Final Feasibility Report
National Waterway-104,
Region VI – Tungabhadra River
Murva Konda to Chikka Jantakal
(232.4km)

SURVEY PERIOD: 25 Apr to 30 Jun 2016

Volume - I

Prepared for:
Inland Waterways Authority of India
(Ministry of Shipping, Govt. of India)
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Uttar Pradesh – 201 301

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ACKNOWLEDGEMENT

IIC Technologies Ltd. expresses its sincere gratitude to IWAI for awarding the work of carrying out detailed hydrographic surveys in the New National Waterways in NW-104 in Region VI – Tungabhadra River from confluence with river Krishna near village Murva Konda to Bridge on State highway - 29 near Chikka Jantakal village.

We would like to use this opportunity to pen down our profound gratitude and appreciations to **Shri Pravir Pandey, IA&AS, Chairman IWAI** for spending his valuable time and guidance for completing this Project. IIC Technologies Ltd., would also like to thank, **Shri Alok Ranjan, ICAS, Member (Finance), Shri Shashi Bhushan Shukla, Member (Traffic), Shri S.K. Gangwar, Member (Technical)** for their valuable support during the execution of project.

IIC Technologies Ltd, wishes to express their gratitude to **Capt. Ashish Arya, Hydrographic Chief IWAI, Cdr. P.K. Srivastava ex-Hydrographic Chief and Shri SVK Reddy, Chief Engineer-I** for their guidance and inspiration for this project. IIC Technologies Ltd, would also like to thank **Sh. Rajiv Singhal, A.H.S., IWAI** for his invaluable support and suggestions provided throughout the survey period. IIC Technologies Ltd, is pleased to place on records its sincere thanks to other staff and officers of IWAI for their excellent support and cooperation throughout the survey period.

CONTENTS

List of Abbreviations

CD	Chart Datum
DGPS	Differential Global Positioning Systems
ETS	Electronic Total Station
TNG	Tungabhadra
GPS	Global Positioning Systems
LAD	Least Available Depth
LBM	Local Bench Mark
MSL	Mean Sea Level
RL	Reference Level
SD	Sounding Datum
SBAS	Satellite-Based Augmentation System
TBC	Trimble Business Center
CWC	Central Water Commission
PIA	Project Influence Area
NH	National Highway
SH	State Highway

SALIENT FEATURES AT A GLANCE

<table>
<tr><th>#</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>IIC Technologies Limited, Hyderabad</td></tr>
<tr><td>2.</td><td>Region number & State(s)</td><td>Region–VI (Karnataka, Andhra Pradesh and Telangana)</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW #
(from…. to; total length)</td><td>National Waterway No – 104
Chikka Jantakal to Murva Konda (232.4km)</td></tr>
<tr><td>4.</td><td>Navigability Status</td><td>Ferry point/terminal exists near Kurnool city at 31.6km chainage, however, services are not available due to non-availability of navigable waters.</td></tr>
<tr><td>a)</td><td>Tidal & non-tidal portions
(from… to, length, average tidal variation)</td><td>The survey Stretch of Tungabhadra River is non-tidal.</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t. CD)
i) Survey period (12 Feb to 08 Mar, 2016.)
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)</td><td>Tungabhadra River is dry and the survey was conducted by topographic method.
<table>
<tr><th>LAD (m)</th><th>0 - 20 km</th><th>20 -40 km</th><th>40-60km</th><th>60-90km</th><th>90-114km</th><th>114-140km</th><th>140-165km</th><th>165-190km</th><th>190-210km</th><th>210-232.4km</th><th>Total</th></tr>
<tr><td>< 1.2</td><td>20</td><td>20</td><td>20</td><td>30</td><td>24</td><td>26</td><td>25</td><td>25</td><td>20</td><td>22.4</td><td>232.40</td></tr>
<tr><td>1.2 - 1.4</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1.5 - 1.7</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1.8 - 2.0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>> 2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>20</td><td>20</td><td>20</td><td>30</td><td>24</td><td>26</td><td>25</td><td>25</td><td>20</td><td>22.4</td><td>232.40</td></tr>
</table></td></tr>
<tr><td>c)</td><td>Cross structures
i) Dams, weirs, barrages etc
(total number; with navigation locks or not)
ii) Bridges, Power cables etc
[total number; range of horizontal and vertical clearances]</td><td>Cross Structures:
i) Check Dams – 10Nos, Barrages – 02Nos.
ii) No of Navigation Locks - Nil
iii) Bridges –10Nos
Horizontal Clearance Range – 11.605 to 40.208m
Vertical Clearance Range: 3.751 to 10.441m w.r.t. HFL
iv) Pipeline – 01Nos
Horizontal Clearance Range – 9.992m
Vertical Clearance Range: 9.91m w.r.t. HFL
v) High Tension Lines – 9Nos
Vertical Clearance Range: 32m – 45m w.r.t. HFL</td></tr>
<tr><td>d)</td><td>Avg. discharge & no. of days</td><td>Discharge data not available from authorities</td></tr>
</table>

<table>
<tr><th>#</th><th>Particulars</th><th>Details</th></tr>
<tr><td>e)</td><td>Slope (1 in ….)</td><td>
<table>
<tr><th colspan="2">Chainage (km)</th><th rowspan="2">Slope (A/B)</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td>0</td><td>20</td><td>1 : 0.389</td></tr>
<tr><td>20</td><td>40</td><td>1 : 0.575</td></tr>
<tr><td>40</td><td>60</td><td>1 : 0.437</td></tr>
<tr><td>60</td><td>90</td><td>1 : 0.479</td></tr>
<tr><td>90</td><td>114</td><td>1 : 0.639</td></tr>
<tr><td>114</td><td>140</td><td>1 : 0.856</td></tr>
<tr><td>140</td><td>165</td><td>1 : 0.008</td></tr>
<tr><td>165</td><td>190</td><td>1 : 0.770</td></tr>
<tr><td>190</td><td>210</td><td>1 : 0.579</td></tr>
<tr><td>210</td><td>232.4</td><td>1 : 0.500</td></tr>
</table>
Average Slope = 1 : 0.525 for entire river stretch
</td></tr>
<tr><td>5.</td><td>Traffic potential</td><td>No navigational traffic is present in the survey stretch of Tungabhadra River.</td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td>No ferry services were observed throughout the Tungabhadra River stretch during survey operations, however, peoples were observed using round shaped country boats to cross the river near Jogulamba Temple at Alampur, Sunkesula barrage (for fishing) and Ulenoor near CWC gauge.</td></tr>
<tr><td>b)</td><td>Important industries within 50km</td><td>Sree Rayalaseema Alkalies, and Allied Chemicals Limited at Gondiparla village near Kurnool and Adani Wilmar Limited, Fortune edible oil near Mantralayam, NSL Sugars Dasanur near Sirguppa.</td></tr>
<tr><td>c)</td><td>Distance of Rail & Road from Industry</td><td>Well connected to Rail and Road network. The prominent railway stations near the survey stretch are Alampur road station, Kurnool city station, and Mantralayam road station.</td></tr>
<tr><td>6.</td><td>Consultant’s recommendation for going ahead with TEF / DPR preparation.</td><td>Due to the continuous gradient of the river and unavailability of water level during the summer season, navigation aspect will not be fulfilled throughout the year. The navigational lock is required to maintain the minimum depth for navigation and regulate the water level in the river. Detailed TEF/DPR shall be required for further assessment. This river stretch is not-viable for navigational channel.</td></tr>
<tr><td>7.</td><td>Any other information/ comment</td><td>Nil</td></tr>
</table>

(Signature)

Date: For IIC Technologies Limited

1 Introduction

1.1 Background

Tungabhadra River is formed by the confluence of the Tunga River and the Bhadra River at Koodli which flows down the Eastern slope of the Western Ghats in the state of Karnataka. It flows through Karnataka during most of its course and then Andhra Pradesh and Telangana and finally meets with Krishna River near Alampur, Mehboobnagar Telangana State. It is one of the major tributaries of Krishna River. Main cities/towns beside the project influence area (survey area) are Kurnool, Mantralayam, Sirguppa, and Kampli. To assess the feasibility of water transportation over this stretch of river a bathymetric survey and topographic survey was carried out by IIC Technologies Ltd. on behalf of IWAI.

1.2 Tributaries of Tungabhadra River

The main tributaries of the Tungabhadra River are the (left) Tunga River, Kumudvati River, Varada River and (right) Bhadra River, Vedavathi River, Handri River. Tunga River and Bhadra River meet at Koodli to form Tungabhadra River which is far away from project influence area. The River Vedavathi inflows into Tungabhadra River near Sirguppa at Karnataka.

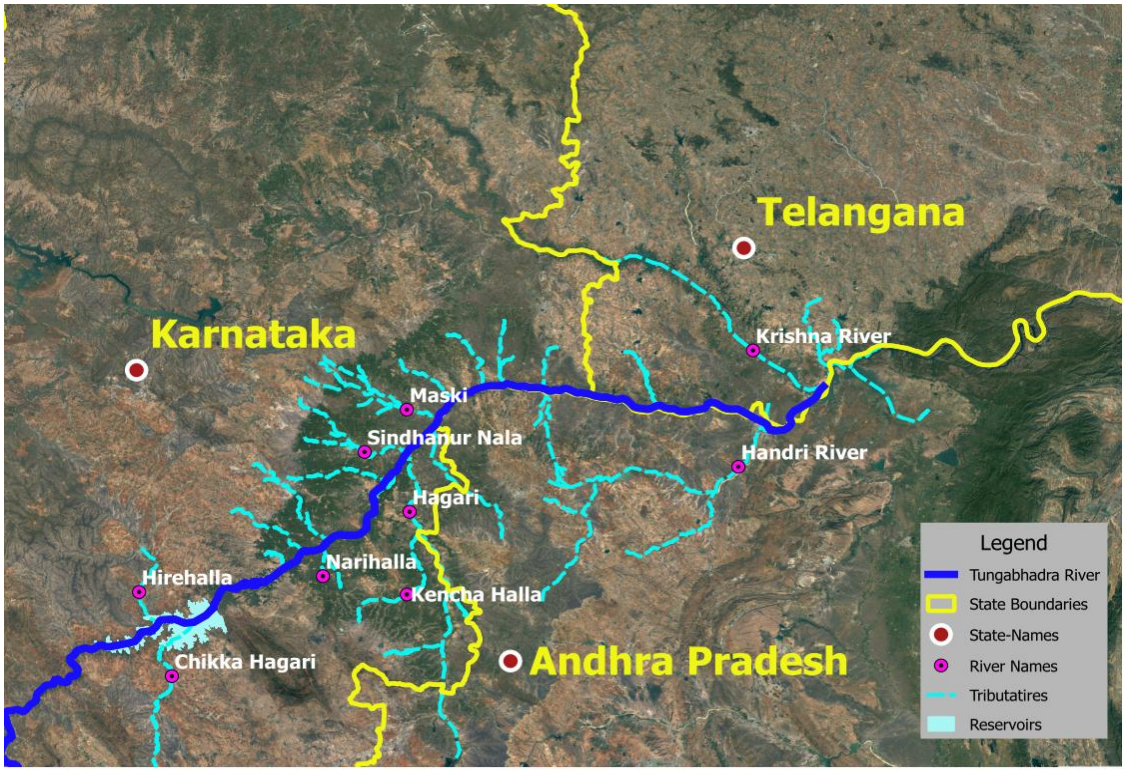


Figure 1 - Tributaries of Tungabhadra River

1.3 State/District through which river passes

The Tungabhadra River flows down through Bellary district in Karnataka state, Kurnool district in Andhra Pradesh and Gadwal, Mehaboob Nagar District of Telangana.

State Name	Chainage (km)		Length in km
	From	To	
Andhra Pradesh/ Telangana	0.00	97.5	97.5
Andhra Pradesh/Karnataka	97.5	158.4	60.9
Karnataka	158.4	232.4	74.0

Table 1 - State wise Waterway

1.4 Map

1.4.1 Full Course of the Waterway

The map displaying the state boundary with road and rail network for the course of water way is represented as below:-

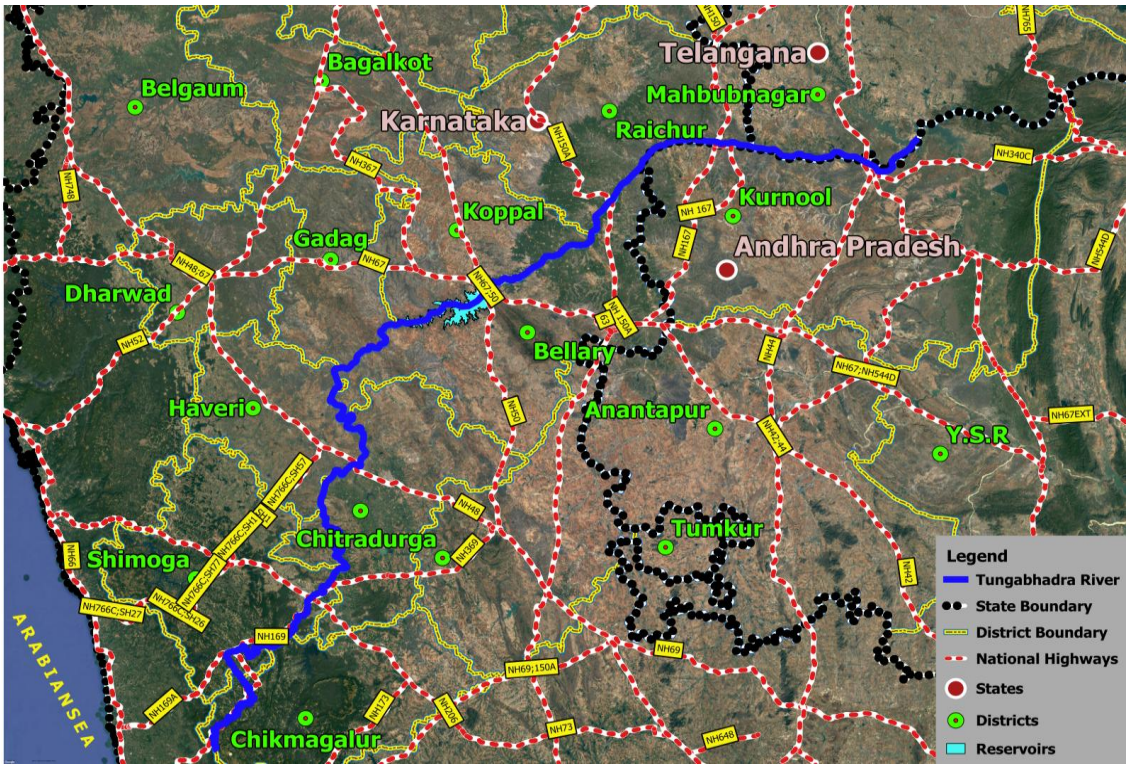


Figure 2 - Full Course of Tungabhadra River

1.4.2 Course of the Waterway under Study

The map displaying the state boundary with road and rail network for the course of water way is represented as below:-

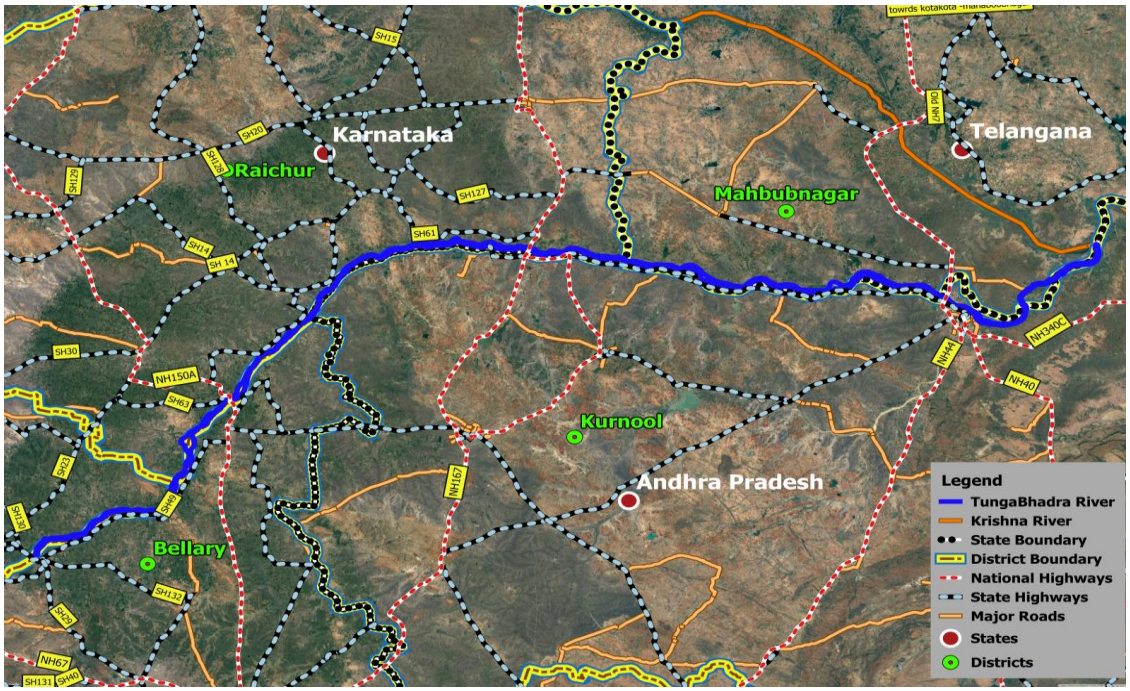


Figure 3 - Course of Tungabhadra River under Study

1.5 Scope of Work

The scope of the work is, to conduct detailed hydrographic and topographic survey of 232.4km length of the Tungabhadra River from confluence with River Krishna near village Murva Konda at Lat 15°57'20.28"N, Long 78°14'29.60"E to Bridge on State Highway-29 near Chikka Jantakal village at Lat 15°24'33.39"N, Long 76°35'12.62"E.

The scope of the work for the conduct of survey of Tungabhadra River includes:

- Bathymetric and topographic survey of proposed waterway is undertaken.
- Establishing horizontal and vertical control stations.
- Construction of benchmark pillars and establishing its reduced level w.r.to Mean Sea Level.
- Setting up and deployment of water level gauges.
- Current velocity and discharge measurements.
- Collection and analysis of water and bottom samples.
- A collection of topographic features including existing cross structures.

- Preparation of an inventory of industries in the project influence area (PIA).
- Analysis of survey data, including assessment of water availability for navigation.
- Preparation of survey charts and feasibility report.

2 Methodology Adopted to Undertake Study

2.1 Recce

Advanced recce of the survey area was undertaken on 19 Apr 2016. The recce commenced from Murva Konda village (Downstream, zero chainage) to Bridge near Chikka Jantakal village at Kampli (Upstream).

The downstream portion of the Tungabhadra River is mostly sandy river bed with farm lands on the river banks and the upstream portion of the river is mostly rocky. Town beside the river banks are Kurnool, Mantralayam, Sriguppa and Kampli which are densely populated, rest entire stretch is moderately populated by distant villages. There is no water available in river except some areas with impounded water, so the operation of survey boat is found to be not possible through the entire stretch of the river.

River banks are mostly clear and without any obstructions as farm lands are stretched up to river banks. Paddy, peanuts, Sugar cane and cotton cultivation are prominent in the entire stretch. The DGPS signal is expected to be good in the entire stretch of the river. The auto leveling is expected to be difficult as no availability of the roads close to river banks.

2.2 Survey Resources and Methodology

The actual survey was commenced on 25 April 2016 and completed on 30 June 2016. The survey was undertaken on a scale of 1:225,000, with survey line spacing, kept at 200 m and plotted on UTM Projection at Zone 43N and 44N as directed in the contract.

2.2.1 Survey Equipment

Following equipment were deployed for the topographic survey.

Equipment	Make	Eqpt. Serial No.	Qty. Employed
GPS Sets	Trimble R3/R4	-	05
Auto Level	Sokkia Auto Level & Accessories	257222 ,234298	02
ETS	Trimble M3	120775	01
Software	AUTOCAD	2012	1
Software	Microsoft Office	2013	1
Software	Trimble Business Center	Version – 12	1

Table 2 - Survey Equipment Used

2.2.2 Topographic Survey

The actual survey was commenced on 25 April 2016 and completed on 30 Jun 2016. The weather was sunny throughout during the survey operations. The weather was favorable with hot climate for the conduct of survey and this condition remained same for the entire duration of the survey. The topographic survey was conducted to collect the following data:-

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

The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 20 m interval. The plotting of the chart was done on UTM Projection at Zone 43N and 44N as directed in the contract specifications. The spot levels along the river were obtained by using Trimble DGPS. The data was post processed using Trimble Business Center to get the precise position and MSL height values of the rover locations. The 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 handed over as deliverable data.

Figure 4 - DGPS Spot Leveling Comparison by Auto Level

2.2.3 Bathymetric Survey and Survey Launch

The deployment of survey boat was not feasible at Tungabhadra River due to non-availability of sufficient water depth throughout the river. Hence the complete survey stretch was surveyed by topographic survey mehods.

Figure 5 - Topographic Survey

2.2.4 Calibration

The equipment used for the survey was calibrated by the equipment supplier. The equipment calibration certificates are placed at Annexure-13 to this report.

2.3 Description of Bench Marks/Authentic Reference Level Used

The GTS Bench Mark established by Survey of India near Gondiparla village at Kurnool was recovered and value of 277.353m above MSL was obtained from CWC regional office, Kurnool, Andhra Pradesh (Copy of field record of CWC regional office Kurnool is enclosed in Annexure-1). The obtained value of 277.353m above MSL was accepted and transferred to CWC tide gauge at CWC Site-31 at Bawapuram (281.565m Above MSL as provided by the Engineer CWC site office, Bawapuram Kurnool, Andhra Pradesh) through auto leveling method and both values are found to be in close agreement.

