

**FINAL FEASIBILITY REPORT ON
DETAILED HYDROGRAPHIC SURVEY IN
INDIRA GANDHI CANAL (373.1 KM) FROM NH15 BRIDGE NEAR PIPERAN
(SURATGARH) TO MOHANGARH (REGION-IIIA, NW- 45)**

Submitted To



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**VOLUME – I
MAIN REPORT**

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List of Abbreviations:

BM	-	Bench Mark
CD	-	Chart Datum
DGPS	-	Differential Geo Positioning System
D/S	-	Downstream
FSL	-	Full Supply Level
FSD	-	Full Supply Depth
GTS	-	Great Trigonometric Survey
IGMC	-	Indira Gandhi Main Canal
IGNP	-	Indira Gandhi Nahar Project
LAD	-	Least Available Depth
MSL	-	Mean Sea Level
PPK	-	Post Processing Kinematics
SD	-	Sounding Datum
RTK	-	Real Time Kinematics
TBM	-	Temporary Bench Mark
TS	-	Total Station
U/S	-	Upstream

VOLUME –II: DRAWINGS

Drawing Title	Drawing Number	Sheet No.	Scale
Composite Map	TVIPL/IWAI/IGI/FD/01	01 of 01	1:300,000
Detailed Hydrographic & Topographic Survey	TVIPL/IWAI/IGI/FD/02	01 of 448	1:1,000

SALIENT FEATURES AT A GLANCE

#	Particulars	Details																																																																													
1.	Name of Consultant	Tojo Vikas International Pvt. Ltd.																																																																													
2.	Region number & State(s)	Region- IIIA State- Rajasthan																																																																													
3.	Waterway stretch, NW Number (From.... To, total length)	Waterway Stretch- Indira Gandhi Canal Waterway Name- NW- 45 Waterway Description - Bridge on NH 15 near Village Piperan Lat 29°12' 18.49"N, Long 73°53'58.09"E to near Mohangarh Lat 27°18' 37"N, Long 71°09'10"E Total Length- 373.1 km																																																																													
4.	<u>Navigability status</u>	Minimal dredging is required in IG Canal so Navigability of this waterway on behalf of dredging/Depth has quite possible. But all locks need to be modified for navigation. Modifications of all bridges are also required for navigation purpose.																																																																													
a)	Tidal & non tidal portions	Non Tidal																																																																													
b)	LAD status (Observed)																																																																														
	i) Survey period																																																																														
	ii) < 1.2 m (km)																																																																														
	iii) 1.2 m to 1.4 m (km)																																																																														
	iv) 1.5 m to 1.7 m (km)																																																																														
	v) 1.8 m to 2.0 m (km)																																																																														
	vi) > 2.0 m (km)																																																																														
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c) Cross structures	Dams- Not Present
i) Dams, weirs, barrages etc. (total number; with navigation locks or not)	Weirs- Not Present Barrages- Not Present
ii) Bridges, Power cables etc. [total number; range of horizontal and vertical clearances]	Navigational Lock- Not Present Locks- 11 Nos. Bridges- 77 Nos. Vertical Clearance- 0.61 m to 2.3 m Horizontal Clearance – 5 m to 10.5 m Power Cable- 109 Vertical Clearance- 7 m to 20 m
d) Avg. discharge & no. of days	138 Cu.m/Sec
e) Slope	Average bed Slope- 1:12000
5. <u>Traffic potential</u>	Not Available
a) Present IWT operations, ferry services, tourism, cargo, if any	Not Present
b) Important industries within 50 km	Not Present
c) Distance of Rail & Road from Industry	Not Applicable
6. Consultant's recommendation for going ahead with TEF / DPR preparation	Recommendation for not going ahead with TEF/ DPR Preparation.
7. Any other information/ comment	

Date:

(Signature)
Name of Consultant

1. INTRODUCTION

1.1 Name of Canal – Indira Gandhi Canal

1.2 Length of Canal – 650 KM

1.3 Background Information, Historical Information, Origin, End

Indira Gandhi canal

Country	India
Source	Harike barrage
Location	Punjab
Average Discharge	138 m ³ /s (4,873 cu ft/s)
End	Jaisalmer

The Indira Gandhi Canal is one of the biggest canal projects in India.

It starts from the Harike Barrage at Sultanpur, a few kilometers below the confluence of the Sutlej and Beas rivers in Punjab state.

Irrigation facilities to the north-western region of Rajasthan, a part of the Thar Desert. It consists of the Rajasthan feeder canal (with the first 167 km in Punjab and Haryana and the remaining 37 km in Rajasthan) and 445 km of the Rajasthan main canal which is entirely within Rajasthan.

The idea of bringing the waters from the Himalayan Rivers flowing through Punjab and into Pakistan was conceived by an hydraulic engineer, Kanwar Sain in the late 1940s who proposed that 2,000,000 ha (20,000 km²) of desert land in Bikaner and the northwest corner of Jaisalmer could be brought under irrigation from the stored waters of Punjab rivers. The project construction commenced in the year **1958**. Though the project is only partially complete it has shown remarkable success. In **1960**, Indus Water Treaty was signed between India and Pakistan which gave India the right to use waters of three rivers – Satluj, Beas and Ravi. The proposed Rajasthan Canal envisaged use of 7.6 million acre feet of water. The initial plan was to build the canal in two stages, Stage I consisting of 204 km (127 mi) feeder canal from Harike barrage in Punjab. Stage I also included constructing distributary canal system of about 2,950 km (1,830 mi) in length. The stage II involved construction of 256 km (159 mi) long main canal and distributary canal network of 3,600 km (2,200 mi). It was planned that the main canal will be 140 ft (43 m) wide at the top and 116 ft (35 m) wide at the bottom with water depth of 21 ft (6.4 m). The canal was scheduled to be completed by **1971**.

The stage I could not be completed in time due to severe financial constraints, neglect and corruption. In 1970 the plan was revised and it was decided that the entire canal will be lined with concrete tiles. Five more lift schemes were added. Flow command of stage II was increased by 100,000 ha (1,000 km²). With increased requirements, the total length of main, feeder and distribution canals was about 9,245 km (5,745 mi). The stage I was completed in **1983** around 20 years behind the completion schedule.

IGNP Stage II comprises construction of a 256 km long main canal and 5,606 km of a lined distribution system, and will serve 1,410 kha of CCA (873577 ha area in flow and 537018 ha under lift), utilizing 4,930 Mm³/yr. of water. The main canal in the entire length was completed in the year **1986**.

After the construction of the Indira Gandhi Canal, irrigation facilities were available over an area of 6770 km² in Jaisalmer district and 37 km² in Barmer district. Irrigation had already been provided in an area of 3670 km² in Jaisalmer district. The canal has transformed the barren deserts of this district into rich and lush fields. Crops of mustard, cotton, and wheat now flourish in this semi-arid north-western region replacing the sand there previously.

Besides providing water for agriculture, the canal will supply drinking water to hundreds of people in far-flung areas.

As the second stage of work on the canal progresses rapidly, there is hope that it will enhance the living standards of the people of the state.

The Indira Gandhi Canal is a major step in reclaiming the Thar Desert and checking desertification of fertile areas. There is a planting programme for greening the desert in areas near the Indira Gandhi Canal which was started in 1965. This consists of the planting of shelter belts along roads and canals, blocks of plantations and sand dune stabilization. The tree species being used for planting are Dalbergiasissoo, Eucalyptus tereticornis, Eucalyptus camaldulensis, Morus alba, Tecomellaundulata, Acacia tortilis, Azadirachtaindica, Albizialebbeck, Cassia fistula, Populusciliata, Meliaazedarach, and Vachellianilotica.

The excessive irrigation and intensification of agriculture over the years has caused environmental degradation and creation of new wastelands. There have been problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. These factors produced a rise in the water table, increased salinity and finally submergence of the land. These problems have been exacerbated by the cultivation of water intensive cash crops.

Indira Gandhi main Canal ends at Mohangarh Form this point a new branch is being taken out which is 90 Kms of length in Jaisalmer district and has Irrigation facilities were created in 15.73 lakh hectares by the end of March, 2009. The canal running throughout the year except essential closure some time.

1.3 State/ District through which Canal passes – Indira Gandhi Canal passes through three States naming Punjab, Haryana and Rajasthan. It enters into Haryana from Punjab near Lohgarh village of Haryana, then running in western part of district Sirsa it enters into Rajasthan near Kharakhera village (Tehsil:Tibbi, district:-Hanumangarh) of Rajasthan. The IGNP traverses seven districts of Rajasthan: Barmer, Bikaner, Churu, Hanumangarh, Jaisalmer, Jodhpur, and Sriganganagar.

1.4 Map of Canal and Survey Area-

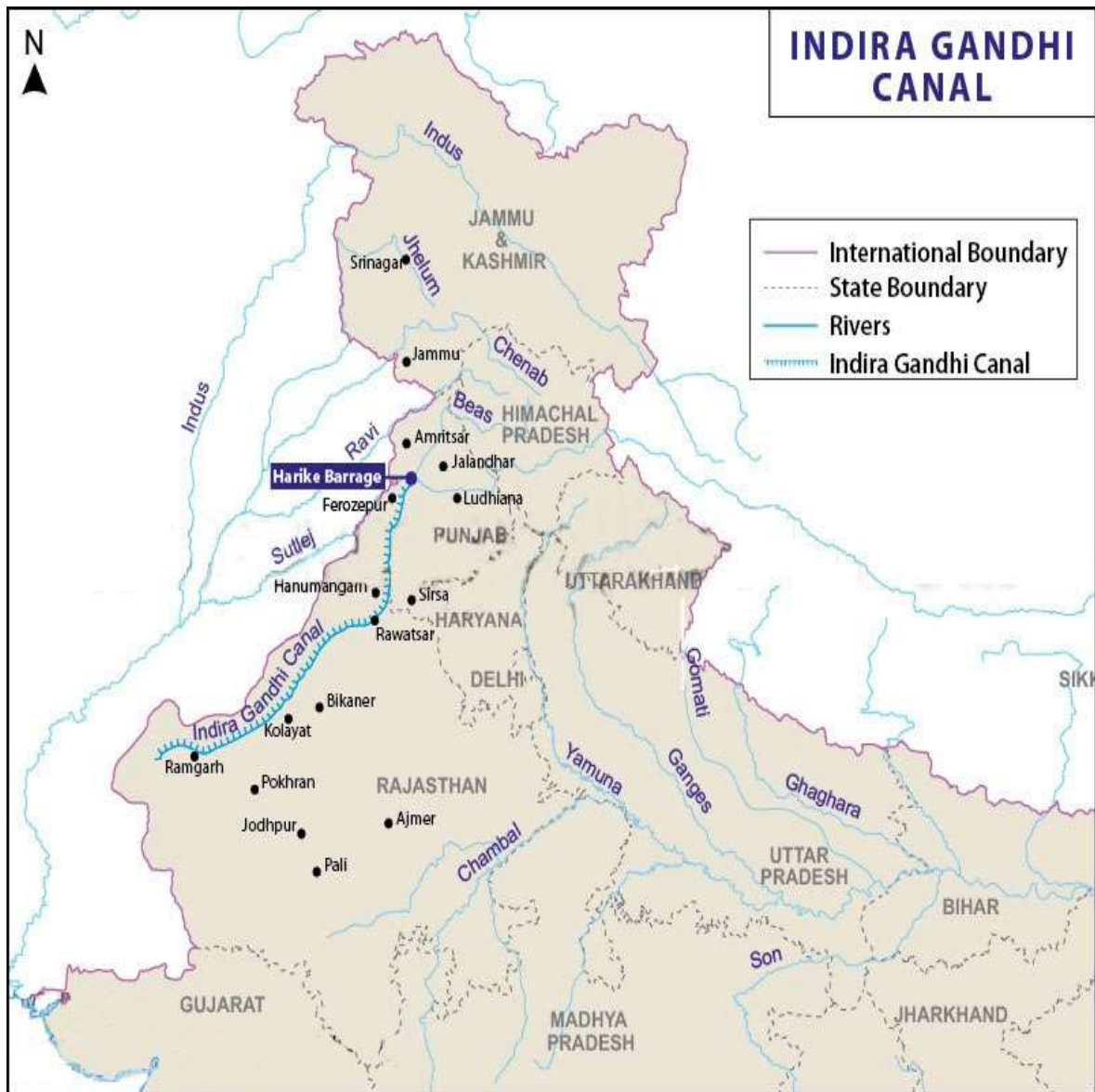


Figure 1 – Map of Canal

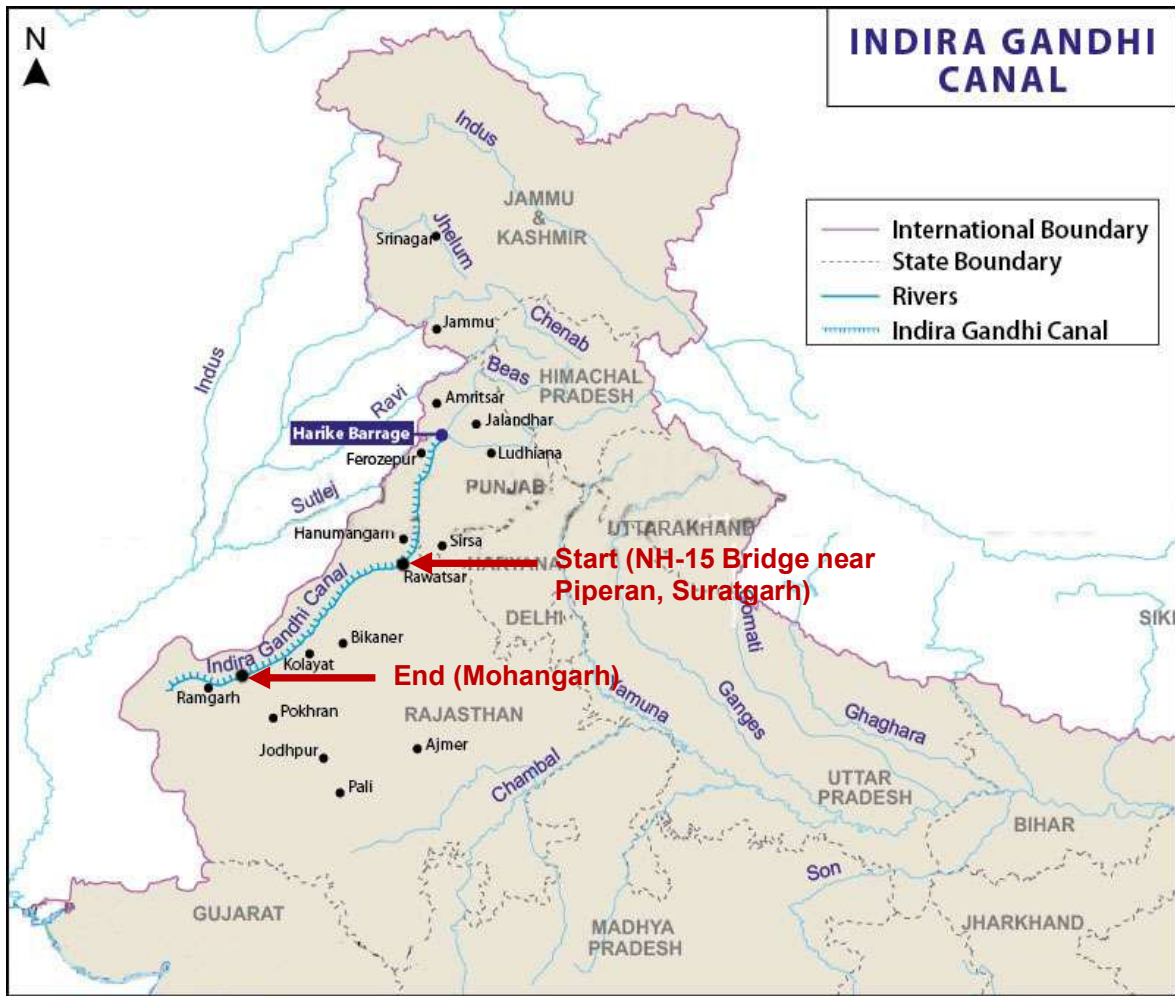


Figure 2 – Map of Survey Area

1.6 Scope of Work

- a) The detailed Hydrographic Survey to assess the Navigability of the canal.
- b) Estimate the Dredging Quantity for developing a Navigational Canal for Depths less than 2.0m, 1.5m and 1.0m (Stretch-wise).
- c) Topographical Survey to assess the extent of land acquisition for 100m Wide corridor and to locate the permanent structure within the corridor.
- d) Construction of BMs at every 10 km and connecting the same with nearest GTS.
- e) Measurement of Speed and Direction of Canal Water.
- f) Collection and analysis of the Water and bottom samples at every 10 km interval along the canal.
- g) To carry out tidal observation during the survey period.
- h) To prepare feasibility report
- i) Collection of Topographical Features

2. METHODOLOGY ADOPTED

2.1 Survey by Tojo Vikas International Pvt. Ltd.

Tojo Vikas International Pvt. Ltd conducted a Bathymetric and Topographic Survey in stretch of about 373.1 KM of Indira Gandhi Canal from NH-15 near Piperan Village to Mohangarh.

The survey was carried out from 08 Jan, 2016 and completed on 12 March, 2016.

The water depths encountered in the survey area varied from 0.6 m to 6.4 m. The boat had to be physically lifted to carry out survey wherever lock present in between the canal.

2.2 Methodology to be elaborated

2.2.1 Topographic Survey

The topographic survey was conducted to ascertain following in the survey area:-

- Spot levels
- High bank Line
- Fixing of bridges and marks
- Assess the type of canal bank
- Collection of local information along the Canal Banks

The spot levels along the Canal were obtained by using RTK and Electronic Total station. Local terrain and limitation of line of sight visibility prohibited the use of optical techniques for obtaining spot levels. GPS control was extended using the co-ordinates and height of the recovered from gauge Bridhwal Head, to various BMs in the respective stretches. These BMs were then used as reference stations for deriving the spot levels of the rover locations in the Stop-Go method and Electronic Total Station. The data was post processed using Sokkia Spectrum Survey office software to get the correct position and height values of the rover locations visited during the day. The details of all spot levels are provided in the respective sheets being presented along-with this report. Additionally, a soft copy of the same in XYZ format is being handed over as deliverable data.

2.2.2 Bathymetry Survey

Bathy-500 DF 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 fed to the HYPACK data logging software for acquisition of survey data in real time. The performance of the echo sounder was found to be satisfactory during the entire duration of the survey.

Sound velocity set on the echo sounder was 1529 meters per second. The echo sounder transducer was mounted on the side of the boat, in all cases. The DGPS Receiver Antenna was mounted exactly above the transducer without any offset to ensure accuracy in the position of soundings. The bar-checks were carried out before/after each sounding session. On all such occasions the error observed was zero or near zero. Therefore, no corrections were necessary.

The sounding lines were run perpendicular to the orientation of river flow (i.e. perpendicular to the orientation of depth contours) in respective stretches. To check the validity of sounding data logged by normal lines, Cross lines were run on an opportunistic basis wherever feasible.

2.2.3 Equipment

Table 1 – Equipment Used

Equipment	Make	Qty. Deployed
Echo Sounder	Bathy 500 DF	1
DGNSS (Attached with Eco Sounder for Position)	C-Nav 1010	1
Tide Gauge	Manual (Pole type)	4
Grab Sampler	Van Veen	1
Bar Check Plate	Manual	1
Current Meter	River flow meter (Roorkee make)	1
DGPS Sets (TS Survey)	Sokkia GRX1	4
Auto Level	Leica	1
Software	HYPACK data acquisition	1
Software	AUTOCAD	1
Software	Microsoft Office	1
Software	Spectrum Survey office v.8	1

2.2.4 Calibration

Echo Sounder – Eco Sounder was calibrated on field every day evening and morning with the help of bar check plate. Bar check plate was lowered in water from 1 m, 2m.....and so on to maximum depth. Value of depth in Eco Sounder on every meter was checked and to be corrected with the help of **Sound velocity** adjustment. The same procedure was followed up to maximum depth reaches.

C-Nav 1010 DGNSS- No need of Calibration.

Grab Sampler- Van Veen Grab Sampler was used for collecting Silt Samples from Ravi River. Calibration was not needed for Grab Sampler.

Current Meter- The equipment's used for the survey was calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Cup Type Magnetic Current Meter Strd. (S. No. 1225) and it was calibrated from Hydraulic Research Station, Malikpur (Pathankot) under Irrigation and Power Research Institute, Department of Irrigation under Government of Punjab, PWD (I.B.)

DGPS- DGPS equipment's used for the survey was also calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Sokkia GRX1.

Auto Level- Auto Level equipment used for the survey was also calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Leica made Current Meter.

No Need of Calibration for other equipment and Software's.

Currently the equipment calibration certificates are placed at **Annexure-9** of this report.

2.3 Description of Bench Marks

The Bench Marks and Vertical Controls of the survey area for Hydrography survey is based on the datum level erected on gauge of Biradhwal lock (187.834 m from MSL) in Indira Gandhi Canal. MSL was the vertical datum used for deducing the heights for spot levels obtained as part of the topographic survey.



Figure 3 – Value of Biradhwal Gauge used for BM and Control Points



Figure 4 – Value of Biradhwal Gauge used for BM and Control Points

2.4 Methodology to fix Chart Datum / Sounding Datum in Tidal and Non-Tidal area

As per the discussion with IWAI officials for fixing of Chart Datum/ Sounding Datum, Full Supply Level (FSL) has to be taken as chart Datum/ Sounding Datum for Whole Canal. FSL is given in **Table-3** Data Collected from Indira Gandhi Nahar Project.

Table 2 – Data Collected from Indira Gandhi Nahar Project

Important data related to Indira Gandhi Feeder and Indira Gandhi Main Canal								
Reach	Discharge in cusec	Chainage (Km)	Bed Level (m) w.r.t MSL		FSD (m)		FSL (m) w.r.t MSL	
			US	DS	US	DS	US	DS
RD NO. (IGMC)								
243.00	15726.00	2.198	180.080	180.080	6.401	6.401	186.481	186.481
415.00	12605	54.734	175.720	175.720	6.401	6.401	182.121	182.121
507.00	11175	82.820	173.400	173.400	6.370	6.370	179.770	179.770
620.00	9947	117.022	170.563	170.594	6.370	6.340	176.933	176.933
750.00	9385.95	157.023	167.369	167.369	6.248	6.248	173.617	173.617
860.00	7686.76	190.461	164.605	164.848	6.248	6.005	170.853	170.853
960.00	6714	221.664	162.257	162.775	6.005	5.486	168.262	168.262
1121.00	6166	270.420	158.859	158.859	5.334	5.334	164.193	164.193
1254.00	5291.11	310.716	155.472	155.472	5.334	5.334	160.806	160.806
1365.00	5291.11	344.390	152.729	152.729	5.273	5.273	158.002	158.002
1458.5			150.290		5.060		155.350	

2.5 Yearly minimum and maximum Water Levels

Table 3 – Yearly Minimum and Maximum Water Levels of IGC at U/S

RD NO. (IGMC)	Minimum Water Level (m)							Maximum Water Level (m)						
	2010	2011	2012	2013	2014	2015	2016	2010	2011	2012	2013	2014	2015	2016
243	4.13	5.66	3.92	3.86	4.65	5.84	5.95	6.90	6.62	6.62	6.62	6.62	5.95	5.97
415	0.00	0.00	0.00	0.00	3.83	0.00	0.00	5.57	5.78	5.72	5.74	5.63	0.00	0.00
507	3.76	4.66	2.51	3.95	4.14	3.18	5.52	6.96	6.08	6.07	6.94	6.93	6.87	6.28
620	0.00	4.79	3.52	5.85	4.41	3.70	2.57	6.06	6.07	6.07	6.49	6.85	6.47	6.42
750	0.00	4.79	5.30	5.53	4.40	4.72	3.55	6.16	6.07	6.16	6.16	6.16	6.16	6.16
860	4.38	5.07	3.14	5.07	3.59	2.45	4.50	6.71	6.71	6.71	6.71	6.71	6.27	6.57
960	3.23	0.00	4.63	4.97	2.24	1.33	5.20	6.82	6.71	6.71	6.71	6.71	6.01	5.99
1121	3.47	4.04	4.26	4.09	4.52	2.63	4.59	6.24	6.27	6.25	6.24	6.23	6.18	5.29
1254	2.48	3.44	1.47	2.01	2.33	2.01	3.60	6.10	6.10	6.10	6.02	6.02	5.39	5.35
1365	2.63	4.27	1.96	1.84	2.75	1.99	2.19	6.22	6.22	6.25	6.25	6.24	5.76	5.35
1458.5	2.61	3.12	2.30	0.00	3.69	1.07	1.77	6.17	5.99	6.00	0.00	6.00	5.39	5.35

2.6 Transfer of Sounding Datum table for tidal rivers / canals

Canal is Non Tidal so there is no need to transfer of sounding datum for tidal river.

