66	-0.06	0.26
37.30	0.20	17.77	17.71	-0.06	0.26
37.40	0.23	17.82	17.77	-0.06	0.29
37.50	0.15	17.88	17.82	-0.06	0.21
37.60	0.25	17.93	17.88	-0.05	0.30
37.70	0.29	17.99	17.93	-0.05	0.34
37.80	0.28	18.04	17.99	-0.05	0.33
37.90	0.21	18.10	18.04	-0.05	0.26
38.00	0.20	18.15	18.10	-0.05	0.25
38.10	0.20	18.21	18.15	-0.05	0.25
38.20	0.20	18.26	18.21	-0.05	0.25
38.30	0.20	18.31	18.26	-0.05	0.25
38.40	0.18	18.37	18.32	-0.05	0.23
38.50	0.40	18.42	18.37	-0.05	0.45
38.60	0.48	18.48	18.43	-0.05	0.53
38.70	0.46	18.53	18.48	-0.05	0.51
38.80	1.00	18.59	18.53	-0.05	1.05
38.90	1.22	18.64	18.59	-0.05	1.27
39.00	1.12	18.70	18.64	-0.05	1.17

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
39.10	0.77	18.75	18.70	-0.05	0.82
39.20	0.30	18.80	18.75	-0.05	0.35
39.30	0.35	18.86	18.81	-0.05	0.40
39.40	0.56	18.91	18.86	-0.05	0.61
39.50	0.40	18.97	18.92	-0.05	0.45
39.60	0.40	19.02	18.97	-0.05	0.45
39.70	0.40	19.08	19.03	-0.05	0.45
39.80	0.32	19.13	19.08	-0.05	0.37
39.90	0.40	19.19	19.14	-0.05	0.45
40.00	0.28	19.24	19.19	-0.05	0.33
40.10	0.21	19.29	19.25	-0.05	0.26
40.20	0.20	19.35	19.30	-0.05	0.25
40.30	0.20	19.40	19.36	-0.05	0.25
40.40	0.25	19.46	19.41	-0.05	0.30
40.50	0.25	19.51	19.47	-0.05	0.30
40.60	0.29	19.57	19.52	-0.05	0.34
40.70	0.20	19.62	19.58	-0.05	0.25
40.80	0.30	19.68	19.63	-0.05	0.35
40.90	0.30	19.73	19.68	-0.05	0.35
41.00	0.29	19.78	19.74	-0.04	0.33
41.10	0.20	19.84	19.79	-0.04	0.24
41.20	0.20	19.89	19.85	-0.04	0.24
41.30	0.20	19.95	19.90	-0.04	0.24
41.40	0.17	20.00	19.96	-0.04	0.21
41.50	0.20	20.06	20.01	-0.04	0.24
41.60	0.20	20.11	20.07	-0.04	0.24
41.70	0.20	20.17	20.12	-0.04	0.24
41.80	0.18	20.22	20.18	-0.04	0.22
41.90	0.20	20.27	20.23	-0.04	0.24
42.00	0.47	20.33	20.29	-0.04	0.51
42.10	0.50	20.38	20.34	-0.04	0.54

