INLAND WATERWAYS AUTHORITY OF INDIA, A-13, SECTOR-1, NOIDA DIST-GAUTAM BUDHA NAGAR, UTTAR PRADESH, PIN- 201 301(UP)

"FINAL FEASIBILITY REPORT ON HYDROGRAPHIC SURVEY

KHERKHAI RIVER (NW-56) (22.104 km)

FROM "CONFLUENCE WITH SUBARNAREKHA RIVER AT JAMSHEDPUR TO UNDER-CONSTRUCTION RCC BRIDGE NEAR GANGIA VILLAGE"

Survey Period from 27.10.15 to 05.11.15

FINAL REPORT ON HYDROGRAPHICAL SURVEY OF KHERKHAI RIVER, JHARKHAND

REPORT SUBMISSION DATE- 29.03.2019

SUBMITTED BY:

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Acknowledgement

B.S.Geotech PVT.Ltd, Konnagar, Hooghly express its sincere gratitude to **IWAI** for awarding the work and guidance for completing this Project of detailed Hydrographic Survey and the Feasibility Report in **Region-VIII (Kherkhai River) from Confluence with Subarnarekha River at Jamshedpur to under-construction RCC Bridge near Gangia Village (22.104 km).**

We would like to use this opportunity to pen down our profound gratitude and appreciations to **Shri Jalaj Srivastava, IAS, Chairman, IWAI** for spending their valuable time and guidance for compleing this project of “ Detailed Hydrography and Topography survey in Kherkhai River.” B.S.Geotech would also like to thanks to **Shri Pravir Pandey, Vice-Chairman, IA&AS., Shri Shashi Bhushan Shukla, Member (Traffic), Shri Alok Ranjan, Member (Finance) and Shri S.K.Gangwar, Member (Technical).**

B.S.Geotech wishes to express their gratitude to **Capt. Ashish Arya, Hydrographic Chief, IWAI, Cdr. P.K. Srivastava, Ex. Hydrographic Chief, IWAI, Shri S.V.K. Reddy, Chief Engineer-I** for his guidance and inspiration for this project. B.S.Geotech would also like to thank **Shri Rajiv Singhal, S.H.S., IWAI** for invaluable support and suggestions provided throughout the survey period. B.S.Geotech is pleased to place on record our sincere thanks to other staff and officers of **IWAI** for their excellent support and co-operation throughout the survey period.

List of Abbreviations

CD	Chart Datum
DGPS	Differential Global Positioning Systems
ETS	Electronic Total Station
GPS	Global Positioning Systems
LBM	Local Bench Mark
MSL	Mean Sea Level
RL	Reference Level
SD	Sounding Datum
SBAS	Satellite-Based Augmentation System
TBC	Trimble Business Centre
FRP	Fiber Reinforced Plastic

Table 1- List of Abbreviations

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ii) 1.2 m to 1.4 m (km)
iii) 1.5 m to 1.7 m (km)
iv) 1.8 m to 2.0 m (km)
v) > 2.0 m (km)

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iv) 1.8 m to 2.0 m (km)
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<table><tr><th>Sub Stretch-1 (0.00-10.00 km)</th><th>Sub Stretch-2 (10.00-22.104 km)</th><th>Total</th></tr><tr><td>4.8</td><td>0.3</td><td>5.1</td></tr><tr><td>0</td><td>1.2</td><td>1.2</td></tr><tr><td>0</td><td>1.7</td><td>1.7</td></tr><tr><td>0</td><td>1.8</td><td>1.8</td></tr><tr><td>5.2</td><td>7.104</td><td>12.304</td></tr><tr><td>Total-10.00</td><td>Total- 12.104</td><td>Total- 22.104 km</td></tr></table>
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<table><tr><th>Sub Stretch-1 (0.00-10.00 km)</th><th>Sub Stretch-2 (10.00-22.104 km)</th><th>Total</th></tr><tr><td>6.6</td><td>0.7</td><td>7.3</td></tr><tr><td>0</td><td>1.2</td><td>1.2</td></tr><tr><td>0</td><td>1.7</td><td>1.7</td></tr><tr><td>0</td><td>1.9</td><td>1.9</td></tr><tr><td>3.4</td><td>6.604</td><td>10.004</td></tr><tr><td>Total-10.00</td><td>Total- 12.104</td><td>Total- 22.104 km</td></tr></table></td></tr>
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<table>
<tr><th>Sl.</th><th>Particulars</th><th>Details</th></tr>
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<tr><td>Kulapdanga Check Dam</td><td>10.642</td><td>126.900</td></tr>
<tr><td>Dudra Check Dam</td><td>15.623</td><td>131.500</td></tr>
</table>
ii) RCC Bridge- 3 (Three), Rail Bridge- 2 (Two)
<table>
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<tr><td>Horizontal Clearance (m)</td><td>14.26</td><td>30.38</td></tr>
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</table>
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iv) Under Construction Railway Bridge- 1 (one)
<table>
<tr><th>Under construction Bridge</th><th>Chainage (km)</th><th>Location</th></tr>
<tr><td>Adityapur village under construction Rail Bridge</td><td>9.223</td><td>Adityapur</td></tr>
<tr><td>Itagarh village under construction RCC Bridge</td><td>16.724</td><td>Itagarh</td></tr>
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</table>
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<table>
<tr><th>Clearance w.r.t H.F.L</th><th>Min (m)</th><th>Max (m)</th></tr>
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</td></tr>
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<tr><th>From</th><th>To</th><td></td><td></td><td></td><td></td></tr>
<tr><td>0.00</td><td>10.00</td><td>3.736</td><td>10.00</td><td>0.373</td><td>37.3</td></tr>
<tr><td>10.01</td><td>22.104</td><td>8.270</td><td>12.094</td><td>0.683</td><td>68.3</td></tr>
<tr><td colspan="4">Avg. Slope</td><td>0.528</td><td>52.8</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Sl.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>8.</td><td>Average Discharge</td><td>
<table>
<tr><th>Sl. No</th><th>Chainage (km)</th><th>Discharge (m3/sec)</th><th rowspan="5">Dated 27.10.15 to 05.11.15</th></tr>
<tr><td>1</td><td>0.107</td><td>224.22</td></tr>
<tr><td>2</td><td>10.720</td><td>177.51</td></tr>
<tr><td>3</td><td>22.073</td><td>95.41</td></tr>
<tr><td colspan="2">Avg. Discharge</td><td>165.71</td></tr>
</table>
</td></tr>
<tr><td>9.</td><td>i) Present IWT operations
ii) Ferry services, tourism, cargo, if any</td><td>i) As follows
ii) There is no ferry service available in this zone of river. There is no cargo available in this zone of river. Joggers park, Bhatia park, Sir Dorabji Tata park, Tinplate Kali Mandir, Surya Mandir park, Jamshedpur, Adityapur etc. tourist places are located in this zone of river.</td></tr>
<tr><td>10.</td><td>Approx Distance of Rail & Road from Industry</td><td>i) Nearest Railway station- i) Adityapur Railway Station (1.69 km from the river side area) ii) Tatanagar Jn. Railway station (3 km from waterway)
ii) Name of National Highway close to the River- NH-32, NH-33 (Distance approximately 10 km from river side)
iii) Name of SH- SH- 5, SH-6
iv) Jamshedpur, a major industrial hub located in this zone of river. Tata steel plant, pellet plant, Adityapur industrial hub, Auro plastic injection moulders pvt. Ltd etc. are located in this zone of river.</td></tr>
<tr><td>11.</td><td>Any other information/ comment</td><td>Recommend for the detailed project report for the waterway development in this region of river. Jamshedpur, Adityapur etc. industrial hub are located in this zone of river. As a major industrial hub, ferry service is also needful in this zone of river for the cago and passenger communication. Besides the industrial goods are easily navigable through the ferry system. So the ferry services is also be required in this zone of river.</td></tr>
</table>

Section-1: Introductory Considerations

1.1- River Course: Background information, Historical Information, Origin, End:-

The name Kherkhai comes from the Sanskrit word Kharakaya it means "Fast flowing river", rising from near Dam; Gangia village of Jharkhand. The place where from the river is flowing is basically a plateau area. The Kherkhai River flows west to east through the eastern part of India. The Kherkhai is one of the smallest rivers in Jharkhand. But it flows to a considerable length through the State of Jharkhand. The river is fairly deep and navigable. It receives on its bank such as the Dhahkidih, Itaghar, Bagbera Colony, Jugsalai lake, South park and Sonari so many small towns on its right and Industrial area and some small villages are situated on the left bank of the river. The city like Jamshedpur is situated on the bank of the river.

Kherkhai is a typical river system consisting through the Indian state of Jharkhand and out falls in the Subarnarekha River in Jamshedpur. The river receives heavy amount of water during the monsoon rains, the stream receive huge amount of water from the various tributaries. The average rainfall in the region is about 1388 mm. and 80% of the Annual rain occurs during 4 to 5 months. The catchment area of this river stretched over Jharkhand. During the monsoon the river reserved a large amount of water along with alluvium and it makes the land of both side of the river. But the stream is suffering lack of water in the season of summer for this reason the small islands are appeared in river. The basic occupation of the people situated on the both banks of the river is cultivation and engaged in factory work in the TATA Steel and the Adityapur Industrial area.

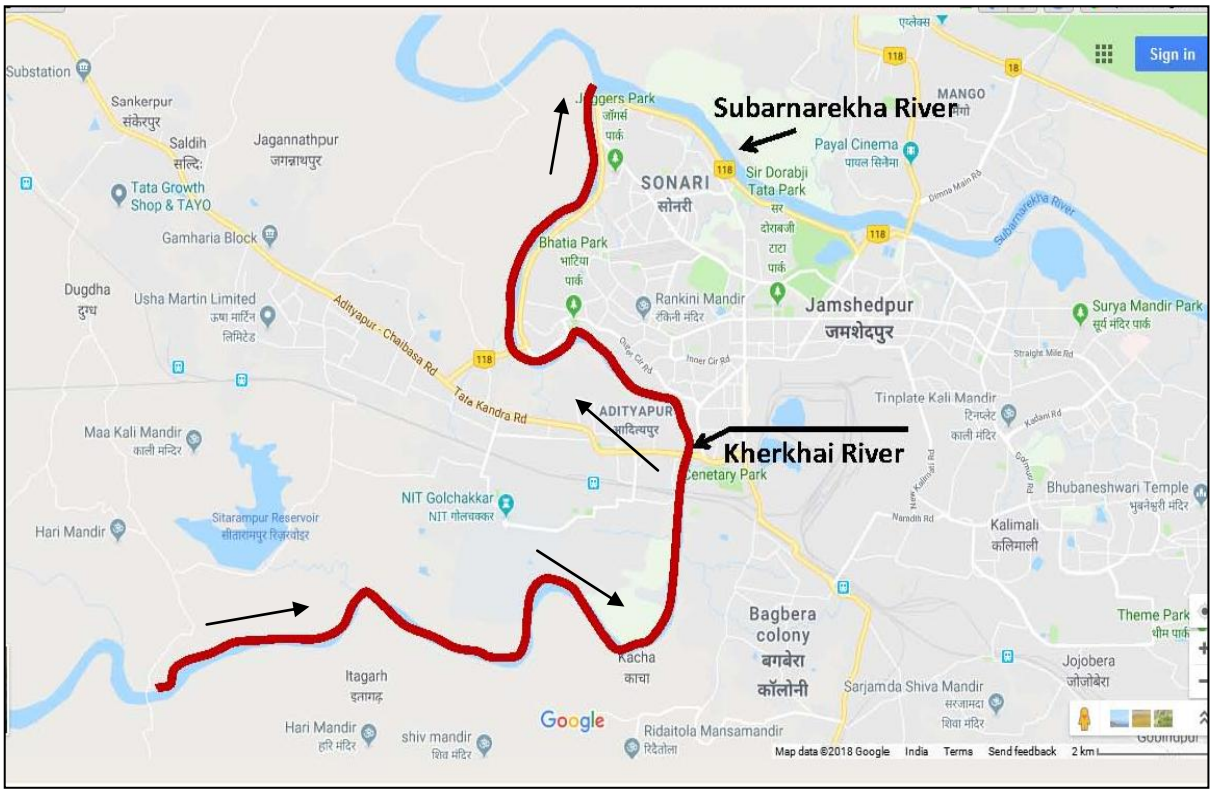


Figure 1- Kherkhai River site Location

1.2 - Tributaries / Network of River/ Basin:-

Kherkhai is one of the major tributaries of Subarnarekha River which is located near Jamshedpur, in the states of Jharkhand. The Tributaries of the Kherkhai river are-

i) Torlo
ii)Lii Gara
iii) Sanjal

1.3 - State / District through which river passes:-

The River Kherkhai passes through the region of west Singbhum , Seraikela, East Singbhum, Bokaro and sakchi in the state of Jharkhand.

1.4 – Project Site Location Map:-

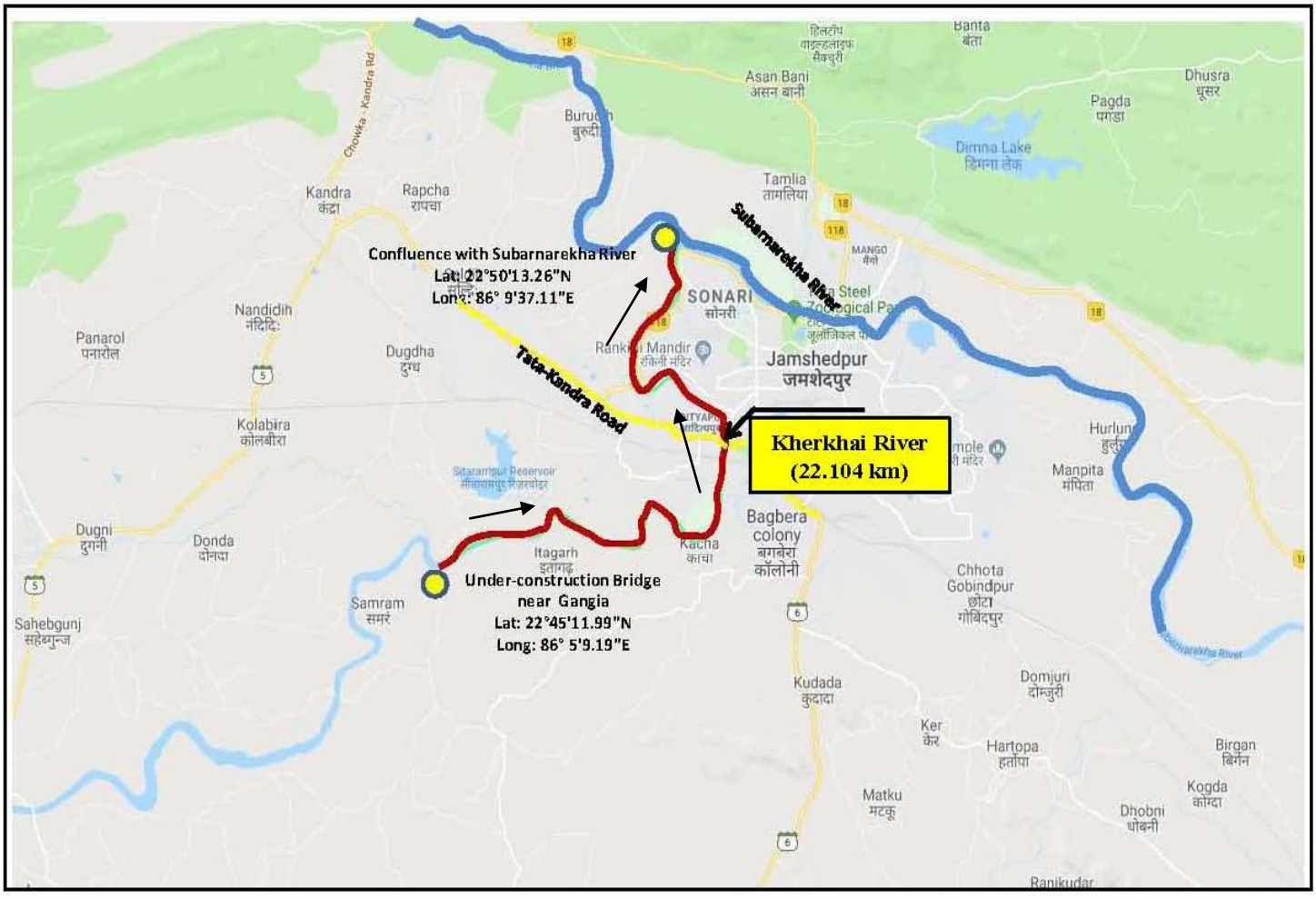


Figure 2-Project site location Map

1.5 - Scope of work:-

The Scope of work shall cover all technical aspects of hydrographic survey at par with International Standards including the following for development of the river/canal for inland navigation.

The detailed hydrographic survey is to be carried out by using Automated Hydrographic Survey System (using digital Echo sounder for depth measurement, DGPS Beacons Receivers for position fixing and Hypackmax or equivalent software for data logging). The survey is to be conducted in WGS"84 datum.