2.7 Table indicating tidal variation at different observation points

Canal is Non Tidal so there is no need of indicating tidal variation at different observation points.

2.8 Salient features of Dam, Barrages, Weirs, Anicut, Locks, Aqueducts

Table 4 – Design Data of Indira Gandhi Canal

Reach	Discharge in cusec	Velocity	Bed width	Side	Bed	Bed width
RD		in Ft/sec	in Ft.	Slope	Slope	in M.
243.0 IGMC	15726	4.85	99	2:1	1:12000	30.18
415.0 IGMC	12605	4.83	62.3	2:1	1:12000	18.99
507.0 IGMC	11175	4.72	60	2:1	1:12000	18.29
620.0 IGMC	9947	4.62	52	2:1	1:12000	15.85
750.0 IGMC	9385.95	4.50	50	2:1	1:12000	15.24
860.0 IGMC	7686.76	4.359	41	2:1	1:12000	12.50
960.0 IGMC	6714	4.07	40	2:1	1:12000	12.19
1121.0 IGMC	6166	4.134	40	2:1	1:12000	12.19
1254.0 IGMC	5291.11	4.07	34	2:1	1:12000	10.36
1365.0 IGMC	5291.11	3.98	34	2:1	1:12000	10.36
1458.5 IGMC TAIL						

Table 5 – Lock Details on Indira Gandhi Canal

SI No	Structure Name	Location	Chainage (km)	Position (Lat mN, Long mE)		Position (UTM)		Sill Level (m)	FSL (m)	Minimum width at entrance (m)	No.of Gates
				Left Bank	Right Bank	Left Bank	Right Bank				
1	Lock Gate	Biradhwal Head RD 243	2.20	29°11'43.2844" 73°52' 48.6433"	29°11'44.0484" 73°52'48.0772"	391131.537 3230148.783	391116.474 3230172.443	180.707	186.481	5.00	4
2	Lock Gate	Harinagar RD 415	54.73	28°57'47.7323" 73°26' 39.6492"	28°57'48.3041" 73°26' 38.8273"	348415.989 3204911.699	348393.971 3204929.592	175.720	182.121	5.00	4
3	Lock Gate	RD 507 Head	82.82	28°46'57.7451" 73°15' 38.6667"	28°46'58.0469" 73°15' 37.6718"	330226.638 3185152.589	330202.258 3185162.408	173.400	179.770	4.50	4
4	Lock Gate	Kharola RD 620 Head	117.02	28°34'16.9381" 73°2'26.4840"	28°34'17.6957" 73°2'25.9635"	308360.973 3162066.260	308347.211 3162089.814	170.563	176.933	4.88	4
5	Lock Gate	Amarpura RD 750 Head	157.02	28°16'56.7764" 72°49'39.8805"	28°16'57.0641" 72°49'38.9111"	286946.551 3130403.344	286923.254 3130413.637	167.369	173.617	4.00	4
6	Lock Gate	RD860 Head	190.46	28°4'45.8774" 72°36'23.2492"	28°4'46.2046" 72°36'22.5672"	264795.300 3108312.444	264776.876 3108322.886	164.605	170.853	4.00	3
7	Lock Gate	Sharanwala Branch RD 961 Head	221.66	27°53'20.0242" 72°23'3.4785"	27°53'20.4093" 72°23'2.9798"	242503.773 3087645.443	242490.383 3087657.590	164.918	168.262	4.00	3
8	Lock Gate	MaddasarHead RD1121	270.42	27°38'50.8282" 72°1'49.9527"	27°38'50.8224" 72°1'49.2249"	206995.583 3061675.223	207015.542 3061674.923	158.859	164.193	5.00	3
9	Lock Gate	RD1254 Head	310.72	27°26'46.9780" 71°38'35.3571"	27°26'48.2482" 71°38'35.3544"	761251.363 3038656.588	761250.457 3038695.692	155.472	160.806	4.50	3
10	Lock Gate	RD 1365 Head	344.39	27°25'50.1543" 71°23'0.4772"	27°25'50.6064" 71°23'0.1463"	735608.032 3036387.852	735598.677 3036401.598	152.729	158.002	4.50	3
11	Lock Gate	RD1458 Head	373.10	27°18'37.0190" 71°9'9.4461"	27°18'37.6825" 71°9'10.2318"	713012.903 3022639.186	713034.151 3022659.982		155.350	5.00	2

Note- Photos of all locks are present in annexure- 13 Field Photographs.

2.9 Description of Bench Marks

The Bench Marks of the survey area for Hydrography survey is based on the datum level erected on gauge of Biradhwal lock on Indira Gandhi Canal. Canal has divided into 38 stretches for ease of applying water level corrections to the collected bathymetric data as detailed in Table-6. Tide poles were set up along the canal stretches, for the duration of survey. The tide poles remained vertical during the course of survey and no shift was observed in the poles for the duration of survey. The value of water gauge at Biradhwal lock at Indira Gandhi Canal was used to transfer of datum (MSL) to the BMs. New bench Mark Pillars (Naming as IG) were constructed and erected along the canal stretches, from NH-15 near Piperan Village to Mohangarh. The value of these bench marks w.r.t. MSL was obtained by RTK method from Gauge level at Biradhwal lock. The final coordinates of these Bench Marks are shown in Table -6.

Table 6 – Final BM Coordinates

Sr. No.	Station	Chainage (KM)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Ellipsoidal Height (m)	Height above MSL (m)	Height w.r.t SD (m)
1	IG 01	0.311	29°12' 10.706"	73°53' 50.9249"	392821.513	3230976.885	139.036	186.028	0.609
2	IG 02	10.29	29°9' 59.4212"	73°48' 26.8861"	384029.707	3227021.494	135.071	182.161	3.490
3	IG 03	20.303	29°7' 47.4286"	73°43' 2.6243"	375225.341	3223050.969	134.419	181.592	3.229
4	IG 04	30.441	29°5' 52.1611"	73°37' 31.0953"	366224.175	3219604.122	137.049	184.384	-0.393
5	IG 05	40.392	29°2' 41.7962"	73°32' 51.53"	358594.109	3213835.197	132.419	179.899	3.262
6	IG 06	50.687	28°59' 21.1881"	73°28' 23.4659"	351263.488	3207751.758	135.391	182.761	-0.430
7	IG 07	60.571	28°56' 16.4621"	73°23' 39.8844"	343511.528	3202167.280	136.843	184.371	-3.101
8	IG 08	70.766	28°52' 8.2156"	73°19' 38.4851"	336867.156	3194616.263	127.219	174.753	5.680
9	IG 09	80.806	28°47' 58.6428"	73°16' 6.3257"	331006.471	3187016.338	130.567	178.149	1.623
10	IG 10	90.537	28°43' 41.3286"	73°12' 53.126"	325649.172	3179173.064	129.602	177.263	1.671
11	IG 11	100.989	28°39' 9.3415"	73°9' 42.9969"	320361.339	3170879.031	134.634	182.25	-4.146
12	IG 12	111.181	28°35' 37.4679"	73°5' 28.4957"	313346.640	3164465.313	136.414	183.969	-6.694
13	IG 13	121.159	28°32' 15.9219"	73°1' 34.3145"	306881.892	3158364.252	124.830	172.443	4.484
14	IG 14	131.152	28°27' 44.7266"	72°58' 29.7949"	301725.043	3150099.527	128.538	176.079	0.019
15	IG 15	141.386	28°24' 7.816"	72°54' 6.2617"	294439.401	3143545.108	126.701	174.193	1.076
16	IG 16	151.414	28°19' 11.6267"	72°51' 48.737"	290534.398	3134492.955	122.948	170.357	4.083
17	IG 17	161.613	28°14' 44.7096"	72°48' 21.7297"	284746.049	3126377.146	121.465	168.818	4.793
18	IG 18	171.642	28°10' 3.0632"	72°45' 27.4618"	279834.870	3117793.767	122.102	169.385	3.399
19	IG 19	181.817	28°8' 13.8559"	72°39' 42.7122"	270364.773	3114609.292	122.972	170.262	1.695
20	IG 20	191.857	28°4' 3.3171"	72°36' 5.0522"	264272.600	3107011.953	119.970	167.299	3.551
21	IG 21	201.958	28°0' 22.1987"	72°31' 56.0459"	257334.689	3100340.318	123.620	170.877	-0.858
22	IG 22	212.156	27°56' 52.3594"	72°27' 13.9265"	249491.011	3094038.295	117.175	164.452	4.737
23	IG 23	222.205	27°53' 4.0438"	72°22' 53.3212"	242215.386	3087159.366	120.032	167.162	1.097
24	IG 24	232.11	27°49' 22.4587"	72°18' 50.3128"	235417.743	3080480.928	117.348	164.345	3.079
25	IG 25	242.885	27°46' 6.913"	72°13' 56.3354"	227234.690	3074638.894	115.723	162.657	3.933
26	IG 26	252.404	27°43' 37.7716"	72°9' 5.7588"	219169.799	3070228.484	122.074	168.868	-3.113
27	IG 27	262.497	27°42' 41.6158"	72°3' 25.4037"	209802.629	3068718.767	119.200	165.943	-1.022
28	IG 28	272.66	27°37' 41.0641"	72°1' 33.4601"	206511.521	3059537.564	120.415	166.958	-2.772
29	IG 29	282.379	27°34' 26.4899"	71°56' 59.0938"	791233.219	3053488.587	120.290	166.779	-3.433
30	IG 30	292.952	27°31' 26.3026"	71°51' 37.7865"	782545.168	3047733.343	127.557	173.997	-11.492
31	IG 31	302.577	27°29' 6.7831"	71°46' 31.0058"	774220.195	3043246.058	111.544	158.032	3.633
32	IG 32	313.085	27°27' 20.396"	71°40' 42.7596"	764728.575	3039760.413	112.281	158.897	1.902
33	IG 33	323.109	27°25' 40.9042"	71°35' 5.2456"	755522.615	3036500.962	121.028	167.777	-7.786
34	IG 34	333.176	27°25' 44.9691"	71°29' 17.5004"	745967.458	3036431.172	102.804	149.786	9.373
35	IG 35	343.001	27°26' 10.9774"	71°23' 45.2462"	736825.385	3037052.507	109.255	156.45	1.560
36	IG 36	353.435	27°22' 25.1053"	71°19' 10.6003"	729411.578	3029956.407	101.708	149.004	8.064
37	IG 37	363.509	27°19' 59.7195"	71°14' 8.1903"	721181.409	3025329.222	113.429	160.952	-4.807
38	IG 38	373.089	27°18' 33.9237"	71°9' 7.2383"	712953.844	3022542.860	107.066	154.836	0.514

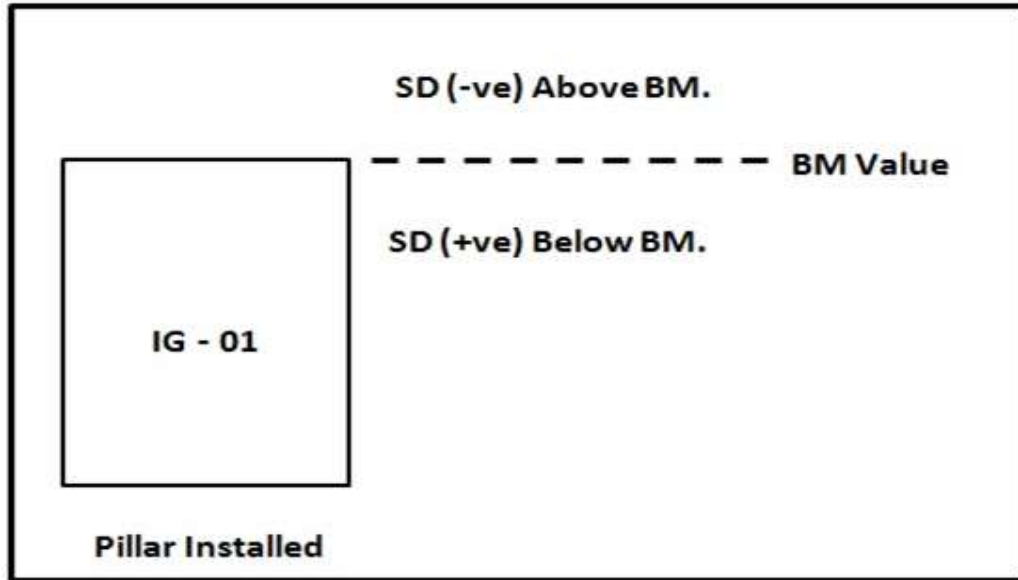


Figure 5 - Height of Bench Mark (BM) w.r.t sounding Datum (SD)

Note: - Height of Bench Mark (BM) w.r.t. sounding Datum (SD) indicates

- A) Positive value indicate that BM value below SD value
- B) Negative value indicate that BM value above SD Value

Station description of all bench marks (BM) in Indira Gandhi Canal is placed at **Annexure- 7** of this report.

MSL was the vertical datum used for deducing the heights for spot levels obtained as part of the topographic survey.

2.10 Description of erected Tide Gauges

Table 7 – Description of erected tide Gauges

Tide Gauge No	Location	Chainage (km)	Easting	Northing	Zero of the Tide Gauge w.r.t. MSL (m)	Period of observation
1	RD 243 US	2.10	29°11'44.55"N	73°52'51.81"E	186.490	01-Mar-16
2	RD 243 DS	2.20	29°11'43.18"N	73°52'48.35"E	184.020	01-Mar-16
3	D/S OF RD 243	12.20	29° 9'30.90"N	73°47'25.20"E	183.170	01-Mar-16
4	D/S OF RD 243	12.20	29° 9'30.90"N	73°47'25.20"E	182.460	02-Mar-16
5	D/S OF RD 309	22.20	29° 7'59.04"N	73°41'53.74"E	181.630	02-Mar-16
6	D/S OF RD 341	32.20	29° 5'35.16"N	73°36'29.62"E	180.800	02-Mar-16
7	D/S OF RD 341	32.20	29° 5'35.16"N	73°36'29.62"E	181.850	03-Mar-16
8	D/S OF RD 374	42.20	29° 2'31.46"N	73°31'49.00"E	181.110	03-Mar-16
9	D/S OF RD 407	52.20	28°58'42.27"N	73°27'48.93"E	180.740	03-Mar-16
1	RD 415 US	54.70	28°57'48.46"N	73°26'40.33"E	180.630	03-Mar-16

Tide Gauge No	Location	Chainage (km)	Easting	Northing	Zero of the Tide Gauge w.r.t. MSL (m)	Period of observation
11	RD 415 DS	54.90	28°57'43.47"N	73°26'35.83"E	180.310	04-Mar-16
12	RD 449	64.90	28°54'36.51"N	73°21'50.83"E	179.420	04-Mar-16
13	RD 449	64.90	28°54'36.51"N	73°21'50.83"E	179.870	21-Mar-16
14	RD 481	74.90	28°50'40.70"N	73°17'45.58"E	179.650	21-Mar-16
15	RD 507 US	82.80	28°46'58.50"N	73°15'37.77"E	179.550	21-Mar-16
16	RD 507 DS	82.90	28°46'55.22"N	73°15'37.89"E	177.870	05-Mar-16
17	RD 540	92.90	28°42'38.49"N	73°12'4.84"E	177.500	05-Mar-16
18	RD 573	102.90	28°38'14.76"N	73° 9'7.88"E	177.130	05-Mar-16
20	RD 605 DS	112.90	28°35'27.62"N	73° 4'29.83"E	176.720	21-Mar-16
21	RD 619 3 US	117.00	28°34'18.11"N	73° 2'26.84"E	176.650	21-Mar-16
22	RD 619 3 DS	117.10	28°34'15.31"N	73° 2'24.08"E	175.870	20-Mar-16
23	RD 619 3 DS	117.10	28°34'15.31"N	73° 2'24.08"E	174.640	06-Mar-16
24	RD 652 DS	127.10	28°29'20.26"N	73° 0'7.16"E	173.870	06-Mar-16
26	RD 652 DS	127.10	28°29'20.26"N	73° 0'7.16"E	175.150	20-Mar-16
27	RD 685 DS	137.10	28°26'1.36"N	72°55'34.70"E	174.470	20-Mar-16
28	RD 718 DS	147.10	28°21'28.72"N	72°52'18.41"E	173.840	20-Mar-16
29	RD 750 US	157.00	28°16'57.94"N	72°49'39.33"E	173.220	20-Mar-16
30	RD 750 DS	157.10	28°16'54.82"N	72°49'37.66"E	172.140	06-Mar-16
31	RD 783 DS	167.10	28°12'13.92"N	72°46'43.10"E	171.260	06-Mar-16
32	RD 816	177.10	28° 9'22.74"N	72°42'12.54"E	170.670	06-Mar-16
34	RD 816	177.10	28° 9'22.74"N	72°42'12.54"E	171.170	07-Mar-16
35	RD 849	187.10	28° 6'22.64"N	72°37'19.17"E	170.500	07-Mar-16
36	RD 859 US	190.40	28° 4'47.19"N	72°36'24.12"E	170.240	07-Mar-16
37	RD 859 DS	190.50	28° 4'44.68"N	72°36'21.29"E	169.300	09-Mar-16
38	RD 892	200.50	28° 0'48.35"N	72°32'40.23"E	168.590	09-Mar-16
39	RD 925	210.50	27°57'35.92"N	72°27'49.36"E	168.210	09-Mar-16
41	RD 958	220.50	27°53'44.86"N	72°23'34.99"E	168.020	09-Mar-16
42	RD 961 US	221.60	27°53'21.26"N	72°23'5.21"E	168.170	09-Mar-16
43	RD 961 DS	221.70	27°53'19.13"N	72°23'1.23"E	165.340	10-Mar-16
44	RD 994	231.70	27°49'36.03"N	72°18'56.05"E	164.790	10-Mar-16
45	RD 1027	241.70	27°46'23.88"N	72°14'34.77"E	164.400	10-Mar-16
47	RD 1060	251.70	27°43'52.96"N	72° 9'25.54"E	164.070	10-Mar-16
48	RD 1093	261.70	27°42'53.30"N	72° 3'50.97"E	163.800	10-Mar-16
49	RD 1121 US	270.40	27°38'52.08"N	72° 1'48.86"E	163.720	10-Mar-16
50	RD 1121 DS	270.50	27°38'48.47"N	72° 1'49.93"E	161.820	11-Mar-16
51	RD 1155	280.50	27°35'3.40"N	71°57'54.92"E	161.110	11-Mar-16
52	RD 1155	280.50	27°35'2.65"N	71°57'55.38"E	162.110	16-Mar-16
54	RD 1187	290.50	27°32'20.65"N	71°52'42.47"E	161.430	16-Mar-16
55	RD 1220	300.50	27°28'31.23"N	71°44'55.32"E	160.810	16-Mar-16
56	RD 1254 US	310.50	27°27'35.32"N	71°42'14.74"E	160.490	16-Mar-16
57	RD 1254 DS	310.80	27°27'36.23"N	71°42'5.34"E	159.740	17-Mar-16

Tide Gauge No	Location	Chainage (km)	Easting	Northing	Zero of the Tide Gauge w.r.t. MSL (m)	Period of observation
58	RD 1286	320.50	27°26'16.46"N	71°36'29.39"E	159.020	17-Mar-16
59	RD 1319	330.50	27°25'40.55"N	71°30'52.36"E	158.360	17-Mar-16
60	RD 1319	330.50	27°25'39.63"N	71°30'51.87"E	158.540	18-Mar-16
61	RD 1352	340.50	27°26'35.95"N	71°25'9.17"E	158.160	18-Mar-16
62	RD 1365 US	344.30	27°25'51.59"N	71°23'3.22"E	158.020	18-Mar-16
63	RD 1365 DS	344.50	27°25'48.71"N	71°22'56.43"E	156.280	18-Mar-16
64	RD 1398	354.50	27°22'17.39"N	71°18'32.28"E	155.550	18-Mar-16
65	RD 1430	364.50	27°19'35.84"N	71°13'43.42"E	154.840	18-Mar-16
66	RD 1430	364.50	27°19'36.14"N	71°13'42.36"E	154.970	19-Mar-16
67	RD 1458 US	373.00	27°18'36.61"N	71° 9'9.87"E	155.550	19-Mar-16

2.11 Establishment of Sounding Datum

For establishing sounding datum, FSL of 11 locations has used on IG canal which are mentioned below:-

As per discussion with IWAI officials, FSL (Table-2) is assumed as Sounding Datum (SD). Sounding Datum at intermediate observed gauge levels is calculated by interpolation method.

