



Final Feasibility Report National Waterways-11, Region V – Arunawati-Aran River Chimata to Manora (98.9km)

SURVEY PERIOD: 20 MAY 2016 TO 10 AUG 2016



Volume - I

Prepared for:

Inland Waterways Authority of India

(Ministry of Shipping, Govt. of India)

A-13, Sector – 1, NOIDA

Distt. Gautam Budh Nagar,

Uttar Pradesh – 201 301

Document Distribution				
Date	Revision	Distribution	Hard Copy	Soft Copy
28 Nov 2016	Rev – 0	INLAND WATERWAYS AUTHORITY OF INDIA	01	01
29 Apr 2016	Rev – 1.0	INLAND WATERWAYS AUTHORITY OF INDIA	01	01
07 Sep 2017	Rev – 1.1	INLAND WATERWAYS AUTHORITY OF INDIA	04	04
01 Dec 2017	Rev – 1.2	INLAND WATERWAYS AUTHORITY OF INDIA	01	01
31 Oct 2018	Rev – 1.3	INLAND WATERWAYS AUTHORITY OF INDIA	04	04

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-11 in Region V – Arunawati-Aran River from Manora to Chimata.

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.

List of Abbreviations

CD	Chart Datum
DGPS	Differential Global Positioning Systems
ETS	Electronic Total Station
GPS	Global Positioning Systems
ARN	Arunawati
LBM	Local Bench Mark
MSL	Mean Sea Level
RL	Reference Level
SD	Sounding Datum
SBAS	Satellite-Based Augmentation System
TBC	Trimble Business Center
PIA	Project Influence Area
NH	National Highway
SH	State Highway

CONTENTS

1	Introduction.....	3
1.1	Background.....	3
1.2	Tributaries of Arunawati-Aran River.....	4
1.3	State/District through which Arunawati-Aran River passes.....	5
1.4	Maps.....	5
1.4.1	Full course of the waterway.....	5
1.4.2	Course of the waterway under study.....	6
1.5	Scope of Work.....	7
2	Methodology Adopted to Undertake Study.....	8
2.1	Recce.....	8
2.2	Survey Resources and Methodology.....	8
2.2.1	Survey Launch.....	8
2.2.2	Survey Equipment.....	9
2.2.3	Topographic Survey.....	9
2.2.4	Bathymetric Survey and Survey Launch.....	10
2.2.5	Calibration.....	10
2.3	Description of Bench Marks/Authentic Reference Level Used.....	10
2.4	Tidal influence Zone and Tidal Variation.....	11
2.5	Methodology to fix Chart Datum / Sounding Datum.....	11
2.5.1	Sounding Datum.....	11
2.5.2	Datum Calculation.....	11
2.6	Average of 06 years minimum Water Levels to arrive at Chart Datum (CD).....	13
2.7	Transfer of Sounding Datum.....	13
2.8	Table indicating Tidal Variation at Different Observation Points.....	13
2.9	Salient features of Dam, Barrages etc.....	13
2.9.1	Salient Features of Arunawati Dam:-.....	13
2.10	Erected IWAI Benchmark Pillars.....	14
2.11	Chart Datum / Sounding Datum and Reductions Details.....	15
2.12	HFL/MHWS values of Bridges/Cross Structures.....	15
2.13	Graph: Sounding Datum and HFL vs Chainage.....	17
2.14	Average Bed Slope.....	17
2.15	Details of Dam, Barrages, Weirs, Anicut, etc.....	18

2.16	Details of Locks	19
2.17	Details of Aqueducts.....	20
2.18	Details of existing Bridges and Crossings over Waterway	20
2.19	Details of other Cross structures, pipe-lines, under water cables.....	22
2.20	Details of High Tension Lines / Electric lines / Tele-communication lines	22
2.21	Current Meter and Discharge Details.....	24
2.22	Water Sample Locations	24
3	Description of Waterway	25
3.1	Sub-Stretch-01: Chimata to Heti (Chainage 0.0km to 30.00km).....	25
3.1.1	Observed and reduced Bed Profile of the stretch.....	29
3.2	Sub-Stretch-2: Heti to Sawanga Kh. (30.0km to 60.00km)	30
3.2.1	Observed and reduced Bed Profile of the stretch.....	34
3.3	Sub-Stretch-3: Sawang kh. To Waroli (60.00km to 90.00km)	35
3.3.1	Observed and reduced Bed Profile of the stretch.....	39
3.4	Sub-Stretch-4: Waroli to Manora (90.00km to 98.9km).....	40
3.4.1	Observed and reduced Bed Profile of the stretch.....	41
3.5	Other Aspects of Waterway	42
3.5.1	Fishing.....	42
3.5.2	Industries.....	42
3.5.3	Crops	42
3.5.4	Settlements.....	42
3.5.5	Drinking Water	42
3.5.6	Important Cities/Towns.....	43
3.5.7	Road Network	43
3.5.8	Land Use	44
3.5.9	Construction Material	45
3.5.10	Conditions of banks	45
3.5.11	Jetties and Terminals.....	45
3.5.12	Cargo Movement.....	45
3.5.13	Passenger Ferry Services	45
3.5.14	Historic importance.....	45
3.5.15	Tourism	46
3.5.16	Irrigation Canals and Outlets	46

4	Terminals.....	46
4.1	Details of Terminal survey carried out.....	46
5	Fairway Development	46
5.1	Fairway Dimensions	46
5.2	Calculation of Dredging Quantity.....	47
5.2.1	Zone 44N	47
5.2.2	Zone 43N	49
6	Conclusion.....	51
6.1	Description of Waterways.....	51
6.2	Methods for making waterway feasible	52
6.3	Modifications/ improvement measures	53
6.4	Recommendation	53
7	Details of Annexures.....	54
	Annexure-1 Source and type of data collected from various agencies.....	55
	Annexure-2 Stretch wise Data of Observed Depths to Reduced Depths.....	57
	Annexure-3 Dredge Volumes (per km) for different classification with length of shoal.....	59
	Annexure-4 Water Level Details.....	71
	Annexure-5 Survey Dates.....	73
	Annexure-6 Details of Bank Protection.....	75
	Annexure-7 Details of Riverside Features.....	77
	Annexure-8 Horizontal and Vertical Control.....	79
	Annexure-9 Equipment Photographs.....	83
	Annexure-10 Bench Mark Pillar Forms.....	85
	Annexure-11 Levelling Data.....	109
	Annexure-12 Current Meter Observation and Discharge Calculation.....	253
	Annexure-13 Water Sample Analysis.....	255
	Annexure-14 Calibration Certificates.....	257
	Annexure-15 Survey Chart Scheming Index and chart details.....	260
	Annexure-16 Field Photographs.....	265

Figure 1 - Locations around 43N Zone	3
Figure 2 - Locations around 44N Zone	4
Figure 3 - Arunawati-Aran River Tributaries	5
Figure 4 - Full Course of Arunawati-Aran River	6
Figure 5 - Map of Arunawati-Aran River	7
Figure 6 - Spot leveling by DGPS.....	10
Figure 7 - Graph of Sounding Datum & HFL vs Chainage	17
Figure 8 - Stretch-01 Chimta to Heti.....	25
Figure 9 - Khadka Road Bridge (2.72 km chainage)	26
Figure 10 - Pardii Road Bridge (14.48 km chainage)	27
Figure 11 - Vitholi Road Bridge (25.82 km chainage)	27
Figure 12 - Foot walk board Bridge at shiur (27.12 km chainage)	28
Figure 13 - Insufficient water and slate rocks at Stretch-1	28
Figure 14 - Stretch-1 Observed and reduced bed profile	29
Figure 15 - Stretch 2 Heti to Sawanga Kh. Village.....	30
Figure 16 - Vitholi Bridge (34.38 km chainage).....	31
Figure 17 - Arni Road Bridge (45.26 km chainage)	32
Figure 18 - Highway Bridge at Arni (46.18 km chainage)	32
Figure 19 - Saikhed Sanko Bridge (54.98 km chainage)	33
Figure 20 - River Side features upon this stretch	33
Figure 21 - Stretch 2 Observed and reduced bed profile.....	34
Figure 22 - Stretch 3 Sawang kh. To Waroli.....	35
Figure 23 - Chirkuta Road Bridge (63.4 km chainage).....	36
Figure 24 - Digras Arunawati Dam (65.37 km chainage).....	36
Figure 25 - Darwha By pass Road on SH 213 (81.92 km chainage)	37
Figure 26 - Harsul Iron Bridge (83.12 km chainage).....	37
Figure 27 - Waroli Road Bridge (88.08 km chainage).....	38
Figure 28 - Harsul Bridge (85.52 km chainage)	38
Figure 29 - Stretch 3 Observed and reduced bed profile.....	39
Figure 30 - Stretch-4 Waroli to Manora.....	40
Figure 31 - Slatted Rocks	41
Figure 32 - Stretch 4 River-bed profile	41

Figure 33 - Road Network.....	44
Figure 34 - Fairway Channel Dimensions	47
Table 1 - State wise waterway	5
Table 2 - Survey Equipment Used	9
Table 3 - Accepted Station coordinates (WGS-84).....	11
Table 4 - Established CD for per kilometer stretch.....	13
Table 5 - Salient features of Arunawati Dam.....	14
Table 6 - Accepted BM coordinates w.r.t. established CD	15
Table 7 - HFL values of Bridges/Cross Structures	16
Table 8 - Average Bed Slope	18
Table 9 - Arunawati Dams & Barrages w.r.t. MSL	19
Table 10 - Details of cross structures	21
Table 11 - High Tension Lines Details	23
Table 12 - Stretch-1 Dredging Quantity Details	29
Table 13 - Stretch 2 Dredging Quantity Details.....	34
Table 14 - Stretch 3 Dredging Quantity	39
Table 15 - Stretch 4 Dredging Quantity	41
Table 16 - Major District Roads.....	43
Table 17 - Class I Stretchwise Dredge Volumes.....	47
Table 18 - Class II Stretchwise Dredge Volumes	48
Table 19 - Class III Stretchwise Dredge Volumes	48
Table 20 - Class IV Stretchwise Dredge Volumes.....	49
Table 21 - Class I Stretchwise Dredge Volumes.....	49
Table 22 - Class II Stretchwise Dredge Volumes	50
Table 23 - Class III Stretchwise Dredge Volumes	50
Table 24 - Class IV Stretchwise Dredge Volumes.....	51
Table 25 - Stretch wise Average width and slope of waterway	52
Table 26 - Class-wise Reduced Dredging quantity	52
Table 27 - Class-wise availability of reduced depth of the waterway.....	52
Table 28 - Bridges and HTL Clearances less than Class no	53

SALIENT FEATURES AT A GLANCE

#	Particulars	Details																																										
1.	Name of Consultant	IIC Technologies Limited, Hyderabad																																										
2.	Region number & State(s)	Region – V, Maharashtra																																										
3.	Waterway stretch, NW # (from.... to; total length)	National Waterway No – 11 Manora to Chimata (98.9km)																																										
4.	Navigability Status	At present the survey stretch of Arunawati-Aran River is non-navigable condition.																																										
a)	Tidal & non tidal portions to, length, average tidal variation)	The survey Stretch of Arunawati-Aran River is non-tidal.																																										
b)	Least Spot Height 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)	<p>Arunawati-Aran River is dry and the survey was conducted by topographic method.</p> <table border="1"> <thead> <tr> <th>LAD (m)</th> <th>0 - 30 km</th> <th>30 - 60 km</th> <th>60 - 90 km</th> <th>90 - 98.9 km</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>< 1.2</td> <td>30</td> <td>30</td> <td>30</td> <td>8.9</td> <td>98.9</td> </tr> <tr> <td>1.2 - 1.4</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> </tr> <tr> <td>1.8 - 2.0</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> </tr> <tr> <td>Total</td> <td>30</td> <td>30</td> <td>30</td> <td>8.9</td> <td>98.9</td> </tr> </tbody> </table>	LAD (m)	0 - 30 km	30 - 60 km	60 - 90 km	90 - 98.9 km	Total	< 1.2	30	30	30	8.9	98.9	1.2 - 1.4	0	0	0	0	0	1.5 - 1.7	0	0	0	0	0	1.8 - 2.0	0	0	0	0	0	> 2	0	0	0	0	0	Total	30	30	30	8.9	98.9
LAD (m)	0 - 30 km	30 - 60 km	60 - 90 km	90 - 98.9 km	Total																																							
< 1.2	30	30	30	8.9	98.9																																							
1.2 - 1.4	0	0	0	0	0																																							
1.5 - 1.7	0	0	0	0	0																																							
1.8 - 2.0	0	0	0	0	0																																							
> 2	0	0	0	0	0																																							
Total	30	30	30	8.9	98.9																																							
c)	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]	<p>Cross Structures</p> <p>i) No Navigational locks are present in the survey stretch of Arunawati River. The details of Dam, check Dam and Barrages are as follows:-</p> <p>(a) Dams – 01 nos</p> <p>(b) Barrages – 07 Nos</p> <p>(c) Check Dam – 03 Nos</p> <p>ii) Bridges – 16 Nos. Horizontal Clearance – 2.5 to 12.802m Vertical Clearance w.r.t. HFL- -1.24 to 5.82m</p>																																										

#	Particulars	Details																	
		Power cables – 09 Nos Vertical Clearance w.r.t. HFL- 9.003 to 20.125m High Tension Lines – 06 Nos Vertical Clearance w.r.t. HFL- 10.658 to 28.263m																	
d)	Avg. discharge & no. of days	As the river is dried so avg. discharge is cannot be calculated																	
e)	Slope (1 in)	<table border="1"> <thead> <tr> <th colspan="2">Chainage (km)</th> <th rowspan="2">Slope (A/B)</th> </tr> <tr> <th>From</th> <th>To</th> </tr> </thead> <tbody> <tr> <td>0.0</td> <td>30.0</td> <td>1 : 1.548</td> </tr> <tr> <td>30.0</td> <td>60.0</td> <td>1 : 0.932</td> </tr> <tr> <td>60.0</td> <td>90.0</td> <td>1 : 1.285</td> </tr> <tr> <td>90.0</td> <td>98.9</td> <td>1 : 1.398</td> </tr> </tbody> </table> <p>Average slope is 1 : 268 for entire river stretch</p>	Chainage (km)		Slope (A/B)	From	To	0.0	30.0	1 : 1.548	30.0	60.0	1 : 0.932	60.0	90.0	1 : 1.285	90.0	98.9	1 : 1.398
Chainage (km)		Slope (A/B)																	
From	To																		
0.0	30.0	1 : 1.548																	
30.0	60.0	1 : 0.932																	
60.0	90.0	1 : 1.285																	
90.0	98.9	1 : 1.398																	
5.	Traffic potential	No Navigational traffic is present in the survey stretch of Arunawati River.																	
a)	Present IWT operations, ferry services, tourism, cargo, if any	No local boats or ferry services.																	
b)	Important industries within 50 km	<ul style="list-style-type: none"> Raymonds Limited Yavatmal, (MIDC) Cloth manufacture at Bhoyar is 37.52km away from Arunawati River. Oil mills, Ginning and spinning mills at Kursheed Nagar, Adilabad is 40.67km away from Arunawati River. 																	
c)	Distance of Rail & Road from Industry	<ul style="list-style-type: none"> Raymonds Limited Yavatmal, (MIDC) Cloth manufacture at Bhoyar is 2.13km away from NH204 and 0.73km away from SH212. Oil mills, Ginning and spinning mills at Kursheed Nagar, Adilabad is 1.59km away from NH7. 																	
6.	Consultant's recommendation for going ahead with TEF / DPR preparation	No Scope of TEF/DPR can be provided for the Arunawati-Aran River since the river is dry. This River Stretch is not-viable for navigable channel.																	
7.	Any other information/ comment	-Nil-																	

(Signature)

Date:

Name of Consultant

1 Introduction

1.1 Background

The stretch of about 98.9km of Arunawati-Aran River, from a Bridge on State Highway No-211 near Manora town to confluence of Arunawati and Aran River near Ratnapur to confluence of Aran and Penganga Rivers near Chimata village. This area of interest was identified for Inland Water transport facility as per a study carried out earlier. 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.

The source of the Aran River is in the Washim district of Maharashtra. The River Arunawati is a right bank tributary of this River and meets Aran at about 13 kilometers before it confluences with the Penganga. It runs across Darwha and certain parts of Kelapur. It flows for about 113 km. A Taluk headquarters called Arni is located on the bank of the Arunawati-Aran River. The Arunawati Dam near Digras in the district of Yavatmal, Maharashtra, is on this River. The River dries up in the summer, leaving only pools towards the end of its course.