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
42.20	0.40	20.44	20.40	-0.04	0.44
42.30	0.10	20.49	20.45	-0.04	0.14
42.40	0.13	20.55	20.51	-0.04	0.17
42.50	0.20	20.60	20.56	-0.04	0.24
42.60	0.21	20.66	20.62	-0.04	0.25
42.70	0.25	20.71	20.67	-0.04	0.29
42.80	0.25	20.76	20.72	-0.04	0.29
42.90	0.30	20.82	20.78	-0.04	0.34
43.00	0.33	20.87	20.83	-0.04	0.37
43.10	0.34	20.93	20.89	-0.04	0.38
43.20	0.30	20.98	20.94	-0.04	0.34
43.30	0.30	21.04	21.00	-0.04	0.34
43.40	0.30	21.09	21.05	-0.04	0.34
43.50	0.20	21.15	21.11	-0.04	0.24
43.60	0.10	21.20	21.16	-0.04	0.14
43.70	0.10	21.25	21.22	-0.04	0.14
43.80	0.10	21.31	21.27	-0.04	0.14
43.90	0.26	21.36	21.33	-0.04	0.30
44.00	0.30	21.42	21.38	-0.04	0.34
44.10	0.20	21.47	21.44	-0.04	0.24
44.20	0.30	21.53	21.49	-0.04	0.34
44.30	0.25	21.58	21.55	-0.04	0.29
44.40	0.20	21.64	21.60	-0.04	0.24
44.50	0.25	21.69	21.66	-0.03	0.28
44.60	0.20	21.74	21.71	-0.03	0.23
44.70	0.20	21.80	21.76	-0.03	0.23
44.80	0.23	21.85	21.82	-0.03	0.26
44.90	0.25	21.91	21.87	-0.03	0.28
45.00	0.20	21.96	21.93	-0.03	0.23
45.10	0.20	22.02	21.98	-0.03	0.23
45.20	0.22	22.07	22.04	-0.03	0.25

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
45.30	0.28	22.13	22.09	-0.03	0.31
45.40	0.30	22.18	22.15	-0.03	0.33
45.50	0.30	22.23	22.20	-0.03	0.33
45.60	0.24	22.29	22.26	-0.03	0.27
45.70	0.10	22.34	22.31	-0.03	0.13
45.80	0.10	22.40	22.37	-0.03	0.13
45.90	0.15	22.45	22.42	-0.03	0.18
46.00	0.29	22.51	22.48	-0.03	0.32
46.10	0.21	22.56	22.53	-0.03	0.24
46.20	0.30	22.62	22.59	-0.03	0.33
46.30	0.26	22.67	22.64	-0.03	0.29
46.40	0.25	22.72	22.70	-0.03	0.28
46.50	0.28	22.78	22.75	-0.03	0.31
46.60	0.24	22.83	22.81	-0.03	0.27
46.70	0.25	22.89	22.86	-0.03	0.28
46.80	0.47	22.94	22.91	-0.03	0.50
46.90	0.20	23.00	22.97	-0.03	0.23
47.00	0.25	23.05	23.02	-0.03	0.28
47.10	0.20	23.11	23.08	-0.03	0.23
47.20	0.25	23.16	23.13	-0.03	0.28
47.30	0.30	23.21	23.19	-0.03	0.33
47.40	0.30	23.27	23.24	-0.03	0.33
47.50	0.26	23.32	23.30	-0.03	0.29
47.60	0.25	23.38	23.35	-0.03	0.28
47.70	0.23	23.43	23.41	-0.03	0.26
47.80	0.22	23.49	23.46	-0.03	0.25
47.90	0.40	23.54	23.52	-0.02	0.42
48.00	0.28	23.60	23.57	-0.02	0.30
48.10	0.21	23.65	23.63	-0.02	0.23
48.20	0.31	23.70	23.68	-0.02	0.33
48.30	0.39	23.76	23.74	-0.02	0.41