- Detailed Hydrographic Survey to assess the navigability of the waterway.
- To collect Water and bottom samples, current meter observation and discharge from the deepest route at every 10 km interval.
- To identify cross structures which are obstructing navigation.
- To identify the length of bank protection required.
- The BM is denoted by a "." mark engraved on a plate. The plate is fixed on a 5cm diameter GI pipe. The GI pipe is cemented with construction pillar of 30cmX30cmX150cm.
- The pillar extends 60.cms above ground level. Inscription "IWAI", "B.S. Geotech" and BM No. can be seen on the face of the pillar.

Section-2: Methodology Adopted to undertake Study

2.1 - Methodology Adopted including Resources and equipment used and calibration: -

Equipment:-

Following equipments are employed for the Bathymetric and Topographic survey:-

Equipment	Make	Version	Qty Employed
Echo sounder	Bathy MF 500	……	1
Current Meter	AEM 213-D	……	1
Tide Gauge	Manual (Pole type)	----------	4
RTK	South S86T	----------	3
GPS Sets	Trimble –Becon Receiver SPS 361	----------	1
Software	HYPACK data acquisition	Version 14	1
Software	AUTOCAD	2013	1
Software	Microsoft Office	2013	1

Table 2 - Equipments

- **Conduct of survey work**

- **Topography Survey:-**

The Topography survey of Kherkhai River has been carried out from "Confluence with Subarnarekha River at Jamshedpur (Lat: - 22°50'13.26"N, Long: - 86°09'37.11"E) to under-construction RCC Bridge near Gangia village (Lat: - 22°45'11.99"N, Long: - 86°05'9.19"E)". The Length of the topography survey is from Chainage 0.00 km to Chainage 22.104 km.

The Topography survey has been conducted to ascertain following in the survey area:-

- Spot levels
- High bank Line
- Vegetation covered
- Bridges and permanent structures
- Road, culvert and other communication network

GPS RTK (Real Time Kinematic) satellite navigation is a technique used in land survey and in hydrographic survey based on the use of carrier phase measurements of the GPS, GLONASS and / or Galileo signals where a single reference station provides the real-time corrections, providing up to centimeter-level accuracy. When referring to GPS in particular, the system is also commonly referred to as Carrier-Phase Enhancement, CPGPS. RTK systems use a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier that it measured, and the mobile units compare their own phase measurements with the ones received from the base station. There are several ways to transmit a correction signal from base station to mobile station. The most popular way to achieve real-time, low-cost signal transmission is to use a radio modem, typically in the UHF band. This allows the units to calculate their relative position to millimeters, although their absolute position is accurate only to the same accuracy as the position of the base station.

- **Establishment of Horizontal Control:-**

The Horizontal control for Topography survey: - High precision RTK DGPS in fix mode is using UHF Radio Modem with IHO accuracy standards, with minimum 24 hours observations at some permanent platform/base. The survey was undertaken as per the line plan provided by IWAI office. The plotting of the chart was done on UTM Projection at Zone 45 N /WGS-84 Datum as directed in the contract specifications.
The Horizontal control for Bathymetry survey: - DGPS is receiving corrections from Beacons from the Base stations.

- **Establishment of Vertical Control:-**

Vertical control from C.W.C Gauge is used for the entire survey work. Its value is 123.00 meter w.r.t. M.S.L has been considered for calculating the vertical levels. Total 3 no. Bench Mark was established along the 22.104 km of Kherkhai River with the reference of C.W.C Gauge which is situated near Adityapur Colony area.

Topography Survey:-

The survey was commenced on 27th October, 2015 and completed on 5th November, 2015. Then the days were autumn season and arrival of winter season. The climate become normal which reached about 20◦ C. Mostly day weather was sunny and was very favorable for the conduct of survey and the weather condition remains same for the entire duration of the survey.
The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 40 m interval. The plotting of the chart was done on UTM Projection at Zone 45 N as directed in the contract specifications. The spot levels along the river were obtained by using Trimble DGPS. The data was post processed using Trimble Business Center to get the precise position and MSL height values of the rover locations. Topographic survey Equipments: South (S86T) GNSS RTK, Total Station was used for conducting the topographic survey.

Figure 3- During the Topography survey in the River bank area

Bathymetry Survey:-

Bathy 500 MF was used to obtain soundings onboard the survey boat. A working frequency of 210 KHz was used for sounding operations. The digital output from the echo sounder was automatically fed to the HYPACK data logging software on a real-time basis for the acquisition of survey data. No breakdown of equipment was reported and the performance of the equipment was found to be satisfactory during the entire duration of the survey.

The sound velocity was set to 1475 m/s on single beam echo sounder during acquisition by the Bar check procedure method. The Daily bar checks were done prior to the sounding operation and before the closing of the sounding operation for the day. Being very shallow depths, the echo sounder depths were also cross-checked in between by using demarcated sounding poles during the conduct of the survey. The sounding lines were run using Survey boat to identify the design line of the Kherkhai River for the possible stretch. The sounding lines were run perpendicular to the orientation of river flow (i.e. perpendicular to the orientation of depth contours) in respective stretches. The spot sounding was also carried out in the area where the survey boat cannot be operated due to low depth. The hemisphere DGPS and Sounding Pole were used for Spot sounding at shallow locations in the Kherkhai River. The DGPS position along with water depths was recorded simultaneously and the tidal reduction was applied to the obtained depths.

Bathy- 500MF Echo sounder: The Bathy- 500MF Echo Sounder is an electronic hydrographic survey instrument used for measuring depths with precision chart recordings and digital data output manufactured by Syqwest Incorporated, USA. The Bathy-500 echo sounding systems are based on the principle that when a sound signal is sent into the water it will be reflected back when it strikes an object. The Bathy-500 is technologically sophisticated, utilizing modern, micro processor based electronics and a thermal chart recorder mechanism. Digital processing enables the instrument to offer fully automatic digitizing capabilities. When interfaced to a NMEA 0183 compatible position sensor, it provides user with a complete, integrated hydrographic survey environment. The instrument front panel consists of a high contrast, backlit four line LCD displays and a fully sealed input keypad. The front panel encompassing system data, status and setup parameters with RS232/RS422 output format. All operating functions are set via the front panel interface. Setup selections are stored within internal, non-volatile memory for instant availability upon power-up. The instrument decodes and processes the NMEA 0183 formatted sentence GGA or GLL from GPS/DGPS using variable Baud rates for communication.

2.2 - Description of Bench Marks (B.M) / authentic Reference Level used:-

For Topographic survey, the horizontal control has been carried out from the CWC Gauge level, situated near Adityapur Colony RCC Bridge area. The level of the CWC Gauge is:

	Geographic position		UTM position		
Location Name	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Elevation w.r.t. M.S.L (m)
Adityapur Colony	22°47'15.091"	86°10'27.2"	2520235.774	415239.091	123.00 m.

Figure 4- C.W.C Gauge area of Kherkhai River

2.3 - Tidal Influence Zone and tidal variation in different stretches:-

There are no Tidal influences or effects found in this zone of river.

2.4 - Methodology to fix Chart Datum/ Sounding Datum:-

IWAI had provided Sounding Datum at Adityapur and Confluence with Subarnarekha River. The same was used to arrive the Sounding Datum values at BM Pillars and at tide gauges.

Sl. No	Place	Sounding Datum w.r.t MSL (Provided by IWAI)
1	Adityapur (Chainage-8.697 km)	124.362 meter
2	Confluence with Subarnarekha River (Chainage-0.00 km)	119.494 meter

2.5 - Yearly minimum Water Levels Average of 06 years minimum Water Levels to arrive at Chart Datum (CD) / Sounding Datum (SD):-

The CD level of Adityapur (Chainage-8.697 km) in the river Kherkhai is 124.362 meter

The CD level of Confluence with Subarnarekha River (Chainage-0.00 km) is 119.494 meter

2.6 -Transfer of Sounding Datum table for Tidal Rivers:-

There is no tidal influence found in this zone of river.

2.7 –Table indicating tidal variation at different observation points (say at every 10 KM):-

There is no tidal influence found in this zone of river.

2.8 - Salient features of Dam, Barrages, Weirs, Anicut, Locks, Aqueducts etc.:-

There are two check Dams found in this zone of River.

Sl. No	Structure Name	Chainage (km)	Location	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Length (m)	Width (m)	Height w.r.t. above M.S.L (m)	Present Condition
1	Check Dam	10.642	Kulapdanga	22°46'6.32"	86°10'20.04"	2518122.20	415023.16	103.403	1.805	126.900	Complete
2	Check Dam	15.623	Dudra	22°45'33.921"	86°08'29.568"	2517143.73	411866.93	186.781	36.037	131.500	Complete

Table 3- Details of Check dam

2.9- Description of erected Bench mark Pillars:-

Sl. No	BM No	Location	Chainage (Km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	BM Height above MSL (m)	BM Height above SD (m)
1	BM 1	Baba Tilka Majhi Basti	0.107	22°50'5.92"	86° 9'37.89"	413863.072	2525497.435	137.553	18.059
2	BM 2	Jugsalai	10.720	22°46'4.546"	86°10'23.555"	415123.05	2518066.998	135.203	8.303
3	CP K-11	Itagarh	15.690	22°45'29.789"	86° 8'27.137"	411796.868	2517017.069	131.892	0.392
4	BM 3	Gangia	22.073	22°45'11.033"	86°5'5.005"	406199.290	2516288.400	144.36	12.860

Table 4 - Bench Mark Details

2.10- Description of erected Tide Gauges:-

Sl. No	Tide Gauge No	Chainage (km)	Easting (m)	Northing (m)	Latitude (N)	Longitude (E)	W.L w.r.t MSL	Period of observation
1	GS (TP) -3	0.02	413677.31	2525595.94	22°50'09.105"	86°09'31.358"	119.500	24 hrs
2	GS (TP) - 1	10.600	415094.92	2518014.49	22°46'02.833"	86°10'22.579"	126.900	24 hrs
3	GS (TP) - 2	15.600	411846.485	2517154.457	22°45'34.266"	86°08'28.849"	131.500	24 hrs

Table 5- Tide Gauge Details

2.11- Chart Datum / Sounding Datum and Reductions details:-

Sl no	CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation w.r.t. SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above M.S.L -ve indicates above M.S.L	E	F=(E-WL Data in MSL)	G=(E-Topo levels in MSL)
1	Confluence (284.850)	0		119.494			
2	GS (TP) -3	0.02	0.00-1.00		119.494	-0.006	Kherkhai Reduced Topo.xyz
3	GS (TP) - 3/A	1.5	1.00-2.00		119	-0.625	Submitted in Soft copy
4	GS (TP) -3/B	2.5	2.00-3.00		119.85	-0.428	
5	GS (TP) -3/C	3.5	3.00-4.00		120.37	-0.513	
6	GS (TP) -3/D	4.5	4.00-5.00		121.68	-0.661	
7	GS (TP) -3/E	5.5	5.00-6.00		122.06	-0.572	
8	GS (TP) -3/F	6.5	6.00-7.00		122.09	-0.662	
9	GS (TP) -3/G	7.5	7.00-8.00		122.33	-0.648	
10	GS (TP) -3/H	8.5	8.00-9.00		122.345	-0.553	
11	Adityapur	8.697		124.362			
12	GS (TP) -3/I	9.5	9.00-10.00		122.35	-0.635	
13	GS (TP) -3/J	10.5	10.00-10.600		123.23	-0.607	
14	GS (TP) - 1	10.6	10.6-15.6		126.9	0	
15	GS (TP) - 2	15.6	15.6-22.104		131.5	0	

Table 6 - Chart Datum / Sounding Datum & Reduction Details

2.12- High Flood Level (H.F.L.) at known gauge stations and cross-structures:-

There is only one H.F.L value found near Adityapur area in this zone of river.

Sl no	Location and description of CWC gauge / Dam / Barrages / Weirs / Anicut / Locks / Aqueducts / BM	Cross-structure details	Chainage (km)	Established HFL / MHWS / FSL / MWL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
1	Adityapur	-	8.697	137.800	-

Table 7- H.F.L Details

2.13 - Average Slope:-

Sl. No	Reach		River Level Change (m)	Distance (km)	Slope (m/km)	Slope (cm/km)
	From	To				
1	0.00	10.00	3.736	10.00	0.373	37.3
2	10.01	22.104	8.270	12.094	0.683	68.3
Avg. Slope					0.528	52.8

Table 8 - Average slope

2.14 - Details of Dam, Barrages, Weirs, Anicut, etc. w.r.t. MSL:-

There are two check Dams found in this zone of River. The Details are tabulated below:-

Sl. No	Structure Name	Chainage (km)	Location	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Length (m)	Width (m)	Height w.r.t. above M.S.L (m)	Present Condition
1	Check Dam	10.642	Kulapdanga	22°46'6.32"	86°10'20.04"	2518122.20	415023.16	103.403	1.805	126.900	Complete
2	Check Dam	15.623	Dudra	22°45'33.921"	86°08'29.568"	2517143.73	411866.93	186.781	36.037	131.500	Complete

Table 9- Dam Details

2.15 - Details of Locks:-

There are no locks found in this zone of river.

2.16 - Details of Aqueducts:-

There are no aqueducts found in this zone of River.

2.17- Details of existing Bridges and Crossings over waterway:-

Three RCC Bridges and two Rail Bridges are situated in this zone of river. The Bridge details are tabulated below:-

Sl. No	Chainage (km)	Location	Cross-Structure details	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Length (m)	Width (m)	No of Piers	Horizontal Clearance (m)	Vertical Clearance w.r.t H.F.L (m)	Present Condition
1	4.615	Adityapur	Adityapur Toll Bridge	22°48'1.95"	86° 8'46.50"	2521693.27	412376.53	247.75	19.71	9	30.00	4.550	Complete
2	8.610	Adityapur	RCC Colony Bridge	22°47'11.30"	86°10'29.15"	2520119.22	415294.53	213.885	9.84	14	14.26	2.350	Complete
3	8.636	Adityapur	RCC Colony Bridge	22°47'10.46"	86°10'29.68"	2520093.11	415309.42	221.611	24.449	8	24.60	5.600	Complete
4	9.197	Adityapur	Rail Bridge	22°46'53.03"	86°10'23.79"	2519558.47	415138.56	274.575	9.378	9	30.38	13.68	Complete
5	9.275	Adityapur	Rail Bridge	22°46'50.18"	86°10'25.21"	2519470.33	415178.91	266.647	8.858	8	29.00	8.320	Complete

Table 10 - Bridge Details

2.18 - Details of other Cross structures, pipe-lines, under water cables:-

There are two Under-Construction RCC Bridges and one under construction Rail Bridge found in this zone of river. The Details are tabulated below:-

Sl. No	Chainage (km)	Location	Cross-Structure details	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Length (m)	Width (m)	No of Piers	Horizontal Clearance (m)	Vertical Clearance w.r.t H.F.L (m)	Present Condition
1	9.223	Adityapur	Under Construction Rail Bridge	22°46'51.99"	86°10'23.20"	2519526.07	415121.57	-	-	-	-	-	Under-Construction
2	16.724	Itagarh	Under Construction RCC Bridge	22°45'40.94"	86° 7'51.83"	2517366.01	410792.91	-	-	-	-	-	Under-Construction
3	22.104	Itagarh	Under Construction RCC Bridge	22°45'6.67"	86° 5'9.64"	2516340.41	406160.60	-	-	-	-	-	Under-Construction

Table 11- Under- Construction RCC Bridge

2.19 - High Tension Lines / Electric lines / Tele-communication lines:-

Sl. no	Line	Chainage (km)	Location	Position				No of piers	Horizontal clearance (m)	Vertical clearance w.r.t H.F.L (m)	Present Condition
				Latitude (N)	Longitude (E)	Easting (m)	Northing (m)				
1.	Electric Line	2.522	Ramnagar	22°49'5.611"	86°9'4.82"	412909.644	2523647.720	8	235.371	6.80	Complete
2.	Electric Line	2.791	Ramnagar	22°48'57.779"	86°8'55.586"	412645.037	2523408.390	8	284.734	7.366	Complete
3.	High Tension line	3.498	Pratima Nagar	22°48'36.417"	86°8'51.674"	412529.721	2522752.128	8	236.777	8.987	Complete
4.	Electric Line	4.273	Ramjanam Nagar village	22°48'16.684"	86°8'48.513"	412436.084	2522145.816	8	304.168	6.928	Complete
5.	High Tension line	9.096	Adityapur	22°46'55.97"	86°10'25.80"	415196.86	2519648.64	8	207.332	5.941	Complete
6.	Electric Line	9.414	Adityapur	22°46'45.44"	86°10'27.565"	415244.399	2519323.909	8	204.278	3.485	Complete
7.	High Tension Line	17.608	Itagarh	22°46'4.727"	86°7'30.552"	410189.403	2518100.931	8	332.048	13.72	Complete
8.	High Tension Line	20.526	Itagarh	22°45'28.755"	86°10'25.80"	407681.650	2517009.701	8	437.395	14.60	Complete

Table 12 - High Tension Lines / Electric lines

2.20 - Current Meter and Discharge details:-

Stretch No.	Chainage (km)	Position				Observed Depth (m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional area (sq. m.)	Discharge (m3/sec)
		Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		0.5 D			
1	0.000	22°50'11.086"	86°9'34.772"	413774.9550	2525656.3150	4.3	1.221	1.102	186.852	205.91
2	10.000	22°46'27.753"	86°10'21.547"	415069.7684	2518780.9713	0.4	0.235	0.235	161.381	37.924
3	20.000	22°45'39.946"	86°6'15.003"	408030.3000	2517351.7550	2.4	1.02	1.02	232.725	237.38