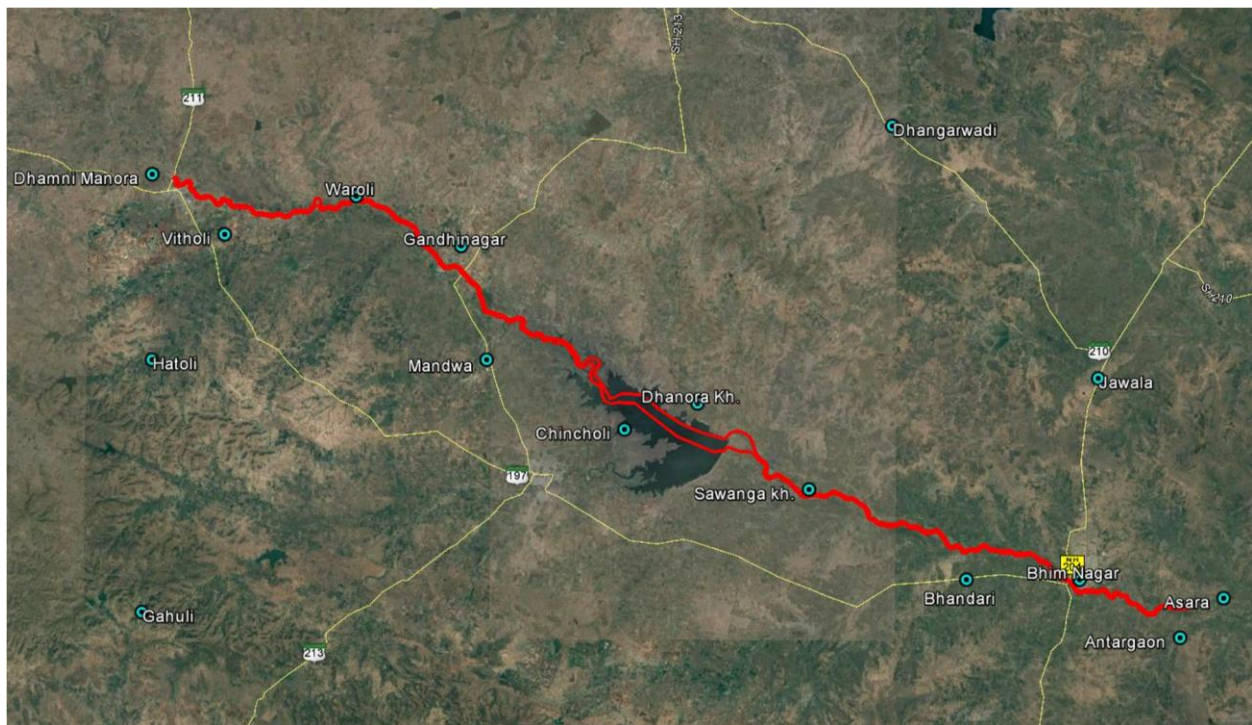


Figure 1 - Locations around 43N Zone

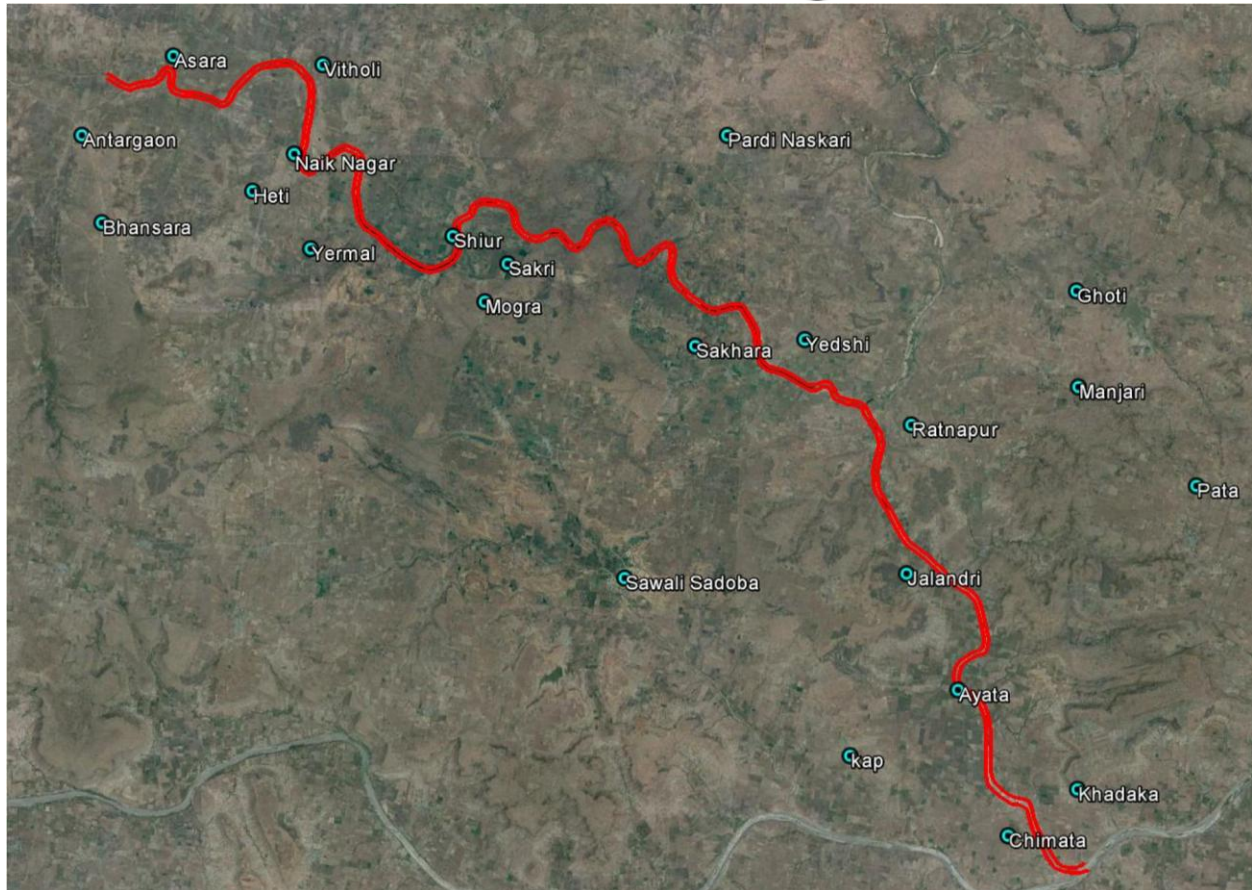


Figure 2 - Locations around 44N Zone

1.2 Tributaries of Arunawati-Aran River

Arunawati-Aran River does not have any tributary, she herself is a tributary of Aran River and finally forms the tributary of Penganga River. As per the survey stretch, the length of the Arunawati River is 85.9 km. The river flows across Darwha and certain areas of Kelapur. Arunawati River merges with the Aran River. Arni, a taluk headquarters, is located on the banks of the river. As per the survey stretch, the length of the Aran/Adan River is 13.0 km. The tributaries of Aran/Adan River are Arunawati is the left tributary. Aran/Adan River is in Washim district of Maharashtra and it is the principal tributary of Penganga River.

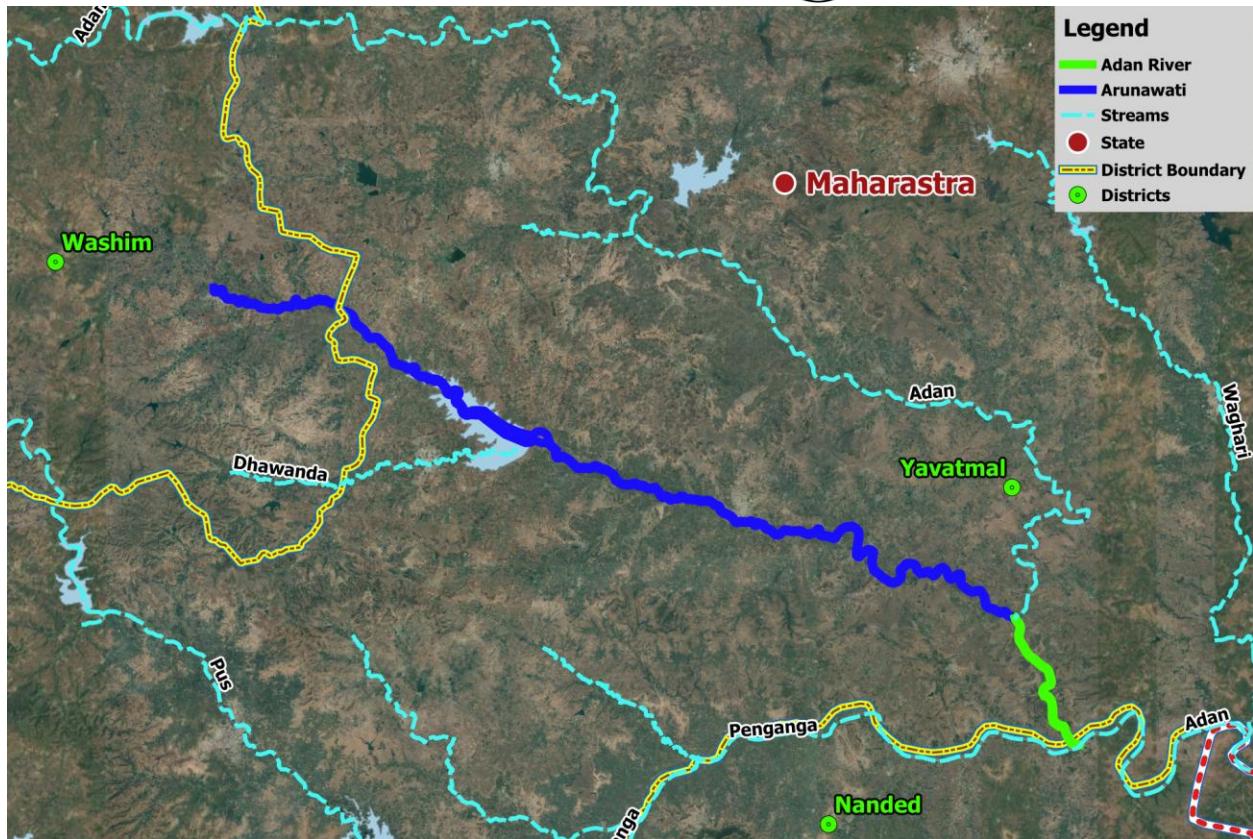


Figure 3 - Arunawati-Aran River Tributaries

1.3 State/District through which Arunawati-Aran River passes

The Arunawati-Aran River passes through Washim and Yavatmal district in Maharashtra.

State Name	Chainage (km)		Length in km
	From	To	
Maharashtra	0.00	98.9	98.9

Table 1 - State wise waterway

1.4 Maps

1.4.1 Full course of the waterway

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

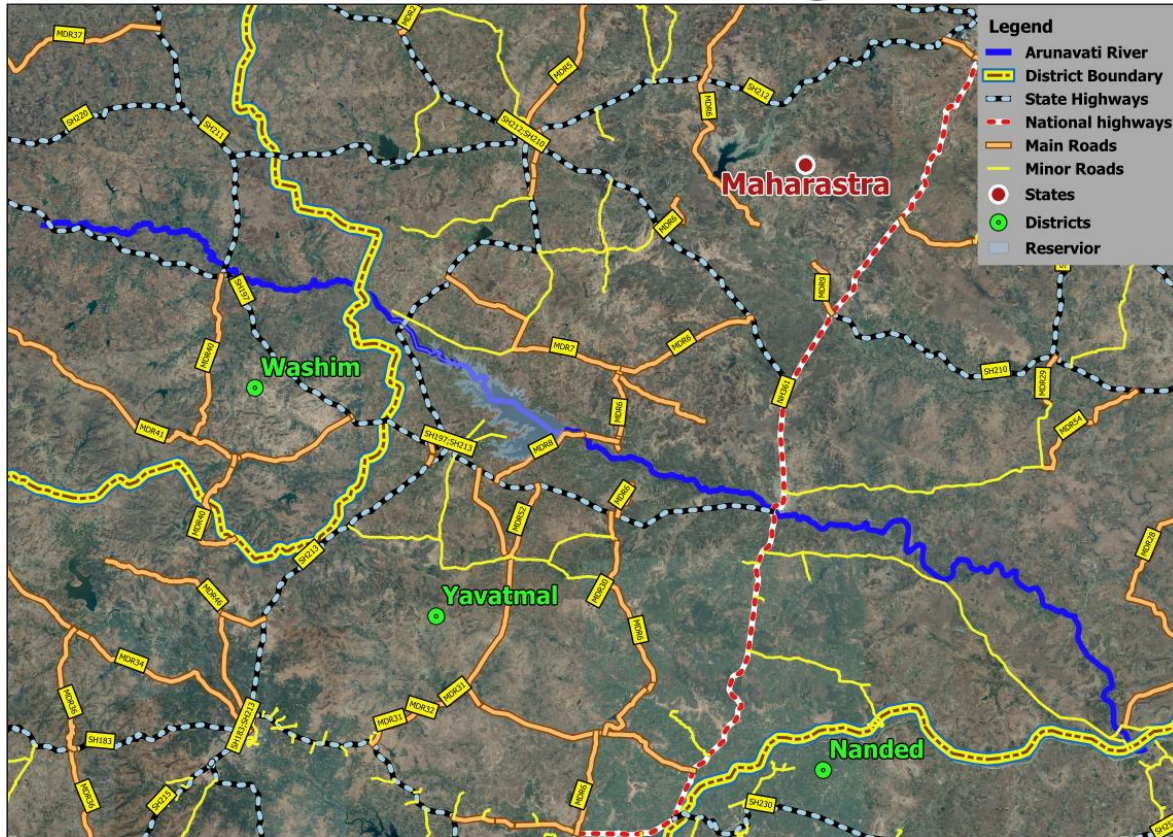


Figure 4 - Full Course of Arunawati-Aran River

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 5 - Map of Arunawati-Aran River

1.5 Scope of Work

The major part of the work is to conduct detailed hydrographic and topographic survey of 98.9km length of the River from a Bridge on State Highway No.211 at Latitude $20^{\circ}13'32.91''N$ and Longitude $77^{\circ}33'23.32''E$ to confluence of Arunawati and Aran River near Ratnapur village at Latitude $19^{\circ}59'30.70''N$ and Longitude $78^{\circ}9'37.51''E$ to confluence of Aran and Penganga Rivers near Chimata village at Latitude $19^{\circ}54'8.32''N$ and Longitude $78^{\circ}12'36.43''E$. The scope of the work for the conduct of survey of Arunawati-Aran River includes:

- Undertake bathymetric and topographic survey of proposed waterway.
- 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 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

Advance recce of the survey area was undertaken in early 15th Mar 2016 by a detach survey party. The recce was started from a Chimata village, Yavatmal Dist. in Maharashtra to Manora town in Washim Dist. in Maharashtra. Stretch was examined at four places namely villages Chimata, Arni at near SH-204 bridge, Digras Dam and Manora village at SH-211 bridge, which contain rocks and bushes growth both side of the banks.

The following observation has been made.

- The survey area is 98.9km, from the Manora State Highway towards downstream.
- River width varied between 30 mtr to 110 mtr.
- The work of Topography is also very much time consuming and not feasible due to rocks and thick vegetation growth and cliffs on both the banks.

It was observed that most of the River stretch was scattered flow of water dry and preliminary queries revealed that the River remains dry for most of the year. Hence a decision was taken to undertake topographic survey initially for the complete River stretch, hydrographic survey would be undertaken depending on the field conditions and availability of water in limited pockets of the River stretch under consideration

2.2 Survey Resources and Methodology

The actual survey was commenced on 20th May and completed on 10th Aug 2016. The survey was undertaken on a scale of 1:7500 for 43N and 50000 for 44N, with sounding line spacing, kept at 100 m and plotted on UTM Projection at Zone 43N and 44N as directed in the contract specifications.

2.2.1 Survey Launch

The bathymetric survey was unable to conduct due to the unavailability of sufficient water in the River stretch.

2.2.2 Survey Equipment

Following equipment were employed for the bathymetric and topographic survey.

Equipment	Make	Eqpt. Serial No.	Qty. Employed
GPS Sets	Trimble R3/R4	-	06
Auto Level	Sokkia Auto level & Accessories	102662, 120840	02
ETS	Trimble M3	-	01
Software	HYPACK data acquisition	Version 15	1
Software	AUTOCAD	2012	1
Software	Microsoft Office	2013	1

Table 2 - Survey Equipment Used

2.2.3 Topographic Survey

The survey was commenced on 20th May 2016 and completed on 10th Aug 2016. The weather was sunny throughout the period during survey operations. The weather was favorable with moderate hot climate for the conduct of survey and the weather condition remains same for the entire duration of the survey.

The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 20 mtr 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 river locations. The topographic survey for the entire survey stretch was conducted to collect the following data:-

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

The details of all spot levels are provided in the respective sheets being presented along-with this report. Additionally, a soft copy of the same in XYZ format is being handed over as deliverable data.



Figure 6 - Spot leveling by DGPS

2.2.4 Bathymetric Survey and Survey Launch

The bathymetric survey by survey launch of the Arunawati-Aran River was unable to conduct, due to non-availability of water throughout the River.

2.2.5 Calibration

The equipment used for the survey was calibrated by the equipment supplier. The equipment calibration certificates are placed at Annexure - 14 to this report.

2.3 Description of Bench Marks/Authentic Reference Level Used

The established benchmark of government organizations were not available for the entire survey stretch of the Arunawati-Aran River as per the list given by IWAI.

