Preface

India is the largest peninsula in the world with a coastline of about 7517 km with 12 major ports and 185 non major / intermediate ports with a very impressive water network consisting of rivers, lakes, creeks and canals.

An efficient transport sector is vital for development of the economy to stimulate optimum competitive business environment. Indian transport system comprises various modes, viz. Railways, Roadways, Inland Waterways, Coastal Shipping and Airways. Integrated development of waterways can generate waterway grid that may in future help shift cargo traffic from road transport to the cheaper and eco-friendly inland waterways.

The first national waterways were established in India in mid 1980s & 1993 with a combined length of 2,716 km:

NW 1 (1620 km): Ganga - Bhagirathi- Hooghly river system between Haldia & Allahabad declared as National waterway in 1986

NW 2 (891 Km): Brahmaputra River between Bangladesh Border and Sadiya declared as National waterway in 1988

NW 3 (205 km): West coast canal (168 km) - Udyogmandal canal (23 km) - Champakara canal (14 km) declared as National waterway in 1993

The government also declared the following two inland waterways as national waterways during 2008:

NW 4 (1078 km): Kakinada-Pondicherry canal - Godavari and Krishna rivers

NW 5 (588 km): East Coast Canal - Brahmani River and Mahanadi delta

Given the untapped potential of India's inland waterways, the Govt. of India desires to explore the commercial navigation potential on year round basis. Ministry of Shipping (MoS), Govt. of India has directed Inland Waterways Authority of India (IWAI) to identify the viable waterways in India for their phased development.

Accordingly, to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation,
National waterway act, 2016 has received the assent of the President on the 25th March, 2016 declaring a total of 111 National Waterways.
IWAI, a statutory body under MoS, Govt. of India, has entrusted WAPCOS with the responsibility for preparation of two stages DPR of proposed six waterways in Tamilnadu and Andhra Pradesh: **National waterway No's 55 (Kaveri Kollidam), 75 (Palar), 77 (Pazhyar), 79 (Pennar), 80 (Ponniyar) and 99 (Tamaraparani)** for a total length of 763 km.

This Final Feasibility report (Stage-I) covers the review of data, reconnaissance survey, preliminary traffic and market analysis and navigation development feasibility for Palar river. The consultant team has physically visited the 141 km river stretch and gathered all requisite information.

Acknowledgement

This Final Feasibility report (stage-1) is the outcome of review of existing infrastructure along the Palar River, present state of affairs and the probability of development as Inland waterway. This vision is shared jointly by IWAI and WAPCOS Limited.

This report gives the present status of water ways assets, topographic features, climatic variability, land use / land cover pattern, details of all cross structures, socio-economic information of the waterways and the feasibility of its development for navigation as per classification by Govt. of India (Gazette Notification).

We, WAPCOS project team acknowledge Cdr. P. K. Srivastava, Hydrographic Chief, Inland Waterways Authority of India; Sh Rajiv Singhal, AHS for constant encouragement and guidance, technical discussions and for evincing keen interest in the project and this report.

WAPCOS Team

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List of Abbreviations

ATT	Admiralty Tide Table
BM	Bench Mark / Local Reference Level
CH	Chainage
CM	Central Meridian
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
CVT	Calibration, Verification & Test
DF	Dual Frequency
DGPS	Differential Global Positioning System
DPR	Daily Progress Report
GPS	Global Positioning System
HFL	Highest Flood Level
HC	Horizontal Clearance
HSE	Health, Safety and Environment
kHz	kilohertz
km	kilometer
m	meter
mmtpa	million metric tons per annum
MN	million
m/s	meter per second
ms	milliseconds
MSL	Mean Sea Level
MHWS	Mean High Water Spring
PWD	Public Works Department
QA/QC	Quality Assurance / Quality Control
QMS	Quality Management System
Rev	Revision
Rep.	Representative
SBES	Single Beam Echo sounder
SD	Standard Deviation
Sr	Senior
UTM	Universal Transverse Mercator
VC	Vertical Clearance
WGS	World Geodetic System

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SUMMARY – SALIENT FEATURES AT A GLANCE

