IIC TECHNOLOGIES™

Final Feasibility Report
National Waterway-69,
Region VI – Manimutharu River
Aladiur to Manimutharu Dam (4.75km)

SURVEY PERIOD: 24 JAN 2016 TO 8 FEB 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-69 in Region VI –Manimutharu River from Aladiur to Manimutharu Dam.

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 thanks, **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.

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CONTENTS

List of Abbreviations

CD	Chart Datum
DGPS	Differential Global Positioning Systems
PDOP	Position Dilution of Precision
LBS	Left Bank Side
Man	Manimutharu
ETS	Electronic Total Station
FRP	Fiber Reinforced Plastic
GPS	Global Positioning Systems
LBM	Local Bench Mark
MSL	Mean Sea Level
RL	Reference Level
SD	Sounding Datum
SBAS	Satellite-Based Augmentation System
TBC	Trimble Business Center
PIA	Project Influence Area
GTS	Great Trigonometrically Survey
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 & Tamilnadu</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW #
(from…. to; total length)</td><td>National Waterway No – 69
Aladiur to Manimutharu Dam (4.75km)</td></tr>
<tr><td>4.</td><td>Navigability Status</td><td>At present partially navigable</td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions
(from… to, length, average tidal variation)</td><td>Manimutharu River is Non-Tidal river</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t. CD)
i) Survey period (24th Jan 2016 to 8th Feb 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>
<table>
<tr><th>LAD (m)</th><th>0-0.670 (km)</th><th>0.67-2.67 (km)</th><th>2.67-4.75 (km)</th><th>Total</th></tr>
<tr><td>< 1.2</td><td>0.14</td><td>1.311</td><td>2.08</td><td>3.531</td></tr>
<tr><td>1.2 - 1.4</td><td>0.323</td><td>0.235</td><td>0</td><td>0.558</td></tr>
<tr><td>1.5 - 1.7</td><td>0.131</td><td>0.36</td><td>0</td><td>0.491</td></tr>
<tr><td>1.8 - 2.0</td><td>0.026</td><td>0.084</td><td>0</td><td>0.11</td></tr>
<tr><td>> 2</td><td>0.05</td><td>0.01</td><td>0</td><td>0.06</td></tr>
<tr><td>Total</td><td>0.67</td><td>2</td><td>2.08</td><td>4.75</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:
No Navigational locks are present in the survey stretch of Manimutharu River. The details of Dams, Check dams, bridges are as follow:
i) Dams/Check Dams – 01 & 03 Nos
ii) Bridges – 01 Nos.
Horizontal Clearance - 5.351m
Vertical Clearance - 0.8m
iii) High Tension Lines - Nil</td></tr>
<tr><td>d)</td><td>Avg. discharge & no. of days</td><td>Discharge data not available from authorities</td></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>0.67</td><td>1 : 3.012</td></tr>
<tr><td>0.67</td><td>2.67</td><td>1 : 0.000</td></tr>
<tr><td>2.67</td><td>4.75</td><td>1 : 0.012</td></tr>
</table>
Average slope is 1 : 0.076 for entire river stretch</td></tr>
</table>

#	Particulars	Details
5.	Traffic potential	Non Navigable at present condition
a)	Present IWT operations, ferry services, tourism, cargo, if any	At present there is no IWT operations.
b)	Important industries within 50km	No Large scale industries exist near to the survey area.
c)	Distance of Rail & Road from Industry	The both sides of the Manimutharu are connected with good road transport network and private vehicles are also available in the nearby area.
6.	Consultant's recommendation for going ahead with TEF / DPR preparation	1. The Manimutharu River flows North-Eastern with no major sharp curves or deviation of river stream. 2. The water availability is very less and the steep gradient in the upstream portion of river and the presence of large rocks and boulders on the stretches from 2.67 to 4.75 m makes the river not navigable. 3. The design of the waterway cannot be altered to a major extent as this is used mainly for irrigation purpose and drinking water supply. Overall the river stretch is not-viable technically
7.	Any other information/ comment	Nil

(Signature)

Date: Name of Consultant

1 Introduction

1.1 Background

The River Manimutharu is a major tributary of the Thamirabarani, Manimutharu River originates on the eastern slopes of Western Ghats in Tirunelveli District of the state of Tamil Nadu, India. It arises from the dense forest a top Senkutheri at the height of about 1300 m from MSL. The river contributes a lot, as tributary to enhance the water level of Thamirabarani River as it is always in full spate and perennial. 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.

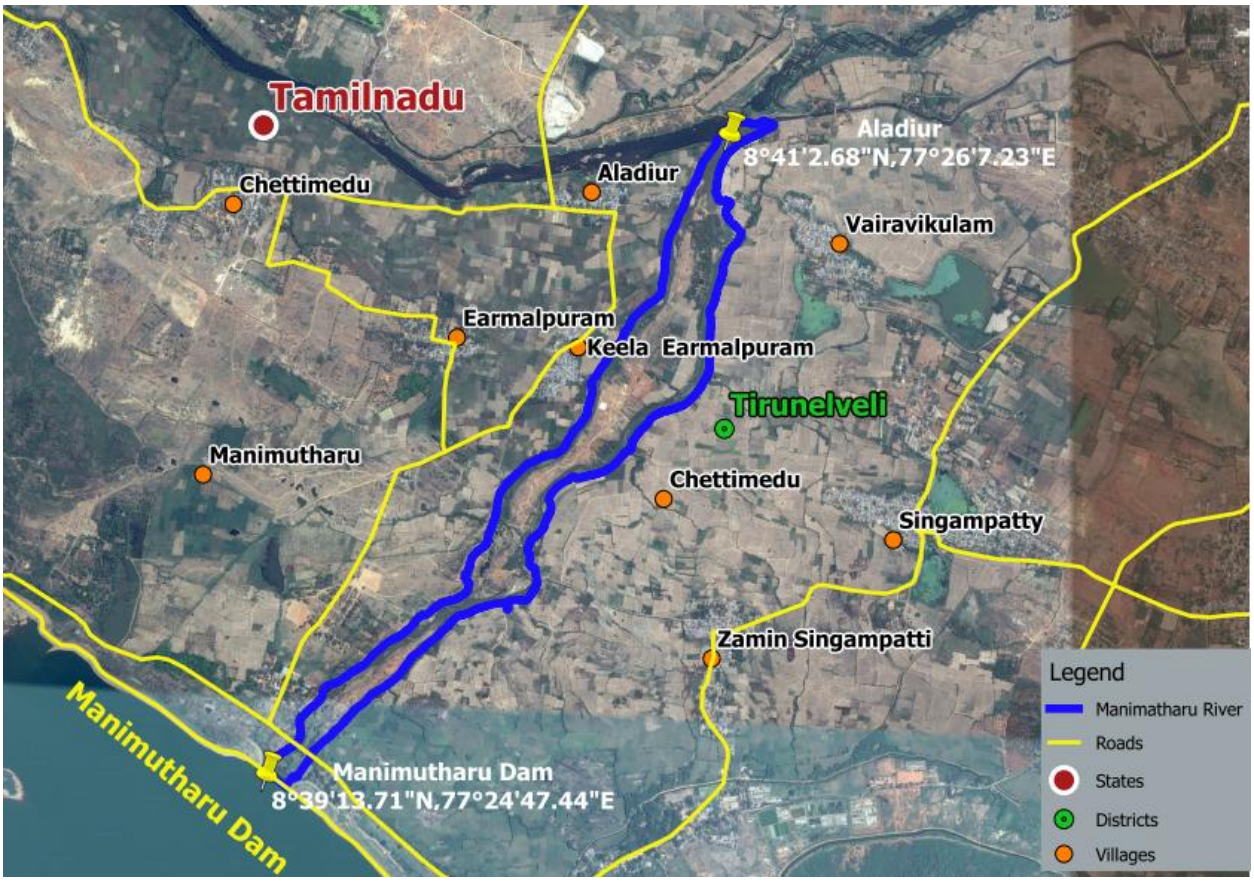


Figure 1 - Map of Manimutharu River

1.2 Tributaries of Manimutharu River

Manimutharu River originates on the eastern slopes of Western Ghats in Tirunelveli District of Tamilnadu State. The tributaries of Manimuthar River are Keezha River and Varattar River, however there are no tributaries joining in the survey stretch.

1.3 State/District through which River Passes

The Manimutharu River passes through Tirunelveli district of Tamilnadu.

State Name	Chainage (km)		Length (km)
	From	To	
Tamilnadu	0.00	4.75	4.75

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 Manimutharu 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 the Waterway under Study

1.5 Scope of Work

The major part of the work is, to conduct detailed hydrographic and topographic survey of 4.75kms length of the river from confluence with Tamaraparani River near Aladiur at Lat 8°41'2.68"N, Long 77°26'7.23"E to Manimutharu Dam at Lat 8°39'13.71"N, Long 77°24'47.44"E.

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

a) Undertake bathymetric and topographic survey of proposed waterway.
b) Establishing horizontal and vertical control stations
c) Construction of benchmark pillars and establishing its reduced level w.r.to Mean Sea Level

d) Setting up and deployment of water level gauges
e) Current velocity and discharge measurements
f) Collection and analysis of water and bottom samples.
g) Collection of topographic features including existing cross structures.
h) Preparation of inventory of industries in the project influence area (PIA)
i) Analysis of survey data, including assessment of water availability for navigation.
j) Preparation of survey charts and feasibility report

2 Methodology Adopted to Undertake Study

2.1 Recce

Advance recce of the survey area was undertaken on 19th Jan 2016. The Recce commenced form Manimuthar Dam (Upstream) to Aladiur (Downstream). The BM established by PWD dam Sub-section near to Manimutharu Dam was recovered for establishing vertical control station.

The Upstream stretch of the Manimutharu River, the river bed is rocky nature and several rock boulders forms obstruction to the continuous flow of the river. This causes the practical inability to use any type of boat for sounding in the area. The help from local people and hiring of local personnel for the spot sounding in the dam area and at least up to 1km chainage is extremely advised by the Manimutharu Dam authority.

Thick Vegetation exists on the near river banks and beyond that the paddy cultivation is prominent for the entire area. The loss of lock for the DGPS is expected more on the LBS of the Manimutharu River and observation time need to be selected cautiously by the DGPS operators according to the PDOP and Satellite availability.

2.1.1 Survey Resources and Methodology

The survey was commenced on 24th Jan 2016 and completed on 8th Feb 2016. The survey was undertaken on a scale of 1:2000, with sounding line spacing kept at 50 m and plotted on UTM Projection at Zone 43N as directed in the contract specifications.