The extension of Horizontal control was done by carrying out simultaneous GPS observations on IWAI BM PNG-25 and IWAI ARN-01 and the data was downloaded and processed in Trimble Business Center Software in Baseline Method. Similarly the extension of Vertical control was done by transferring the Reference level from IWAI BM PNG-25 to IWAI ARN-01 by Levelling and thereafter from one pillar to another.

The new Benchmark Pillars (IWAI BM Pillars) were constructed as per specification and erected at an average distance of 10 to 11 Km along the River stretch from starting to end chainage of the River. The value of these benchmarks w.r.t. MSL was obtained by leveling them to the Local benchmarks established earlier.

The final accepted co-ordinates and reduced level (R.L) values of these Bench Marks and other station established for setting up of reference DGPS base stations are as below:

Sl. No.	Station	Chainage (km)	Latitude	Longitude	Height. (above MSL) (m)	Source/ Type
1	IWAI BM PNG-25	1.22	N19°55'00.90749"	E78°12'56.19793"	259.291	Baseline Processed
2	IWAI BM ARN-01	8.34	N19°57'43.89141"	E78°11'05.64876"	259.547	Baseline Processed
3	IWAI BM ARN-02	18.50	N20°01'17.09082"	E78°07'47.69069"	293.049	Baseline Processed
4	IWAI BM ARN-03	27.10	N20°01'01.23173"	E78°04'09.07202"	283.485	Baseline Processed
5	IWAI BM ARN-04	37.90	N20°03'30.51963"	E78°00'38.11993"	301.885	Baseline Processed
6	IWAI BM ARN-05	48.29	N20°04'39.22404"	E77°55'55.46839"	306.152	Baseline Processed
7	IWAI BM ARN-06	59.65	N20°06'13.97504"	E77°50'11.14680"	316.154	Baseline Processed
8	IWAI BM ARN-07	69.58	N20°08'56.45197"	E77°46'18.00083"	346.051	Baseline Processed
9	IWAI BM ARN-08	80.94	N20°10'55.57471"	E77°41'26.40806"	343.815	Baseline Processed
10	IWAI BM ARN-09	91.85	N20°13'12.82139"	E77°36'36.80059"	361.843	Baseline Processed
11	IWAI BM ARN-10	98.88	N20°13'31.92400"	E77°33'22.87398"	370.794	Baseline Processed

Table 3 - Accepted Station coordinates (WGS-84)

2.4 Tidal influence Zone and Tidal Variation

The survey stretch of Arunawati-Aran River is non-tidal water body and no influence of tidal force was observed throughout the survey period.

2.5 Methodology to fix Chart Datum / Sounding Datum

The Arunawati-Aran River is a 98.9km stretch which is between Chimata to Manora village is completely dry except small water pockets at some places. The water depth by an average of 0.1 to 0.2 meters is available in the river near Arunawati Dam and the water level is recorded as Dry (dead level) as per dam authorities.

2.5.1 Sounding Datum

The established CWC Chart Datum values are not available for the survey stretch of Arunawati-Aran River. The Arunawati-Aran River being dry, the entire River stretch is divided into per-km stretches and the least MSL Value obtained during the conduct of a Topographic survey for the stretch is considered as Chart Datum for the Dredging Volume calculations

2.5.2 Datum Calculation

The datum for calculation of dredge volume needs to be adopted as per the gradient of the River and the average water level of the River. The datum for calculation of dredge volume was accepted as the least spot height in the stretch for the entire River. The newly established sounding datum is established by assuming the least value of the Spot height for every 01km of the River stretch.

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	233.125	233.125		50-51	296.214	296.214
1-2	236.147	236.147		51-52	297.025	297.025
2-3	237.447	237.447		52-53	298.258	298.258
3-4	240.125	240.125		53-54	299.147	299.147
4-5	241.159	241.159		54-55	300.269	300.269
5-6	242.214	242.214		55-56	302.087	302.087
6-7	242.156	242.156		56-57	303.169	303.169
7-8	242.125	242.125		57-58	304.115	304.115
8-9	243.125	243.125		58-59	305.464	305.464
9-10	244.147	244.147		59-60	306.117	306.117
10-11	245.147	245.147		60-61	307.095	307.095
11-12	245.236	245.236		61-62	308.214	308.214
12-13	246.147	246.147		62-63	309.074	309.074
13-14	247.658	247.658		63-64	310.058	310.058
14-15	248.753	248.753		64-65	311.379	311.379
15-16	251.147	251.147		65-65.4	312.083	312.083
16-17	253.147	253.147		65.4-66	321.092	321.092
17-18	254.258	254.258		66-67	321.243	321.243
18-19	256.147	256.147		67-68	321.551	321.551
19-20	257.125	257.125		68-69	322.343	322.343
20-21	258.059	258.059		69-70	322.743	322.743
21-22	259.236	259.236		70-71	323.243	323.243
22-23	261.147	261.147		71-72	323.643	323.643
23-24	263.258	263.258		72-73	324.443	324.443
24-25	266.658	266.658		73-74	324.824	324.824
25-25	269.125	269.125		74-75	325.205	325.205
25-26	272.156	272.156		75-76	325.204	325.204
26-27	274.101	274.101		76-77	326.113	326.113
27-28	275.432	275.432		77-78	326.719	326.719
28-29	276.258	276.258		78-79	327.159	327.159
29-30	277.754	277.754		79-80	328.214	328.214
30-31	279.147	279.147		80-81	329.125	329.125
31-32	280.125	280.125		81-82	330.025	330.025
32-33	280.236	280.236		82-83	331.225	331.225
33-34	281.156	281.156		83-84	332.214	332.214
34-35	281.847	281.847		84-85	334.025	334.025
35-36	282.147	282.147		85-86	335.258	335.258
36-37	283.347	283.347		86-87	338.214	338.214
37-38	284.156	284.156		87-88	339.797	339.797
38-39	286.025	286.025		88-89	343.214	343.214
39-40	286.025	286.025		89-90	344.147	344.147
40-41	286.758	286.758		90-91	346.159	346.159
41-42	287.258	287.258		91-92	347.114	347.114
42-43	289.214	289.214		92-93	348.147	348.147
43-44	290.408	290.408		93-94	349.025	349.025
44-45	291.324	291.324		94-95	351.025	351.025

Km- Stretch	Least Level w.r.t. MSL (m)	Established CD (m)		Km- Stretch	Least Level w.r.t. MSL (m)	Established CD (m)
45-46	292.147	292.147		95-96	352.159	352.159
46-47	292.258	292.258		96-97	353.147	353.147
47-48	293.214	293.214		97-98	355.259	355.259
48-49	294.159	294.159		98-98.9	357.147	357.147
49-50	295.214	295.214				

Table 4 - Established CD for per kilometer stretch

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

Arunawati-Aran River is non-tidal River body having the primary source of water receiving from rain water and ends up drying in summer. There are no CWC gauges in the entire stretch of Arunawati-Aran River.

2.7 Transfer of Sounding Datum

The Arunawati-Aran River is non-tidal River and lowest MSL level of the 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 Arunawati-Aran River is non-tidal River and the River dries fully during the summer season.

2.9 Salient features of Dam, Barrages etc.

The details of Arunawati-Aran Dam were collected during the conduct of survey and the details are as follows:

2.9.1 Salient Features of Arunawati Dam:-

Arunawati Dam is a major irrigation project across River Arunawati a tributary of River Aran in Godavari basin. The dam is located near Savanga of Digras Taluka in Yavatmal district, Maharashtra.

Salient Features of Arunawati Dam			
Name of the Dam	Arunawati Dam	Dam Status	Completed
River	Arunawati	Purpose	Irrigation
Nearest City	Digras	Completion Year	1994
District	Yavatmal	Operating and Maintenance Agency	WRD,GOM
State	Maharashtra	Max Height above Foundation(m)	29.58
Basin Name	Godavari	Total Volume content of Dam (TCM)	4412
Seismic Zone	Seismic Zone-II	Type of Spillway Gates	RD

Salient Features of Arunawati Dam			
Dam Type	Earthen / Gravity / Masonry	Number of Spillway Gates	11
Length of Dam (m)	5170	Size of Spillway Gates (m X m)	12 x 8
Type of Spillway	OG	Mode of Operation	-
Length of Spillway (m)	162	Live Storage Capacity(MCM)	169.675
Crest Level of Spillway	322.85	Dead Storage Capacity(MCM)	28.72
Spillway Capacity (cumec)	8525	Submergence Area (Th.Ha.)	4.005
Design Flood (cumec)	8525	Catchment Area(Sq.Km.)	894
Maximum Water Level (m)	331.4	Gross Storage Capacity(MCM)	198.395
Full Reservoir Level (m)	330.85	Minimum Draw Down Level(m)	322.5



Table 5 - Salient features of Arunawati Dam

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 IWAI BM PNG-25 as Reference. The value of these benchmarks w.r.t. MSL was obtained by Auto leveling from IWAI-BM-PNG-25. The final accepted co-ordinates and a Reference Level value of IWAI BM Pillars are as below:

Station	Chainage (km)	Latitude (N) Longitude (E)	Easting (E) Northing (N)	Ellipsoidal Height (m)	Height above MSL (m)	CD w.r.t. MSL (m)	BM Height w.r.t. Established CD (m)	UTM Zone
IWAI BM PNG-25	1.22	N19°55'00.907" E78°12'56.197"	2204701.80 208497.08	185.794	259.291	233.125	26.166	44N
IWAI BM ARN-01	8.34	N19°57'43.891" E78°11'05.648"	2209769.98 205364.3	185.934	259.547	243.125	16.422	44N

Station	Chainage (km)	Latitude (N) Longitude (E)	Easting (E) Northing (N)	Ellipsoidal Height (m)	Height above MSL (m)	CD w.r.t. MSL (m)	BM Height w.r.t. Established CD (m)	UTM Zone
IWAI BM ARN-02	18.50	N20°01'17.090" E78°07'47.690"	2216427.46 199717.83	218.831	293.049	256.147	36.902	44N
IWAI BM ARN-03	27.10	N20°01'01.231" E78°04'09.072"	2216049.76 193351.45	208.463	283.485	275.432	8.053	44N
IWAI BM ARN-04	37.90	N20°03'30.519" E78°00'38.119"	2220752.14 187298.37	226.466	301.885	286.025	15.86	44N
IWAI BM ARN-05	48.29	N20°04'39.224" E77°55'55.468"	2222759.72 806662.82	230.662	306.152	294.159	11.993	43N
IWAI BM ARN-06	59.65	N20°06'13.975" E77°50'11.146"	2225501.9 796603.4	240.456	316.154	307.095	9.059	43N
IWAI BM ARN-07	69.58	N20°08'56.451" E77°46'18.000"	2230386.75 789743.82	269.786	346.051	322.343	23.708	43N
IWAI BM ARN-08	80.94	N20°10'55.574" E77°41'26.408"	2233912.4 781212.25	267.318	343.815	326.719	17.096	43N
IWAI BM ARN-09	91.85	N20°13'12.821" E77°36'36.800"	2238000.31 772733.47	284.992	361.843	343.214	18.629	43N
IWAI BM ARN-10	98.88	N20°13'31.924" E77°33'22.873"	2238500.15 767092.96	293.423	370.794	352.159	18.635	43N

Table 6 - Accepted BM coordinates w.r.t. established CD

2.11 Chart Datum / Sounding Datum and Reductions Details

The water availability in Arunawati-Aran River is only in monsoon as confirmed by local residents and she dries up in summer. The spot heights by topographic method was adopted for the entire survey stretch of Arunawati-Aran River. The least MSL level for 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

During the conduct of survey in the entire stretch of Arunawati-Aran River, it was observed that there were no CWC gauges available. The available FRL of Arunawati Dam near Digras in Yavatmal Dist., Maharashtra is 330.85m and this FRL is used for interpolating the HFL in upstream of the river. Whereas for downstream, the details of CWC gauge at PG Bridge was used for interpolation of HFL values. The vertical clearances mentioned against each cross structures and electrical line are fixed on enquiry with local residents and visual assessment in the field during the conduct of the survey. The details of established and computed HFL values for the entire stretch is as follows:

SI No.	Location and description of CWC gauge / Dam / Barrages / Weirs / Anicut / Locks / Aqueducts / BM	Cross-structure details	Chainage (km)	Established HFL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
	A	B	C	D	E
1	Khadaka Road Bridge	Bridge	2.72	-	266.400
2	Chimata-Barrage	Barrage	2.84	-	266.687
3	Pardi Road Bridge	Bridge	14.48	-	276.649
4	Vitholi Road Bridge	Bridge	25.82	-	286.610
5	Shiur Foot walk Road Bridge	Bridge	27.12	-	287.760
6	Bhandari-Check-Dam	Check Dam	30.16	-	290.441
7	Naik Nagar-Check Dam	Check Dam	31.71	-	291.782
8	Shiur village Road Bridge	Bridge	34.38	-	294.081
9	Arni Road Bridge	Bridge	45.26	-	303.564
10	Arni Road Bridge NH--204	Bridge	46.18	-	304.426
11	Saikhed Sankho Village Road Bridge	Bridge	54.98	-	312.088
12	Chirkuta Road Bridge	Bridge	63.40	-	319.464
13	Arunawati/Digras Dam	Dam	65.37	330.850	-
14	Darwa Bypass Bridge SH-213	Bridge	81.92	-	345.755
15	Harsul Foot walk Bridge	Bridge	83.12	-	347.206
16	Harsul Bridge	Bridge	85.52	-	349.976
17	Harsul-1-Check Dam	Check Dam	85.56	-	350.108
18	Waroli Barrage - 1	Barrage	86.87	-	351.691
19	Waroli Road Bridge	Bridge	88.08	-	353.142
20	Waroli Barrage - 2	Barrage	88.44	-	353.669
21	Karkheda Bridge	Bridge	92.03	-	358.550
22	Karkheda Barrage	Barrage	92.95	-	359.605
23	Ramtirth Road Bridge	Bridge	93.72	-	360.528
24	Ramthirth Barrage - 2	Barrage	94.73	-	361.716
25	Ramthirth Barrage - 1	Barrage	96.17	-	363.694
26	Manora Barrage - 1	Barrage	97.69	-	365.541
27	Manora Road Bridge SH-211	Bridge	98.89	-	366.860

Table 7 - HFL values of Bridges/Cross Structures

2.13 Graph: Sounding Datum and HFL vs Chainage

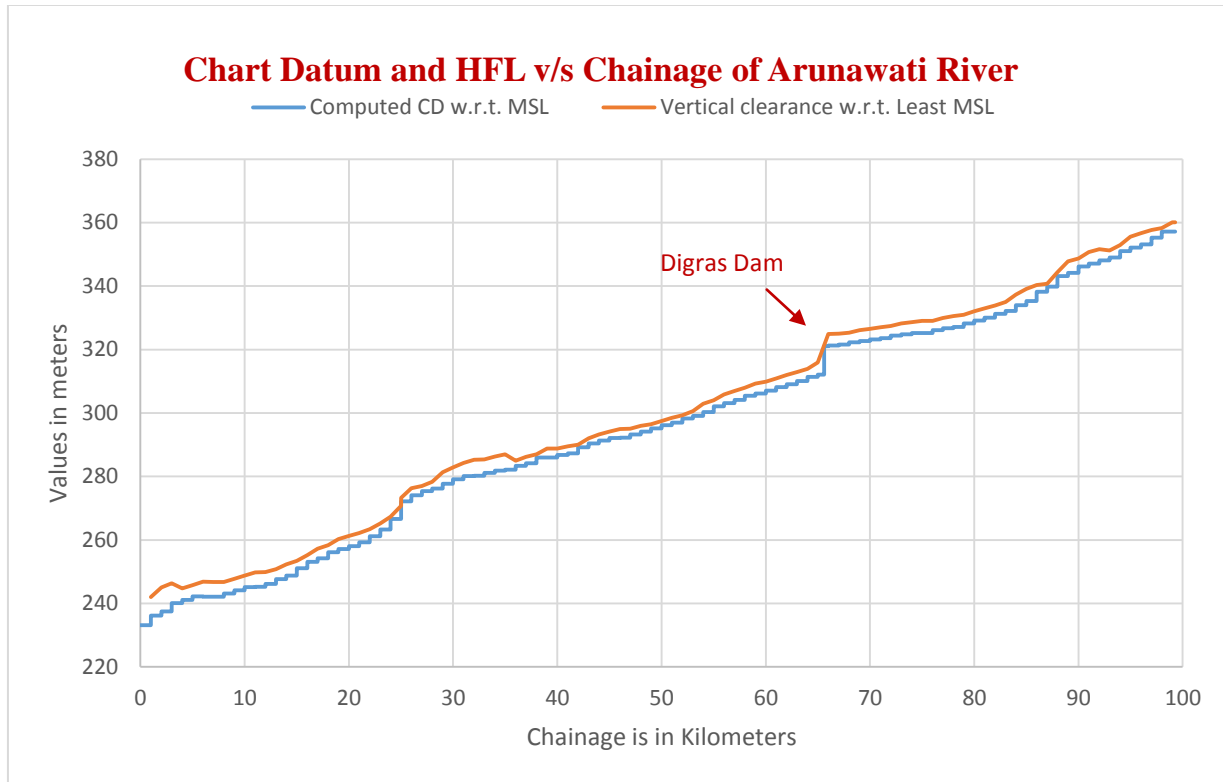


Figure 7 - Graph of Sounding Datum & HFL vs Chainage

2.14 Average Bed Slope

The average bed slope for the Arunawati-Aran 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_233.236	Ch. 30 - RBL_279.687	46.451	30	1 : 1.548
Ch. 30 - RBL_279.687	Ch. 60 - RBL_307.658	27.971	30	1 : 0.932
Ch. 60 - RBL_307.658	Ch. 90 - RBL_346.214	38.556	30	1 : 1.285
Ch. 90 - RBL_346.214	Ch. 98.9 - RBL_358.654	12.440	8.9	1 : 1.398