Sr. No.	Particulars	Details
1.	Name of Consultant	**WAPCOS Limited**
2.	Cluster number and State(s)	Cluster-5, Tamil Nadu
3.	Waterway stretch, NW	141 km length of the river from rail bridge at Virudampattu, Vellore to confluence with Bay of Bengal at Sadurangapattinam **(National Waterway 75)**
4.	Navigability status	
a)	Tidal & non-tidal portions (from…to, length, average tidal variation)	From the analysis of survey of India toposheets for the coastal zone, it was found that the tidal reach of the river is small 1-2 km. The Nearest Port is Chennai. The tidal variation between MLLW springs (0.1) and MHW springs (1.10) is 1.0 m. Source: Admiralty Tide Table (ATT) Vol-3 for the nearest Chennai Port.
b)	LAD status (w.r.t. CD) Survey period (Feb to March 2016)	Since the river remains dry throughout the year and has a very less Water availability, that too for Very short duration (about 18 days in a year).
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)	An old dam (not in use) was observed at Lat. 12°52‟28.44”N, Long 79°22‟20.21”E at CH 110.460. None of the existing Check Dams have navigational lock. 21 existing bridges, 3 under construction bridges between chainage 3.5 to 141 km V.C. for bridges varies from 0.5m to 4m. H.C. for bridges varies from 6m to 35m. 13 HT lines between chainage 8 to 130 km V.C. varies from 3 m to 6 m. H.C. varies from 150m and 800m.
d)	Avg discharge & no. of days	**No of Gauge Stations:** One (Arcot) **Arcot** June to August 0 to 3 m^3/s September to December 15 to 60 m3/s January to May 5 to 2 m^3/s

<table>
<tr><td>e)</td><td>Slope (1 in ….)</td><td colspan="2"><table>
<tr><th colspan="2">Reach</th><th rowspan="2">River Bed Level Change</th><th rowspan="2">Distance</th><th rowspan="2">Slope</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td>Avarankuppam
RBL 365.73 m</td><td>Arcot
RBL 158.07 m</td><td>207.66 m</td><td>99.11 km</td><td>1/477</td></tr>
<tr><td>Arcot
RBL 158.07 m</td><td>Mouth
RBL 0.0 m</td><td>158.07 m</td><td>114.35 km</td><td>1/723</td></tr>
</table></td></tr>
<tr><td>f)</td><td>Consultant’s inference</td><td colspan="2">The present stretch of 141 km of Palar River is Not Feasible for Inland Navigation due to:
Hydraulic Conditions: Remains dry throughout the year, Very less Water availability, that too for Very short duration (18 days in a year)
Traffic Studies and Market Analysis: No potential cargo and passenger traffic.</td></tr>
<tr><td>5.</td><td><u>Traffic Potential</u></td><td colspan="2"></td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td colspan="2">Cargo
There does not exist any possibility of shifting cargo from Chennai port. No potential exists for river movement. Hence, It is commercially not viable to shift to waterways

Ferry services
There are no passenger ferry services along Palar River.

Tourism
A lot of temples, tourist sites including Vellore Fort, Jain Temple etc. are situated nearby Palar River.</td></tr>
<tr><td>b)</td><td>Important Industries within 50 km</td><td colspan="2">Kancheepuram, Vellore and Tiruvannamalai have several industries. Out of these, the leading industries in terms of total production are textile, leather, handloom, silk weaving and rice mills. Chennai port is located at about 75 km from the River.</td></tr>
<tr><td>c)</td><td>Distance of Rail & Road from industry</td><td colspan="2">Various Industries at Kancheepuram and Vellore are located at a distance of about 5 km to 65 km from the river.</td></tr>
<tr><td>6.</td><td>Consultant’s recommendation for going ahead with Stage-II (DPR preparation)</td><td colspan="2">Presently, Govt. of Andhra Pradesh has started studies to divert the flood water of Godavari River to Palar and Pennar Rivers. Till these studies get completed and unless a big dam/reservoir is constructed over Palar River, it is not feasible for navigation. Hence, it is not recommended for Stage II.</td></tr>
<tr><td>7.</td><td>Any other information/ comment</td><td colspan="2">-----</td></tr>
</table>

1. About the Studies

M/s Inland Waterways Authority of India (IWAI), a statutory body under ministry of shipping, Govt. of India, has entrusted WAPCOS with the responsibility for preparation of two stage DPR for 6 national waterways of rivers Pennar, Kaveri Kollidam, Palar, Pazhyar, Ponniyar, Tamaraparani in Tamilnadu and Andhra Pradesh. The approximate lengths of all six national waterways are given in the table below:

Sl. No.	Name of the River / Canal	Description of Inland Waterway	From:	Upto:
1.	Pennar River, Andhra Pradesh	29 km length of the river from Penna Barrage, Pothireddypalem to confluence with Bay of Bengal near Kudithipalem (National Waterway 79)	14°28'8.38"N, 79°59'9.31"E	14°35'36.75"N, 80°11'30.61"E
2.	**Palar River, Tamilnadu**	**141 km length of the river from rail bridge at Virudampattu, Vellore to confluence with Bay of Bengal at Sadurangapattinam (National Waterway 75)**	**12°56'14.07"N 79° 7'29.70"E**	**12°27'52.16"N, 80° 9'13.47"E**
3.	Ponniyar River, Tamilnadu	125 km length of the river from Sathanur Dam to Cuddalore at confluence of Bay of Bengal (National Waterway 80)	12°11'0.06"N, 78°51'1.25"E	11°46'21.76"N, 79°47'41.70"E
4.	Kaveri Kollidam, Tamilnadu	364 km length of the river from Uratchikottai Barrage to confluence with Bay of Bengal at Pazhaiyar (National Waterway 55)	11°29'3.09"N 77°42'13.68"E	11°21'37.97"N7 9°49'53.23"E
5.	Tamaraparani River, Tamilnadu	64 km length of the river from Sulochana Mudalir bridge, Tirunelveli to confluence with Bay of Bengal near Punnaikayal (National Waterway 99)	8°43'43.17"N, 77°42'53.94"E	8°38'24.90"N, 78° 7'37.85"E
6.	Pazhyar River, Tamilnadu	20 km length of the river from Bridge near Veeranarayana Mangalam village to confluence with Arabian Sea at Manakudi (National Waterway 77)	8°13'48.97"N 77°26'27.34"E	8°5'15.01"N 77°29'7.61"E

Table 1: National Waterways in Tamilnadu and Andhra Pradesh

The Google Map showing all river stretches is enclosed as **Figure 1**.