Table 13 - Current Meter Details

2.21 - (a) Soil Sample Locations:-

Sample No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Depth (m)
1	0.000	22°50'11.086"	86°9'34.772"	413774.9550	2525656.3150	4.3
2	10.000	22°46'27.753"	86°10'21.547"	415069.7684	2518780.9713	3.8
3	20.000	22°45'39.946"	86°6'15.003"	408030.3000	2517351.7550	0.6

Table 14 - Soil Sample Locations

Note: - The Soil Sample Report have been shown in Annexure-11, at page no-61

(b) Water Sample Locations:-

Sample No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Total Depth (d) (m)	Mid-Depth (0.5d) (m)
1	0.000	22°50'11.086"	86°9'34.772"	413774.9550	2525656.3150	4.3	2.15
2	10.000	22°46'27.753"	86°10'21.547"	415069.7684	2518780.9713	3.8	1.9
3	20.000	22°45'39.946"	86°6'15.003"	408030.3000	2517351.7550	0.6	0.3

Table 15 - Water Sample Locations

Note: - The water Sample Report have been shown in Annexure-12, at page no-65

Section-3: Description of waterway

3.1- From Chainage 0.00 Km to Chainage 10.00 Km. (Subarnarekha Confluence to Adityapur Colony):-

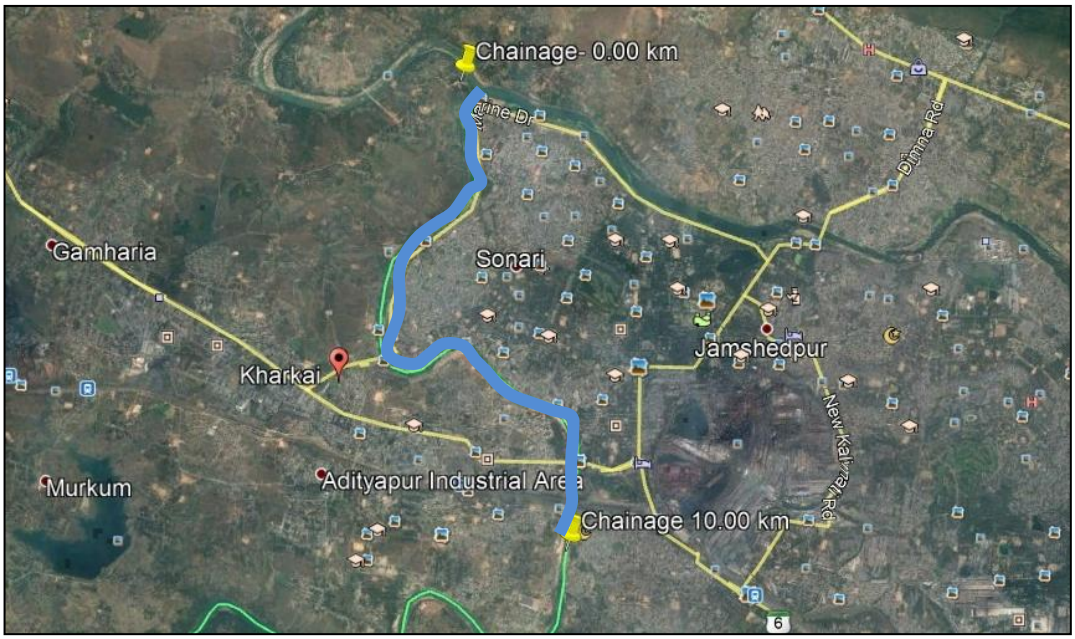


Figure 5- Chainage 0.00 km to Chainage 10.00 km

The River width of Kherkhai River from Chainage 0.00 km to 10.00 km is approximately 194 m to 230 m. The average width portion of the river is 212 m.

Near the Chainage 0.00 km, the confluence of Subarnarekha River is located where a temple is noticed right bank side of the Kherkhai River. BM-1 is situated near the Chainage of 0.107 km left bank side of the river. Three important RCC Bridges and two Rail Bridges are situated near Adityapur area. Adityapur RCC Toll Bridge is situated near the Chainage of 4.615 km which is connected with Tata Kandra road (SH-5). The position of the Bridge is (**Lat: - 22°48'1.95"N, Long: - 86° 8'46.50"E**). Two RCC Colony Bridges are also situated near the Chainage of 8.610 km and 8.636 km at Adityapur village site. These bridges are also linked with Tata-Kandra Road and have an outer circle road. The position of the RCC Colony Bridges are (**Lat: - 22°47'11.30"N, Long: -86°10'29.15"E**), (**Lat: - 22°47'10.46"N, Long: - 86°10'29.68"E**) respectively. Two Rail Bridges are also situated near the Chainage of 9.197 km and 9.275 km. These Rail Bridges are connected with Adityapur Railway station and Tatanagar Jn. Railway station. The position of the Rail Bridges are (**Lat: - 22°46'53.03"N, Long: - 86°10'23.79"E**), (**Lat: - 22°46'50.18"N, Long: - 86°10'25.21"E**) respectively. An under-construction Rail Bridge is situated near the Chainage of 9.223 km at Adityapur colony area. The position of the under-construction Rail bridge is (**Lat: - 22°46'51.99"N, Long: - 86°10'23.20"E**). C.W.C office is situated near the Chainage of 8.533 km. Five electric lines and one H.T.line are situated near the Chainage of 2.522 km, 2.791 km, 4.273 km, 9.096 km, 9.414 km and 3.498 km respectively. Baba Tilka Majhi basti, Adarsh Nagar, Sangam Vihar, roop nagar Basti, Sonari Airport, Ram Nagar, Kagal nagar, Jamshedpur city are located left bank side of the river and Adityapur colony, Anand Vihar, LIC colony, Majhitala, Dindli etc. located right bank side of the river.

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	0.00	10.00	0.4	5.2	10000	367796.9	-0.3	3.4	10000	862169.5
II	0.00	10.00	0.2	5.3	10000	573201.3	-0.3	3.5	10000	1228774.3
III	0.00	10.00	0.1	5.3	10000	886507.7	-0.3	3.6	10000	1734496.8
IV	0.00	10.00	0.1	5.3	10000	1083387.5	-0.3	3.7	10000	1979483.9

Figure 6- Adityapur Toll Bridge (4.615 km)

Figure 7- Adiyapur RCC Colony Bridge (Chainage-8.610 km and 8.636 km)

Figure 8- Adityapur Colony Rail Bridge (Chainage- 9.197 km and 9.275 km)

Figure 9- High Tension Line (Chainage-3.498 km)

- **Bathymetry Survey:-**

a) Length of the stretch for which the Bathymetric survey has been carried out:-

The Bathymetry survey of the Kherkhai River has been carried out from Confluence with Subarnarekha River to Islamnagar. The stretch of the Bathymetry survey is from Chainage 0.00 km to Chainage 0.420 km. The Remaining Chainage 0.421 km to Chainage 10.00 km, the Bathymetry survey was not possible due to insufficient layer of water.

Date of Survey	Type of survey	Chainage	
		From (km)	To (km)
31.01.16	Bathymetry Survey	0.00	0.420

- **Topographic Survey:-**

a) Length of the stretch for which the Topographic survey has been carried out:-

The Topographic survey has been carried out from Confluence with Subarnarekha River to Islamnagar. The Stretches of the Topographic survey has been carried out from Chainage 0.00 km to Chainage 10.00 km.

a) Prominent Dams / Barrage:-

There are no Check Dams found in this stretches of River.

b) Conditions of banks (protected, un-protected):-

The bank of the river includes with villages, Roads, RCC Bridges, Rail bridges. The Bank of the River Kherkhai has been affected by floods, sometimes it become dangerous during the monsoon. As a result, short as well as long embankments are needed in the both bank side of the river. Bolder Pitching is also used for protecting the both bank side of the river. Most of the river portions are covered with embankment. Besides, the Roadside is also helpful for the protection of the both side of the river bank. From Chainage 1.00 km to Chainage 3.00 km, Boulder pitching is covered in the left side of the river bank and also noticed near at Chainage of 4 km to 6 km left side of the river bank. Some agricultural lands are found in the right side bank of the river. Sonari airport, Jamshedpur Tata steel plant, Bhatia park, villages, plants are covered the left bank side of the river. The left bank side is more protected than right bank side.

c) Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes:-

Dalma wildlife Sanctuary (7.50 km approx from 0.00 Chainage), Dalma hill, Tata zoological park, Jubilee park at Jamshedpur are situated near the bank side of the river which are protected the river side and also become a security for the states.

d) Details of Protected Area- Wildlife, Defence, Atomic Power Plants and any other issue attached to it:-

Dalma wildlife Sanctuary (7.50 km approx from 0.00 Chainage), Dalma hill , Tata steel Zoological Park (5.23 km approx from Adityapur toll bridge) is located near the bank side of the river. Jamshedpur Steel plant. Sonari Airport is also situated near the bank side of the river. Adityapur Railway station is also situated in this stretches of river.

e) NH/SH/MDR along and/or within 5 km from the waterways:-

NH-32 and NH-33 are situated approximately 10.00 km far from the river side which are the major communication way in this zone of river. Besides, SH-5, SH-6 is also linked with NH-32 and NH-33 which communicate easily for the local villagers and also for the tourists.

f) Railway Line and Stations in the vicinity:-

Two important Railway Bridges are passed over this river at Adityapur Colony area near at Chainage of 9.197 km and 9.275 km. Adityapur Railway station is close to the river side. Besides Tatanagar Jn. Railway station is located approximately 3.00 km from the river side.

g) Land Use Pattern along Waterway on visual assessment:-

The bank side of the river is mainly used as an industrial hub. Jamshedpur, Adityapur etc. places are situated near the bank side of the river. Adityapur industrial hub, Tata steel plant, Burma Mines and a numbers of small industries are built up in this zone of river. Besides, the land is also used as zoological park at Jamshedpur, some industrial plants and temple etc. Some agricultural lands are also found in this zone of river.

h) Crops / Agriculture in the region on visual assessment:-

The major crops Paddy, jute, Tea, Rice, Wheat, Maize, Pulses, oilseeds and Spices are cultivated in this region. Besides, fruits, vegetables, cashew nuts are also noticed in this zone of river.

i) Availability of Bulk / Construction Material:-

The availability of the construction materials is too easy for construction & any kind of structure. There is some cement factories and brick fields located near Adityapur and Jamshedpur area. Burma Mines is located approximately 4.25 km from the river side. The position of the Burma Mines is (Lat: - 22°46'7.66"N, Long: - 86°12'47.88"E) Iron ore is an important material found in this zone of river.

j) Existing Industries along Waterway with their types and details:-

Jamshedpur which is famous industrial hub situated in this zone of river at a distance of 3.86km from Sonari Airport (Lat- 22°48'47.98"N, Long: - 86°10'9.92"E). Jamshedpur Steel plant, Adityapur industrial area (Lat: - 22°47'9.36"N, Long: - 86° 9'54.48"E) are situated in this zone of river. Iron ore is an important material located in this zone of river. Besides, some small kinds of industries are located near Tatanagar, Sonari airport is situated near the bank side of this river. Auro Plastic Injection Moulders Pvt Ltd (Lat- 22°48'7.94"N, Long: - 86° 7'17.83"E), Tata Steel Plant area (Lat: - 22°47'10.14"N, Long: - 86°11'52.95"E) are situated in this zone of river. Tatanagar Railway station is communicated well in this zone of river.

k) Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any):-

There is no Jetty service available in this stretches of river.

l) Existing Cargo Movement:-

The cargo movement is generally processed through waterways system like Ferry services. There is no ferry services found in this zone of river. So the cargo movement is unavailable in this zone of river.

m) Prominent City / Town / Places of Worship / Historical places for Tourism:-

Adarsh Nagar, Adityapur, Sonari, Jamshedpur etc. importantcities are located in this stretches of river. Dalma wildlife sanctuary and Dalma hills, Tata steel zoological park, Sir Dorabji Tata park, Jubilee park, Dimna Lake, Hudco Lake, Bhatia Park , Joggers park, Surya Mandir park etc. are the important tourist places situated in this zone of river. Tinplate kali mandir, shiv temple etc worship places are located in this stretches of river.

n) Village / colonies along the sub-stretch and approx. Population:-

Adityapur Colony, Swastri Nagar, Goalpara, Baba Tilka Majhi Basti, Sangam Vihar, Jahira basti, Roop Nagar Basti, Ramnagar, Gandhi Basti, Pratima Nagar, Bhatia Colony, Gwalpara, Ramjanam Nagar, Swastri Nagar, Dindli, Kajal Nagar, Sonari, Raydih, Bhtrapur, Islamnagar, Hadgodam Basti, Paan Dukaan chowk, Majhi tola, New Swarnarekha colony are located in this stretches of river.

o) Availability of Passenger Ferry Services with facilities and Annual movement data:-

There is no Passenger ferry service available in this zone of river.

p) Available and probable Water Sport Recreational Facilities:-

There are no water sport recreational facilities available in this zone of river.

q) Fishing activities:-

Fish and fishing business in the river Subarnarekha and Kherkhai are an important sector in this region. Cast nets, Scoop nets, Gill nets, Fishing lines, Tire tubes, make shift wooden platforms and Traditional Bamboo Trap used for catching the fishes here. Fishing plays an important role in supporting livelihood for the inhabitants of this Region. Fishes are one of the main occupations in this region of people where so many people are engaged with this profession for the demand of fish.

r) Sand mining:-

The bank of the River Kherkhai is also used for the sand mines. The Sand Mining helps the people for collection sand which is the major component for Building purposes. The Motor vehicles can easily collect the sand and move for transportation. Sand Mines is an important sector where so many people are engaged and these activities help them to get their daily livelihood. Besides this, sand is also exported to other states as it becomes demandful for making Building or Industries. Sand mining contributes to the construction of buildings and development. However, the negative effects of sand mining include the permanent loss of sand in areas, as well as major habitat destruction.

s) Tributaries:-

There is no tributary found in this stretches of river.

t) Details of Irrigation Canals and Outlets:-

There is no irrigation canal and outlets found in this stretches of river.

u) Details of Nalas. Polluted water discharge in to the rivers and treatment plants (if any):-

There are no Nalas found in this zone of river.

v) Usage of water (drinking, irrigation, industries, navigation etc.) Water quality:-

The water of the river is used for cultivation and industrial purposes. The water is used in the industrial hubs like Jamshedpur steel plant, Adityapur industrial hub and small kinds of industries. The water is used as irrigation purposes. With the help of the irrigation system, the cultivation can easily accessible. As an industry based area, the most of the quantities of water is used in the industry based activities.

3.2 - From Chainage 10.00 Km to Chainage 22.104 Km (Adityapur Colony to Gangia village):-

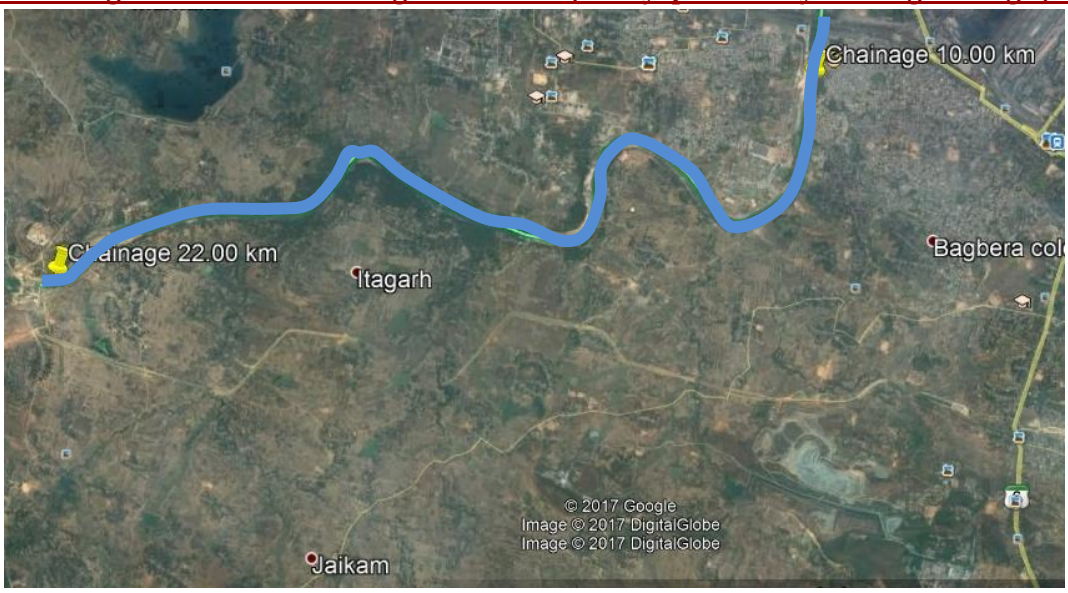


Figure 10 – Chainage 10.00 km to Chainage 22.104 km

The River width of Kherkhai River from Chainage 10.00 km to 22.104 km is approximately 230 m. to 134.05 m. The average width portion of the river is 182.025m.