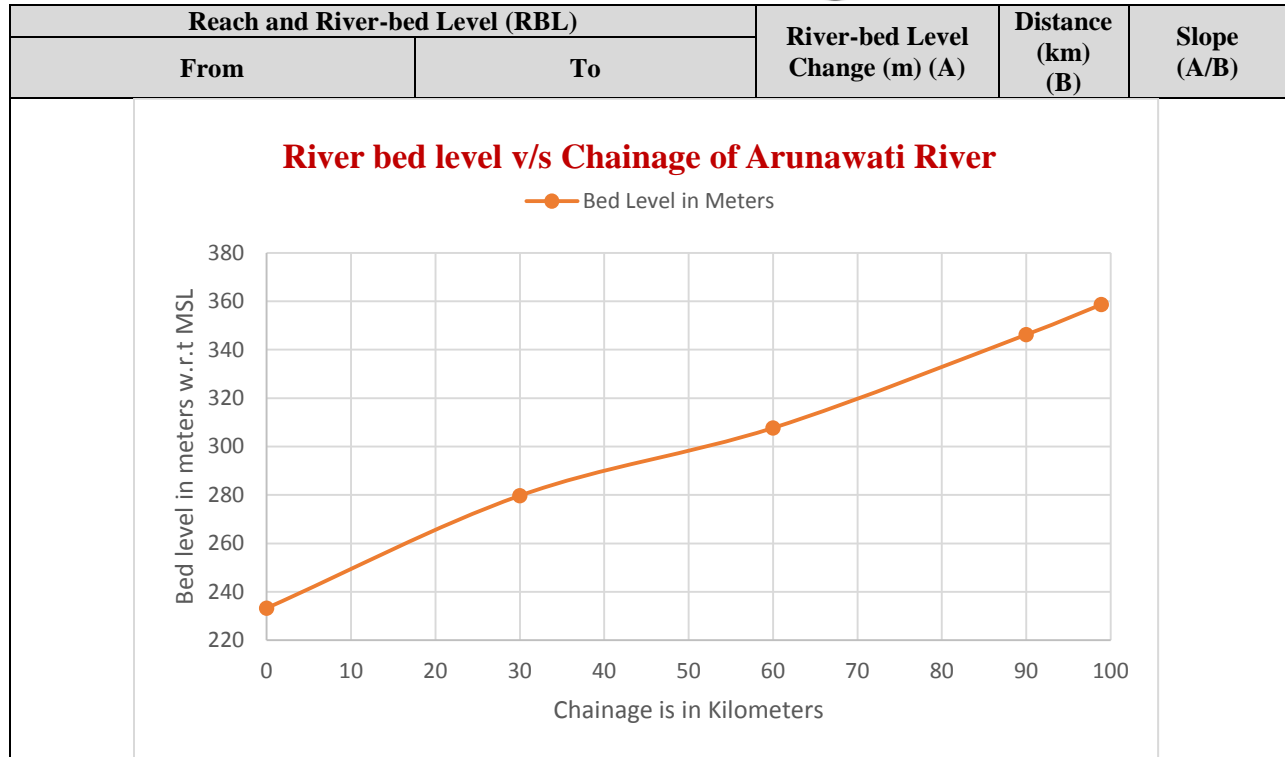


Table 8 - Average Bed Slope

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. MSL (m)	Present condition
1	Chimata-Barrage	2.84	Chimata	Left Bank: 19°54'57.9334"N 78°11'28.3047"E	Left Bank: 205937.953 2204652.860	132.37	2.52	244.16	Damaged/ Not in use
				Right Bank: 19°55'1.3159"N 78°11'31.1194"E	Right Bank: 206021.598 2204755.561				
2	Bhandari-Check-Dam	30.16	Bhandari	Left Bank: 20°02'7.5567"N 78°03'10.4449"E	Left Bank: 191682.360 2218120.569	75.752	2.77	278.76	Damaged
				Right Bank: 20°02'9.3130"N 78°03'12.2727"E	Right Bank: 191736.466 2218173.674				
3	Naik Nagar-Check Dam	31.71	Naik Nagar	Left Bank: 20°02'8.6659"N 78°02'37.6810"E	Left Bank: 190730.182 2218171.531	33.552	1.77	282.36	Damaged
				Right Bank: 20°02'9.1365"N 78°02'36.6394"E	Right Bank: 190700.149 2218186.548				
4	Arunawati/Digras Dam	65.37	Arunawati	Left Bank: 20°07'11.3903"N 77°47'55.9749"E	Left Bank: 792644.950 2227201.960	200	6.711	322.85	Operational

Sl No	Structure Name	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	Height w.r.t. MSL (m)	Present condition
				Right Bank: 20°07'15.1415"N 77°47'49.9769"E	Right Bank: 792468.700 2227314.450				
5	Harsul-1 check Dam	85.56	Harsul	Left Bank: 20°12'25.3547"N 77°39'30.0308"E Right Bank: 20°12'27.4782"N 77°39'31.5035"E	Left Bank: 777787.481 2236619.994 Right Bank: 777829.204 2236686.010	78.053	1.56	336.96	Completed and in use
6	Waroli Barrage - 1	86.87	Waroli	Left Bank: 20°12'48.5367"N 77°38'53.1550"E Right Bank: 20°12'49.6671"N 77°38'53.5890"E	Left Bank: 776705.113 2237316.041 Right Bank: 776717.161 2237351.019	40	6.617	341.78	Completed and in use
7	Waroli Barrage - 2	88.44	Waroli	Left Bank: 20°12'57.8861"N 77°38'4.7702"E Right Bank: 20°12'59.2528"N 77°38'3.5873"E	Left Bank: 775260.361 2237622.772 Right Bank: 775295.382 2237581.272	53	1.082	348.39	Damaged
8	Karkheda Barrage	92.95	Karkheda	Left Bank: 20°12'36.0045"N 77°36'2.1925"E Right Bank: 20°12'37.0893"N 77°36'1.8916"E	Left Bank: 771746.244 2236851.870 Right Bank: 771736.982 2236885.106	32	5.833	352.27	Completed and in use
9	Ramthirth Barrage - 2	94.73	Ramthirth	Left Bank: 20°12'49.1229"N 77°35'4.4607"E Right Bank: 20°12'50.1292"N 77°35'4.4933"E	Left Bank: 770063.358 2237229.213 Right Bank: 770063.821 2237260.186	30.961	6.06	354.36	Completed and in use
10	Ramthirth Barrage - 1	96.17	Ramthirth	Left Bank: 20°12'57.5401"N 77°34'26.7717"E Right Bank: 20°12'58.2317"N 77°34'27.4497"E	Left Bank: 768964.841 2237471.120 Right Bank: 768984.199 2237492.701	28.978	7.04	355.27	Completed and in use
11	Manora Barrage - 1	97.69	Manora	Left Bank: 20°13'21.5065"N 77°33'48.5043"E Right Bank: 20°13'21.5535"N 77°33'51.6846"E	Left Bank: 767842.165 2238191.175 Right Bank: 767934.493 2238194.050	90	3.584	360.28	Completed and in use

Table 9 - Arunawati Dams & Barrages w.r.t. MSL

2.16 Details of Locks

There are no Locks present in the entire survey stretch of Arunawati-Aran River.

2.17 Details of Aqueducts

There are no Aqueducts present in the survey stretch of Arunawati-Aran River.

2.18 Details of existing Bridges and Crossings over Waterway

SI No	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	Length (m)	Width (m)	No. of Piers	HC (clear distance Between piers) (m)	VC w.r.t. HFL (m)	Remarks (complete / under - construction), in use or not, condition
1	Khadaka Road Bridge	2.72	RCC	Khadaka	Left Bank: 19°54'54.99"N 78°11'31.28"E Right Bank: 19°54'59.66"N 78°11'34.56"E	Left Bank: 206023.019 2204560.853 Right Bank: 206120.865 2204702.941	172	5.322	21	7.101	5.82	Completed and in use
2	Pardi Road Bridge	14.48	RCC	Yedshi	Left Bank: 19°59'43.17"N 78°08'53.65"E Right Bank: 19°59'45.47"N 78°08'55.02"E	Left Bank: 201586.737 2213504.856 Right Bank: 201627.790 2213574.944	80	4.566	9	7.125	1.52	Completed and in use
3	Vitholi Road Bridge	25.82	RCC	Vitholi	Left Bank: 20°01'30.80"N 78°04'30.40"E Right Bank: 20°01'32.34"N 78°04'24.88"E	Left Bank: 193987.654 2216948.715 Right Bank: 193827.953 2216998.910	90	7.114	8	9.012	1.47	Completed and in use
4	Shiur Foot walk Road Bridge	27.12	RCC	Shiur	Left Bank: 20°00'58.51"N 78°04'08.94"E Right Bank: 20°01'00.68"N 78°04'09.10"E	Left Bank: 193346.146 2215966.083 Right Bank: 193351.970 2216032.772	170	4.001	56	2.5	0.27	Completed and in use
5	Shiur Village Road Bridge	34.38	RCC	Shiur	Left Bank: 20°03'19.64"N 78°02'21.05"E Right Bank: 20°03'22.35"N 78°02'22.12"E	Left Bank: 190285.267 2220364.016 Right Bank: 190317.858 2220446.853	65	3.964	6	7.211	2.91	Completed and in use
6	Arni Road Bridge	45.26	RCC	Arni	Left Bank: 20°03'33.06"N 77°57'10.30"E Right Bank: 20°03'35.64"N 77°57'09.24"E	Left Bank: 808874.383 2220762.201 Right Bank: 808842.158 2220841.043	80	3.717	6	6.012	0.2	Completed and in use
7	Arni Road Bridge NH--204	46.18	RCC	Arni	Left Bank: 20°03'48.46"N 77°56'45.30"E Right Bank: 20°03'50.87"N 77°56'47.11"E	Left Bank: 808139.123 2221223.219 Right Bank: 808190.439 2221298.305	80	7.661	6	8.201	4.41	Completed and in use
8	SaikhedSankho Village Road Bridge	54.98	RCC	Saikhed	Left Bank: 20°05'11.26"N 77°52'29.29"E	Left Bank: 800651.920 2223641.069	90	7.661	6	8.201	-1.24	Completed and in use

SI No	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	Length (m)	Width (m)	No. of Piers	HC (clear distance Between piers) (m)	VC w.r.t. HFL (m)	Remarks (complete / under - construction), in use or not, condition
					Right Bank: 20°05'14.07"N 77°52'29.69"E	Right Bank: 800662.056 2223727.730						
9	Chirkuta Road Bridge	63.4	RCC	Chirkuta	Left Bank: 20°06'49.31"N 77°48'37.46"E Right Bank: 20°06'50.39"N 77°48'39.50"E	Left Bank: 793862.046 2226542.920 Right Bank: 793920.774 2226577.150	68	5.741	6	8.201	1.22	Completed and in use
10	Darwa Bypass Bridge SH-213	81.92	RCC	Harsul	Left Bank: 20°11'13.30"N 77°40'56.89"E Right Bank: 20°11'16.41"N 77°40'59.86"E	Left Bank: 780345.991 2234443.842 Right Bank: 780430.713 2234540.918	130	8.034	8	12.802	4.25	Completed and in use
11	Harsul Foot walk Bridge	83.12	Iron	Harsul	Left Bank: 20°11'26.83"N 77°40'22.72"E Right Bank: 20°11'29.03"N 77°40'25.14"E	Left Bank: 779346.753 2234844.077 Right Bank: 779415.954 2234912.893	97	5.19	9	7.701	1.52	Completed and in use
12	Harsul Bridge	85.52	RCC	Harsul	Left Bank: 20°12'24.94"N 77°39'31.25"E Right Bank: 20°12'27.52"N 77°39'33.15"E	Left Bank: 777823.094 2236607.804 Right Bank: 777877.002 2236688.063	97	8.101	7	12.032	1.66	Non - Operational
13	Waroli Road Bridge	88.08	RCC	Waroli	Left Bank: 20°12'58.81"N 77°38'13.79"E Right Bank: 20°13'01.70"N 77°38'16.46"E	Left Bank: 775556.872 2237613.863 Right Bank: 775632.995 2237704.007	115	7.971	11	8.911	0.47	Completed and in use
14	Karkheda Bridge	92.03	RCC	Karkheda	Left Bank: 20°12'40.013"N 77°36'30.609"E Right Bank: 20°12'41.080"N 77°36'29.927"E	Left Bank: 2236988.176 772569.560 Right Bank: 772549.250 2237020.677	42	7.247	5	7.452	-0.83	Completed and in use
15	Ramtirth Road Bridge	93.72	RCC	Ramtrith	Left Bank: 20°12'37.99"N 77°35'35.77"E Right Bank: 20°12'40.40"N 77°35'35.91"E	Left Bank: 770977.950 2236900.929 Right Bank: 770980.855 2236975.133	75	9.139	4	6.011	1.62	Completed and in use
16	Manora Road Bridge SH-211	98.89	RCC	Manora	Left Bank: 20°13'32.31"N 77°33'22.81"E Right Bank: 20°13'33.30"N 77°33'23.86"E	Left Bank: 767090.922 2238511.994 Right Bank: 767120.941 2238542.920	45	6.329	3	5.812	2.51	Completed and in use

Table 10 - Details of cross structures

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

There were no Pipe lines or under water cables cross-through the Arunawati-Aran River.

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

Total of 15 High Tension electrical lines were also present in the Arunawati-Aran River and the height of the high tension line were also measured by ETS. There are no piers for electrical lines constructed in the River bed of Arunawati-Aran River.

SI. No	Type of line	Chainage (km)	Location	Position (Lat Long)		No. of Piers	HC(clear distance Between piers) (m)	Vertical clearance w.r.t. HFL (m)	Remarks (complete / under - construction)
				Left Bank	Right Bank				
1	EP	2.72	Yedshi	Left Bank: 19°59'41.5126"N 78°08'52.9375"E	Left Bank: 2213454.21 201565.14	-	-	12.032	Complete
				Right Bank: 19°59'46.2095"N 78°08'56.4007"E	Right Bank: 2213597.01 201668.34				
2	EP	14.49	Yedshi	Left Bank: 19°59'43.0678"N 78°08'53.0425"E	Left Bank: 2213502.01 201569.01	-	-	12.651	Complete
				Right Bank: 19°59'45.7057"N 78°08'54.9248"E	Right Bank: 2213582.24 201625.14				
3	EP	34.30	Vitholi	Left Bank: 20°03'19.6224"N 78°02'21.5604"E	Left Bank: 2220363.21 190300.10	-	-	9.003	Complete
				Right Bank: 20°03'22.5054"N 78°02'22.6391"E	Right Bank: 2220451.37 190333.04				
4	HTL	37.77	Asara	Left Bank: 20°03'7.7667"N 78°00'41.9432"E	Left Bank: 2220050.01 187397.00	-	-	27.441	Complete
				Right Bank: 20°03'11.5844"N 78°00'52.2921"E	Right Bank: 2220162.10 187700.02				
5	HTL	43.47	Antagaon	Left Bank: 20°03'21.4362"N 77°57'47.6265"E	Left Bank: 2220423.76 809966.04	-	-	26.853	Complete
				Right Bank: 20°03'32.1961"N 77°58'10.9586"E	Right Bank: 2220766.91 810638.57				
6	EP	45.26	Laxmi Nagar Arni	Left Bank: 20°03'32.9015"N 77°57'9.9526"E	Left Bank: 2220757.14 808864.37	-	-	9.145	Complete
				Right Bank: 20°03'35.9677"N 77°57'9.2760"E	Right Bank: 2220851.15 808843.03				
7	EP	46.18	Arni	Left Bank: 20°03'48.5185"N 77°56'45.3028"E	Left Bank: 2221225.02 808139.17	-	-	14.036	Complete
				Right Bank: 20°03'51.0858"N	Right Bank: 2221305.03				