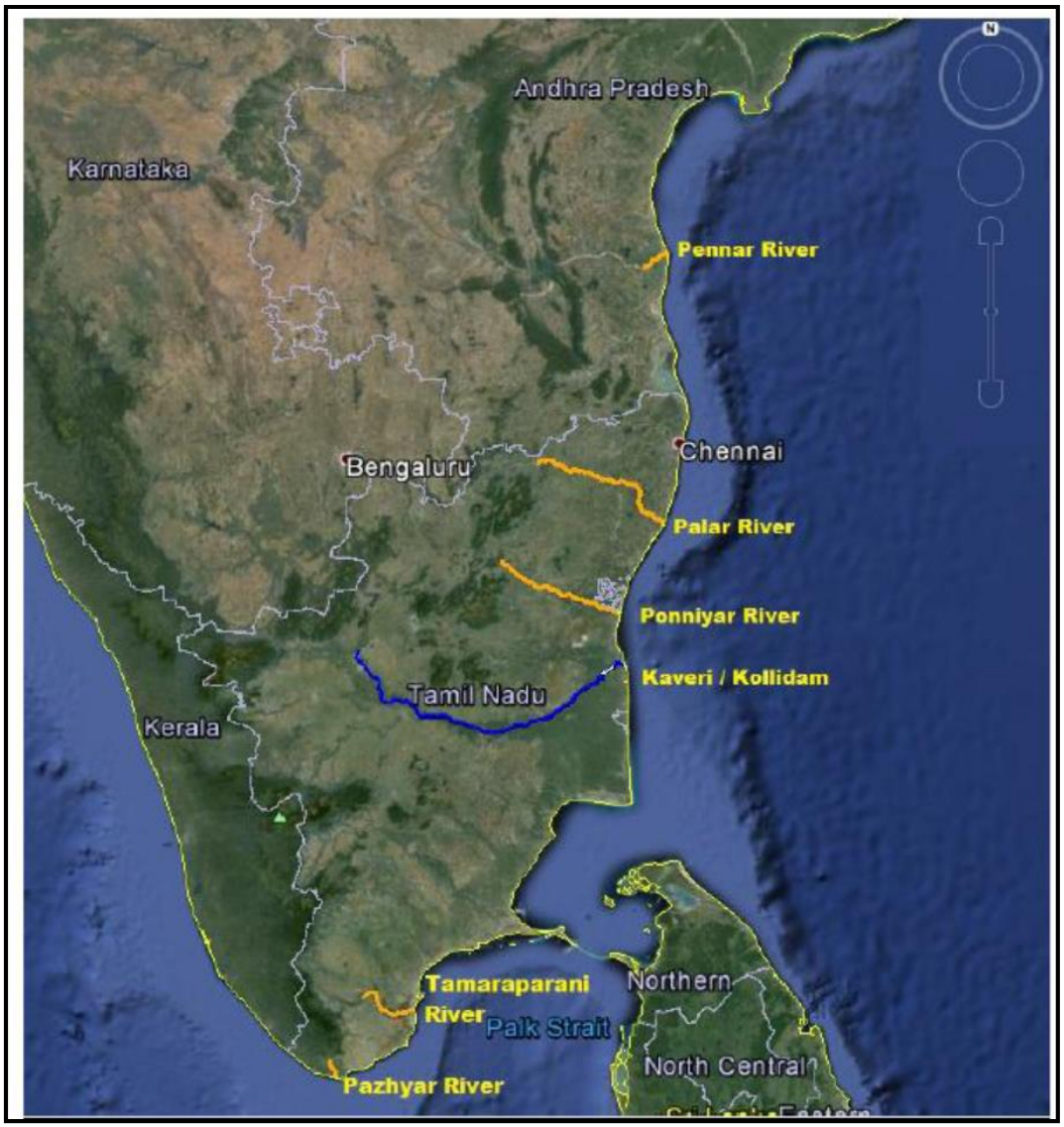


Figure 1: Google Map showing six rivers in Andhra Pradesh & Tamilnadu

Accordingly, WAPCOS Ltd. has undertaken the studies for 6 national waterways (Pennar, Kaveri Kollidam, Palar, Pazhyar, Ponniyar and Tamaraparani) in Tamilnadu and Andhra Pradesh. The brief scope of work is depicted as under:

Stage-1

A. Reconnaissance Survey

B. Collection and Review of available data

C. Feasibility Report

Stage-2

A. Hydrographic Survey & Hydro-morphological survey

B. Traffic Survey & Techno economic feasibility

C. Preparation of Detailed Project Report

The present studies are limited to establish the feasibility of waterways for Inland navigation i.e. up to Stage 1 only**.**

The present **Final Feasibility Report** covers the review of data, reconnaissance survey, present state of affairs, traffic analysis, possible navigable stretches for Palar River as detailed below:

- ✓ **Introductory Considerations,**
- ✓ **Classification of waterways**
- ✓ **Details of existing structures**
- ✓ **Reconnaissance survey & site visit**
- ✓ **Single Line Longitudinal Survey**
- ✓ **Bed Profile**
- ✓ **Soil Texture**
- ✓ **Hydrological Data collection and analysis**
- ✓ **Preliminary Traffic studies and Market analysis**
- ✓ **Results and feasibility of waterways**

2. Introductory Considerations

As discussed in previous chapter, Cluster 5 consists of six rivers in the states of Tamilnadu and Andhra Pradesh. This chapter covers the introductory considerations, origin, hydrological parameters like altitude, length, catchment area, Annual rainfall, major dams, and barrages along the river, tributaries, and major cities along their bank, historical and religious places for Palar River.

2.1 Name of River: Palar

2.2 Length of River

The total length of the river from origin to its outfall in the Bay of Bengal is about 348 km. The length under present studies is detailed below:

141 km length of the river from rail bridge at Virudampattu, Vellore to confluence with Bay of Bengal at Sadurangapattinam (National Waterway 75)	**From: 12°56'14.07"N 79° 7'29.70"E**	**Up to: 12°27'52.16"N, 80° 9'13.47"E**

2.3 State, District through which river passes

The total length of this East flowing river from its origin to its outfall into the Bay of Bengal is about 348 Km. The river Palar passes through Kolar district of Karnataka, before entering the Chittoor District of Andhra Pradesh, through which it enters the Vellore District of Tamil Nadu finally discharging into Bay of Bengal near Kuvattur.

The main towns in the vicinity of Palar River are Tirukalukundram, Chengalpattu, Maduranthakam, Cheyyur, Uthiramerur, Kanchipuram, Arcot, Arakonam and Cheyyar in its 141 km stretch.