Table 8 – Chart Datum Calculation for Indira Gandhi Canal

S. No	Location	Chainage (km)	Stretch for reduction (km)	Sounding Datum 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)	FSL (m) w.r.t. MSL		
					E = (D- WL data in MSL)	F = ((D- topo levels in MSL)			
	A	B	C	D	Details at Annexure-2.	A separate xyz file is to create (not to plot).	G		
1	RD 236	0.000	--	186.663					--
2	RD 243 US	2.100	0.00 - 2.15	186.489					--
3	BIRADHWAL HEAD RD243	2.198	--	186.481					186.481
4	RD 243 DS	2.200	2.15 - 7.20	186.481					--
5	D/S OF RD 243	12.200	7.20 - 17.20	185.651					--
6	D/S OF RD 243	12.200		185.651					--
7	D/S OF RD 309	22.200	17.20 - 27.20	184.821					--
8	D/S OF RD 341	32.200	27.20 - 37.20	183.991					--
9	D/S OF RD 341	32.200		183.991					--
10	D/S OF RD 374	42.200	37.20 - 47.20	183.161					--
11	D/S OF RD 407	52.200	47.20 - 53.40	182.331					--

S. No	Location	Chainage (km)	Stretch for reduction (km)	Sounding Datum 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)	FSL (m) w.r.t. MSL
					E = (D- WL data in MSL)	F = ((D- topo levels in MSL)	
12	RD 415 US	54.700	53.40 - 54.80	182.124			--
13	HARINAGAR RD 415	54.734	--	182.121			182.121
14	RD 415 DS	54.900	54.80 - 59.90	182.107			--
15	RD 449	64.900	59.90 - 69.90	181.270			--
16	RD 449	64.900		181.270			--
17	RD 481	74.900	69.90 - 78.85	180.433			--
18	RD 507 US	82.800	78.85 - 82.85	179.772			--
19	RD 507 HEAD	82.822	--	179.770			179.770
20	RD 507 DS	82.900	82.85 - 87.90	179.764			
21	RD 540	92.900	87.90 - 97.90	178.934			
22	RD 573	102.900	97.90 - 107.90	178.104			
23	RD 605 DS	112.900	107.90 - 114.95	177.275			
24	RD 619 3 US	117.000	114.95 - 117.05	176.935			
25	KHAROLA	117.022	--	176.933			176.933
26	RD 619 3 DS	117.100	117.05 - 122.10	176.927			--
27	RD 619 3 DS	117.100		176.927			--
28	RD 652 DS	127.100	122.10 - 132.10	176.098			--
29	RD 652 DS	127.100		176.098			--
30	RD 685 DS	137.100	132.10 - 142.10	175.269			--
31	RD 718 DS	147.100	142.10 - 152.05	174.440			--
32	RD 750 US	157.000	152.05 - 157.05	173.619			--
33	AMARPURA HEAD RD 750	157.023	--	173.617			173.617
34	RD 750 DS	157.100	157.05 - 162.10	173.611			--
35	RD 783 DS	167.100	162.10 - 172.10	172.784			--
36	RD 816	177.100	172.10 - 182.10	171.957			--
37	RD 816	177.100		171.957			--
38	RD 849	187.100	182.10 - 188.75	171.131			--
39	RD 859 US	190.400	188.75 - 190.45	170.858			--
40	RD860 HEAD	190.461	--	170.853			170.853
41	RD 859 DS	190.500	190.45 - 195.50	170.850			--
42	RD 892	200.500	195.50 - 205.50	170.019			--
43	RD 925	210.500	205.50 - 215.50	169.189			--
44	RD 958	220.500	215.50 - 221.05	168.359			--
45	RD 961 US	221.600	221.05 - 221.65	168.267			--

S. No	Location	Chainage (km)	Stretch for reduction (km)	Sounding Datum 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)	FSL (m) w.r.t. MSL
					E = (D- WL data in MSL)	F = ((D- topo levels in MSL)	
46	SHARANWALA BRANCH RD 961	221.664	--	168.262			168.262
47	RD 961 DS	221.700	221.65 - 226.70	168.259			--
48	RD 994	231.700	226.70 - 236.70	167.424			--
49	RD 1027	241.700	236.70 - 246.70	166.590			--
50	RD 1060	251.700	246.70 - 256.70	165.755			--
51	RD 1093	261.700	256.70 - 266.05	164.921			--
52	RD 1121 US	270.400	266.05 - 270.45	164.195			--
53	MADDASAR HEAD RD1121	270.420	--	164.193			164.193
54	RD 1121 DS	270.500	270.45 - 275.50	164.186			--
55	RD 1155	280.500	275.50 - 285.50	163.346			--
56	RD 1155	280.500		163.346			--
57	RD 1187	290.500	285.50 - 295.50	162.505			--
58	RD 1220	300.500	295.50 - 305.50	161.665			--
59	RD 1254 US	310.500	305.50 - 310.65	160.824			--
60	RD1254	310.716	--	160.806			160.806
61	RD 1254 DS	310.800	310.65 - 315.65	160.799			--
62	RD 1286	320.500	315.65 - 325.50	159.991			--
63	RD 1319	330.500	325.50 - 335.50	159.159			--
64	RD 1319	330.500		159.159			--
65	RD 1352	340.500	335.50 - 342.40	158.326			--
66	RD 1365 US	344.300	342.40 - 344.40	158.010			--
67	HEAD 1365	344.394	--	158.002			158.002
68	RD 1365 DS	344.500	344.40 - 349.50	157.992			--
69	RD 1398	354.500	349.50 - 359.50	157.068			--
70	RD 1430	364.500	359.50 - 368.75	156.145			--
71	RD 1430	364.500		156.145			--
72	RD 1458 US	373.000	368.75 - 373.10	155.359			--
73	RD1458	373.100	--	155.350			155.350

2.12 High Flood Level (H.F.L.) and Maximum WL/Full Reservoir Level (MWL/FRL)

FSL (full Supply Level) in case of Canals and details of FSL are given in table-3.

2.13 Graph between Sounding Datum and HFL v/s Chainage

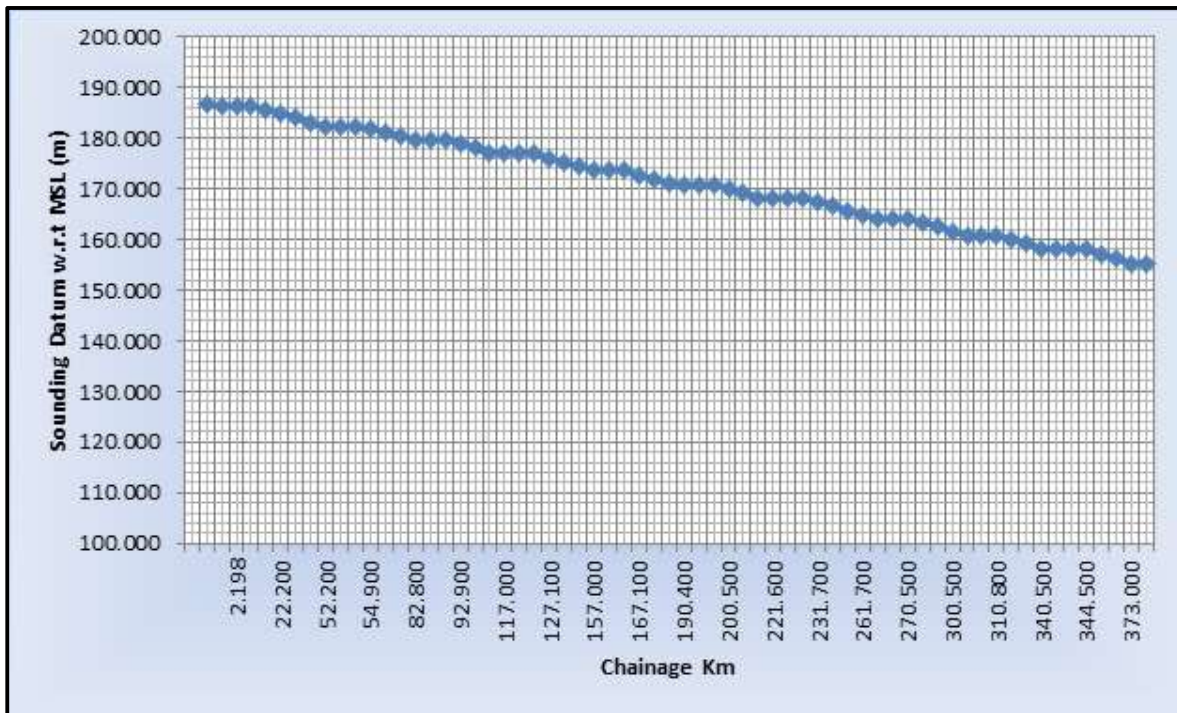


Figure 6 – Graphs between chainage and Sounding Datum (SD) in Indira Gandh Canal

Observed Water Level, Reductions and Corrected Water Levels are given in **Annexure – 3**.

2.14 Average Bed Slope

Table 9 – Average Bed Slope

Reach (km)		River / Canal Bed Level Change (m)	Distance (km)	Slope
From	To			
0.0	54.8	4.139	54.80	1:13239
54.8	82.9	2.146	28.10	1:13094
82.9	117.0	2.527	34.10	1:13494
117.0	157.0	3.024	40.00	1:13227
157.0	190.5	2.657	33.50	1:12608
190.5	221.7	2.500	31.20	1:12480
221.7	270.5	3.951	48.80	1:12351
270.5	310.8	3.222	40.30	1:12507
310.8	344.5	2.720	33.70	1:12389
344.5	373.1	2.306	28.60	1:12404

2.15 Details of Dam, Barrages, Weirs, Anicut

No Dam, Barrages, Weirs, Anicut Present in this waterway.

2.16 Details of Locks

Table 10 – Lock Details on Indira Gandhi Canal

Sl No	Structure Name	Location	Chainage (km)	Position (Lat mN, Long mE)		Position (UTM)		Sill Level (m)	FSL (m)	Minimum width at entrance (m)	No. of Gates
				Left Bank	Right Bank	Left Bank	Right Bank				
1	Lock Gate	Biradhwal Head RD 243	2.20	29°11'43.2844" 73°52' 48.6433"	29°11'44.0484" 73°52'48.0772"	391131.537 3230148.783	391116.474 3230172.443	180.707	186.481	5.00	4
2	Lock Gate	Harinagar RD 415	54.73	28°57'47.7323" 73°26' 39.6492"	28°57'48.3041" 73°26' 38.8273"	348415.989 3204911.699	348393.971 3204929.592	175.720	182.121	5.00	4
3	Lock Gate	RD 507 Head	82.82	28°46'57.7451" 73°15' 38.6667"	28°46'58.0469" 73°15' 37.6718"	330226.638 3185152.589	330202.258 3185162.408	173.400	179.770	4.50	4
4	Lock Gate	Kharola RD 620 Head	117.02	28°34'16.9381" 73°2'26.4840"	28°34'17.6957" 73°2'25.9635"	308360.973 3162066.260	308347.211 3162089.814	170.563	176.933	4.88	4
5	Lock Gate	Amarapura RD 750 Head	157.02	28°16'56.7764" 72°49'39.8805"	28°16'57.0641" 72°49'38.9111"	286946.551 3130403.344	286923.254 3130413.637	167.369	173.617	4.00	4
6	Lock Gate	RD860 Head	190.46	28°44'5.8774" 72°36'23.2492"	28°44'6.2046" 72°36'22.5672"	264795.300 3108312.444	264776.876 3108322.886	164.605	170.853	4.00	3
7	Lock Gate	Sharanwala Branch RD 961 Head	221.66	27°53'20.0242" 72°23'3.4785"	27°53'20.4093" 72°23'2.9798"	242503.773 3087645.443	242490.383 3087657.590	164.918	168.262	4.00	3
8	Lock Gate	MaddasarHead RD1121	270.42	27°38'50.8282" 72°1'49.9527"	27°38'50.8224" 72°1'49.2249"	206995.583 3061675.223	207015.542 3061674.923	158.859	164.193	5.00	3
9	Lock Gate	RD1254 Head	310.72	27°26'46.9780" 71°38'35.3571"	27°26'48.2482" 71°38'35.3544"	761251.363 3038656.588	761250.457 3038695.692	155.472	160.806	4.50	3
10	Lock Gate	RD 1365 Head	344.39	27°25'50.1543" 71°23'0.4772"	27°25'50.6064" 71°23'0.1463"	735608.032 3036387.852	735598.677 3036401.598	152.729	158.002	4.50	3
11	Lock Gate	RD1458 Head	373.10	27°18'37.0190" 71°9'9.4461"	27°18'37.6825" 71°9'10.2318"	713012.903 3022639.186	713034.151 3022659.982	155.350	155.350	5.00	2

2.17 Details of Aqueducts

No Aqueduct Present in this stretch of waterway.

2.18 Details of Cross-structures in Indira Gandhi Canal

Table 11 – Bridges and Cross Structure in Indira Gandhi Canal

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
1	District Road Bridge	0.00	RD 236	29°12'17.1397"N 73°53'57.9292"E	29°12' 19.581"N 73°53'57.9658"E	393017.159 3231168.398	393019.162 3231261.420	75.00	11.10	6.00	9.50	1.35
2	Lock Road Bridge	2.20	RD 243	29°11'43.2844"N 73°52'48.6433"E	29°11'44.0484"N 73°52'48.0772"E	391131.537 3230148.783	391116.474 3230172.443	25.00	4.00	5.00	5.0	1.45
3	Village Road Bridge	5.11	RD 253	29°11' 7.7943"N 73°51' 8.6958"E	29°11' 9.6342"N 73°51' 7.9289"E	388421.555 3229082.469	388401.392 3229139.303	60.00	5.45	6.00	8.00	1.14
4	Village Road Bridge	10.25	RD 270	29°10' 1.4247"N 73°48'27.8352"E	29°10'3.2863"N 73°48'6.9458"E	384053.278 3227083.464	384032.527 3227140.444	60.00	4.80	6.00	8.00	0.91

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
5	District Road Bridge	15.62	RD 287	29°8' 28.7295"N 73°45'41.8569"E	29°8' 30.4583"N 73°45'40.7747"E	379542.001 3224276.109	379513.316 3224329.629	60.00	7.00	4.00	10.50	1.00
6	Village Road Bridge	20.32	RD 302	29°7' 50.8925"N 73°43' 2.2177"E	29°7' 52.8648"N 73°43' 2.248"E	375215.514 3223157.706	375216.995 3223218.404	61.00	5.00	6.00	8.00	1.17
7	Village Road Bridge	24.23	RD 315	29°7' 40.7301"N 73°40' 41.844"E	29°7' 42.5776"N 73°40'41.1237"E	371418.386 3222886.885	371399.560 3222943.969	60.00	5.90	6.00	8.00	0.72
8	Village Road Bridge	28.90	RD 330	29°6' 26.6556"N 73°38'13.1404"E	29°6' 27.8415"N 73°38'11.3833"E	367373.114 3220652.671	367326.039 3220689.724	60.00	4.40	6.00	8.00	0.80
9	Village Road Bridge	34.30	RD 348	29°4' 43.0232"N 73°35'41.7712"E	29°4' 44.385"N 73°35'40.4992"E	363243.304 3217510.880	363209.408 3217553.208	55.00	7.00	5.00	8.00	1.77
10	Village Road Bridge	38.81	RD 363	29°3' 13.7296"N 73°33'36.2863"E	29°3'14.7254"N 73°33'34.5754"E	359816.692 3214803.296	359770.795 3214834.511	55.00	6.00	5.00	8.00	0.61
11	Village Road Bridge	42.450	RD 375	29°2' 28.4997"N 73°31'40.3448"E	29°2' 30.2481"N 73°31'39.8265"E	356663.549 3213449.780	356650.200 3213503.771	55.00	5.00	5.00	8.00	2.44
12	Village Road Bridge	47.20	RD 390	29°0' 56.0625"N 73°29'28.0539"E	29°0' 57.5801"N 73°29'26.9706"E	353048.756 3210649.651	353020.044 3210696.737	55.00	5.00	5.00	8.00	2.34
13	District Road Bridge	49.79	RD 399	28°59'47.6951"N 73°28'38.2057"E	28°59'48.3971"N 73°28'36.2896"E	351672.910 3208562.528	351622.278 3208587.033	55.00	8.00	4.00	10.00	1.05
14	Lock Road Bridge	54.73	RD 415	28°57'47.7323"N 73°26'39.6492"E	28°57'48.3041"N 73°26'38.8273"E	348415.989 3204911.699	348393.971 3204929.592	28.00	4.00	3.00	7.00	1.62
15	Village Road Bridge	58.68	RD 428	28°56'45.2064"N 73°24'35.6943"E	28°56'46.9427"N 73°24'35.2794"E	345034.596 3203031.676	345024.080 3203085.271	55.00	5.50	4.00	10.00	0.86
16	Village Road Bridge	63.81	RD 445	28°55' 1.4401"N 73°22'19.0546"E	28°55' 2.8826"N 73°22'17.8498"E	341291.113 3199887.864	341259.093 3199932.717	55.00	5.00	4.00	10.00	0.86
17	Village Road Bridge	70.08	RD 465	28°52' 25.7398"N 73°19' 54.6867"E	28°52' 27.0719"N 73°19' 53.3155"E	337313.734 3195149.509	337277.160 3195191.036	55.00	5.00	4.00	10.00	1.29
18	Village Road Bridge	76.66	RD 487	28°49' 45.3114"N 73°17' 32.8804"E	28°49' 46.0937"N 73°17' 31.0388"E	333400.505 3190265.860	333350.933 3190290.658	55.00	5.00	4.00	10.00	1.60
19	Lock Road Bridge	82.82	RD 507	28°46' 57.7451"N 73°15' 38.6667"E	28°46' 58.0469"N 73°15' 37.6718"E	330226.638 3185152.589	330202.258 3185162.408	26.00	3.00	3.00	6.50	1.39
20	Village Road Bridge	88.90	RD 528	28°44' 28.4784"N 73°13' 21.5191"E	28°44' 29.4601"N 73°13' 19.8532"E	326441.218 3180612.924	326396.471 3180643.817	54.00	5.00	4.00	10.00	0.66

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
21	Village Road Bridge	94.78	RD 546	28°41' 56.2232"N 73°11' 17.6376"E	28°41' 57.7439"N 73°11' 16.5571"E	323009.090 3175976.768	322980.476 3176024.024	55.00	6.00	4.00	10.00	0.90
22	District Road Bridge	98.76	RD 559	28°40' 21.1427"N 73°9' 47.2438"E	28°40' 21.6067"N 73°9' 45.2915"E	320510.655 3173087.473	320457.873 3173102.571	55.00	8.00	4.00	10.00	1.23
23	Village Road Bridge	103.23	RD 572	28°38'3.8773"N 73°9'8.0370"E	28°38'4.0232"N 73°9'6.0468"E	319380.905 3168878.529	319326.923 3168883.855	55.00	5.50	4.00	10.00	0.78
24	District Road Bridge	107.80	RD 587	28°36'22.4023"N 73°7'22.3068"E	28°36'24.1274"N 73°7'21.8130"E	316460.445 3165799.603	316447.865 3165852.916	55.00	9.00	4.00	10.00	1.49
25	Village Road Bridge	112.48	RD 604	28°35'35.8172"N 73°4'42.2659"E	28°35'37.3844"N 73°4'41.1667"E	312089.809 3164434.604	312060.720 3164483.326	55.00	7.00	4.00	10.00	1.24
26	Lock Road Bridge	117.02	RD 620	28°34'16.9381"N 73°2'26.4840"E	28°34'17.6957"N 73°2'25.9635"E	308360.973 3162066.260	308347.211 3162089.814	28.00	4.00	3.00	6.00	1.09
27	Village Road Bridge	124.61	RD 644	28°30'32.1061"N 73°0'50.0412"E	28°30'32.8845"N 73°0'48.3488"E	305624.417 3155187.708	305579.830 3155213.057	51.00	5.50	4.00	9.00	2.05
28	Village Road Bridge	131.96	RD 668	28°27'26.9258"N 72°58'7.1569"E	28°27'28.1410"N 72°58'5.8267"E	301099.943 3149561.950	301064.388 3149599.972	52.00	5.60	4.00	9.00	1.23
29	Village Road Bridge	136.57	RD 682	28°26'14.3198"N 72°55'48.2252"E	28°26'15.3761"N 72°55'46.7083"E	297281.802 3147391.340	297241.086 3147424.569	52.50	7.50	4.00	9.00	1.35
30	Village Road Bridge	141.15	RD 698	28°24'15.7882"N 72°54'7.0709"E	28°24'16.5319"N 72°54'5.3104"E	294465.704 3143790.144	294418.184 3143813.872	53.00	3.50	4.00	9.00	0.94
31	Village Road Bridge	144.76	RD 710	28°22'35.5799"N 72°52'58.9740"E	28°22'36.0562"N 72°52'58.0225"E	292557.933 3140737.758	292532.285 3140752.875	30.00	4.00	2.00	10.00	1.20
32	Village Road Bridge	151.21	RD 731	28°19'18.9123"N 72°51'46.0454"E	28°19'19.1239"N 72°51'44.0958"E	290465.046 3134718.537	290412.055 3134725.990	53.00	4.00	4.00	10.00	0.88
33	Lock Road Bridge	157.02	RD 750	28°16'56.7764"N 72°49'39.8805"E	28°16'57.0641"N 72°49'38.9111"E	286946.551 3130403.344	286923.254 3130413.637	25.00	4.00	3.00	6.00	1.06
34	Village Road Bridge	161.20	RD 763	28°14'55.5516"N 72°48'31.6781"E	28°14'56.7309"N 72°48'30.2440"E	285023.294 3126706.002	284984.857 3126743.013	53.00	7.00	4.00	9.00	1.10
35	Village Road Bridge	168.09	RD 786	28°11'44.8580"N 72°46'28.9888"E	28°11'45.5158"N 72°46'27.3083"E	281570.900 3120896.580	281525.436 3120917.670	50.00	4.00	4.00	10.00	1.69
36	Village Road Bridge	172.44	RD 801	28°9'58.7349"N 72°44'58.4703"E	28°10'0.3973"N 72°44'57.8652"E	279038.435 3117677.447	279024.890 3117723.870	48.00	5.00	4.00	9.00	0.77

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
1.81	Village Road Bridge	178.24	RD 820	28°9'13.0910"N 72°41'32.5114"E	28°9'14.5960"N 72°41'32.1186"E	273395.820 3116375.557	273385.984 3116422.093	47.00	5.00	4.00	10.00	
38	Village Road Bridge	183.44	RD 837	28°7'45.1471"N 72°38'52.6579"E	28°7'46.4048"N 72°38'51.6221"E	268981.675 3113751.848	268954.157 3113791.116	48.00	4.00	4.00	8.00	1.07
39	Village Road Bridge	187.70	RD 850	28°6'5.1881"N 72°37'10.6019"E	28°6'5.8875"N 72°37'9.0627"E	266136.061 3110728.748	266094.463 3110751.104	48.00	4.00	4.00	8.00	2.19
40	Lock Road Bridge	190.46	RD 860	28°4'45.8774"N 72°36'23.2492"E	28°4'46.2046"N 72°36'22.5672"E	264795.300 3108312.444	264776.876 3108322.886	21.00	4.00	2.00	7.00	1.14
41	Village Road Bridge	194.98	RD 873	28°2'33.2884"N 72°35'16.5312"E	28°2'33.8563"N 72°35'14.9215"E	262892.664 3104266.483	262849.043 3104284.837	47.00	4.00	4.00	8.00	1.10
42	Village Road Bridge	198.83	RD 886	28°1'12.0071"N 72°33'35.7471"E	28°1'13.2937"N 72°33'34.8573"E	260089.649 3101818.932	260066.134 3101859.029	46.00	4.00	4.00	8.00	0.82
43	Village Road Bridge	205.77	RD 910	27°59'15.4849"N 72°30'1.4933"E	27°59'16.6767"N 72°30'0.3850"E	254162.482 3098350.133	254132.945 3098387.447	47.00	4.00	4.00	8.00	0.95
44	Village Road Bridge	212.25	RD 931	27°56'52.2541"N 72°27'9.4905"E	27°56'53.4067"N 72°27'8.3274"E	249369.662 3094037.585	249338.603 3094073.734	47.00	7.00	4.00	8.00	1.37
45	Village Road Bridge	216.29	RD 944	27°55'23.7807"N 72°25'20.6716"E	27°55'24.8237"N 72°25'19.3828"E	246337.062 3091376.052	246302.496 3091408.907	47.00	4.00	4.00	8.00	1.22
46	Lock Road Bridge	221.66	RD 961	27°53'20.0242"N 72°23'3.4785"E	27°53'20.4093"N 72°23'2.9798"E	242503.773 3087645.443	242490.383 3087657.590	18.00	4.00	2.00	6.00	1.28
47	Village Road Bridge	227.21	RD 980	27°51'4.3431"N 72°20'54.2713"E	27°51'5.2594"N 72°20'52.3251"E	238878.721 3083544.012	238826.072 3083573.377	60.00	4.00	6.00	7.00	1.13
48	Village Road Bridge	232.76	RD 997	27°49'11.6338"N 72°18'28.9615"E	27°49'12.8394"N 72°18'28.0925"E	234825.970 3080160.452	234802.997 3080198.094	44.00	4.00	4.00	7.50	1.08
49	Village Road Bridge	239.77	RD 1020	27°46'25.7477"N 72°15'45.5248"E	27°46'27.0594"N 72°15'44.9497"E	230238.081 3075151.829	230223.229 3075192.569	44.00	4.00	4.00	8.00	0.69
50	Village Road Bridge	246.10	RD 1041	27°45'38.9705"N 72°12'4.6934"E	27°45'39.9935"N 72°12'3.6257"E	224157.406 3073847.783	224128.879 3073879.946	42.00	5.00	4.00	8.00	0.97
51	Village Road Bridge	251.10	RD 1058	27°43'59.5273"N 72°9'45.8608"E	27°44'0.9334"N 72°9'45.3340"E	220284.025 3070872.987	220270.589 3070916.616	45.00	7.00	4.00	6.00	1.34
52	Village Road Bridge	257.93	RD 1080	27°43'43.2787"N 72°5'55.9562"E	27°43'44.5261"N 72°5'55.1864"E	213973.211 3070519.571	213953.023 3070558.479	44.00	4.50	4.00	8.00	0.95