SI. No	Type of line	Chainage (km)	Location	Position (Lat Long)		Position (UTM)		No. of Piers	HC (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL (m)	Remarks (complete / under - construction)
				Left Bank	Right Bank	Left Bank	Right Bank				
				77°56'47.2759"E		808195.15					
8	HTL	48.28	Rudrapur	Left Bank: 20°04'26.8125"N 77°55'46.0707"E	Right Bank: 20°04'34.9235"N 77°55'59.0788"E	Left Bank: 2222373.01 806396.32	Right Bank: 2222629.23 806770.11	-	-	28.263	Complete
9	HTL	53.43	Chikhani	Left Bank: 20°04'58.6769"N 77°53'13.3138"E	Right Bank: 20°05'7.2780" N 77°53'21.9683"E	Left Bank: 2223276.01 801938.37	Right Bank: 2223545.02 802185.37	-	-	10.658	Complete
10	EP	55.00	Saikhed	Left Bank: 20°05'11.0108"N 77°52'28.6013"E	Right Bank: 20°05'14.5772"N 77°52'29.0487"E	Left Bank: 2223633.06 800632.03	Right Bank: 2223743.01 800643.15	-	-	20.125	Complete
11	HTL	59.50	Sawanga	Left Bank: 20°05'47.5476"N 77°50'13.9735"E	Right Bank: 20°05'58.7078"N 77°50'19.1992"E	Left Bank: 2224690.18 796699.41	Right Bank: 2225036.15 796845.46	-	-	15.369	Complete
12	HTL	80.42	Mandwa	Left Bank: 20°10'31.5096"N 77°41'23.0633"E	Right Bank: 20°10'40.8081"N 77°41'31.1106"E	Left Bank: 2233170.45 781127.09	Right Bank: 2233460.31 781356.21	-	-	11.856	Complete
13	EP	81.91	Harsul	Left Bank: 20°11'12.1155"N 77°40'56.8044"E	Right Bank: 20°11'16.7607"N 77°41'00.5334"E	Left Bank: 2234407.36 780344.09	Right Bank: 2234552.02 780450.10	-	-	15.002	Complete
14	EP	88.19	Harsul	Left Bank: 20°12'59.6253"N 77°38'11.7779"E	Right Bank: 20°13'04.3733"N 77°38'13.7865"E	Left Bank: 2237638.02 775498.04	Right Bank: 2237785.01 775554.05	-	-	13.036	Complete
15	EP	93.66	Karkhed	Left Bank: 20°12'37.5762"N 77°35'37.6455"E	Right Bank: 20°12'40.7572"N 77°35'37.8925"E	Left Bank: 2236889.05 771032.62	Right Bank: 2236987.02 771038.26	-	-	12.369	Complete

Table 11 - High Tension Lines Details

2.21 Current Meter and Discharge Details

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

2.22 Water Sample Locations

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

3 Description of Waterway

The Waterway of Arunawati-Aran River coming within survey limits is divided in to four stretches in accordance with the topographic feature and nature of River stream. The details are as follows:

3.1 Sub-Stretch-01: Chimata to Heti (Chainage 0.0km to 30.00km)

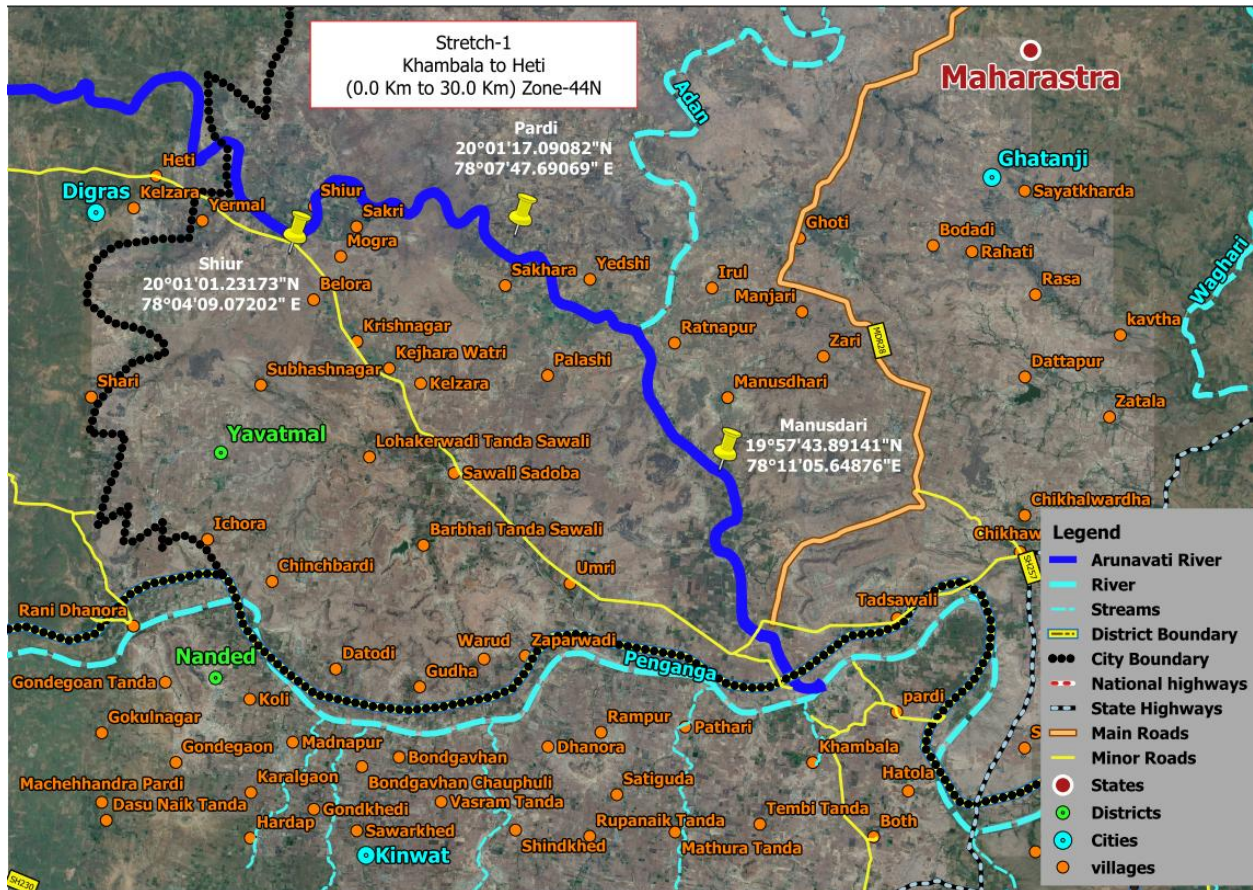


Figure 8 - Stretch-01 Chimta to Heti

- **Bathymetry Survey**
 - a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
 - b) 30.0km of the length of the stretch for which the Topographic survey has been carried out.

Stretch-1 covers 30.00km i.e. from 0.0km to 30.00km from Chimata to Heti.

During the survey it is observed that, the stretch is totally dry in nature, somehow we found water patches which was negligible to carry out hydrographic survey so only topographic survey was being conducted by measuring spot levels using Trimble r4 DGPS for the stretch.

Chimata is a place located in Arni Mandal, in Yavatmal district of Maharashtra state. Distance from Mandal headquarter is approximately 40km. Chimata village is the place where the Arunawati-Aran River confluence with Penganga River. At the time of initial recce to the survey area the presence of water in pockets and was very shallow in the vicinity.

In this stretch along right bank of the River Khadaka, Bilayat, Mansudhara, Ratnapur, Yedshi, Nidhu, Shiru and Bhandari villages are located and left bank of the River Jalandri, Plashi, Sakhara, Sakri, Chatari and Hermal villages are located. Both side of River banks having good cultivable land. Sunflowers, Soyabean, Cotton, Sugarcane, Mung, Bajra, are the major crops that are cultivated mostly in the area.

At chainage 2.72km a bridge is constructed near chimata village which is in between Arni to Sawali village named as Khadkaroad Bridge.



Figure 9 - Khadka Road Bridge (2.72 km chainage)

In this stretch at chainage 14.48km a bridge is constructed at near Yedshi village which is a road Way Bridge connects between Yedshi and Palashi villages. As per the local people the bridge is called as Pardi Road Bridge.



Figure 10 - Pardi Road Bridge (14.48 km chainage)

At 25.82 km Chainage a bridge is constructed in between Shakri and Shiur villages. It's a small bridge across the River.



Figure 11 - Vitholi Road Bridge (25.82 km chainage)

At chainage 27.12km a small bridge is constructed which is a connecting between village shiur to Arni Sawali road.



Figure 12 - Foot walk board Bridge at shiur (27.12 km chainage)

During survey it is being observed that the entire stretch was dry and as per the local villagers during rainy season the River get flooded. In this River's stretch area found full rocks and scattered flow of water. Area between BM ARN-02 to ARN-03 both sides of River bank having forest and hillocks.



Figure 13 - Insufficient water and slate rocks at Stretch-1

Zone 44N												
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	30	0.00	0.00	30000	1,281,799.89	1,281,799.89	-0.300	0.000	30000	1,633,432.42	1,633,432.42
II	0	30	0.00	0.00	30000	1,952,090.36	1,952,090.36	-0.300	0.000	30000	2,404,767.85	2,404,767.85
III	0	30	0.00	0.00	30000	2,951,234.99	2,951,234.99	-0.300	0.000	30000	3,513,929.86	3,513,929.86
IV	0	30	0.00	0.00	30000	3,560,883.38	3,560,883.38	-0.300	0.000	30000	4,149,049.47	4,149,049.47

Table 12 - Stretch-1 Dredging Quantity Details

3.1.1 Observed and reduced Bed Profile of the stretch

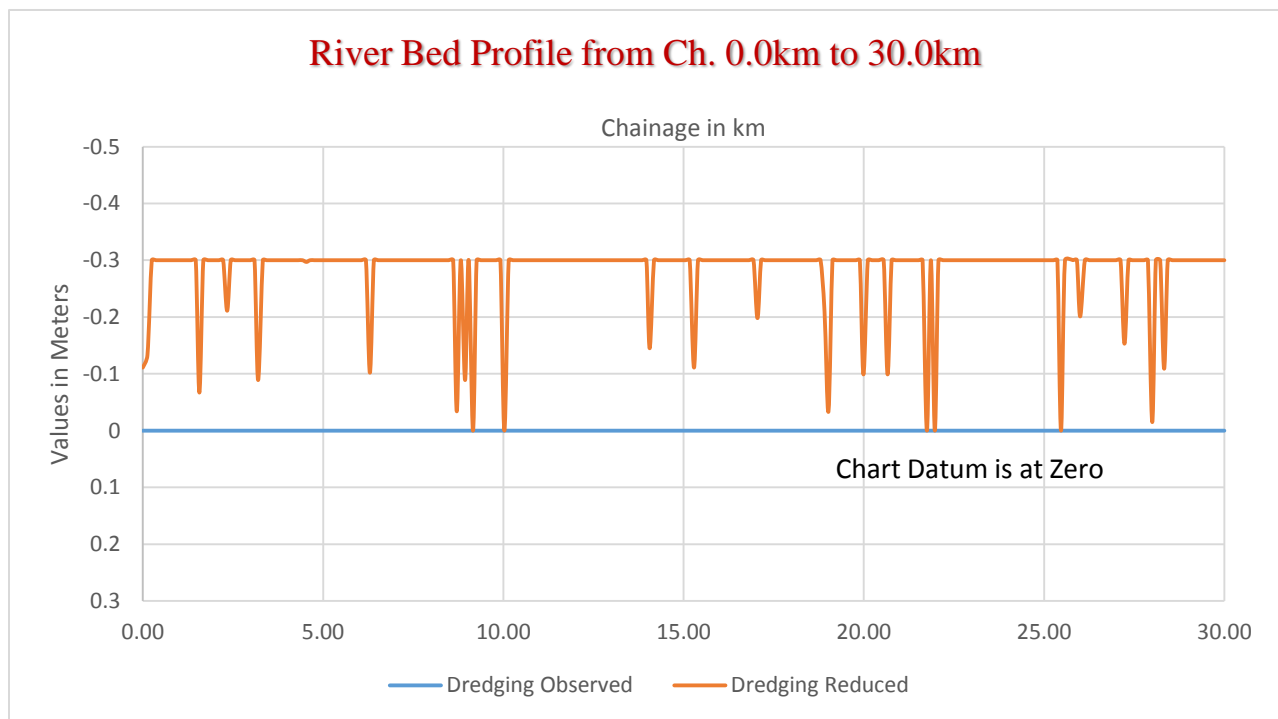


Figure 14 - Stretch-1 Observed and reduced bed profile

3.2 Sub-Stretch-2: Heti to Sawanga Kh. (30.0km to 60.00km)

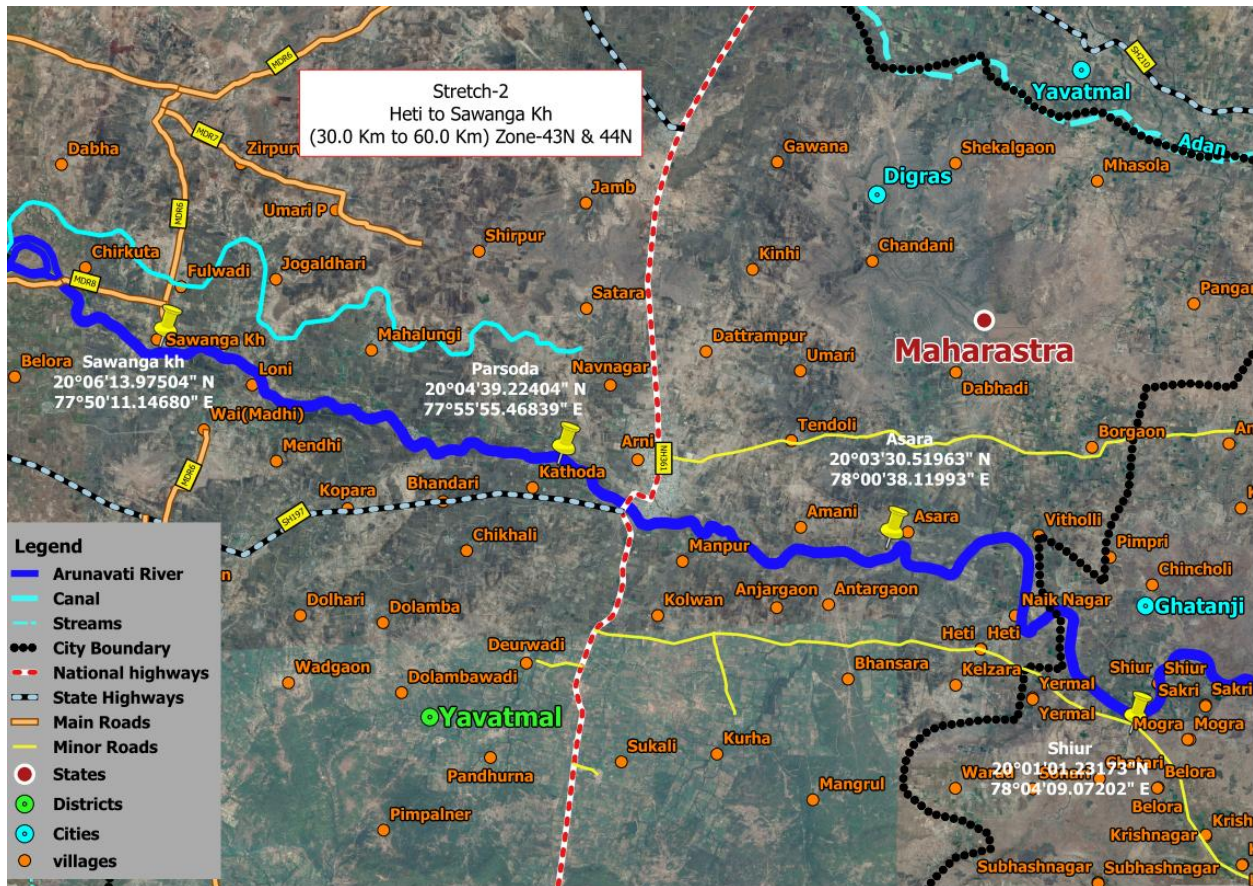


Figure 15 - Stretch 2 Heti to Sawanga Kh. Village

- **Bathymetry Survey**
 - a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
 - b) 30.00km of the length of the stretch for which the Topographic survey has been carried out.

Stretch-2 covers 30.00km. This 30.00km of stretch is falling under two different zone 43 and 44 i.e. 30.0 to 39.4km is coming under zone 44 and from 39.4km of chainage towards upstream is coming under zone 43. Stretch starting from Heti village to Sawanga Kh. village.

In this stretch of river only scattered flow of water is observed and there is no sufficient water for navigation and hydrographic survey using a survey boat could not be carried out. The spot levels by topographic survey method were measured using Trimble R4 GPS.

In this stretch along right bank of the Rivers Vitholi, Asara Amani and Arni villages are located and left bank of the Rivers Naik Sagar, Anjargaon Manpur and Kathoda villages are located. Arni is the city falling along-side of the Arunawati River in this stretch.

Arni is a taluka place in Yavatmal district of Maharashtra State in India. It is situated on the bank of Arunawati River. State highway no. 3 (Nagpur-Tuljapur) passes from Arni, and so city gets unusual importance. Both side of River banks having well cultivated land.

Arni has big grain market food grain like Wheat and Jowar. Arni is also famous for its cotton production. The place is having importance for Muslims as a worship place, the Kambalposh baba Dargah Sharif is situated at the bank of Arunawati.

At 34.38km near vitholi village a bridge is constructed on Shiur vitholi road. It is a small bridge constructed upon River Arunawati. Nayaknagar, Borgaon, Asara villages are the nearby villages. Which is well connected by Road network.