2.1.2 Survey Equipment

Following equipment were deployed for the survey of Manimutharu River.

Equipment	Make	Eqpt. Serial No.	Qty. Employed
Current Meter	Valeport801	23447	1
Tide Gauge	Manual (Pole type)	-	3
Grab Sampler	Vanveen	-	1

Equipment	Make	Eqpt. Serial No.	Qty. Employed
Water sampler	Naskin Water sampler	-	1
DGPS	Hemisphere Differential DGPS	18260616	1
GPS Sets	Trimble R3/R4	-	06
Auto Level	Sokkia Auto level & Accessories	120595, 102775	02
ETS	Trimble M3	-	01
E/S Calibration	Bar Check	-	1
Software	HYPACK data acquisition	Version 12	1
Software	AUTOCAD	2012	1
Software	Microsoft Office	2013	1
Software	Trimble Business Center	Version-12	1

Table 2 - Survey Equipment Used

2.1.3 Topographic Survey

The survey was commenced on 24th Jan 2016 and completed on 8th Feb 2016. The weather was sunny throughout the period during survey operations. The weather was sunny throughout the period during survey operations. The weather was very favorable for the conduct of survey and the weather condition remains same for the entire duration of the survey.

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

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

Figure 4 - DGPS Spot leveling near Manimuthar Dam

2.1.4 Bathymetric Survey and Survey Launch

The water level is very low for the entire river chainage of 4.75km and at many places, the river bed being rocky in nature the Survey boat could not be deployed for Bathymetric data collection.

2.1.5 Calibration

The equipment used for the survey was calibrated by the equipment supplier. The equipment calibration certificates are placed at Annexure-15 to this report.

2.2 Description of Bench Marks/Authentic Reference Level Used

The GTS station near to the Manimutharu Dam was recovered and the value of 91.365m above MSL was obtained from the log book of Manimutharu Dam authority.

This station was used as the initial reference for vertical control and the Reference Level value of the same was transferred to station MAN-01 and IWAI-BM-MAN-01 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 WGS84 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
01	MAN-01	4.57	8°39'15.53853"N	77°24'53.66398"E	74.640	Online Processing
02	IWAI-BM-MAN-01	2.67	8°39'56.14695"N	77°25'30.87637"E	71.904	Baseline processing

Table 3 - Accepted Station coordinates (WGS-84)

Figure 5 - GTS station (RBM) near Manimutharu Dam

2.3 Tidal influence Zone and Tidal Variation

Manimutharu River is non-tidal water body having the primary source of water receiving from Manimutharu Dam.

2.4 Methodology to fix Chart Datum / Sounding Datum

The Manimutharu is 4.75km stretch river with Kanadian check dam on Starting Chainage (Downstream point) and one Spillage check dam (Kothikal check Dam) on 0.7km chainage and one rock/sand barrage act as the temporary road/spillage barrier (Zamin Singampatti) on chainage 2.7km. These check dams are primarily used for irrigation purpose.

There is no CWC gauge data available for Manimutharu River and no gauge readings are being recorded for the Check Dam in view of manpower shortage on Tamilnadu PWD office (Cheranmahadevi Sub Division). Detailed attempt for obtaining the low flood level of Manimutharu River was carried out. The Various organizations were approached and

on final note the historic Low Food Level could not be obtained for the Manimutharu River.

On detailed observation and inputs from the Assistant Engineer of Manimutharu Dam, The water level on the Kothikal check dam and others is found to be same throughout the period as it is charged with the dam water during dry season and any excess amount will clear as spillage. So considering this fact, sounding datum was taken on safe side of 0.3 m below the normal water level (Approx. 01 Feet). The out of 06 tide pole erected, most suitable tide pole readings in each section is selected for reducing to depth value collected spot level.

Tide Gauge No.	Location	Chainage (km)	Easting/ Northing	Zero of Tide Gauge w.r.t. MSL (m)	Period of Observation
4	Kanadian (0) to Kothikal Check dam (0.67)	-0.09	768074.444 960823.373	64.030	Used only as a reference for datum calculation
2	Kothikal Check Dam (0.67) to Zamin Singampatti (2.67)	0.67	767934.993 960153.316	66.069	

Table 4 - Erected Tide Pole Details

2.4.1 Slope Calculation

The slope of the Manimutharu river was computed and to be found agreeing with the topography of the area. The tide Poles (Total 06 No's) were erected on upstream and downstream of all check dams/place having large variation in Gradient. It is observed that there is no slope between the check dams and the water level remains same for the respective stretch.

The area between chainage 2.725km to 4.75km is having slope with large boulders and rocky terrain throughout the chainage. This area is not suitable for navigation in all condition and for making navigable a major capital dredging may be required for this area. Remaining area is found to be with gentle slope and with backwater effect of the check dam throughout the stretch. The details of slope calculation are as follows:-

Sl. No.	River Chainage (km)	Water Level w.r.t MSL (m)	Difference in water level	Remarks
1	0	65.343	0	Kanadian to Kothikkal Check dam
	0.67	65.345		
2	0.67	66.724	0	Kothikal Check Dam to Zamin Singampatti
	2.67	66.732		
3	2.67	67.217	0.444	Zamin Singampatti upstream area
	3.7	67.661		

4	3.7	67.661	2.62	Manimutharu Dam Downstream area
	4.75	70.482		

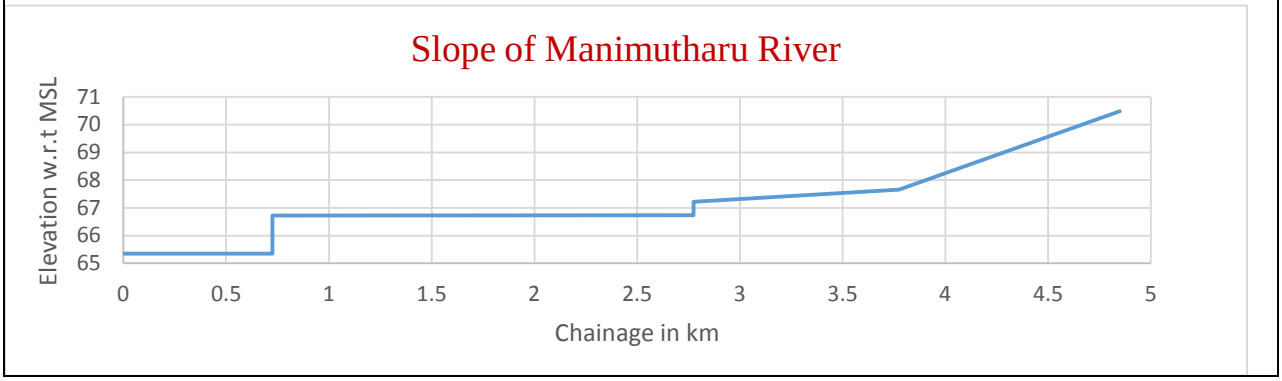


Table 5 - Slope calculation Manimutharu River (w.r.t Water level)

2.4.2 Sounding Datum

The Manimutharu River is 4.75km stretch river with Kanadian check dam on Starting Chainage (Downstream point) and one Spillage check dam (Kothikal check Dam) on 0.7km chainage and one rock/sand barrage act as the temporary road/spillage barrier (Zamin Singampatti) on chainage 2.67km. The Manimutharu River, lowest water level value is not available with Dam authority, CWC, IWAI Regional Office, PWD/ Irrigation Department.

On detailed observation and inputs from the Assistant Engineer of Manimutharu Dam, The lowest water level on the Kothikal check dam and others is found to be same throughout the period as it is charged with the dam water during dry season and any excess amount will clear as spillage. So considering this fact, sounding datum was taken on safe side of 0.3m below the normal water level (approx. 01 Feet).

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

Manimutharu River is non-tidal water body having the primary source of water receiving from Manimutharu Dam. Detailed attempt for obtaining the HFL and LFL of the river was carried out during survey and found there is no CWC gauge data available for Manimutharu River.

2.6 Transfer of sounding Datum

The Tide poles were erected at 06 Locations where the rapid variation in the Gradient was observed, significantly on upstream and downstream of check dams. A total of 06 Tide poles were erected for 03 stretches of Manimutharu and out of 06 Tide poles erected, most suitable tide pole readings in each section is selected for defining the sounding datum of the respective stretch of the river. The value of sounding datum was

further distributed to the respective stretches in reference with the common vertical control point (IWAI-BM-MAN-01).

Steep gradient is observed from 2.67km to 4.75km stretch of the Manimutharu River with height difference of 2.1m. The water availability in this area is limited to very narrow streams flowing between the large boulders situated on the river bed. The sounding datum for this area is obtained as the least bed level value at 01km interval between 2.67km to 4.75km chainage of the river.

2.6.1 Sounding Datum adopted for Dredging Calculation

The obtained Sounding Datum value is in general agreement with the depths in the river and the details of sounding datum value assigned at different stretches for reduction are as follows:-

Sl. No.	TP	Chainage (km)		Water Level w.r.t MSL (m)	Accepted SD Value w.r.t MSL (m)
		From	To		
01	TP_04	0	0.67	65.343	65.0
02	TP_02	0.67	2.67	66.724	66.4
03	-	2.67	3.7	Dry Stretch of Manimutharu River	67.217
04	-	3.7	4.75		67.661

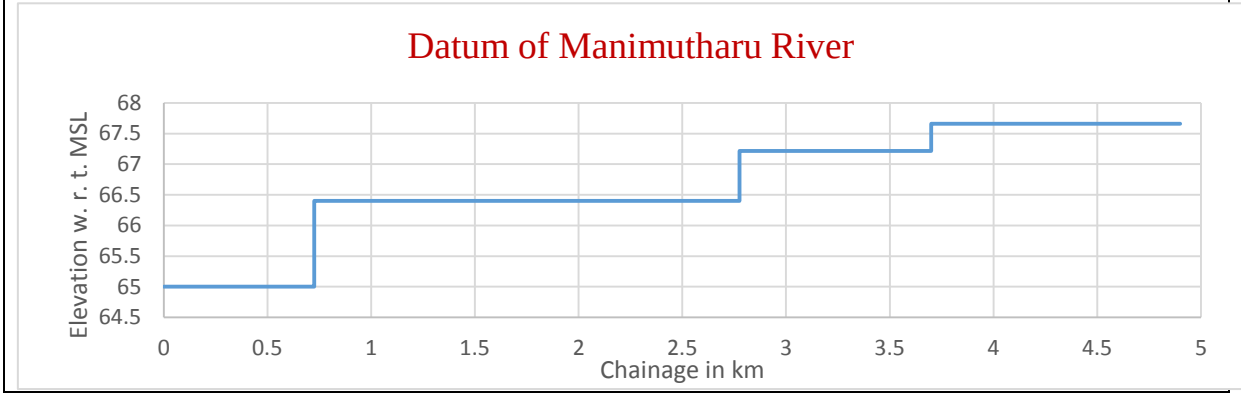


Table 6 - Transfer of Sounding Datum – Manimutharu River

The tide gauges remained vertical for the complete duration of survey and no shift (vertical/ horizontal) was observed in the gauges during the observation period. The gauges were leveled to IWAI-BM-MAN-01/ Local Bench Marks/ Bench Marks set up in the respective stretches. MSL heights of the BM/ LBMs were used to obtain the value of zero of gauge w.r.t MSL. The calculation details of Leveling and Tide poles are placed at Annexure –11 to this report, respectively.