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
53	Village Road Bridge	262.32	RD 1095	27°42'46.6699"N 72°3'29.5029"E	27°42'48.0278"N 72°3'29.0469"E	209918.684 3068871.715	209907.187 3068913.826	44.00	5.00	4.00	8.00	1.21
54	Lock Road Bridge	270.42	RD 1121	27°38'50.8282"N 72°1'49.9527"E	27°38'50.8224"N 72°1'49.2249"E	206995.583 3061675.223	207015.542 3061674.923	20.00	5.00	2.00	6.00	1.22
55	Village Road Bridge	276.11	RD 1140	27°36'32.0721"N 71°59'59.1269"E	27°36'33.3856"N 71°59'58.4425"E	796079.418 3057474.516	796059.662 3057514.505	45.00	4.50	4.00	7.50	1.86
56	Village Road Bridge	280.30	RD 1154	27°35'5.5106"N 71°58'1.9060"E	27°35'6.7502"N 71°58'1.0920"E	792904.668 3054769.013	792927.919 3054731.377	45.00	4.50	4.00	7.00	1.48
57	Village Road Bridge	284.59	RD 1168	27°33'58.4429"N 71°55'45.0577"E	27°33'59.6306"N 71°55'44.1726"E	789222.179 3052576.679	789197.022 3052612.674	44.00	5.00	4.00	7.00	1.09
58	Village Road Bridge	289.78	RD 1185	27°32'33.7573"N 71°53'4.4440"E	27°32'34.8405"N 71°53'3.3410"E	784875.604 3049865.526	784844.554 3049898.173	45.00	4.50	4.00	8.00	2.13
59	Village Road Bridge	295.75	RD 1205	27°30'41.7750"N 71°50'8.2997"E	27°30'43.1068"N 71°50'7.4459"E	780095.712 3046346.318	780120.09 3046305.847	48.00	4.50	4.00	8.00	0.88
60	Village Road Bridge	301.25	RD 1223	27°29'19.9624"N 71°47'17.0183"E	27°29'21.3986"N 71°47'16.6646"E	775474.538 3043680.180	775463.833 3043724.183	45.00	4.50	4.00	7.00	0.91
61	Village Road Bridge	307.37	RD 1243	27°27'50.8468"N 71°44'4.5664"E	27°27'51.9561"N 71°44'3.4601"E	770250.660 3040818.773	770219.522 3040852.256	45.50	4.50	4.00	8.00	1.21
62	Village Road Bridge	309.79	RD 1251	27°27'35.4125"N 71°42'40.1699"E	27°27'36.7074"N 71°42'41.2860"E	767943.198 3040292.733	767972.982 3040333.272	50.00	8.00	4.00	8.00	2.46
63	Lock Road Bridge	310.72	RD 1254	27°27'35.4775"N 71°42'7.2400"E	27°27'36.0724"N 71°42'7.2181"E	767038.752 3040275.020	767037.752 3040293.323	18.00	4.50	2.00	5.50	0.98
64	Village Road Bridge	312.50	RD 1260	27°27'25.4873"N 71°41'3.5871"E	27°27'26.9525"N 71°41'3.2327"E	765297.215 3039929.521	765286.508 3039974.422	46.00	4.50	4.00	8.00	0.85
65	Village Road Bridge	310.72	RD 1274	27°26'46.9780"N 71°38'35.3571"E	27°26'48.2482"N 71°38'35.3544"E	761251.363 3038656.588	761250.457 3038695.692	40.00	4.50	4.00	7.50	0.61
66	Village Road Bridge	320.21	RD 1285	27°26' 22.0966"N 71°36' 37.9543"E	27°26'23.2089"N 71°36'36.9497"E	758037.093 3037830.916	758014.462 3037856.04	34.00	4.50	4.00	7.50	0.66
67	Village Road Bridge	323.14	RD 1295	27°25'42.8568"N 71°35'2.8160"E	27°25'44.1037"N 71°35'2.0750"E	755454.620 3036559.690	755433.467 3036597.657	43.50	4.50	4.00	7.50	0.74
68	Village Road Bridge	332.21	RD 1325	27°25'33.5919"N 71°29'50.8302"E	27°25'35.0494"N 71°29'50.9722"E	746890.044 3036099.285	746893.042 3036144.233	45.00	4.50	4.00	7.00	1.54

S. No.	Structure Name	Chainage (Km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t FSL (m)
				Left Bank	Right Bank	Left Bank	Right Bank					
69	Village Road Bridge	336.15	RD 1338	27°26'15.3906"N 71°27'43.4723"E	27°26'16.8255"N 71°27'43.3617"E	743366.024 3037316.263	743362.11 3037360.377	45.00	4.50	4.00	7.50	1.73
70	Village Road Bridge	341.73	RD 1356	27°26'31.4457"N 71°24'24.8845"E	27°26'32.8259"N 71°24'24.3351"E	737901.908 3037703.646	737885.994 3037745.844	45.00	4.50	4.00	6.50	0.90
71	Lock Road Bridge	344.39	RD 1365	27°25'50.1543"N 71°23'0.4772"E	27°25'50.6064"N 71°23'0.1463"E	735608.032 3036387.852	735598.677 3036401.598	17.00	4.50	2.00	5.00	2.53
72	Village Road Bridge	349.37	RD 1380	27°23'55.4465"N 71°20'57.1535"E	27°23'56.7008"N 71°20'56.4110"E	732287.323 3032792.286	732266.195 3032830.511	44.00	4.50	4.00	7.00	1.07
73	Village Road Bridge	356.85	RD 1405	27°21'35.8530"N 71°17'24.1358"E	27°21'36.9701"N 71°17'23.2619"E	726513.693 3028386.166	726489.042 3028420.110	42.00	4.50	4.00	7.00	2.24
74	Village Road Bridge	360.31	RD 1416	27°20'47.9289"N 71°15'40.2443"E	27°20'49.3516"N 71°15'40.3306"E	723685.095 3026858.821	723686.672 3026902.658	44.00	4.50	4.00	7.00	0.62
75	Village Road Bridge	363.91	RD 1428	27°19'51.0391"N 71°13'57.0631"E	27°19'51.9393"N 71°13'55.8648"E	720880.297 3025056.550	720846.86 3025083.668	43.00	5.50	4.00	7.00	1.39
76	Village Road Bridge	367.26	RD 1439	27°18'39.3299"N 71°12'29.0720"E	27°18'40.6944"N 71°12'28.7040"E	718500.424 3022806.197	718489.565 3022848.019	44.00	4.50	4.00	7.00	1.90
77	Lock Road Bridge	373.10	RD 1458	27°18'37.0190"N 71°9'9.4461"E	27°18'37.6825"N 71°9'10.2318"E	713012.903 3022639.186	713034.151 3022659.982	25.00	5.00	3.00	8.00	1.32

2.19 Details of other Cross structures, pipe-lines, underwater

There are no cross structures other than Locks, Road Bridges, Power Cable and High Tension Line.

2.20 Details of High Tension Lines / Electric lines / Tele-communication lines

Table 12 – High Tension Lines / Electric lines / Tele-communication lines

S. No.	Features Name	Position (Lat, Long)		Position (UTM)		Chainage (Km)	Vertical Clearance w.r.t FSL
		Left Bank	Right Bank	Left Bank	Right Bank		
1	Electric Line	29°12' 16.0335"N 73°53' 56.9957"E	29°12' 19.2755"N 73°53' 57.0591"E	392986.993 3231139.326	392989.642 3231239.094	0.22	10.00
2	HT Line	29°12' 16.0335"N 73°53' 56.9957"E	29°12' 19.2755"N 73°53' 57.0591"E	392986.993 3231139.326	392989.642 3231239.094	0.35	20.00
3	HT Line	29°12' 10.2444"N 73°53' 49.1643"E	29°12' 12.2623"N 73°53' 46.5147"E	392773.835 3230963.126	392702.866 3231025.908	0.37	20.00
4	Electric Line	29°12' 9.9202"N 73°53' 48.244"E	29°12' 12.0523"N 73°53' 46.2345"E	392748.887 3230953.379	392695.239 3231019.513	0.374	12.00
5	Electric Line	29°11' 41.5571"N 73°52' 47.0914"E	29°11' 42.6877"N 73°52' 44.2833"E	391089.118 3230096.017	391013.612 3230131.54	2.279	11.00
6	Electric Line	29°10' 1.175"N 73°48' 27.7377"E	29°10' 3.5611"N 73°48' 26.7192"E	384053.259 3227075.241	384026.492 3227148.965	10.248	12.00

S. No.	Features Name	Position (Lat, Long)		Position (UTM)		Chainage (Km)	Vertical Clearance w.r.t FSL
		Left Bank	Right Bank	Left Bank	Right Bank		
7	Electric Line	29°9' 9.2633"N 73°46' 49.2846"E	29°9' 12.356"N 73°46' 48.867"E	381376.964 3225504.695	381366.669 3225600.006	13.353	12.00
8	Electric Line	29°8' 30.7942"N 73°45' 46.5445"E	29°8' 32.616"N 73°45' 44.6034"E	379669.336 3224338.328	379617.475 3224394.955	15.480	10.00
9	Electric Line	29°8' 27.6814"N 73°45' 39.4187"E	29°8' 29.2242"N 73°45' 37.9391"E	379475.776 3224244.544	379436.294 3224292.452	15.690	10.00
10	Electric Line	29°8' 19.3001"N 73°45' 20.6666"E	29°8' 21.5184"N 73°45' 19.0687"E	378966.325 3223991.917	378923.868 3224060.653	16.258	8.00
11	Electric Line	29°7' 40.8472"N 73°40' 42.2474"E	29°7' 43.3374"N 73°40' 43.0476"E	371429.329 3222890.368	371451.816 3222966.773	24.195	9.00
12	Electric Line	29°6' 25.715"N 73°38' 12.2748"E	29°6' 26.8669"N 73°38' 10.5376"E	367349.38 3220623.989	367302.83 3220659.99	28.935	10.00
13	Electric Line	29°4' 39.9611"N 73°35' 38.2009"E	29°4' 41.8965"N 73°35' 37.2297"E	363145.641 3217417.777	363120.09 3217477.662	34.416	12.00
14	Electric Line	29°2' 28.1808"N 73°31' 40.1356"E	29°2' 30.4051"N 73°31' 39.4332"E	356657.767 3213440.035	356639.622 3213508.738	42.454	12.00
15	Electric Line	29°0' 56.1338"N 73°29' 28.527"E	29°0' 57.9355"N 73°29' 27.2359"E	353061.584 3210651.681	353027.362 3210707.584	47.185	12.00
16	Electric Line	28°58' 34.8895"N 73°27' 40.9074"E	28°58' 36.2582"N 73°27' 38.9342"E	350093.156 3206341.567	350040.296 3206384.39	52.519	9.00
17	Electric Line	28°58' 0.1036"N 73°26' 52.4448"E	28°58' 0.9439"N 73°26' 50.4024"E	348767.369 3205287.955	348712.422 3205314.544	54.224	8.00
18	Electric Line	28°57' 22.8631"N 73°26' 15.0345"E	28°57' 24.9951"N 73°26' 13.2383"E	347739.547 3204154.976	347691.788 3204221.243	55.742	10.50
19	Electric Line	28°57' 13.754"N 73°25' 50.1486"E	28°57' 16.0484"N 73°25' 50.1361"E	347062.11 3203883.501	347062.708 3203954.131	56.451	12.00
20	Electric Line	28°57' 6.9334"N 73°25' 30.8178"E	28°57' 8.6989"N 73°25' 29.6508"E	346535.972 3203680.508	346505.102 3203735.271	57.031	9.00
21	Electric Line	28°57' 1.5687"N 73°25' 18.3867"E	28°57' 3.6898"N 73°25' 17.4861"E	346197.218 3203519.857	346173.704 3203585.473	57.400	9.50
22	Electric Line	28°56' 44.8653"N 73°24' 35.6631"E	28°56' 47.1379"N 73°24' 35.0899"E	345033.61 3203021.186	345019.032 3203091.349	58.679	8.00
23	Electric Line	28°56' 13.2099"N 73°23' 33.4752"E	28°56' 15.4727"N 73°23' 32.1642"E	343336.624 3202069.528	343302.072 3202139.66	60.733	8.00
24	Electric Line	28°55' 29.6399"N 73°23' 3.7602"E	28°55' 31.5797"N 73°23' 1.793"E	342513.713 3200739.322	342461.253 3200799.759	62.312	10.00
25	Electric Line	28°55' 1.5418"N 73°22' 20.3058"E	28°55' 3.9676"N 73°22' 18.9513"E	341325.043 3199890.531	341289.385 3199965.703	63.762	10.00
26	Electric Line	28°54' 34.393"N 73°21' 49.5534"E	28°54' 36.3275"N 73°21' 48.1575"E	340480.634 3199066.316	340443.649 3199126.386	64.960	10.00
27	Electric Line	28°54' 18.1371"N 73°21' 31.297"E	28°54' 19.6036"N 73°21' 29.7312"E	339979.228 3198572.772	339937.442 3198618.501	65.671	11.50
28	Electric Line	28°54' 9.3176"N 73°21' 21.5851"E	28°54' 11.9305"N 73°21' 20.9191"E	339712.405 3198304.937	339695.48 3198385.618	66.023	12.00
29	Electric Line	28°52' 44.5635"N 73°20' 15.3148"E	28°52' 45.6926"N 73°20' 13.186"E	337880.763 3195721.088	337823.576 3195756.654	69.273	11.00
30	Electric Line	28°52' 24.5062"N 73°19' 53.5581"E	28°52' 26.6589"N 73°19' 52.1162"E	337282.622 3195111.967	337244.487 3195178.78	70.114	12.00
31	Electric Line	28°52' 23.8083"N 73°19' 52.7316"E	28°52' 26.5984"N 73°19' 51.7929"E	337259.927 3195090.799	337235.701 3195177.042	70.135	12.00
32	Electric Line	28°51' 57.4268"N 73°19' 19.7483"E	28°51' 59.3025"N 73°19' 18.5938"E	336354.769 3194291.333	336324.304 3194349.513	71.353	10.00
33	Electric Line	28°50' 51.773"N 73°17' 55.8538"E	28°50' 53.2338"N 73°17' 53.5627"E	334052.536 3192302.745	333991.09 3192348.599	74.462	10.00
34	Electric Line	28°49' 47.4211"N 73°17' 34.215"E	28°49' 49.4657"N 73°17' 32.4181"E	333437.614 3190330.28	333389.812 3190393.919	76.570	8.00
35	Electric Line	28°49' 24.0551"N 73°17' 12.1081"E	28°49' 25.2806"N 73°17' 10.1715"E	332828.006 3189619.655	332776.054 3189658.137	77.526	9.00

S. No.	Features Name	Position (Lat, Long)		Position (UTM)		Chainage (Km)	Vertical Clearance w.r.t FSL
		Left Bank	Right Bank	Left Bank	Right Bank		
36	Electric Line	28°48' 39.8511"N 73°16' 24.3534"E	28°48' 40.9517"N 73°16' 22.2916"E	331513.701 3188277.706	331458.297 3188312.396	79.413	10.00
37	Electric Line	28°46' 27.9579"N 73°15' 14.8415"E	28°46' 29.3288"N 73°15' 12.8542"E	329569.541 3184245.277	329516.262 3184288.266	83.962	12.00
38	Electric Line	28°45' 58.337"N 73°14' 30.1536"E	28°45' 59.8795"N 73°14' 28.616"E	328344.091 3183351.326	328303.089 3183399.424	85.473	12.00
39	Electric Line	28°45' 21.1021"N 73°14' 9.4579"E	28°45' 22.1789"N 73°14' 7.2945"E	327765.776 3182213.461	327707.583 3182247.476	86.772	12.00
40	Electric Line	28°44' 34.1093"N 73°13' 25.9968"E	28°44' 35.8795"N 73°13' 24.2574"E	326565.281 3180784.443	326518.903 3180839.639	88.669	8.00
41	Electric Line	28°44' 26.9453"N 73°13' 21.1857"E	28°44' 28.4822"N 73°13' 18.8824"E	326431.467 3180565.865	326369.686 3180614.108	88.931	11.00
42	Electric Line	28°44' 1.5262"N 73°13' 3.7212"E	28°44' 1.5573"N 73°13' 0.6851"E	325945.952 3179790.489	325863.592 3179792.679	89.875	12.00
43	Electric Line	28°43' 6.2734"N 73°12' 29.9219"E	28°43' 7.7388"N 73°12' 28.3501"E	325003.349 3178103.436	324961.375 3178149.185	91.785	12.00
44	Electric Line	28°42' 10.8739"N 73°11' 43.6806"E	28°42' 12.7198"N 73°11' 42.0928"E	323722.744 3176417.037	323680.513 3176474.509	93.938	10.00
45	Electric Line	28°41' 56.8105"N 73°11' 18.7092"E	28°41' 58.3978"N 73°11' 17.0634"E	323038.45 3175994.405	322994.524 3176043.944	94.744	10.00
46	Electric Line	28°41' 7.3777"N 73°10' 18.4171"E	28°41' 9.3115"N 73°10' 17.5684"E	321378.746 3174497.708	321356.62 3174557.587	97.004	8.00
47	Electric Line	28°40' 26.7518"N 73°9' 49.4613"E	28°40' 27.6704"N 73°9' 47.0943"E	320573.512 3173259.21	320509.688 3173288.474	98.566	9.00
48	Electric Line	28°40' 23.4925"N 73°9' 48.4302"E	28°40' 23.0126"N 73°9' 45.4184"E	320543.975 3173159.31	320461.986 3173145.797	98.695	10.00
49	Electric Line	28°40' 20.6643"N 73°9' 47.2663"E	28°40' 21.2434"N 73°9' 44.6514"E	320511.038 3173072.737	320440.324 3173091.655	98.769	12.00
50	Electric Line	28°38' 32.8987"N 73°9' 21.2606"E	28°38' 34.9807"N 73°9' 19.3803"E	319753.814 3169766.328	319703.744 3169831.205	102.220	12.00
51	Electric Line	28°37' 10.2018"N 73°8' 43.8356"E	28°37' 11.9759"N 73°8' 41.5552"E	318698.014 3167236.439	318636.921 3167292.01	105.027	12.00
52	Electric Line	28°36' 28.9776"N 73°7' 50.8294"E	28°36' 30.9599"N 73°7' 50.6208"E	317238.435 3165989.87	317233.721 3166050.978	106.987	15.00
53	Electric Line	28°35' 53.6626"N 73°6' 7.1311"E	28°35' 55.3127"N 73°6' 5.7448"E	314404.225 3164947.134	314367.369 3164998.526	110.041	14.50
54	Electric Line	28°35' 30.1228"N 73°4' 35.099"E	28°35' 30.956"N 73°4' 32.6159"E	311892.275 3164262.436	311825.221 3164289.17	112.760	11.00
55	Electric Line	28°35' 10.7478"N 73°4' 17.0691"E	28°35' 12.0168"N 73°4' 15.2985"E	311392.800 3163673.898	311345.321 3163713.739	113.522	12.50
56	Electric Line	28°34' 15.1911"N 73°2' 24.1445"E	28°34' 16.8342"N 73°2' 23.2077"E	308296.519 3162013.517	308271.888 3162064.516	117.099	12.00
57	Electric Line	28°30' 31.4899"N 73°0' 49.8488"E	28°30' 32.505"N 73°0' 47.8531"E	305619.905 3155169.448	305566.156 3155201.594	124.618	12.00
58	Electric Line	28°27' 26.9734"N 72°58' 7.6146"E	28°27' 28.5831"N 72°58' 5.8055"E	301112.42 3149563.203	301064.041 3149613.587	131.948	10.00
59	Electric Line	28°26' 18.4799"N 72°55' 52.1641"E	28°26' 20.0643"N 72°55' 50.1529"E	297391.185 3147517.558	297337.297 3147567.273	136.394	11.00
60	Electric Line	28°26' 17.0287"N 72°55' 50.6557"E	28°26' 18.3969"N 72°55' 48.3215"E	297349.372 3147473.588	297286.581 3147516.801	136.458	14.00
61	Electric Line	28°21' 21.5222"N 72°52' 17.1022"E	28°21' 23.3401"N 72°52' 15.531"E	291377.649 3138478.026	291335.851 3138534.744	147.300	12.00
62	Electric Line	28°20' 42.8542"N 72°52' 6.6052"E	28°20' 43.3887"N 72°52' 4.4189"E	291070.755 3137292.712	291011.504 3137310.217	148.551	11.50
63	Electric Line	28°19' 54.745"N 72°51' 53.8305"E	28°19' 55.1992"N 72°51' 51.2572"E	290696.631 3135817.86	290626.788 3135833.082	150.078	8.50