Figure 6 - View of GTS Benchmark, Gondiparla (ch. 27.59km)

The Details of GTS Bench Mark, Gondiparla:- 15°49'26.40"N, 78°05'13.50"E			
(a)	GTS Bench Mark, Gondiparla	277.353m	Source: CWC Sub Divisional office. Kurnool
(b)	River Chainage	27.59 km	
The Details of CWC Site at Bawapuram:- 15°52'55.1653"N, 77°57'25.4670"E			
(a)	Zero of Tide gauge	270.245 m	Source: Site Engineer, Central Water Commission, Bawapuram, Kurnool
(b)	Value of CWC MBM (RBS)	281.565 m	
(c)	Highest Flood Level	277.738 m	
(d)	River Chainage	45.04km	
The Details of Sunkesula Barrage:-			
(a)	Sill level	284.500 m	Salient features board
(b)	Crest level	285.000 m	
(c)	Full reservoir level	292.000 m	
(d)	River Chainage	60.27km	
The Details of CWC Site at Mantralayam:- 15°56'51.56N, 077°25'47.34"E			
(a)	Zero of Tide Gauge	306.000 m	Salient features board
(b)	Value of CWC MTBM	313.705 m	
(c)	Highest Flood Level	313.328 m	
(d)	River Chainage	106.52km	
The Details of CWC Site at Ulenoor:- 15°29'36.30"N, 076°43'04.22"E			
(a)	Zero of Tide Gauge	370.000 m	Salient features board
(b)	Highest Flood Level	377.636 m	
(c)	River Chainage	214.38km	

Table 3 - Reference Level Value of CWC Gauges

The Reference Value of GTS Bench Mark at Gondiparla, Kurnool was used as the initial reference for vertical control and the Reference Level value 277.353m was transferred to IWAI Bench Mark pillars through Auto Level (optical leveling method). The leveling data for establishing the Reference Level for the newly constructed benchmark pillars are placed at Annexure-10 to this report. The final accepted WGS 84 coordinates and details of station & IWAI Benchmark established during the conduct of survey are as follows:

Sl. No.	Station	Chainage (km)	Latitude	Longitude	Ht. above MSL (m)	Source/Type
1	IWAI_BM_TNG-01	-0.14	N15°57'48.96046"	E78°17'01.99180"	283.554	6 Hrs. Observation
2	IWAI_BM_TNG-02	9.24	N15°53'44.05072"	E78°12'22.42103"	283.789	6 Hrs. Observation
3	IWAI_BM_TNG-03	15.74	N15°53'00.59279"	E78°08'19.27149"	272.753	6 Hrs. Observation
4	IWAI_BM_TNG-04	27.42	N15°49'25.68133"	E78°05'19.35214"	277.307	6 Hrs. Observation
5	IWAI_BM_TNG-05	37.63	N15°52'00.30333"	E78°00'41.55909"	282.306	Online processed
6	BM_ TNB-01	38.01	N15°51'38.82155"	E78°00'13.45175"	274.219	6 Hrs. Observation
7	IWAI_BM_TNG-06	49.39	N15°53'21.09232"	E77°54'21.02154"	289.484	6 Hrs. Observation
8	IWAI_BM_TNG-07	62.31	N15°52'20.50289"	E77°48'43.58067"	296.595	6 Hrs. Observation
9	IWAI_BM_TNG-08	75.44	N15°53'00.01287"	E77°42'01.25277"	296.331	6 Hrs. Observation
10	IWAI_BM_TNG-09	88.48	N15°54'31.18507"	E77°35'21.82668"	303.195	6 Hrs. Observation
11	IWAI_BM_TNG-10	99.06	N15°55'51.04426"	E77°29'44.59154"	309.682	6 Hrs. Observation
12	IWAI_BM_TNG-11	108.54	N15°56'19.75235"	E77°24'50.43049"	313.637	6 Hrs. Observation
13	IWAI_BM_TNG-12	117.54	N15°56'50.34016"	E77°19'59.60941"	319.133	6 Hrs. Observation
14	IWAI_BM_TNG-13	128.49	N15°57'10.61711"	E77°14'11.37376"	332.682	6 Hrs. Observation
15	IWAI_BM_TNG-14	140.52	N15°55'53.17673"	E77°07'45.82069"	337.498	6 Hrs. Observation
16	IWAI_BM_TNG-15	151.15	N15°52'53.88188"	E77°03'33.59421"	338.122	6 Hrs. Observation
17	IWAI_BM_TNG-16	157.95	N15°49'57.16110"	E77°01'36.86187"	345.536	6 Hrs. Observation
18	IWAI_BM_TNG-17	170.23	N15°45'33.33053"	E76°56'35.39013"	345.169	6 Hrs. Observation
19	IWAI_BM_TNG-18	178.46	N15°41'29.26624"	E76°54'45.96447"	348.084	6 Hrs. Observation
20	IWAI_BM_TNG-19	186.40	N15°38'38.04034"	E76°51'47.45085"	360.653	6 Hrs. Observation
21	IWAI_BM_TNG-20	194.74	N15°34'55.09026"	E76°50'11.90307"	367.782	6 Hrs. Observation
22	IWAI_BM_TNG-21	203.61	N15°30'43.13933"	E76°48'39.86997"	370.922	6 Hrs. Observation
23	IWAI_BM_TNG-22	212.26	N15°29'18.51033"	E76°44'07.08776"	376.311	6 Hrs. Observation
24	IWAI_BM_TNG-23	221.13	N15°27'04.19216"	E76°40'28.70674"	383.768	6 Hrs. Observation
25	IWAI_BM_TNG-24	232.45	N15°24'25.21976"	E76°35'15.92222"	387.498	6 Hrs. Observation

Table 4 - Accepted Station coordinates (WGS-84)

2.4 Tidal Influence Zone and Tidal Variation

Entire survey stretch of Tungabhadra River is non-tidal water body receiving a primary source of water from Tungabhadra Dam at Hospet, Karnataka. Hence no influence of tidal forces was observed through the survey period.

2.5 Methodology to fix Chart Datum / Sounding Datum

Detailed attempt for obtaining the low flood level of Tungabhadra River was carried out. CWC gauge data available for various locations was used to establish suitable Sounding Datum at Tungabhadra River.

The Tungabhadra River survey stretch is 232.4km. Sunkesula Barrage and other various spillage & check dams are present in the survey stretch of the river. The gauge readings are recorded at Bawapuram site-31 is at its lowest ever, and at Mantralayam and Ulenoor are observed to be dry. The water depth on an average of 0.3m is available near the check dams and the water level is recorded as dry as the water presently held in barrage are stagnant and being not available for any other use.

2.5.1 Sounding Datum

The survey stretch of Tungabhadra River is mostly in dry condition and as per the information collected from local people, water on various stretches is expected to be fully dry by mid-July. The established CWC gauges in the survey stretch of Tungabhadra River was observed to be fully dry or below zero level of the gauge. In view of the above conditions, the least MSL value for the per km stretch is taken as the reference and the established CD values of the CWC gauges within the survey stretch and water levels in the barrages were also considered for the computation of SD/CD value.

2.5.2 Datum Calculation

The most of the survey stretches of Tungabhadra River being dry, the river chainage is divided as 01km stretches and the least MSL values obtained during the conduct of topographic survey for each stretch is considered as the Chart Datum for the Dredging Volume calculations. CD at down streams of barrages fixed by considering least MSL value, however at upstream crest level/MDDL of barrages was also considered. The details of established datum value for per- km stretches are as tabulated below:-

Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)
0-1	249.70	249.70	77-78	297.65	286.00	154-155	332.5	332.5
1-2	249.70	249.70	78-79	298.60	286.00	156-157	332.5	332.5
2-3	249.70	249.70	79-80	298.70	286.00	157-158	332.5	332.5
3-4	250.80	250.80	80-81	301.60	287.20	158-159	332.5	332.5
4-5	250.80	250.80	81-82	301.60	291.10	159-160	332.5	332.5
5-6	250.80	250.80	82-83	303.90	292.10	160-161	332.5	332.5
6-7	250.80	250.80	83-84	303.90	293.30	161-162	332.5	332.5

Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)
7-8	252.50	252.50	84-85	303.90	293.30	162-163	332.5	332.5
8-9	254.50	254.50	85-86	305.95	294.00	163-164	332.5	332.5
9-10	259.00	259.00	86-87	305.95	294.60	164-165	332.5	332.5
10-11	260.00	260.00	87-88	305.95	295.60	165-166	332.5	332.5
11-12	260.00	260.00	88-89	305.95	295.60	166-167	332.5	332.5
12-13	260.00	260.00	89-90	305.95	295.60	167-168	332.5	332.5
13-14	260.30	260.30	90-91	305.95	295.60	168-169	332.5	332.5
14-15	260.50	260.50	91-92	305.95	297.70	169-170	332.5	332.5
15-16	260.50	260.50	92-93	307.00	297.70	170-171	332.5	332.5
16-17	260.50	260.50	93-94	307.00	297.70	171-172	332.5	332.5
17-18	260.50	260.50	94-95	308.00	297.70	172-173	332.5	332.5
18-19	260.50	260.50	95-96	308.50	297.65	173-174	333.8	333.8
19-20	260.50	260.50	96-97	311.00	298.60	174-175	333.8	333.8
20-21	260.50	260.50	97-98	311.00	298.70	175-176	335.8	335.8
21-22	260.50	260.50	98-99	311.00	301.60	176-177	335.8	335.8
22-23	260.50	260.50	99-100	311.00	301.60	177-178	340.2	340.2
23-24	260.50	260.50	100-101	313.10	303.90	178-179	340.2	340.2
24-25	260.50	260.50	101-102	313.10	303.90	179-180	342.2	342.2
25-26	261.00	261.00	102-103	316.20	303.90	180-181	342.2	342.2
26-27	263.20	263.20	103-104	316.20	305.95	181-182	342.2	342.2
27-28	263.20	263.20	104-105	316.20	305.95	182-183	342.2	342.2
28-29	263.20	263.20	105-106	316.20	305.95	183-184	343.3	343.3
29-30	263.60	263.60	106-107	317.20	305.95	184-185	345.7	345.7
30-31	264.60	264.60	107-108	320.20	305.95	185-186	346.3	346.3
31-32	264.90	264.90	108-109	322.20	305.95	186-187	347.2	347.2
32-33	264.90	264.90	109-110	322.20	305.95	187-188	348.2	348.2
33-34	264.90	264.90	110-111	323.30	307.00	188-189	348.2	348.2
34-35	266.10	266.10	111-112	325.30	307.00	189-190	348.2	348.2
35-36	266.50	266.50	112-113	326.20	308.00	190-191	348.2	348.2
36-37	267.50	267.50	113-114	327.30	308.50	191-192	349.9	349.9
37-38	267.50	267.50	114-115	327.30	311.00	192-193	349.9	349.9
38-39	267.50	267.50	115-116	327.30	311.00	193-194	353.8	353.8
39-40	267.50	267.50	116-117	331.20	311.00	194-195	353.8	353.8
40-41	267.50	267.50	117-118	331.20	311.00	195-196	353.8	353.8
41-42	268.70	268.70	118-119	331.20	313.10	196-197	354.4	354.4
42-43	270.29	270.29	119-120	331.20	313.10	197-198	354.4	354.4
43-44	270.29	270.29	120-121	331.20	316.20	198-199	354.4	354.4
44-45	270.70	270.70	121-122	331.20	316.20	199-200	354.4	354.4
45-46	271.90	271.90	122-123	331.50	316.20	200-201	356.3	356.3
46-47	272.80	272.80	123-124	331.50	316.20	201-202	356.3	356.3
47-48	273.80	273.80	124-125	331.50	317.20	202-203	356.3	356.3
48-49	274.70	274.70	125-126	331.50	320.20	203-204	356.3	356.3
49-50	276.10	276.10	126-127	331.50	322.20	204-205	357.3	357.3
50-51	277.10	277.10	127-128	331.50	322.20	205-206	358.2	358.2
51-52	277.50	277.50	128-129	331.50	323.30	206-207	358.2	358.2
52-53	277.90	277.90	129-130	331.50	325.30	207-208	359.2	359.2

Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)	Km Stretch	Least Level w.r.t MSL (m)	Established CD (m)
53-54	278.80	278.80	130-131	331.50	326.20	208-209	361.3	361.3
54-55	279.40	279.40	131-132	331.50	327.30	209-210	362.27	362.27
55-56	279.40	279.40	132-133	331.50	327.30	210-211	362.27	362.27
56-57	280.40	280.40	133-133.8	331.50	327.30	211-211.4	362.27	362.27
57-58	280.90	280.90	133.8-134	331.50	331.20	211.4-212	371.306	371.306
58-59	280.90	280.90	134-135	331.50	331.20	212-213	371.306	371.306
59-59.7	280.90	280.90	135-136	331.50	331.20	213-214	371.306	371.306
59.7-60	285.00	285.00	136-137	297.65	331.20	214-215	371.306	371.306
60-61	285.00	285.00	137-138	298.60	331.20	215-216	371.306	371.306
61-62	285.00	285.00	138-139	298.70	331.20	216-217	371.306	371.306
62-63	285.00	285.00	139-140	301.60	331.50	217-218	371.306	371.306
63-64	285.00	285.00	140-141	301.60	331.50	218-219	371.306	371.306
64-65	285.00	285.00	141-142	303.90	331.50	219-220	371.306	371.306
65-66	285.00	285.00	142-143	303.90	331.50	220-221	371.306	371.306
66-67	285.00	285.00	143-144	303.90	331.50	221-222	371.306	371.306
67-68	285.00	285.00	144-145	305.95	331.50	222-223	371.8	371.8
68-69	285.00	285.00	145-146	305.95	331.50	223-224	371.8	371.8
69-70	285.00	285.00	146-147	305.95	331.50	224-225	371.8	371.8
70-71	285.40	285.40	147-148	305.95	331.50	225-226	371.8	371.8
71-72	285.40	285.40	148-149	305.95	331.50	226-227	371.8	371.8
72-73	285.40	285.40	149-150	305.95	331.50	227-228	371.8	371.8
73-74	285.40	285.40	150-151	305.95	331.50	228-229	371.8	371.8
74-75	285.40	285.40	151-152	307.00	331.50	229-230	371.8	371.8
75-76	286.00	286.00	152-153	307.00	331.50	230-231	371.8	371.8
76-77	286.00	286.00	153-154	308.00	331.50	231-232.4	371.8	371.8

Table 5 - Established CD for Per Km stretch

2.6 Average of 06 years minimum Water Levels to arrive at Chart Datum (CD)

There are three CWC gauge stations exist in the entire survey stretch of Tungabhadra River at Bawapuram, Kurnool, Mantralayam at Kurnool, Ulenoor at Karnataka. The average data for last seven years of CWC gauges was used to compile the chart datum. The yearly minimum & maximum water level values at CWC tide gauges for last seven years are as below:-

		2009	2010	2011	2012	2013	2014	2015
		Gauge	Gauge	Gauge	Gauge	Gauge	Gauge	Gauge
Jan	min	270.345	270.695	270.705	270.515	270.425	270.425	270.415
	max	270.465	271.945	270.775	270.635	270.485	270.505	270.595
Feb	min	270.335	270.745	270.585	270.505	270.395	270.305	270.415
	max	270.585	270.975	270.795	270.605	270.425	270.455	270.485
Mar	min	270.305	270.515	270.525	270.395	270.345	270.285	270.275
	max	270.375	270.905	270.605	270.545	270.385	270.815	270.495
Apr	min	270.265	270.515	270.435	270.295	270.100	270.225	270.265
	max	270.345	270.895	271.205	270.515	270.325	270.335	270.795
May	min	270.265	270.605	270.545	270.385	270.045	270.215	270.275
	max	271.735	272.045	270.995	270.535	270.225	271.135	270.465
Jun	min	270.475	270.615	270.485	270.425	270.075	270.225	
	max	273.095	272.005	272.835	271.615	272.245	271.025	
Jul	min	270.325	270.535	270.465	270.425	270.205	270.265	
	max	274.045	271.415	270.845	270.545	275.345	270.325	
Aug	min	270.665	270.505	270.535	270.375	270.735	270.265	
	max	274.375	276.675	274.005	272.475	275.755	276.105	
Sep	min	270.865	271.855	270.715	270.545	270.735	270.665	
	max	275.585	274.330	275.590	273.585	273.685	273.565	
Oct	min	271.525	270.750	270.635	270.485	270.565	270.425	
	max	281.585	274.925	271.875	272.555	272.770	272.745	
Nov	min	271.395	270.725	270.665	270.525	270.525	270.445	
	max	273.045	274.485	271.870	274.120	271.235	271.645	
Dec	min	270.745	270.665	270.585	270.455	270.455	270.415	
	max	271.645	271.965	271.835	270.965	270.685	270.595	
	min	270.265	270.505	270.435	270.295	270.045	270.215	270.265
	max	281.585	276.675	275.590	274.120	275.755	276.105	270.795
	ave	CD		270.293				

Table 6 - Yearly Minimum and Maximum Water Level – CWC Bawapuram

		2009	2010	2011	2012	2013	2014	2015
		Gauge	Gauge	Gauge	Gauge	Gauge	Gauge	Gauge
Jan	min	306.400	306.810	306.450	306.410	306.150	306.040	306.340
	max	306.700	307.670	306.940	306.830	306.760	306.830	306.950
Feb	min	306.360	306.620	306.490	306.280	305.890	306.020	306.390
	max	306.750	306.890	306.750	306.620	306.460	306.600	306.650
Mar	min	306.120	306.570	306.400	305.960	305.710	305.850	306.210
	max	306.800	306.890	306.600	306.610	306.540	307.300	306.980
Apr	min	306.010	306.570	306.140	306.300	305.800	305.770	306.240
	max	306.190	306.840	307.160	306.600	306.250	306.320	307.120
May	min	306.050	306.550	306.480	306.300	305.720	306.270	306.190
	max	307.660	307.470	306.700	306.745	306.440	306.890	306.695
Jun	min	306.360	306.600	306.280	305.890	306.060	306.020	
	max	307.995	307.250	307.885	307.000	308.195	306.700	
Jul	min	305.920	306.390	306.160	305.880	305.960	305.890	
	max	310.010	306.810	306.750	306.485	311.070	306.470	
Aug	min	307.200	306.280	306.640	305.940	307.550	305.910	
	max	309.830	312.690	309.535	308.115	311.390	312.015	
Sep	min	307.630	307.380	306.820	306.490	307.270	307.000	
	max	310.795	309.750	311.030	309.705	309.520	309.420	
Oct	min	306.750	307.060	306.540	306.440	306.700	306.630	
	max	318.770	310.570	307.655	308.410	308.620	309.140	
Nov	min	307.000	307.400	306.710	306.560	306.760	306.800	
	max	308.030	309.830	307.515	309.555	307.170	307.420	
Dec	min	306.740	306.650	306.480	306.440	306.130	306.400	
	max	307.210	307.640	307.185	306.980	306.810	307.440	
	min	305.920	306.280	306.140	305.880	305.710	305.770	306.190
	max	318.770	312.690	311.030	309.705	311.390	312.015	307.120
	ave	CD		305.950				

Table 7 - Yearly Minimum and Maximum Water Level – CWC Mantralayam

		2009	2010	2011	2012	2013	2014	2015
		Gauge	Gauge	Gauge	Gauge	Gauge	Gauge	Gauge
Jan	min		372.808				372.808	
	max		373.008				373.288	
Feb	min						372.648	372.928
	max						373.128	373.308
Mar	min						372.488	
	max						373.218	
Apr	min						372.218	
	max						372.648	
May	min						372.188	
	max						372.838	
Jun	min	372.198			371.488	371.188	371.178	
	max	372.748			372.508	373.438	372.788	
Jul	min	372.008		371.488	371.178	371.048	370.868	
	max	376.018		372.968	373.048	376.708	372.608	
Aug	min	373.008		372.698	371.298	373.278	371.548	
	max	375.188		375.028	373.248	377.188	377.808	
Sep	min	372.908		372.678	372.158	372.958	372.788	
	max	376.048		376.838	374.968	374.848	374.788	
Oct	min	372.648		372.798	372.318	372.328	372.548	
	max	379.728		373.248	373.518	373.698	374.188	
Nov	min	372.628		372.818	372.878	372.818	372.618	
	max	373.098		373.088	374.308	372.998	373.448	
Dec	min					372.648		
	max					373.278		
	min	372.008	372.808	371.488	371.178	371.048	370.868	372.928
	max	379.728	373.008	376.838	374.968	377.188	377.808	373.308
	ave	CD		371.306				

Table 8 - Yearly Minimum and Maximum Water Level – CWC Ulenoor

2.7 Transfer of Sounding Datum

The Tungabhadra River is a non-tidal river and lowest river-bed level with respect to MSL, for per-km stretch is considered as the datum value for computing sounding datum at different stretches.

2.8 Table indicating Tidal Variation at Different Observation Points

The survey stretch of Tungabhadra River is a non-tidal river and the river dries up fully during the summer season.

2.9 Salient Features of Dam, Barrages etc.

The details of Sunkesula barrage and Rajoli banda diversion scheme were collected during the conduct of survey and the details are as follows:-

2.9.1 Sunkesula Barrage

HYDRAULIC PARTICULARS OF SUNKESULLA BARRAGE		
Chainage	60.27km	**HEAD REGULATOR**

		Design Discharge	3850 Cusecs
SPILLWAY		No. of gates	04 Vertical
Design flood discharge	525000 Cusecs	Size of Gates	8.5 m X 2.5 m
Number of Gates	30 Radial	Sill level	+285.770
Size of Gates	18m X 7m	**KC CANAL**	
Crest Level	+ 285 m	Length of Main Canal	305.60 km
SCOURING SLUICE		Ayacut Kurnool District	184272 Acres
Design Discharge	33300 Cusecs	Ayacut Kadapa District	80550 Acres
No. of Gates	04 Vertical		
Size of Gates	10m X 3.5m		
Sill Level	+284.5m		
Earth Bund Length	1167m		
Flood Bank Length	3265 m		
RESERVOIR			
Full Reservoir Level	+292 m		
Storage Capacity	1.2 TMC		

Table 9 - Salient Features of Sunkesulla Barrage

2.9.2 Rajolibanda

SALIENT FEATURES OF RAJOLIBANDA DIVERSION SCHEME			
Chainage	134.07 km	**IRRIGATION POTENTIAL**	
		Khariff	35127 Acres wet 4603 Perennial
ANICUT WORKS		Rabi	47770 Acres ID
Catchment area at the site	23717 Sq Miles	Spill Way	820 m
Maximum Flood Discharge	750000 Cusecs	Area of Submergence	5.7 Sq km
Water utilization by AP & TS	17.1 TMC	Anicut Type	Ogee type (Masonry anicut)
Water Utilization by Karnataka	1.20 TMC	Length of Anicut	2690 feet
CANAL		Number of regulators	05
Carrying capacity of Canal at Head	850 Cusecs	Size of regulators	6’ x 7’
Bed Width	23 Feet		
Full Supply Depth	7 Feet		
Total Length	89 Miles		
Length in AP	62 Miles		
Length in Karnataka	27 Miles		
Gross Command Area	215000Acres		
Irrigation Proposed in Karnataka	5879 Acres		
No. of Villages Benefited	15		

Table 10 - Salient features of Rajolibanda

2.10 Erected IWAI Benchmark Pillars

New Bench Mark Pillars were constructed as per specification at suitable locations as specified in the contract. The extension of horizontal control was made by the baseline processing of 06 hourly DGPS observations carried out with the nearest reference station. The value of these benchmarks w.r.t. MSL was obtained by Auto leveling with GTS Bench Mark obtained from CWC office Kurnool. The final accepted co-ordinates and a reduced level (R.L) value of IWAI BM Pillar are as below:-

Station	Chainage (km)	Latitude (N) / Longitude (E)	Easting / Northing	Ellipsoidal Height (m)	Height above MSL (m)	CD w.r.t. MSL (m)	BM Height w.r.t. Established CD/SD (m)
IWAI_BM_TNG_01	-0.14	15°57'48.96046"N 78°17'01.99180"E	209253.15 1766805.4	200.991	283.554	249.7	33.854
IWAI_BM_TNG_02	9.24	15°53'44.05072"N 78°12'22.42103"E	200833.73 1759382.7	202.304	283.789	259.0	24.789
IWAI_BM_TNG_03	15.74	15°53'00.59279"N 78°08'19.27149"E	193577.78 1758143.9	189.896	272.753	254.5	12.253
IWAI_BM_TNG_04	27.42	15°49'25.68133"N 78°05'19.35214"E	188129.86 1751607.2	194.913	277.307	263.2	14.107
IWAI_BM_TNG_05	37.63	15°52'00.30333"N 78°00'41.55909"E	179925.09 1756479.9	200.005	282.306	267.5	14.806
IWAI_BM_TNG_06	49.39	15°53'21.0923"N 77°54'21.0215"E	811185.27 1758840.3	205.099	289.484	276.1	13.384
IWAI_BM_TNG_07	62.31	15°52'20.5029"N 77°48'43.5807"E	801165.4 1756839.3	214.363	296.595	285.0	11.595
IWAI_BM_TNG_08	75.44	15°53'0.0129"N 77°42'1.2528"E	789173.16 1757896.8	215.442	296.331	286.0	10.331
IWAI_BM_TNG_09	88.48	15°54'31.1851"N 77°35'21.8267"E	777249.83 1760550.3	222.694	303.195	295.6	7.595
IWAI_BM_TNG_10	99.06	15°55'51.0443"N 77°29'44.5915"E	767184.89 1762883.9	227.862	309.682	301.6	8.082
IWAI_BM_TNG_11	108.54	15°56'19.7524"N 77°24'50.4305"E	758422.38 1763663.6	230.795	313.637	305.95	7.687
IWAI_BM_TNG_12	117.54	15°56'50.3401"N 77°19'59.6094"E	749759.71 1764505.7	238.526	319.133	311.0	8.133
IWAI_BM_TNG_13	128.49	15°57'10.6171"N 77°14'11.3738"E	739393.75 1765015.5	251.594	332.682	323.3	9.382
IWAI_BM_TNG_14	140.52	15°55'53.1767"N 77°07'45.8207"E	727949.68 1762514.5	258.15	337.498	331.5	5.998
IWAI_BM_TNG_15	151.15	15°52'53.8819"N 77°03'33.5942"E	720501.02 1756927.2	258.782	338.122	331.5	6.622
IWAI_BM_TNG_16	157.95	15°49'57.1611"N 77°01'36.8619"E	717080.36 1751460.5	264.846	345.536	332.5	13.036
IWAI_BM_TNG_17	170.23	15°45'33.3305"N 76°56'35.3901"E	708183.52 1743265.3	263.538	345.169	332.5	12.669
IWAI_BM_TNG_18	178.46	15°41'29.2662"N 76°54'45.9645"E	704993.87 1735732.9	263.046	348.084	340.2	7.884
IWAI_BM_TNG_19	186.40	15°38'38.0403"N	699724.16	279.938	360.653	347.2	13.453

Station	Chainage (km)	Latitude (N)	Easting	Ellipsoidal Height	Height above	CD w.r.t.	BM Height w.r.t.
		76°51’47.4509”E	1730422.1				
IWAI_BM_TNG_20	194.74	15°34’55.0903”N 76°50’11.9031”E	696937.38 1723544.2	285.671	367.782	353.8	13.982
IWAI_BM_TNG_21	203.61	15°30’43.1393”N 76°48’39.8700”E	694261 1715776.2	289.975	370.922	356.3	14.622
IWAI_BM_TNG_22	212.26	15°29’18.5103”N 76°44’7.0878”E	686152.26 1713107.6	293.761	376.311	371.306	5.005
IWAI_BM_TNG_23	221.13	15°27’4.1921”N 76°40’28.7067”E	679675.45 1708927.5	302.042	383.768	371.306	12.462
IWAI_BM_TNG_24	232.45	15°24’25.2198”N 76°35’15.9222”E	670387.35 1703970.7	305.215	387.498	371.8	15.698

Table 11 - Established IWAI-BM-Pillars

2.11 Chart Datum / Sounding Datum and Reductions Details

The water availability in Tungabhadra River is very less, hence spot leveling by topographic method was attempted for the entire survey stretch of Tungabhadra River. The least MSL level for the per-kilometer stretch was obtained as the established Chart Datum. The details of topographic level converted as depth for volume calculation is forwarded as soft copy along with the report.