BM-2 and BM-3 are situated near the Chainage of 10.720 km and 22.073 km left bank side of the river. Two important check Dams are situated near the Chainage of 10.642 km at Kulaptanga village and 15.623 km at Dudra village. The position of the Check Dams are (**Lat: - 22°46'6.32"N, Long: - 86°10'20.04"E**), (**Lat: - 22°45'33.921"N, Long: - 86°08'29.568"E**) respectively. Besides, two under-construction RCC Bridges are situated near the Chainage of 16.724 km and 22.104 km at Itagarh village. The position of the under construction RCC Bridges are (**Lat: - 22°45'40.94"N, Long: - 86° 7'51.83"E**), (**Lat: - 22°45'6.67"N, Long: - 86° 5'9.64"E**) respectively. Marwari para, chowk bazaar, Jugsalai, Ambedkar Nagar, Bagbera Colony, Jatajhupri, Ranidih, Kacha, Itagarh, Dhahkidah etc. villages are situated left bank side of the river and Dhowadungri, Assangi, Udaipur, Gangia etc. villages are situated right bank side of the river.

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	10.00	22.104	0.3	7.5	8150	134787.4	-0.3	5.1	8080	155959
II	10.00	22.104	0.1	7.6	9250	227618.9	-0.3	5.2	10100	262375.5
III	10.00	22.104	0.1	7.6	11050	397948	-0.3	5.3	11000	469186.6
IV	10.00	22.104	0.1	7.6	12000	527414.4	-0.3	5.4	12000	611599.4

Figure 11- Check Dam at Kalpatanga village (Chainage-10.642 km)

Figure 12-Check Dam at Dudra village (Chainage-15.623 km)

Figure 13-Under-Construction RCC Bridge (Chainage-16.724 km)

Figure 14-Under-Construction RCC Bridge (Chainage-22.104 km)

- **Bathymetry Survey:-**

a) Length of the stretch for which the Bathymetric survey has been carried out:-

The Bathymetry survey of the Kherkhai River has been carried out from Islamnagar to under-construction RCC Bridge near Gangia village. The length of the Bathymetry survey is Chainage 10.6 km to 14.2 km and 15.6 km to 22.104 km.

Date of Survey	Type of survey	Chainage	
		From (km)	To (km)
30.01.16	Bathymetry Survey	10.6	14.2
31.01.16	Bathymetry Survey	15.6	22.104

- **Topography Survey:-**

a) Length of the stretch for which the Topographic survey has been carried out:-

The Topography survey has been carried out from Islamnagar to under-construction RCC Bridge near Gangia village. The length of the Topography survey is Chainage 10.00 km to Chainage 22.104 km.

a) Prominent Dams / Barrage:-

There are two Check Dams found in this stretches of River.

Sl. No	Structure Name	Chainage (km)	Location	Latitude (N)	Longitude (E)	Northing (m)	Easting (m)	Length (m)	Width (m)	Height w.r.t. above M.S.L (m)	Present Condition
1	Check Dam	10.642	Kulapdanga	22°46'6.32"	86°10'20.04"	2518122.20	415023.16	103.403	1.805	126.900	Complete
2	Check Dam	15.623	Dudra	22°45'33.92"	86°08'29.56"	2517143.73	411866.93	186.781	36.037	131.500	Complete

b) Conditions of banks (protected, un-protected):-

The bank of the river includes with villages, Roads, under construction RCC Bridges, Check Dams. The Bank of the River Kherkhai has been affected by floods, sometimes it become dangerous during the monsoon. As a result, short as well as long embankments are needed in the both bank side of the river. Bolder Pitching is also used for protecting the both bank side of the river. Most of the river portions are covered with embankment. Besides, the Roadside is also helpful for the protection of the both side of the river bank. Check Dam area is covered with concrete and Boulder pitching. Agricultural lands are noticed both side of the river bank. Some industrial plants are located right side bank of the river.

c) Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes:-

There are two numbers of check dams which is caused hindrances in this stretches of river. The two check dams are located near Chainage 10.642 km and 15.623 km.

d) Details of Protected Area- Wildlife, Defence, Atomic Power Plants and any other issue attached to it:-

There is no wildlife sanctuary found in this stretches of river.

e) NH/SH/MDR along and/or within 5 km from the waterways:-

There is no NH found in this stretches of river. SH-5(approx-3 km) and SH-6(approx-1.2 km) are found in this stretches of river.

f) Railway Line and Stations in the vicinity:-

There is no railway line found in this stretches of river.

g) Land Use Pattern along Waterway on visual assessment:-

The most of the land portion in this stretches of river covered with agricultural lands. Besides, some major and small kinds of industries are set up in this stretches of river.

h) Crops / Agriculture in the region on visual assessment:-

The major crops Paddy, jute, Tea, Rice, Wheat, Maize, Pulses, oilseeds and Spices are cultivated in this region. Besides, fruits, vegetables, cashew nuts are also noticed in this zone of river.

i) Availability of Bulk / Construction Material:-

The availability of the construction materials is too easy for construction & any kind of structure. There are many cementing factories and brick fields are located and the sand is also available from the river. Burma Mines is located near the river side. Iron ore is an important material found in this zone of river.

j) Existing Industries along Waterway with their types and details:-

Burma Mines (Near Tatanagar Jn. Railway Station), Tata Motors, Tata Power Company and small kind of plants and industries are located in this stretches of river.

k) Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any):-

There is no Jetty service, ferry ghat and terminal available in this stretches of river.

l) Existing Cargo Movement:-

The cargo movement is generally processed by waterways system like Ferry services. There is no ferry services found in this zone of river. So the cargo movement is unavailable in this zone of river.

m) Prominent City / Town / Places of Worship / Historical places for Tourism:-

Tatanagar, Chowk Bazar, Marwari para etc. places are located in this stretches of river.

n) Village / colonies along the sub-stretch and approx. Population:-

Bikrampur, Barodaghat colony, Kulaptanga, Jatajhupri, Transport Nagar, Kacha, Jilingbera, Dhowadungri, Dudra, Itagarh, Dhahkidah, Udaipur, Gangia, Nayagarh etc. villages are located in this stretches of river.

o) Availability of Passenger Ferry Services with facilities and Annual movement data:-

There is no Passenger ferry service available in this stretches of river.

p) Available and probable Water Sport Recreational Facilities:-

There are no water sport recreational facilities available in this zone of river.

q) Fishing activities:-

Fish and fishing business in the river Subarnarekha and Kherkhai are an important sector in this region. Cast nets, Scoop nets, Gill nets, Fishing lines, Tire tubes, make shift wooden platforms and Traditional Bamboo Trap used for catching the fishes here. Fishing plays an important role in supporting livelihood for the inhabitants of this Region. Fishes are one of the main occupations in this region of people where so many people are engaged with this profession for the demand of fish.

r) Sand mining:-

The bank of the River Kherkhai is also used for the sand mines. The Sand Mining helps the people for collection sand which is the major component for Building purposes. The Motor vehicles can easily collect the sand and move for transportation. Sand Mines is an important sector where so many people are engaged and these activities help them to get their daily livelihood. Besides this, sand is also exported to other states as it becomes demandful for making Building or Industries.

s) Tributaries:-

There is no tributary found in this stretches of river.

t) Details of Irrigation Canals and Outlets:-

The Irrigation canals and outlets have been found near the Chainage of 12.1 km, 16 km in the left bank side of the river and 10.720 km in the right bank side of the river.

u) Details of Nalas. Polluted water discharge in to the rivers and treatment plants (if any):-

There are no Nalas found in this zone of river.

v) Usage of water (drinking, irrigation, industries, navigation etc.) Water quality:-

The water of the river is used for agriculture and industrial purposes. Tata Motors, Burma mines and small kind of industries are located in this stretches of river. Most of the parts in this stretches of river covered with agricultural lands. So the water of the river is used as irrigation purposes. With the help of irrigation canal and outlets the cultivation is easily accessible in this stretches of river.

Section 4: Terminals

There is no existing terminal found in this zone of river. But Adityapur colony area may develop as a proposed terminal location where a circle road is communicated in this zone of river. Adityapur – Kandra highway, Bistupur road is connected with outer circle road in this river site. Adityapur railway station is also located 0.42 km (approx) far from Tata kandra road. K S link road is linked with outer circle road which communicates with Sonari Airport area. Adityapur industrial hub, Tatanagar Jn. Railway station, Tata steel plant is also located in this zone of river.

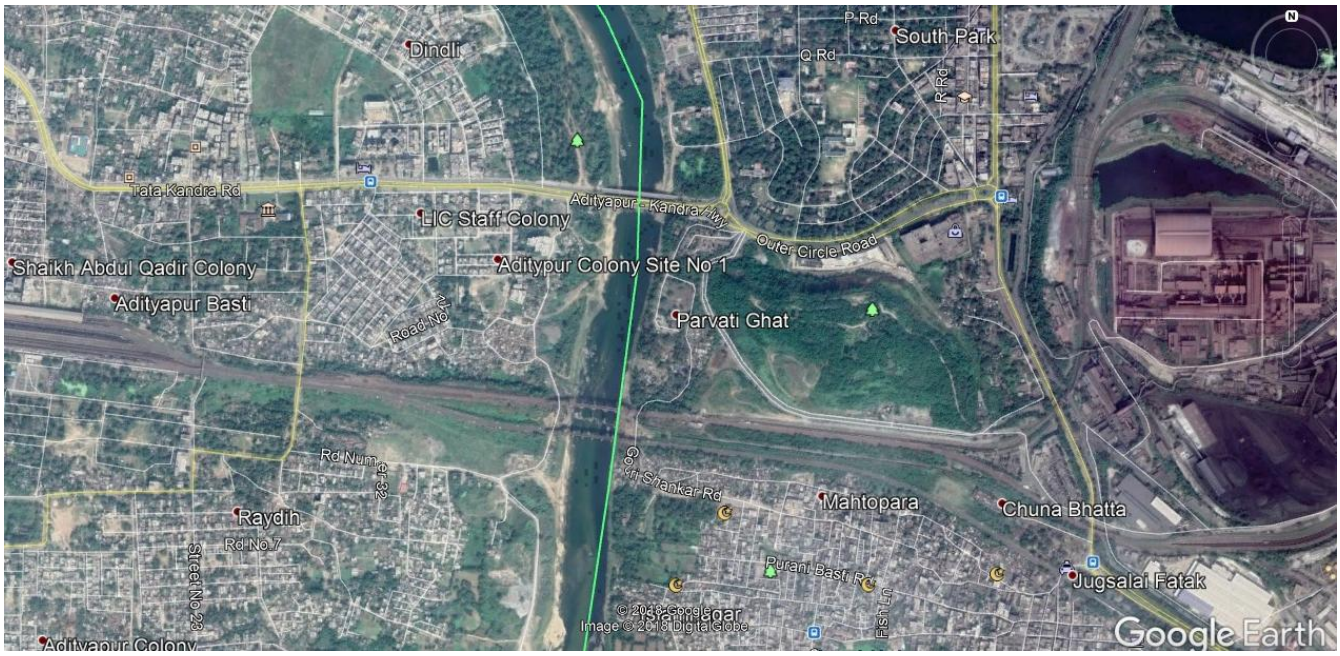


Figure 15- Proposed Terminal location of Adityapur colony area

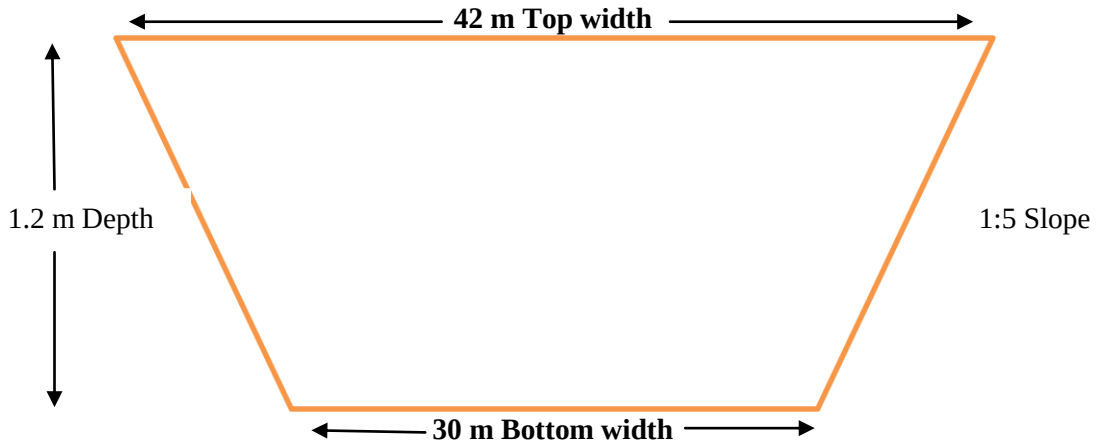
4.1 Details of Land use, owner etc:-

The both sides bank of the River Kherkhai used for cultivation and as an industrial land. Besides, some portions of the land are surrounded by small and major industries like Tata Steel plant, Burma Mines, Adityapur industrial hub, Tata Motors etc. Though bolder pitching is found in some places, But in Recent times, the bank of the river has been worn away in some places for lack of trees. Sometimes, the land of the river has been changed into a heap of garbage. As a result, the river side becomes polluted land. In the Monsoon period, Flood and erosion has been affected both sides of the river bank. Joggers park, Sir Dorabji Tata park, Surya Mandir park, Dalma wildlife sanctuary and Dalma hills, Tata Jubilee Park, Bhatia Park etc. are located in this zone of river.

Section 5: Fairway development:-

Dredging sections, summary of depths and dredging quantity for different classification of waterways (stretch-wise)

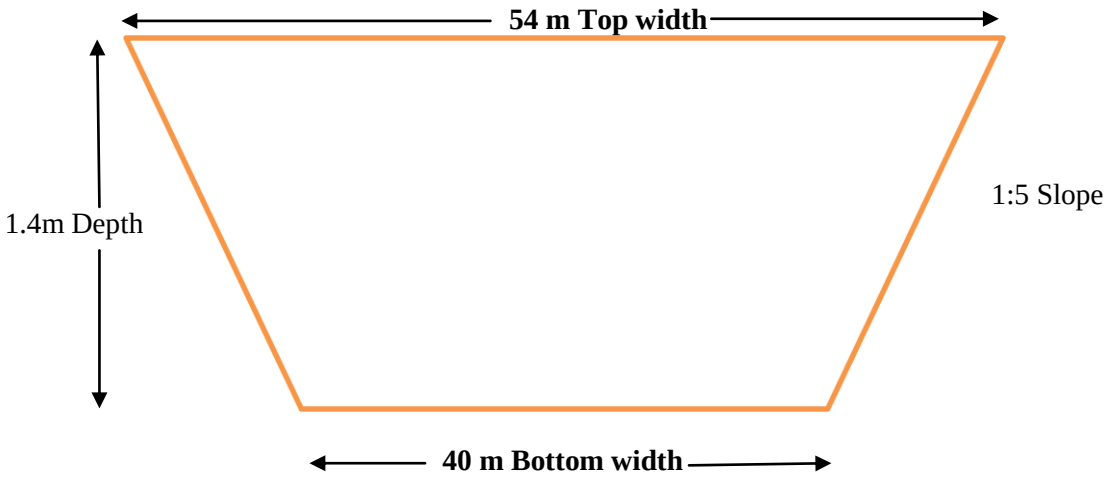
Class-I:-



Class-I													
Location		Chainage (km)		Observed Dredging Qty.w.r.t Sounding Datum					Reduced Dredging Qty.w.r.t Sounding Datum				
From	To	From	To	Min depth (m)	Max depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)	Min Depth (m)	Max Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)
Confluence of Subarnarekha river	Adityapur	0.00	10.00	0.4	5.2	10000	367796.90	367796.90	-0.3	3.4	10000	862169.50	862169.50
Adityapur	Gangia	10.00	22.104	0.3	7.5	7800	134787.40	502584.30	-0.3	5.1	7390	155959.00	1018128.50
Total						17800	502584.30		Total		17390	1018128.50	

Table 16- Dredging quantity in class-I

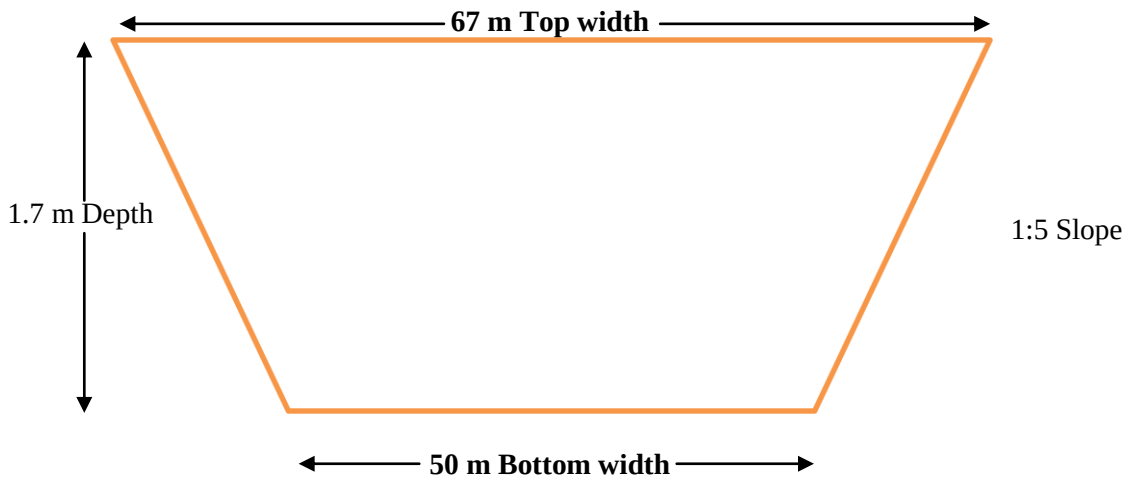
Class-II:-



Class-II													
Location		**Chainage (km)**		**Observed Dredging Qty.w.r.t Sounding Datum**					**Reduced Dredging Qty.w.r.t Sounding Datum**				
From	**To**	**From**	**To**	**Min depth (m)**	**Max depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Cumulative Dredging Qty. (cu.m.)**	**Min Depth (m)**	**Max Depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Cumulative Dredging Qty. (cu.m.)**
Confluence of Subarnarekha river	Adityapur	0.00	10.00	0.2	5.3	10000	573201.3	573201.3	-0.3	3.5	10000	1228774.30	1228774.30
Adityapur	Gangia	10.00	22.104	0.1	7.6	8560	227618.90	800820.20	-0.3	5.2	9950	262375.50	1491149.80
Total						18560	800820.20		Total		19950	1491149.80	