S. No.	Features Name	Position (Lat, Long)		Position (UTM)		Chainage (Km)	Vertical Clearance w.r.t FSL
		Left Bank	Right Bank	Left Bank	Right Bank		
64	Electric Line	28°16' 56.6344"N 72°49' 40.0458"E	28°16' 57.3556"N 72°49' 38.1961"E	286953.939 3130399.848	286903.932 3130422.958	157.022	9.00
65	Electric Line	28°16' 2.1288"N 72°49' 13.1997"E	28°16' 2.6447"N 72°49' 10.5938"E	286192.1 3128735.095	286121.361 3128752.257	158.861	10.00
66	Electric Line	28°11' 45.1844"N 72°46' 29.209"E	28°11' 45.9056"N 72°46' 27.433"E	281577.089 3120906.515	281529.06 3120929.606	168.075	10.00
67	Electric Line	28°9' 13.1178"N 72°41' 34.4281"E	28°9' 15.1626"N 72°41' 32.7077"E	273448.134 3116375.384	273402.389 3116439.226	178.198	11.00
68	Electric Line	28°9' 12.8428"N 72°41' 32.8207"E	28°9' 15.032"N 72°41' 32.3114"E	273404.116 3116367.751	273391.5 3116435.412	178.223	11.50
69	Electric Line	28°9' 11.4335"N 72°41' 26.1237"E	28°9' 13.8454"N 72°41' 27.2571"E	273220.56 3116327.842	273252.898 3116401.503	178.389	12.50
70	Electric Line	28°8' 49.7342"N 72°40' 32.353"E	28°8' 52.0622"N 72°40' 31.0972"E	271740.605 3115687.82	271707.71 3115760.146	180.059	11.00
71	Electric Line	28°8' 46.8663"N 72°40' 27.615"E	28°8' 47.9175"N 72°40' 25.1315"E	271609.627 3115602.008	271542.478 3115635.667	180.239	12.00
72	Electric Line	28°8' 25.9989"N 72°39' 55.4218"E	28°8' 27.647"N 72°39' 54.3919"E	270718.802 3114976.45	270691.673 3115027.728	181.307	8.00
73	Electric Line	28°8' 18.2659"N 72°39' 43.7193"E	28°8' 19.7394"N 72°39' 42.2929"E	270394.87 3114744.528	270356.817 3114790.642	181.711	8.00
74	Electric Line	28°8' 10.4462"N 72°39' 31.6232"E	28°8' 11.985"N 72°39' 30.3951"E	270060.13 3114510.152	270027.529 3114558.172	182.117	9.50
75	Electric Line	28°7' 54.985"N 72°39' 8.2205"E	28°7' 56.5475"N 72°39' 6.8535"E	269412.265 3114046.496	269375.889 3114095.32	182.915	10.50
76	Electric Line	28°7' 44.9053"N 72°38' 52.7627"E	28°7' 46.4953"N 72°38' 51.2963"E	268984.391 3113744.344	268945.32 3113794.069	183.440	10.00
77	Electric Line	28°7' 19.1925"N 72°38' 13.4151"E	28°7' 20.2989"N 72°38' 11.4062"E	267895.114 3112973.593	267840.948 3113008.722	184.786	10.00
78	Electric Line	28°6' 56.4459"N 72°37' 41.6982"E	28°6' 57.8551"N 72°37' 40.0425"E	267015.762 3112290.182	266971.417 3112334.447	185.895	12.50
79	Electric Line	28°6' 43.6598"N 72°37' 33.4176"E	28°6' 44.3543"N 72°37' 31.3765"E	266782.047 3111900.96	266726.752 3111923.429	186.361	12.50
80	Electric Line	28°4' 55.6053"N 72°36' 29.7385"E	28°4' 56.0515"N 72°36' 27.552"E	264978.379 3108608.441	264918.948 3108623.354	190.120	10.00
81	Electric Line	28°4' 54.3817"N 72°36' 29.1611"E	28°4' 55.3003"N 72°36' 26.9712"E	264961.873 3108571.082	264902.636 3108600.537	190.154	10.00
82	Electric Line	28°4' 24.5801"N 72°36' 12.8581"E	28°4' 25.8433"N 72°36' 11.0324"E	264498.654 3107662.361	264449.567 3107702.233	191.167	11.50
83	Electric Line	27°59' 12.3514"N 72°29' 57.8808"E	27°59' 14.2068"N 72°29' 56.7976"E	254061.776 3098255.681	254033.344 3098313.41	205.899	12.00
84	Electric Line	27°58' 37.3751"N 72°29' 12.9187"E	27°58' 38.2768"N 72°29' 10.5187"E	252810.794 3097204.095	252745.768 3097233.207	207.557	8.00
85	Electric Line	27°57' 9.5071"N 72°27' 25.6944"E	27°57' 10.0994"N 72°27' 23.8803"E	249823.737 3094559.531	249774.521 3094578.801	211.561	9.00
86	Electric Line	27°56' 51.0291"N 72°27' 7.9071"E	27°56' 51.9426"N 72°27' 6.1297"E	249325.585 3094000.767	249277.578 3094029.905	212.308	9.50
87	Electric Line	27°53' 16.7526"N 72°23' 0.8031"E	27°53' 17.5064"N 72°22' 59.1541"E	242428.432 3087546.275	242383.819 3087570.448	221.793	9.00
88	Electric Line	27°53' 13.8053"N 72°22' 57.7828"E	27°53' 14.5732"N 72°22' 56.0548"E	242343.867 3087457.3	242297.102 3087481.953	221.917	8.00
89	Electric Line	27°53' 3.9161"N 72°22' 47.6974"E	27°53' 2.9746"N 72°22' 42.6073"E	242061.451 3087158.725	241921.58 3087132.721	222.401	8.50
90	Electric Line	27°52' 35.5708"N 72°22' 21.031"E	27°52' 36.0921"N 72°22' 18.6285"E	241313.207 3086301.647	241247.82 3086319.109	223.478	10.00
91	Electric Line	27°49' 47.4142"N 72°19' 6.424"E	27°49' 49.2414"N 72°19' 5.0996"E	235875.561 3081239.641	235840.538 3081296.692	231.240	12.00

S. No.	Features Name	Position (Lat, Long)		Position (UTM)		Chainage (Km)	Vertical Clearance w.r.t FSL
		Left Bank	Right Bank	Left Bank	Right Bank		
92	Electric Line	27°49' 37.5982"N 72°18' 57.713"E	27°49' 39.3638"N 72°18' 56.684"E	235630.512 3080942.629	235603.535 3080997.606	231.622	12.00
93	Electric Line	27°45' 38.9942"N 72°12' 5.1803"E	27°45' 40.474"N 72°12' 3.5799"E	224170.76 3073848.204	224127.961 3073894.768	246.086	11.50
94	Electric Line	27°44' 54.9375"N 72°11' 12.3007"E	27°44' 54.6086"N 72°11' 9.1094"E	222691.312 3072524.725	222603.658 3072516.596	248.111	11.00
95	Electric Line	27°44' 0.14"N 72°9' 48.5522"E	27°44' 1.8161"N 72°9' 47.7553"E	220358.198 3070890.148	220337.555 3070942.261	251.028	12.00
96	Electric Line	27°43' 59.2694"N 72°9' 45.6845"E	27°44' 0.8924"N 72°9' 44.8559"E	220279.012 3070865.155	220257.462 3070915.651	251.112	14.00
97	Electric Line	27°40' 39.6723"N 72°2' 48.1401"E	27°40' 40.2962"N 72°2' 45.5685"E	208691.388 3064988.23	208621.352 3065009.13	266.648	13.00
98	Electric Line	27°39' 48.5476"N 72°2' 14.5379"E	27°39' 49.3121"N 72°2' 12.6914"E	207732.396 3063436.059	207682.337 3063460.817	268.472	9.50
99	Electric Line	27°39' 22.7656"N 72°1' 58.4227"E	27°39' 23.6038"N 72°1' 56.8558"E	207271.46 3062652.777	207229.117 3062679.623	269.377	9.00
100	Electric Line	27°38' 55.0712"N 72°1' 50.6553"E	27°38' 55.5138"N 72°1' 48.6739"E	207037.955 3061805.108	206983.952 3061820.045	270.284	9.00
101	Electric Line	27°35' 5.2963"N 71°58' 1.9446"E	27°35' 6.9825"N 71°58' 0.9206"E	792929.136 3054724.801	792899.794 3054776.05	280.303	10.00
102	Electric Line	27°30' 41.7159"N 71°50' 8.9599"E	27°30' 43.587"N 71°50' 7.6163"E	780138.258 3046304.441	780100.051 3046361.208	295.740	12.00
103	Electric Line	27°30' 34.6659"N 71°49' 55.9416"E	27°30' 36.1628"N 71°49' 54.6841"E	779785.820 3046079.195	779750.245 3046124.494	296.165	12.00
104	Electric Line	27°28' 35.8832"N 71°45' 16.3935"E	27°28' 38.0995"N 71°45' 15.8102"E	772192.542 3042249.011	772175.008 3042316.894	304.905	8.00
105	Electric Line	27°27' 35.1984"N 71°42' 40.3928"E	27°27' 37.1378"N 71°42' 42.1851"E	767949.466 3040286.273	767997.388 3040347.058	309.786	14.00
106	Electric Line	27°20' 47.7034"N 71°15' 39.7874"E	27°20' 49.4536"N 71°15' 40.0024"E	723672.663 3026851.651	723677.598 3026905.631	360.320	11.00
107	Electric Line	27°19' 50.9683"N 71°13' 57.727"E	27°19' 52.5382"N 71°13' 55.6235"E	720898.592 3025054.694	720839.899 3025101.983	363.892	7.00
108	Electric Line	27°19' 30.9008"N 71°13' 40.0356"E	27°19' 32.468"N 71°13' 37.6265"E	720423.271 3024428.291	720356.179 3024475.35	364.682	7.50
109	Electric Line	27°18' 38.8475"N 71°12' 29.6356"E	27°18' 41.1317"N 71°12' 29.0094"E	718516.188 3022791.620	718497.725 3022861.626	367.251	8.00

2.21 Current Meter Observations and Discharge Calculation

Table 13 – Current Meter and Discharge Details

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area	Discharge (Cu.m/sec)
		Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		0.3 D	0.5 D	0.9 D			
1	0.31	29°12' 11.759"	73°53' 52.3776"	392861.05	3231008.93	5.7	1.19	1.18	1.16	1.18	196.21	231.53
2	10.29	29°10' 0.5825"	73°48' 27.3623"	384042.94	3227057.108	2.9	1.52	1.5	1.48	1.5	79.48	119.22
3	20.303	29°7' 49.3798"	73°43' 5.0287"	375290.97	3223110.319	2.6	1.49	1.48	1.46	1.48	68.00	100.64
4	30.44	29°5' 54.582"	73°37' 32.4764"	366262.38	3219678.201	3.8	1.53	1.51	1.5	1.51	108.52	163.87
5	40.392	29°2' 46.9758"	73°32' 52.558"	358623.88	3213994.287	5	1.18	1.17	1.15	1.17	111.50	130.46

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area	Discharge (Cu.m/sec)
		Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		0.3 D	0.5 D	0.9 D			
6	50.686	28°59' 22.9331"	73°28' 24.7324"	351298.46	3207805.029	4.1	1.96	1.94	1.92	1.94	109.06	211.57
7	60.57	28°56' 21.9774"	73°23' 35.9151"	343406.35	3202338.509	4.2	1.83	1.82	1.81	1.82	107.88	196.34
8	70.765	28°52' 10.459"	73°19' 39.0424"	336883.23	3194685.106	4.8	1.67	1.66	1.64	1.66	127.19	211.13
9	80.806	28°48' 0.7866"	73°16' 7.1369"	331029.43	3187082.008	4.6	1.84	1.82	1.81	1.82	143.62	261.39
10	90.537	28°43' 50.8035"	73°12' 47.3356"	325496.43	3179467.079	4.4	1.94	1.92	1.91	1.92	120.87	232.06
11	100.988	28°39' 11.1459"	73°9' 41.7513"	320328.37	3170935.093	4.8	1.67	1.66	1.64	1.66	133.29	221.27
12	111.18	28°35' 46.3124"	73°5' 34.5923"	313516.62	3164734.931	4.5	1.74	1.72	1.71	1.72	132.22	227.43
13	121.159	28°32' 17.6924"	73°1' 32.2229"	306825.93	3158419.692	3.8	2	2.01	1.99	2	100.20	200.39
14	131.152	28°27' 46.1572"	72°58' 24.294"	301576.14	3150146.087	4.4	1.74	1.72	1.71	1.72	117.03	201.30
15	141.385	28°24' 10.1058"	72°54' 13.5521"	294639.07	3143612.139	4.5	1.44	1.42	1.41	1.42	99.37	141.10
16	151.413	28°19' 14.9332"	72°51' 41.8185"	290347.74	3134598.078	4.4	1.54	1.52	1.51	1.52	104.62	159.03
17	161.613	28°14' 46.9083"	72°48' 13.7998"	284531.1	3126448.753	3.4	1.55	1.54	1.5	1.53	73.26	112.09
18	171.642	28°10' 9.7398"	72°45' 27.3238"	279834.91	3117999.375	3.7	1.53	1.51	1.5	1.51	86.10	130.01
19	181.817	28°8' 16.2632"	72°39' 44.2914"	270409.3	3114682.573	3.6	1.53	1.51	1.5	1.51	88.80	134.08
20	191.857	28°4' 4.735"	72°36' 10.9483"	264434.47	3107052.432	3.6	1.53	1.51	1.5	1.51	68.96	104.13
21	201.958	28°0' 24.7811"	72°31' 59.158"	257421.33	3100418.101	3.6	1.53	1.51	1.5	1.51	83.08	125.46
22	212.155	27°56' 53.7266"	72°27' 6.7967"	249296.96	3094084.452	3.5	1.53	1.51	1.5	1.51	85.50	129.11
23	222.204	27°53' 7.4528"	72°22' 52.2661"	242188.77	3087264.941	2.8	1.52	1.5	1.48	1.5	49.96	74.95
24	232.11	27°49' 27.7341"	72°18' 45.0959"	235278.5	3080646.482	2.7	1.52	1.5	1.48	1.5	47.68	71.52
25	242.884	27°46' 11.5663"	72°14' 3.2526"	227427.36	3074777.904	2.5	1.52	1.5	1.48	1.5	52.68	79.02
26	252.403	27°43' 39.8543"	72°9' 6.7933"	219199.63	3070291.959	2.5	1.52	1.5	1.48	1.5	60.48	90.72
27	262.497	27°42' 43.3302"	72°3' 30.7014"	209949.07	3068768.088	3.1	1.49	1.48	1.46	1.48	62.90	93.08
28	272.66	27°37' 41.4721"	72°1' 23.247"	206231.72	3059556.879	2.4	1.52	1.5	1.48	1.5	51.73	77.60
29	282.378	27°34' 29.856"	71°57' 9.9461"	791129.959	3053728.754	2.6	1.52	1.5	1.48	1.5	43.27	64.90
30	292.951	27°31' 28.0095"	71°51' 43.2029"	782478.076	3047839.811	3.5	1.49	1.48	1.46	1.48	68.26	101.03
31	302.577	27°29' 9.8141"	71°46' 33.908"	774275.896	3043416.862	3.3	1.49	1.48	1.46	1.48	89.70	132.76

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area	Discharge (Cu.m/sec)
		Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		0.3 D	0.5 D	0.9 D			
32	313.084	27°27' 21.7271"	71°40' 45.1536"	764720.981	3039842.895	3.6	1.49	1.48	1.46	1.48	49.61	73.43
33	323.109	27°25' 43.2123"	71°35' 8.3465"	755421.915	3036558.253	3.6	1.49	1.48	1.46	1.48	57.49	85.08
34	333.175	27°25' 46.4629"	71°29' 9.8122"	746008.921	3036540.908	3.2	1.49	1.48	1.46	1.48	62.24	92.12
35	343.001	27°26' 13.8454"	71°23' 49.6481"	736771.889	3037158.722	3.3	1.49	1.48	1.46	1.48	72.06	106.65
36	353.434	27°22' 28.1365"	71°19' 13.3815"	729363.860	3030064.818	3.3	1.29	1.28	1.26	1.28	50.97	65.24
37	363.508	27°20' 1.5856"	71°14' 10.5485"	721087.713	3025365.208	3.6	1.29	1.28	1.26	1.28	60.54	77.49
38	373.089	27°18' 36.8035"	71°9' 8.5549"	712997.030	3022644.129	3.6	1.19	1.18	1.16	1.18	39.87	47.05

2.22 (A) Soil and Water Sample Locations

Canal bed soil and water sampling was undertaken using van-veen Grab and by deploying sampling bottles at respective locations. The samples were collected at same location in the canal stretches. Test result of Soil samples are given in **Annexure-8** and Water Samples are given in **Annexure-9**. The details of sampling locations are as follows:

Table 14 – Soil and Water Sample Locations in IG Canal

S. No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Location
1	0.310	29°12' 11.759"	73°53' 52.3776"	392861.047	3231008.930	IG Canal
2	10.290	29°10' 0.5825"	73°48' 27.3623"	384042.935	3227057.108	IG Canal
3	20.303	29°7' 49.3798"	73°43' 5.0287"	375290.974	3223110.319	IG Canal
4	30.440	29°5' 54.582"	73°37' 32.4764"	366262.381	3219678.201	IG Canal
5	40.392	29°2' 46.9758"	73°32' 52.558"	358623.877	3213994.287	IG Canal
6	50.686	28°59' 22.9331"	73°28' 24.7324"	351298.456	3207805.029	IG Canal
7	60.570	28°56' 21.9774"	73°23' 35.9151"	343406.353	3202338.509	IG Canal
8	70.765	28°52' 10.459"	73°19' 39.0424"	336883.229	3194685.106	IG Canal
9	80.806	28°48' 0.7866"	73°16' 7.1369"	331029.426	3187082.008	IG Canal
10	90.537	28°43' 50.8035"	73°12' 47.3356"	325496.433	3179467.079	IG Canal
11	100.988	28°39' 11.1459"	73°9' 41.7513"	320328.371	3170935.093	IG Canal
12	111.180	28°35' 46.3124"	73°5' 34.5923"	313516.618	3164734.931	IG Canal
13	121.159	28°32' 17.6924"	73°1' 32.2229"	306825.934	3158419.692	IG Canal
14	131.152	28°27' 46.1572"	72°58' 24.294"	301576.142	3150146.087	IG Canal

S. No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Location
15	141.385	28°24' 10.1058"	72°54' 13.5521"	294639.071	3143612.139	IG Canal
16	151.413	28°19' 14.9332"	72°51' 41.8185"	290347.735	3134598.078	IG Canal
17	161.613	28°14' 46.9083"	72°48' 13.7998"	284531.103	3126448.753	IG Canal
18	171.642	28°10' 9.7398"	72°45' 27.3238"	279834.906	3117999.375	IG Canal
19	181.817	28°8' 16.2632"	72°39' 44.2914"	270409.295	3114682.573	IG Canal
20	191.857	28°4' 4.735"	72°36' 10.9483"	264434.470	3107052.432	IG Canal
21	201.958	28°0' 24.7811"	72°31' 59.158"	257421.333	3100418.101	IG Canal
22	212.155	27°56' 53.7266"	72°27' 6.7967"	249296.958	3094084.452	IG Canal
23	222.204	27°53' 7.4528"	72°22' 52.2661"	242188.766	3087264.941	IG Canal
24	232.110	27°49' 27.7341"	72°18' 45.0959"	235278.496	3080646.482	IG Canal
25	242.884	27°46' 11.5663"	72°14' 3.2526"	227427.363	3074777.904	IG Canal
26	252.403	27°43' 39.8543"	72°9' 6.7933"	219199.629	3070291.959	IG Canal
27	262.497	27°42' 43.3302"	72°3' 30.7014"	209949.072	3068768.088	IG Canal
28	272.660	27°37' 41.4721"	72°1' 23.247"	206231.717	3059556.879	IG Canal
29	282.378	27°34' 29.856"	71°57' 9.9461"	791129.959	3053728.754	IG Canal
30	292.951	27°31' 28.0095"	71°51' 43.2029"	782478.076	3047839.811	IG Canal
31	302.577	27°29' 9.8141"	71°46' 33.908"	774275.896	3043416.862	IG Canal
32	313.084	27°27' 21.7271"	71°40' 45.1536"	764720.981	3039842.895	IG Canal
33	323.109	27°25' 43.2123"	71°35' 8.3465"	755421.915	3036558.253	IG Canal
34	333.175	27°25' 46.4629"	71°29' 9.8122"	746008.921	3036540.908	IG Canal
35	343.001	27°26' 13.8454"	71°23' 49.6481"	736771.889	3037158.722	IG Canal
36	353.434	27°22' 28.1365"	71°19' 13.3815"	729363.860	3030064.818	IG Canal
37	363.508	27°20' 1.5856"	71°14' 10.5485"	721087.713	3025365.208	IG Canal
38	373.089	27°18' 36.8035"	71°9' 8.5549"	712997.030	3022644.129	IG Canal

3. DESCRIPTION OF WATERWAY FOR INDIRA GANDHI CANAL

Hydrographic Survey was done for whole canal reach. Locks on IG canal were affecting Bathymetry Survey. Boat was pulling up at upstream of each lock and pulling down at downstream of each lock. In between two locks there were no hindrances. Only some bridges were present and height of these bridges was enough to cross survey boat. So we have divided our survey area of Indira Gandhi Canal is divided into 10 different stretches as per the design data mentioned in Table 15 and details of stretches given below from Para 3.1 to 3.10.

3.1 NH-15 Bridge near Piperan to RD 415 Head (Ch. 00.00 km – 54.80 km)

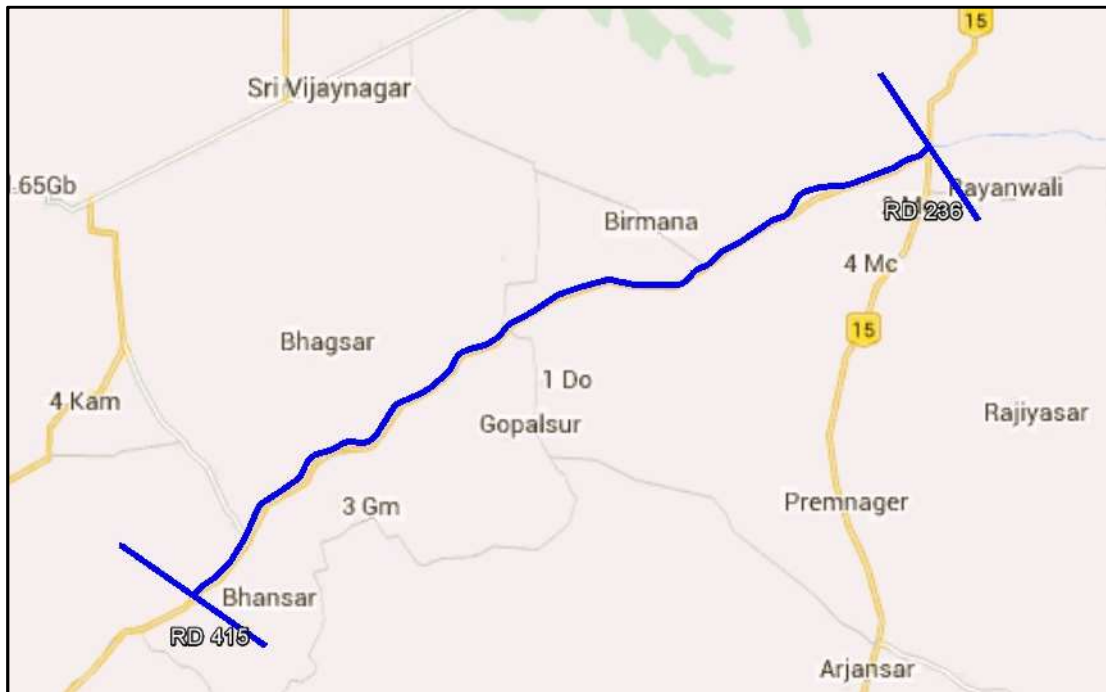


Figure 7 – NH 15 Bridge Near Piperan to RD 415 Head

Table 15 – Minimum – Maximum Depths, Bridge near Piperan to RD 415 Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	0.0	54.8	0.9	6.1	0.2	4.82	1.6	7.4	0.00	0.00
2	0.0	54.8	0.9	6.1	10.4	4125.17	1.6	7.4	0.00	0.000
3	0.0	54.8	0.9	6.1	19.2	34843.16	1.6	7.4	0.10	70.1

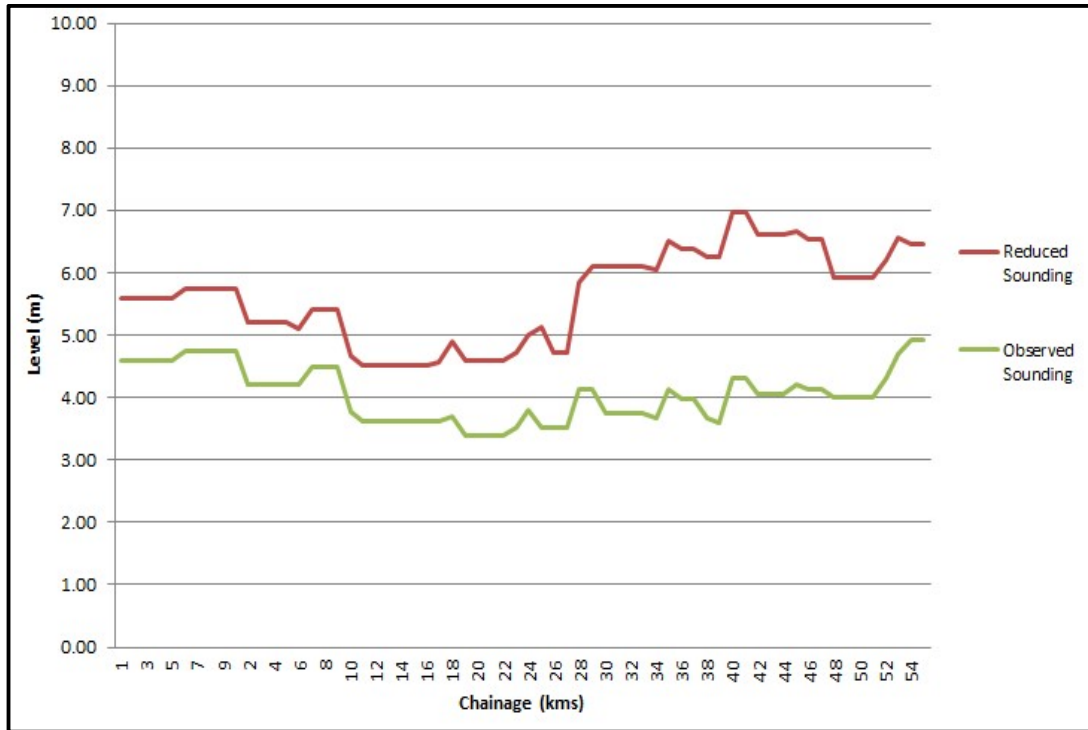


Figure 8 – Reduced and Observed BH 15 Bridge Near Pipersan to RD 415

IG Canal Originates from Harike Dam in Punjab and after travelling 277.00 KM, a Bridge on NH-15 near Piperan village encounter. It is starting point of Hydrographic survey for Tojo Vikas International Pvt. Ltd.