2.7 Table indicating Tidal Variation at Different Observation Points

The survey stretch of the Manimutharu River is non-tidal in nature and no variation is observed during the conduct of survey.

2.8 Salient Features of Dam, Barrages etc

Salient Features of Manimuthar Dam				
Attribute	**Value**		**Attribute**	**Value**
Name of the Dam	Manimuthar Dam		Dam Status	Completed
River	Manimutharu		Purpose	Irrigation
Nearest City	Ambasamudram		Completion Year	1958
District	Tirunelveli		Operating and Maintainance Agency	WRD-TamilNadu
Basin Name	East flowing rivers between Pennar and Kanyakumari		Seismic Zone	Seismic Zone-II
Dam Type	Earthen / Gravity / Masonry		Max Height above Foundation(m)	45.72
Length of Dam (m)	2825		Total Volume content of Dam (TCM)	4582
Type of Spillway	OG		Type of Spillway Gates	VL
Length of Spillway (m)	102		Number of Spillway Gates	7
Crest Level of Spillway	104.55		Size of Spillway Gates (m x m)	12.19 x 4.5
Spillway Capacity (cumec)	1710		Design Flood (cumec)	1699.2

Salient Features of Manimuthar Reservoir				
Attribute	**Value**		**Attribute**	**Value**
Name of Reservoir	Manimuthar Reservoir		Status	Operational
State	Tamil Nadu		Basin	East flowing rivers between Pennar and Kanyakumari
River	Manimuthar			
Maximum Water Level (m)	109.12		Full Reservoir Level (m)	109.12
Minimum Draw Down Level(m)	73.152		Live Storage Capacity(MCM)	159.5018
Gross Storage	159.734		Submergence Area (Th.Ha.)	0.94

Salient Features of Manimuthar Reservoir				
Capacity(MCM)				
Number of Families Affected - Total	858		Catchment Area(Sq.Km.)	161.61

Figure 6 - Salient Features of Manimutharu Dam

Figure 7 - View of Manimuthar Dam

2.9 Erected IWAI Benchmark Pillars

New bench Mark Pillar (IWAI-BM-MAN-01) was constructed as per specification at the mid chainage of the river. The value of these benchmark w.r.t. MSL was obtained by leveling them to the GTS station obtained from Manimutharu Dam Authority. Station description of all Station and bench marks is placed at Annexure-10 to this report. The final accepted co-ordinates and a reduced level (R.L) value of IWAI BM Pillar is as below:

Sl.	Station	Chainage	Latitude (N)	Easting	Ellipsoidal	Height	Height

No.	Name	(km)	Longitude (E)	Northing	Height (m)	above MSL (m)	above SD (m)
1	IWAI-BM-MAN-01	2.67	08°39'56.1469"N 77°25'30.8763"E	766885.069 958733.189	-25.593	71.904	5.504

Table 7 - Accepted coordinates of established IWAI BM Pillar

2.10 Chart Datum / Sounding Datum and Reductions Details

The water availability in Manimutharu River is very less and the spot leveling by topographic method was attempted for the entire survey stretch of Manimutharu River. The tide poles were erected only to find the slope of the river and no bathymetric survey was conducted for Manimutharu River.

Sl. No.	Tide Gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation wrt SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = ((E- Topo Levels in MSL)
1	TP_04	0	0-0.67	65	65	Entire Stretch being dry, tide readings not used for reductions.	Reduced_Level_CD.xyz
2	TP_02	0.67(U/s)	0.67-2.67	66.4	66.4		
3	-	-	2.67-3.7	67.217	-		
4	-	-	3.7-4.75	67.661	-		

Table 8 - CD /SD and Reductions

2.11 HFL/MHWS values of Bridges/Cross Structures

The details of established HFL/MHWS values for the downstream of the Manimutharu Dam is not available with the Manimutharu Dam authorities. The HFL level at Manimutharu Bridge was computed by on-field observation and local input. The details of computed HFL values for the entire stretch is as follows:-

Sl. No.	Location and description of Tide Guage	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	TP_04	-	-0.09	-	68.3
2	TP_02	-	0.67	-	69.7
3	**BM-01**	-	2.67	-	69.7
4	-	Manimutharu Bridge	4.54	-	73.3

Table 9 - HFL/MHWS values of Bridges/Cross Structures

2.12 Graph: Sounding Datum and HFL vs Chainage

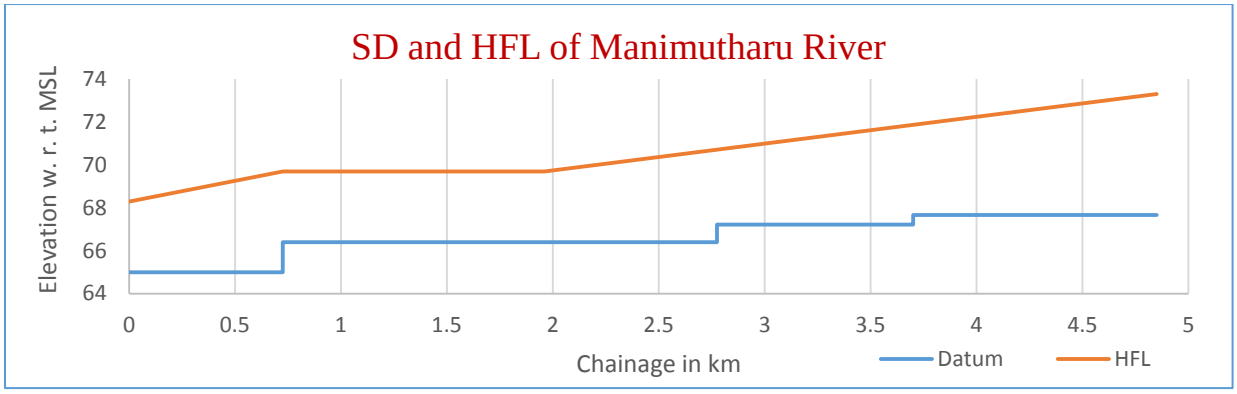


Figure 8 - CD and HFL vs Chainage

2.13 Average Bed Slope

Reach and River-bed Level (RBL)		River-bed Level Change (m) (A)	Distance (km) (B)	Slope (A/B)
From	To			
Ch. 0 - RBL_2.042	Ch. 0.67 - RBL_0.024	2.018	0.67	1 : 3.012
Ch. 0.67 - RBL_0.024	Ch. 2.67 - RBL_0.024	0	2	1 : 0.000
Ch. 2.67 - RBL_0.024	Ch. 4.75 - RBL_0	0.024	2.08	1 : 0.012

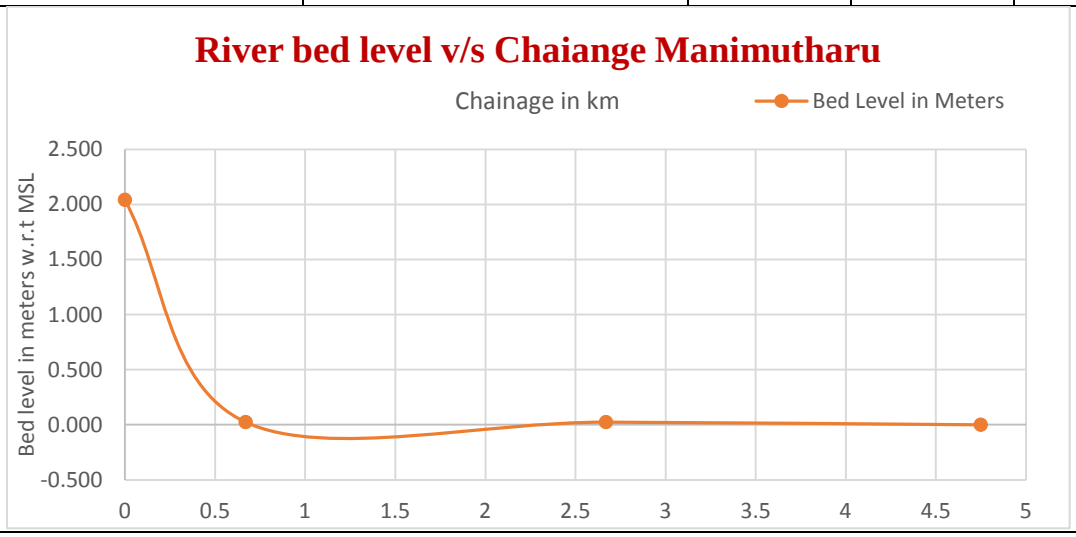


Table 10 - Average Bed Slope

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

There details of dams and check dams present in the survey stretch of Manimutharu River are as follows:-

Sl. No.	Structure Name	Ch. (km)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	Top Elevation w.r.t MSL (m)	Present Condition
				Left Bank	Right Bank	Left Bank	Right Bank				
1	Kanadian Check Dam	-0.06	Aladiur	8°41’4.22”N 77°26’9.17”E	8°41’5.62”N 77°26’4.18”E	768043.36 960833.69	767889.99 960875.06	530	3	65.3	Ops
2	Kothikal Check Dam	0.67	Vairavikulam	8°40’45.39”N 77°26’8.53”E	8°40’39.85”N 77°26’3.65”E	768027.63 960254.04	767879.47 960083.19	227	3	66.7	Ops
3	Zamin Singampatti check Dam	2.67	Zamin Singampatti	8°39'54.60"N 77°25'32.34"E	8°39'53.31"N 77°25'32.70"E	766930.40 958686.68	766941.40 958646.35	41	5	67.4	Ops
4	Manimutharu Dam	4.75	Manimutharu	8°39'8.9801"N 77°24'53.32"E	8°39'16.1688"N 77° 24' 43.46"E	765745.616 957276.154	765442.643 957495.193	2825	7	111.8	Ops

Table 11 - Details of Dam/Barrages

Kanadian Check Dam

Kothikal Check Dam

Zamin Singampati Check Dam

2.15 Details of Locks

There are no locks present in the Manimutharu River.