Table 17- Dredging quantity in class-II

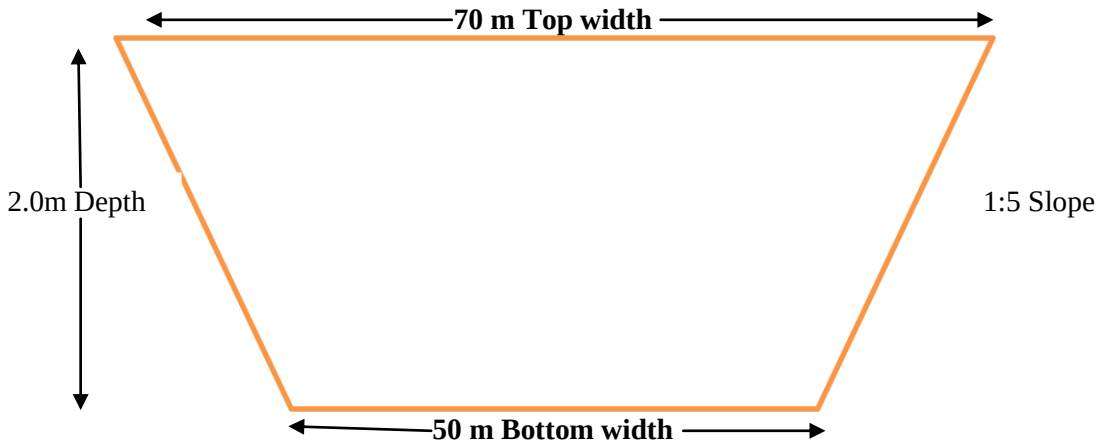
Class-III:-



Class-III													
Location		Chainage (km)		Observed Dredging Qty.w.r.t Sounding Datum					Reduced Dredging Qty.w.r.t Sounding Datum				
From	To	From	To	Min depth (m)	Max depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)	Min Depth (m)	Max Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)
Subarnarekha Conflue	Adityapur	0	10	0.1	5.3	10000	886507.70	886507.70	-0.3	3.6	10000	1734496.80	1734496.80
Adityapur	Gangia	10	22.1	0.1	7.6	11050	397948.00	1284455.70	-0.3	5.3	11000	469186.60	2203683.40
Total						21050	1284455.70		Total		21000	2203683.40	

Table 18- Dredging quantity in class-III

Class-IV:-



Class-IV													
Location		Chainage (km)		Observed Dredging Qty.w.r.t Sounding Datum					Reduced Dredging Qty.w.r.t Sounding Datum				
From	To	From	To	Min depth (m)	Max depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)	Min Depth (m)	Max Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty. (cu.m.)
Subarnarekha Confluence	Adityapur	0	10	0.1	5.3	10000	1083387.50	1083387.50	-0.3	3.7	10000	1979483.90	1979483.90
Adityapur	Gangia	10	22.104	0.1	7.6	12000	527414.40	1610801.90	-0.3	5.4	12000	611599.40	2591083.30
Total						22000	1610801.90		Total		22000	2591083.30	

Table 19- Dredging quantity in class- IV

Section 6: Conclusion

The Survey stretch of Kherkhai River is 22.104 km, major tributaries of the Subarnarekha River situated near at Jamshedpur Site, Jharkhand. There is no Ferry service available in this zone of river. The waterway of the Kherkhai River includes with many villages, Rail and Road etc. There are two Railway Bridges are crossing over the river which is very communicative for the native villagers and the foreigners. The Railway line is connected with Adityapur, Tatanagar Jn. Railway station. Three RCC bridges are situated in this zone of river which is named Adityapur RCC Colony Bridge and RCC Toll Bridge which are also linked with Adityapur-Kandra road. Tourists can have beautiful view of the river and its natural surroundings. Adityapur, Adarsh Nagar, Jamshedpur etc. cities are situated in this zone of river. NH-32, NH-33 is the major communicative way in this zone and other state-Highways like SH-5, SH-6 are situated for a better communication system and good transportation.

Jamshedpur steel plants, Burma Mines, Tatanagar, Adityapur industrial hub are located near the river side. Besides, small kinds of industries are also located near the Jamshedpur city. Sonari Airport is situated in this zone of river. Dalma wildlife sanctuary, Jubilee Park, Sir Dorabji Tata Park, Hudco Lake, Bhuvneswari temple, Kalibari temple, St.mary church, Dimna Lake, Dalma hills are the important tourist places located in this zone of river. The Material like Iron ore is found near at Jamshedpur site.

6.1 Class wise Avg. Reduced Depths/Percentage:-

Sl. No	From Chainage (km)	To Chainage (km)	Minimum Avg. Reduced Depth/Percentage				Maximum Avg. Reduced Depth/percentage			
			Class-I	Class-II	Class-III	Class-IV	Class-I	Class-II	Class-III	Class-IV
1	0.00	10.00	-0.3/-0.003	-0.3/-0.003	-0.3/-0.003	-0.3/-0.003	0.62/0.0062	0.714/0.00714	0.808/0.00808	0.902/0.00902
2	10.00	22.104	0.28/0.0028	0.08/0.0008	0.04/0.0004	-0.08/-0.0008	2.28/0.0228	2.38/0.0238	2.49/0.0249	2.59/0.0259

6.2 Range of Depths:-

Sl No	From Chainage (km)	To Chainage (km)	Reduced Depth				
			<1.2 m (km)	1.2 m to 1.4 m (km)	1.5 m to 1.7 m (km)	1.8 m to 2.0 m (km)	>2.0 m (km)
1	0.00	10.00	6.6	0	0	0	3.4
2	10.00	22.104	0.7	1.2	1.7	1.9	6.6

6.3 Min/Max and Avg. Width of Waterway:-

Sl. No	From Chainage (km)	To Chainage (km)	Min. width of waterway (m)	Max. width of waterway (m)	Avg. width of waterway (m)
1	0.00	10.00	194	230	212
2	10.00	22.104	230	134.05	182.025

6.4 Dredging Summary:-

Class	Observed Dredging Qty. w.r.t Sounding Datum (Cubic meter)	Reduced Dredging Qty. w.r.t Sounding Datum (Cubic meter)
Class-I	502584.3	1018128.5
Class-II	800820.2	1491149.8
Class-III	1284455.7	2203683.4
Class-IV	1610801.9	2591083.3

6.5 Avg. Slope:-

Chainage (km)		Slope (m/km)
From	To	
0.00	10.00	0.373
10.01	22.104	0.683
Avg. Slope		0.528

Annexure:-

Annexure-1 Source and type of data collected from various agencies:-

The Chart Datum value and HFL values of Adityapur and Confluence of Subarnarekha River has been provided by IWAI office.

Annexure-2 Min. / max. depth, length of shoal per km-wise for different classification in the designed dredged channel:-

Class-I:-

Class-I											
Chainage (km)		Observed Dredging Qty. w.r.t Sounding Datum					Reduced Dredging Qty. w.r.t Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m)
0	1	0.8	5.2	1000	10145.40	10145.40	-0.3	3.4	1000	10508.90	10508.90
1	2	0.6	0.8	1000	35998.60	46144.00	-0.3	0.2	1000	76993.90	87502.80
2	3	0.5	0.7	1000	41597.70	87741.70	-0.3	0.3	1000	113289.00	200791.80
3	4	0.4	0.7	1000	44711.10	132452.80	-0.3	0.1	1000	138886.60	339678.40
4	5	0.7	1	1000	34362.50	166815.30	-0.3	0.3	1000	67724.50	407402.90
5	6	0.5	0.7	1000	37406.80	204222.10	-0.3	0.4	1000	71475.40	478878.30
6	7	0.4	0.8	1000	40613.60	244835.70	-0.3	0.5	1000	115260.30	594138.60
7	8	0.4	0.8	1000	41388.90	286224.60	-0.3	0.3	1000	77618.30	671756.90
8	9	0.4	0.9	1000	38702.30	324926.90	-0.3	0.3	1000	88078.40	759835.30
9	10	0.4	0.6	1000	42870.00	367796.90	-0.3	0.4	1000	102334.20	862169.50
10	11	1	5.9	1000	27838.90	395635.80	0.3	2.5	1000	70914.10	933083.60
11	12	1.5	6.5	0	0.00	395635.80	1.2	2.4	0	0.00	933083.60
12	13	1.1	6.2	350	541.00	396176.80	0.2	1.7	430	519.30	933602.90
13	14	1.1	6.3	1000	1463.60	397640.40	0.4	2.6	550	948.60	934551.50
14	15	0.3	0.5	1000	37796.20	435436.60	0.1	0.3	1000	22844.60	957396.10
15	16	1.1	2.7	1000	26361.00	461797.60	-0.3	2.1	1000	17910.30	975306.40
16	17	1.5	7.5	0	0.00	461797.60	1.4	5.1	0	0.00	975306.40
17	18	1.6	5.8	0	0.00	461797.60	1.3	3.5	0	0.00	975306.40
18	19	1.1	1.8	600	925.40	462723.00	-0.3	3.2	560	925.40	976231.80
19	20	1	2.3	850	4318.60	467041.60	-0.3	3.3	850	4318.60	980550.40
20	21	1	3.8	1000	14479.50	481521.10	-0.3	0.3	1000	14479.50	995029.90
21	22.104	1.1	4.3	1000	21063.20	502584.30	-0.3	0.4	1000	23098.60	1018128.50
Total				17800	502584.30		Total		17390	1018128.50	

Table 20- Minimum & Maximum depth per km wise (Class-I)

Class-II:-

Class-II											
Chainage (km)		Observed Dredging Qty. w.r.t Sounding Datum					Reduced Dredging Qty. w.r.t Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m)
0	1	0.7	5.3	1000	19801.10	19801.10	-0.3	3.5	1000	20572.80	20572.80
1	2	0.59	0.81	1000	56463.00	76264.10	-0.3	0.21	1000	110146.10	130718.90
2	3	0.4	0.8	1000	63587.90	139852.00	-0.3	0.4	1000	155710.40	286429.30
3	4	0.2	0.9	1000	68369.70	208221.70	-0.3	0.3	1000	192746.90	479176.20
4	5	0.6	1.1	1000	54377.80	262599.50	-0.3	0.4	1000	99718.90	578895.10
5	6	0.49	0.71	1000	58168.80	320768.30	-0.3	0.41	1000	103031.40	681926.50
6	7	0.3	0.9	1000	62352.40	383120.70	-0.3	0.6	1000	162177.80	844104.30
7	8	0.2	1	1000	63900.60	447021.30	-0.3	0.5	1000	113361.10	957465.40
8	9	0.3	1	1000	60030.30	507051.60	-0.3	0.4	1000	125515.10	1082980.50
9	10	0.38	0.62	1000	66149.70	573201.30	-0.3	0.42	1000	145793.80	1228774.30
10	11	0.9	6	1000	42962.60	616163.90	0.2	2.6	1000	100519.90	1329294.20
11	12	1.3	6.7	150	256.40	616420.30	1	2.6	850	1253.30	1330547.50
12	13	1.2	6.21	750	3073.20	619493.50	0.19	1.71	1000	4738.20	1335285.70
13	14	1.2	6.4	1000	5088.80	624582.30	0.3	2.7	1000	4412.60	1339698.30
14	15	0.1	0.7	1000	59400.30	683982.60	-0.3	0.5	1000	42117.00	1381815.30
15	16	1.28	2.72	1000	40642.70	724625.30	-0.3	2.12	1000	30386.90	1412202.20
16	17	1.4	7.6	0	0.00	724625.30	1.4	5.2	0	0.00	1412202.20
17	18	1.3	5.9	100	2.60	724627.90	-0.3	3.6	100	2.60	1412204.80
18	19	1.18	1.82	560	2397.40	727025.30	-0.3	3.22	1000	2397.40	1414602.20
19	20	1.2	2.4	1000	8930.60	735955.90	-0.3	3.4	1000	8930.60	1423532.80
20	21	1.1	4	1000	26830.90	762786.80	-0.3	0.5	1000	26830.90	1450363.70
21	22.1	1.1	4.4	1000	38033.40	800820.20	-0.3	0.5	1000	40786.10	1491149.80
Total				19250	800820.20		Total		20100	1491149.80	

Table 21 - Minimum & Maximum depth per km wise (Class II)

Class-III:-

Class-III											
Chainage (km)		Observed Dredging Qty. w.r.t Sounding Datum					Reduced Dredging Qty. w.r.t Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m)
0	1	0.6	5.3	1000	37774.30	37774.30	-0.3	3.6	1000	39665.90	39665.90
1	2	0.49	0.71	1000	87594.20	125368.50	-0.3	0.22	1000	155987.50	195653.40
2	3	0.3	0.8	1000	96460.70	221829.20	-0.3	0.5	1000	210990.60	406644.00
3	4	0.1	0.7	1000	103628.50	325457.70	-0.3	0.5	1000	262923.20	669567.20
4	5	0.6	0.9	1000	85147.60	410605.30	-0.3	0.5	1000	145572.70	815139.90
5	6	0.49	0.61	1000	89780.30	500385.60	-0.3	0.42	1000	146926.80	962066.70
6	7	0.2	0.8	1000	94892.80	595278.40	-0.3	0.7	1000	225560.10	1187626.80
7	8	0.1	0.8	1000	97905.20	693183.60	-0.3	0.7	1000	164879.90	1352506.70
8	9	0.3	0.8	1000	92128.60	785312.20	-0.3	0.5	1000	176644.00	1529150.70
9	10	0.28	0.52	1000	101195.50	886507.70	-0.3	0.44	1000	205346.10	1734496.80
10	11	0.5	5.9	1000	65876.20	952383.90	0.2	2.7	1000	141023.20	1875520.00
11	12	1.1	6.5	1000	4558.40	956942.30	0.8	2.8	1000	14298.50	1889818.50
12	13	1.29	5.91	1000	12189.80	969132.10	0.17	1.72	1000	21076.20	1910894.70
13	14	1	6.2	1000	18732.30	987864.40	0.3	2.8	1000	20081.30	1930976.00
14	15	0.1	0.8	1000	93128.60	1080993.00	-0.3	0.7	1000	76071.00	2007047.00
15	16	1.18	2.52	1000	62182.00	1143175.00	-0.3	2.14	1000	50716.40	2057763.40
16	17	1.2	7.6	850	902.90	1144077.90	1.2	5.3	700	816.50	2058579.90
17	18	1.3	5.6	200	403.90	1144481.80	-0.3	3.7	300	403.90	2058983.80
18	19	0.98	1.32	1000	6376.00	1150857.80	-0.3	3.24	1000	7283.20	2066267.00
19	20	1.2	2.2	1000	17531.90	1168389.70	-0.3	3.5	1000	17649.50	2083916.50
20	21	1	3.8	1000	48881.10	1217270.80	-0.3	0.7	1000	48881.10	2132797.60
21	22.104	1	4.3	1000	67184.90	1284455.70	-0.3	0.6	1000	70885.80	2203683.40
Total				21050	1284455.70		Total		21000	2203683.40	

Table 22 - Minimum & Maximum depth per km wise (Class III)