Figure 16 - Vitholi Bridge (34.38 km chainage)

At chainage 45.26km a small bridge is constructed across Amarawati River, at Arni village. We found some water patches near to this bridge but the availability of water is very negligible so topographic method was being applied to acquire the data.



Figure 17 - Arni Road Bridge (45.26 km chainage)

Upon Sholapur Nagpur Highway NH361 a highway bridge is constructed at Arni city at chainage 46.18km River Arunawati-Aran. This is a small bridge connecting NH 361, SH 197 and MSH 03



Figure 18 - Highway Bridge at Arni (46.18 km chainage)

At chainage 54.98km near Saikhed village a small bridge is constructed across River Arunawati. It's a crossover Bridge between Lingi village and Mahalungi village, the nearby villagers used this bridge which are present approx. 2km along the River stretch. This Bridge is named as Saikhed Sanko Bridge.



Figure 19 - Saikhed Sanko Bridge (54.98 km chainage)



Figure 20 - River Side features upon this stretch

Zone 44N												
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	30	39.4	0.00	0.00	9400	3,98,729.07	1,680,528.96	-0.30	0.000	9400	5,08,995.22	2,142,427.64
II	30	39.4	0.00	0.00	9400	6,07,316.63	2,559,406.99	-0.30	0.000	9400	7,49,028.35	3,153,796.20
III	30	39.4	0.00	0.00	9400	9,17,263.47	3,868,498.46	-0.30	0.000	9400	1,092,790.79	4,606,720.65
IV	30	39.4	0.00	0.00	9400	1,106,561.92	4,667,445.30	-0.30	0.000	9400	1,289,856.01	5,438,905.48

Zone 43N												
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	39.4	60	0.000	0.000	20600	8,72,816.59	8,72,816.59	-0.300	0.000	20600	1,106,114.00	1,106,114.00
II	39.4	60	0.000	0.000	20600	1,329,081.35	1,329,081.40	-0.300	0.000	20600	1,629,677.60	1,629,677.60
III	39.4	60	0.000	0.000	20600	2,008,732.41	2,008,732.41	-0.300	0.000	20600	2,382,655.06	2,382,655.06
IV	39.4	60	0.000	0.000	20600	2,423,793.71	2,423,793.70	-0.300	0.000	20600	2,814,598.60	2,814,598.60

Table 13 - Stretch 2 Dredging Quantity Details

3.2.1 Observed and reduced Bed Profile of the stretch

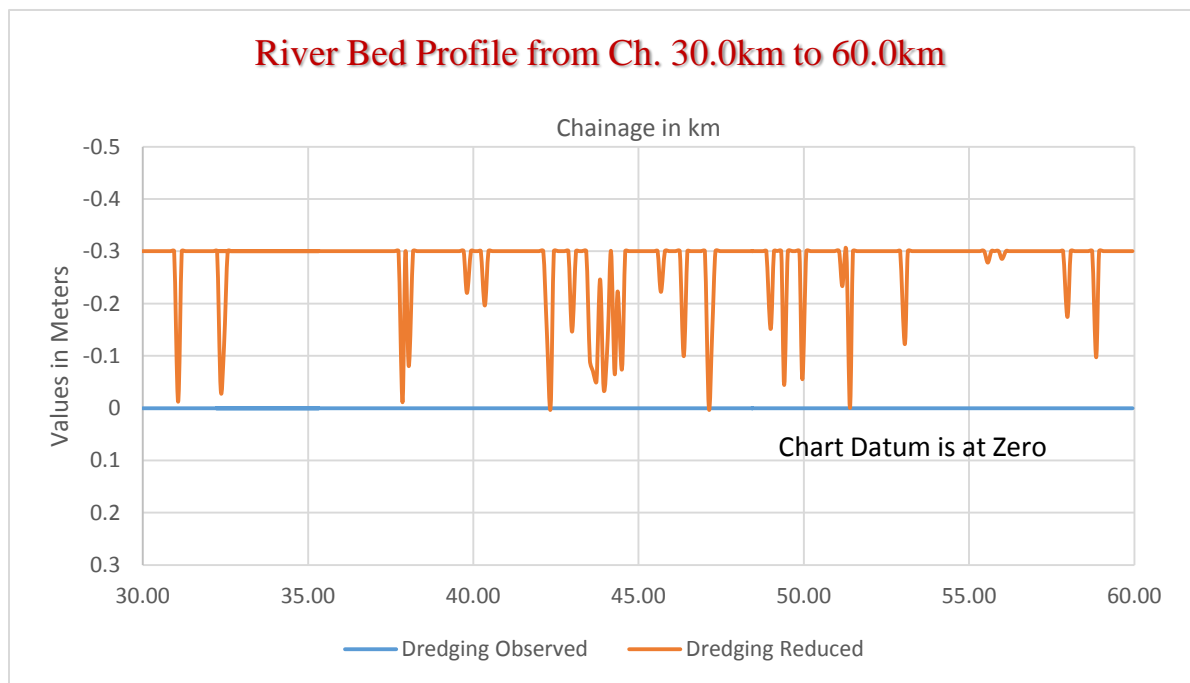


Figure 21 - Stretch 2 Observed and reduced bed profile

3.3 Sub-Stretch-3: Sawang kh. To Waroli (60.00km to 90.00km)

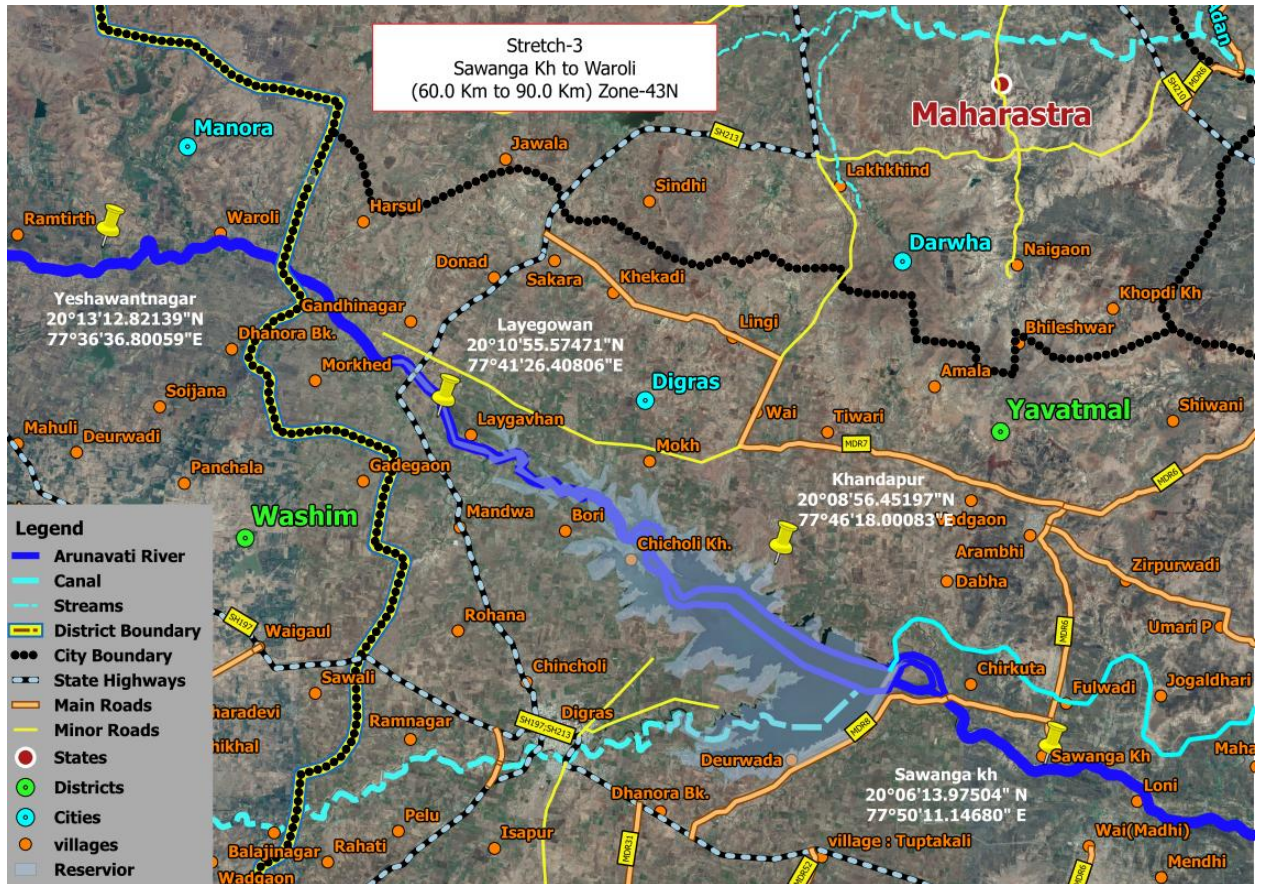


Figure 22 - Stretch 3 Sawang kh. To Waroli

- **Bathymetry Survey**
 - a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
 - b) 30.00km of the length of the stretch for which the Topographic survey has been carried out.

Stretch-3 covers 30.0km i.e. from 60.00 to 90.00km from Sawang kh to Waroli village Yavatmal District, in Maharashtra state and a stream flows near Digras dam. The Dhanori, Bori, Much, Layganya, Dorli and Harsul are the nearby villages around this stretch.

In this stretch the River is full of rocks and water accumulation was found at Dam near Digras village called Arunawati Dam. The depth are very shallow and are swampy in nature, the topographic spot levelling were measured by using Trimble R4 GPS.

At Chainage 63.4km a Road way bridge is constructed over Arunawati River near Chirkuta village.



Figure 23 - Chirkuta Road Bridge (63.4 km chainage)

Arunawati Dam is a major irrigation project across River Arunawati in Godavari basin. The dam is located near Savanga of Digras taluka in Yavatmal district, Maharashtra at chainage 65.37km. The CCA of the project is 25295 hectare and the ultimate irrigation potential of the project is 25155 hectare. The dam is Earth-fill Gravity + Masonry Dam. The length of dam is 5170 m (16961.94 Feet), while the height of the dam above lowest foundation is 29.5 m (96.78 Feet). Project has a Spillway of Ogee type. Length of the spillway is 162 m (531.49 Feet). The Dam Spillway has 11 Radial Type of spillway gates.



Figure 24 - Digras Arunawati Dam (65.37 km chainage)

At chainage 81.92km Darwha Bypass Road Bridge is constructed over Arunawati River near Dorli village.



Figure 25 - Darwha By pass Road on SH 213 (81.92 km chainage)

At chainage 83.12km Harsul Bridge made of iron and steel is built on Arunawati River near Harsul village for crossing the river from one end to other.



Figure 26 - Harsul Iron Bridge (83.12 km chainage)

At chainage 88.08km near Harsul a roadway bridge is constructed. Which is connecting between Harsul to Dhanora Bk. Villages.



Figure 27 - Waroli Road Bridge (88.08 km chainage)

At chainage 85.52km near Harsul village a foot over bridge in damaged condition was found it is not in use by the local villagers.



Figure 28 - Harsul Bridge (85.52 km chainage)

Zone 43N												
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	65.5	0.000	0.000	5500	2,34,283.76	1,107,100.35	-0.300	0.000	5500	2,95,870.64	1,401,984.65
I	65.5	90	0.000	0.000	24500	1,043,574.50	2,150,674.85	-0.300	0.000	24500	1,316,023.72	2,718,008.37
II	60	65.5	0.000	0.000	5500	3,56,832.11	1,685,913.46	-0.300	0.000	5500	4,36,548.43	2,066,226.03
II	65.5	90	0.000	0.000	24500	1,589,526.26	3,275,439.72	-0.300	0.000	24500	1,939,659.71	4,005,885.74
III	60	65.5	0.000	0.000	5500	5,39,315.50	2,548,047.91	-0.300	0.000	5500	6,38,984.37	3,021,639.43
III	65.5	90	0.000	0.000	24500	2,402,366.92	4,950,414.83	-0.300	0.000	24500	2,836,639.82	5,858,279.25
IV	60	65.5	0.000	0.000	5500	6,50,743.07	3,074,536.78	-0.300	0.000	5500	7,55,036.16	3,569,634.78
IV	65.5	90	0.000	0.000	24500	2,898,769.09	5,973,305.87	-0.300	0.000	24500	3,352,461.90	6,922,096.68

Table 14 - Stretch 3 Dredging Quantity

3.3.1 Observed and reduced Bed Profile of the stretch

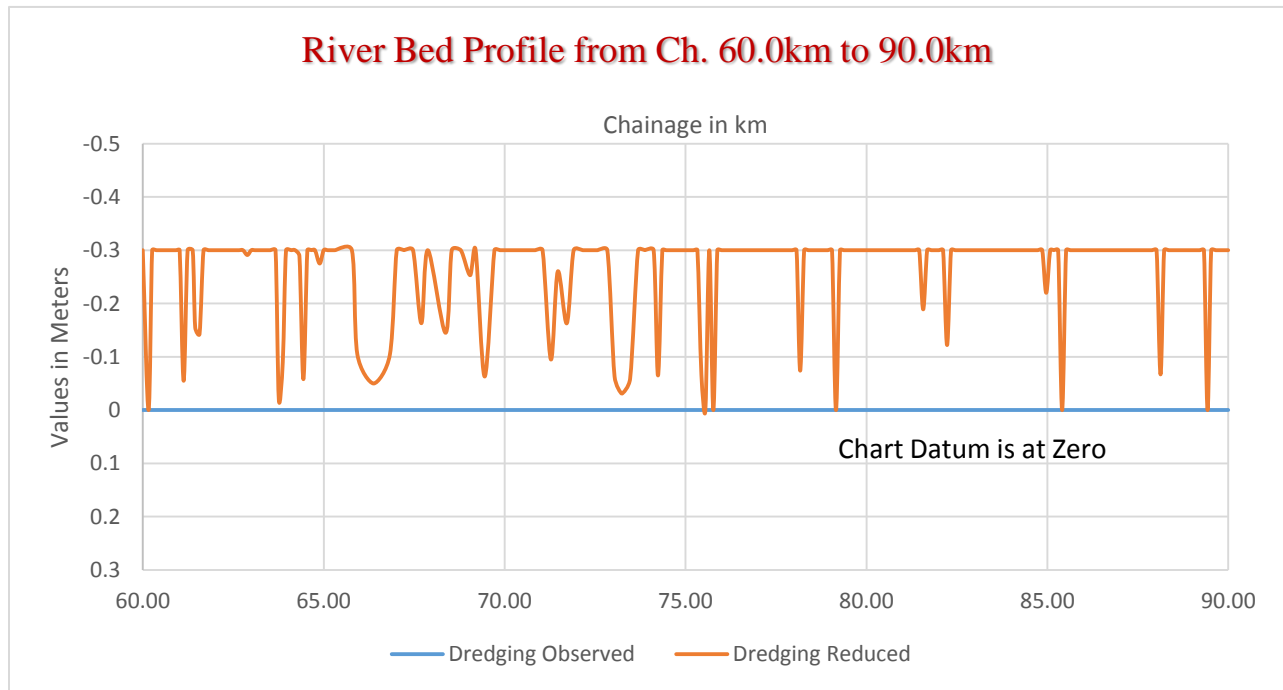


Figure 29 - Stretch 3 Observed and reduced bed profile

3.4 Sub-Stretch-4: Waroli to Manora (90.00km to 98.9km)



Figure 30 - Stretch-4 Waroli to Manora

- **Bathymetry Survey**
 - a) No bathymetric survey is conducted due to the unavailability of water
- **Topographic Survey**
 - b) 8.9km of the length of the stretch for which the Topographic survey has been carried out.

Stretch-4 covers 8.9km i.e. from 90.00km to 98.9km from Waroli village to Manora in Washim District in Maharashtra State. The Waroli, Ramtirth, Manora and Vitholi Kharkheda are the nearby villages around this stretch.

Manora is a town in Washim district, Maharashtra state, India. Nearby are other towns such as Waigaul, Poharadevi and Asola. Many people from the area are members of the Banjara community. The population mostly follow either Muslim or Hindu religion. In Manora there are two Urdu Jr. colleges and one Graduation College known as M.S.P. College Manora.