Main villages are Birmana, Gopalsur, Bhagsar and Bhansar. Two locks are present in this stretch of canal. Travelling 2.10 KM from starting point of survey, Biradhwai head (Lock) is present with 4 Nos. of gates. Two branches originates from main canal just before Biradhwai lock on both bank naming Anupgarh Branch on Right Bank and Lunaksar branch on left bank. Locks are present on mouth of both branches. Another lock is present at ch. 54.73 km with 4 nos. of gates. Main Villages in this stretch are Ladhana, Birmana, Gopalsur, Kharbara, Mile-80. Up to Biradhwai head there is no hindrances, in between of U/S and D/S of Biradhwai head boat was pulling up to cross the lock gates and there is no side channel for crossing of this lock. Width of Canal is 50m to 60 m in this stretch. Banks of this stretch is mainly protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. NH 15 present at Ch. 0.00 which joins Suratgarh to Bikaner. This highway is used mainly for transportation of goods by trucks from Kandla Port (Gujrat) to Rajsthan, Punjab and J&K. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops.

One railway crossing present upstream of Ch. 0.00. Piperan and Biradhwai Railway

station in vicinity of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. Suratgarh and Bikaner are prominent cities. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway.



Figure 9 – Ch: 0.00 Km NH-15 Bridge Near Piperan villlage



Figure 10 – CH: 2.20 Km Biradhwal Head



Figure 11 – Side Branch n Biradhwal Head, Lunaksar Shakha (branch CH:2.20Km)



Figure 12 – Side Branch on Biradhwal Head, Anoopgarh Shakha (brnach CH: 2.20Km)



Figure 13 – Ladhana Bridge RD 253 (Ch: 5.11Km)



Figure 14 – Electric Line (Ch: 13.36 Km)



Figure 15 – Harinagar 415 RD Head Lock (Ch: 54.73 Km)

3.2 415 RD Head to 507 RD Head (Ch. 54.80 km – 82.90km)



Figure 16 – 415 RD Head to 507 RD Head (Ch. 54.80 Km – 82.90 Km)

Table 16 – Minimum – Maximum Depths, 415 RD Head to 507 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	54.8	82.9	1.5	5.1	0.0	0.00	1.9	6.3	0.00	0.000
2	54.8	82.9	1.3	5.1	0.2	0.80	1.9	6.3	0.00	0.000
3	54.8	82.9	1.2	5.1	1.4	1590.72	1.9	6.3	0.10	28.290

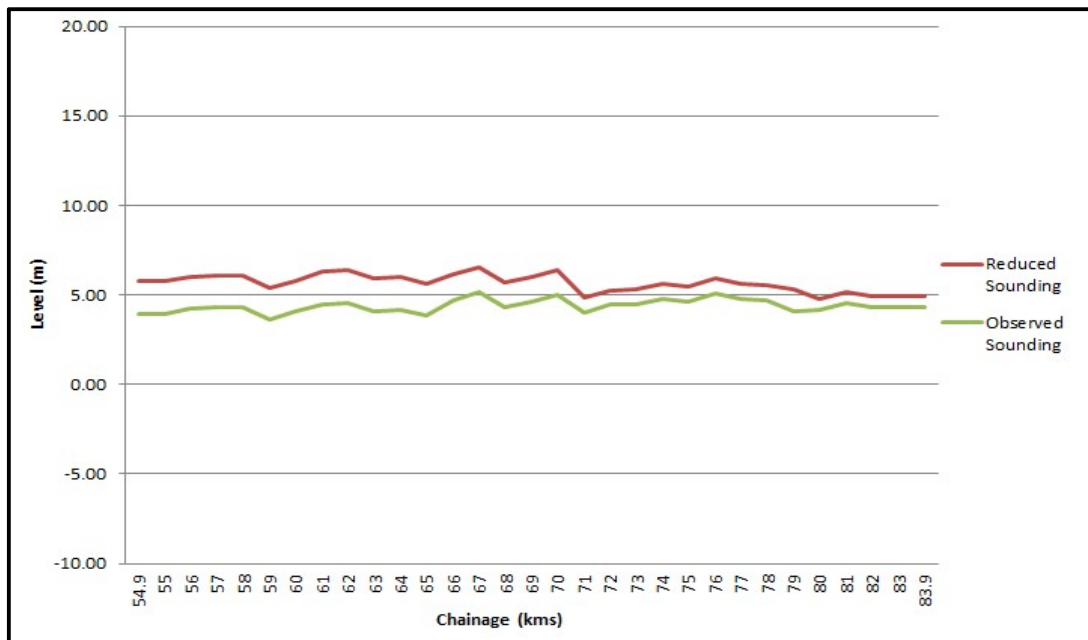


Figure 17 – Observed and Reduced Bed Profile (Ch.54.80Km – 82.90 Km)

Main Villages in this stretch are Raner and RD 465. Mahajan Field Firing Range is present in vicinity of this stretch. In between this stretch one head lock present where navigation to cross this lock is not possible because of non-availability of navigational channel. Many small branches and minors are originates from canal in this stretch. All branch and minors are used for irrigation purpose only. Width of Canal varies between 55 m to 50 m in this stretch. Bed Width of Canal varies between 30 m to 18 m. Approach roads on both banks of canal are constructed & in use. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is

present along this Stretch which is used for transportation of mainly limestone mineral and crops. No railway line and railway station in vicinity of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land within 50 m width from both bank of canal present. There are no prominent cities in this stretch of waterway. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for this stretch of Waterway for navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. One escape Canal present on right bank of canal upstream of 507 RD head and one Branch on Right bank of canal near 507 RD head.



Figure 18 – Sherpur Bridge 445 RD (Ch.63.80 Km)



Figure 19 – 507 RD Head (Ch. 82.82 Km)



Figure 20 – Escape Canal at 507 RD Head (Ch. 82.82 Km)

3.3 507 RD Head to 620 RD Head (Ch. 82.90 km – 117.10 km)



Figure 21 – 507 RD Head to 620 RD Head

Table 17 – Minimum – Maximum Depths, 507 RD Head to 620 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	82.9	117.0	1.2	5.2	0.0	0.00	2.0	6.4	0.00	0.000
2	82.9	117.0	1.2	5.2	0.3	99.47	1.9	6.4	0.00	0.000
3	82.9	117.0	1.2	5.2	2.6	2646.01	2.2	6.4	0.00	0.000

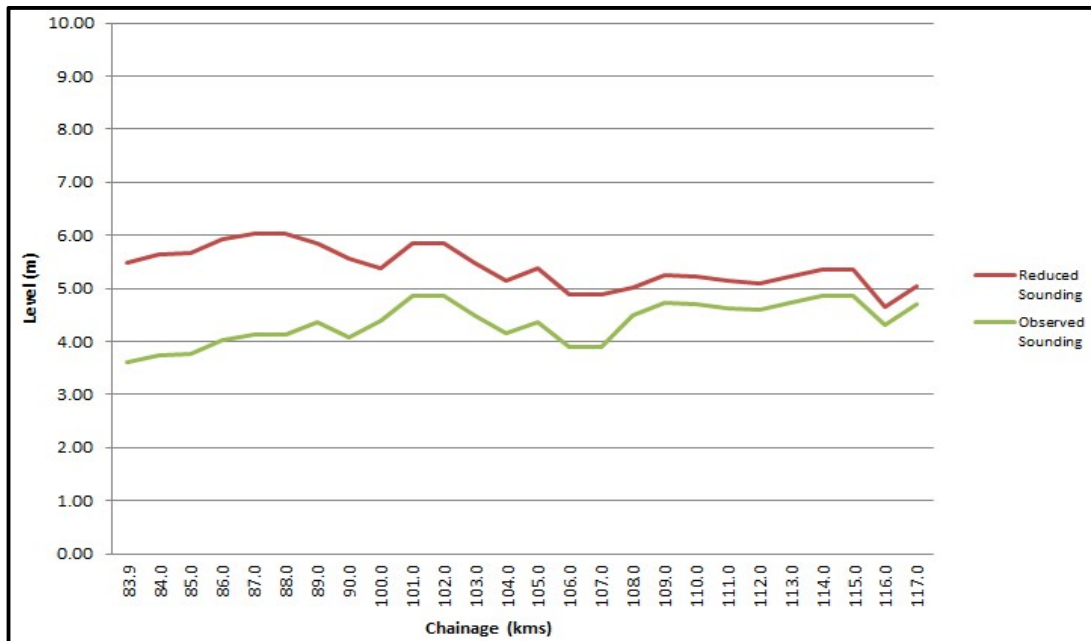


Figure 22 – Observed and Reduced Bed Profile from 507 RD Head to 620 RD Head

Main villages in this stretch are Chattargarh and Sattasar. In between this stretch one head lock is present where navigation to cross this lock is not possible because of non-availability of navigational channel. Many small branches and minors are originates from canal of this stretch. All branch and minors are used for irrigation purpose only. Width of canal varies between 50 m to 45 m this stretch. Bed width of Canal varies between 18 m to 16 m. Approach roads on both banks of canal are constructed & in use. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Bikaner railway line and Bikaner railway station in vicinity of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. Sattasar and Bikaner are prominent cities. Bikaner is the nearest railway station of this stretch. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy, clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Two Branches originates on right bank of IG Canal from upstream of 620 RD head both are used for irrigation purpose.



Figure 23 – Bridge on RD 528 (Ch.88.90 Km)



Figure 24 – Bridge on RD 550 (Ch. 96.25 Km)



Figure 25 – Bridge on RD 587 (Ch. 107.80 Km)



Figure 26 – 620 RD Head Lock and Lock Bridge (Ch. 117.02 Km)

3.4 620 RD Head to 750 RD Head (Ch. 117.10 km – 157.10 km)

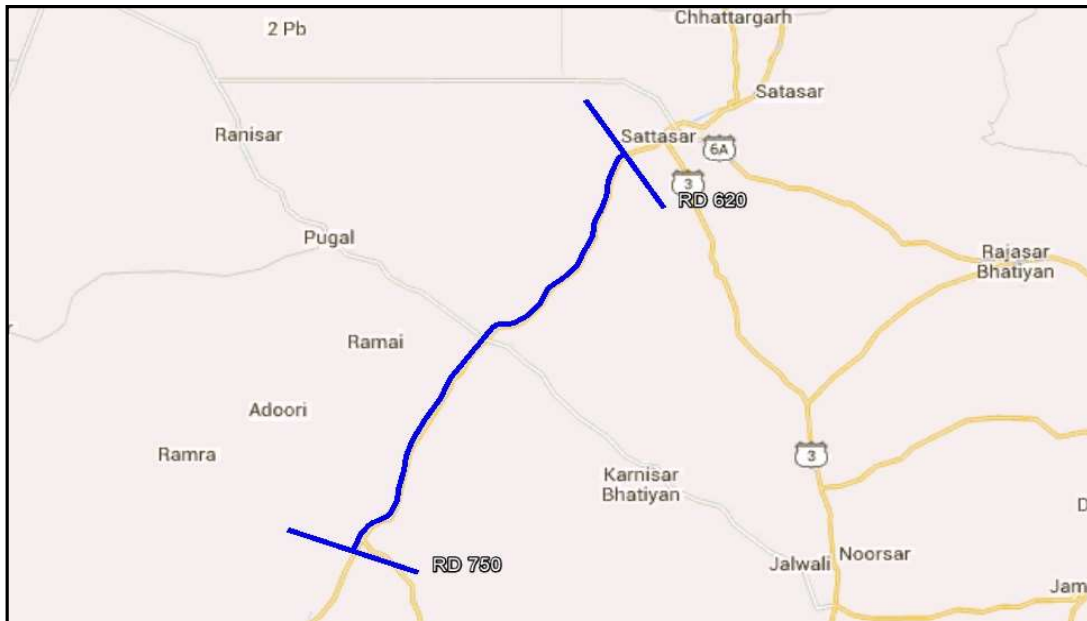


Figure 27 – 620 RD Head to 750 RD Head

Table 18 – Minimum – Maximum Depths, 620 RD Head to 750 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	117.0	157.0	1.2	5.2	0.0	0.00	1.8	6.5	0.00	0.000
2	117.0	157.0	1.2	5.2	0.5	69.72	1.8	6.5	0.00	0.000
3	117.0	157.0	1.1	5.2	3.6	2855.28	2.0	6.5	0.00	0.000

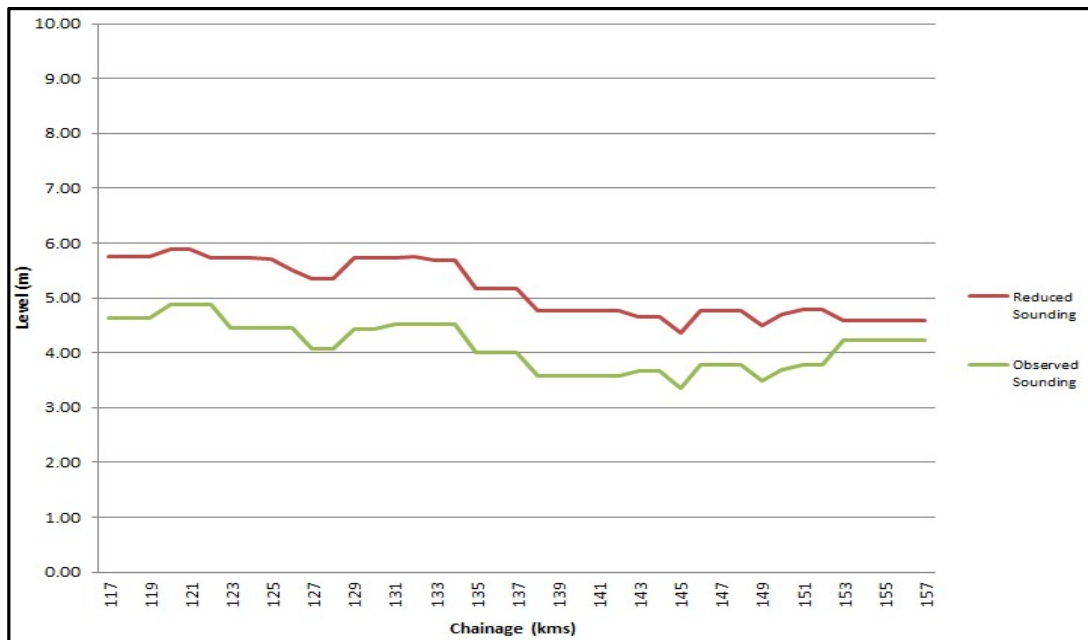


Figure 28 – Observed and Reduced Bed Profile 620 RD Head to 750 RD Head

Main villages in this stretch are Tharusar, Rami and Pugal. Width of canal varies between 50 m to 45 m this stretch. Bed Width of Canal varies between 16 m to 15 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present in this Stretch. Navigation to cross this lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Bikaner railway line and Bikaner railway station in vicinity of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present. Two Branches originates one on left bank and one on right bank at upstream of 750 RD head. Left bank branch is lift irrigation and right bank branch is escape canal.



Figure 29 – Weeds floating over water in IG Canal at RD 633 (Ch. 121 Km)



Figure 30 – Ramal Head at IG Canal at RD 702.30 (Ch. 142.38 Km)



Figure 31 – Head Lock RD 750 (Ch. 157.02 Km)

3.5 750 RD Head to 860 RD Head (Ch. 157.10 km – 190.50 km)

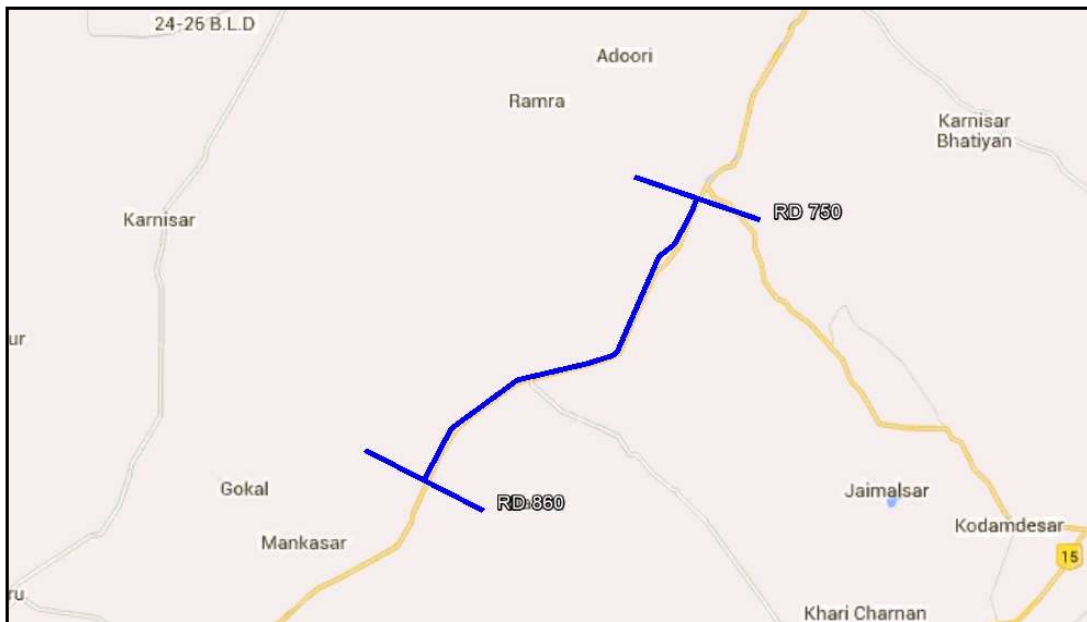


Figure 32 – 750 RD Head to 860 RD Head

Table 19 – Minimum – Maximum Depths, 750 RD Head to 860 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	157.0	190.5	1.2	5.3	0.0	0.00	1.3	5.5	0.00	0.000
2	157.0	190.5	1.2	4.3	0.7	265.20	1.3	5.5	0.100	57.300
3	157.0	190.5	1.1	4.4	4.0	3526.11	1.2	5.6	0.400	772.170

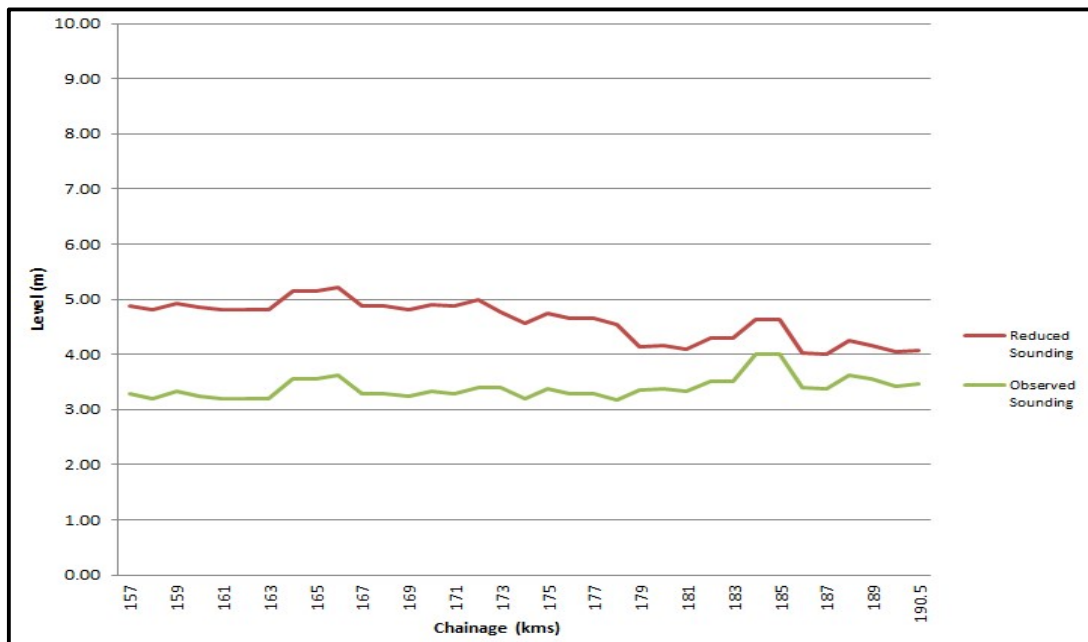


Figure 33 – Observed and Reduced Bed Profile of 750 RD Head to 860 RD Head

Main villages in this stretch are Amarpura, Sukhdevpura, Angneu and Prithviraj ka bera. Width of canal varies between 50 m to 45 m this stretch. Bed Width of Canal varies between 15.20 m to 12.50 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 190.04 km of this Stretch. Navigation to cross these locks is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security

issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Phalodi and Pokran are nearest railway station of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present Two Branches originates one on left bank and one on right bank at upstream of 860 RD head.