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
48.40	0.20	23.81	23.79	-0.02	0.22
48.50	0.19	23.87	23.85	-0.02	0.21
48.60	0.20	23.92	23.90	-0.02	0.22
48.70	0.22	23.98	23.95	-0.02	0.24
48.80	0.21	24.03	24.01	-0.02	0.23
48.90	0.20	24.09	24.06	-0.02	0.22
49.00	0.25	24.14	24.12	-0.02	0.27
49.10	0.27	24.19	24.17	-0.02	0.29
49.20	0.37	24.25	24.23	-0.02	0.39
49.30	0.39	24.30	24.28	-0.02	0.41
49.40	0.30	24.36	24.34	-0.02	0.32
49.50	0.20	24.41	24.39	-0.02	0.22
49.60	0.20	24.47	24.45	-0.02	0.22
49.70	0.31	24.52	24.50	-0.02	0.33
49.80	0.40	24.58	24.56	-0.02	0.42
49.90	0.40	24.63	24.61	-0.02	0.42
50.00	0.33	24.69	24.67	-0.02	0.35
50.10	0.30	24.74	24.72	-0.02	0.32
50.20	0.30	24.79	24.78	-0.02	0.32
50.30	0.30	24.85	24.83	-0.02	0.32
50.40	0.26	24.90	24.89	-0.02	0.28
50.50	0.20	24.96	24.94	-0.02	0.22
50.60	0.20	25.01	24.99	-0.02	0.22
50.70	0.20	25.07	25.05	-0.02	0.22
50.80	0.20	25.12	25.10	-0.02	0.22
50.90	0.17	25.18	25.16	-0.02	0.19
51.00	0.22	25.23	25.21	-0.02	0.24
51.10	0.29	25.28	25.27	-0.02	0.31
51.20	0.20	25.34	25.32	-0.02	0.22
51.30	0.20	25.39	25.38	-0.01	0.21
51.40	0.26	25.45	25.43	-0.01	0.27

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
51.50	0.16	25.50	25.49	-0.01	0.17
51.60	0.27	25.56	25.54	-0.01	0.28
51.70	0.30	25.61	25.60	-0.01	0.31
51.80	0.20	25.67	25.65	-0.01	0.21
51.90	0.22	25.72	25.71	-0.01	0.23
52.00	0.34	25.77	25.76	-0.01	0.35
52.10	0.40	25.83	25.82	-0.01	0.41
52.20	0.30	25.88	25.87	-0.01	0.31
52.30	0.38	25.94	25.93	-0.01	0.39
52.40	0.30	25.99	25.98	-0.01	0.31
52.50	0.28	26.05	26.03	-0.01	0.29
52.60	0.25	26.10	26.09	-0.01	0.26
52.70	0.30	26.16	26.14	-0.01	0.31
52.80	0.25	26.21	26.20	-0.01	0.26
52.90	0.21	26.26	26.25	-0.01	0.22
53.00	0.20	26.32	26.31	-0.01	0.21
53.10	0.22	26.37	26.36	-0.01	0.23
53.20	0.20	26.43	26.42	-0.01	0.21
53.30	0.20	26.48	26.47	-0.01	0.21
53.40	0.20	26.54	26.53	-0.01	0.21
53.50	0.34	26.59	26.58	-0.01	0.35
53.60	0.30	26.65	26.64	-0.01	0.31
53.70	0.30	26.70	26.69	-0.01	0.31
53.80	0.25	26.75	26.75	-0.01	0.26
53.90	0.28	26.81	26.80	-0.01	0.29
54.00	0.40	26.86	26.86	-0.01	0.41
54.10	0.50	26.92	26.91	-0.01	0.51
54.20	0.40	26.97	26.97	-0.01	0.41
54.30	0.32	27.03	27.02	-0.01	0.33
54.40	0.31	27.08	27.08	-0.01	0.32
54.50	0.40	27.14	27.13	-0.01	0.41