Figure 31 - Slatted Rocks

Zone 43N												
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	98.9	0.000	0.000	8900	3,61,176.17	2,511,851.02	-0.300	0.000	8900	4,61,346.15	3,179,354.52
II	90	98.9	0.000	0.000	8900	5,49,508.87	3,824,948.59	-0.300	0.000	8900	6,77,996.48	4,683,882.22
III	90	98.9	0.000	0.000	8900	8,29,683.23	5,780,098.06	-0.300	0.000	8900	9,88,961.72	6,847,240.97
IV	90	98.9	0.000	0.000	8900	1,000,980.41	6,974,286.28	-0.300	0.000	8900	1,167,363.35	8,089,460.03

Table 15 - Stretch 4 Dredging Quantity

3.4.1 Observed and reduced Bed Profile of the stretch

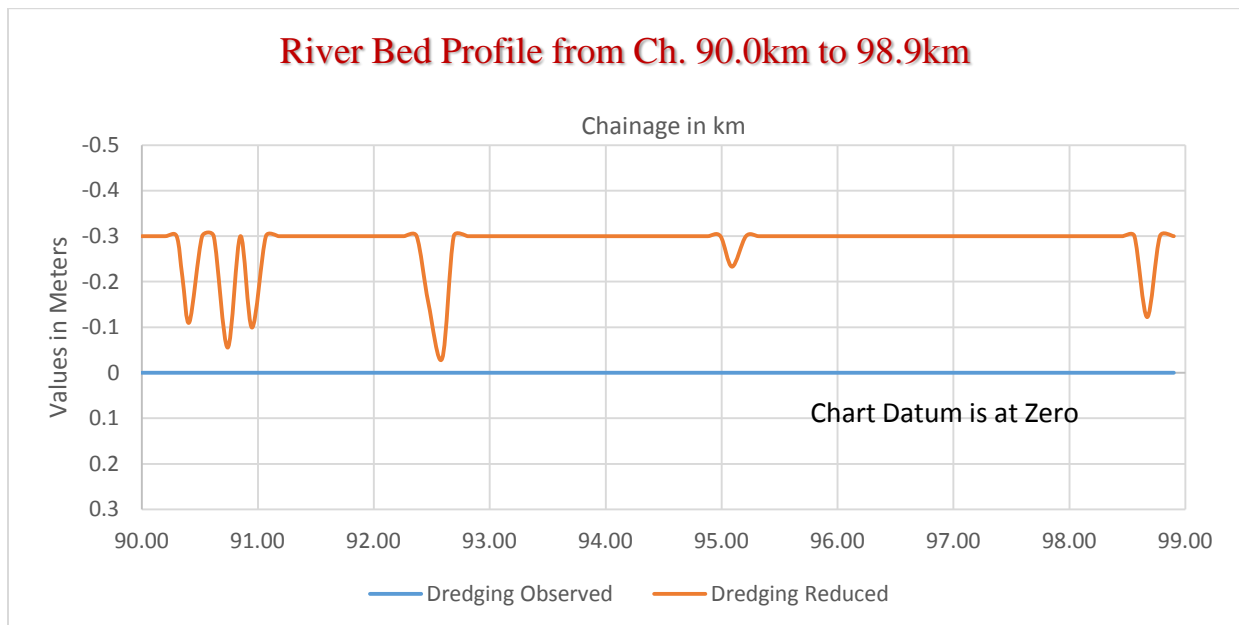


Figure 32 - Stretch 4 River-bed profile

3.5 Other Aspects of Waterway

3.5.1 Fishing

No fishing activities exist on the entire survey stretch of the Arunawati-Aran River. No scope of fishing do exist in the river due to non-availability of water during the summer season. The fishing boats/any other type country boats are also not available in the Arunawati-Aran River due to low depths.

3.5.2 Industries

No Major Industries and factory found along the Arunawati-Aran River Survey stretch. But in the district head quarter in Yavatmal having small beverage and agro industries found.

The ginning and pressing Mills are present at Digras and Darwha near to the river stretch. Otherwise no major industries are present.

3.5.3 Crops

The crops cultivated in Yavatmal districts are Cotton, Jawar, Wheat, Sugarcane, Betel leaves, Bajra, Gram, Tur, Groundnut, Orange, and Sunflower.

The crops cultivated in Washim district is Soyabean, Jawar, Tur, Moog, and Gram. Cotton is the major crop grown in this district.

3.5.4 Settlements

The overall River banks are sparsely populated for the entire survey stretch. There is only three main small towns along the river in our Area of Interest namely Arni, Digras and Manora. The population depends on cultivation. The river stretch is well connected with the roads and state run public transport system.

3.5.5 Drinking Water

Arunawati Dam is a major irrigation project across river Arunawati a tributary of river Penganga in Godavari basin. The dam is located near Savanga of Digras taluka in Yavatmal district, Maharashtra. The dam is an Earth-fill Gravity + Masonry Dam. The length of the dam is 5170m (16961.94ft), while the height of the dam above lowest foundation is 29.5m (96.78ft). The project has a spillway of OG type length of the spillway is 162m (531.49ft). The Dam Spillway has 11 Radial type of spillway gates. Dam's catchment area is 89.4 thousand hectors maximum/gross storage capacity is 198.395 MCM.

The CCA of the project is 25295 hectare and the ultimate irrigation potential of the project is 25155 hectare. The main component of the project is earthen dam (including spillway) 4810.0m long with a maximum height of 29.58 meters and 360.0m long of 12x8m size to pass the design flood discharge of 8525 cumecs.

46.00km long Right bank canal with a design discharge of 7.14 cumec and 56.0km long. Left bank canal with a design discharge of 14.896 cumecs.

3.5.6 Important Cities/Towns

The Major towns situated along the bank of Arunawati-Aran River is Arni, Digras, and Manora. Arni is a Taluka place in Yavatmal district SH 3 (Nagpur -Tuljapur) passes from Arni. It is better known for its cotton and also having a famous grain market.

3.5.7 Road Network

3.5.7.1 National Highway

One national highway is passing through the Arunawati-Aran River. National Highway-361 is passing at Arni city in Yavatmal district.

3.5.7.2 State Highway

Two state highways are crossing through Arunawati-Aran River at Arni in Yavatmal and Manora in Washim District. SH 213 passing at Harsul village also called Darwa bypass. SH 211 passing through the Arunawati-Aran River at the Manora village in Washim district.

3.5.7.3 Major District Roads

Yavatmal and Washim districts had a good road network. The major district roads route numbers are listed below:

Sl. No.	Route	Description
1	MDR7	Sakara to Shirpur
2	MDR6	Siwani to Dheni
3	MDR8	Chirkuta to Dhanora Bk.
4	MDR28	Ghantanji to Khadaka

Table 16 - Major District Roads

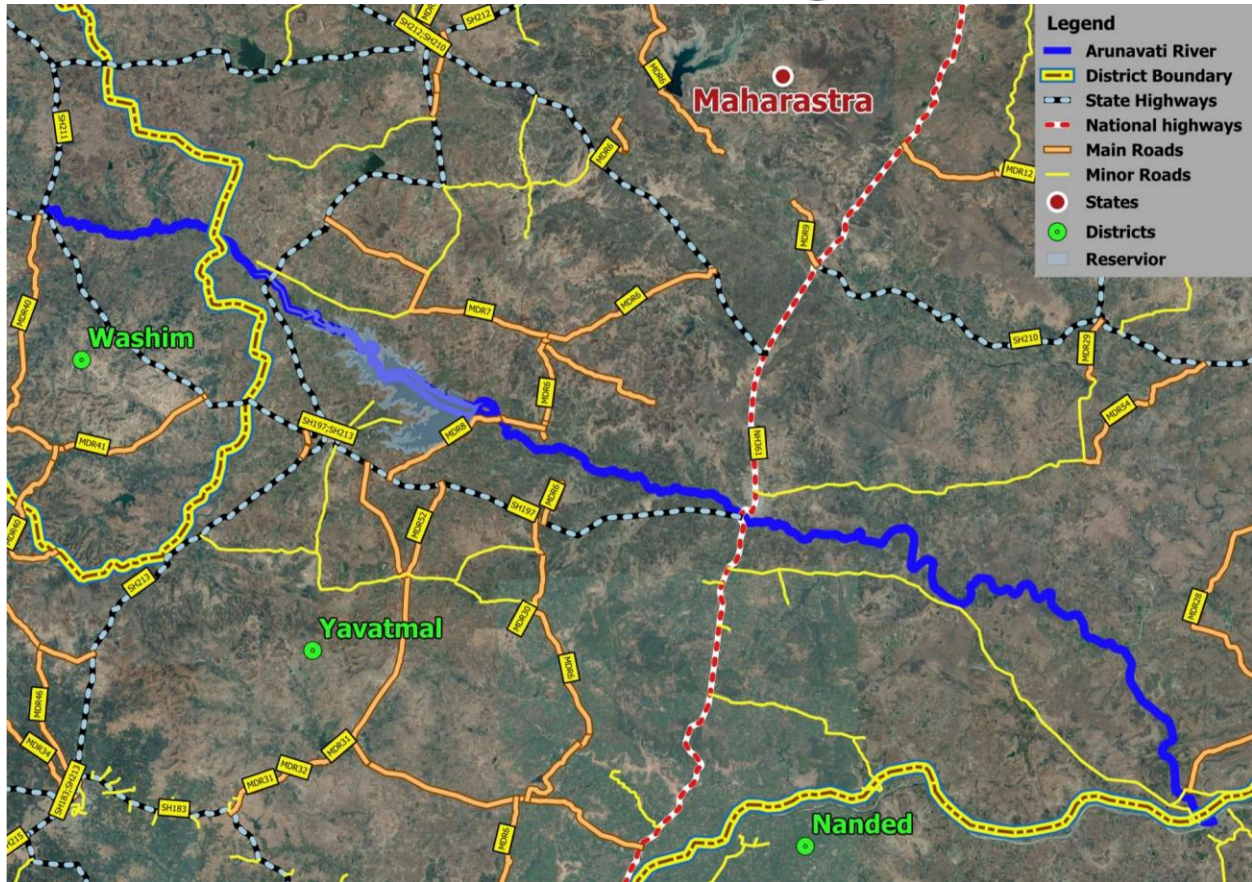


Figure 33 - Road Network

3.5.7.4 Rail Network

There is no Rail network as such is present along or across the Arunawati-Aran River considered for study.

3.5.8 Land Use

In Yavatmal District the land use is divided into Forest area, Cultivation area and Net area Shown.

- Forest area - 2 178 Sq.km
- Cultivable area - 12,72,789 ha
- Net area shown - 11,42,549 ha

In Washim District the land use is as follows:

- Geographical area – 516 ha
- Cultivable area – 310.5 ha
- Forest area – 34 ha

- Land under nonagricultural use – 30 ha
- Permanent pastures – 12 ha
- Cultivable wasteland – 12
- Barren and uncultivable land – 28

3.5.9 Construction Material

The area being near to Digras town and a municipal council in Yavatmal district in Maharashtra State, all type of modern construction materials like cement, Iron etc. are available in bulk quantity.

3.5.10 Conditions of banks

Bank is unprotected in nature along the River

3.5.11 Jetties and Terminals

Lack of the jetties and Terminals along the River.

3.5.12 Cargo Movement

No cargo movement or passenger movement is expected to be there in this stretch of Arunawati-Aran River.

3.5.13 Passenger Ferry Services

No passenger ferry service is available in the survey stretch of the Arunawati-Aran River.

3.5.14 Historic importance

Yavatmal has been mentioned in the Mahabharata. According to ancient history, Yavatmal was part of the Berar region, which in turn was ruled by the Mauryan Empire. In fact this region had been invaded by a number of rulers, such as, the Satavahanas Rashtrakutas, Vakataka dynasty, Chalukyas, Yadavas and was finally captured by the Muslim invaders in the 14th century.

Yavatmal City was main town of Berar. Region of Yavatmal (now District of Yavatmal) was part of the dominion of Allauddin Bahmani Shah-The founder of the Bahmani dynasty since 1347. In 1572 ruler of Ahmednagar annexed the Yavatmal District.

In 1596, Chand Bibi the queen of Ahmednagar surrendered the district of Yavatmal to Mughals. After the death of Aurangzeb in 1707, Yavatmal was passed on to the Great Marathas. When Raghaji Bhonsle became the ruler of Nagpur in 1783, he included the Yavatmal district in his kingdom. After British East India Company took over Berar in 1853, by 1863, Yavatmal became part of East Berar District and later of South East Berar

district which were districts of Central Provinces. Quite late before the 1947, Yavatmal was part of Madhya Pradesh but in 1956 after the reorganization of states in India District of Yavatmal was transferred to Bombay state. When the state of Maharashtra came into existence in 1960 (1st of May), Yavatmal District became part of Maharashtra.

The Satavahanas, Rashtrakutas, Vakataka dynasty, Chalukyas, Yadavas, Marathas, Nizams, Mughals and British.

3.5.15 Tourism

Yavatmal, the district headquarters is the biggest city in the district. Ginning Factories, Oil and Pulse Mills and Saw Mills are located in the city. Educational facilities such as Medical College, Ayurvedic College and Polytechnic institutions/college for boys and girls, Physical Training Colleges are available in the city. Jagat Mandir and Khoja mosque are important places in the city.

Arni - Located on the bank of the river Arunawati-Aran. A huge fair (Ursa-Shariff) of Baba Kambalposh is held here.

3.5.16 Irrigation Canals and Outlets

The Arunawati-Aran River is not having any irrigation canal and outlets.

4 Terminals

4.1 Details of Terminal survey carried out

In this River stretch could not find any adequate proposed terminal, due to the unavailability of water in this stretch.

5 Fairway Development

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 50m width, 2m depth and side slop of 1:5 is shown below.

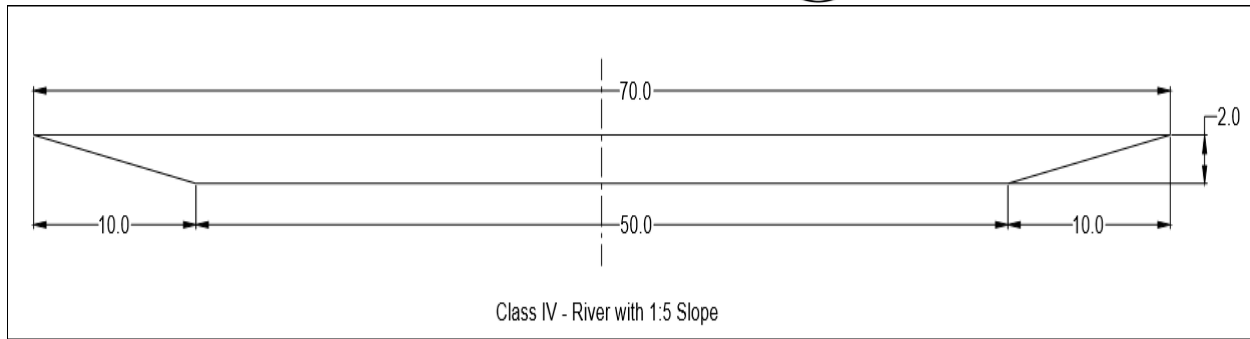


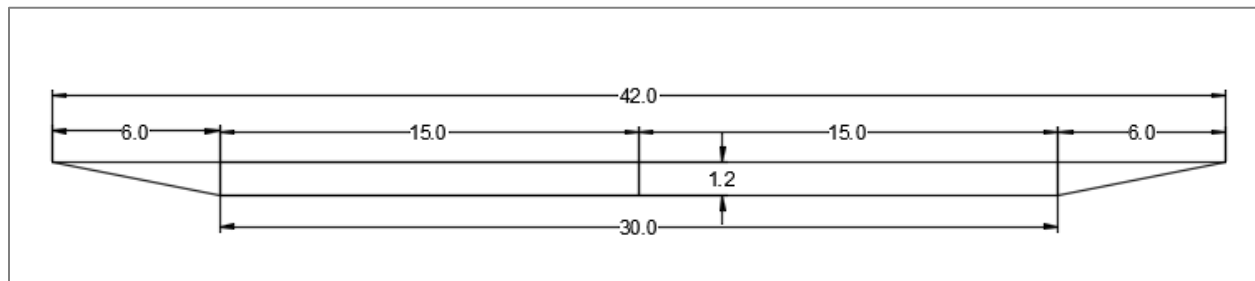
Figure 34 - Fairway Channel Dimensions

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 kilo meter 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 different class of fairway is as follows:

5.2.1 Zone 44N

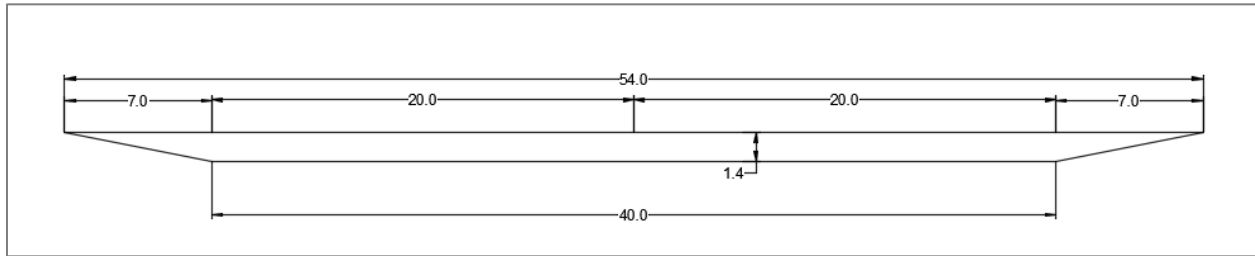
Class I



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.	
Chimata	Heti	0	30	0.000	0.000	30000	1,281,799.89	1,281,799.89	-0.300	0.000	30000	1,633,432.42	1,633,432.42	
Heti	Asara	30	39.4	0.000	0.000	9400	3,98,729.07	1,680,528.96	-0.300	0.000	9400	5,08,995.22	2,142,427.64	
Total						39400	1,680,528.96	1,680,528.96	Total			39400	2,142,427.64	2,142,427.64