2.12 HFL/MHWS values of Bridges/Cross Structures

The established HFL values of 03 CWC gauges (Bawapuram, Mantrayalam, and Ulenoor) and the flood level and ponding limit of the Sunkesula and other Barrages were considered for the computations of HFL values at respective chainages. The HFL values for the remaining survey stretch of Tungabhadra river was computed and the details are as follows:-

Sl. No.	Location and Description of CWC gauge / Dam / Barrages / Weirs / Anicut / Locks / Aqueducts / BM	Cross-Structure Details	Chainage (km)	Established HFL / MHWS / FSL / MWL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
1	Alampur Check Dam	Check Dam	17.17	-	265.2
2	Alampur Village	Bridge (Under Construction)	17.14	-	265.2
3	Devmada Village Check Dam 1	Check Dam	23.00	-	267.91
4	Devmada Village Check Dam 2	Check Dam	23.46	-	268.19

Sl. No.	Location and Description of CWC gauge / Dam / Barrages / Weirs / Anicut / Locks / Aqueducts / BM	Cross-Structure Details	Chainage (km)	Established HFL / MHWS / FSL / MWL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
5	Devmada Village Check Dam 3	Check Dam	23.84	-	268.38
6	Devmada Village Check Dam 4	Check Dam	24.31	-	268.57
7	Devmada Village Check Dam 5	Check Dam	24.37	-	268.57
8	Kurnool City	Railway Bridge	33.93	-	273.06
9	Panchalingala	NH-7 Hyderabad To Kurnool Bridge	37.51	-	274.74
10	Panchalingala	Nh-7 Kurnool To Hyderabad Bridge	37.53	-	274.74
11	CWC Gauge Bawapuram	Gauge	45.04	277.738	-
12	Sunkesula Barrage	Barrage	60.27	292.000	-
13	Sunkesula	Bridge	60.28	-	292.00
14	Nagaladinne	Bridge	90.96	-	303.87
15	CWC Gauge Mantralayam	Gauge	106.52	313.328	-
16	Madhavaram	Bridge	114.42	-	317.1
17	Madhavaram Check Dam	Check Dam	114.47	-	317.1
18	Mantralayam Road Station	Bridge	120.99	-	323.08
19	Rajoli Check Dam	Check Dam	127.14	-	323.56
20	Jukur Check Dam	Check Dam	129.54	-	330.55
21	Rajolibanda	Dam	134.07	-	338.58
22	Dadesagur	Bridge	179.99	-	349.13
23	CWC Gauge Ullenoor	Gauge	214.38	377.636	-
24	Belugoduhal	Pipe line	228.08	-	378.13
25	Kampli	Bridge 6	232.43	-	378.13

Table 12 - HFL values of Bridges/Cross Structures

2.13 Graph: Sounding Datum and HFL vs Chainage

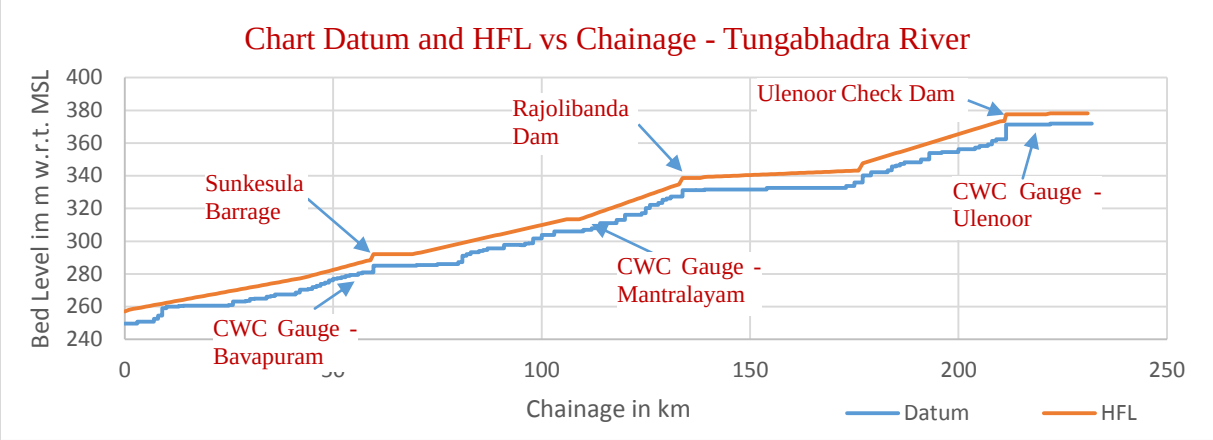


Figure 7 - CD and HFL vs Chainage

2.14 Average Bed Slope

The Average bed slope of Tungabhadra River is as follows:-

Reach and River-bed Level (RBL)		River-bed Level Change (m) (A)	Distance (km) (B)	Slope (A/B)
From	To			
Ch. 0 - RBL_253.969	Ch. 20 - RBL_261.74	7.771	20	1 : 0.389
Ch. 20 - RBL_261.74	Ch. 40 - RBL_273.235	11.495	20	1 : 0.575
Ch. 40 - RBL_273.235	Ch. 60 - RBL_281.795	8.56	20	1 : 0.437
Ch. 60 - RBL_281.795	Ch. 90 - RBL_296.155	14.36	30	1 : 0.479
Ch. 90 - RBL_296.155	Ch. 114 - RBL_311.494	15.339	24	1 : 0.639
Ch. 114 - RBL_311.494	Ch. 140 - RBL_333.746	22.252	26	1 : 0.856
Ch. 140 - RBL_333.746	Ch. 165 - RBL_333.953	0.207	25	1 : 0.008
Ch. 165 - RBL_333.953	Ch. 190 - RBL_353.194	19.241	25	1 : 0.770
Ch. 190 - RBL_353.194	Ch. 210 - RBL_364.769	11.575	20	1 : 0.579
Ch. 210 - RBL_364.769	Ch. 232.4 - RBL_375.971	11.202	22.4	1 : 0.500

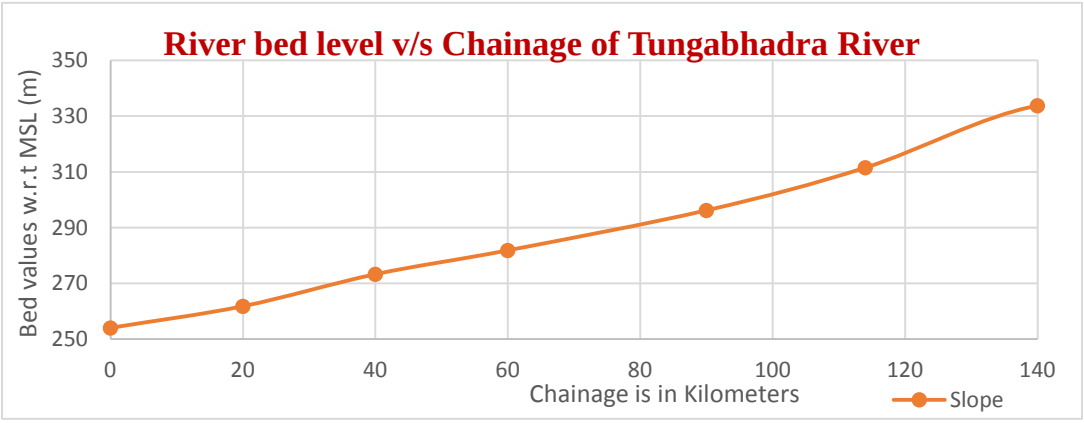


Table 13 - Average Bed Slope

2.15 Details of Dam, Barrages, Weirs, Anicut, etc

Sl. No.	Structure Name	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	Height w.r.t. Crest Level above MSL (m)	Present Condition
1	Alampur Check Dam	17.17	Alampur	**Right Bank:** 15°52'19.05"N 78°07'52.70"E **Left Bank:** 15°52'14.32"N 78°07'56.00"E	**Right Bank:** 192769.262 1756876.941 **Left Bank:** 192865.512 1756730.106	176.66	10.06	261.316	Operational
2	Devmada Check Dam 1	23.00	Devmada	**Right Bank:** 15°49'30.59"N 78°07'37.38"E **Left Bank:** 15°49'28.94"N 78°07'40.45"E	**Right Bank:** 192242.159 1751701.55 **Left Bank:** 192332.882 1751649.547	106.54	8.14	263.324	Operational
3	Devmada Check Dam 2	23.46	Devmada	**Right Bank:** 15°49'23.09"N 78°07'24.51"E **Left Bank:** 15°49'19.80"N 78°07'27.56"E	**Right Bank:** 191855.759 1751476.107 **Left Bank:** 191945.196 1751373.666	138.97	7.89	263.171	Operational
4	Devmada Check Dam 3	23.84	Devmada	**Right Bank:** 15°49'15.74"N 78°07'13.43"E **Left Bank:** 15°49'14.15"N 78°07'16.93"E	**Right Bank:** 191522.247 1751254.551 **Left Bank:** 191626.271 1751204.215	116.94	8.23	264.025	Operational
5	Devmada Check Dam 4	24.31	Devmada	**Right Bank:** 15°49'10.50"N 78°07'00.30"E **Left Bank:** 15°49'07.96"N 78°07'00.38"E	**Right Bank:** 191129.513 1751098.739 **Left Bank:** 191130.822 1751020.578	79.2	9.4	263.564	Operational
6	Devmada Check Dam 5	24.37	Devmada	**Right Bank:** 15°49'11.90"N 78°06'58.38"E **Left Bank:** 15°49'06.55"N 78°06'58.37"E	**Right Bank:** 191072.929 1751142.58 **Left Bank:** 191070.371 1750978.029	172.89	11.26	236.902	Operational
7	Sunkesula Barrage	60.27	Sunkesula	**Right Bank:** 15°53'13.20"N 77°49'19.31"E **Left Bank:** 15°52'39.88"N 77°49'57.75"E	**Right Bank:** 802207.185 1758474.497 **Left Bank:** 803365.327 1757465.108	1557.45	18.85	296.471	Operational
8	Madhavaram	114.47	Madhavaram	**Right Bank:**	**Right Bank:**	399.2	12.53	312.475	Operational

Sl. No.	Structure Name	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	Height w.r.t. Crest Level above MSL (m)	Present Condition
	Check Dam			15°57'04.74"N 77°21'43.07"E	752832.539 1764983.092				
				Left Bank: 15°56'52.29"N 77°21'40.64"E	**Left Bank:** 752764.587 1764599.455				
9	Rajoli Check Dam	127.14	Rajoli	**Right Bank:** 15°57'57.06"N 77°14'38.75"E	**Right Bank:** 740192.702 1766452.225	788.01	7.55	325.241	Operational
				Left Bank: 15°57'39.31"N 77°14'57.84"E	**Left Bank:** 740766.42 1765912.605				
10	Jukur Check Dam	129.54	Jukur	**Right Bank:** 15°57'39.95"N 77°13'45.20"E	**Right Bank:** 738605.53 1765909.05	697.57	8.32	325.164	Operational
				Left Bank: 15°57'29.80"N 77°13'23.23"E	**Left Bank:** 733714.693 1765739.158				
11	Rajolibanda	134.07	Rajalbanda	**Right Bank:** 15°57'36.11"N 77°11'0.73"E	**Right Bank:** 733714.693 1765739.158	838.64	9.42	329.945	Operational
				Left Bank: 15°57'9.07"N 77°11'03.07"E	**Left Bank:** 733793.011 1764908.538				
12	Ulenoor Check Dam	211.08	Ulenoor	**Right Bank:** 15°29'35.02"N 76°44'46.60"E	**Right Bank:** 687325.834 1713624.65	507.44	9.46	373.311	Operational
				Left Bank: 15°29'25.66"N 76°44'57.28"E	**Left Bank:** 687646.505 1713339.545				

Table 14 - Details of Dam, Barrages

2.16 Details of Locks

There are no Locks present in the entire survey stretch of Tungabhadra River.

2.17 Details of Aqueducts

There are no Aqueducts present in the survey stretch of Tungabhadra River.

2.18 Details of existing Bridges and Crossings over Waterway

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank Right Bank	Left Bank Right Bank						
1	Alampur Bridge	17.14	RCC	Alampur Village	**Left Bank** 15°52'0.15"N 78°8'11.70"E **Right Bank** 15°52'30.16"N 78°7'42.19"E	**Left Bank** 193327.96 1756288.96 **Right Bank** 192461.56 1757223.87	890	5.18	24	24.282	9.207	Under construction
2	Kurnool Railway Bridge	33.93	RCC	Kurnool City	**Left Bank** 15°50'42.03"N 78° 2'14.90"E **Right Bank** 15°51'8.15"N 78° 2'28.51"E	**Left Bank** 182670.17 1754032.59 **Right Bank** 183086.77 1754830.34	899	4.84	44	12.755	10.441	Operational
3	NH-7 Hyderabad To Kurnool Bridge	37.51	RCC	Panchalingala	**Left Bank** 15°51'33.61"N 78°0'31.17"E **Right Bank** 15°51'52.22"N 78°0'39.49"E	**Left Bank** 179604.31 1755663.00 **Right Bank** 179860.13 1756232.809	625	11.7	16	12.37	9.188	Operational
4	Nh-7 Kurnool To Hyderabad Bridge	37.53	RCC	Panchalingala	**Left Bank** 15°51'33.53"N 78°0'30.43"E **Right Bank** 15°51'52.53"N 78°0'38.94"E	**Left Bank** 179582.02 1755661.91 **Right Bank** 179843.70 1756241.85	635	8.32	30	12.606	9.372	Operational
5	Sunkesula Bridge	60.28	RCC	Sunkesula	**Left Bank:** 15°52'56.88"N 77°49'42.67"E **Right Bank** 15°52'39.94"N 77°49'57.89"E	**Left Bank** 802917.569 1757976.47 **Right Bank** 803375.977 1757474.76	402.8	9.31	30	12.556	8.508	Operational
6	Nagaladinne Bridge	90.96	RCC	Nagaladinne	**Left Bank** 15°55'17.44"N 77°34'8.28"E **Right Bank** 15°54'59.92"N 77°34'8.66"E	**Left Bank** 775045.885 1761932.95 **Right Bank** 775083.005 1761391.52	600	-	22	25	7.2	Ruined/under construction
7	Madhavaram Bridge	114.42	RCC	Madhavaram	**Left Bank** 15°57'7.72"N 77°21'46.22"E **Right Bank** 15°56'48.70"N 77°21'40.96"E	**Left Bank** 752928.374 1765065.42 **Right Bank** 752774.569 1764472.18	603.1	12.403	12	40.208	9.439	Operational
8	Mantralayam Bridge	120.99	RCC	Mantralayam Road Station	**Left Bank** 15°57'46.56"N 77°18'13.43"E **Right Bank** 15°57'11.74"N 77°18'2.89"E	**Left Bank** 746598.92 1766197.20 **Right Bank** 746269.508 1765109.69	797	14.322	34	21.533	10.164	Operational
9	Dadesagur Bridge	179.99	RCC	Dadesagur	**Left Bank** 15°41'25.92"N 76°53'46.06"E **Right Bank** 15°41'9.92"N 76°53'45.05"E	**Left Bank** 703218.146 1735615.49 **Right Bank** 703189.938 1735113.42	493	5.933	34	13.678	7.784	Operational
10	Kampli Bridge	232.43	RCC	Kampli	**Left Bank** 15°24'43.85"N 76°35'8.01"E	**Left Bank** 670153.049 1704537.80	603.4	7.119	50	11.605	3.751	Operational

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank Right Bank	Left Bank Right Bank						
					Right Bank 15°24'25.22"N 76°35'16.30"E	**Right Bank** 670408.822 1703943.32						

Table 15 - Details of Existing Bridges and Crossings over Waterway

2.19 Details of other Cross structures, pipelines, underwater cables

There is numerous small pipeline connection between Drinking water well and shore Pump houses in the Tungabhadra River, however, no major Pipelines or underwater cables cross-through the Tungabhadra River.

Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)	Remarks (complete / under - construction), in use or not, condition
Pipe line	228.08	RCC	Belugoduhal	**Left Bank** 15°26'38.65"N 76°36'26.13"E **Right Bank** 15°26'19.14"N 76°36'36.63"E	**Left Bank** 672456.456 1708103.287 **Right Bank** 672778.3380 1707472.639	799.36	2.812	80	9.992	9.910	Operational

Table 16 - Details of other Cross structures, Pipelines

2.20 High Tension Lines / Electric lines / Telecommunication lines

Total 09 in numbers High Tension electrical lines were present in the Tungabhadra River and the height of the high tension line was also measured by ETS. There are no piers for electrical lines constructed in between the river bed of Tungabhadra River.

Sl. No.	Type of Line	Chainage (km)	Location	Position (Geographic)	Position (UTM)	No. of Piers	Clearance between Piers	Vertical clearance from HFL (M)	Remarks
1		25.88	Pudur	**Left Bank:** 15°49'08.13"N7 8° 06'07.16"E **Right Bank:** 15°48'55.83"N7 8° 06'10.21"E	**Left Bank:** 189546.06 1751047.62 **Right Bank:** 189631.66 1750668.3	-	-	32	Complete
2	HTL	27.01	Padidempadu	**Left Bank:** 15°49'07.64"N7 8° 05'30.67"E	**Left Bank:** 188459.20 1751047.57	-	-	33	Complete

Sl. No.	Type of Line	Chainage (km)	Location	Position (Geographic)	Position (UTM)	No. of Piers	Clearance between Piers	Vertical clearance from HFL (M)	Remarks
				Right Bank: 15°49'00.46"N 78° 05'30.91"E	**Right Bank:** 188463.28 1750826.00				
3	HTL	37.68	Kurnool	**Left Bank:** 15°51'52.82"N78° 00'34.80"E	**Left Bank:** 179720.56 1756252.53	-	-	35	Complete
				Right Bank: 15°51'36.91"N 78° 0'25.51"E	**Right Bank:** 179436.96 1755767.06				
4	HTL	37.73	Kurnool	**Left Bank:** 15°51'53.65"N78° 00'32.88"	**Left Bank:** 17966.76 1756278.88	-	-	35	Complete
				E **Right Bank:** 15°51'37.66"N78° 0'23.95"E	**Right Bank:** 179378.93 1755790.96				
5	HTL	46.64	Singavaram	**Left Bank:** 15°53'09.06"N77°55'59.81"E	**Left Bank:** 814131.32 1758511.20	-	-	36	Complete
				Right Bank: 15°52'59.74"N 77°55'55.43"E	**Right Bank:** 814004.94 1758222.69				
6	HTL	74.76	Gundrevula	**Left Bank:** 15°53'27.14"N77°42'06.69"E	**Left Bank:** 789228.65 1766114.42	-	-	35	Complete
				Right Bank: 15°53'13.25"N 77°42'19.74"E	**Right Bank:** 789718.18 1758311.00				
7	HTL	109.49	Mantralayam	**Left Bank:** 15°56'41.23"N77°24'13.78"E	**Left Bank**: 757324.36 1764311.45	-	-	38	Complete
				Right Bank: 15°56'27.39"N77°24'15.84"E	**Right Bank:** 757390.55 1763886.59				
8	HTL	182.03	Kengal	**Left Bank:** 15°40'37.01"N 76°53'0.43"E	**Left Bank:** 701875.53 1732960.72	-	-	40	Complete
				Right Bank: 15°40'33.57"N76°53'07.40"E	**Right Bank:** 702073.94 1733994.49				
9	HTL	231.11	Kampli Village	**Left Bank:** 15°25'06.41"N 76°35'36.35"E	**Left Bank:** 670987.06 1705241.83	-	-	45	Complete
				Right Bank: 15°25'02.36"N76°35'47.40"E	**Right Bank:** 671317.43 1705119.18				

Table 17 - Details of High Tension Lines / Electric lines

2.21 Current Meter and Discharge Details

Current meter observation is not done in Tungabhadra River due to non-availability of water.

2.22 Water Sample Locations

Water Samples were not collected in Tungabhadra River due to non-availability of water.

3 Description of Waterway

The survey area of Tungabhadra River is coming under two zones (Zone-43 & Zone-44) and the entire river chainage is divided into various stretches in accordance with the geographical condition of the river. The details are as follows:

Tungabhadra River stretch in Zone-43

3.1 Sub-Stretch-01: Murva-Konda Village to Kindi Singavaram Village (0km to 20km)

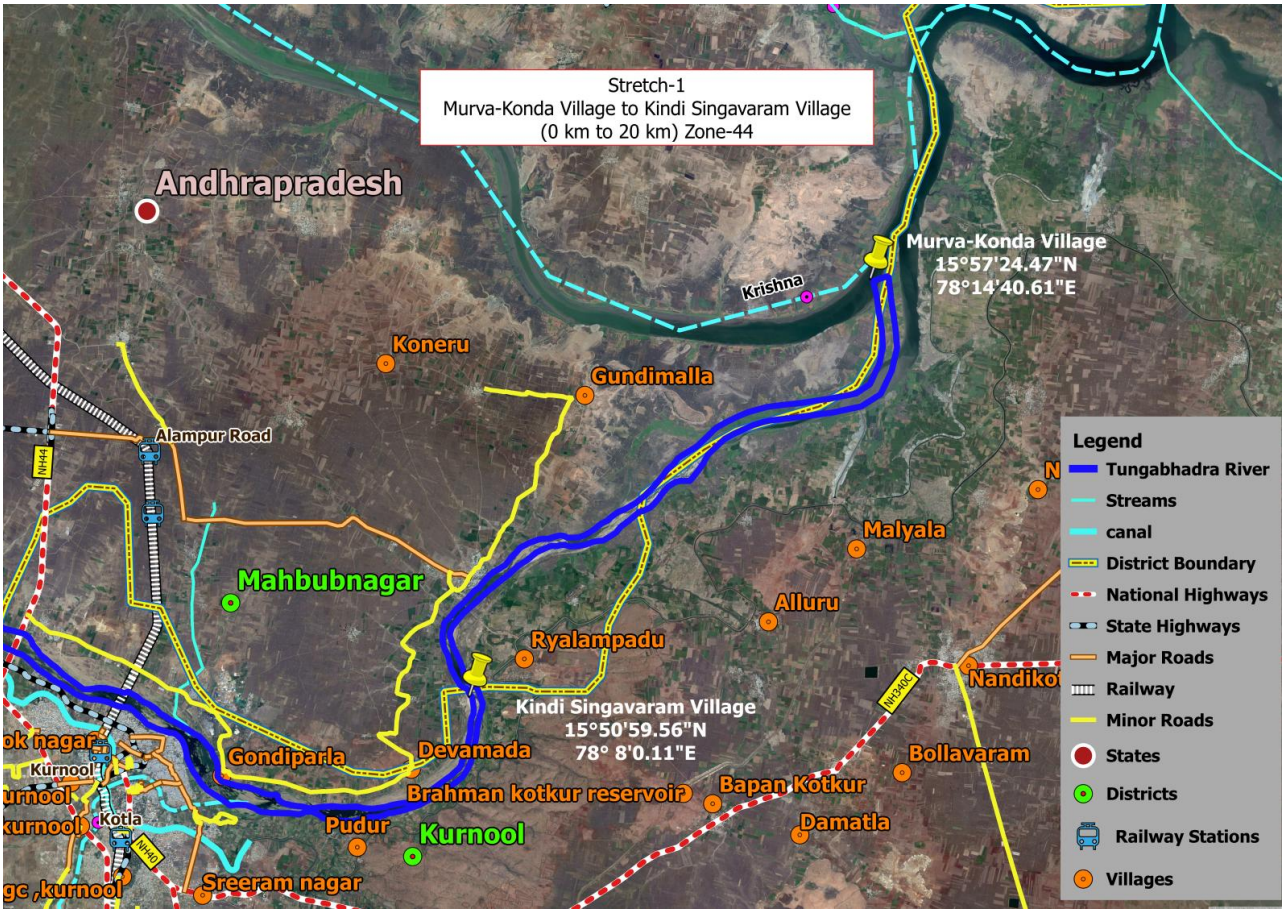


Figure 8 - Stretch-01 Murva-Konda Village to Kindi Singavaram Village

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 20km of the length of the stretch for which the topographic survey has been carried out.