Class - IV:-

Class-IV											
Chainage (km)		Observed Dredging Qty. w.r.t Sounding Datum					Reduced Dredging Qty. w.r.t Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Cumulative Dredging Qty (cu.m)
0	1	0.5	5.3	1000	51391.00	51391.00	-0.3	3.7	1000	53636.80	53636.80
1	2	0.48	0.72	1000	107251.90	158642.90	-0.3	0.23	1000	179288.90	232925.70
2	3	0.2	0.9	1000	116559.20	275202.10	-0.3	0.6	1000	236458.80	469384.50
3	4	0.1	0.9	1000	125162.00	400364.10	-0.3	0.7	1000	292886.50	762271.00
4	5	0.5	1	1000	104727.90	505092.00	-0.3	0.6	1000	169059.70	931330.70
5	6	0.48	0.62	1000	109506.60	614598.60	-0.3	0.43	1000	169652.50	1100983.20
6	7	0.1	0.9	1000	114900.80	729499.40	-0.3	0.8	1000	253356.50	1354339.70
7	8	0.1	1	1000	119144.30	848643.70	-0.3	0.9	1000	190846.80	1545186.50
8	9	0.2	0.9	1000	112041.80	960685.50	-0.3	0.6	1000	201286.70	1746473.20
9	10	0.26	0.54	1000	122702.00	1083387.50	-0.3	0.46	1000	233010.70	1979483.90
10	11	0.4	6	1000	80199.20	1163586.70	0.2	2.8	1000	159811.00	2139294.90
11	12	0.9	6.7	1000	8093.20	1171679.90	0.7	3	1000	21119.80	2160414.70
12	13	1.28	5.92	1000	22397.60	1194077.50	0.17	1.73	1000	34019.20	2194433.90
13	14	0.9	6.3	1000	32157.50	1226235.00	0.3	2.9	1000	34820.00	2229253.90
14	15	0.1	1	1000	114313.60	1340548.60	-0.3	0.9	1000	97857.80	2327111.70
15	16	1.16	2.54	1000	75607.80	1416156.40	-0.3	2.16	1000	63984.00	2391095.70
16	17	1.1	7.6	1000	2564.50	1418720.90	-0.3	5.4	1000	2389.10	2393484.80
17	18	1.2	5.7	1000	1598.90	1420319.80	-0.3	3.8	1000	1598.90	2395083.70
18	19	0.96	1.34	1000	10646.70	1430966.50	-0.3	3.26	1000	11957.10	2407040.80
19	20	1.1	2.3	1000	25474.20	1456440.70	-0.3	3.6	1000	25699.50	2432740.30
20	21	0.8	4	1000	66143.40	1522584.10	-0.3	0.9	1000	66168.60	2498908.90
21	22.104	0.9	4.4	1000	88217.80	1610801.90	-0.3	0.7	1000	92174.40	2591083.30
Total				22000	1610801.90		Total		22000	2591083.30	

Table 23- Minimum & Maximum depth per km wise (Class IV)

Annexure-3 Details of collected Water level of different gauge stations w.r.t. MSL (CWC, Irrigation, Ports, Maritime Boards, Observed stations during survey etc.) – Table indicating Chainage (zero at downstream) and following:-

Date	Tide Pole name	Chainage (km)	Time	T. Reading (m)	Zero of TP w.r.t. MSL (m)	W.L w.r.t. MSL (m)	SD value w.r.t. MSL (m)	Corrected Tide (m)
				A	B	C = A+B	D	E = D-C
30.01.16	GS (TP) - 1	10.600	24 hrs	0.25	126.65	126.900	126.900	0.000
31.01.16	GS (TP) - 2	15.600	24 hrs	0.29	131.21	131.500	131.500	0.000
31.01.16	GS (TP) -3	0.02	24 hrs	0.33	119.17	119.500	119.494	-0.006
31.01.16	GS (TP) - 3/A	1.500	24 hrs	0.37	119.255	119.625	119.000	-0.625
31.01.16	GS (TP) -3/B	2.500	24 hrs	0.41	119.868	120.278	119.850	-0.428
31.01.16	GS (TP) -3/C	3.500	24 hrs	0.45	120.433	120.883	120.370	-0.513
31.01.16	GS (TP) -3/D	4.500	24 hrs	0.51	121.831	122.341	121.680	-0.661
31.01.16	GS (TP) -3/E	5.500	24 hrs	0.59	122.042	122.632	122.060	-0.572
31.01.16	GS (TP) -3/F	6.500	24 hrs	0.61	122.142	122.752	122.090	-0.662
31.01.16	GS (TP)-3/G	7.500	24 hrs	0.65	122.328	122.978	122.330	-0.648
31.01.16	GS (TP)-3/H	8.500	24 hrs	0.71	122.188	122.898	122.345	-0.553
31.01.16	GS (TP)- 3/I	9.500	24 hrs	0.73	122.255	122.985	122.350	-0.635
31.01.16	GS (TP) 3/J	10.500	24 hrs	0.81	123.027	123.837	123.230	-0.607

Table 24- Details of Collected water level at different gauge station

Annexure-4 Details of Bathymetric surveys carried out:-

Date of Survey	Type of survey	Chainage	
		From (km)	To (km)
31.01.16	Bathymetry Survey/Topography Survey	0.00	0.420
30.01.16	Bathymetry Survey/Topography Survey	10.6	14.2
31.01.16	Bathymetry Survey/Topography Survey	15.6	22.104

Table 25- Details of Bathymetry survey

Annexure-5 Bank Protection along the Bank:-

The Bank of the river is well protected by both side embankment and also Boulder pitching. RCC Bridges, Rail Bridges, Check Dams, H.T. Lines area are well protected by concrete pitching. During the monsoon, the level of water becomes high and as a result the Basti area used to flood every year. Baba Tilka Majhi basti, Gandhi Basti, Roop Nagar Basti area are often flooded in the monsoon. Boulder Pitching is not only protecting the flood but it also can control the water pollution in recent times. From Chainage 0.00 km to 3.00 km, 5 km and 6 km Boulder pitching has been found left bank side of the river. Beside this, Tata Zoological Park, Dalma wildlife Sanctuary and Dalma Hills, Jubilee Park are located near the bank side of this river which are protected the bank side.

Annexure-6 Details of Features across the Bank:-

The bank of the river includes villages, Ferry ghat, Irrigation canals and outlets, Rail Bridges, RCC Bridges and Forest etc. The both side river bank are highly protected by embankment and bolder pitching due to flood, erosion etc. The villagers are also situated near the bank side of the river. Recently different kinds of industries are also located near the bank side of the river. Adityapur Toll Bridge, Adityapur Colony RCC Bridges, Adityapur colony Rail Bridges, Check Dams, Electric Lines, H.T.Lines are located in this region of river. Jamshedpur, a major industrial hub is located in this region of river. Tata steel plant, Burma Mines etc. Industries are located in this region of river. Adityapur Railway station and Tatanagar Railway station are located in this zone of river. Sonari airport, Dalma wildlife sanctuary and Dalma hills, Tata Zoological Park, Bhatia Park, Hudco Lake, Dimna Lake etc. tourist places are located in this zone of river. Adarsh Nagar, Adityapur, Jamshedpur, Tatanagar like cities are located in this region. Some Basti area like Baba Tilka Majhi Basti, Roop Nagar Basti is located in this zone. Kalibari temple, Parsee Fire temple, Bhuvneswari temple, Sai Baba temple, Rankini Mandir, St. Mary church are the places of worship located in this region of river.

Annexure-7 Detailed methodology adopted for carrying out survey. Horizontal Control and Vertical Details Control:-

The Horizontal control for Topography survey: - High precision RTK DGPS in fix mode is using UHF Radio Modem with IHO accuracy standards, with minimum 24 hours observations at some permanent platform/base. The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 40 m interval. The plotting of the chart was done on UTM Projection at Zone 45 N /WGS-84 Datum as directed in the contract specifications. Topographic survey Equipments like South (S86T) GNSS RTK, Total Station was used for conducting the Topography survey.

The Horizontal control for Bathymetry survey: - DGPS is receiving corrections from Beacons by the Bar check Procedure method. The sound velocity was set to 1475 m/s on single beam echo sounder during acquisition. The Daily bar checks were done prior to the sounding operation and before the closing of the sounding operation for the day. Being very shallow depths, the echo sounder depths were also cross-checked in between by using demarcated sounding poles during the conduct of the survey. The sounding lines were run using Survey boat to identify the design line of the Kherkhai River for the possible stretch. The cross lines were run perpendicular to the orientation of river flow (i.e. perpendicular to the orientation of depth contours) in respective stretches. The spot sounding was also carried out in the area where the survey boat cannot be operated due to low depth. The hemisphere DGPS and Sounding Pole were used for Spot sounding at shallow locations in the Kherkhai River. The DGPS position along with water depths was recorded simultaneously and the tidal reduction was applied to the obtained depths.

- **Establishment of Vertical Control:-**

Vertical control from C.W.C Gauge is used for the entire survey work. Its value is 123.00 meter w.r.t. M.S.L has been considered for calculating the vertical levels. Total 3 no. Bench Mark was established along the 22.104 km of Kherkhai River with the reference of C.W.C Gauge which is situated near Adityapur Colony area.

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Topography Survey:-

The survey was commenced on 27th October, 2015 and completed on 05th November, 2015. Then the days were autumn season and arrival of winter season. The climate become normal which reached about 20◦ C. Mostly day weather was sunny and was very favorable for the conduct of survey and the weather condition remains same for the entire duration of the survey. The length of the Topography survey is from Chainage 0.00 km to Chainage 22.104 km.

The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 40 m interval. The plotting of the chart was done on UTM Projection at Zone 45 N as directed in the contract specifications. The spot levels along the river were obtained by using Trimble DGPS. The data was post processed using Trimble Business Center to get the precise position and MSL height values of the rover locations. The topographic survey for the entire survey stretch was conducted to collect the following data:-

- Spot levels
-Delineation of Islands
-Fixing of bridges and marks
-Assess the type of river bank
-Extending the vertical and horizontal control throughout the survey area
-Collection of local information along the river Banks

South RTK (S86T) satellite navigation is a technique used in land survey and in hydrographic survey based on the use of carrier phase measurements of the GPS, GLONASS and / or Galileo signals where a single reference station provides the real-time corrections, providing up to centimeter-level accuracy. When referring to GPS in particular, the system is also commonly referred to as Carrier-Phase Enhancement, CPGPS. RTK systems use a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier that it measured, and the mobile units compare their own phase measurements with the ones received from the base station. There are several ways to transmit a correction signal from base station to mobile station. The most popular way to achieve real-time, low-cost signal transmission is to use a radio modem, typically in the UHF band. This allows the units to calculate their relative position to millimeters, although their absolute position is accurate only to the same accuracy as the position of the base station.

RTK systems are available in dual-frequency and single-frequency versions. Dual-frequency systems deliver greater precision, faster and over longer baselines than single-frequency systems. Leica GS09 & GS12 GNSS RTK that used for the survey contains dual-frequency requires antenna and controller to suit any surveying task with a wide range of functionality. Leica GS09 & GS12 GNSS RTK Rover is extremely light-weight and cable free rover is comfortable to use and withstand even for rough use and topple over. It uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier that it measured, and the mobile units compare their own phase measurements with the ones received from the base station. So, that centimeter level accuracy can be achieved from latitude, longitude and altitude. RTK technique in terms of general navigation, it is perfectly suited to roles like surveying. In this case, the base station is located at a known surveyed location, often a benchmark, and the mobile units can then produce a highly accurate map by taking fixes relative to that point. RTK has also found uses in auto drive/autopilot systems, precision farming and similar roles.

Figure 16- Topography Survey Instruments

- **Bathymetry Survey:-**

The bathymetry survey was carried out using Bathy 500 portable shallow water Echosounder supported by DGPS Beacon Receiver and HYPACK Data collection and processing software. The survey equipment was installed as per the standard procedure the survey vessel equipped with safety gears.

Bathy- 500MF Echosounder: The Bathy- 500MF echosounder is an electronic hydrographic survey instrument used for measuring depths with precision chart recordings and digital data output manufactured by Syqwest Incorporated, USA. The Bathy-500 echo sounding systems are based on the principle that when a sound signal is sent into the water it will be reflected back when it strikes an object. The Bathy-500 is technologically sophisticated, utilizing modern, micro processor based electronics and a thermal chart recorder mechanism. Digital processing enables the instrument to offer fully automatic digitizing capabilities. When interfaced to a NMEA 0183 compatible position sensor, it provides user with a complete, integrated hydrographic survey environment. The instrument front panel consists of a high contrast, backlit four line LCD displays and a fully sealed input keypad. The front panel encompassing system data, status and setup parameters with RS232/RS422 output format. All operating functions are set via the front panel interface. Setup selections are stored within internal, non-volatile memory for instant availability upon power-up. The instrument decodes and processes the NMEA 0183 formatted sentence GGA or GLL from GPS/DGPS using variable Baud rates for communication.

Figure 17- Bathymetry Survey Instruments

Annexure-8 Photographs of Equipment:-

Following equipment was employed for the bathymetric and topographic survey:-

Equipment	Model/Make	Version	Qty Employed
Echo sounder	Bathy MF 500	……	1
Current Meter	AEM 213-D	……	1
Tide Gauge	Manual (Pole type)	-	4
RTK	South S86T		3
GPS Sets	Trimble –Becon Rover SPS 361		1
Software	HYPACK data acquisition	Version 14	1
Software	AUTOCAD	2013	1
Software	Microsoft Office	2013	1

- **Survey vessel :-**

Figure 18- Survey Vessel

- **Positioning System:-**

- 1 no Trimble DGPS system (SPS361)

Figure 19- DGPS Survey Instrument

- **Navigation & Data Logging System:-**

- To provide on-line route guidance, log navigation data, provide QC of navigation data, etc. The system comprises the following equipment:
- 1 no. DELL Laptop
- 1 no. Hypack version 2014 Navigation & Data Logging Software
- 1 no. Positioning & sensor interfaces
- Sufficient Paper Rolls

- **Single Beam Echo Sounder System:-**

  - 1 no. Bathy 500MF multi frequency Echo sounder
  - 1 no. transducer 210 kHz + mounting bracket & base plate

Figure 20- Echo Sounder Instrument

- **Current Meter:-**

  - 1 no. current meter (AEM 213-D) was used during water velocity
  - observation

Figure 21- Current Meter Reading

- **Calibration:-**

  All the equipments of Machinery details are attached in **Annexure** portion

Annexure-9 Bench Mark Forms:-

BM Name	Northing (m)	Easting (m)	BM Height above M.S.L (m)	Latitude (N)	Longitude (E)	Height above SD (m)
BM-1	2525497.435	413863.072	137.553	22°50'5.92"	86° 9'37.89"	18.059

Pillar Established by: - B.S Geotech Pvt. Ltd. Surveyor – Mr. Bimal Das
Date of Establishment: 02.10.15

Station Description :-

Benchmark is located near Baba Tilka Majhi Basti area. The Bench mark is close to the river meet road.

The BM is denoted by a "." mark engraved on a plate. The plate is fixed on a 5cm diameter GI pipe. The GI pipe is cemented with construction pillar of 30cmX30cmX150cm.The pillar extends 60.cms above ground level. Inscription "IWAI", and BM-1 No. can be seen on the face of the pillar.

The measurements of the bench mark pillar from notable locations / edges as follows:

South From Sangam Vihar - 426 metre

Life of Station : 15Yrs	Datum: - WGS 84	**ZONE :** 45 N

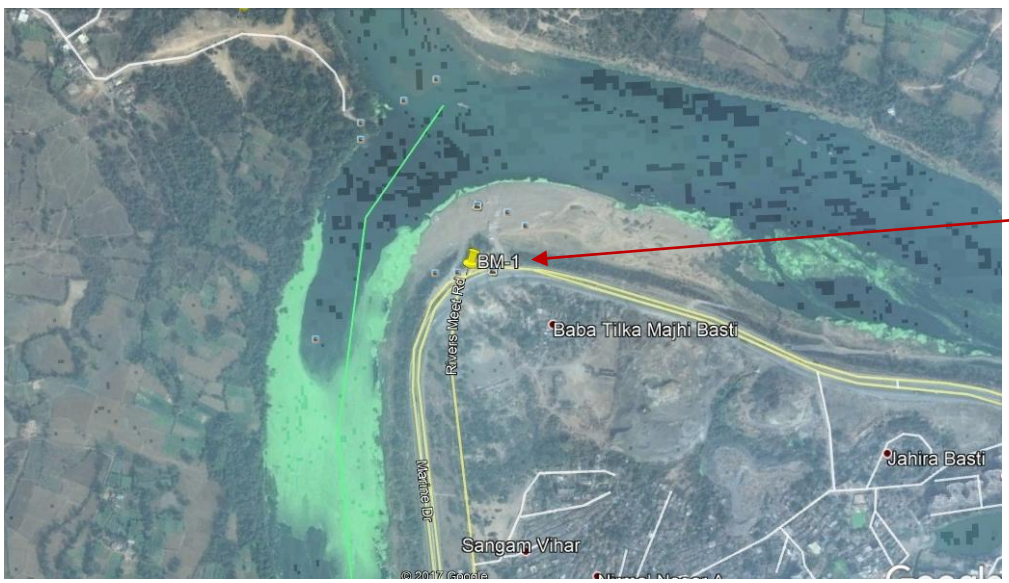


Figure 22- BM Form & Google image view of BM-1

BM Name	Northing (m)	Easting (m)	BM Height above M.S.L (m)	Latitude (N)	Longitude (E)	Height Above S.D (m)
BM-2	2518066.998	415123.05	135.203	22°46'4.546"	86°10'23.555"	8.303

Pillar Established by: - B.S Geotech Pvt. Ltd. Surveyor – Mr. Bimal Das
Date of Establishment:02.11.15

Station Description :-

Benchmark is located near Jugsalai area, located near Bagbera Basti.

The BM is denoted by a "." mark engraved on a plate. The plate is fixed on a 5cm diameter GI pipe. The GI pipe is cemented with construction pillar of 30cm X 30cm X 150cm.The pillar extends 60.cms above ground level. Inscription "IWAI", and BM-2 No. can be seen on the face of the pillar.