2.16 Details of Aqueducts

There are no Aqueducts present in the Manimutharu River.

2.17 Details of existing Bridges and Crossings over Waterway

There exist only Manimutharu Bridge in the entire survey stretch of Manimutharu River. The details of existing Bridge and crossing over waterway are as follows.

Sl. No.	Structure Name	Ch. (km)	Location	Position (Lat Long) Left bank / Right Bank	Position (UTM) Left bank / Right Bank	Length (m)	Width (m)	No. of Piers	Horizontal clearance (Dist. Between piers) (m)	Vertical clearance w.r.t .HFL (m)
1	Manimutharu Bridge	4.53	Manimutharu	**Left Bank:** 8°39'16.68"N 77°24'54.53"E **Right Bank:** 8°39'18.872"N 77°24'51.64"E	**Left Bank:** 765781.12 957513.51 **Right Bank:** 765692.384 957579.884	132.88	5.6	24	5.351	0.8

Table 12 - Bridge crossing over waterway

Figure 9 - Manimuthar Bridge (4.53 km chainage)

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

There are no other Cross structures, pipe-lines, under water cables in the survey stretch of Manimutharu River.

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

There are no High Tension Line/Electric line crossing the River.

2.20 Current Meter and Discharge details

Valeport801 velocity meter was used to log the flow rates of the river. On considering the field aspects, additional velocity meter observation were also carried out to the contractual obligation for depicting clear picture on the velocity of the river streams at various locations. The locations of current meter deployment are as follows

Sample No.	Chainage (km)	Position		Observed Depth (m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m)
		Lat/Long	Easting/ Northing (m)		0.5 D			
MAN-01	0.68	08º 40’ 41.70” N 77º 26’ 05.48” E	767934.466 960140.096	1.3	0.047	0.05	33.17	1.659
MAN-02	3.93	08º 39’ 32.50” N 77º 25’ 05.00” E	766098.252 958001.331	0.7	0.031	0.03	46.14	1.392
MAN-03	4.65	08° 39' 15.41" N, 77° 24' 50.19" E	765648.536 957473.296	0.8	0.102	0.10	23.04	2.304

Table 13 - Current meter deployment locations

2.21 Soil and Water Sample Locations

a) Soil Sample Locations

River bed soil and water sampling was undertaken using Vanveen Grab and by deploying sampling bottles at respective locations. The samples were collected at one location each in the river. The details of sampling locations are as follows:

Sample No.	Chainage (km)	Latitude Longitude	Easting Northing (m)	Depth (m)
MAN-01	0.68	08º 40’ 41.70” N 77º 26’ 05.48” E	767934.466 960140.096	1.3
MAN-02	3.93	08º 39’ 32.50” N 77º 25’ 05.00” E	766098.252 958001.331	0.7

Table 14 - Soil Sampling Locations

b) Water Sample Locations

Sample No.	Chainage (km)	Latitude Longitude	Easting Northing (m)	Total Depth (d) (m)	Mid-Depth (0.5d) (m)
MAN-01	0.68	08º 40’ 41.70” N 77º 26’ 05.48” E	767934.466 960140.096	1.3	0.5
MAN-02	3.93	08º 39’ 32.50” N 77º 25’ 05.00” E	766098.252 958001.331	0.7	0.5

Table 15 - Water Sampling of Manimutharu

2.22 Analysis

The collected samples were analyzed for following properties:-

a) Soil Samples
- Grain size
- Specific gravity

- PH Value
- Cu, Cc
- Clay Silt percentage

b) Water samples

- Sediment Concentration

A detailed report on sample analysis is placed at Annexure 13 & 14 to this report.

Figure 10 - Soil &Water Sampling of Manimutharu River

3 Description of Waterway

The Waterway of Manimutharu River within survey limits can be broadly divided in to three stretches in accordance with the gradient of the river. The details are as follows:-

3.1 Sub-Stretch-1: From Kanadian Sipllage to Kothikal Spillage (0.0km to 0.67km)

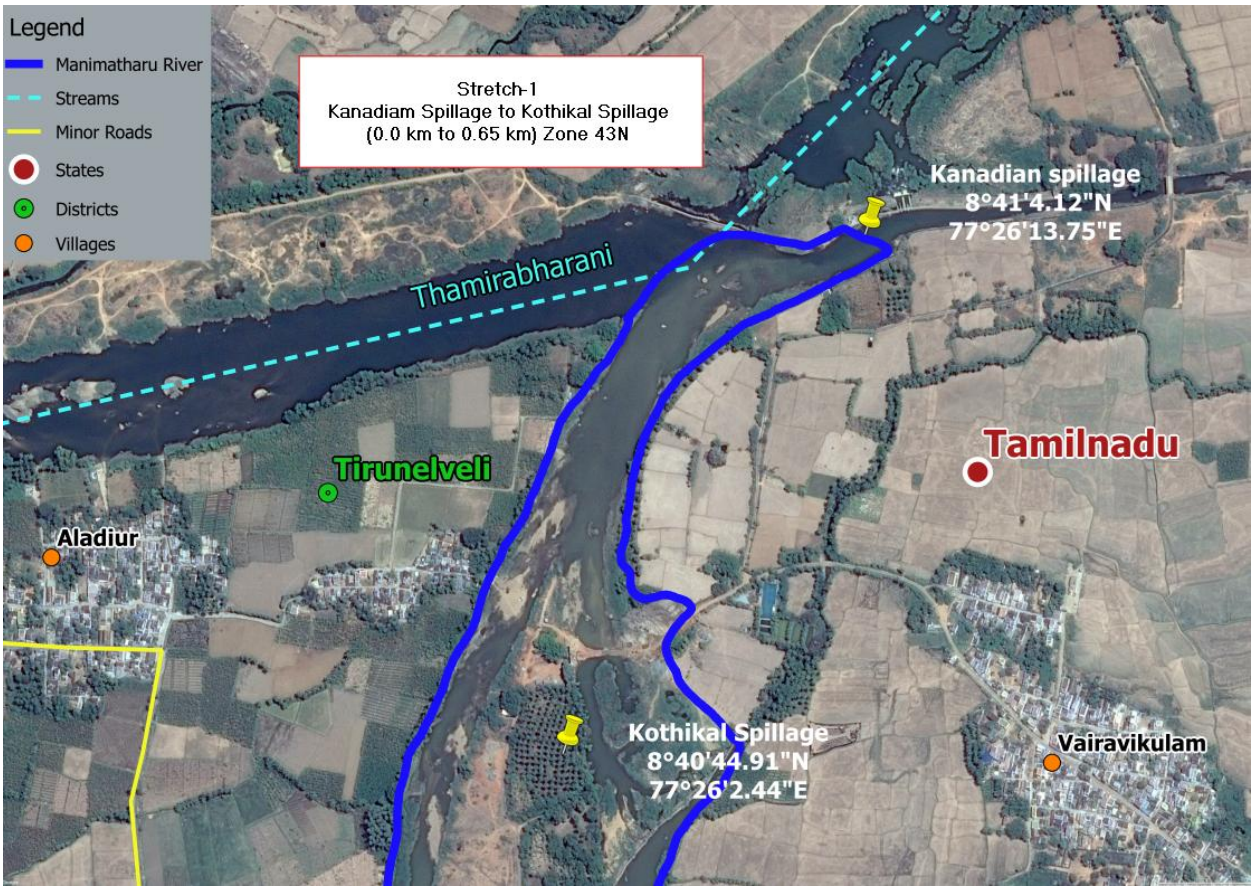


Figure 11 - Stretch-01 Kanadian Sipllage to Kothikal Spillage

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of sufficient water.
- **Topographic Survey**
  b) 0.67km of the length of the stretch for which the topographic survey has been carried out.

This stretch is between 0 to 0.67km chainage of the Manimutharu Dam. It is the Downstream portion of the Manimutharu river where it confluence with the Thamirabarani River. This stretch is considerably wide with some portion of the river bank being protected in nature. There exists many pumping station for drinking water supply for the nearby village. The Kanadian spillage is also diverted to form irrigational canal through the right bank side. The paddy fields in the area largely depend on this irrigational facility for the crops.

There are no overhead obstructions/crossovers in this stretch, however the feasibility survey for proposed new bridge between Vairavikulam and Aladiyur was completed by the Highway authorities. As per the local information the approval for construction of bridge is obtained and may commence the construction jobs as soon as possible.

There are no ferry services on this stretch of Manimutharu River, the Kanadian spillage crust is used by the local peoples for crossing the river by walk. On discussion with PWD-Subsection office (Cheranmadevi), it was told that the District Collector had expressed his interest in developing Kanadian spillage area.