This stretch is between 0 to 20km chainage of Tungabhadra River. It is the Downstream portion of the Tungabhadra River where it confluence with the Krishna River. The downstream portion of this stretch is comparatively wider than upper stretch and no water is available at this portion, the river bed is mostly sandy and villagers are observed to be crossing the river on two-wheelers to another side of the river near Murva Konda village. Whereas river stretch near to Jogulamba Temple is rocky at some places. Water is impounded at Jogulamba Temple near about 300 m stretch, pilgrims to Jogulamba Temple performs their holy rituals here and take a holy dip. Pumping station for drinking water supply for the nearby village also exist here. Sump for storing/supply water is also constructed near the temple. Some fishing activities observed near the Temple.

An under construction bridge exists in this stretch near Jogulamba Temple, which connects Alampur to Ryalampadu village, however, construction of the bridge has been stopped halfway for unknown reasons, a reclaimed mud road near to bridge is being used by vehicles as well as pedestrians to cross the river. Famous Jogulamba and Bala Brahmeshwara Swamy Temple of Alampur exist in this stretch. Temple has a great historical value and pilgrims attraction throughout the country. It is known as “Dakshina Kashi” and one of the “Shakti Peeta”. Marvelous temple and remains of ancient temple signify Badami Chalukyan architecture.

There are no ferry services in this stretch of Tungabhadra River, however, the country made round shaped boats (Putty) are being used for transportation and fishing activities across the river.

Figure 9 - View of Bridge at Alampur from Left Bank (ch. 17.17km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	0	20	0.000	0.000	20000	859,634.43	859,634.43	-0.300	0.000	20000	1,097,187.57	1,097,187.57
II	0	20	0.000	0.000	20000	1,309,337.42	1,309,337.42	-0.300	0.000	20000	1,613,856.56	1,613,856.56
III	0	20	0.000	0.000	20000	1,978,903.30	1,978,903.30	-0.300	0.000	20000	2,356,884.09	2,356,884.09
IV	0	20	0.000	0.000	20000	2,387,804.74	2,387,804.74	-0.300	0.000	20000	2,782,726.61	2,782,726.61

Table 18 - Stretch 1 Dredging Quantity

3.1.1 Stretch-1 - Observed and Reduced River-bed Profile

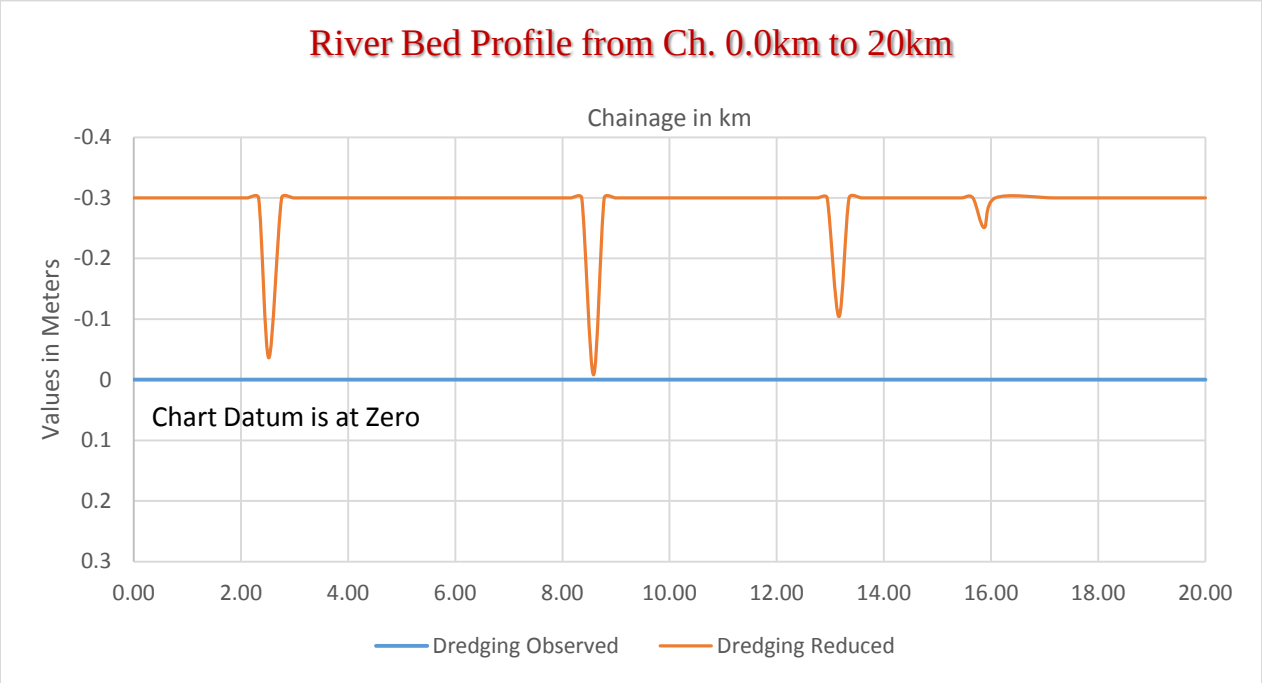


Figure 10 - Stretch 1 River-bed Profile

3.2 Sub-Stretch-02: Kindi Singavaram Village to Munagalapadu Village (20km to 40km)

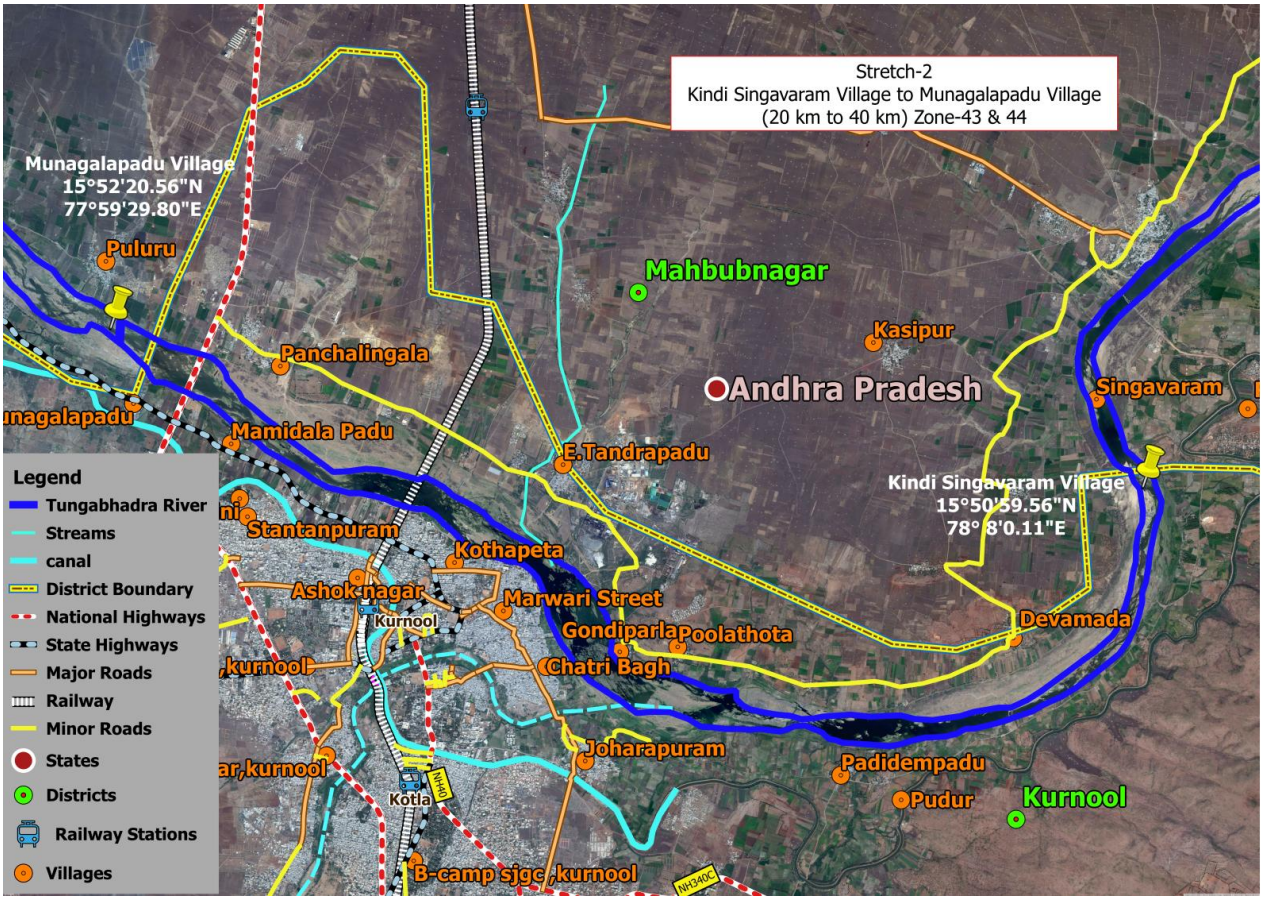


Figure 11 - Stretch-02 Kindi Singavaram Village to Munagalapadu Village

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 20km of the length of the stretch for which the topographic survey has been carried out.

This stretch is between 20 to 40km chainage of Tungabhadra River. The river banks of this stretch are unprotected in nature but the high rise river banks on both sides prevent the flood in the area. The paddy cultivation is very prominent in the area. Sand mining in tractors and bullock carts is observed in this stretch. Outcrops are also observed at some places. Aquatic vegetation is also observed near to railway bridge at Kurnool, waste water of Kurnool town drains near to this bridge on the right bank of Tungabhadra River.

Sree Rayalaseema Alkalies and Allied Chemicals Ltd. and Sai Rayalaseema Paper Mills Ltd. are present in the left bank of Tungabhadra River in this stretch. Nawab Bangla (RBS) to Paper Mill (LBS) ferry route exists in this stretch, however, due to none availability of sufficient waters in the area peoples are using "Putty" for transportation across the channel.

A bridge on Kurnool to Hyderabad national highway (NH-7) and railway bridge near postal colony Kurnool exist in this stretch. Many pumping stations are observed in this stretch to meet daily requirements of nearby residents.

Figure 12 - View of Railway Bridge Kurnool (ch. 33.93km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	20	38.5	0.000	0.000	18500	797,448.71	1,657,083.14	-0.300	0.000	18500	1,029,150.48	2,126,338.05
II	20	38.5	0.000	0.000	18500	1,214,628.65	2,523,966.07	-0.300	0.000	18500	1,512,463.29	3,126,319.85
III	20	38.5	0.000	0.000	18500	1,835,787.19	3,814,690.49	-0.300	0.000	18500	2,205,305.81	4,562,189.90
IV	20	38.5	0.000	0.000	18500	2,215,122.04	4,602,926.78	-0.300	0.000	18500	2,601,160.81	5,383,887.42

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	38.5	40	0.000	0.000	1500	62,459.17	62,459.17	-0.300	0.000	1500	80,673.27	80,673.27
II	38.5	40	0.000	0.000	1500	95,163.20	95,163.20	-0.300	0.000	1500	118,590.52	118,590.52
III	38.5	40	0.000	0.000	1500	143,821.50	143,821.50	-0.300	0.000	1500	172,886.47	172,886.47
IV	38.5	40	0.000	0.000	1500	173,542.11	173,542.11	-0.300	0.000	1500	203,908.25	203,908.25

Table 19 - Stretch 2 Dredging Quantity

3.2.1 Stretch-2 - Observed and Reduced River-Bed Profile

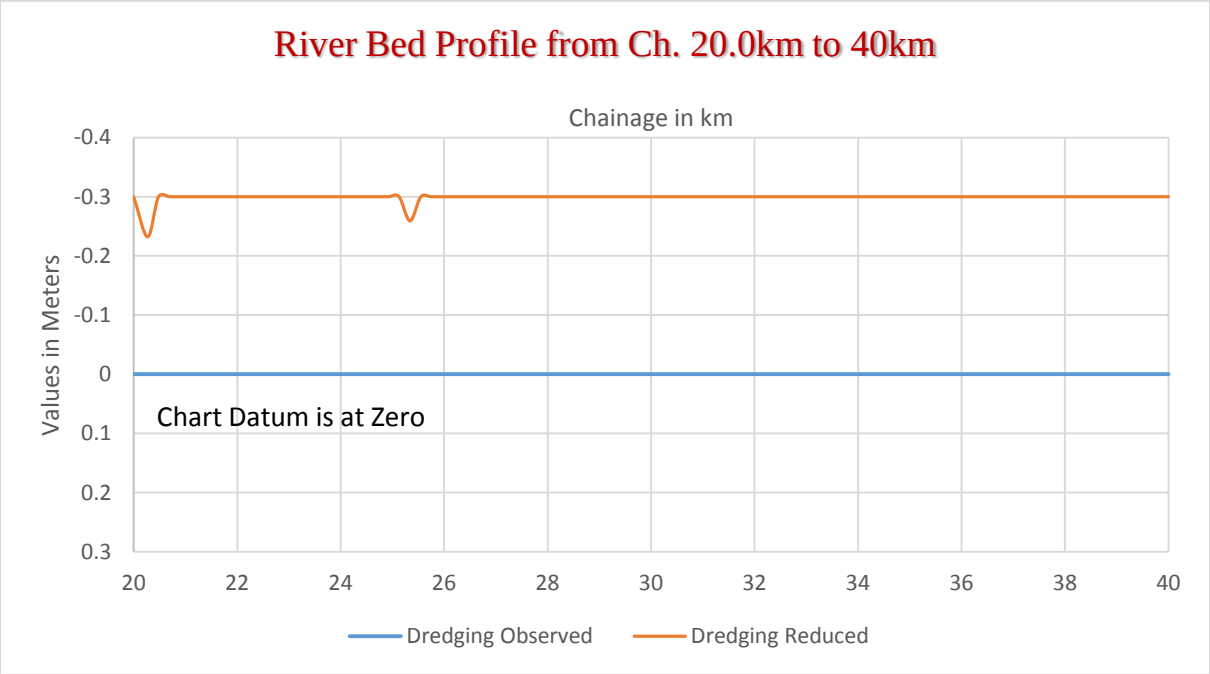


Figure 13 - Stretch 2 River-bed Profile

3.3 Sub-Stretch-03: Munagalapadu Village to Downstream of Sunkesula Barrage (40km to 60.0km)

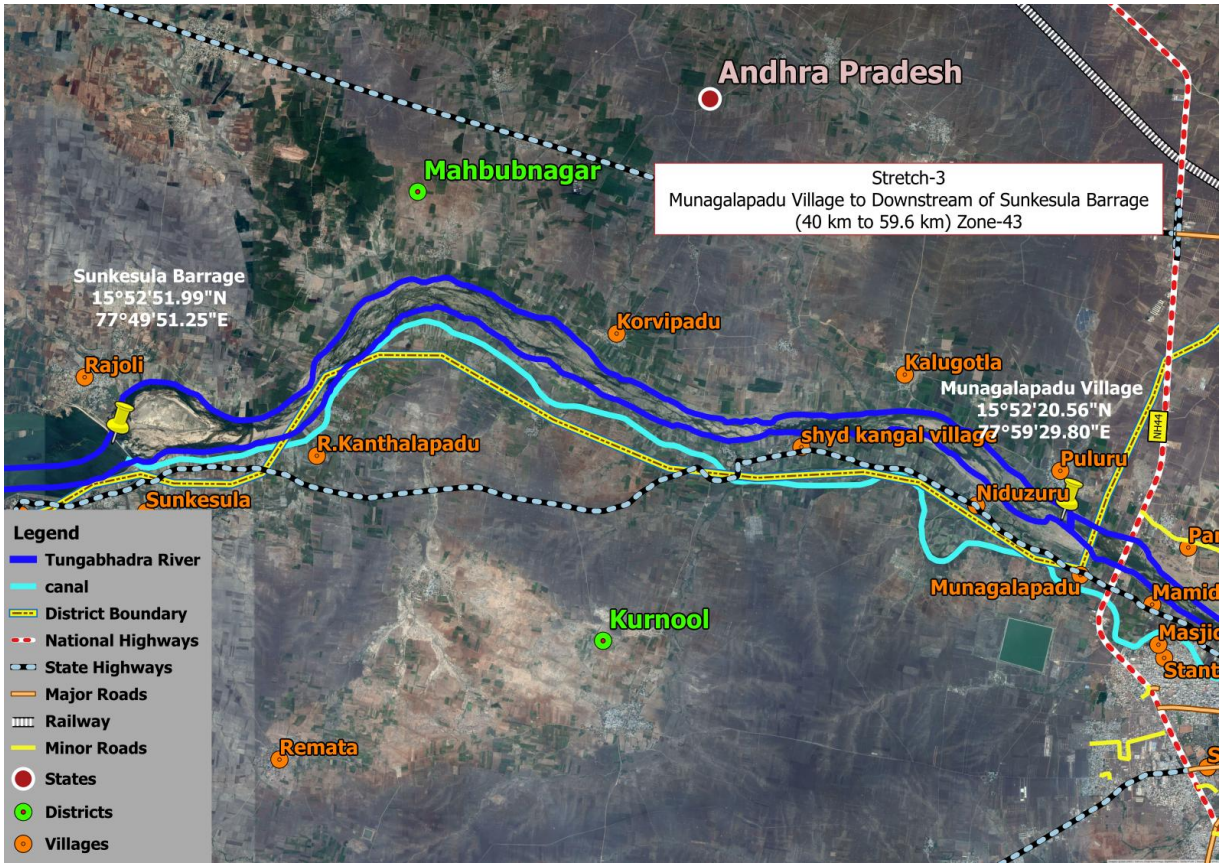


Figure 14 - Stretch-03 Munagalapadu Village to Downstream of Sunkesula Barrage

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 20km of the length of the stretch for which the topographic survey has been carried out.

This stretch is part of the downstream portion of Sunkesula Barrage up to NH-7 Bridge at Kurnool. The area covers the river chainage of 40 to 59.6km of Tungabhadra River. This stretch has a gradient of 10.5 m and consists of abundant rock boulders and outcrops; hence navigation is not feasible in this stretch.

There is no overhead obstruction/crossover present in the entire river stretch. CWC site-31 at Bawapuram exists in the stretch. A series of manual tide gauges and an automated

tide gauge with telemetry link is installed on the site. On discussion with site engineer, it is observed that water level has dried down 0.5 m below zero of gauge and expected to move further down. It is also revealed that site office is provided with a motor boat but due to non-availability of sufficient water and presence of outcrops boat operations are not feasible.

Figure 15 - Sunkesula Barrage downstream view (ch. 60.27km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	40	60	0.000	0.000	20000	861,487.85	923,947.02	-0.300	0.000	20000	1,101,212.23	1,181,885.50
II	40	60	0.000	0.000	20000	1,312,174.08	1,407,337.28	-0.300	0.000	20000	1,620,604.20	1,739,194.72
III	40	60	0.000	0.000	20000	1,983,210.66	2,127,032.16	-0.300	0.000	20000	2,365,964.06	2,538,850.53
IV	40	60	0.000	0.000	20000	2,393,020.41	2,566,562.52	-0.300	0.000	20000	2,792,900.50	2,996,808.75

Table 20 - Stretch 3 Dredging Quantity

3.3.1 Stretch-3 – Observed and Reduced River-Bed Profile

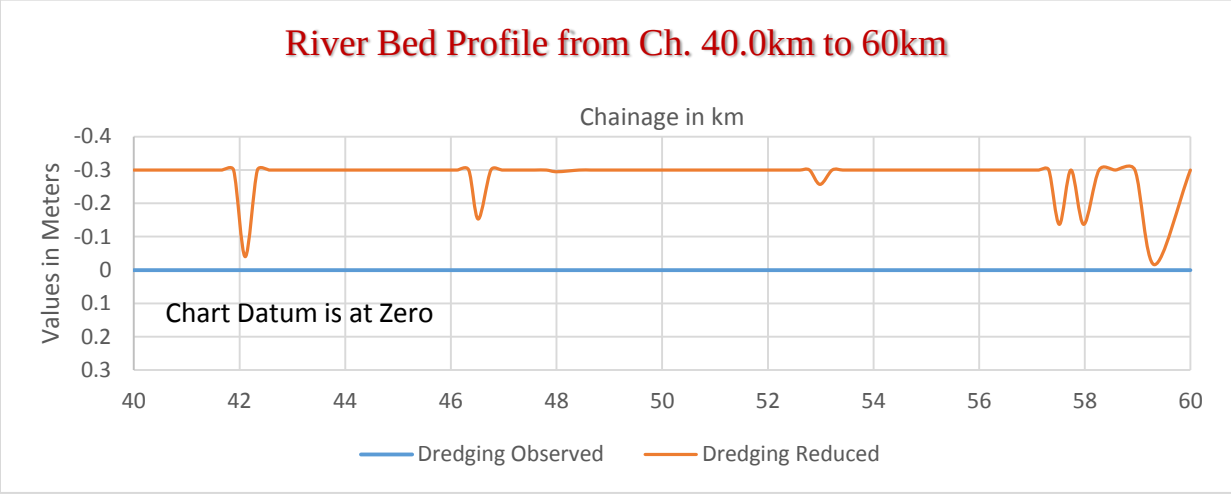


Figure 16 - Stretch 3 River-bed Profile

3.4 Sub-Stretch-04: Sunkesula Barrage to Guruzala Village (60.0km to 90km)

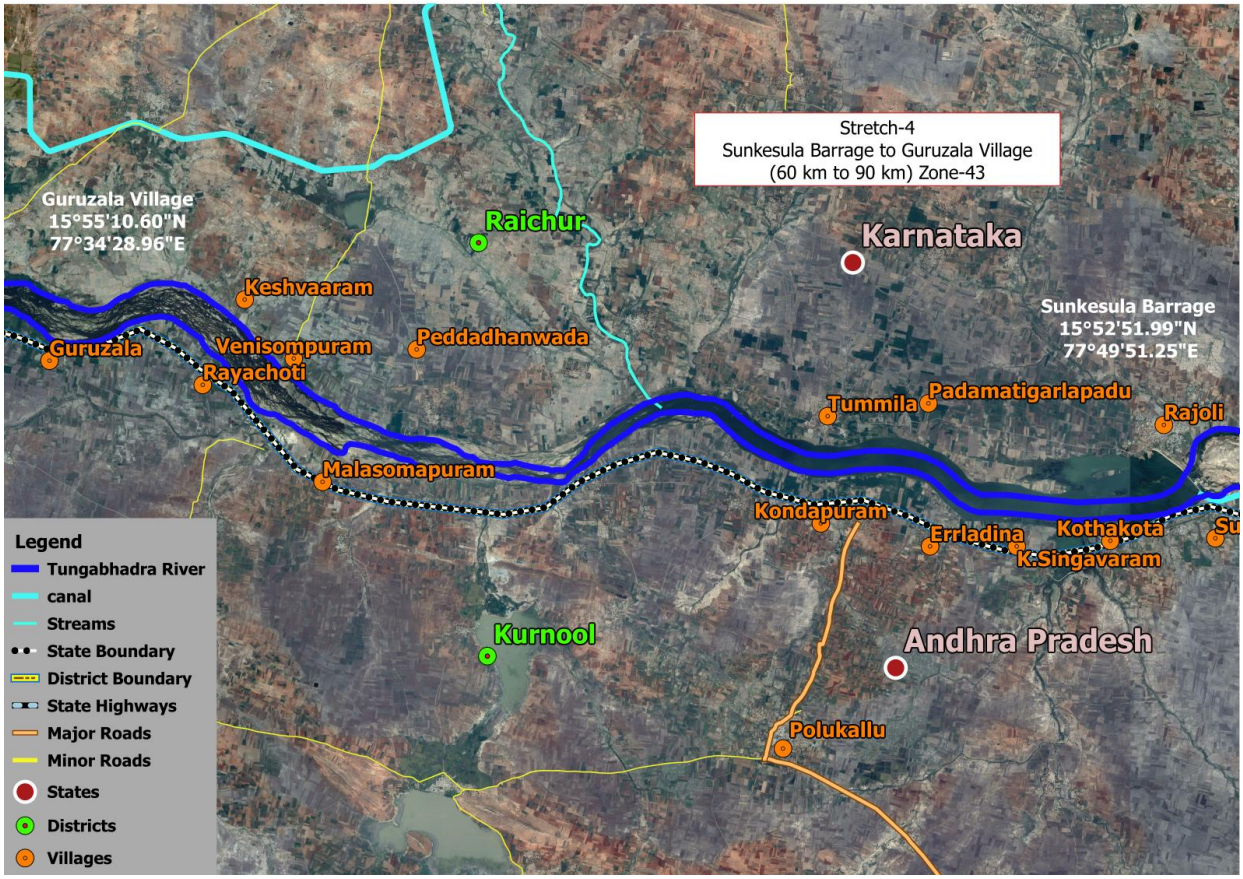


Figure 17 - Stretch-04 Sunkesula Barrage to Guruzala Village

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 30km of the length of the stretch for which the topographic survey has been carried out.