The measurements of the bench mark pillar from notable locations / edges as follows:

East from Jugsalai- 785 metre

Life of Station : 15Yrs	Datum: - WGS 84	**ZONE :** 45N

Figure 23- BM Form & Google image view of BM-2

BM Name	Northing (m)	Easting (m)	BM Height above M.S.L (m)	Latitude (N)	Longitude (E)	Height Above S.D (m)
BM-3	2516288.400	406199.290	144.360	22°45'11.033"	86°5'5.005"	12.860

Pillar Established by: - B.S Geotech Pvt. Ltd. Surveyor – Mr. Bimal Das
Date of Establishment: 02.11.15

Station Description :-

Benchmark is located near Gangia village.

The BM is denoted by a "." mark engraved on a plate. The plate is fixed on a 5cm diameter GI pipe. The GI pipe is cemented with construction pillar of 30cm X 30cm X 150cm.The pillar extends 60.cms above ground level. Inscription "IWAI", and BM-3 No. can be seen on the face of the pillar.

The measurements of the bench mark pillar from notable locations / edges as follows:

North from Gangia village- 830 metre

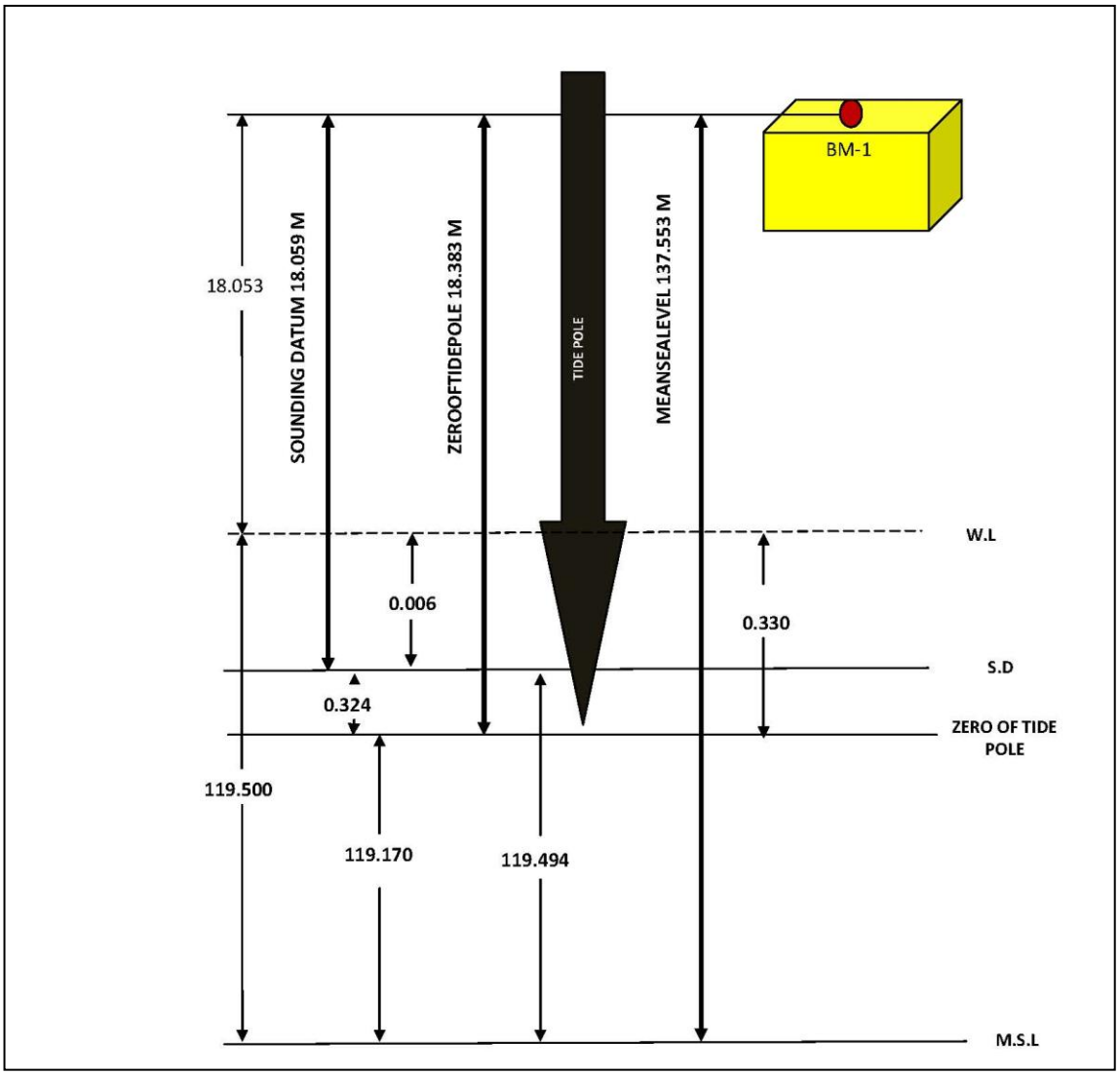
Life of Station : 15Yrs	Datum: - WGS 84	**ZONE :** 45N

Figure 24-BM Form & Google image view of BM-3

Annexure-10 Levelling Calculation and Levelling Diagram:

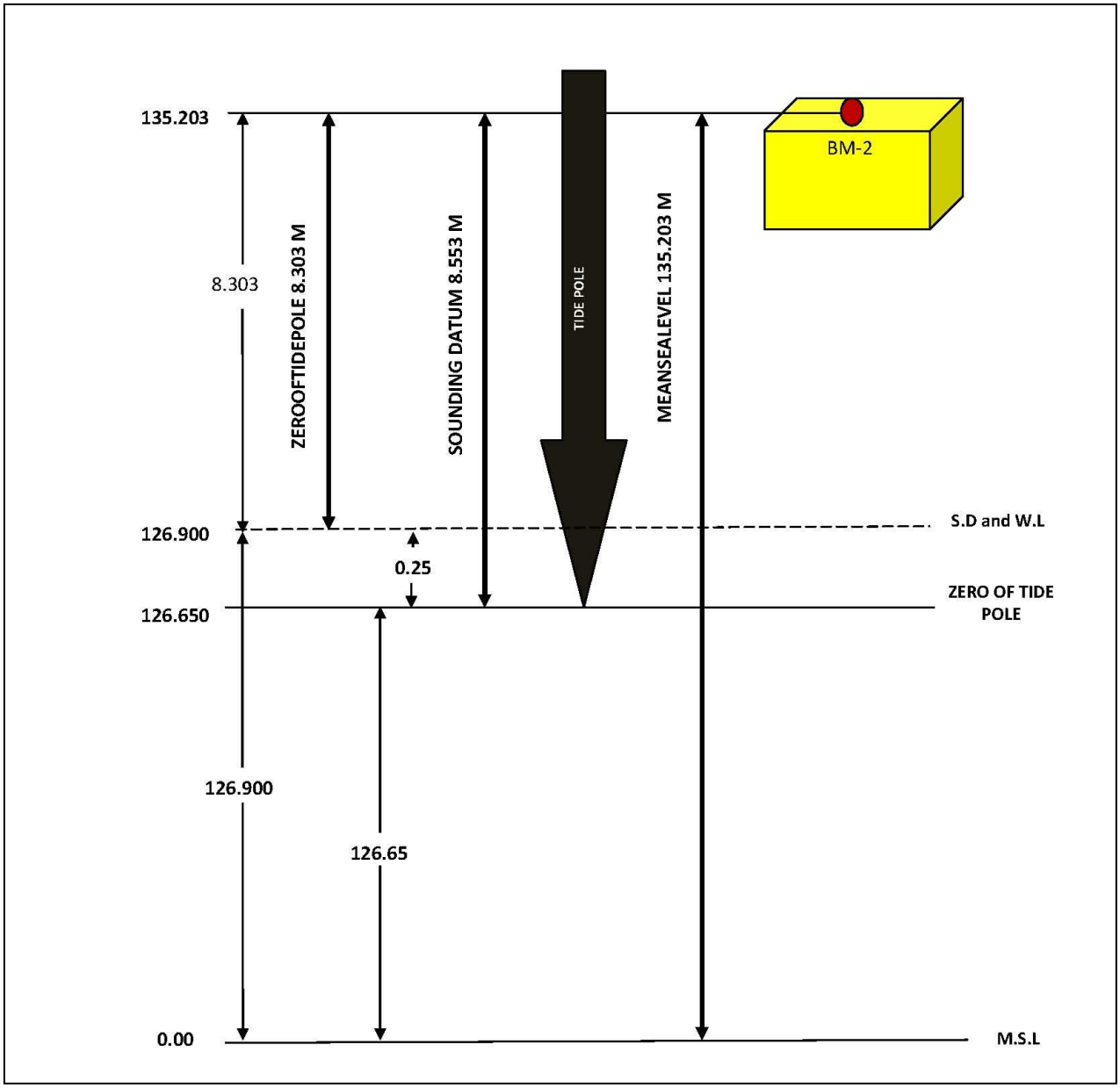
Levelling from BM-1 to GS-3

BS	IS	FS	RISE (+)	FALL (-)	RL	REMARKS
0.455					137.553	BM-1
0.425		2.991		2.536	135.017	
0.350		3.115		2.690	132.327	
0.545		3.065		2.715	129.612	
0.388		2.865		2.320	127.292	
0.680		2.980		2.592	124.700	
0.520		3.150		2.470	122.230	
		3.250		2.730	119.500	GS-3



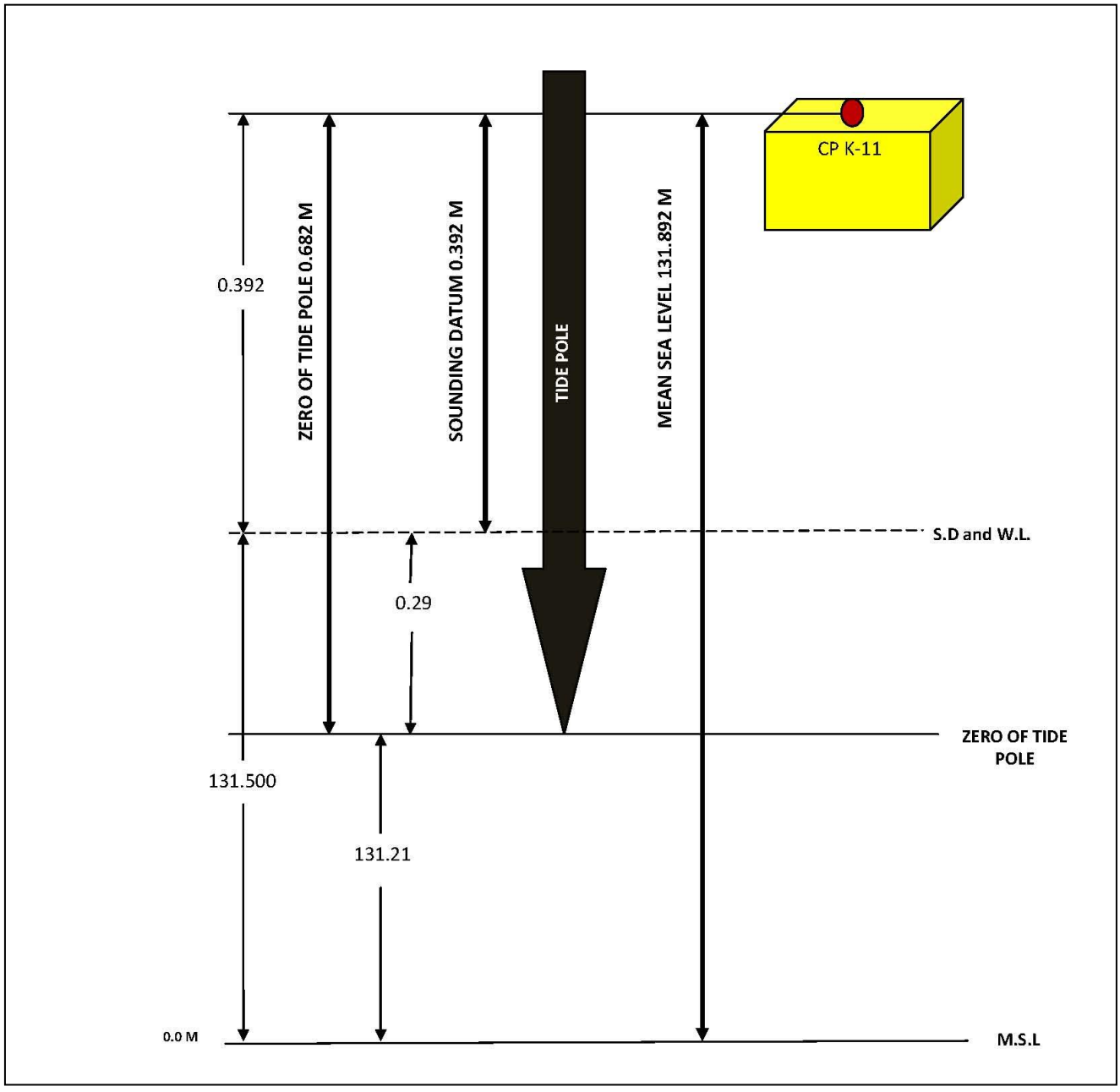
Levelling from BM-2 to GS-1

BS	IS	FS	RISE (+)	FALL (-)	RL (m)	REMARKS
0.341					135.203	BM-2
0.632		2.060		1.719	133.484	
0.752		2.980		2.348	131.136	
0.378		2.833		2.081	129.055	
		2.533		2.155	126.900	GS-1



Levelling from CP-K-11 to GS-2

BS	IS	FS	RISE (+)	FALL (-)	RL (m)	REMARKS
1.886					131.892	CP-K11
		2.278		0.392	131.500	GS-2



Annexure-11 Soil Sample Report:

RESULTS OF TEST OF SOIL SAMPLES

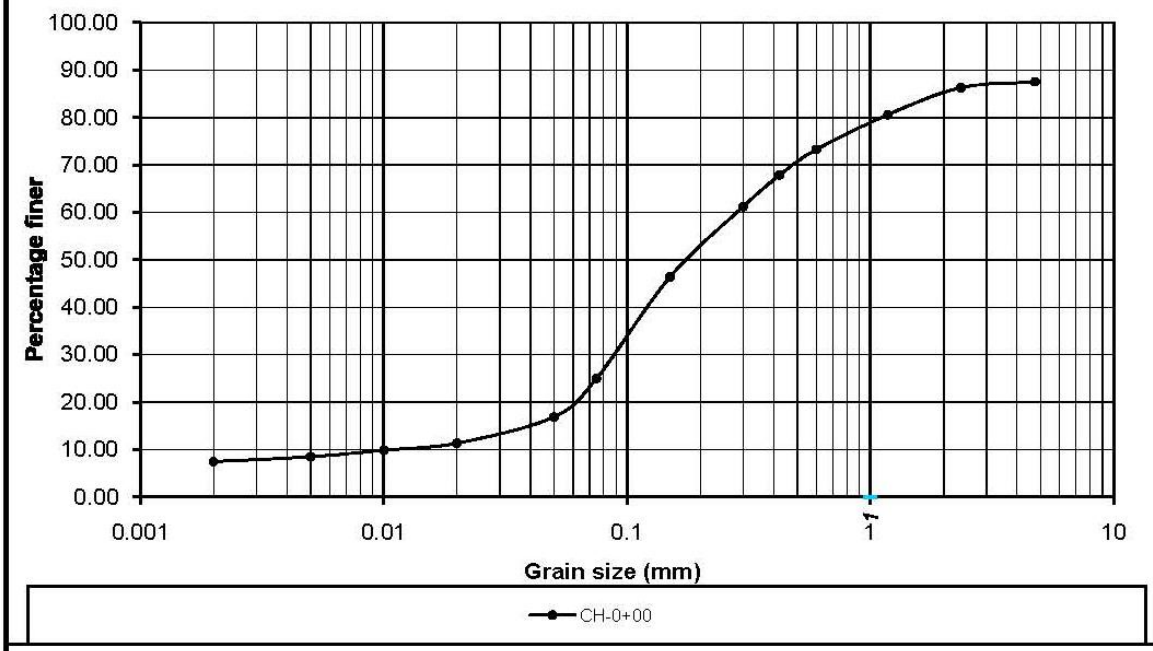
SITE – KHERKAI RIVER

PHYSICAL ANALYSIS OF SOIL

Sl.No.	CH.	GRAVEL (%)	SAND (%)	SILT+CLAY (%)	SPECIFIC GRAVITY	pH VALUE	SILT (%)	CLAY (%)	Cu	Cc
1	0+000	12.50	62.50	25.00	2.64	7.50	17.52	7.48	15.00	1.67
2	10+000	14.00	60.00	26.00	2.64	7.30	19.05	6.95	17.00	2.20
3	20+000	9.68	43.50	46.82	2.63	7.40	37.00	9.82	18.52	3.27

Note: - The position of the Soil sample Reports have been shown at Para no-2.21 (a), page no-23