Figure 12 - View of Kanadian Spillage from the RBS (0.0 km chainage)

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	0.67	0	2.518	84	1,310.07	1,310.07	-0.3	2.175	463	4,823.79	4,823.79
II	0	0.67	0	2.518	436	4,366.15	4,366.15	-0.3	2.175	594	11,087.21	11,087.21
III	0	0.67	0	2.518	578	13,254.83	13,254.83	-0.3	2.175	620	25,318.17	25,318.17
IV	0	0.67	0	2.518	610	22,171.32	22,171.32	-0.3	2.175	670	37,374.12	37,374.12

Table 16 - Stretch 1 Dredging Quantity

3.1.1 Observed and Reduced River-bed Profile

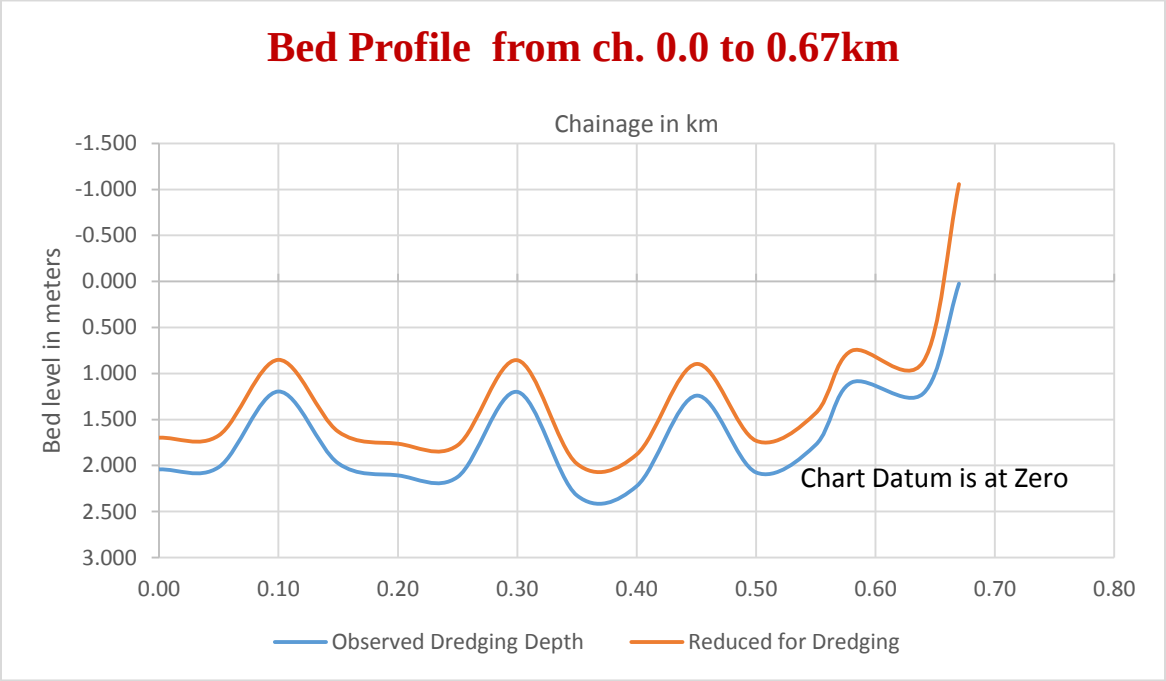


Figure 13 - Stretch 1 River-bed Profile

3.2 Sub-Stretch-2: From Kothikal spillage to Zamin Singampatti (0.67km to 2.67km)

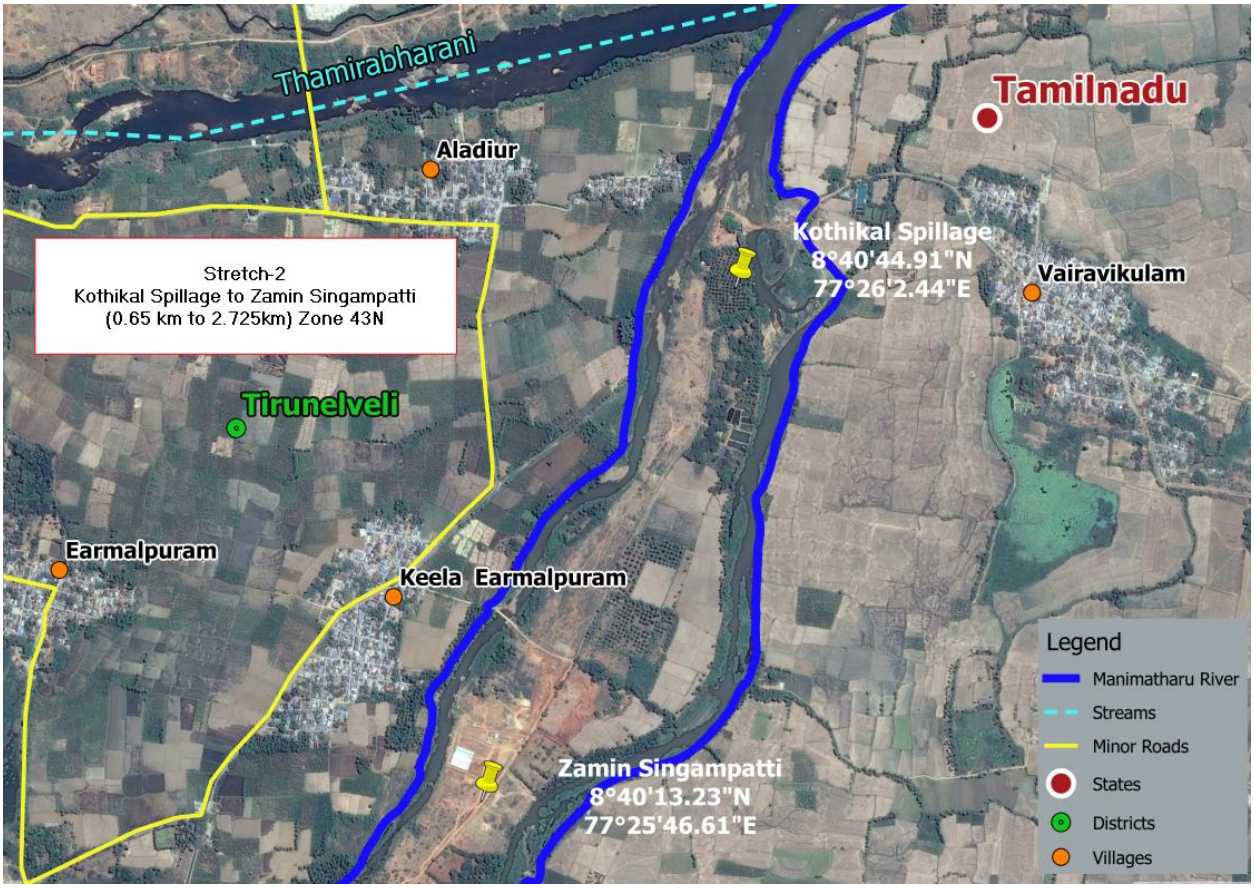


Figure 14 - Stretch-02 Kothikal Spillage to Zamin Singampatti

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of sufficient water.
- **Topographic Survey**
  b) 2.000km of the length of the stretch for which the topographic survey has been carried out.

This is longest stretch of Manimutharu River between the chainage of 0.67km to 2.67km, where considerable amount of water is present. The river banks of this stretch is un-protected in nature but the high rise riverbanks on both sides prevent the flood in the area. The paddy cultivation is very prominent on the area. The coconut trees are also abundant in the river banks.

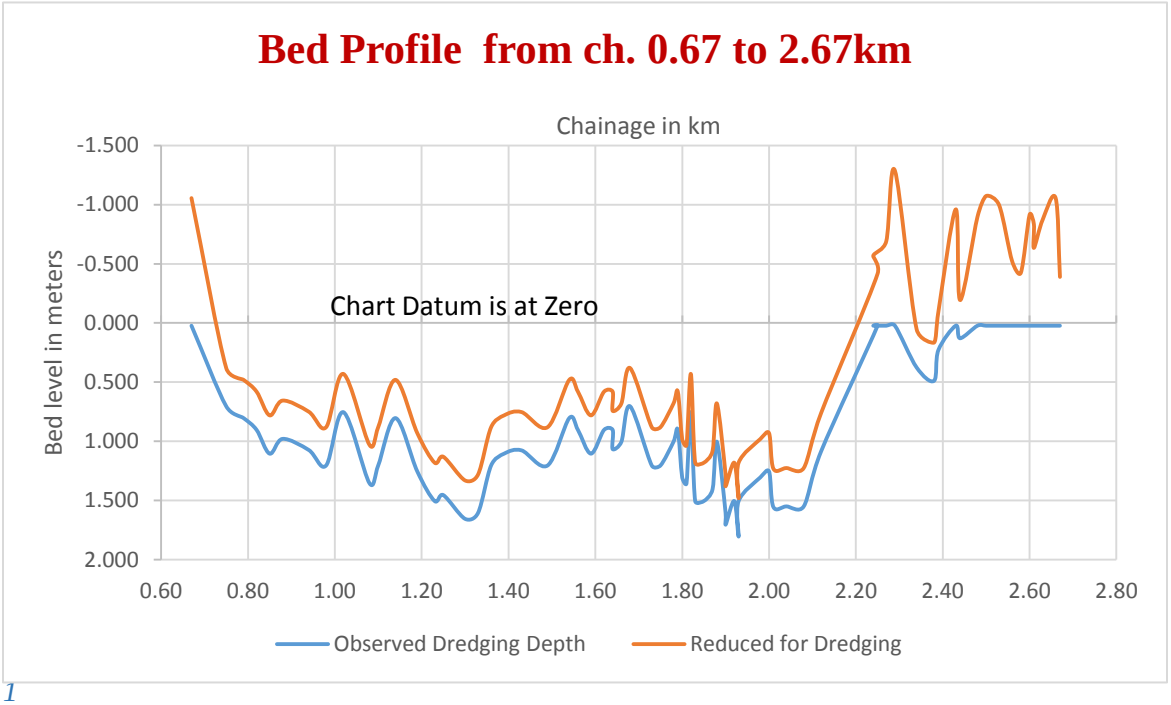
The small scale fish breeding industry is present on the both side of the river and small parasol of FRP made is used by the local people for the transportation of the materials between the river banks.

The Kothikal spillage present in this stretch is also diverted to form another irrigational canal for supply of water for agriculture purpose. There are no overhead obstructions/crossings in this stretch.