This stretch is a part of the upstream portion of Sunkesula Barrage. The area covers the river chainage from 60 to 90km of Tungabhadra River starting from Sunkesula Barrage. Irrigational K. C. canal also originates from this stretch which covers Kurnool and Cuddapah districts. It was observed that Sunkesula Barrage has dried down to Sill level hence there is no water left in K. C. canal. The downstream portion of this stretch is

mostly sandy whereas upstream portion consists of abundant rock boulders and outcrops. This river stretch has a gradient of 10m.

There is no overhead obstruction/crossover present in entire river stretch. There is no continuous flow of water is observed, however, impounded water was found in few locations in this stretch near to barrage and upstream of the barrage. Fishing activities were also observed in the barrage. Many pump wells exist in the stretch.

Figure 18 - Topo Survey in Impounded water

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	60	90	0.000	0.000	30000	1,293,038.07	2,216,985.09	-0.300	0.000	30000	1,663,788.38	2,845,673.88
II	60	90	0.000	0.000	30000	1,969,486.70	3,376,823.98	-0.300	0.000	30000	2,446,113.51	4,185,308.23
III	60	90	0.000	0.000	30000	2,976,679.21	5,103,711.37	-0.300	0.000	30000	3,568,081.24	6,106,931.77
IV	60	90	0.000	0.000	30000	3,591,781.01	6,158,343.53	-0.300	0.000	30000	4,209,630.07	7,206,438.82

Table 21 - Stretch 4 Dredging Quantity

3.4.1 Stretch-4 – Observed and Reduced River-Bed Profile

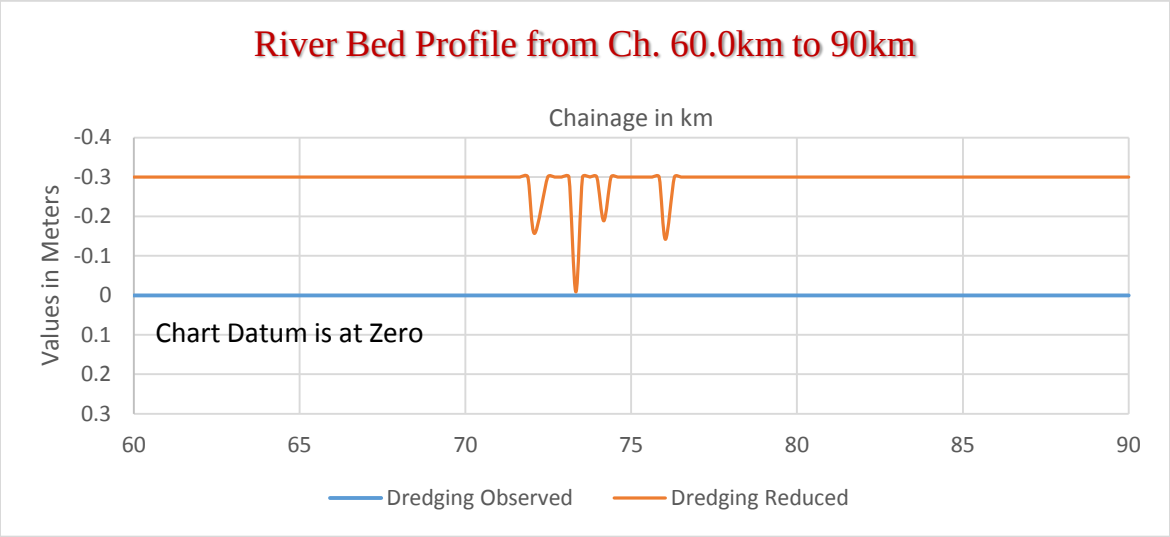


Figure 19- Stretch 4 River-bed Profile

3.5 Sub-Stretch-05: Guruzala Village to Madhavaram Bridge (90km to 114km)

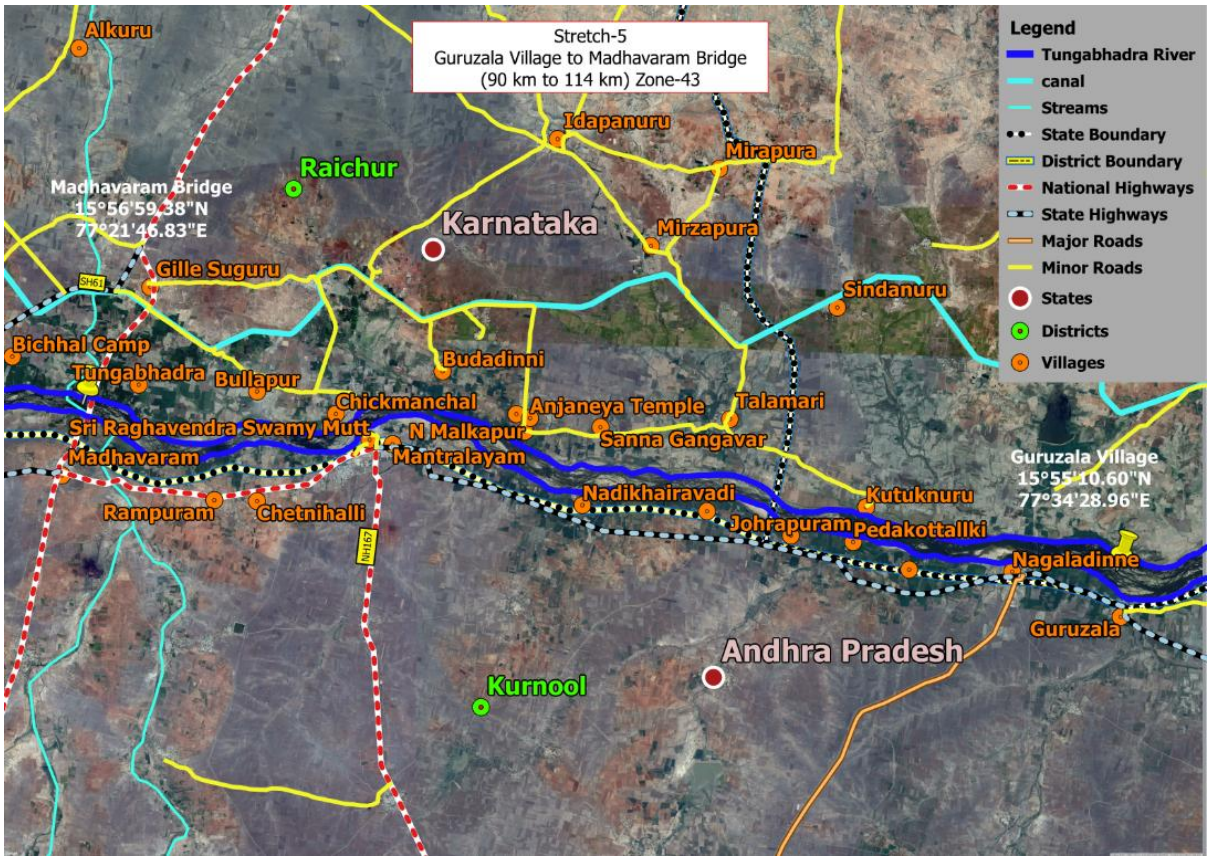


Figure 20 - Stretch-05 Guruzala Village to Madhavaram Bridge

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 24km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 24km of Tungabhadra River starting from chainage 90 to 114km from Guruzala to Madhavaram Bridge. This stretch is mostly consists of abundant rock boulders and outcrops, hence navigation is not feasible in this stretch. Few local streams/tributaries with an inflow of rain water also drain in this portion.

There are two overhead obstructions/crossovers present in this river stretch, one at Nagaladinne village which is being reconstructed, ruins of old bridge are also found there. The second bridge is at Madhavaram which connects Mantralayam and Adoni.

Famous Mantralayam town also exists in this stretch on the right bank of Tungabhadra River. Pilgrims come here to visit Sri Raghavendra Swamy Temple from all around the country round the year.

Figure 21 - Under Construction Bridge at Nagaladdine (ch. 90.96km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	90	114	0.000	0.000	24000	1,034,869.81	3,251,854.90	-0.300	0.000	24000	1,327,775.19	4,173,449.07
II	90	114	0.000	0.000	24000	1,576,262.40	4,953,086.38	-0.300	0.000	24000	1,952,836.82	6,138,145.05
III	90	114	0.000	0.000	24000	2,382,349.66	7,486,061.03	-0.300	0.000	24000	2,849,655.30	8,956,587.07
IV	90	114	0.000	0.000	24000	2,874,620.19	9,032,963.72	-0.300	0.000	24000	3,362,816.60	10,569,255.42

Table 22 - Stretch 5 Dredging Quantity

3.5.1 Stretch-5 Observed and Reduced River-Bed Profile

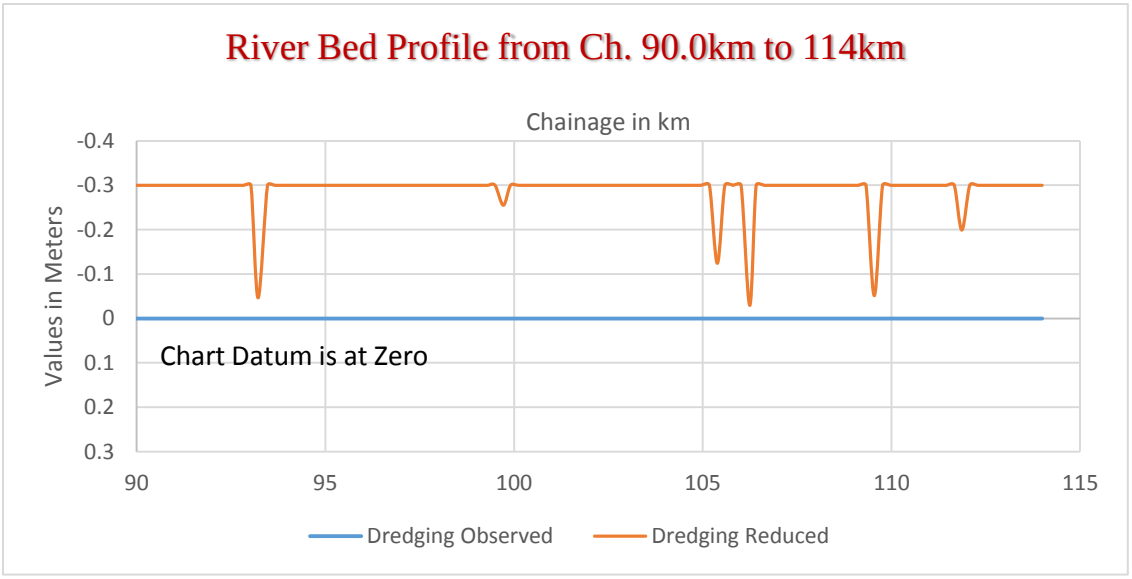


Figure 22 - Stretch 5 River-bed Profile

3.6 Sub-Stretch-06: Madhavaram Bridge to Gurraladoddi Village (114km to 140km)

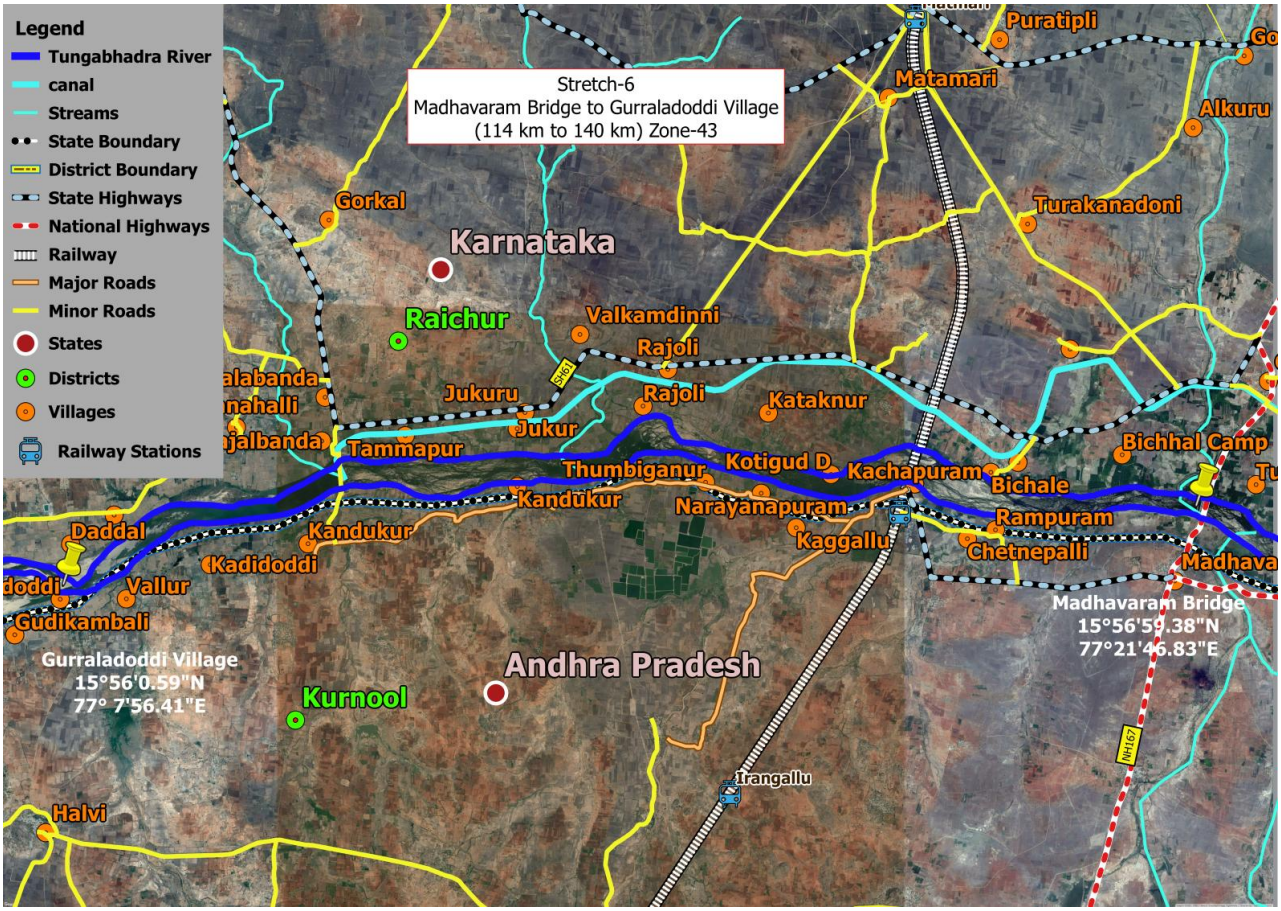


Figure 23- Stretch-06 Madhavaram Bridge to Gurraladoddi Village

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 26km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 26km of Tungabhadra River starting from chainage 114 to 140km from Madhavaram Bridge to Gurraladoddi. Tungabhadra River follows a straight path in and no major curves are there in this stretch. This river stretch has a gradient of 12m.

There is one overhead obstruction/crossover present in this river stretch, Railway Bridge at Kachapuram. This bridge connects Mantralayam Road Station and Adoni station on the right bank to Matmari station.

Rajolibanda diversion scheme an irrigation project also exist in the upstream portion of this stretch of Tungabhadra River. It is an interstate barrage which supplies water to Andhra Pradesh, Telangana, and Karnataka. Left canal at Rajolibanda supplies water to Raichur and Mahabubnagar districts as the irrigational canal.

Figure 24 - Rajolibanda Left Bank View (ch. 134.07km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	114	140	0.000	0.000	26000	1,120,775.93	4,372,630.83	-0.300	0.000	26000	1,431,188.84	5,604,637.91
II	114	140	0.000	0.000	26000	1,707,111.23	6,660,197.61	-0.300	0.000	26000	2,105,962.80	8,244,107.85
III	114	140	0.000	0.000	26000	2,580,112.28	10,066,173.31	-0.300	0.000	26000	3,074,810.30	12,031,397.37
IV	114	140	0.000	0.000	26000	3,113,254.93	12,146,218.65	-0.300	0.000	26000	3,630,029.07	14,199,284.49

Table 23 - Stretch 6 Dredging Quantity

3.6.1 Stretch-6 - Observed and Reduced River-bed Profile

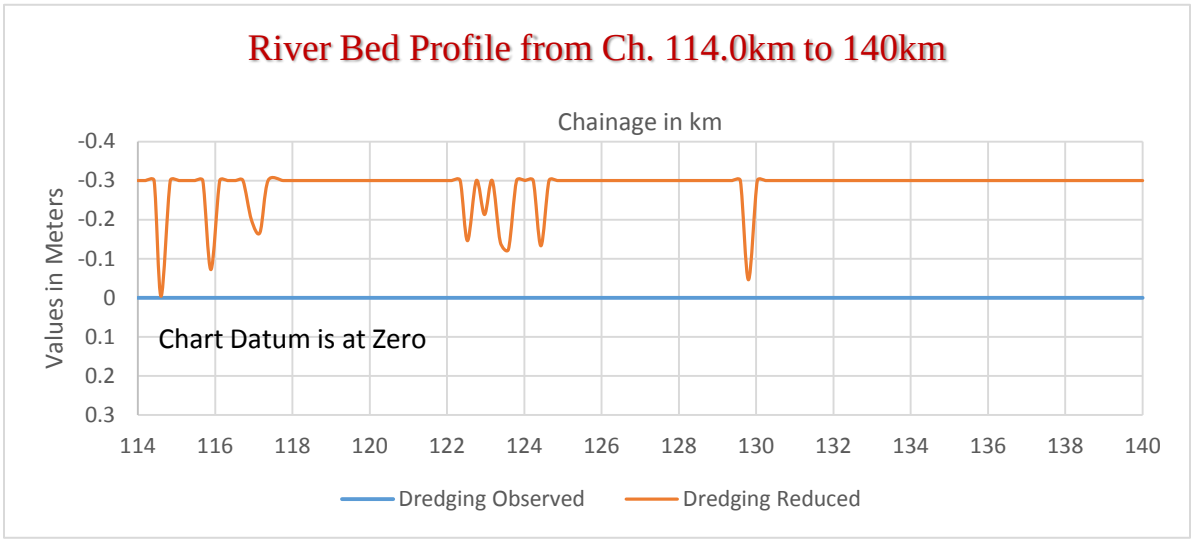


Figure 25 - Stretch 6 River-bed Profile

3.7 Sub-Stretch-07: Gurraladoddi Village to Valaballari Village (140km to 165km)

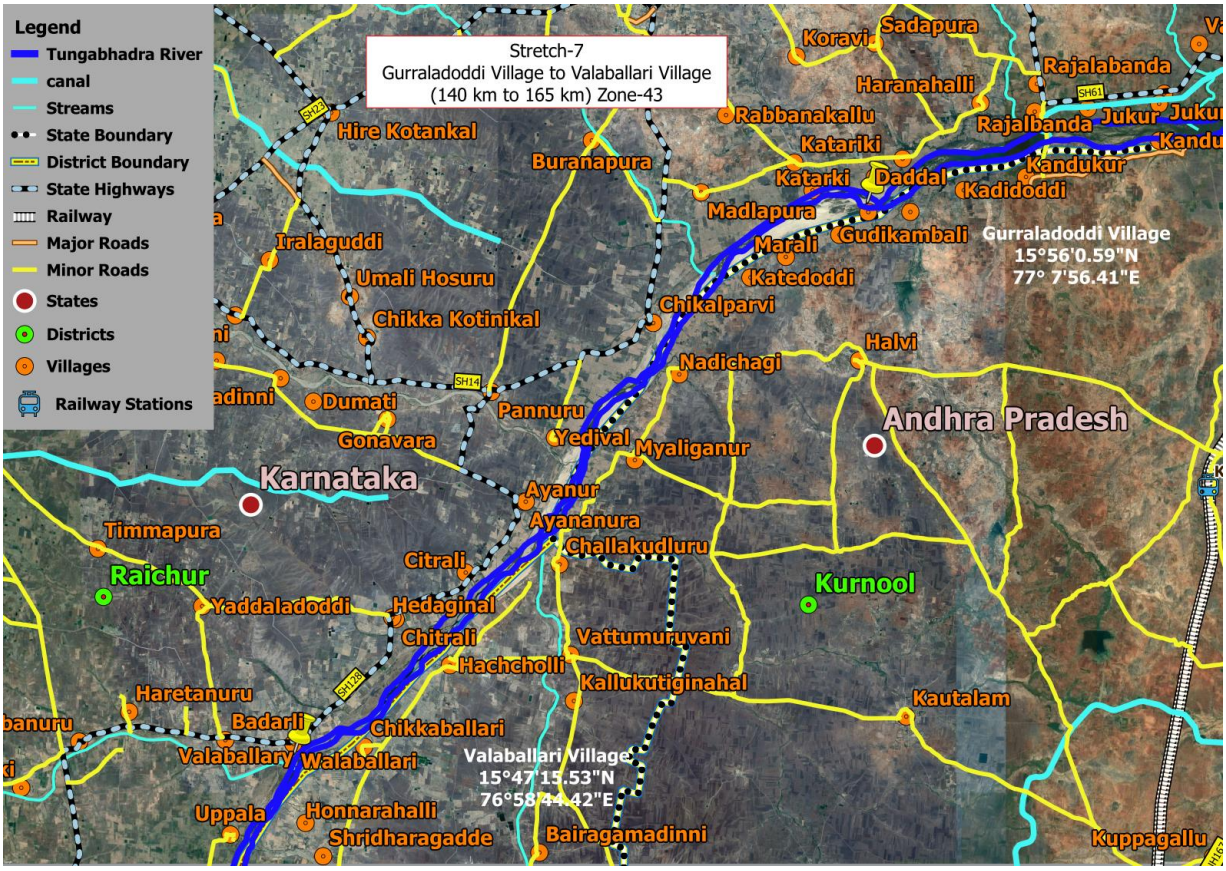


Figure 26 - Stretch-07 Gurraladoddi to Valaballari

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water.
- **Topographic Survey**
  b) 25km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 25km of Tungabhadra River starting from chainage 140 to 165km from Gurraladoddi to Valaballari. Tungabhadra River bed at this stretch observed to be sandy and no outcrops observed throughout this stretch, hence this stretch of Tungabhadra River is favorable in navigation point of view.