2.4 Maps

A Map showing entire Palar basin (Source: CWC) and Present study stretch is attached as Figure 2 & Figure 3 respectively.

2.5 River Characteristics

2.5.1 River Course

The river Palar rises beyond Talagvare village in the Kolar district of Karnataka. The flow is generally in the South-Easterly direction to Kolar District of Karnataka, before entering the Chittoor District of Andhra Pradesh, through which it enters the Vellore District of Tamil Nadu finally discharging into Bay of Bengal near Kuvattur (refer Figure 2 & Figure 3).

2.5.2 River Basin (Catchment Area)

The Palar drains an area of 17,871 Sq.Km out of which nearly 57 percent lies in Tamil Nadu and the balance in the states of Karnataka and Andhra Pradesh. Though most of the drainage area lies in Tamil Nadu, its drainage area extends to cover the South-East and South-Western parts of Karnataka and Andhra Pradesh respectively. The shape of the basin is rhombus and finds its outlet in to Bay of Bengal.

Name of State	Drainage Area (sq km)	Percentage of total
Karnataka	3044	17.0
Andhra Pradesh	4681	26.2
Tamilnadu	10146	56.80
Total	17871	100

Table 2: Palar River Catchment

2.5.3 Tributaries

Palar has two main tributaries namely, the Poini (left bank) and the Cheyyar (right bank). They together account for near about 25 percent of the total catchment of the Palar basin. The Poini rises in the Chittoor district of Andhra Pradesh and flows in the Easterly and South-Easterly direction before joining the Palar near Walajapet. The Cheyyar, rises in the Jawadu hills in the Chengam taluk, Tiruvannamalai district of Tamil Nadu and flows in the North-Easterly direction before confluencing with the Palar near Tirumukkudal.

2.5.4 Topography

At Kolar, Palar elevation is about 900 m above m.s.l. Its left tributary, Poini starts at elevation of about 1,050 m above m.s.l. and flows 90 km length to join River Palar. Its right bank tributary, Cheyyar starts at elevation of about 1,080 m above m.s.l., flows through 190 km length before joining Palar River.

2.5.5 Climate, Temperature & Humidity

Winter, summer, South-East monsoon and North-East monsoon season occurs in Palar Basin. The south-west monsoon arrives in first week of June and ends by the end of September. The western part of the basin receives the major part of this rainfall. The north-east monsoon occurs from October to December.

The variation of temperature is small throughout the year. The mean temperatures in the basin vary from 25° C in January to 30° C in April and 27.5° C in October.

2.5.6 Rainfall

The average rainfall in the basin varies around 1000 mm, which is below the average rainfall in the country. It receives rainfall from both northeast and southwest monsoon.