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
54.60	0.40	27.19	27.18	-0.01	0.41
54.70	0.41	27.24	27.24	0.00	0.41
54.80	0.48	27.30	27.29	0.00	0.48
54.90	0.30	27.35	27.35	0.00	0.30
55.00	0.30	27.41	27.40	0.00	0.30
55.10	0.39	27.46	27.46	0.00	0.39
55.20	0.35	27.52	27.51	0.00	0.35
55.30	0.30	27.57	27.57	0.00	0.30
55.40	0.30	27.63	27.62	0.00	0.30
55.50	0.29	27.68	27.68	0.00	0.29
55.60	0.25	27.73	27.73	0.00	0.25
55.70	0.25	27.79	27.79	0.00	0.25
55.80	0.30	27.84	27.84	0.00	0.30
55.90	0.30	27.90	27.90	0.00	0.30
56.00	0.40	27.95	27.95	0.00	0.40
56.10	0.40	28.01	28.01	0.00	0.40
56.20	0.40	28.06	28.06	0.00	0.40
56.30	0.50	28.12	28.12	0.00	0.50
56.40	0.00	28.17	0.00	Not Applicable	
56.60	0.00	29.50	0.00	Not Applicable	
56.70	0.00	29.23	0.00	Not Applicable	
56.80	0.00	28.80	0.00	Not Applicable	
56.90	0.00	28.35	0.00	Not Applicable	
57.00	0.00	28.35	0.00	Not Applicable	
57.10	0.00	28.44	0.00	Not Applicable	
57.30	0.00	28.93	0.00	Not Applicable	
57.40	0.00	29.09	0.00	Not Applicable	
57.50	0.00	29.03	0.00	Not Applicable	
57.60	0.00	29.19	0.00	Not Applicable	
57.70	0.00	29.33	0.00	Not Applicable	
57.80	0.00	29.33	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
57.90	0.00	28.91	0.00	Not Applicable	
58.00	0.00	29.20	0.00	Not Applicable	
58.10	0.00	29.29	0.00	Not Applicable	
58.20	0.00	29.22	0.00	Not Applicable	
58.40	0.00	29.52	0.00	Not Applicable	
58.60	0.00	31.38	0.00	Not Applicable	
58.70	0.00	31.86	0.00	Not Applicable	
58.80	0.00	30.69	0.00	Not Applicable	
58.90	0.00	31.49	0.00	Not Applicable	
59.00	0.00	32.07	0.00	Not Applicable	
59.10	0.00	31.74	0.00	Not Applicable	
59.20	0.00	31.95	0.00	Not Applicable	
59.40	0.00	31.18	0.00	Not Applicable	
59.50	0.00	29.65	0.00	Not Applicable	
59.60	0.00	30.02	0.00	Not Applicable	
59.70	0.00	30.59	0.00	Not Applicable	
59.80	0.00	30.46	0.00	Not Applicable	
59.90	0.00	30.20	0.00	Not Applicable	
60.00	0.00	30.67	0.00	Not Applicable	
60.10	0.00	30.37	0.00	Not Applicable	
60.20	0.00	30.56	0.00	Not Applicable	
60.30	0.00	30.73	0.00	Not Applicable	
60.40	0.00	31.21	0.00	Not Applicable	
60.50	0.00	30.43	0.00	Not Applicable	
60.60	0.00	30.38	0.00	Not Applicable	
60.70	0.00	30.34	0.00	Not Applicable	
60.80	0.00	30.47	0.00	Not Applicable	
61.00	0.00	31.69	0.00	Not Applicable	
61.10	0.00	32.29	0.00	Not Applicable	
61.20	0.00	32.42	0.00	Not Applicable	
61.30	0.00	32.13	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
61.40	0.00	32.06	0.00	Not Applicable	
61.50	0.00	31.89	0.00	Not Applicable	
61.60	0.00	31.73	0.00	Not Applicable	
61.70	0.00	31.51	0.00	Not Applicable	
61.80	0.00	30.94	0.00	Not Applicable	
61.90	0.00	30.95	0.00	Not Applicable	
62.00	0.00	31.05	0.00	Not Applicable	
62.10	0.00	31.32	0.00	Not Applicable	
62.20	0.00	31.49	0.00	Not Applicable	
62.30	0.00	31.40	0.00	Not Applicable	
62.40	0.00	31.02	0.00	Not Applicable	
62.50	0.00	31.65	0.00	Not Applicable	
62.60	0.00	31.72	0.00	Not Applicable	
62.70	0.00	31.78	0.00	Not Applicable	
62.80	0.00	31.82	0.00	Not Applicable	
62.90	0.00	32.17	0.00	Not Applicable	