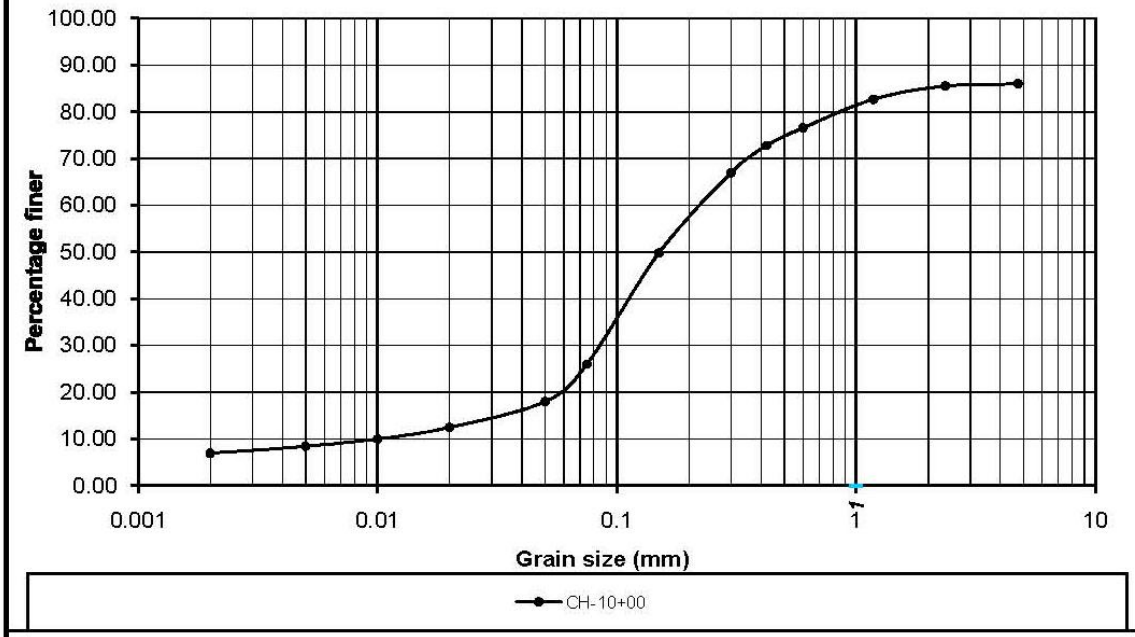
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-4.75*	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Gravel (%)**
CH-0+00	7.48	17.52	62.50	12.50

*Silt & Clay

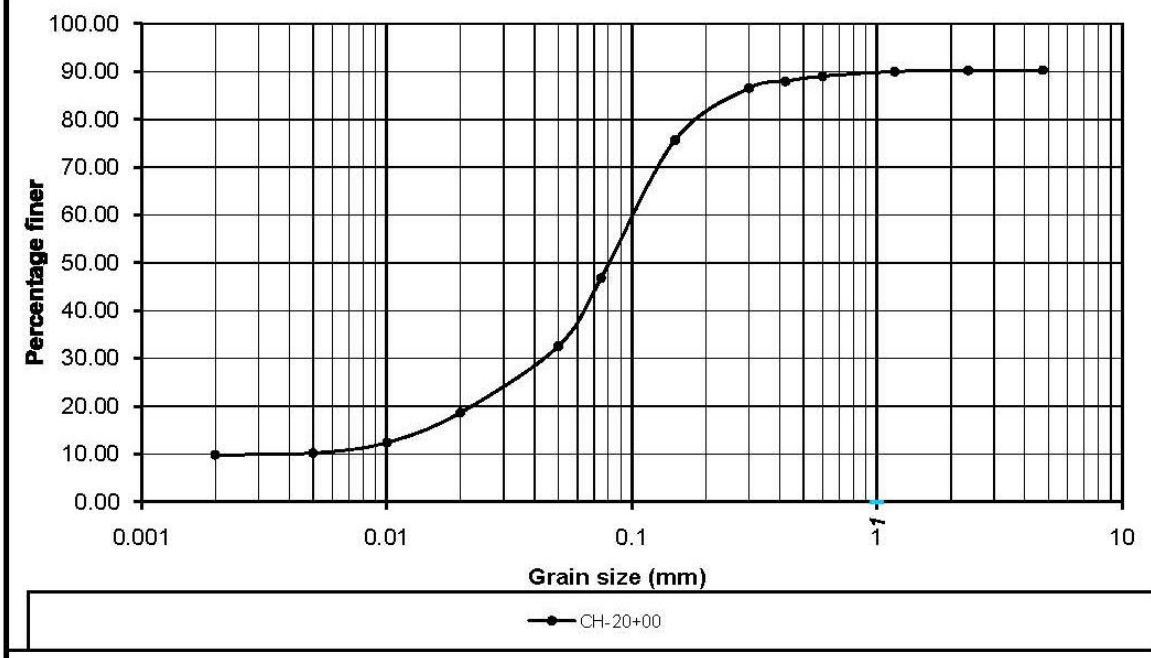
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-4.75*	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Gravel (%)**
CH-10+00	6.95	19.05	60.00	14.00

*Silt & Clay

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	*<0.002*	*0.002-0.075*	*0.075-4.75*	*>4.75*
Sample No.	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Gravel (%)**
CH-20+00	9.82	37.00	43.50	9.68

*Silt & Clay

Annexure-12 Water Sample Report:

RESULTS OF EXAMINATION OF SAMPLES OF WATER

SITE- RIVER KHERKAI

PARAMETER – pH Value at 25° C

SL.NO;	CH.No.	LOCATION	PARAMETER	WATER SAMPLE RESULTS	PERMISSIBLE LIMIT IS:456-2000
1	00+000	UPPER		6.6	
		MIDDLE		6.8	
		LOWER		6.7	
2	10+000	UPPER	pH at 25°C	6.7	6.5-8.5
		MIDDLE		6.9	
		LOWER		6.8	
3	20+000	UPPER		6.6	
		MIDDLE		6.9	
		LOWER		6.8	

Note: - The position of the Water sample Reports have been shown at Para no-2.21 (b), page no-23

RESULTS OF EXAMINATION OF SAMPLES OF WATER

SITE- **RIVER KHERKAI**

PARAMETER – **Chloride as Cl(mg/l)**

SL.NO;	CH.No.	LOCATION	PARAMETER	WATER SAMPLE RESULTS(mg/l)	PERMISSIBLE LIMIT IS:456-2000
1	00+000	UPPER		8	
		MIDDLE		14	
		LOWER		15	
2	10+000	UPPER	Chloride as Cl(mg/l)	9	2000mg/l for concrete not containing embedded steel and 500 mg/l for reinforced
		MIDDLE		14	
		LOWER		16	
3	20+000	UPPER		8	
		MIDDLE		15	
		LOWER		14	

RESULTS OF EXAMINATION OF SAMPLES OF WATER

SITE- RIVER KHERKAI

PARAMETER – Sulphates as SO_4(mg/l)

SL.NO;	CH.No.	LOCATION	PARAMETER	WATER SAMPLE RESULTS(mg/l)	PERMISSIBLE LIMIT IS:456-2000
1	00+000	UPPER		64	
		MIDDLE		83	
		LOWER		86	
2	10+000	UPPER	Sulphates as SO_4(mg/l)	65	400(mg/l)
		MIDDLE		84	
		LOWER		86	
3	20+000	UPPER		64	
		MIDDLE		84	
		LOWER		87	

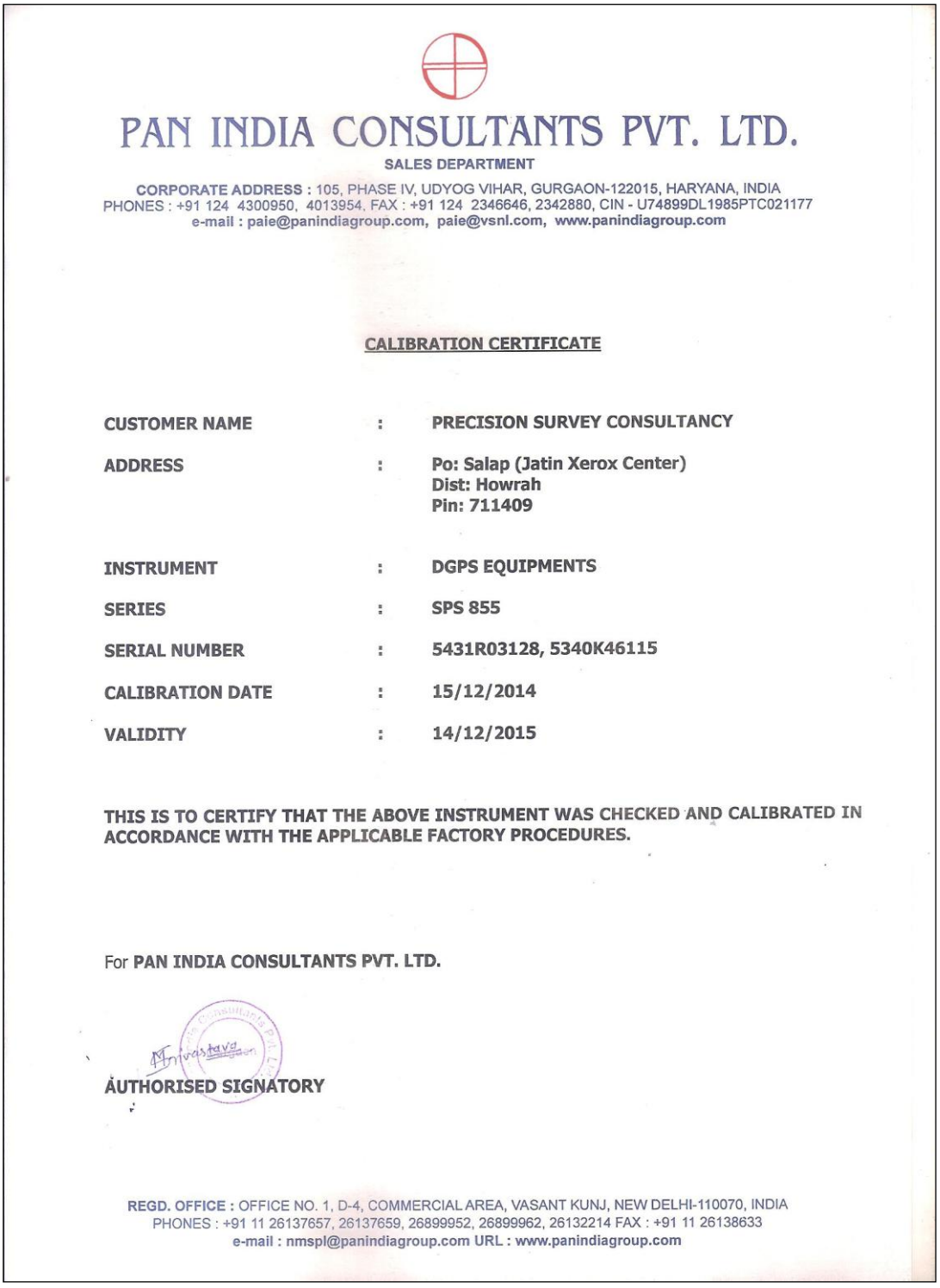
RESULTS OF EXAMINATION OF SAMPLES OF WATER

SITE- RIVER KHERKAI

PARAMETER – Sediment Concentration(mg/l)

SL.NO;	CH.No.	LOCATION	PARAMETER	WATER SAMPLE RESULTS(mg/l)	PERMISSIBLE LIMIT IS:456-2000
1	00+000	UPPER		15	
		MIDDLE		14	
		LOWER		20	
2	10+000	UPPER	Sediment Concentration (mg/l)	16	2000mg/l
		MIDDLE		15	
		LOWER		20	
3	20+000	UPPER		15	
		MIDDLE		15	
		LOWER		21	

Annexure-13 Calibration Certificate:-



PAN INDIA CONSULTANTS PVT. LTD.

SALES DEPARTMENT

CORPORATE ADDRESS : 105, PHASE IV, UDYOG VIHAR, GURGAON-122015, HARYANA, INDIA
PHONES : +91 124 4300950, 4013954, FAX : +91 124 2346646, 2342880, CIN - U74899DL1985PTC021177
e-mail : paie@panindiagroup.com, paie@vsnl.com, www.panindiagroup.com

CALIBRATION CERTIFICATE

CUSTOMER NAME	:	PRECISION SURVEY CONSULTANCY
ADDRESS	:	Po: Salap (Jatin Xerox Center) Dist: Howrah Pin: 711409
INSTRUMENT	:	DGPS EQUIPMENTS
SERIES	:	SPS 855
SERIAL NUMBER	:	5431R03128, 5340K46115
CALIBRATION DATE	:	15/12/2014
VALIDITY	:	14/12/2015

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENT WAS CHECKED AND CALIBRATED IN ACCORDANCE WITH THE APPLICABLE FACTORY PROCEDURES.

For PAN INDIA CONSULTANTS PVT. LTD.

AUTHORISED SIGNATORY

REGD. OFFICE : OFFICE NO. 1, D-4, COMMERCIAL AREA, VASANT KUNJ, NEW DELHI-110070, INDIA
PHONES : +91 11 26137657, 26137659, 26899952, 26899962, 26132214 FAX : +91 11 26138633
e-mail : nmspl@panindiagroup.com URL : www.panindiagroup.com

Table 26- Calibration Certificate of DGPS

PAN INDIA CONSULTANTS PVT. LTD.

SALES DEPARTMENT

CORPORATE ADDRESS : 105, PHASE IV, UDYOG VIHAR, GURGAON-122015, HARYANA, INDIA
PHONES : +91 124 4300950, 4013954, FAX : +91 124 2346646, 2342880, CIN - U74899DL1985PTC021177
e-mail : paie@panindiagroup.com, paie@vsnl.com, www.panindiagroup.com

CALIBRATION CERTIFICATE

CUSTOMER NAME	:	PRECISION SURVEY CONSUTLANCY
ADDRESS	:	P.O. –SALAP (Jatin Xerox Center) Dist. –Howrah Pin: 711 409
INSTRUMENT	:	ECHO –SOUNDER
SERIES	:	500MF
SERIAL NUMBER	:	B5MF0560
CALIBRATION DATE	:	28/04/2015
VALIDITY	:	27/04/2016

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENT WAS CHECKED AND CALIBRATED IN ACCORDANCE WITH THE APPLICABLE FACTORY PROCEDURES.

For **PAN INDIA CONSULTANTS PVT. LTD.**

AUTHORISED SIGNATORY

REGD. OFFICE : OFFICE NO. 1, D-4, COMMERCIAL AREA, VASANT KUNJ, NEW DELHI-110070, INDIA
PHONES : +91 11 26137657, 26137659, 26899952, 26899962, 26132214 FAX : +91 11 26138633
e-mail : nmspl@panindiagroup.com URL : www.panindiagroup.com

Table 27- Calibration Certificate of Eco Sounder

SOUTH PRECISION INSTRUMENT PVT. LTD.
FA - 229 B, Ground Floor, Mansarover Garden, New Delhi-110015
Ph. : 011- 45544114, 65568870 Fax: 011- 45530854 Mob.: 9999999255

Calibration Certificate

SOUTH Precision Instrument Pvt. Ltd. Calibration laboratory certifies that the instrument has been inspected, tested and calibrated in accordance with the documented procedures using measuring and test equipment, which are traceable to national standards and of the international accepted standard.

We hereby certify that the instrument mentioned below meet the specification and result of the traceability is carried out in accordance to our company's standard.

INSTRUMENT TYPE	:	GPS RTK
MODEL	:	S-86T
MAKE	:	SOUTH
INSTRUMENT SR. NO.	:	S86951117129438GEM W1286752342GM
CALIBRATION DATE	:	10/02/2015
VALID UPTO	:	09/02/2016
ISSUED TO	:	PRECISION SURVEY CONSULTANCY

For SOUTH PRECISION INSTRUMENT PVT. LTD.
For SOUTH PRECISION INSTRUMENT PVT. LTD.
Authorised Signatory
Authorised Signatory

Table 28- Calibration Certificate of GPS RTK

Annexure-14 Site Picture:-

Figure 25- Boulder pitching area

Figure 26- Health Centre

Figure 27- River bank side area

Figure 28- Low water level in the river

Figure 29-Check Dam near at Chainage 10.642 km

Annexure-15 Survey Charts:-

Sl. No.	Chart No.	Chainage (from ..... km to .... km)	Location (from .... to .....)	Scale	Size of the Chart
1	1	0.000 km to 1.448 km	Confluence of Subansiri River to Hadgodam Basti	1:2000	A-1
2	2	1.448 km to 3.000 km	Hadgodam Basti to Bage Basti	1:2000	A-1
3	3	3.000 km to 4.574 km	Bage Basti to Adityapur colony	1:2000	A-1
4	4	4.574 km to 6.166 km	Adityapur Colony to Jai prakash Nagar	1:2000	A-1
5	5	6.166 km to 7.582 km	Jai Prakash Nagar to Shastri nagar block no-1	1:2000	A-1
6	6	7.582 km to 9.407 km	Shastri nagar block no-1 to parvati ghat basti	1:2000	A-1
7	7	9.407 km to 11.00 km	parvati ghat basti to Jatajhupri village	1:2000	A-1
8	8	11.000 km to 13.00 km	Jatajhupri village to Ashram colony	1:2000	A-1
9	9	13.000 km to 14.775 km	Ashram colony to Jilingbera	1:2000	A-1
10	10	14.775 km to 16.321 km	Jilingbera village to Itagarh village	1:2000	A-1
11	11	16.321 km to 18.000 km	Itagarh village to Udaipur village	1:2000	A-1
12	12	18.000 km to 19.844 km	Udaipur village to Dhahkidih village	1:2000	A-1
13	13	19.844 km to 21.504 km	Dhahkidih village to Nayagarh village	1:2000	A-1
14	14	21.504 km to 22.104 km	Nayagarh village to Gangia village	1:2000	A-1

Table 29- Survey Charts