Figure 34 – Village Road Bridge RD 786 (Ch. 168.09 Km)



Figure 35 – Spot Level Acquisition RD 800 (Ch. 172.35 Km)



Figure 36 – Village Road Bridge RD 850 (Ch. 187.70 Km)



Figure 37 – RD 860 Head Lock (Ch. 190.04 Km)

3.6 860 RD Head to 961 RD Head (Ch. 190.50 km – 221.70 km)

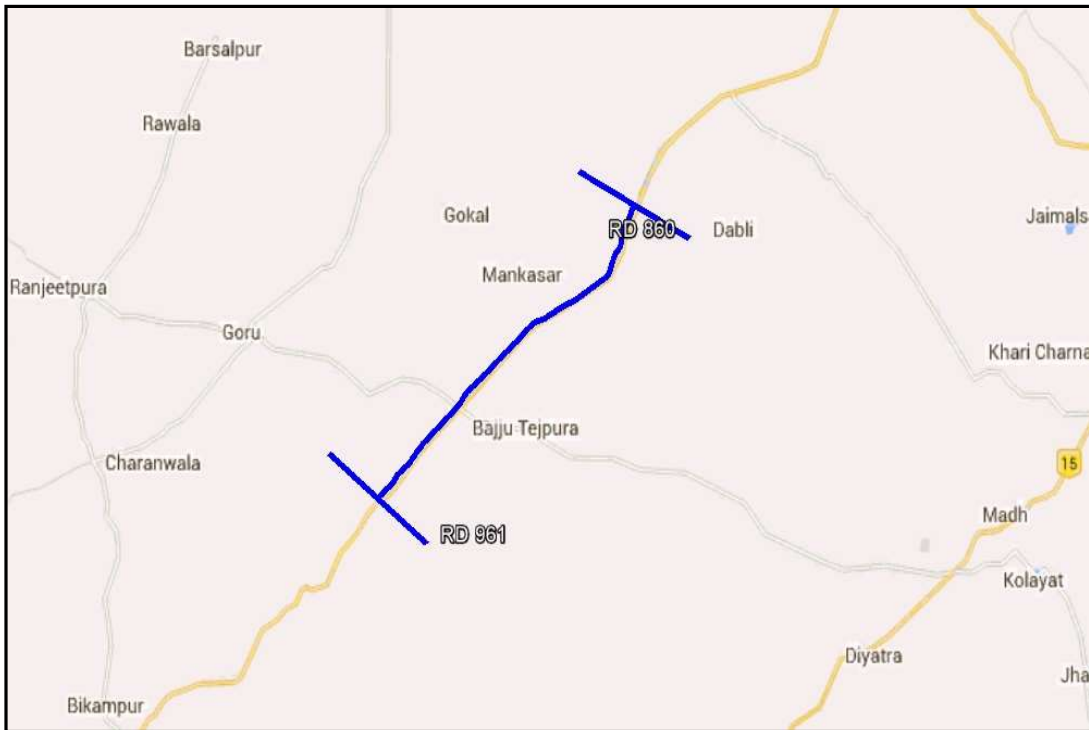


Figure 38 – 860 RD Head to 961 RD Head

Table 20 – Minimum – Maximum Depths, 860 RD Head to 961 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	190.5	221.7	1.4	4.3	0.0	0.00	1.6	5.7	0.00	0.000
2	190.5	221.7	1.2	4.3	0.2	39.31	1.6	5.7	0.000	0.000
3	190.5	221.7	1.2	4.3	2.9	1350.26	0.9	5.7	0.100	55.350

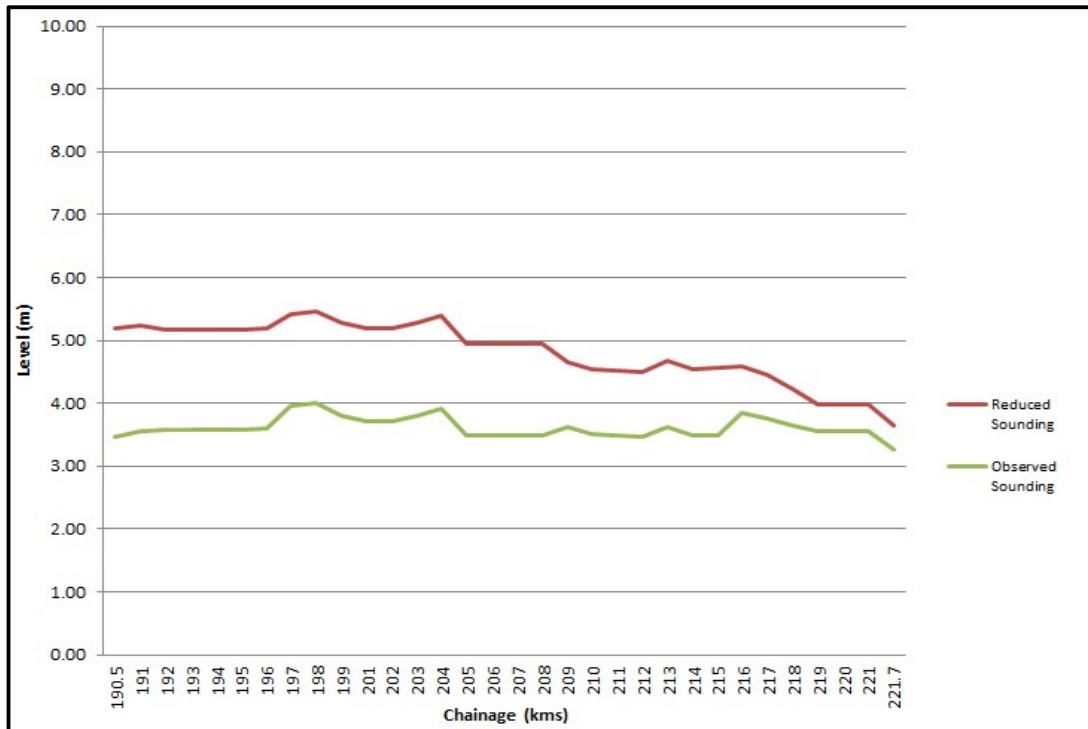


Figure 39 – Observed and Reduced Bed Profile of 860 RD Head to 961 RD Head

Main villages in this stretch are Bangasar, Manaksar, Panwarwala, Purnwala, Modayat, Bajju, Berasar and Mithriya. Width of canal varies between 45 m to 40 m this stretch. Bed Width of Canal varies between 12.50 m to 12.20 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 221.66 km of in this Stretch. Navigation to cross this

lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. There is no nearest railway station of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present. Two Branches originates one on left bank and one on right bank at upstream of 961 RD head.



Figure 40 – Village Road Bridge RD 945 (Ch. 216.28 Km)



Figure 41 – RD 961 Head Lock and Lock Bridge (Ch. 221.66 Km)

3.7 961 RD Head to 1121 RD Head (Ch. 221.70 km – 270.50 km)



Figure 42 – 961 RD Head to 1121 RD Head

Table 21 – Minimum – Maximum Depths, 961 RD Head to 1121 RD Head

Class	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	221.7	270.5	1.1	3.3	0.0	0.00	1.9	5.8	0.00	0.000
2	221.7	270.5	1.1	3.3	6.0	2995.10	1.9	5.8	0.000	0.000
3	221.7	270.5	1.1	3.3	24.2	36669.08	1.8	5.8	0.100	2.660

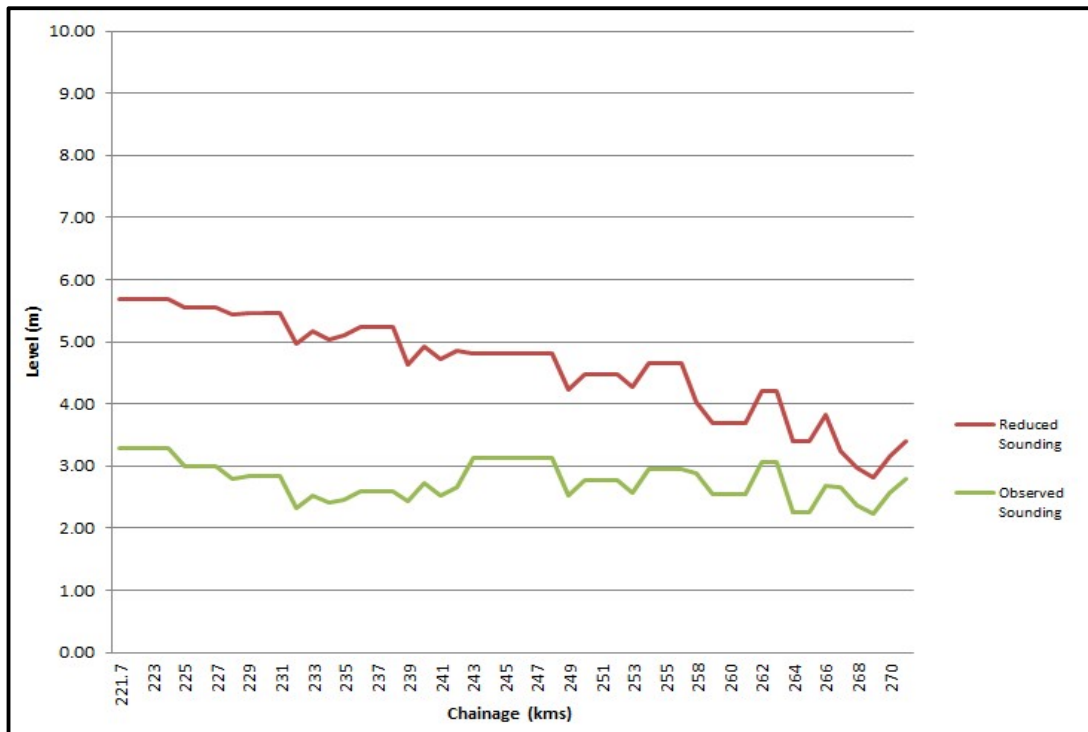


Figure 43 – Observed and Reduced Bed Profile of 961 RD Head to 1121 RD Head

Main villages in this stretch are Bikampur, Gogariyala, Madasr and Bharamsar. Width of canal varies between 45 m to 40 m this stretch. Bed Width of Canal varies between 12.20 m to 12.00 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 270.42 km of in this Stretch. Navigation to cross this lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage.

Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Phalodi is nearest railway station of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present. Three Branches originates one on left bank and Two on right bank at upstream of 1121 RD head. Two Left bank branches are lift irrigation and right bank branch is escape canal.



Figure 44 – Village Road Bridge RD 1041 (Ch. 246.10 Km)



Figure 45 – Village Road Bridge RD 1058 (Ch. 251.10 Km)

3.8 1121 RD Head to 1254 RD Head (Ch. 270.50 km – 310.80 km)

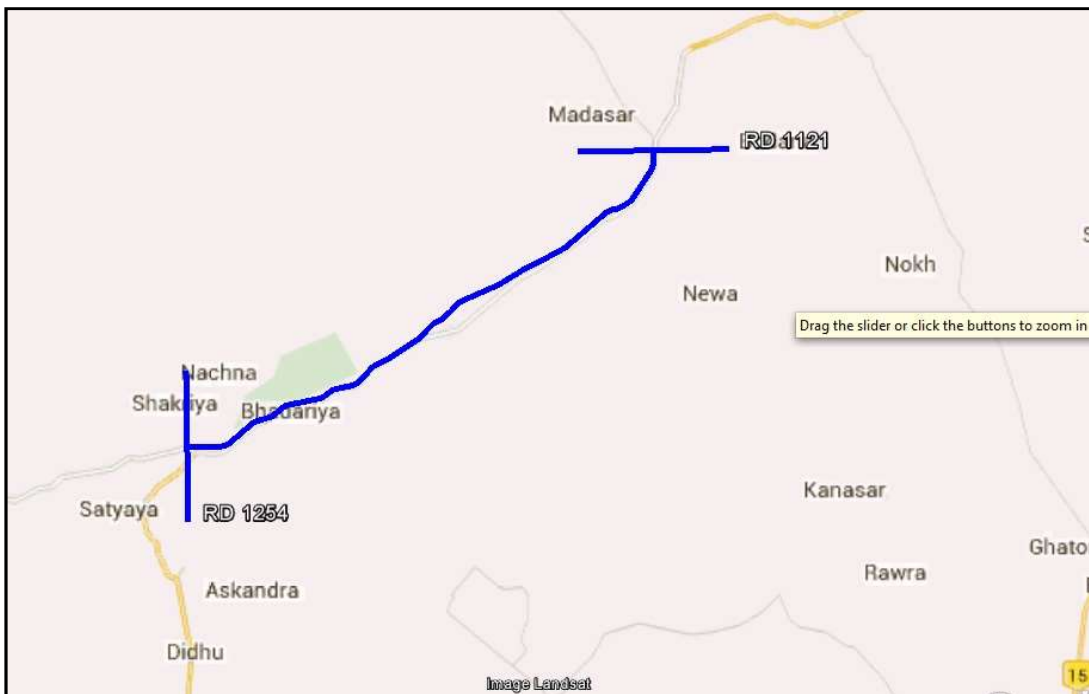


Figure 46 – 1121 RD Head to 1254 RD Head

Table 22 – Minimum – Maximum Depths, 1121 RD Head to 1254 RD Head

S. No.	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	270.5	310.8	1.1	4.1	0.0	0.00	1.6	5.2	0.00	0.000
2	270.5	310.8	1.1	4.1	2.4	1839.02	1.5	5.2	0.000	0.000
3	270.5	310.8	1.1	4.1	11.6	19607.99	1.3	5.2	0.100	93.060

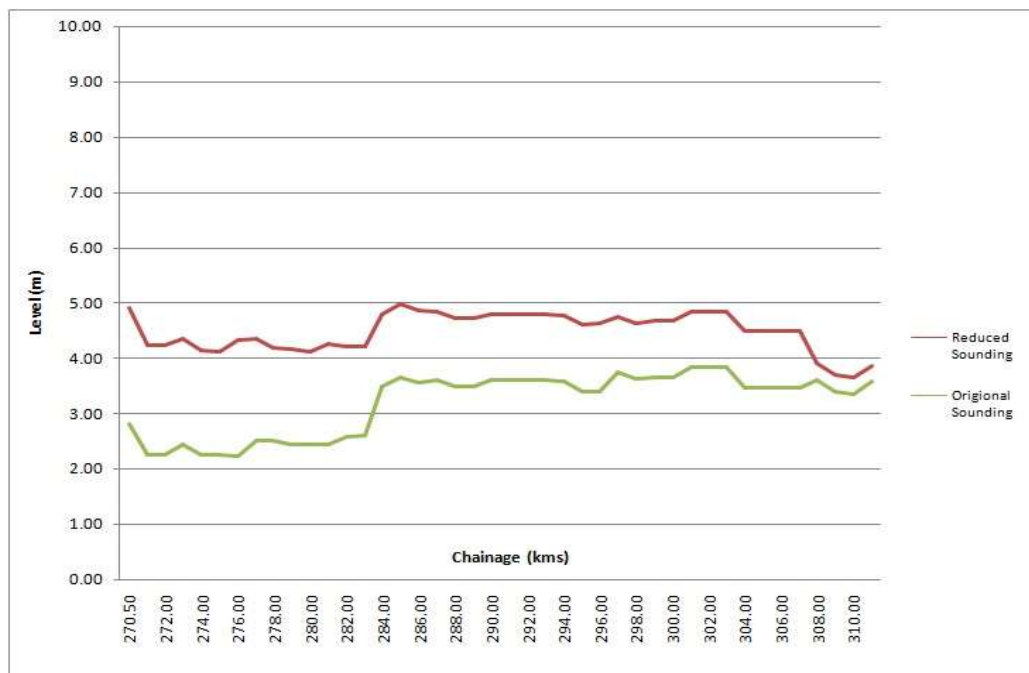


Figure 47 – Observed and Reduced Bed Profile of 1121 RD Head to 1254 RD Head

Main villages in this stretch are Nachna and Bhadariya. Width of canal varies between 45 m to 40 m this stretch. Bed Width of Canal varies between 12.00 m to 10.00 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 310.80 km in this Stretch. Navigation to cross this lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Phalodi and Pokhran are nearest railway stations of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties

and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present.



Figure 48 – Lift Irrigation Canal on Left bank of Canal RD 1205 (Ch. 294.80 Km)



Figure 49 – RD 1254 Head Lock (Ch. 310.80 Km)

3.9 1254 RD Head to 1365 RD Head (Ch. 310.80 km – 344.50 km)



Figure 50 – 1254 RD Head to 1365 RD Head

Table 23 – Minimum – Maximum Depths, 1254 RD Head to 1365 RD Head

S. No.	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	310.8	344.5	1.1	4.0	0.0	0.00	1.4	5.2	0.00	0.000
2	310.8	344.5	1.1	4.0	1.6	720.47	1.4	5.2	0.100	3.070
3	310.8	344.5	1.1	4.3	8.2	11166.35	1.4	5.2	1.500	1665.960

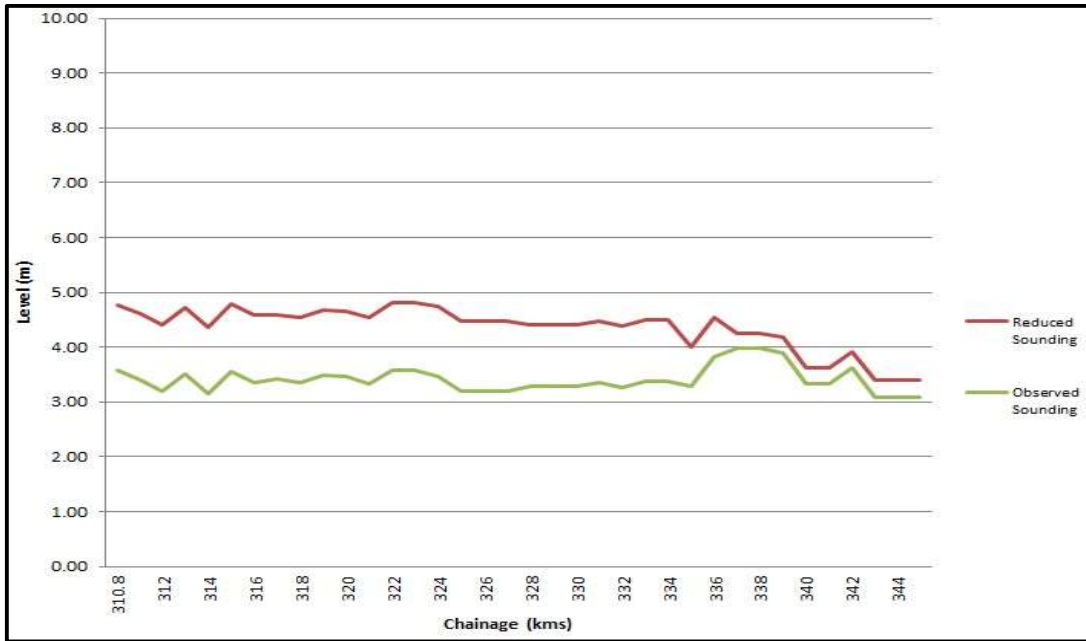


Figure 51 – Observed and Reduced Bed Profile of 1254 RD Head to 1365 RD Head

Main villages in this stretch are Satyaya and Tadana. Width of canal varies between 45 m to 40 m this stretch. Bed Width of Canal varies between 10.50 m to 10.00 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 344.36 km in this Stretch. Navigation to cross this lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. Pokhran is nearest railway station of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There are no prominent cities in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy, clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present. Two Branches originates on right bank at upstream of 1365 RD head. One is escape canal and second for Irrigation.



Figure 52 – RD 1304 Minor (Ch. 326.10 Km)



Figure 53 – RD 1365 Head Lock (Ch. 344.36 Km)

3.10 1365 RD Head to 1458.5 RD Head (Ch. 344.50 km – 373.10 km)



Figure 54 – 1365 RD Head to 1458.5 RD Head

Table 24 – Minimum – Maximum Depths, 1358 RD Head to 1458.5 RD Head

S. No.	Chainage		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	344.500	373.100	1.1	4.0	0.0	0.00	1.4	5.4	0.00	0.000
2	344.500	373.100	1.1	4.0	1.3	320.50	1.3	5.4	0.100	14.440
3	344.500	373.100	1.0	4.0	11.9	11294.52	1.1	5.4	1.600	2269.530

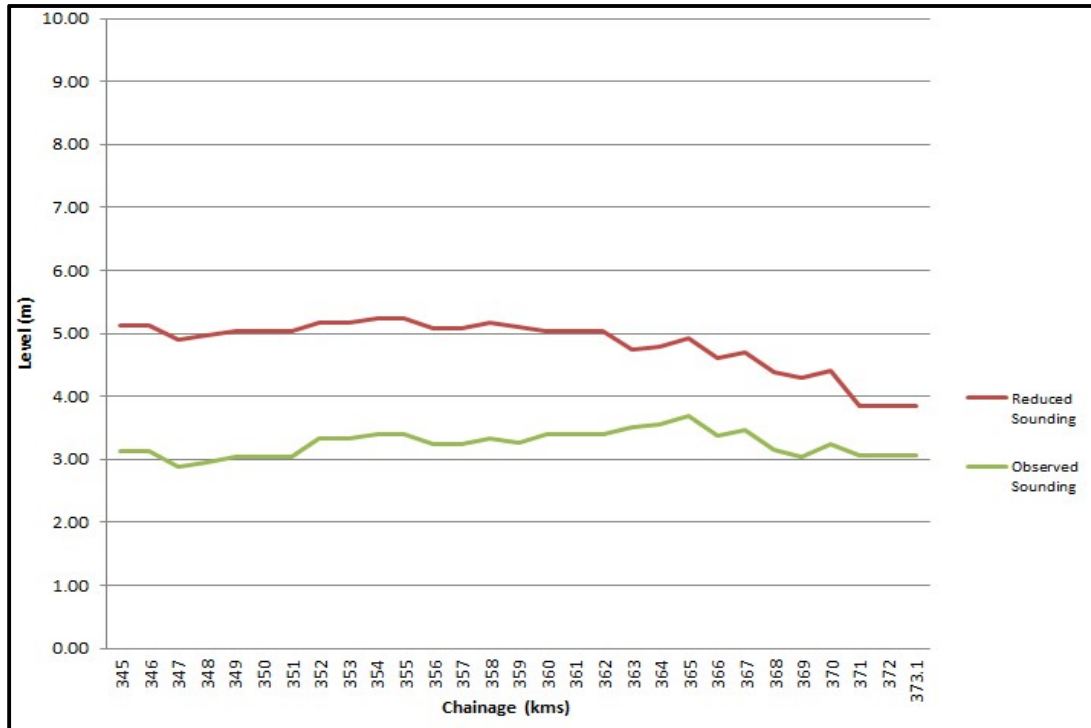


Figure 55 - Observed and Reduced Bed Profile of 1358 RD Head to 1458.5 RD Head

Main villages in this stretch are Amirnada and Shri Mohangarh. Width of canal varies between 45 m to 40 m this stretch. Bed Width of Canal varies between 10.00 m. Approach roads on both banks of canal are constructed & in use. Many Bridges are crossings the canal. Soil type is mostly sandy and rocks / boulders were not present. Wheat, Mustered and Gram is main crop. 1 No. of Lock is present at Ch. 373.10 km in this Stretch. Navigation to cross this lock is not possible because of non-availability of navigational channel. Both Banks are protected but problems with water-logging caused by excessive irrigation, seepage from canals and poor drainage. Hyacinth, rocks, rapid waterfalls, forest, wild-life sanctuary, security issues etc. are not present in this stretch. Gradient of canal is smooth. BRO road is present along this Stretch which is used for transportation of mainly limestone mineral and crops. There is no nearest railway station of this stretch of Indira Gandhi canal. Land is generally used for agriculture purpose on both bank of canal. Forest land around 50 m width from both bank of canal present. No Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. Shrimohangarh is prominent city in this stretch of waterway. No ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Many Bridges are crossings the canal. Height of these bridges is not sufficient for Waterway make navigational. Soil type is mostly sandy, clay and rocks/boulders were not present. Wheat, Mustered, Gram and cotton are main crop. Many Bridges are crossings the canal. Soil type is mostly sandy clay and rocks / boulders were not present. At the end main canal is divided into three branches. One is Sagarmal Gopsakha Second is Mandau Vitrika and third is small branch for near areas irrigation.