63.00	0.00	33.03	0.00	Not Applicable	
63.10	0.00	32.61	0.00	Not Applicable	
63.20	0.00	32.49	0.00	Not Applicable	
63.30	0.00	31.57	0.00	Not Applicable	
63.40	0.00	31.90	0.00	Not Applicable	
63.50	0.00	32.06	0.00	Not Applicable	
63.70	0.00	31.13	0.00	Not Applicable	
63.90	0.00	32.42	0.00	Not Applicable	
64.00	0.00	31.91	0.00	Not Applicable	
64.10	0.00	31.75	0.00	Not Applicable	
64.20	0.00	31.92	0.00	Not Applicable	
64.30	0.00	32.26	0.00	Not Applicable	
64.40	0.00	33.47	0.00	Not Applicable	
64.50	0.00	33.31	0.00	Not Applicable	
64.60	0.00	33.23	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
64.70	0.00	32.72	0.00	Not Applicable	
64.80	0.00	32.99	0.00	Not Applicable	
64.90	0.00	33.08	0.00	Not Applicable	
65.00	0.00	32.65	0.00	Not Applicable	
65.10	0.00	33.42	0.00	Not Applicable	
65.20	0.00	34.13	0.00	Not Applicable	
65.30	0.00	33.65	0.00	Not Applicable	
65.40	0.00	33.17	0.00	Not Applicable	
65.50	0.00	33.03	0.00	Not Applicable	
65.60	0.00	33.41	0.00	Not Applicable	
65.70	0.00	33.14	0.00	Not Applicable	
65.80	0.00	33.46	0.00	Not Applicable	
65.90	0.00	33.45	0.00	Not Applicable	
66.00	0.00	33.28	0.00	Not Applicable	
66.10	0.00	33.03	0.00	Not Applicable	
66.20	0.00	32.89	0.00	Not Applicable	
66.30	0.00	33.27	0.00	Not Applicable	
66.40	0.00	33.38	0.00	Not Applicable	
66.50	0.00	34.37	0.00	Not Applicable	
66.60	0.00	33.32	0.00	Not Applicable	
66.70	0.00	33.71	0.00	Not Applicable	
66.80	0.00	33.55	0.00	Not Applicable	
66.90	0.00	33.81	0.00	Not Applicable	
67.00	0.00	33.82	0.00	Not Applicable	
67.10	0.00	33.99	0.00	Not Applicable	
67.20	0.00	33.92	0.00	Not Applicable	
67.30	0.00	33.55	0.00	Not Applicable	
67.40	0.00	34.03	0.00	Not Applicable	
67.50	0.00	33.89	0.00	Not Applicable	
67.60	0.00	33.86	0.00	Not Applicable	
67.70	0.00	34.14	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
67.80	0.00	33.91	0.00	Not Applicable	
67.90	0.00	34.09	0.00	Not Applicable	
68.00	0.00	34.43	0.00	Not Applicable	
68.10	0.00	34.62	0.00	Not Applicable	
68.20	0.00	35.45	0.00	Not Applicable	
68.30	0.00	35.67	0.00	Not Applicable	
68.40	0.00	35.50	0.00	Not Applicable	
68.50	0.00	35.28	0.00	Not Applicable	
68.60	0.00	35.32	0.00	Not Applicable	
68.80	0.00	35.36	0.00	Not Applicable	
68.90	0.00	35.31	0.00	Not Applicable	
69.00	0.00	35.01	0.00	Not Applicable	
69.10	0.00	35.03	0.00	Not Applicable	
69.20	0.00	35.18	0.00	Not Applicable	
69.30	0.00	35.37	0.00	Not Applicable	
69.40	0.00	35.40	0.00	Not Applicable	
69.60	0.00	35.29	0.00	Not Applicable	
69.70	0.00	35.54	0.00	Not Applicable	
69.80	0.00	35.62	0.00	Not Applicable	
69.90	0.00	35.63	0.00	Not Applicable	
70.00	0.00	35.55	0.00	Not Applicable	
70.10	0.00	36.00	0.00	Not Applicable	
70.20	0.00	35.91	0.00	Not Applicable	
70.30	0.00	35.89	0.00	Not Applicable	
70.40	0.00	35.91	0.00	Not Applicable	
70.50	0.00	36.02	0.00	Not Applicable	
70.60	0.00	35.99	0.00	Not Applicable	
70.70	0.00	36.01	0.00	Not Applicable	
70.80	0.00	35.98	0.00	Not Applicable	
70.90	0.00	35.94	0.00	Not Applicable	
71.00	0.00	36.20	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