There is no overhead obstruction/crossover present in this river stretch; Tungabhadra River channel is comparatively narrow at this stretch. River banks are mostly clear as occupied by farm lands on both river banks. Tungabhadra River banks at this stretch are moderately populated by distant villages. Many pump wells and pumping stations exist in this stretch to supply water to nearby villages to fulfill daily needs.

Figure 27 - Pump Wells View

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	140	165	0.000	0.000	25000	1,077,998.20	5,450,629.03	-0.300	0.000	25000	1,355,359.05	6,959,996.96
II	140	165	0.000	0.000	25000	1,641,954.67	8,302,152.28	-0.300	0.000	25000	1,999,078.45	10,243,186.30
III	140	165	0.000	0.000	25000	2,481,647.30	12,547,820.61	-0.300	0.000	25000	2,925,336.99	14,956,734.36
IV	140	165	0.000	0.000	25000	2,994,452.16	15,140,670.81	-0.300	0.000	25000	3,458,240.11	17,657,524.60

Table 24 - Stretch 7 Dredging Quantity

3.7.1 Stretch-7 - Observed and Reduced River-bed Profile

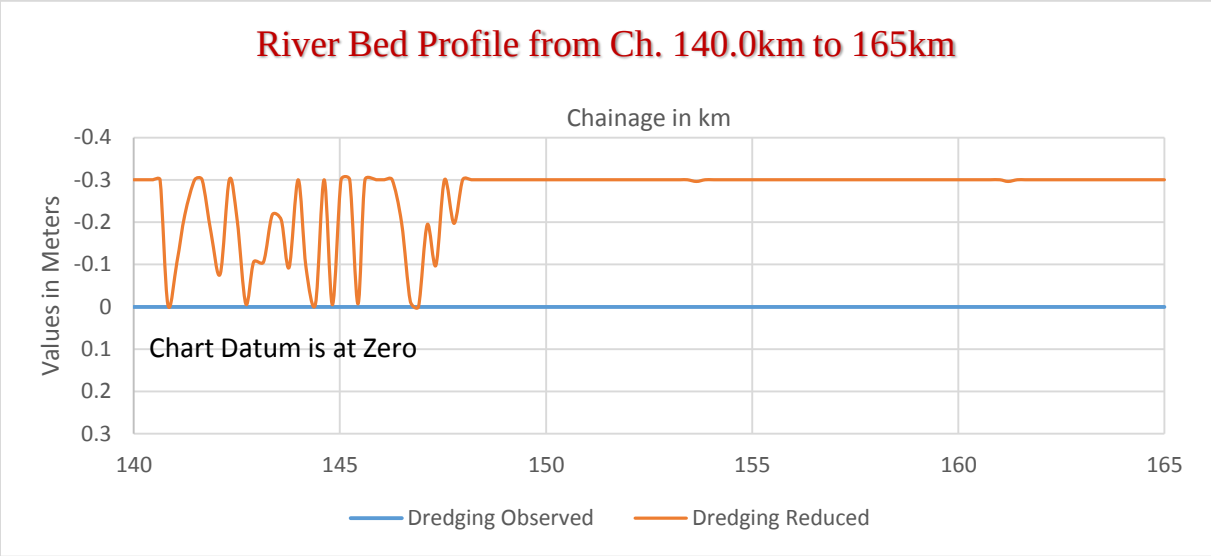


Figure 28 - Stretch 7 River-bed Profile

3.8 Sub-Stretch-08: Valaballari Village to Kenchanagudda Village (165km to 190km)

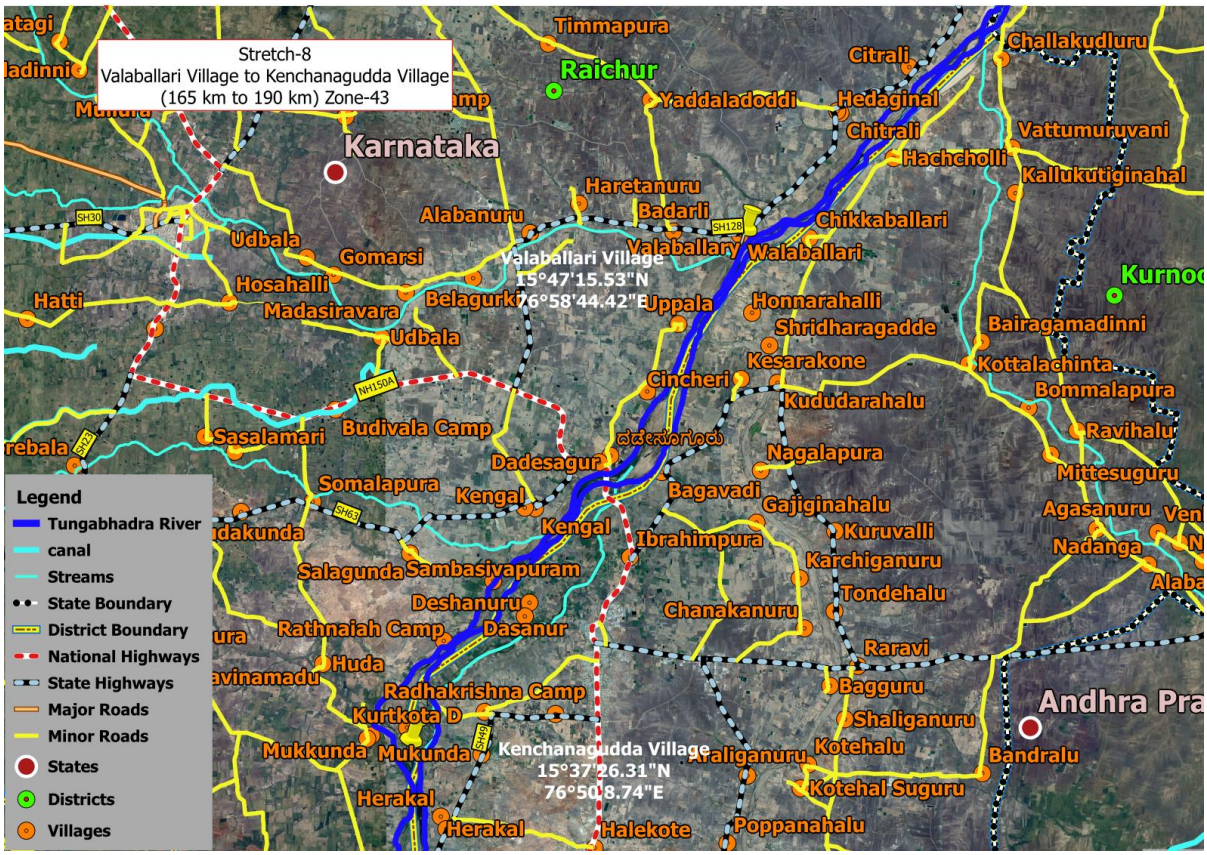


Figure 29 - Stretch-08 Valaballari to Kenchanagudda

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 25km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 25km of Tungabhadra River starting from chainage 165 to 190km from Valaballari to Kenchanagudda. Tungabhadra River bed at this stretch observed to be of combined nature as sandy and rocky. The width of the channel observed to be narrow from Valaballari to Chincheri village, from Dadesagur to Kengal and at Rathanaiah camp as the river gets divided into two streams from Rathanaiah and meets with the mainstream again at Dadesagur which forms an Island in between at Dasanur. This river stretch has a gradient of 10m.

Sirguppa town of Bellary district, Karnataka exists in this stretch. Sirguppa town is taluk headquarter. Paddy cultivation is most prominent in this stretch. Sirguppa town plays a major role in supplying rice to Karnataka state for exporting.

There is one overhead obstruction/crossover present in this river stretch of Tungabhadra River. Bridge near Dadesagur connects Sirguppa town and Dadesagur village. Tungabhadra River gets divided into various small streams near Kurtkota D. Two local rivers drains in this stretch near Valaballari and Helekota.

Figure 30 - Rock Outcrops at stretch 08

Clas	Chainage (km)	Observed	Reduced w.r.t. Sounding Datum

	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	165	190	0.000	0.000	25000	1,077,454.98	6,528,084.01	-0.300	0.000	25000	1,388,008.25	8,348,005.21
II	165	190	0.000	0.000	25000	1,641,130.54	9,943,282.82	-0.300	0.000	25000	2,040,403.77	12,283,590.07
III	165	190	0.000	0.000	25000	2,480,406.34	15,028,226.95	-0.300	0.000	25000	2,975,675.69	17,932,410.05
IV	165	190	0.000	0.000	25000	2,992,954.75	18,133,625.56	-0.300	0.000	25000	3,510,433.56	21,167,958.16

Table 25 - Stretch 8 Dredging Quantity

3.8.1 Stretch-8 Observed and Reduced River-Bed Profile

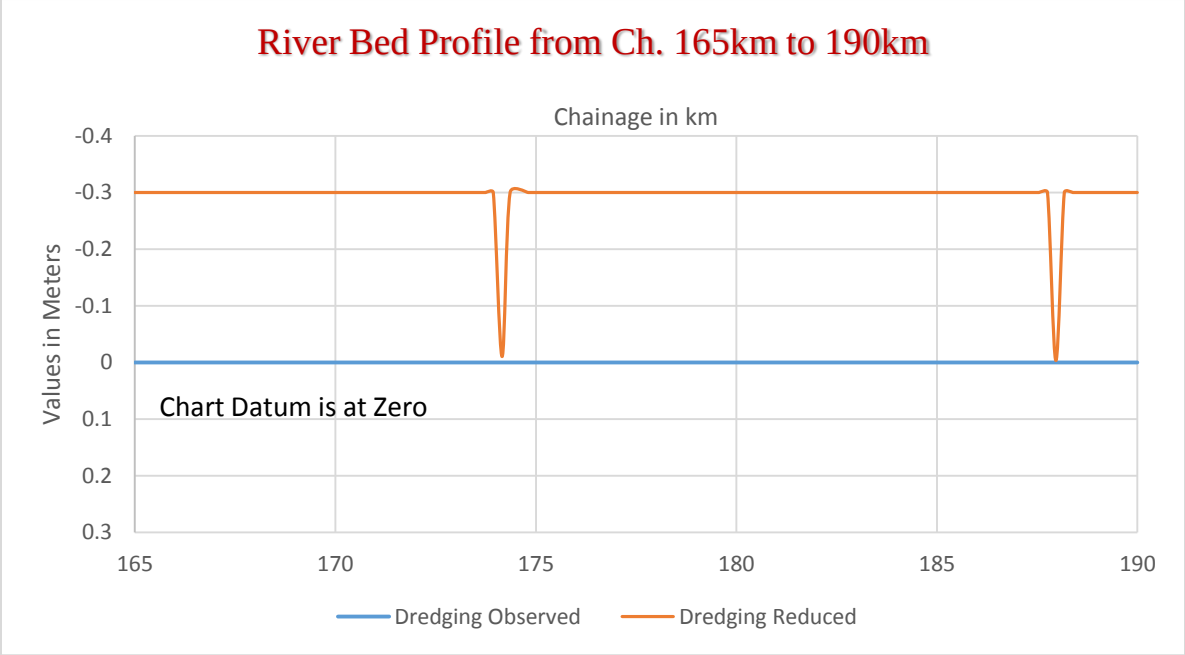


Figure 31 - Stretch 8 River-bed Profile

3.9 Sub-Stretch-09: Kenchanagudda Village to Manur Village (190km to 210km)

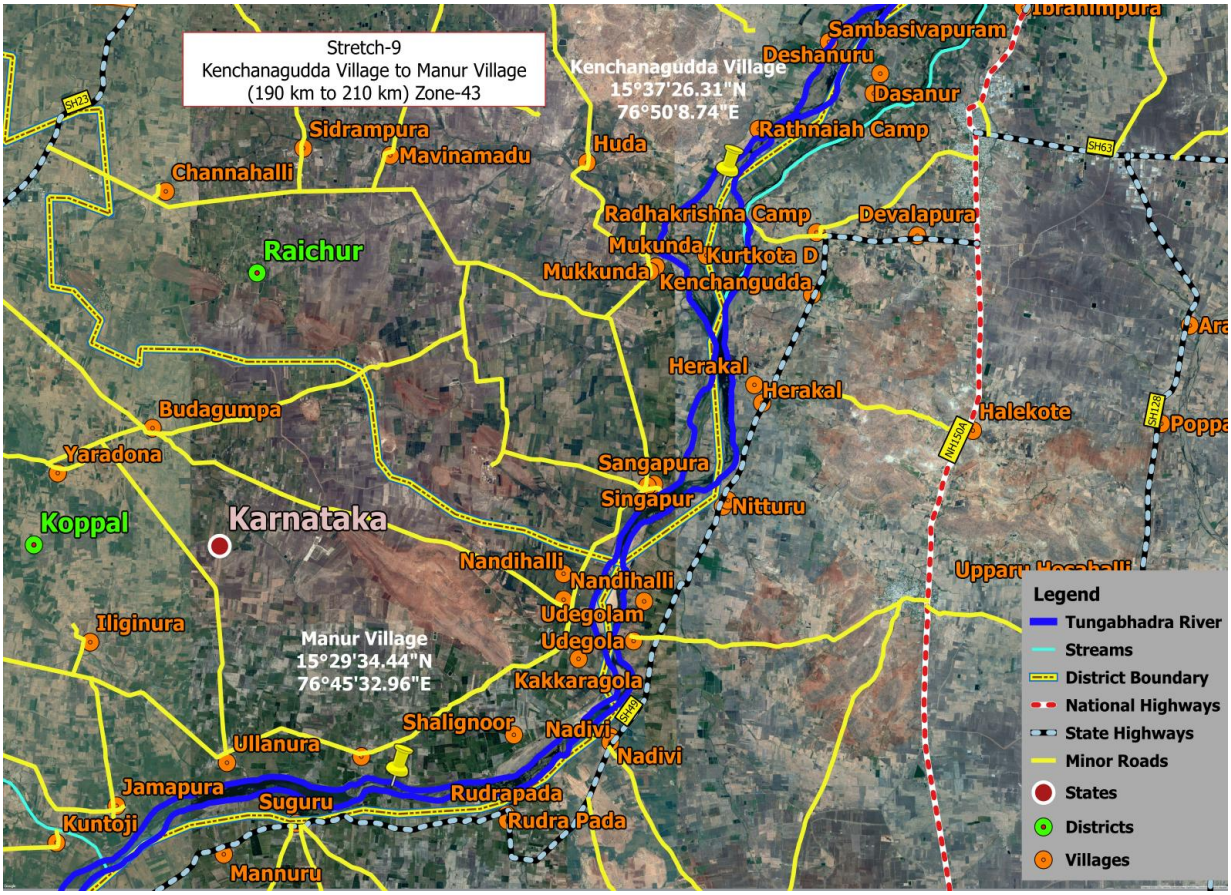


Figure 32 - Stretch-09 Kenchanagudda Village to Manur Village

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 20km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 20km of Tungabhadra River starting from chainage 190 to 210km from Kenchanagudda to Manur. Tungabhadra River bed at this stretch observed to be rocky from Kenchangudda, whereas no outcrops were observed near Manursugur. The upstream portion of this stretch observed to be sandy.

A check dam exists at this stretch of Tungabhadra River around 2.5km downstream of Ulenoor. Check dam is constructed for irrigation purpose. Residents of nearby villages

are using Putti to cross the river near Ulenoor. A CWC manual tide gauge site at Ulenoor also exists in this stretch, the, however, the gauge was observed to be dry.

There is no any overhead obstruction/crossover present in this river stretch of Tungabhadra River. Many pumping stations exist in this stretch to supply water to nearby villages. Place near Ulenoor may be developed as ferry point or terminal in future.

Figure 33 - Check Dam near Ulenoor (ch. 211.08km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	190	210	0.000	0.000	20000	862,004.38	7,390,088.39	-0.300	0.000	20000	1,100,838.79	9,448,844.00
II	190	210	0.000	0.000	20000	1,312,954.79	11,256,237.61	-0.300	0.000	20000	1,620,087.11	13,903,677.18
III	190	210	0.000	0.000	20000	1,984,407.18	17,012,634.13	-0.300	0.000	20000	2,365,389.27	20,297,799.32
IV	190	210	0.000	0.000	20000	2,394,458.94	20,528,084.50	-0.300	0.000	20000	2,792,542.13	23,960,500.29

Table 26 - Stretch 9 Dredging Quantity

3.9.1 Stretch-9 - Observed and Reduced River-Bed Profile

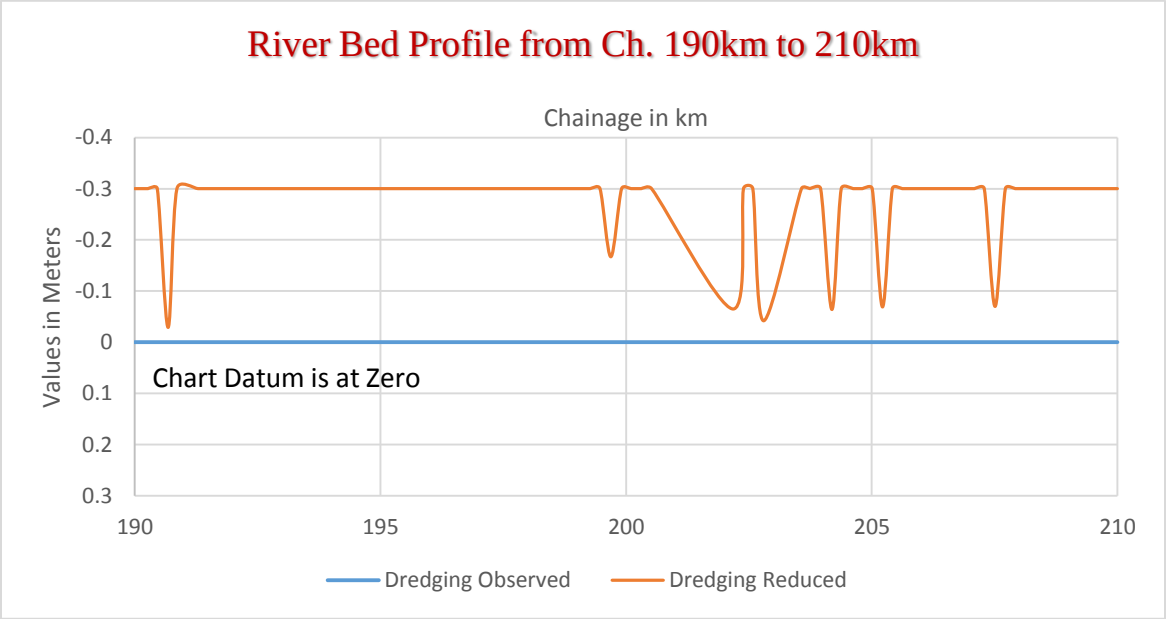


Figure 34 - Stretch 9 River-bed Profile

3.10 Sub-Stretch-10: Manur Village to Kampli Bridge (210km to 232.4km)

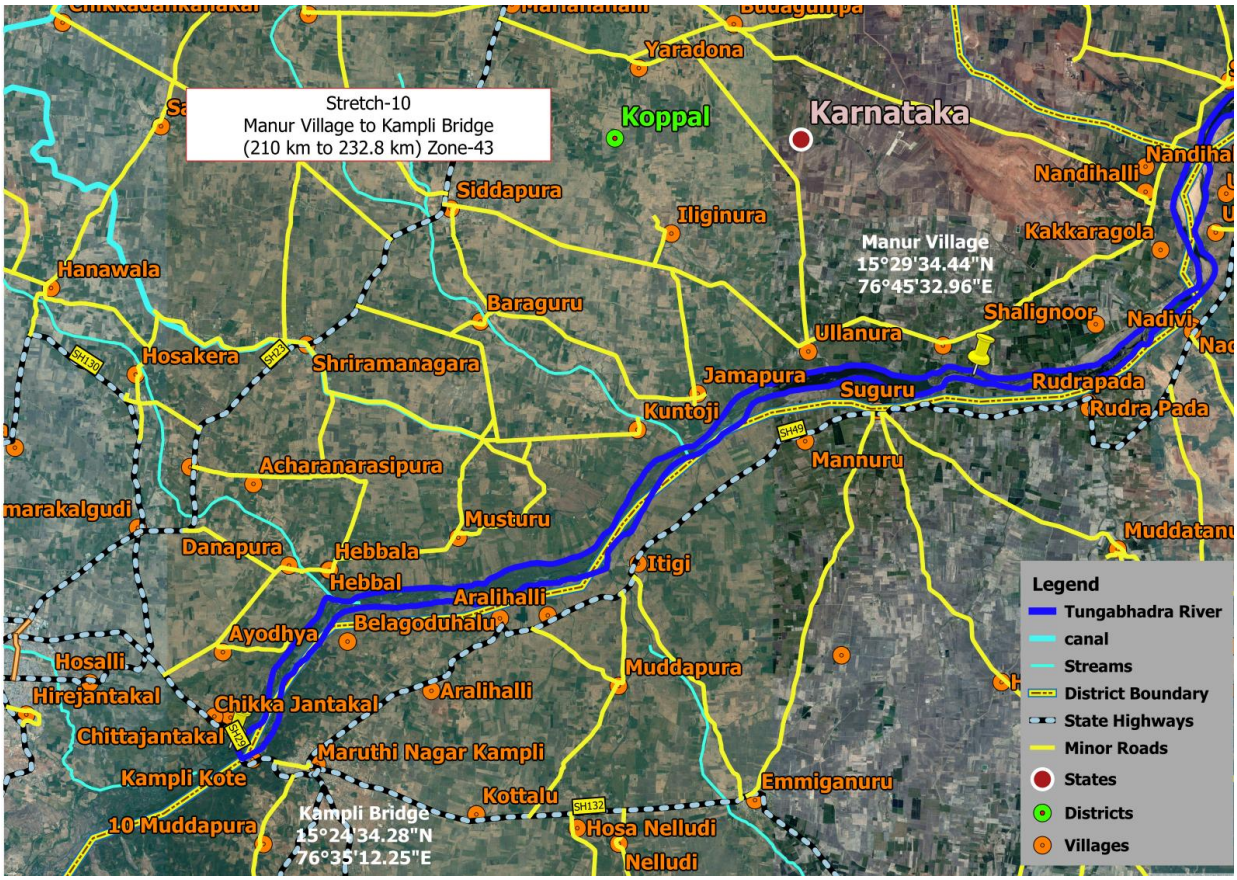


Figure 35 - Stretch-10 Manur Village to Kampli Bridge

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
  b) 22.4km of the length of the stretch for which the topographic survey has been carried out.

This stretch covers 22.4km of Tungabhadra River starting from chainage 210 to 232.4km from Manur to Kampli Bridge. River bed at this stretch of Tungabhadra consists of abundant rocks and outcrops. Tungabhadra River follows a straight path and no major curves exist in this stretch.

Thick vegetation and shrubs are found on the banks of Tungabhadra River at this stretch after Vegetation River banks are occupied by farm lands. Paddy, sugarcane, and ground nuts are the prominent crops of the area. Kampli town of Bellary district comes in this stretch of Tungabhadra River.

There are two overhead obstructions/crossovers present in this stretch of Tungabhadra River. One overhead pipeline of Bellary Thermal Power station of Karnataka Power Corporation Limited near Hebbal on left bank. Another one is Kampli Bridge near Chikka Jantakal village. This bridge links Kampli to Gangavathi. The vertical clearance of this bridge is very less, the hence bridge is prone to submerge in floods and discharge from Hospet dam.

Local residents nearby Kampli Bridge revealed while collecting the general information about the river stretch that the bridge got submerge in Sep 2011 as shown in Figure below, in support of collected information the source (Hindu News Paper, Bellary, Karnataka 04 Sep 2011) was referred to internet and image was downloaded from website www.hindu.com.