Figure 56 – Village Road Bridge RD 1405 (Ch. 356.85 Km)



Figure 57 – RD 1458.5 Head Lock (Ch. 373.10 Km)

4. LOCATIONS FOR TERMINAL CONSTRUCTION

Total 04 (four) locations are proposed for construction of terminals along the IG Canal stretch. The locations have been proposed based on following considerations:-

- Availability of suitable depths for vessel berthing
- Availability of land for construction of terminal
- Connectivity to hinterland
- Distance from city traffic limits
- Possibility of future expansion
- Possibility of new industrial setup along the river stretch in future

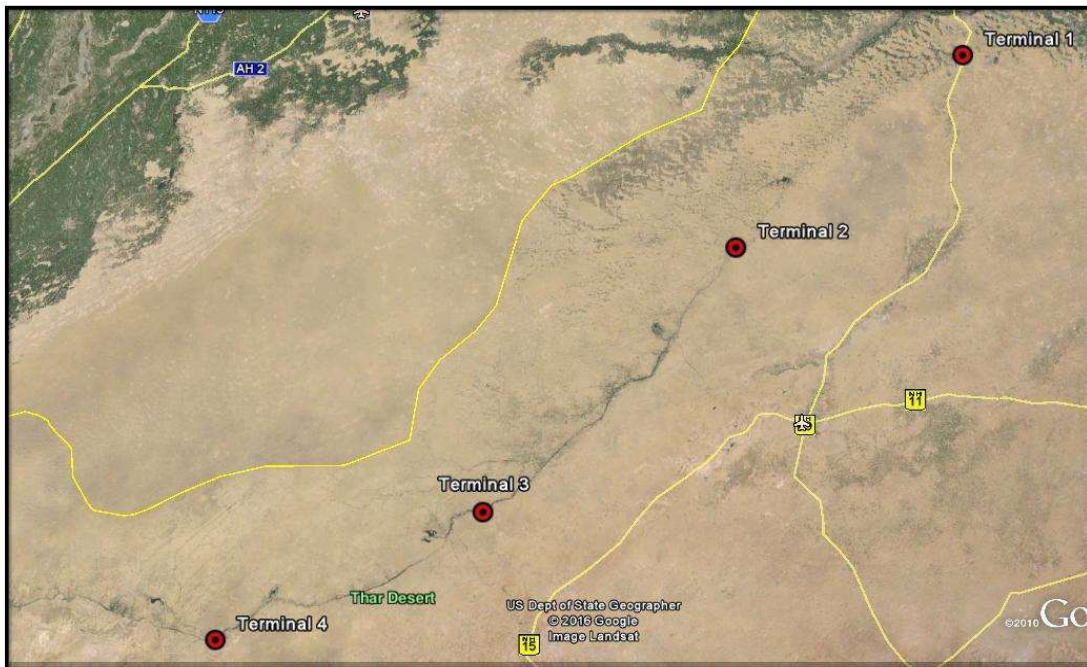


Figure 58 – Overview, Terminal Locations

Table 25 – Terminal Location

Stretch No.	Chainage (km)	Location	Position			
			Longitude (E)	Latitude (N)	Easting (m)	Northing (m)
1	0.000	U/S OF RD 236 (Piperan Near Suratgarh)	73°53' 57.333"E	29°12' 16.9"N	E 392994.195	N 3231168.341
2	113.564	RD 608 (Near Sattasar)	73°4' 16.3671"E	28°35' 9.8245"N	E 311371.189	N 3163647.052
3	250.807	RD 1057 (Near Beekampur)	72°9' 56.1057"E	27°44' 2.4954"N	E 220567.648	N 3070957.693
4	367.105	RD 1439 (Near Mohangarh)	71°12'34.68"E	27°18'40.63"N	E 718654.320	N 3022849.76

A brief discussion on the proposed locations is presented below:-

4.1 Terminal 1 (US of Ch. 00 km):

The suggested location is on the Indira Gandhi Canal near NH-15 and Suratgarh - Bikaner Railway line. The location is well connected to NH-15 and can be developed as a start/end point terminal for IWT, from Suratgarh City. The location has potential to be developed into a major terminal in future. Canal type is protected.



Figure 59 – Terminal 1

4.2 Terminal 2 (Near Sattasar at Ch. 113.564 km):

Sattasar Terminal on the Left bank of Indira Gandhi Canal mainly protected. The place is well connected to main road and has the potential to be developed into industrial hub.

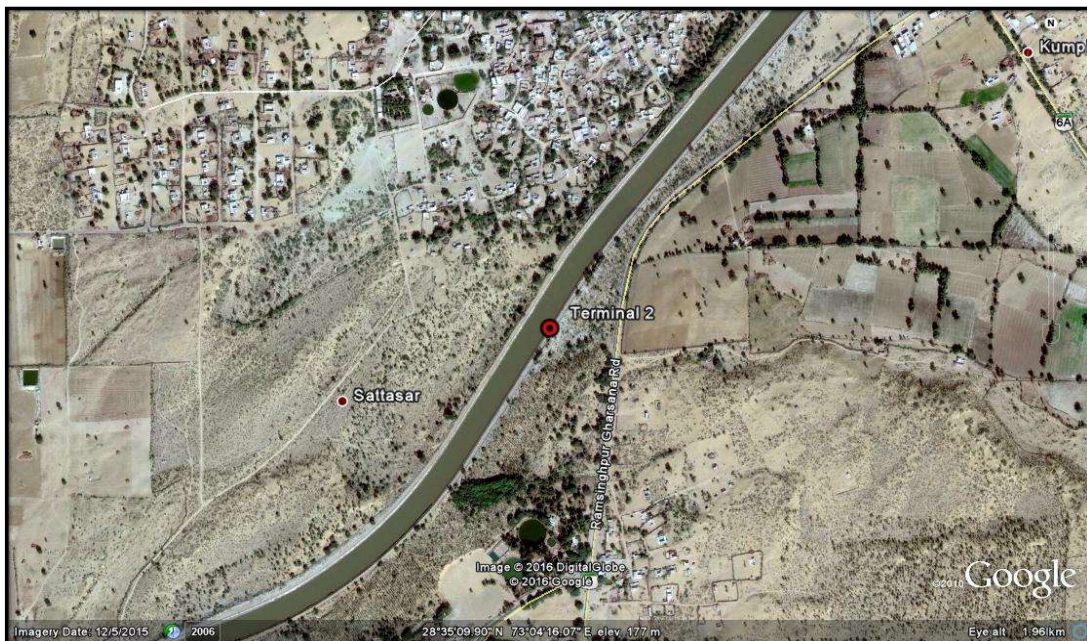


Figure 60 – Terminal 2 (Sattasar)

4.3 Terminal 3 (Near Bikampur at Ch. 250.807 km):

The suggested location is on Left bank of Canal near Bikampur on Bikaner-Jaisalmer Highway

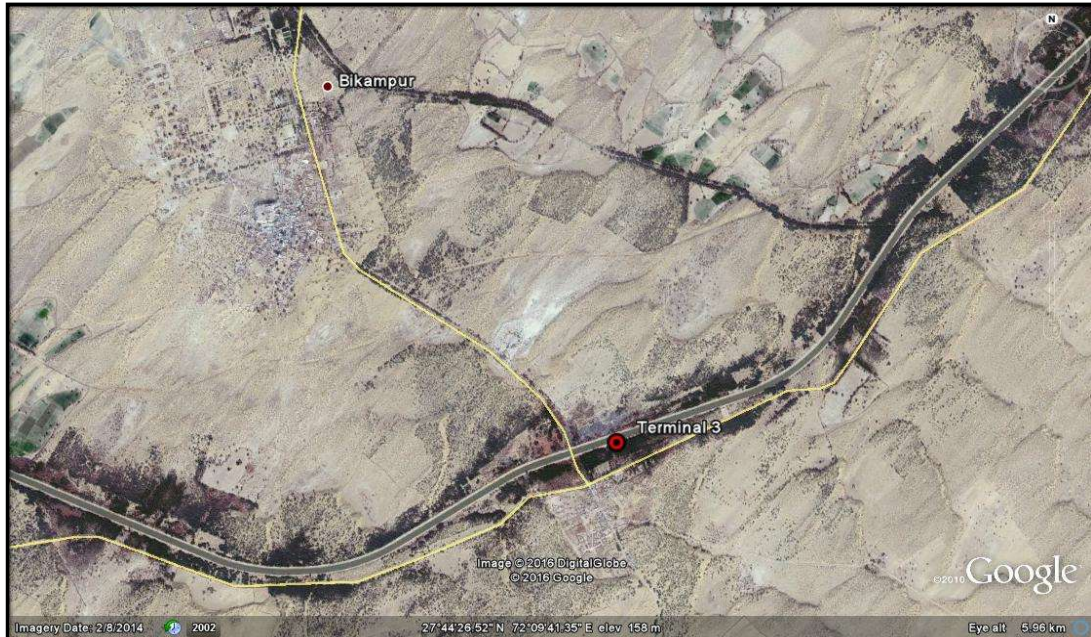


Figure 61 – Terminal 3 (Bikampur)

4.4 Terminal 4 (Near Mohangarh at Ch.367.105km):

The suggested location is on the Indira Gandhi Canal in Mohangarh City. The location is well connected to Bikaner-Jaisalmer Highway and can be developed as a start/end point terminal for IWT. The location has potential to be developed into a major terminal in future. Canal type is protected.

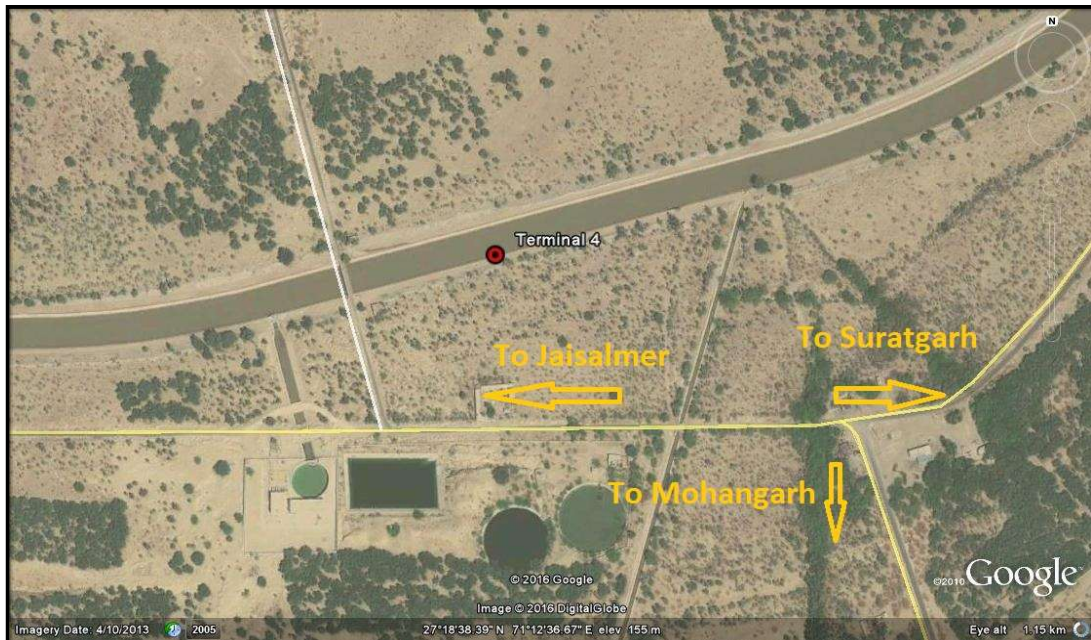
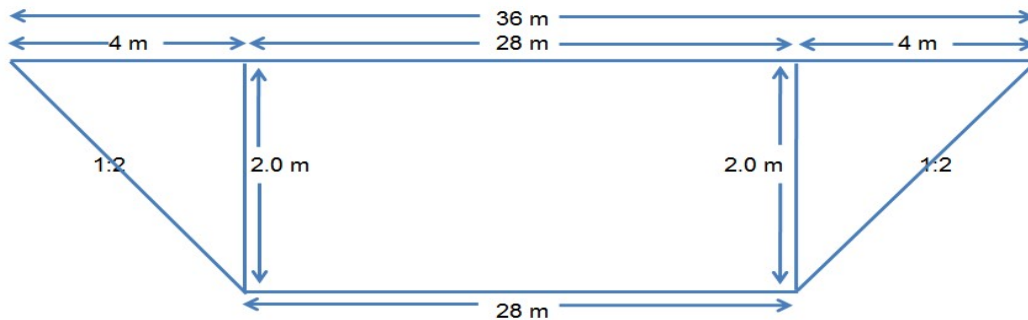


Figure 62 – Terminal 4 (Mohangarh)

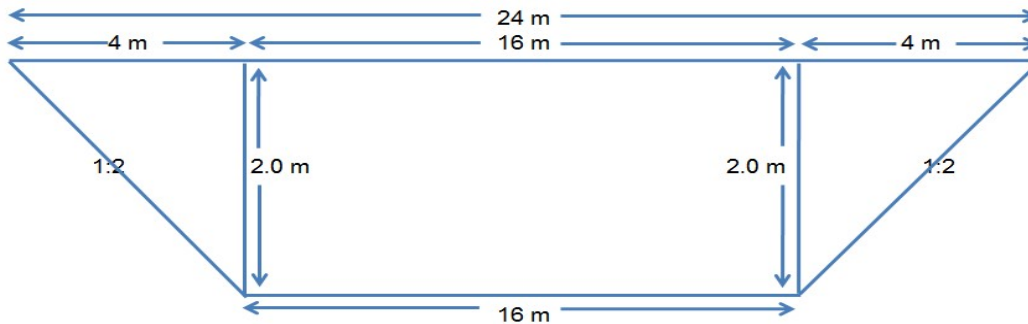
5. FAIRWAY DEVELOPMENTS

As per the design data of Indira Gandhi Canal, fairway dimension of channel has made of 4 types for each depth (2.0m, 1.5m and 1.0 m) with the help of bed width of Indira Gandhi Canal (in Table-3 and Table-4). Below showing fairway dimension for 2.0 m depth.

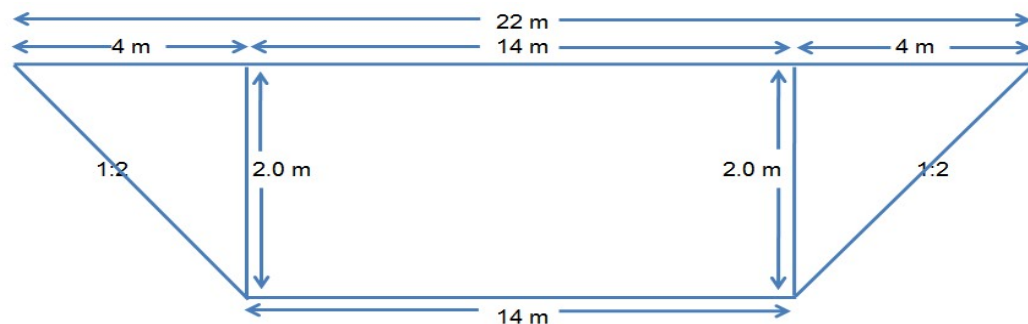
- 1) 28m x 2.0m from Ch.0.00 to 2.30 with Side slope of 1:2, along the deepest route.



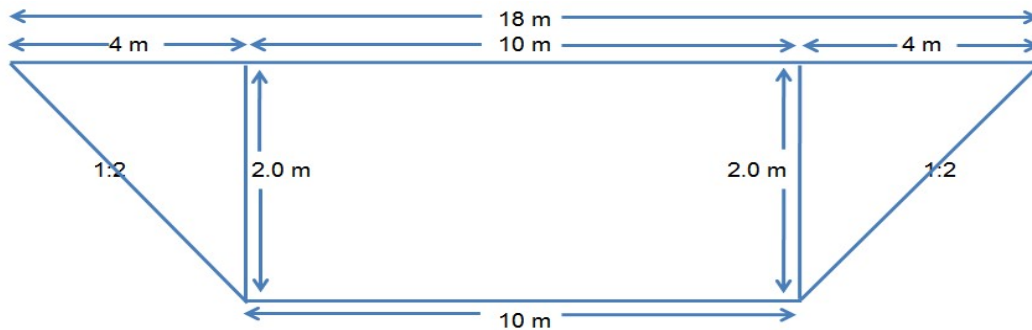
- 2) 16m x 2.0m from Ch.2.30 to 83.00 with Side slope of 1:2, along the deepest route.



- 3) 14m x 2.0m from Ch.83.00 to 157.20 with Side slope of 1:2, along the deepest route.



4) 10m x 2.0m from Ch.157.20 to 373.10 with Side slope of 1:2, along the deepest route.



Dredging quantity for the depths of **2.0 m, 1.5 m, and 1.0 m** is calculated stretch wise for width. The dredge volume calculations were accomplished using the HYPACK dredge volume computation utility (Standard Hypack method). The stretch wise results of the dredge volume are as given:-

Table 26 – Dredging Volume Summary in Indira Gandhi Canal at 2.0m depth

S. No.	Position		Chainage		Observed					Reduce Depth (m) w.r.t. Sounding Datum (Avg. LWL)				
	From	To	From	To	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)
1	RD 236	RD415	0.000	54.800	0.9	6.1	19.2	34843.16	34843.16	1.6	7.4	0.10	70.100	70.1
2	RD415	RD507	54.800	82.900	1.2	5.1	1.4	1590.72	36433.88	1.9	6.3	0.10	28.290	98.390
3	RD507	RD620	82.900	117.000	1.2	5.2	2.6	2646.01	39079.89	2.2	6.4	0.00	0.000	98.390
4	RD620	RD750	117.000	157.000	1.1	5.2	3.6	2855.28	41935.17	2.0	6.5	0.00	0.000	98.390
5	RD750	RD860	157.000	190.500	1.1	4.4	4.0	3526.11	45461.28	1.2	5.6	0.400	772.170	870.560
6	RD860	RD961	190.500	221.700	1.2	4.3	2.9	1350.26	46811.54	0.9	5.7	0.100	55.350	925.910
7	RD961	RD1121	221.700	270.500	1.1	3.3	24.2	36669.08	83480.62	1.8	5.8	0.100	2.660	928.570
8	RD1121	RD1254	270.500	310.800	1.1	4.1	11.6	19607.99	103088.61	1.3	5.2	0.100	93.060	1021.630
9	RD1254	RD1365	310.800	344.500	1.1	4.3	8.2	11166.35	114254.96	1.4	5.2	1.500	1665.960	2687.590
10	RD1365	RD1458	344.500	373.100	1.0	4.0	11.9	11294.52	125549.48	1.1	5.4	1.600	2269.530	4957.120
Total								125,549.48		Total			4,957.12	

Table 27 – Dredging Volume Summary in Indira Gandhi Canal at 1.50m depth

S. No.	Position		Chainage		Observed					Reduce Depth (m) w.r.t. Sounding Datum (Avg. LWL)				
	From	To	From	To	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)
1	RD 236	RD415	0.000	54.800	0.9	6.1	10.4	4125.17	4125.17	1.6	7.4	0.00	0.000	0.000
2	RD415	RD507	54.800	82.900	1.3	5.1	0.2	0.80	4125.97	1.9	6.3	0.00	0.000	0.000
3	RD507	RD620	82.900	117.000	1.2	5.2	0.3	99.47	4225.44	1.9	6.4	0.00	0.000	0.000
4	RD620	RD750	117.000	157.000	1.2	5.2	0.5	69.72	4295.16	1.8	6.5	0.00	0.000	0.000
5	RD750	RD860	157.000	190.500	1.2	4.3	0.7	265.20	4560.36	1.3	5.5	0.100	57.300	57.300
6	RD860	RD961	190.500	221.700	1.2	4.3	0.2	39.31	4599.67	1.6	5.7	0.000	0.000	57.300
7	RD961	RD1121	221.700	270.500	1.1	3.3	6.0	2995.10	7594.77	1.9	5.8	0.000	0.000	57.300
8	RD1121	RD1254	270.500	310.800	1.1	4.1	2.4	1839.02	9433.79	1.5	5.2	0.000	0.000	57.300
9	RD1254	RD1365	310.800	344.500	1.1	4.0	1.6	720.47	10154.26	1.4	5.2	0.100	3.070	60.370
10	RD1365	RD1458	344.500	373.100	1.1	4.0	1.3	320.50	10474.76	1.3	5.4	0.100	14.440	74.810
Total								10,474.76		Total				74.81

Table 28 – Dredging Volume Summary in Indira Gandhi Canal at 1.0m depth

S. No.	Position		Chainage		Observed					Reduce Depth (m) w.r.t. Sounding Datum (Avg. LWL)				
	From	To	From	To	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)	Min	Max	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)
1	RD 236	RD415	0.000	54.800	0.9	6.1	0.2	4.82	4.82	1.6	7.4	0.00	0.000	0.00
2	RD415	RD507	54.800	82.900	1.5	5.1	0.0	0.00	4.82	1.9	6.3	0.00	0.000	0.00
3	RD507	RD620	82.900	117.000	1.2	5.2	0.0	0.00	4.82	2.0	6.4	0.00	0.000	0.00
4	RD620	RD750	117.000	157.000	1.2	5.2	0.0	0.00	4.82	1.8	6.5	0.00	0.000	0.00
5	RD750	RD860	157.000	190.500	1.2	5.3	0.0	0.00	4.82	1.3	5.5	0.00	0.000	0.00
6	RD860	RD961	190.500	221.700	1.4	4.3	0.0	0.00	4.82	1.6	5.7	0.00	0.000	0.00
7	RD961	RD1121	221.700	270.500	1.1	3.3	0.0	0.00	4.82	1.9	5.8	0.00	0.000	0.00
8	RD1121	RD1254	270.500	310.800	1.1	4.1	0.0	0.00	4.82	1.6	5.2	0.00	0.000	0.00
9	RD1254	RD1365	310.800	344.500	1.1	4.0	0.0	0.00	4.82	1.4	5.2	0.00	0.000	0.00
10	RD1365	RD1458	344.500	373.100	1.1	4.0	0.0	0.00	4.82	1.4	5.4	0.00	0.000	0.00
Total								4.82						

Dredging quantity, minimum & maximum depths and length of shoal have also been calculated per km wise and the same is at Annexure-1.

6. CONCLUSION

Indira Gandhi Canal is specially made for irrigation purpose for Rajasthan. IWAI has marked as National Waterways (NW-45) from Harike barrage to Mohangarh but Tojo Vikas international Pvt. Ltd. is doing Suratgarh to Mohangarh stretch of canal and has a total length 373.10 km.

In our survey area of length 373.10 km total 11 nos. of locks are present and crossing of these locks with boat from upstream to Downstream and vice-versa is not possible due to non-presence of Navigational channel on these locks. So to make this stretch navigational it is necessary to make navigational channel on any side of each lock. Many Bridges are present in this stretch of canal and vertical and horizontal clearance of these locks is not suitable for navigational channel so modification of all bridges is required in this stretch of canal. There are no Industries along this stretch of canal so there is no transportation of industrial items through this stretch of canal. This is mainly border area and Mahajan Field Firing Range is near to this stretch so the transportation of Military instruments through cargo is possible. Also the transportation with cargo of agriculture items like wheat, gram, mustered and cotton is quite feasible through this waterway. This waterway is not feasible for passenger ferry or RO-RO facility because BRO road going parallel to whole length of our survey area and bridges on every 5 km (Approx.) are presents on IG canal. This stretch will not to be devolved as tourism hub because there is no tourist place and Historical place in vicinity of our survey area. The canal running throughout the year except essential closure some time and water availability for different period of time quite good throughout the year. Agricultural land exists on both banks of the canal in the stretch.

Minimal dredging is required in all stretch of IG Canal so feasibility of waterway on behalf of dredging has quite possible. All locks need to be modified for further navigation. Modifications of all bridges are also required for navigation purpose. Widening of canal is not required because IG canal has sufficient width for navigational channel.

Table 29 Dredging Summary of Indira Gandhi Canal

Class	Observed						Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
I	00	373.10	0.9	6.1	0.200	4.82	1.3	7.4	0	0
II	00	373.10	0.9	6.1	23.60	10474.76	1.3	7.4	0.300	74.81
III	00	373.10	0.9	6.1	89.60	125549.48	0.9	7.4	4.00	4957.120

7. DETAILS OF ANNEXURES

Annexure - I	Source and type of data collected from various Agencies
Annexure - II	Dredge Volume
Annexure - III	Observed Water Level, Reductions and Corrected Water Levels
Annexure - IV	Details of bathymetric surveys carried out
Annexure - V	Details of Bank Protection
Annexure - VI	Details of Features across the Bank
Annexure - VII	Detailed Methodology adopted Horizontal and Vertical Control
Annexure – VIII	Photographs of equipment
Annexure – IX	Benchmark of IG Canal
Annexure – X	Soil Sample Analysis Reports
Annexure – XI	Water Sample Analysis Reports
Annexure - XII	Calibrations certificates
Annexure - XIII	Field Photographs