71.10	0.00	36.73	0.00	Not Applicable	
71.20	0.00	36.84	0.00	Not Applicable	
71.30	0.00	36.20	0.00	Not Applicable	
71.40	0.00	36.18	0.00	Not Applicable	
71.50	0.00	35.99	0.00	Not Applicable	
71.60	0.00	36.22	0.00	Not Applicable	
71.70	0.00	36.25	0.00	Not Applicable	
71.80	0.00	36.14	0.00	Not Applicable	
71.90	0.00	36.33	0.00	Not Applicable	
72.00	0.00	36.58	0.00	Not Applicable	
72.10	0.00	36.74	0.00	Not Applicable	
72.20	0.00	36.64	0.00	Not Applicable	
72.30	0.00	36.71	0.00	Not Applicable	
72.40	0.00	36.74	0.00	Not Applicable	
72.50	0.00	36.79	0.00	Not Applicable	
72.60	0.00	37.53	0.00	Not Applicable	
72.70	0.00	37.44	0.00	Not Applicable	
72.80	0.00	37.23	0.00	Not Applicable	
72.90	0.00	37.00	0.00	Not Applicable	
73.00	0.00	37.07	0.00	Not Applicable	
73.10	0.00	37.08	0.00	Not Applicable	
73.20	0.00	37.44	0.00	Not Applicable	
73.30	0.00	37.20	0.00	Not Applicable	
73.40	0.00	37.41	0.00	Not Applicable	
73.50	0.00	37.87	0.00	Not Applicable	
73.60	0.00	37.60	0.00	Not Applicable	
73.70	0.00	37.66	0.00	Not Applicable	
73.80	0.00	37.70	0.00	Not Applicable	
73.90	0.00	38.31	0.00	Not Applicable	
74.00	0.00	37.87	0.00	Not Applicable	
74.10	0.00	37.87	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
74.20	0.00	38.04	0.00	Not Applicable	
74.30	0.00	38.21	0.00	Not Applicable	
74.40	0.00	38.24	0.00	Not Applicable	
74.50	0.00	38.34	0.00	Not Applicable	
74.60	0.00	38.36	0.00	Not Applicable	
74.70	0.00	38.43	0.00	Not Applicable	
74.80	0.00	38.47	0.00	Not Applicable	
74.90	0.00	38.21	0.00	Not Applicable	
75.10	0.00	38.20	0.00	Not Applicable	
75.20	0.00	39.17	0.00	Not Applicable	
75.30	0.00	38.84	0.00	Not Applicable	
75.40	0.00	38.80	0.00	Not Applicable	
75.60	0.00	38.87	0.00	Not Applicable	
75.70	0.00	39.08	0.00	Not Applicable	
75.80	0.00	39.90	0.00	Not Applicable	
75.90	0.00	39.16	0.00	Not Applicable	
76.00	0.00	39.03	0.00	Not Applicable	
76.20	0.00	39.84	0.00	Not Applicable	
76.30	0.00	39.50	0.00	Not Applicable	
76.40	0.00	39.49	0.00	Not Applicable	
76.50	0.00	39.52	0.00	Not Applicable	
76.60	0.00	39.53	0.00	Not Applicable	
76.80	0.00	39.65	0.00	Not Applicable	
76.90	0.00	39.72	0.00	Not Applicable	
77.00	0.00	39.54	0.00	Not Applicable	
77.10	0.00	39.77	0.00	Not Applicable	
77.20	0.00	39.91	0.00	Not Applicable	
77.30	0.00	39.65	0.00	Not Applicable	
77.40	0.00	40.41	0.00	Not Applicable	
77.50	0.00	40.02	0.00	Not Applicable	
77.60	0.00	39.80	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
77.70	0.00	40.26	0.00	Not Applicable	
77.80	0.00	40.24	0.00	Not Applicable	
77.90	0.00	40.17	0.00	Not Applicable	
78.00	0.00	40.27	0.00	Not Applicable	
78.10	0.00	40.31	0.00	Not Applicable	
78.20	0.00	40.76	0.00	Not Applicable	
78.30	0.00	41.03	0.00	Not Applicable	
78.40	0.00	40.53	0.00	Not Applicable	
78.50	0.00	40.62	0.00	Not Applicable	
78.60	0.00	41.13	0.00	Not Applicable	
78.70	0.00	41.11	0.00	Not Applicable	
78.80	0.00	41.23	0.00	Not Applicable	
78.90	0.00	41.15	0.00	Not Applicable	
79.00	0.00	41.02	0.00	Not Applicable	
79.10	0.00	41.10	0.00	Not Applicable	
79.20	0.00	40.95	0.00	Not Applicable	