Table 17 - Class I Stretchwise Dredge Volumes

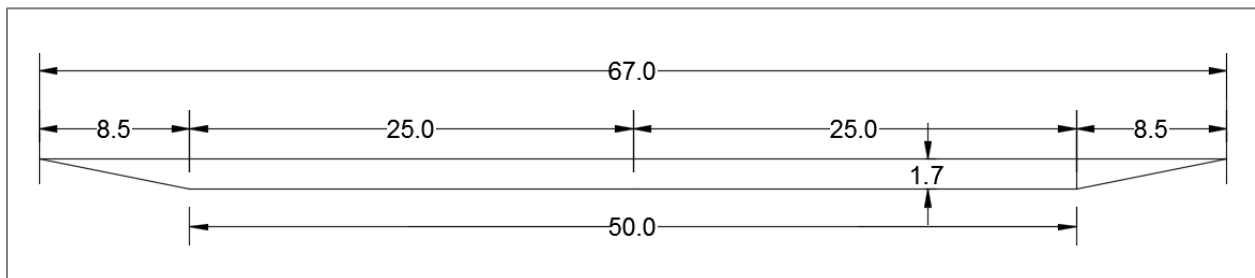
Class II



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.
Chimata	Heti	0	30	0.000	0.000	30000	1,952,090.36	1,952,090.36	-0.300	0.000	30000	2,404,767.85	2,404,767.85
Heti	Asara	30	39.4	0.000	0.000	9400	6,07,316.63	2,559,406.99	-0.300	0.000	9400	7,49,028.35	3,153,796.20
Total						39400	2,559,406.99	2,559,406.99	Total		39400	3,153,796.20	3,153,796.20

Table 18 - Class II Stretchwise Dredge Volumes

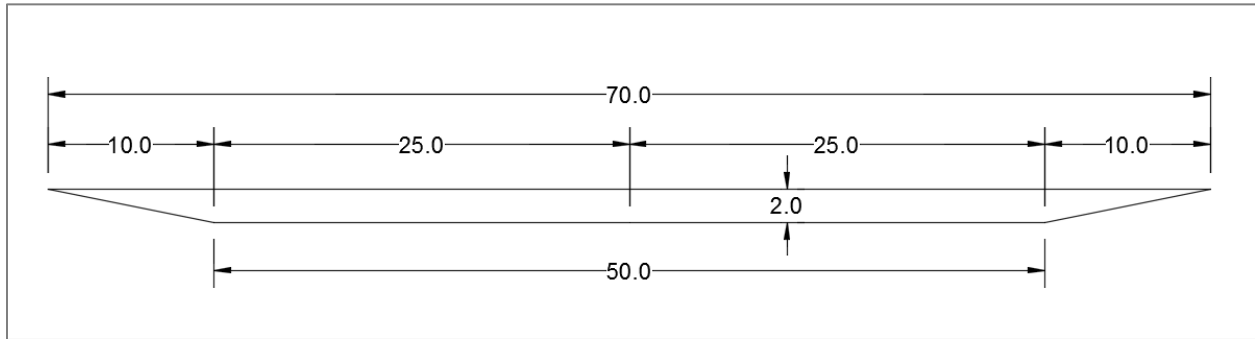
Class III



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.
Chimata	Heti	0	30	0.000	0.000	30000	2,951,234.99	2,951,234.99	-0.300	0.000	30000	3,513,929.86	3,513,929.86
Heti	Asara	30	39.4	0.000	0.000	9400	9,17,263.47	3,868,498.46	-0.300	0.000	9400	1,092,790.79	4,606,720.65
Total						39400	3,868,498.46	3,868,498.46	Total		39400	4,606,720.65	4,606,720.65

Table 19 - Class III Stretchwise Dredge Volumes

Class IV

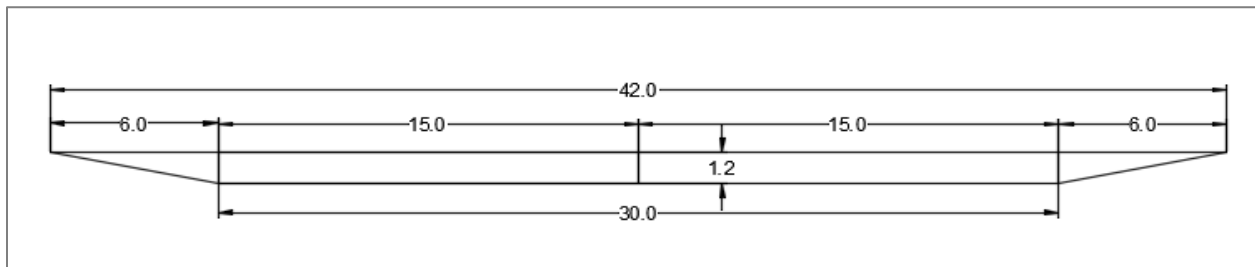


Class IV														
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum					
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	
Chimata	Heti	0	30	0.000	0.000	30000	3,560,883.38	3,560,883.38	-0.300	0.000	30000	4,149,049.47	4,149,049.47	
Heti	Asara	30	39.4	0.000	0.000	9400	1,106,561.92	4,667,445.30	-0.300	0.000	9400	1,289,856.01	5,438,905.48	
Total						39400	4,667,445.3	4,667,445.30	Total			39400	5438905.48	5,438,905.48

Table 20 - Class IV Stretchwise Dredge Volumes

5.2.2 Zone 43N

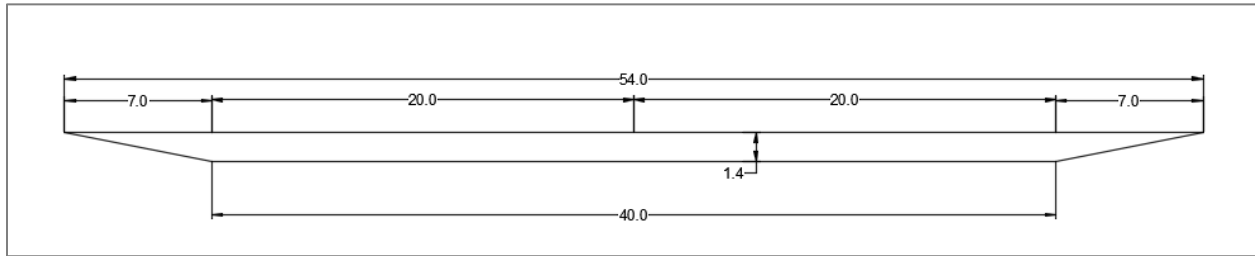
Class I



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.	
Asara	Sawanga Kh.	39.4	60	0.000	0.000	20600	8,72,816.59	2,553,345.55	-0.300	0.000	20600	1,106,114.01	3,248,541.65	
Sawanga Kh.	Digras	60	65.5	0.000	0.000	5500	2,34,283.76	2,787,629.31	-0.300	0.000	5500	2,95,870.64	3,544,412.29	
Digras	Waroli	65.5	90	0.000	0.000	24500	1,043,574.5	3,831,203.81	-0.300	0.000	24500	1,316,023.72	4,860,436.01	
Waroli	Manora	90	98.9	0.000	0.000	8900	3,61,176.17	4,192,379.98	-0.300	0.000	8900	4,61,346.15	5,321,782.16	
Total						59500	2,511,851.02	4,192,379.98	Total			59500	3,179,354.52	5,321,782.16

Table 21 - Class I Stretchwise Dredge Volumes

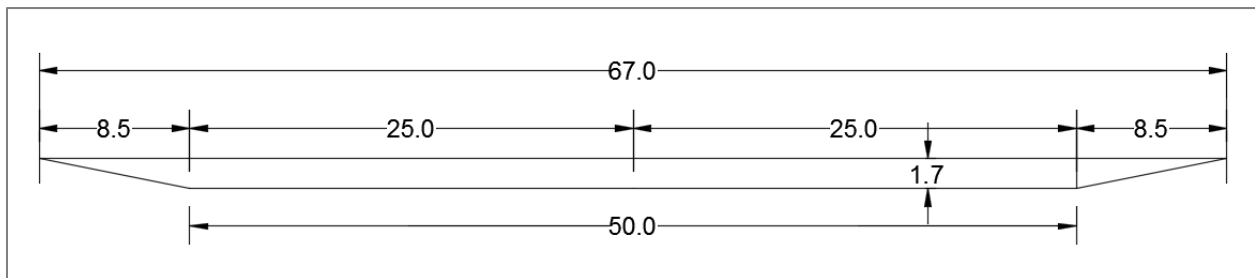
Class II



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.
Asara	Sawanga Kh.	39.4	60	0.000	0.000	20600	1,329,081.35	3,888,488.34	-0.300	0.000	20600	1,629,677.6	4,783,473.80
Sawanga Kh.	Digras	60	65.5	0.000	0.000	5500	3,56,832.11	4,245,320.45	-0.300	0.000	5500	4,36,548.43	5,220,022.23
Digras	Waroli	65.5	90	0.000	0.000	24500	1,589,526.26	5,834,846.71	-0.300	0.000	24500	1,939,659.71	7,159,681.94
Waroli	Manora	90	98.9	0.000	0.000	8900	5,49,508.87	6,384,355.58	-0.300	0.000	8900	6,77,996.48	7,837,678.42
Total						59500	3,824,948.59	6,384,355.58	Total		59500	3,569,337.31	7,837,678.42

Table 22 - Class II Stretchwise Dredge Volumes

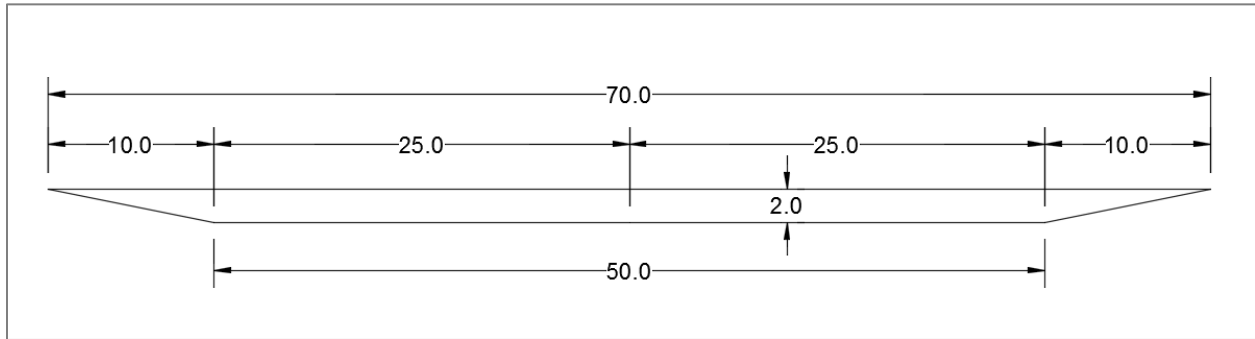
Class III



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.
Asara	Sawanga Kh.	39.4	60	0.000	0.000	20600	2,008,732.41	5,877,230.87	-0.300	0.000	20600	2,382,655.06	6,989,375.71
Sawanga Kh.	Digras	60	65.5	0.000	0.000	5500	5,39,315.5	6,416,546.37	-0.300	0.000	5500	6,38,984.37	7,628,360.08
Digras	Waroli	65.5	90	0.000	0.000	24500	2,402,366.92	8,818,913.29	-0.300	0.000	24500	2,836,639.82	10,464,999.90
Waroli	Manora	90	98.9	0.000	0.000	8900	8,29,683.23	9,648,596.52	-0.300	0.000	8900	9,88,961.72	11,453,961.62
Total						59500	5,780,098.06	9,648,596.52	Total		59500	6,847,240.97	11,453,961.62

Table 23 - Class III Stretchwise Dredge 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.
Asara	Sawanga Kh.	39.4	60	0.000	0.000	20600	2,423,793.71	7,091,239.01	-0.300	0.000	20600	2,814,598.62	8,253,504.10
Sawanga Kh.	Digras	60	65.5	0.000	0.000	5500	6,50,743.07	7,741,982.08	-0.300	0.000	5500	7,55,036.16	9,008,540.26
Digras	Waroli	65.5	90	0.000	0.000	24500	2,898,769.09	10,640,751.17	-0.300	0.000	24500	3,352,461.9	12,361,002.16
Waroli	Manora	90	98.9	0.000	0.000	8900	1,000,980.41	11,641,731.58	-0.300	0.000	8900	1,167,363.35	13,528,365.51
Total						59500	6,974,286.28	11,641,731.58	Total		59500	8,089,460.03	13,528,365.51

Table 24 - Class IV Stretchwise Dredge Volumes

6 Conclusion

The aim is to undertake bathymetric survey, topographic survey, 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.

6.1 Description of Waterways

The surveyed stretch of Arunawati-Aran River is 98.9 Km in length and feasibility for navigation is not possible due to unavailability of water in the River for more than 8 months in the year. This survey stretch starts from confluence of Arunawati-Aran River with Penganga near Chimata village and ends near Manora town. The River banks are well connected with road network and major distribution of settlements is at Arni, Digras and Manora whereas many small villages are present along the River stretch. The stretch wise minimum and maximum width range, average width and average slope of the waterway are as below:-

Sl. No.	Location		Chainage (km)		Width Range of the waterway (m)		Average Width (m)	Average Slope (in m/km)
	From	To	From	To	Min	Max		
1	Chimata	Heti	0	30	95.250	189.640	104.570	1 : 1.548
2	Heti	Sawanga Kh.	30	60	80.335	131.280	103.274	1 : 0.932
3	Sawanga Kh.	Waroli	60	90	55.903	692.120	203.329	1 : 1.285
4	Waroli	Manora	90	98.9	74.013	144.290	101.894	1 : 1.398

Table 25 - 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 River by carrying out capital dredging to achieve the navigability. The class-wise details of reduced dredging quantities of the waterways are as tabulated below:-

Class	0 - 30 (km)	30 - 39.4 (km)	39.4 - 60 (km)	60 - 65.5 (km)	65.5 - 90 (km)	90 - 98.9 (km)	Total
I	1,633,432.42	508,995.22	1,106,114.01	295,870.64	1,316,023.72	461,346.15	5,321,782.16
II	2,404,767.85	749,028.35	1,629,677.60	436,548.43	1,939,659.71	677,996.48	7,837,678.42
III	3,513,929.86	1,092,790.79	2,382,655.06	638,984.37	2,836,639.82	988,961.72	11,453,961.62
IV	4,149,049.47	1,289,856.01	2,814,598.62	755,036.16	3,352,461.90	1,167,363.35	13,528,365.51

Table 26 - 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 navigational Barrage is required to maintain the minimum depth required for navigation and regulate the water level in the River. The class-wise details of reduced depth at different stretches of the waterways are as tabulated below:-

Sl. No.	Chainage (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	30	30	100%	0	0 %	0	0 %	0	0 %	0	0 %
2	30	60	30	100%	0	0 %	0	0 %	0	0 %	0	0 %
3	60	90	30	100%	0	0 %	0	0 %	0	0 %	0	0 %
4	90	98.9	8.9	100%	0	0 %	0	0 %	0	0 %	0	0 %
Total			98.9	100%	0	0 %	0	0 %	0	0 %	0	0 %

Table 27 - Class-wise availability of reduced depth of the waterway

6.3 Modifications/ improvement measures

The road bridges and foot walk bridges constructed across the River which are low lying needs to be raised up to make the navigation possible if the River required to be developed as National Waterway. The class-wise modification details of cross structure and high tension line clearance are as tabulated below:-

Bridges Clearances less than Class			High Tension lines Clearances less than Class	
Class	Horizontal	Vertical	Horizontal	Vertical
I	16	13	0	EP Lines- 08 Nos HTL – 03 Nos
II	16	15		
III	16	16		
IV	16	16		

Table 28 - 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 its geographic condition and non-availability of water throughout the region. The river bed is mainly rocky in nature and the River banks are well connected with the road network and major distribution of settlements is there near to Washim and Yavatmal Cities. There is major industries and factory found along the river, but in the district head quarter in Yavatmal having small beverage and agro industries found. The road is a near parallel on both sides throughout the River stretch. No scope for the future development of the River was recommended for navigational purpose and the survey Stretch is not-viable for navigable channel.

The purpose of the survey was for assessing the River stretch from the Chimata village to Manora village for the development of water transport facilities in the new National Waterway (NW-11). 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

Annexure-1 Source and type of data collected from various agencies.....	55
Annexure-2 Stretch wise Data of Observed Depths to Reduced Depths.....	57
Annexure-3 Dredge Volumes (per km) for different classification with length of shoal.....	59
Annexure-4 Water Level Details.....	71
Annexure-5 Survey Dates.....	73
Annexure-6 Details of Bank Protection.....	75
Annexure-7 Details of Riverside Features.....	77
Annexure-8 Horizontal and Vertical Control.....	79
Annexure-9 Equipment Photographs.....	83
Annexure-10 Bench Mark Pillar Forms.....	85
Annexure-11 Levelling Data.....	109
Annexure-12 Current Meter Observation and Discharge Calculation.....	253
Annexure-13 Water Sample Analysis.....	255
Annexure-14 Calibration Certificates.....	257
Annexure-15 Survey Chart Scheming Index and chart details.....	260
Annexure-16 Field Photographs.....	265

Volume - II