Figure 36 - Kampli Bridge submerged (News paper Source:- Hindu 4 Sep 2011)

Figure 37 - BTPS Pipeline near Hebbal (ch. 228.08km)

Class	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	210	232.4	0.000	0.000	22400	952,760.75	8,342,849.14	-0.300	0.000	22400	1,221,728.65	10,670,572.65
II	210	232.4	0.000	0.000	22400	1,451,194.76	12,707,432.37	-0.300	0.000	22400	1,797,234.73	15,700,911.91
III	210	232.4	0.000	0.000	22400	2,193,337.45	19,205,971.58	-0.300	0.000	22400	2,622,920.56	22,920,719.88
IV	210	232.4	0.000	0.000	22400	2,646,563.27	23,174,647.77	-0.300	0.000	22400	3,095,465.95	27,055,966.24

Table 27 - Stretch 10 Dredging Quantity

3.10.1 Stretch-10 – Observed and Reduced River-Bed Profile

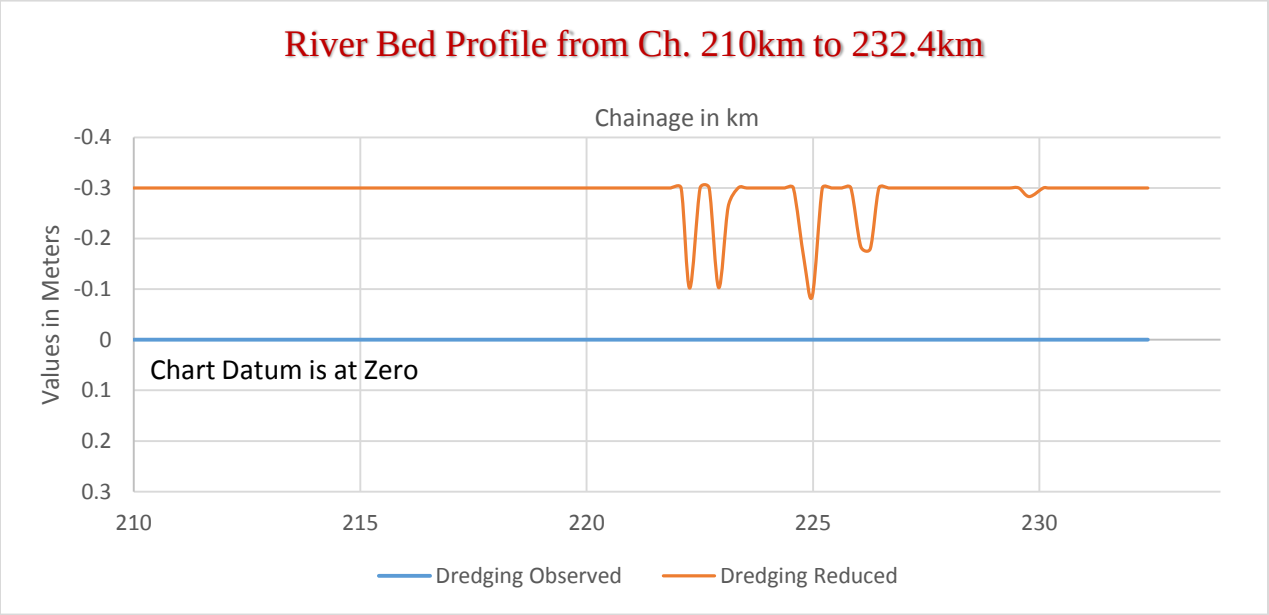


Figure 38 - Stretch 10 River-bed Profile

3.11 Other Aspects of Waterway

3.11.1 Fishing

Fishing activities were seen near Jogulamba Temple at Alampur and Devmada village in Zone – 44N and Sunkesula barrage in Zone – 43N in this entire stretch of Tungabhadra River. Fishermen are using Putti (round type of country boat) for fishing activities due to low water depths. No scope for fishing does exist in other stretches of Tungabhadra River due to non-availability of water during the summer season.

3.11.2 Industries

There are three major industries settled beside the banks of Tungabhadra River, Sree Rayalaseema Alkalies, and Allied Chemicals Limited at Gondiparla village near Kurnool and Adani Wilmar Limited Fortune edible oil near Mantralayam, NSL Sugars Dasanur near Sirguppa. The details of major industries situated near Tungabhadra river are as follows:-

Sl. No.	Industry	Chainage (km)	Position
01	Sree Rayalaseema Alkalies, and Allied Chemicals Limited at Gondiparla, Kurnool	31.8	15°50'37.81"N 78°03'46.24"E
02	Adani Wilmar Limited Fortune edible oil near Mantralayam	120.6	15°56'40.3"N 77°18'05.17"E
03	NSL Sugars Dasanur near Sirguppa	183.8	15°39'41.56"N 76° 52'35.01"E

Table 28 - Details of Industries

3.11.3 Crops

The river banks are mostly occupied with farm lands extended up to the river at most of the places. Paddy, groundnuts, sugar cane and cotton cultivation are most prominent in the entire stretch of Tungabhadra River. Entire stretch these are finely supported by the irrigational system from the Tungabhadra River, however, due to less availability of the water in Tungabhadra River, mostly farmers are dependent on rain waters. Sunflower cultivation is also observed near Sirguppa, Karnataka.

Figure 39 - Sugarcane Cultivation on Tungabhadra Banks

3.11.4 Settlements

The overall river banks of Tungabhadra River are moderately populated for the entire survey stretch. Major towns situated neatly on the river banks are Kurnool, Mantralayam, Sirguppa, and Kampali. However, a small cluster of settlements forms to be villages are situated near to the survey stretch of the Tungabhadra River. Downstream of Tungabhadra River is occupied by Murvakonda, Santhanikota, temple town Alampur, Devmada, Gondiparla and Kurnool Town. In the middle Mantralayam town, Madhvaram, Bichal Camp, Ramapuram, Rajoli, Vallur and in the upstream it is populated by Sirguppa town, Ulenoor, Manur, Dasanur, and Kampli town. These places are well connected with the state-run transportation system.

3.11.5 Drinking water

The water from Tungabhadra River is the primary source of drinking water for nearby cities, towns, and villages situated on both the banks. Several pumping stations are present in the Tungabhadra River for the supply of drinking water and the water available in the river along with the ground water is extensively used to fulfill the water supply demand of the area. There are many spillage dams present in the river stretch to facilitate the water availability for the pump house in the area used for pumping for daily need of water for the nearby villages. Many water purification plants exist in the cities and towns to provide drinking water to residents.

Figure 40 - Drinking Water Well

3.11.6 Important cities/towns

The towns situated near to Tungabhadra River are Kurnool, Mantralayam, Sirguppa, and Kampli. These are small towns which are connected with railway line and also frequent state transport buses runs from Hyderabad and Bengaluru cities. Local shared transport (Tooffan Cabs) also runs between these towns at frequent interval. Local Taxis and Autos are also available along the entire River stretch from the nearby towns.

3.11.7 Road Network

The both sides of Tungabhadra River is well connected with road network and frequent state transport buses runs between Kurnool, Mantralayam, Sirguppa and Kampli cities and to other places/villages nearby to these cities. Local hired/sharing transport is also available along the entire River stretch. The details of National Highway present in the project influence area are NH-07, NH-40, NH-44, NH-150, NH-167 which connects Kurnool, Mantralayam, Sirguppa and Kampli cities. The state Highways SH-14, SH-49, SH-50, SH-61, SH-128 and also connects to these cities to villages.

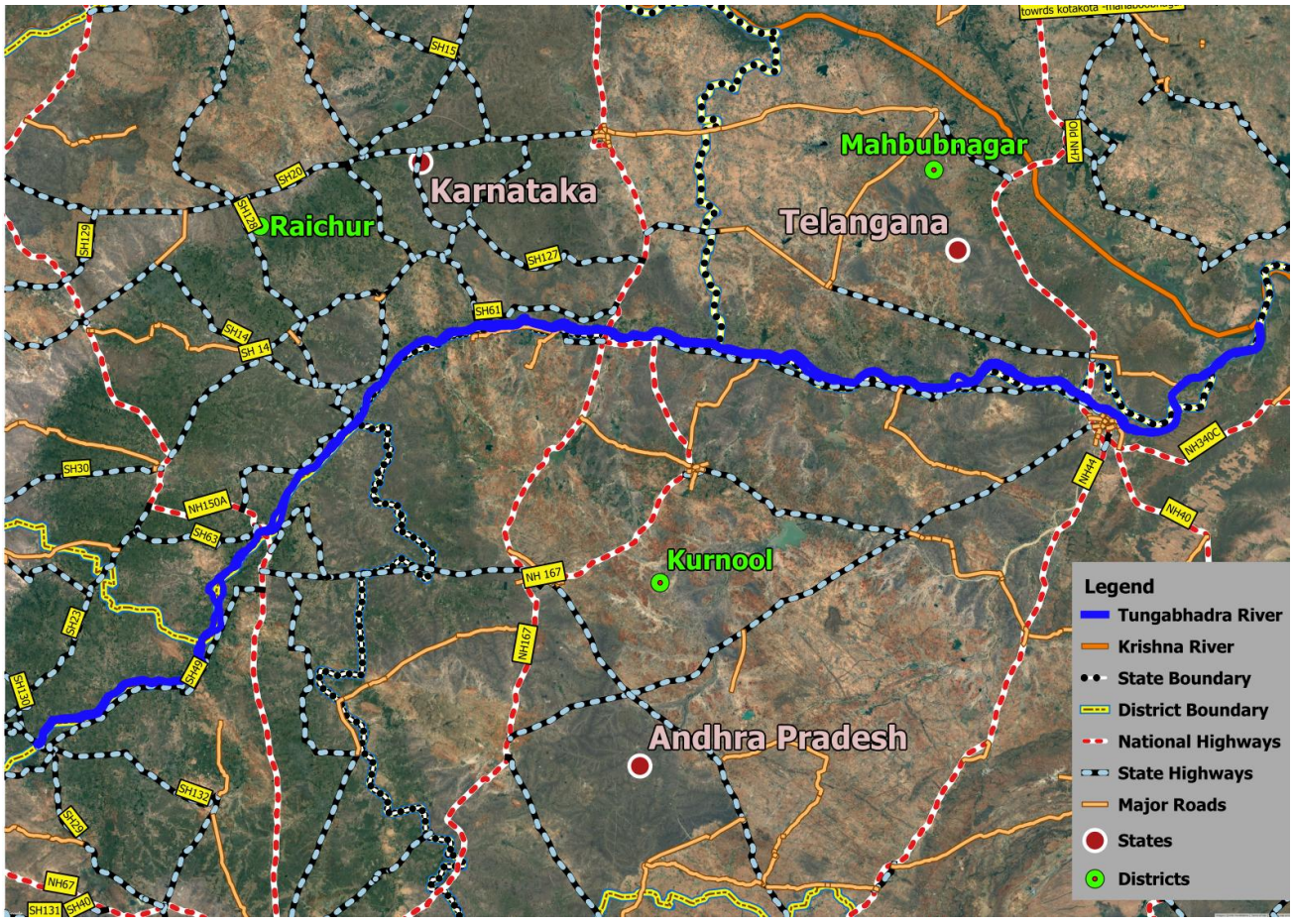


Figure 41 - Road Network

3.11.7.1 Rail Network

The railway network is not very good along Tungabhadra River. Few railway stations near Tungabhadra River comes under project influence area are Alampur road station, Kurnool city station, Mantralayam road stations and Adoni station.

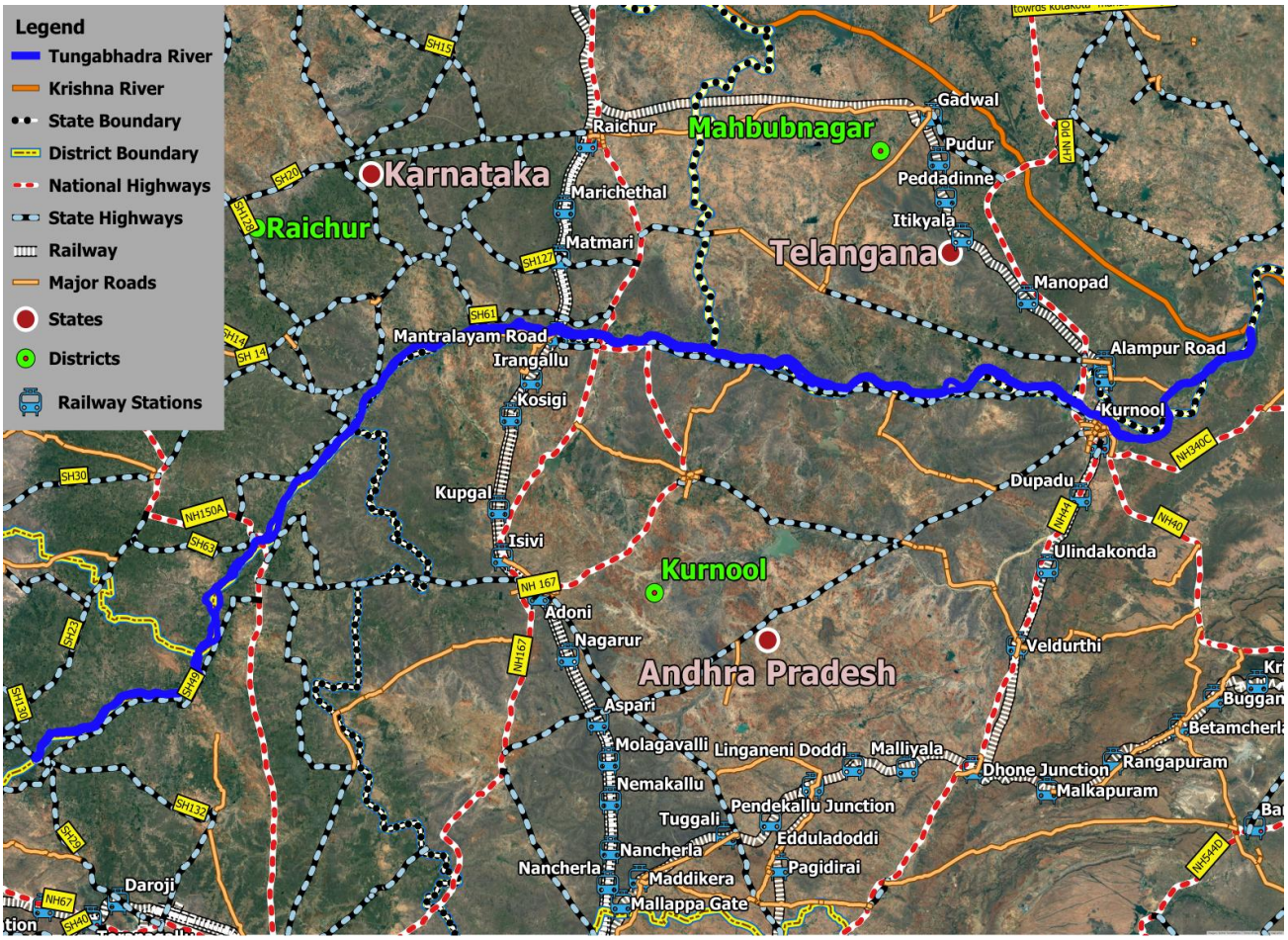


Figure 42 - Rail Network

3.11.8 Land Use

The Kurnool, Mantralayam, Sirguppa and Kampli cities/towns are situated near to the right bank of Tungabhadra River where as temple town Alampur is situated on the left bank of Tungabhadra River. The land near the cities/towns is being used for the commercial and residential purpose. The small scale industries are also situated on both the banks of Tungabhadra River nearby these cities. The land on the remaining stretches of Tungabhadra River is settled with distant villages and also being utilized for agricultural purposes like cotton, sugar canes, peanut farms, and paddy fields.

3.11.9 Construction Material

All type of construction material like cement, Iron etc. are available in bulk quantity. Tungabhadra River is sandy in nature at some places, hence low scale sand mining activities were observed on the survey stretch near Kurnool and Devmada village. Peoples were observed to be using tractors and bullock carts for sand mining in Tungabhadra River.

3.11.10 Cargo Movement

The cargo movement is not envisaged through waterway as industries in the cities/towns are well connected by road and rail network. Cargo movement mostly is being carried through road transport for small scale industries present in nearby villages.

3.11.11 Passenger Ferry Services

Ferry point/terminal exists near Kurnool city nearly at 31.6 km chainage, however, services are not available due to non-availability of navigable waters.

Sl. No.	Ferry Point Name	Chainage (km)	River Bank	Position	Remarks
01	SRAAC Paper Mill Ferry Point	31.6	Left Bank	15°50'11.66"N 78°03'36.16"E	Non-Operational
02	Ferry Point I	31.8	Left Bank	15°50'13.39"N 78°03'23.86"E	Non Operational
03	Nawab Bangla Ferry Terminal	31.8	Right Bank	15°50'37.81"N 78°03'46.24"E	Non-Operational

Table 29 - Details of Passenger Ferry Service

3.11.12 Historic importance

The Historical places are Jogulamba Temple and Navabrahma Temple of Alampur, Mehaboobnagar district and Sree Raghavendra Swami Matha at Mantralayam are present along the waterway.

3.11.13 Tourism

Jogulamba Temple and Navabrahma temple at Alampur, Mehaboobnagar district are situated on left bank, and Sree Raghavendra Swamy Matha at Mantralayam, Kurnool district is situated on the right bank are the famous tourist places in the entire stretch of Tungabhadra River. These tourism places are having historical as well as pilgrimage value. Pilgrims from all around the country used to come here round the year.

Nava Brindavan in Anegundi is located on a small island in the middle of the Tungabhadra River. Ferry service by small local boats is required to reach the place. The island is home to the tombs of nine saints. It is a very important destination for Madhwa brahmins it is also the resting place of (Nava Yethi) nine gurus Brindavana. The island temple is 12km upstream of the survey stretch of Tungabhadra River.

Figure 43- Nava Brindavan (ch. 17.62km)

Alampur is a temple town situated on the left bank of Tungabhadra River and the measures to improve road connectivity by constructing new bridge is in progress. The town is situated 20km away from Kurnool City. The Alampur temple is also known as Dakshina Kashi and famous Shivite Pilgrim Temple

Figure 44 - View of Alampur Temple (ch. 17.48km)

3.11.13.1 Wild Life Sanctuary

Daroji Sloth Bear Sanctuary: This is located in Bellary district and is spread over 55.87 square kilometers (21.57 sq. mi). This sanctuary was mainly created for the conservation of sloth bears. It is 50.8km away from Bellary city traveling on Bellary-Hubli Road. The Wildlife Sanctuary has situated 21km from Hampi and 28km away from the survey stretch of Tungabhadra River.

Figure 45 - Daroji Sloth Bear Sanctuary

3.11.14 Details of Irrigation Canals and Outlets

The water of Tungabhadra River is mainly used for drinking and irrigation purpose, hence several pump wells and pumping stations are present in the Tungabhadra River for the supply of drinking water to nearby villages. Sunkesula barrage and Rajolibanda diversion scheme present in the Tungabhadra River contribute to the water supply for the irrigational canal present in the area. These irrigational canals are used for the supply of water to the fields in nearby areas. The details of Irrigational canals are as follows:

Sl. No.	Canals	Chainage (km)	Type	Description
01	Handri River	30.0	Tributary	Handri River is known as one of the major tributaries of the Tungabhadra River. Its confluence with Tungabhadra River near Kurnool city on the right bank.
02	K C Canal	59.8	Outlet Canal	The canal is an irrigational canal and originates from Sunkesulla Barrage. It is the only major irrigation source to Kurnool and Cuddappah districts. The length of the canal is 305.60 km

Sl. No.	Canals	Chainage (km)	Type	Description
				up to Cuddappah town
03	RDS Left Canal	133.8	Outlet Canal	Rajolibanda Diversion Scheme is an irrigational project. It is an inter-state project on Tungabhadra River to supply water to Karnataka, Telangana and Andhra Pradesh states
04	Canal	155.4	Inlet Canal	An inlet canal confluence with Tungabhadra River on the left bank of the river near Yediwal village. The canal originates from Nagalapur.
05	Hagri/vedavathi	173.6	Tributary	Hagri River is also known as Vedavathi is one of the major tributaries of the Tungabhadra River. Its confluence with Tungabhadra River near Halekota village on the right bank.

Table 30 - Details of Irrigational Canals

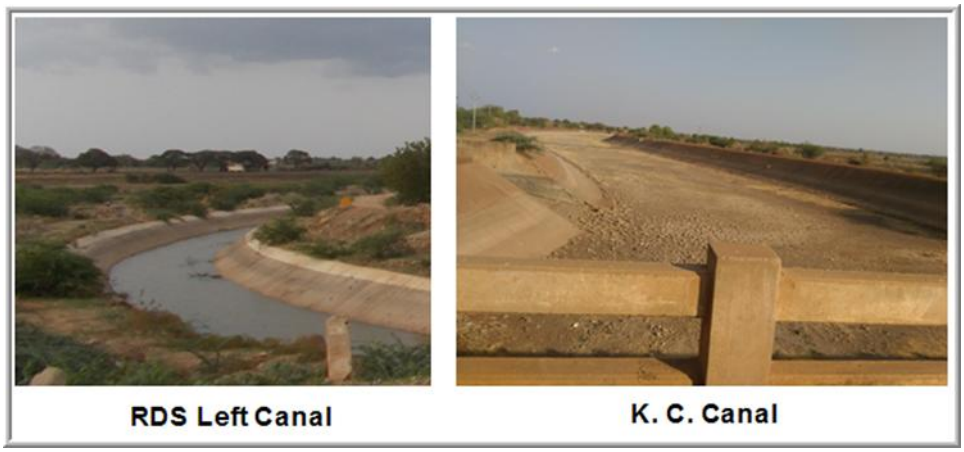


Figure 46 - Irrigational Canals (133.8 & 59.8 km chainage)

4 Terminals

The Tungabhadra River is 232.4km in length with various barrages and obstructions in the survey stretch. The water availability being very low in the river, presently there are no ferry services operating in the entire survey stretch of the Tungabhadra River. however peoples were observed using round shaped country boats to cross the river near Jogulamba temple at Alampur, Sunkesula barrage (for fishing) and Ulenoor near CWC gauge. The details of existing terminals/berthing facilities for the boats were collected during the conduct of survey and the details are as tabulated below:-

Sl. No.	Ferry Point Name	Chainage (km)	River Bank	Position	Remarks
01	SRAAC Paper Mill Ferry Point Gondiparla	31.6	Left Bank	15°50'11.66"N 78°03'36.16"E	Presently Unused
02	Ferry Point I Gondiparla	31.8	Left Bank	15°50'13.39"N 78°03'23.86"E	
03	Nawab Bangla Ferry Terminal, Kurnool	31.8	Right Bank	15°50'37.81"N 78°03'46.24"E	
04	Mantaralaym	107.2	Right Bank	15°56'43.02"N 77°25'19.26"E	Operated by small boats

Table 31 - Details of terminals present in Tungabhadra River

4.1 Proposed Locations for Construction of New Terminals

The locations of the terminals can be considered on the upstream of Sunkesula barrage and near Jogulamba Temple at Alampur for tourism purpose. The detail of the proposed location for construction of terminal is as follows:-

Sl. No.	Location	Lat	Long	Land Use	Owner
01	Alampur Jogulamba Temple	15°52'36.77"N	78° 8'10.65"E	Alampur	Telangana State
	The proposed location is at Alampur near Jogulamba Temple as the place has a significant historical value and pilgrims comes here throughout the country round the year. The area is well connected with the road network and Alampur road railway station is around 10km. The Depth in the area needs to be improved for the berthing of boats throughout the period. The terminal may be developed as tourism as well as passengers point of view as there is no operational bridge exist				

Sl. No.	Location	Lat	Long	Land Use	Owner
	up 37 km of River chainage.				
02	Upstream of Sunkesula Barrage	15°52'24.47"N	77°49'36.25"E	Upstream of Sunkesula Barrage	Andhra Pradesh government
	Location is at upstream of Sunkesula Barrage as deeper navigable depths may be maintained and the place may be Developed as tourism point of view				
03	Ulenoor	15°29'35.02"N	76°44'46.60"E	Ulenoor	Karnataka Government
	Location is at upstream of Ulenoor check dam as deeper navigable depths may be maintained and the place may be developed as passengers' point of view as there is no bridge exist nearby and people were observed using Putty to cross the waterway				

Table 32 - Proposed Locations for Construction of New terminals

5 Fairway Development

The Tungabhadra River flows in North-Easterly direction till Vallur and after that attain an Easterly path. Tungabhadra River takes around 45° diversion near Hebbal, Ittigi, Nittur, Kenchanagudda, Dadesugur, Vallur, Mantralayam, Chamalaguduru, Edurur and around 90° diversion near Nadivi, Devmada, and Alampur.