79.30	0.00	42.11	0.00	Not Applicable	
79.40	0.00	42.06	0.00	Not Applicable	
79.50	0.00	41.13	0.00	Not Applicable	
79.60	0.00	41.30	0.00	Not Applicable	
79.70	0.00	41.11	0.00	Not Applicable	
79.80	0.00	41.10	0.00	Not Applicable	
79.90	0.00	41.22	0.00	Not Applicable	
80.00	0.00	40.96	0.00	Not Applicable	
80.10	0.00	40.69	0.00	Not Applicable	
80.20	0.00	41.11	0.00	Not Applicable	
80.30	0.00	41.06	0.00	Not Applicable	
80.40	0.00	40.95	0.00	Not Applicable	
80.50	0.00	42.02	0.00	Not Applicable	
80.60	0.00	41.43	0.00	Not Applicable	
80.70	0.00	41.24	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
80.80	0.00	41.13	0.00	Not Applicable	
80.90	0.00	41.22	0.00	Not Applicable	
81.00	0.00	41.38	0.00	Not Applicable	
81.10	0.00	41.40	0.00	Not Applicable	
81.20	0.00	41.55	0.00	Not Applicable	
81.30	0.00	41.53	0.00	Not Applicable	
81.40	0.00	41.60	0.00	Not Applicable	
81.50	0.00	42.11	0.00	Not Applicable	
81.60	0.00	42.09	0.00	Not Applicable	
81.70	0.00	41.88	0.00	Not Applicable	
81.80	0.00	41.88	0.00	Not Applicable	
82.00	0.00	42.17	0.00	Not Applicable	
82.10	0.00	40.40	0.00	Not Applicable	
82.20	0.00	40.54	0.00	Not Applicable	
82.30	0.00	39.82	0.00	Not Applicable	
82.40	0.00	40.14	0.00	Not Applicable	
82.50	0.00	40.37	0.00	Not Applicable	
82.60	0.00	38.04	0.00	Not Applicable	
82.70	0.00	42.12	0.00	Not Applicable	
82.80	0.00	41.58	0.00	Not Applicable	
82.90	0.00	42.14	0.00	Not Applicable	
83.00	0.00	42.37	0.00	Not Applicable	
83.10	0.00	42.18	0.00	Not Applicable	
83.20	0.00	42.69	0.00	Not Applicable	
83.30	0.00	42.57	0.00	Not Applicable	
83.40	0.00	42.68	0.00	Not Applicable	
83.50	0.00	42.88	0.00	Not Applicable	
83.60	0.00	42.04	0.00	Not Applicable	
83.80	0.00	42.40	0.00	Not Applicable	
83.90	0.00	42.81	0.00	Not Applicable	
84.00	0.00	42.52	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
84.10	0.00	42.29	0.00	Not Applicable	
84.20	0.00	42.37	0.00	Not Applicable	
84.30	0.00	43.35	0.00	Not Applicable	
84.40	0.00	43.68	0.00	Not Applicable	
84.50	0.00	43.57	0.00	Not Applicable	
84.60	0.00	43.74	0.00	Not Applicable	
85.00	0.00	42.75	0.00	Not Applicable	
85.10	0.00	42.48	0.00	Not Applicable	
85.20	0.00	42.44	0.00	Not Applicable	
85.30	0.00	42.54	0.00	Not Applicable	
85.40	0.00	42.51	0.00	Not Applicable	
85.50	0.00	43.28	0.00	Not Applicable	
85.60	0.00	43.14	0.00	Not Applicable	
85.70	0.00	42.64	0.00	Not Applicable	
85.80	0.00	42.77	0.00	Not Applicable	
85.90	0.00	42.68	0.00	Not Applicable	
86.00	0.00	42.76	0.00	Not Applicable	
86.20	0.00	43.27	0.00	Not Applicable	
86.30	0.00	43.27	0.00	Not Applicable	
86.40	0.00	43.90	0.00	Not Applicable	
86.50	0.00	43.14	0.00	Not Applicable	
86.60	0.00	43.34	0.00	Not Applicable	
86.70	0.00	43.17	0.00	Not Applicable	
86.80	0.00	43.07	0.00	Not Applicable	
86.90	0.00	43.34	0.00	Not Applicable	
87.00	0.00	43.65	0.00	Not Applicable	
87.10	0.00	44.09	0.00	Not Applicable	
87.20	0.00	43.75	0.00	Not Applicable	
87.30	0.00	43.94	0.00	Not Applicable	
87.40	0.00	43.95	0.00	Not Applicable	
87.50	0.00	43.95	0.00	Not Applicable	