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	0.67	2.67	0	2.604	1125	42,499.86	43,809.93	-0.3	2.28	1311	67,224.45	72,048.24
II	0.67	2.67	0	2.604	1420	78,770.85	83,137.00	-0.3	2.28	1546	113,397.34	124,484.55
III	0.67	2.67	0	2.604	1843	140,446.35	153,701.18	-0.3	2.28	1906	184,799.01	210,117.18
IV	0.67	2.67	0	2.604	1950	180,562.71	202,734.03	-0.3	2.28	1990	226,978.64	264,352.76

Table 17 - Stretch 2 Dredging Quantity

3.2.1 bserved and Reduced River-bed Profile



Figur 1

5 - Stretch 2 River-bed Profile

Figure 16 - View of Stretch-02 (1.2 km chainage)

3.3 Sub-Stretch-3: From Zamin Singampatti Check Dam to Manimuthar Dam (2.67km to 4.75km)

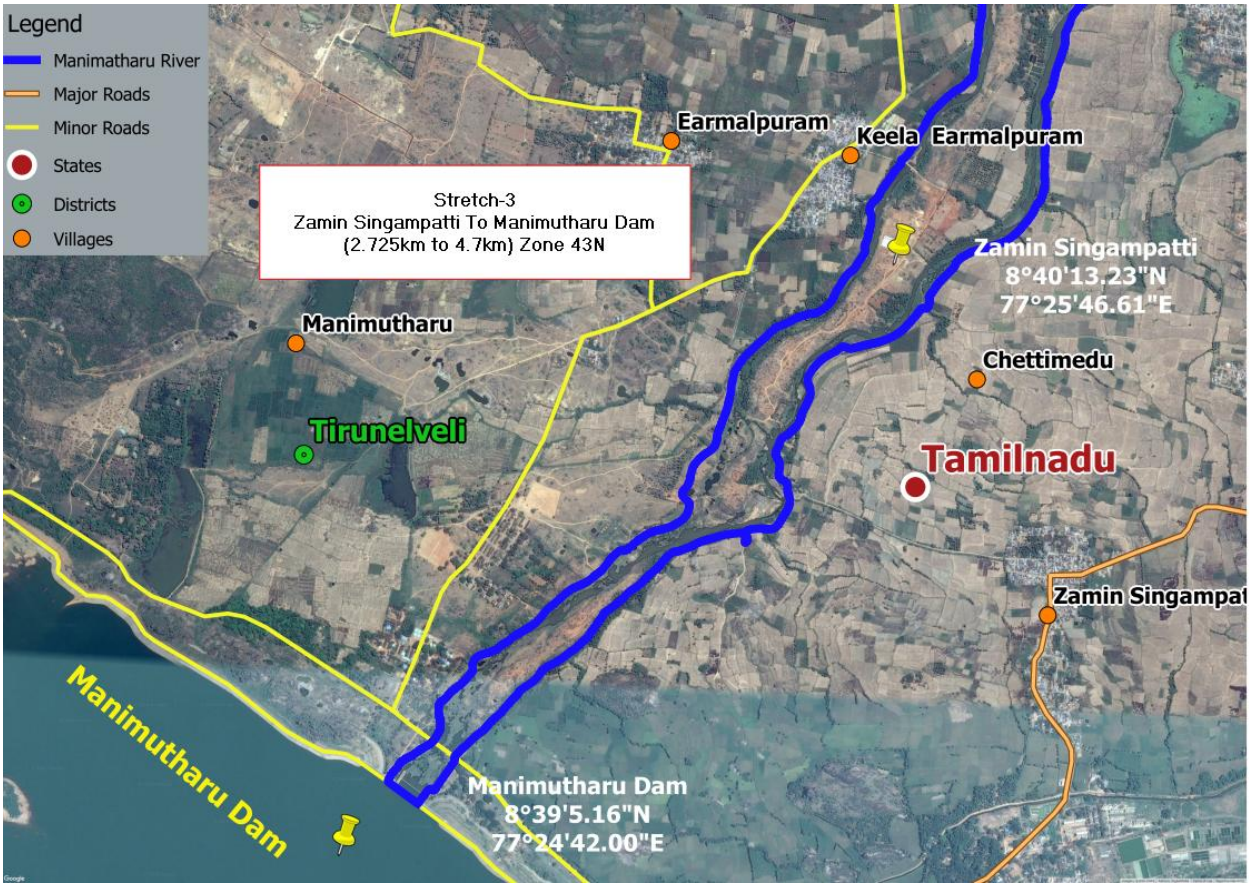


Figure 17 - Stretch-03 Zamin Singampatti check Dam to Manimutharu Dam

- **Bathymetry Survey**
  a) No bathymetric survey is conducted due to the unavailability of sufficient water.
- **Topographic Survey**
  b) 2.080km of the length of the stretch for which the topographic survey has been carried out.

This stretch is part of the upstream area between the river chainage of 2.725km to 4.75km of Manimutharu River. This stretch with gradient nature consists of abundant rock boulders and rocky outcrops throughout the stretch of the river. The center portion of the river bed is significantly raised by the presence of boulders and navigation is not possible in this stretch. The major portions of the river banks are non-protected in nature with some settlement on the LBS of Manimutharu River.

The only overhead obstruction/crossover present in the entire river stretch is the bridge situated near to the Manimutharu Dam. The Manimutharu Dam is one of the tourist attractions of the area.

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	2.67	4.75	0	0	2080	89,131.17	132,941.10	-0.3	0	2080	114,885.17	186,933.41
II	2.67	4.75	0	0	2080	135,875.65	219,012.65	-0.3	0	2080	169,023.56	293,508.11
III	2.67	4.75	0	0	2080	205,703.94	359,405.12	-0.3	0	2080	246,945.12	457,062.30
IV	2.67	4.75	0	0	2080	248,388.55	451,122.58	-0.3	0	2080	291,508.71	555,861.47

Table 18 - Stretch 3 Dredging Quantity

3.3.1 Observed and Reduced River-bed Profile

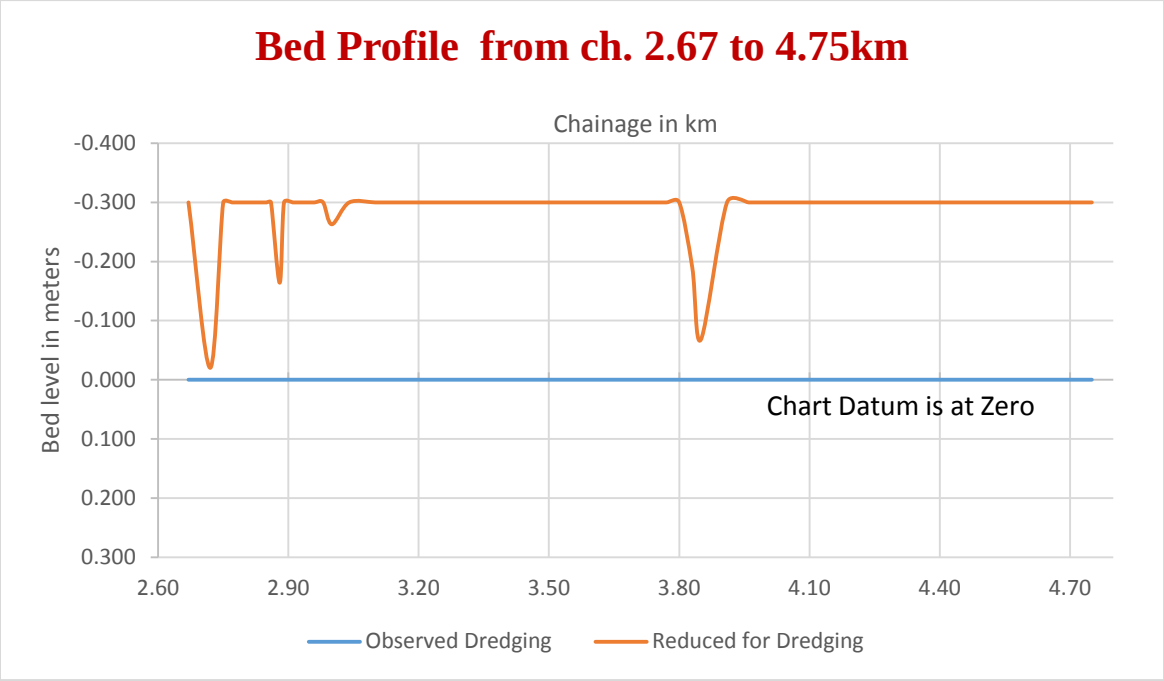


Figure 18 - Stretch 3 River-bed Profile

3.4 Other Aspects of Waterway

3.4.1 Fishing

No fishing activities exist on the entire stretch of the Manimutharu River and no fishing boats are also available at the survey area. The fish breeding center at very small scale is situated near the Vairavikulam area. The fish breeding farms are situated on the either side of river banks, both owned by the single ownership. The fish breeding and sale is also conducted by the dam authorities under state government ownership near to the Manimutharu Dam.

3.4.2 Industries

No Large scale industries exist near to the survey area. The Tamilnadu police Battalion training center is situated near to the Manimutharu Dam.

3.4.3 Crops

The river banks are sparsely spread with coconut trees along with other vegetation on the entire stretch of the river. The paddy cultivation is very prominent for the entire area and these are fine supported by the irrigational system from the Manimutharu River. No other seasonal crops are found in the area.

Figure 19 - Coconut trees on river bank of Manimutharu (2.1 km chaiange)

3.4.4 Settlements

The river banks are sparsely populated and no major town is situated neat to the river banks, however small cluster of settlements forms to be villages are situated near to the survey stretch of the Manimutharu River. Vairavikulam, Zamin Singampetti and Ayan singampetti are situated on the south east side of the river. The villages like Aladiyur, Keela Ermalpuram and Manimutharu are situated on north western side of the river. These villages are well connected with state run transportation system.

3.4.5 Irrigation/Drinking water

The water of Manimutharu River is utilized exclusively for many irrigation projects at various chainage and are also used for pumping of drinking water for the nearby villages.

Figure 20 - Drinking water well on river bank of Manimutharu River

3.4.6 Important Cities/Towns

The towns situated near to Manimutharu are Kallidikurchi and Ambasamudram. These are small towns which are connected with railway line and also frequent state transport buses runs from Thirunelveli Town. Local minivan runs between Kallidakuruchi and Manimutar Dam at frequent interval. Local Taxis and Autos are not available along the entire River stretch, and these can be made available from the nearby towns only.

3.4.7 Transportation

The both sides of the Manimutharu are connected with good road transport network and private vehicles are also available in the nearby area. The public transport buses are operated by Tamilnadu state and the area is well connected with nearby cities. The long trip buses upto Tirunelveli is also operated from Manimutharu Dam.