5.1 Fairway Dimensions

As per the specification of the survey, dredging quantity was required to be estimated for different channel classifications along the deepest route. Class-IV channel with dimension 70m width, 2m depth and side slope of 1:5 is shown below.

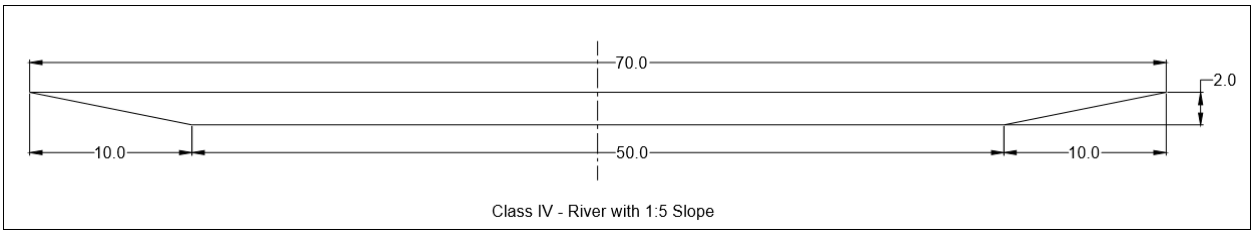
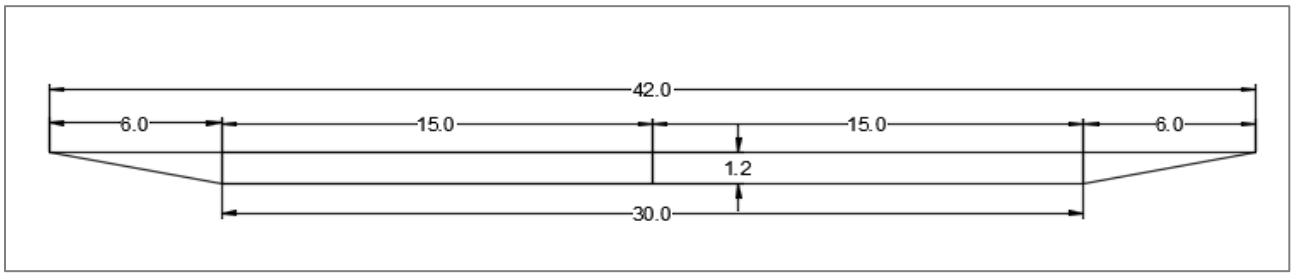


Figure 47 - Fairway Channel Dimensions

5.2 Calculation of Dredging Quantity

The dredge volume calculations were accomplished using the HYPACK dredge volume computation utility. The channel template was created as per the different classification and kilometer wise dredging calculation was carried out. (Enclosed at Annexure-3) The Hypack Standard volume algorithm was used to calculate the dredge volume in each segment. The stretch wise summary of the dredge volume for a different class of fairway is as follows:-

Class I

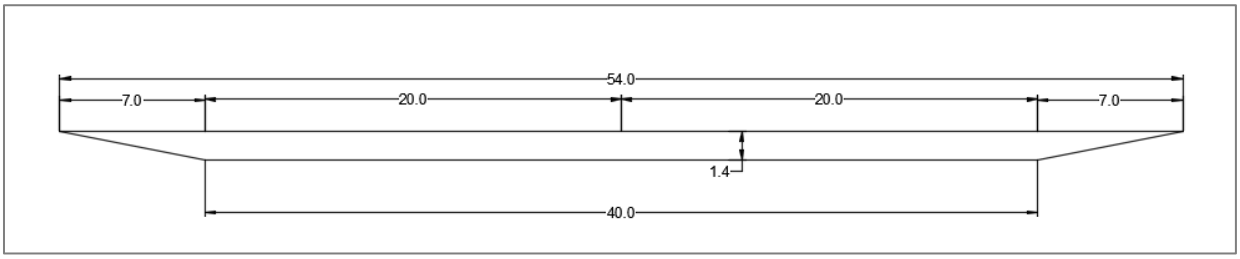


Class I			
Location	**Chainage (km)**	**Observed**	**Reduced w.r.t. Sounding Datum**

From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Murva-Konda Village	Kindi Singavaram Village	0	20	0.000	0.000	20000	859,634.43	859,634.43	-0.300	0.000	20000	1,097,187.57	1,097,187.57
Kindi Singavaram Village	Munagalapadu Village	20	40	0.000	0.000	20000	859,907.88	1,719,542.31	-0.300	0.000	20000	1,109,823.75	2,207,011.32
Munagalapadu Village	Sunkesula Barrage	40	60	0.000	0.000	20000	861,487.85	2,581,030.16	-0.300	0.000	20000	1,101,212.23	3,308,223.55
Sunkesula Barrage	Guruzala Village	60	90	0.000	0.000	30000	1,293,038.07	3,874,068.23	-0.300	0.000	30000	1,663,788.38	4,972,011.93
Guruzala Village	Madhavaram Bridge	90	114	0.000	0.000	24000	1,034,869.81	4,908,938.04	-0.300	0.000	24000	1,327,775.19	6,299,787.12
Madhavaram Bridge	Gurraladoddi Village	114	140	0.000	0.000	26000	1,120,775.93	6,029,713.97	-0.300	0.000	26000	1,431,188.84	7,730,975.96
Gurraladoddi Village	Valaballari Village	140	165	0.000	0.000	25000	1,077,998.20	7,107,712.17	-0.300	0.000	25000	1,355,359.05	9,086,335.01
Valaballari Village	Kenchanagudda Village	165	190	0.000	0.000	25000	1,077,454.98	8,185,167.15	-0.300	0.000	25000	1,388,008.25	10,474,343.26
Kenchanagudda Village	Manur Village	190	210	0.000	0.000	20000	862,004.38	9,047,171.53	-0.300	0.000	20000	1,100,838.79	11,575,182.05
Manur Village	Kampli Bridge	210	232.4	0.000	0.000	22400	952,760.75	9,999,932.28	-0.300	0.000	22400	1,221,728.65	12,796,910.70
					Total	**232400**	**9,999,932.28**	**9,999,932.28**		**Total**	**232400**	**12,796,910.70**	**12,796,910.70**

Table 33 - Class I Dredging Volumes

Class II

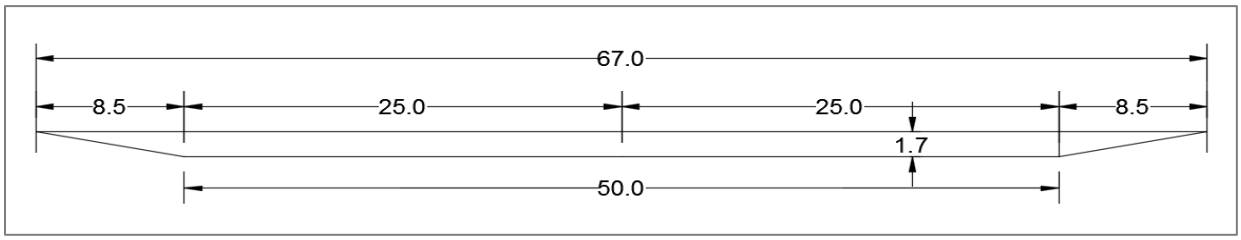


Class II													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Murva-Konda Village	Kindi Singavaram Village	0	20	0.000	0.000	20000	1,309,337.42	1,309,337.42	-0.300	0.000	20000	1,613,856.56	1,613,856.56
Kindi Singavaram Village	Munagalapadu Village	20	40	0.000	0.000	20000	1,309,791.85	2,619,129.27	-0.300	0.000	20000	1,631,053.81	3,244,910.37
Munagalapadu Village	Sunkesula Barrage	40	60	0.000	0.000	20000	1,312,174.08	3,931,303.35	-0.300	0.000	20000	1,620,604.20	4,865,514.57
Sunkesula Barrage	Guruzala Village	60	90	0.000	0.000	30000	1,969,486.70	5,900,790.05	-0.300	0.000	30000	2,446,113.51	7,311,628.08
Guruzala Village	Madhavaram Bridge	90	114	0.000	0.000	24000	1,576,262.40	7,477,052.45	-0.300	0.000	24000	1,952,836.82	9,264,464.90
Madhavaram Bridge	Gurraladoddi Village	114	140	0.000	0.000	26000	1,707,111.23	9,184,163.68	-0.300	0.000	26000	2,105,962.80	11,370,427.70
Gurraladoddi Village	Valaballari Village	140	165	0.000	0.000	25000	1,641,954.67	10,826,118.35	-0.300	0.000	25000	1,999,078.45	13,369,506.15

Class II														
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum					
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Valaballari Village	Kenchanagudda Village	165	190	0.000	0.000	25000	1,641,130.54	12,467,248.89	-0.300	0.000	25000	2,040,403.77	15,409,909.92
Kenchanagudda Village	Manur Village	190	210	0.000	0.000	20000	1,312,954.79	13,780,203.68	-0.300	0.000	20000	1,620,087.11	17,029,997.03
Manur Village	Kampli Bridge	210	232.4	0.000	0.000	22400	1,451,194.76	15,231,398.44	-0.300	0.000	22400	1,797,234.73	18,827,231.76
					Total	**232400**	**15,231,398.44**	**15,231,398.44**		**Total**	**232400**	**18,827,231.76**	**18,827,231.76**

Table 34 - Class II Dredging Volumes

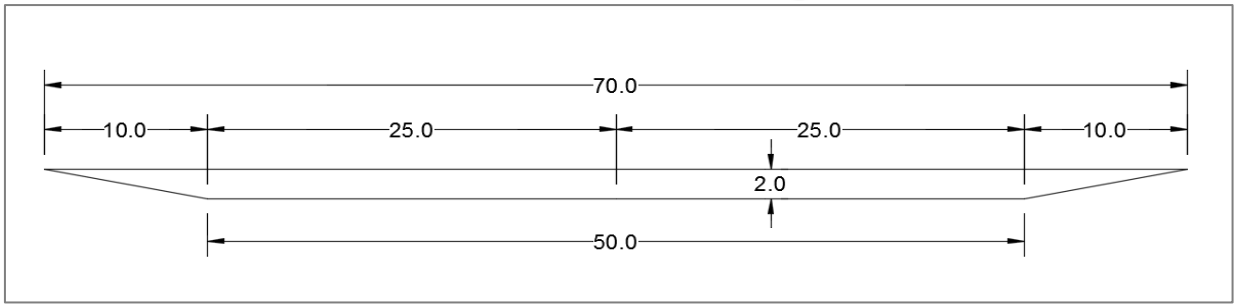
Class III



Class III													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Murva-Konda Village	Kindi Singavaram Village	0	20	0.000	0.000	20000	1,978,903.30	1,978,903.30	-0.300	0.000	20000	2,356,884.09	2,356,884.09
Kindi Singavaram Village	Munagalapadu Village	20	40	0.000	0.000	20000	1,979,608.69	3,958,511.99	-0.300	0.000	20000	2,378,192.28	4,735,076.37
Munagalapadu Village	Sunkesula Barrage	40	60	0.000	0.000	20000	1,983,210.66	5,941,722.65	-0.300	0.000	20000	2,365,964.06	7,101,040.43
Sunkesula Barrage	Guruzala Village	60	90	0.000	0.000	30000	2,976,679.21	8,918,401.86	-0.300	0.000	30000	3,568,081.24	10,669,121.67
Guruzala Village	Madhavaram Bridge	90	114	0.000	0.000	24000	2,382,349.66	11,300,751.52	-0.300	0.000	24000	2,849,655.30	13,518,776.97
Madhavaram Bridge	Gurraladoddi Village	114	140	0.000	0.000	26000	2,580,112.28	13,880,863.80	-0.300	0.000	26000	3,074,810.30	16,593,587.27
Gurraladoddi Village	Valaballari Village	140	165	0.000	0.000	25000	2,481,647.30	16,362,511.10	-0.300	0.000	25000	2,925,336.99	19,518,924.26
Valaballari Village	Kenchanagudda Village	165	190	0.000	0.000	25000	2,480,406.34	18,842,917.44	-0.300	0.000	25000	2,975,675.69	22,494,599.95
Kenchanagudda Village	Manur Village	190	210	0.000	0.000	20000	1,984,407.18	20,827,324.62	-0.300	0.000	20000	2,365,389.27	24,859,989.22
Manur Village	Kampli Bridge	210	232.4	0.000	0.000	22400	2,193,337.45	23,020,662.07	-0.300	0.000	22400	2,622,920.56	27,482,909.78
					Total	**232400**	**23,020,662.07**	**23,020,662.07**		**Total**	**232400**	**27,482,909.78**	**27,482,909.78**

Table 35 - Class III Dredging Volumes

Class IV



Class IV														
Location		**Chainage (km)**		**Observed**					**Reduced w.r.t. Sounding Datum**					
From	**To**	**From**	**To**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Accumulated Qty.**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Accumulated Qty.**
Murva-Konda Village	Kindi Singavaram Village	0	20	0.000	0.000	20000	2,387,804.74	2,387,804.74	-0.300	0.000	20000	2,782,726.61	2,782,726.61
Kindi Singavaram Village	Munagalapadu Village	20	40	0.000	0.000	20000	2,388,664.15	4,776,468.89	-0.300	0.000	20000	2,805,069.06	5,587,795.67
Munagalapadu Village	Sunkesula Barrage	40	60	0.000	0.000	20000	2,393,020.41	7,169,489.30	-0.300	0.000	20000	2,792,900.50	8,380,696.17
Sunkesula Barrage	Guruzala Village	60	90	0.000	0.000	30000	3,591,781.01	10,761,270.31	-0.300	0.000	30000	4,209,630.07	12,590,326.24
Guruzala Village	Madhavaram Bridge	90	114	0.000	0.000	24000	2,874,620.19	13,635,890.50	-0.300	0.000	24000	3,362,816.60	15,953,142.84
Madhavaram Bridge	Gurraladoddi Village	114	140	0.000	0.000	26000	3,113,254.93	16,749,145.43	-0.300	0.000	26000	3,630,029.07	19,583,171.91
Gurraladoddi Village	Valaballari Village	140	165	0.000	0.000	25000	2,994,452.16	19,743,597.59	-0.300	0.000	25000	3,458,240.11	23,041,412.02
Valaballari Village	Kenchanagudda Village	165	190	0.000	0.000	25000	2,992,954.75	22,736,552.34	-0.300	0.000	25000	3,510,433.56	26,551,845.58
Kenchanagudda Village	Manur Village	190	210	0.000	0.000	20000	2,394,458.94	25,131,011.28	-0.300	0.000	20000	2,792,542.13	29,344,387.71
Manur Village	Kampli Bridge	210	232.4	0.000	0.000	22400	2,646,563.27	27,777,574.55	-0.300	0.000	22400	3,095,465.95	32,439,853.66
					Total	**232400**	**27,777,574.55**	**27,777,574.55**		**Total**	**232400**	**32,439,853.66**	**32,439,853.66**

Table 36 - Class IV Dredging Volumes

6 Conclusion

The aim of the survey undertake bathymetric survey, topographic survey, a collection of data on cargo movement, industry survey, tourism facilities etc. in the project area; prepare detailed hydrographic survey charts, topographic survey charts, and feasibility report. The entire river bed of Tungabhadra River starting from confluence with Krishna River is generally sandy in nature; however, river bed from downstream of CWC site Bawapuram to downstream of Sunkesula Barrage from chainage on 44.1km to 59.7km and from Gundrevula village to downstream of Rajolibanda from chainage 74.8km to 133.8km is observed to be rocky. Incidents of sand and soil mining by local peoples using JCB, tractors, and bullock carts were observed near Santhanikota village, Devmada village, and Kurnool city. The river banks of entire stretch are covered with farmlands, dense vegetation and shrubs are also observed at some places. Paddy, cotton, groundnut, and sugarcane are the main crops of the entire project influence area. No specific level of encroachment was observed in the river banks of Tungabhadra River. The water flow of the Tungabhadra River is not obstructed for the entire stretch other than the above-mentioned Dams/Barrages.

6.1 Description of Waterways

The survey stretch of Tungabhadra River is of 232.4km in length, Ferry point/terminal exists near Kurnool city at 31.6km chainage, however, services are not available due to non-availability of navigable waters, however, residents of nearby villages were observed using Putti to cross the River at some location where impounded water is available. This survey stretch starts from the confluence with river Krishna near village Murva Konda to Kampli Bridge on State highway - 29 near Chikka Jantakal village. The Tungabhadra River is used mainly for irrigation purpose and drinking water supply. All dams are used for the irrigational purpose, and the water through the side way canals are used at large extent for irrigation of farmlands and crops thus detailed study on the impact of any change in the channel design needs to be carried out for the entire stretch of Tungabhadra River. The stretch wise minimum and maximum width range, average width and average slope of the waterway are as below:-

Sl. No.	Location		Chaiange (km)		Width Range of the Waterway		Average Width	Average slope (in m/km)
	From	To	From	To	Min	Max		
1	Murva-Konda	Kindi Singavaram	0	20.0	60.55	708.97	361.39	1 : 0.389

Sl. No.	Location		Chaiange (km)		Width Range of the Waterway		Average Width	Average slope (in m/km)
	From	To	From	To	Min	Max		
2	Kindi Singavaram	Munagalapadu	20.0	40.0	94.83	748.67	361.94	1 : 0.575
3	Munagalapadu	Sunkesula Barrage	40.0	60.0	172.30	1465.00	516.42	1 : 0.437
4	Sunkesula Barrage	Guruzala	60.0	90.0	57.17	1449.00	530.79	1 : 0.479
5	Guruzala	Madhavaram Bridge	90.0	114.0	196.26	651.69	446.70	1 : 0.639
6	Madhavaram Bridge	Gurraladoddi	114.0	140.0	4.56	946.36	544.92	1 : 0.856
7	Gurraladoddi	Valaballari	140.0	165.0	112.66	598.62	295.99	1 : 0.008
8	Valaballari	Kenchanagudda	165.0	190.0	82.84	1188.00	398.01	1 : 0.770
9	Kenchanagudda	Manur	190.0	210.0	116.19	2240.00	602.51	1 : 0.579
10	Manur	Kampli Bridge	210.0	232.4	209.64	605.13	391.47	1 : 0.500

Table 37 - Stretch wise Average width and slope of waterway

6.2 Methods for making waterway feasible

The waterway may be developed as a Class IV navigational canal by carrying out capital dredging to achieve the navigability. The class-wise details of reduced dredging quantities of the waterways are as tabulated below:-

Reduced Dredging Values w.r.t. CD				
Class	**I**	**II**	**III**	**IV**
0 - 20 (km)	1,097,187.57	1,613,856.56	2,356,884.09	2,782,726.61
20 - 40 (km)	1,109,823.75	1,631,053.81	2,378,192.28	2,805,069.06
40 - 60 (km)	1,101,212.23	1,620,604.20	2,365,964.06	2,792,900.50
60 - 90 (km)	1,663,788.38	2,446,113.51	3,568,081.24	4,209,630.07
90 - 114 (km)	1,327,775.19	1,952,836.82	2,849,655.30	3,362,816.60
114 - 140 (km)	1,431,188.84	2,105,962.80	3,074,810.30	3,630,029.07
140 - 165 (km)	1,355,359.05	1,999,078.45	2,925,336.99	3,458,240.11
165 - 190 (km)	1,388,008.25	2,040,403.77	2,975,675.69	3,510,433.56
190 - 210 (km)	1,100,838.79	1,620,087.11	2,365,389.27	2,792,542.13
210 - 232.4 (km)	1,221,728.65	1,797,234.73	2,622,920.56	3,095,465.95
Total	**12,796,910.70**	**18,827,231.76**	**27,482,909.78**	**32,439,853.66**

Table 38 - Class-wise Reduced Dredging quantity

Due to the continuous gradient of the river and the water level will not be available during the summer season the navigation aspect will not be fulfilled throughout the year. The Barrage with Navigational channel & Navigational lock is required to maintain the

minimum depth required for navigation and regulate the water level in the river. Boat jetties may be constructed at the upstream of Sunkesula Barrage, near Jogulamba Temple at Alampur and Mantralayam as tourism scope is much at these places. The class-wise details of reduced depth at different stretches of the waterways are as tabulated below:-

Sl. No	Chaiange (km)		< 1.2		1.2 - 1.4		1.5 - 1.7		1.8 - 2.0		> 2.0	
	From	To	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability
1	0	20.0	20	100%	0	0 %	0	0 %	0	0 %	0	0 %
2	20.0	40.0	20	100%	0	0 %	0	0 %	0	0 %	0	0 %
3	40.0	60.0	20	100%	0	0 %	0	0 %	0	0 %	0	0 %
4	60.0	90.0	30	100%	0	0 %	0	0 %	0	0 %	0	0 %
5	90.0	114.0	24	100%	0	0 %	0	0 %	0	0 %	0	0 %
6	114.0	140.0	26	100%	0	0 %	0	0 %	0	0 %	0	0 %
7	140.0	165.0	25	100%	0	0 %	0	0 %	0	0 %	0	0 %
8	165.0	190.0	25	100%	0	0 %	0	0 %	0	0 %	0	0 %
9	190.0	210.0	20	100%	0	0 %	0	0 %	0	0 %	0	0 %
10	210.0	232.4	22.4	100%	0	0 %	0	0 %	0	0 %	0	0 %
Total			**232.4**	**100%**	**0**	**0 %**	**0**	**0 %**	**0**	**0 %**	**0**	**0 %**

Table 39 - Class-wise availability of reduced depth of the waterway

6.3 Modifications/ improvement Measures

Improvement measures for design and depth improvement are required on the first phase of the development. A major capital dredging is required to improve the depth of the channel as there is no facility to retain the water throughout the stretch except Sunkesula Barrage. The construction of weirs may increase the navigable depths of waterway after small stretches of 25 to 30km and Navigational locks to be constructed to retain water. However, the continuous gradient of the river also needs to be considered for any alteration on the channel design. River banks are naturally protected and availability of water is very less, hence no signs of erosion of river banks are found in the entire stretch of Tungabhadra River. Inlet canals may be linked from other rivers and dams/barrages to maintain navigable depths for example around 20km upstream of Rajolibanda on left bank an interlinking canal to Nagalapur reservoir canal may be developed.The class-wise modification details of cross structure and high tension line clearance are as tabulated below:-

Bridges/pipeline Clearances less than Class			High Tension lines Clearances less than Class	
Class	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**

I	09	1	0	0
II	09	1		
III	10	1		
IV	00	7		

Table 40 - Bridges and HTL Clearances less than Class no.

6.4 Recommendation

There is no major scope for a navigational aspect of the waterway due to non-availability of water throughout the season. The river banks are well connected with the road network and major distribution of settlements are there near to Kurnool, Mantralayam, and Sirguppa and Kampli towns. There are three major industries settled beside the banks of Tungabhadra River, Sree Rayalaseema Alkalies and Allied Chemicals Limited at Gondiparla village near Kurnool and Adani Wilmar Limited Fortune edible oil near Mantralayam, NSL Sugars Dasanur near Sirguppa, and the scope of cargo transportation is also very limited due to availability of good road transportation on both sides of the river. No scope for the future development of the river was recommended for navigational purpose and the survey stretch is not-viable for development as navigable channel, however the specific chainages of the waterway may be developed as tourism and passengers point of view in future.

The purpose of the survey was for assessing the river stretch from Bridge on State highway-29 near Chikka Jantakal village confluence with river Krishna near village Murva Konda for the development of water transport facilities in the new National Waterway (NW-104). All conspicuous objects within and in the vicinity of the survey area have been fixed. The deliverable sheets contain mean sea level values of elevation information, important landmarks with the state of the river banks. The survey is considered complete in all respects.

7 Details of Annexures

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