White Cell shows	Stretch with Bathymetric Survey
Highlighted Cell shows	Stretch with Topographic Survey

Chainage (Km)	Raw Depth (m)	CD/SD w.r.t MSL (m)	Observed W.L. w.r.t MSL (m)	Reduction in soundings (m)	Reduced Depth (m)
	A	B	C	D = C - B	E = A-D
87.60	0.00	43.91	0.00	Not Applicable	
87.70	0.00	43.97	0.00	Not Applicable	
87.80	0.00	43.95	0.00	Not Applicable	
87.90	0.00	44.40	0.00	Not Applicable	
88.00	0.00	43.93	0.00	Not Applicable	
88.10	0.00	44.05	0.00	Not Applicable	
88.20	0.00	44.09	0.00	Not Applicable	
88.30	0.00	44.00	0.00	Not Applicable	
88.40	0.00	44.13	0.00	Not Applicable	
88.50	0.00	45.00	0.00	Not Applicable	
88.60	0.00	44.58	0.00	Not Applicable	
88.70	0.00	44.63	0.00	Not Applicable	
88.80	0.00	44.48	0.00	Not Applicable	
88.90	0.00	44.85	0.00	Not Applicable	
89.10	0.00	44.43	0.00	Not Applicable	
89.20	0.00	44.69	0.00	Not Applicable	
89.30	0.00	44.52	0.00	Not Applicable	
89.40	0.00	44.22	0.00	Not Applicable	
89.50	0.00	44.41	0.00	Not Applicable	
89.60	0.00	44.78	0.00	Not Applicable	

Annexure 4: Photographs along Ajoy Waterway

SANKHAI JETTY, 0.0 KP

SRIKRISHNAPUR, VERY SHALLOW PATCH CHAINAGE 56KP

SAND MINING CHAINAGE 84KP

RAILWAY BRIDGE 83KP (2)

PALITPUR, BACKPACK SURVEY CHAINAGE 50.0

NOTUNHAT MAJOR ROADWAYS BRIDGE CHAINAGE 48.90

NARENGA, SHALLOW PATCH CHAINAGE 61KP

NABAGRAM, SAND MINING WATER COLUMN PITS CHAINAGE 52

NABAGRAM, SAND MINING AREA CHAINAGE 51KP

NABAGRAM, BRICK KILN CHAINAGE 51

CHARKHI MAJOR ROADWAYS BRIDGE CHAINAGE 75.5

JASHRA EMBANKMENT WALL CHAINAGE 32KP

JAHANABAD WOODEN BRIDGE CHAINAGE 38