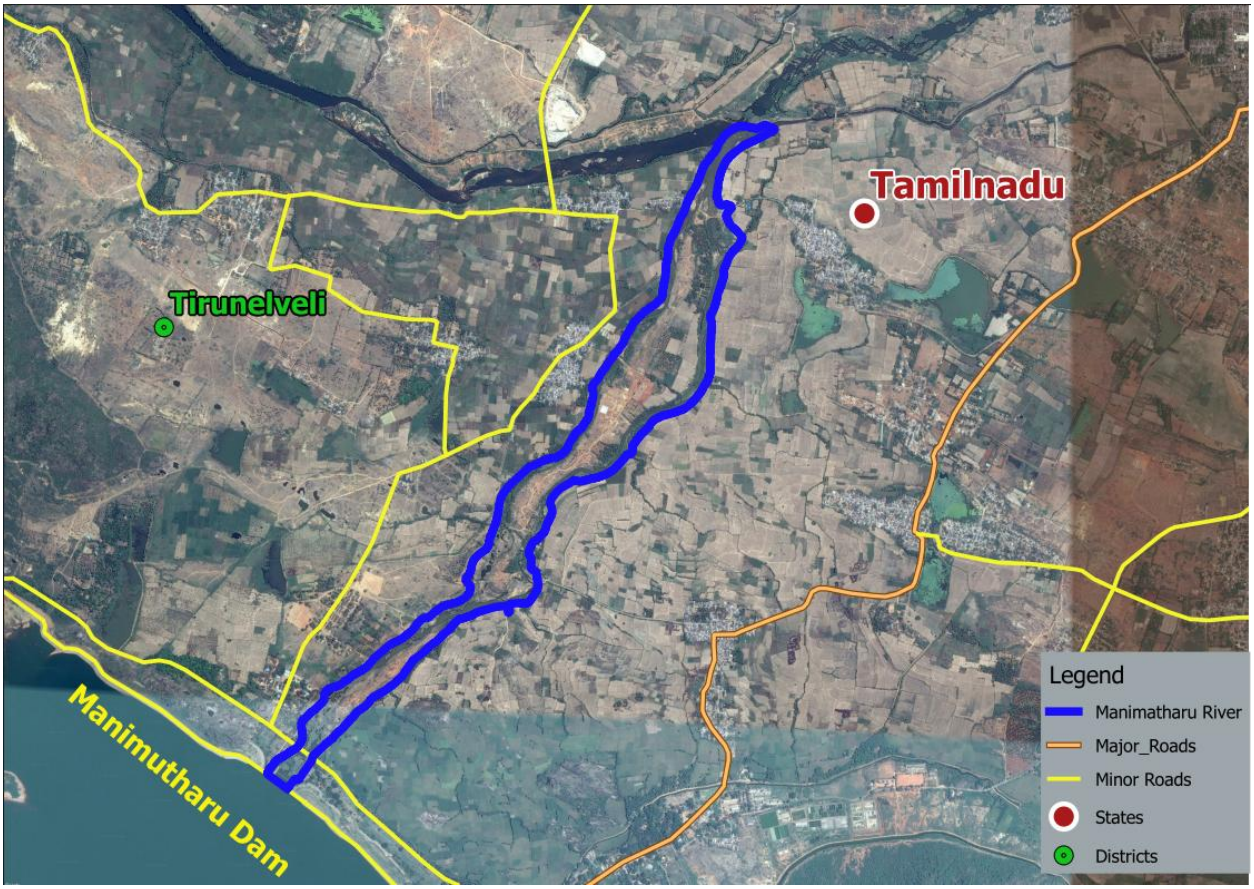


Figure 21 - Road Network

3.4.8 Land Use

The land nearby Manimutharu River is mainly agricultural land. On discussion with the Dam and PWD authorities, there are no major plans for infrastructure development is under consideration for the area near to Manimutharu Dam.

3.4.9 Construction Material

The area being near to Tirunelveli district, all type of modern construction materials like cement, Iron etc. are available in bulk quantity. The large boulders are also available in plenty on the nearby area. The chainages from 0 to 2.7km of Manimutharu River is sandy in nature and small scale of sand mining activities are observed near the 0.75km stretch of the river.

3.4.10 Cargo Movement

There are no industries in the nearby area and no cargo movement or passenger movement is envisaged through this River.

3.4.11 Passenger Ferry Services

Due to the presence of large boulders, rocky outcrops and low depths the navigation aspect is not possible at the upstream areas. The spillage dams are generally used by the local people for crossing the rivers and the water availability in the river is very low and the scope of developing ferry service is also very limited.

3.4.12 Historic importance

The Historical places are not present along the waterway.

3.4.13 Tourism

The Manimutharu Dam is one of the prominent tourist spot. The Kalakad Mundanthurai Tiger Reserve and Manimutharu Waterfalls are located on top of the Manimutharu Dam. Special permission needs to be obtained from forest department for visiting these areas.

The Tea Estates are situated in the Manjolai area. The estates, road and settlements in the Manjolai area are managed by The Bombay Burmah Trading Corporation Ltd.

The Manimutharu Dam is one of the tourist spot which includes the Park and garden on the foot of Dam structure. The area is well connected by the state transport buses from Thirunelveli Town. The state run lodge accommodation is available near to the Manimutharu dam for the tourists on advance booking.

As per the PWD-Subsection office (Cheraimmandevi), it was told that the District collector had expressed his interest to develop the unused premises of PWD works department near to the river as a park and some tourist boats operating in the area limited

to Kanadian Spillage only. The official confirmation could not be obtained in this regard and this plan is not yet finalized by any of the government authorities.

3.4.14 Irrigation Canals and Outlets

The water from Manimutharu is also used for drinking purpose and several pumping stations are present in the Manimutharu River for supply of drinking water to nearby villages. All three spillages present in the Manimutharu River contribute to the water supply for the irrigational canal present in the area. These irrigational canals are used for the supply of water for the paddy field on nearby areas. The details of Irrigational canals are as follows:

Sl. No.	Canals	Chainage (km)	Type	Description
01	Kanadian Canal	-0.5	Outlet Canal	This irrigational canal is situated near the Kanadian Spillage and the water is diverted through the Right bank side on the confluence of Manimutharu and Thamarabharani River. The canal runs through the agricultural lands (mainly Paddy fields) through Kallidakurichi to Cheranmahadevi.
02	Kothikal Canal	0.725	Outlet Canal	This irrigational canal is relatively small and is situated near Kothikal Spillage. The water is diverted through the Right bank side and flows through the agricultural land and ends near Kallidakurichi.

Table 19 - Details of Irrigation Canals

4 Terminals

There are no existing jetties and terminals in the survey stretch of the Manimutharu River. The Manimutharu is only 5km and divided in to 3 stretches on basis of gradient/spillages and with very less possibility for the scope of navigation, the terminals between the stretches are considered not feasible. There is no scope of passenger and cargo movements.

4.1 Proposed Locations for Construction of New Terminals

The locations for Terminal construction on upstream of the Kanadian Check Dam can be considered as feasible locations for operating small boats for tourism purpose.

Sl. No.	Location	Lat	Long	Land Use	Owner
01	Upstream of Kanadian Check Dam	8°41'3.92"N	77°26'9.56"E	Check Dam	Govt. Land (PWD Irrigation)

	This location is under consideration by State PWD office for construction of small terminal for operation of local tourist boats. The feasibility study and approval is still pending from State government authorities.

Table 20 - Details of Terminal Construction

5 Fairway Development

The Manimutharu River is small stretch of 4.75km with boulders and rocks on the major portion of upstream of the survey stretches. The river flows with no major sharp curves or deviation of river stream in down streams.

5.1 Design Channel of the Waterway

Improvement measures for design and depth improvement is required on first phase of the development. River banks being very prominent and less availability of water, no signs of erosion of river banks are found in the entire stretch of Manimutharu River. No major alteration in design possible for Manimutharu River due its importance in agricultural motive.

5.2 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-II channel with dimension 40m width, 1.4m depth and side slop of 1:5 is shown below.

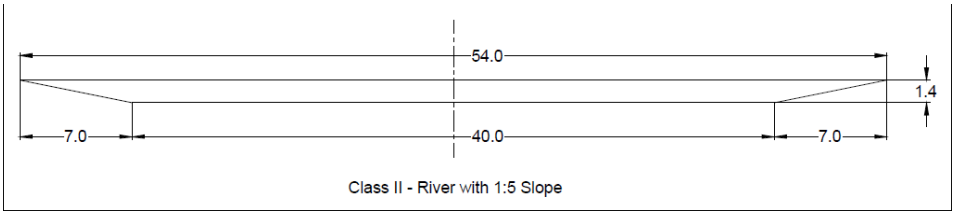
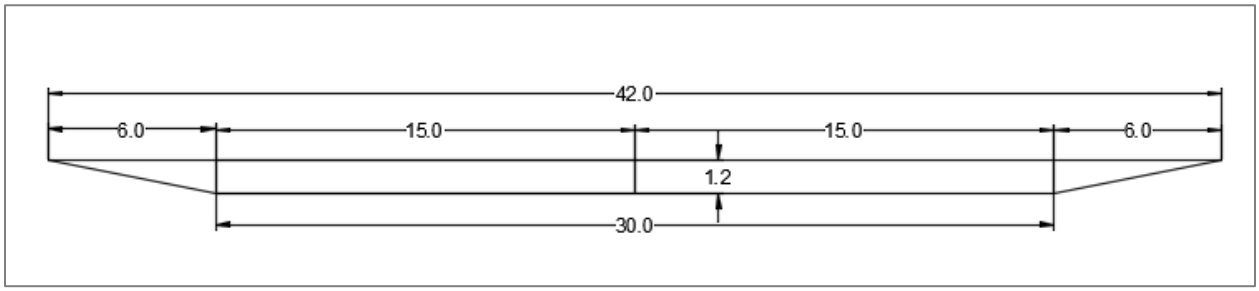


Figure 22 - Fairway Channel Dimensions

5.3 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 dredge volume for different class of fairway is as follows:-

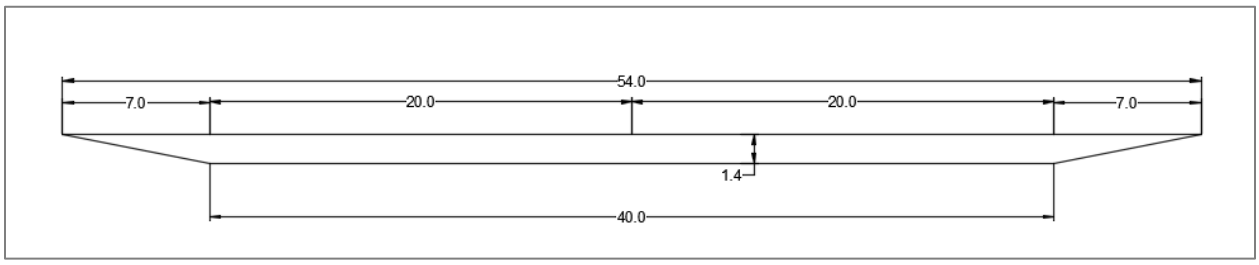
Class I



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.
Kanadian Sipllage	Kothikal Spillage	0	0.67	0	2.518	84	1,310.07	1,310.07	-0.3	2.175	463	4,823.79	4,823.79
Kothikal Spillage	Zamin Singampatti	0.67	2.67	0	2.604	1125	42,499.86	43,809.93	-0.3	2.28	1311	67,224.45	72,048.24
Zamin Singampatti	Manimutharu Dam	2.67	4.75	0	0	2080	89,131.17	132,941.10	-0.3	0	2080	114,885.17	186,933.41
					Total	**3289**	**132,941.10**	**132,941.10**		**Total**	**3854**	**186,933.41**	**186,933.41**

Table 21 - Dredge Volumes Class-I

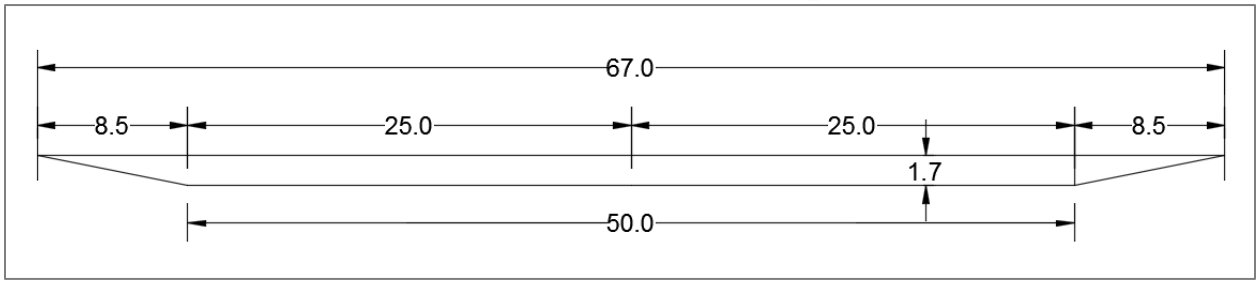
Class II



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.
Kanadian Sipllage	Kothikal Spillage	0	0.67	0	2.518	436	4,366.15	4,366.15	-0.3	2.175	594	11,087.21	11,087.21
Kothikal Spillage	Zamin Singampatti	0.67	2.67	0	2.604	1420	78,770.85	83,137.00	-0.3	2.28	1546	113,397.34	124,484.55
Zamin Singampatti	Manimutharu Dam	2.67	4.75	0	0	2080	135,875.65	219,012.65	-0.3	0	2080	169,023.56	293,508.11
					Total	**3936**	**219,012.65**	**219,012.65**		**Total**	**4220**	**293,508.11**	**293,508.11**

Table 22 - Dredge Volumes Class-II

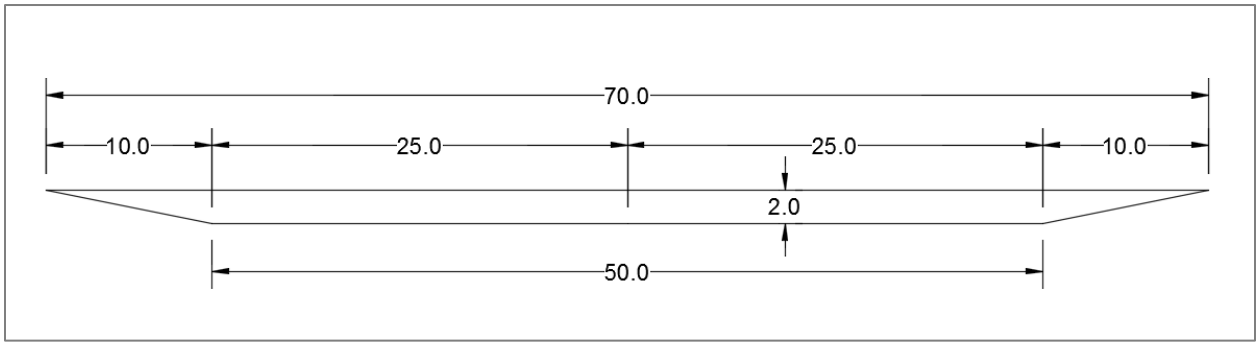
Class III



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.
Kanadian Sipllage	Kothikal Spillage	0	0.67	0	2.518	578	13,254.83	13,254.83	-0.3	2.175	620	25,318.17	25,318.17
Kothikal Spillage	Zamin Singampatti	0.67	2.67	0	2.604	1843	140,446.35	153,701.18	-0.3	2.28	1906	184,799.01	210,117.18
Zamin Singampatti	Manimutharu Dam	2.67	4.75	0	0	2080	205,703.94	359,405.12	-0.3	0	2080	246,945.12	457,062.30
					Total	**4501**	**359,405.12**	**359,405.12**		**Total**	**4606**	**457,062.30**	**457,062.30**

Table 23 - Dredge Volumes Class-III

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.
Kanadian Sipllage	Kothikal Spillage	0	0.67	0	2.518	610	22,171.32	22,171.32	-0.3	2.175	670	37,374.12	37,374.12
Kothikal Spillage	Zamin Singampatti	0.67	2.67	0	2.604	1950	180,562.71	202,734.03	-0.3	2.28	1990	226,978.64	264,352.76
Zamin Singampatti	Manimutharu Dam	2.67	4.75	0	0	2080	248,388.55	451,122.58	-0.3	0	2080	291,508.71	555,861.47
					Total	**4640**	**451,122.58**	**451,122.58**		**Total**	**4740**	**555,861.47**	**555,861.47**

Table 24 - Dredge Volumes Class-IV

6 Conclusion

The aim of the survey undertakes a 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.

6.1 Description of Waterways

The surveyed stretch of Manimutharu River is 4.75km non-tidal stretch from Manimutharu Dam to confluence with Tamaraparani River and was not explored for any navigational possibility in earlier time. This survey stretch starts from the Manimutharu dam and finally confluence with Thamirabarani River. The Manimutharu River is being extensively used for irrigation and drinking water purpose.

The only bridge of permanent nature present in the survey stretch of Manimutharu Dam is with minimum clearance of 0.8 mtr vertical and 5.3 mtr horizontal clearances. The feasibility survey for proposed new bridge between Vairavikulam and Aladiyur was completed by the Highway authorities.

The Kallidikurchi and Ambasamudram are the major towns situated near the survey stretch. The Manimutharu Dam is present on the upstream (4.75 km chainage) of Survey stretch and 03 check dams in the survey stretch are used for irrigation purpose. There are no aqueducts present in the survey stretch of Manimutharu dam. 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 (m)		Average Width (m)	Average Slope (in m/km)
	From	To	From	To	Min	Max		
1	Kanadian Spillage	Kothikal Spillage	0	0.67	54.76	180.31	109.68	1 : 3.100
2	Kothikal Spillage	Zamin Singampatti	0.67	2.67	21.58	159.65	52.85	1 : 0.706
3	Zamin Singampatti	Manimutharu Dam	2.67	4.75	8.06	259.34	64.14	1 : 2.234

Table 25 - Stretch wise Average width and slope of waterway

6.2 Condition of River bed

The river bed of Stretch 01 and 02 is mainly sandy in nature with isolated incident of small scale and conventional sand mining by the local peoples. The stretch 03 the river bed is rocky in nature with steep gradient. The river banks of entire stretch are covered with dense vegetation and beyond that paddy cultivation is prominent in the area. No specific level of encroachment was observed in the river banks of Manimutharu River.

The water flow of the Manimutharu River is not obstructed for the entire stretch other than the assigned spillage barriers.

6.3 Methods for making Waterway Feasible

Improvement measures for design and depth improvement is required on first phase of the development. River banks being very prominent and availability of water on all seasons the stretches from 0 to 2.7km waterway may be developed as a Class III waterway. Due to presence of large boulders and step gradient on the stretches from 2.7 to 4.75km the navigation feasibility is very limited in these stretches. The class-wise details of reduced dredging quantities of the waterways are as tabulated below:-

Reduced Dredging Values w.r.t. CD				
Class	**0 - 0.67 (km)**	**0.67 - 2.67 (km)**	**2.67 - 4.75 (km)**	**Total**
I	4,823.79	67,224.45	114,885.17	**186,933.41**
II	11,087.21	113,397.34	169,023.56	**293,508.11**
III	25,318.17	184,799.01	246,945.12	**457,062.30**
IV	37,374.12	226,978.64	291,508.71	**555,861.47**

Table 26 - Class-wise Reduced Dredging quantity

There are no major industries existed in the nearby area, hence a large and consistent amount of cargo movement is not expected through this River. No cargo movement or passenger movement is envisaged through this River, hence no scope for construction of New Terminals. The riverbanks are moderately connected with roads and other infrastructures. The settlements are sparsely distributed on the river banks and the construction of bridge between Vairavikulam and Aladiyur is expected to be commenced, hence daily commutation of passengers is also a rare possibility. 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	0.67	0.14	21%	0.323	48%	0.131	20%	0.026	4%	0.05	7%
2	0.67	2.67	1.311	66%	0.235	12%	0.36	18%	0.084	4%	0.01	1%
3	2.67	4.75	2.08	100%	0	0%	0	0%	0	0%	0	0%
Total			**3.531**	**75%**	**0.558**	**12%**	**0.491**	**10%**	**0.11**	**2%**	**0.06**	**1%**

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

6.4 Modifications/ improvement Measures

The Manimutharu River is North-Eastern flowing river with no major sharp curves or deviation of river stream. A major capital dredging for improvement of depth and channel design will be required to make the part of Manimutharu River as navigable.

The Design of the waterway cannot be altered to a major extent as this is used mainly for irrigation purpose and drinking water supply. All spillage dams are used for irrigational purpose, and the water through the side way canals are used at large extent for paddy cultivation lands, thus detailed study on the impact of any change in the channel design needs to be carried out for the entire stretch of Manimutharu River. 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	1	1	0	0
II	1	1		
III	1	1		
IV	1	1		

Table 28 - Bridges and HTL Clearances less than Class no.

6.5 Recommendation

There is no major scope for navigational aspect of the waterway due to its geographic condition and the non-availability of any possible ferry service and cargo movements through the river. If adequate depth and width is maintained with bank protection measures, the area upstream of Kanadian Spillage can be developed for tourism activities. Due to presence of large boulders and steep gradient on the stretches from 2.7 to downstream of Manimuthar Dam, the navigation feasibility is very limited in these stretches. No scope for the future development of the River is recommended for navigational purpose and the survey Stretch is not-viable for development as navigable channel.

The propose of the survey was for assessing the river stretch from Manimutharu Dam to confluence with Tamaraparani River near Aladiur for proposed new national waterways of India (NW-69). The areas have been adequately spot leveled and 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