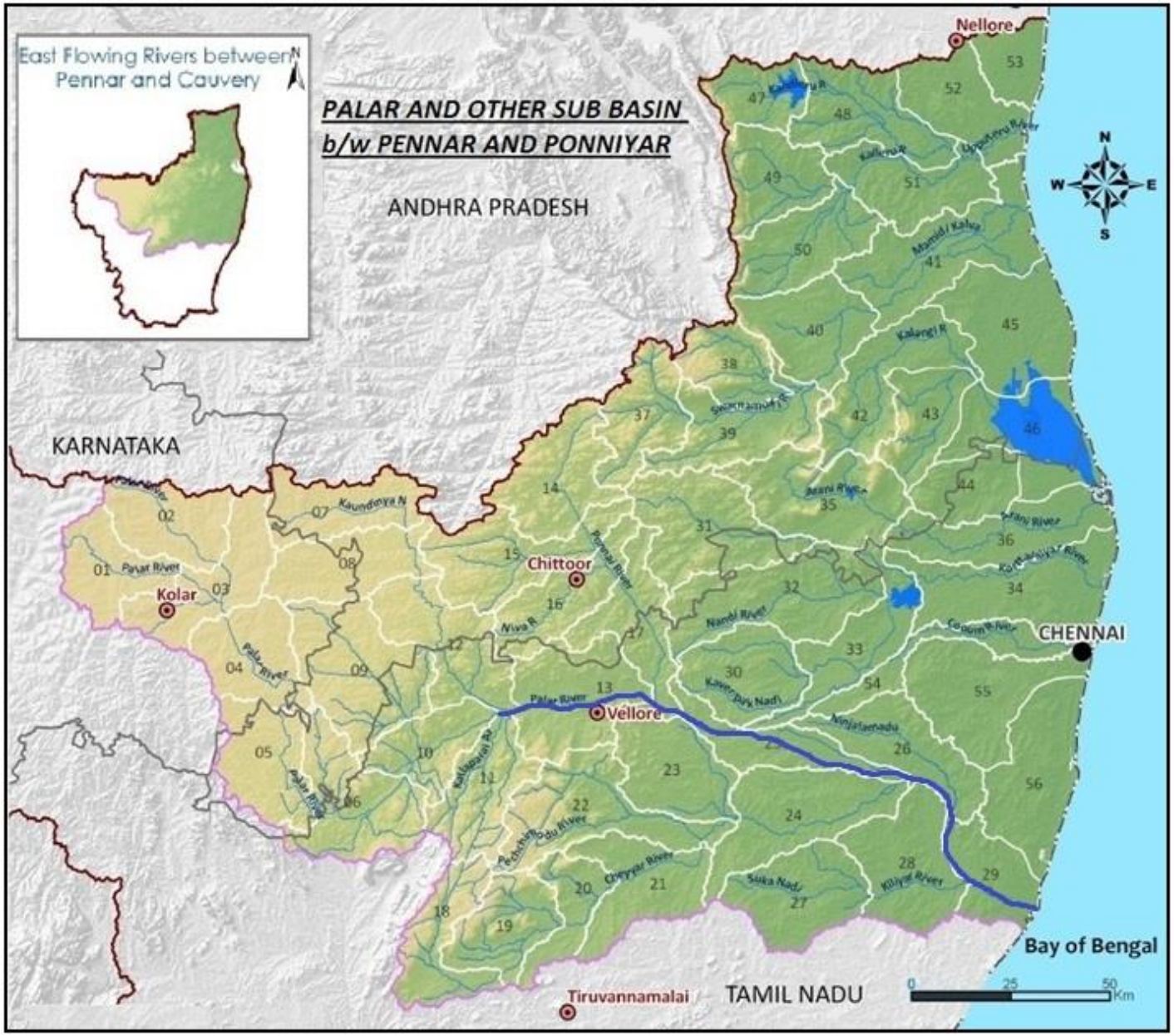


Figure 2: Palar and other sub basin b/w Pennar and Ponniyar

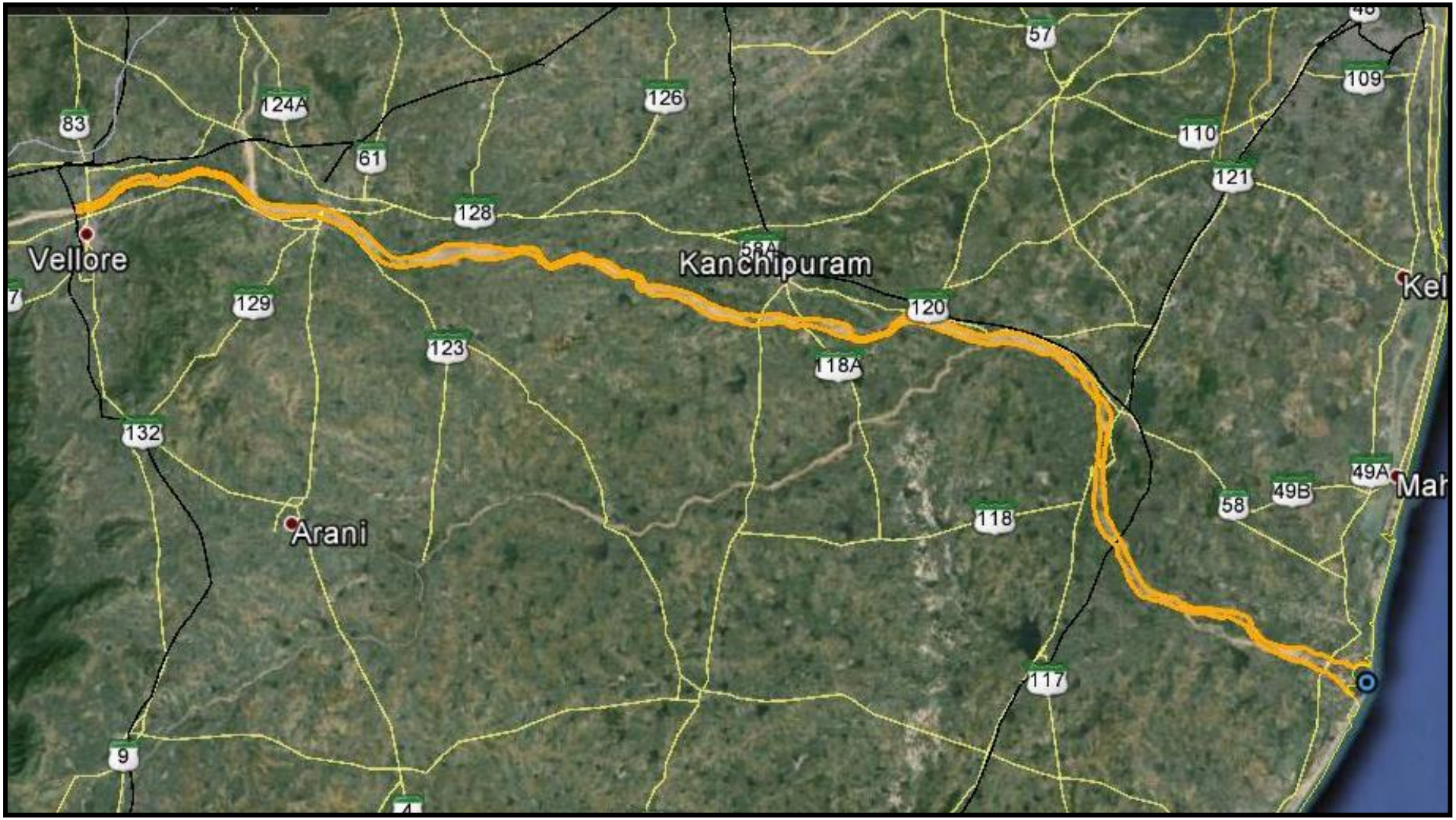


Figure 3: Google image showing Palar River stretch under present studies

2.5.7 Land Use

Three crop seasons viz. kharif, rabi and summer are mainly observed in the basin. The kharif crops are paddy, bajra, ragi, jowar, millets, cotton etc. The main summer crop for this area is paddy. The rabi crops are cholam (Jowar), millets, gram, other pulses, etc.

2.5.8 Soil

The principal soil types found in the basin are mainly red sandy soils and coastal alluvium.

2.5.9 Demography

The main districts are Kancheepuram, Vellore and Tiruannamalai with populations of 40 Lakhs, 39 Lakhs and 24.65 Lakhs respectively.

2.5.10 Dams, Barrages/ Weirs/ Anicut

The Palar anicut is situated across the Palar River, 7 km. below the town of Arcot. The project was completed in 1858 and full fills the irrigation requirement of Vellore district in Tamil Nadu.

The canal system comprising four channels, two on either sides with a total length of 779m. The Poini Anicut is located across the river Poini about 19 km above its confluence with the Palar and about 4 km south of poini village in North Arcot district.

2.5.11 Tourism

Vedanthangel Bird sanctuary, Sadurangapatinam beach are the main tourist attraction in the basin with Kancheepuram district which is famous for its sarees.

2.6 Methodology and Data collection

2.6.1 Importance of Hydrological and Topographical data

Navigability of a natural river channel or tidal creek primarily depends upon hydraulic parameters like water discharge, flow depth, velocity, sediment load and width of river channel. These parameters are function of topography/bathymetry of river bed and discharge in river during different seasons. Apart from these important parameters, there are other natural factors such as tidal range and length of tidal reach, type/nature of river bed (rocky, sandy, silty, clayey), bends in river course and stability of alignment of deep channel of river over long period. Apart from above natural factors, information on other factors such as various structures across (Dams/weirs/barrages/bridges) and along the river bank (river training and bank protection works) is also required.

2.6.2 Data Requirement

The following data was required for Stage-1 feasibility report:

1. Type of crops (in different seasons) and industries along the waterway
2. Availability of passenger ferry services. Prominent towns / City along the waterway.
3. Historical and tourist places.
4. Existing water sport and recreational activities and future probability.
5. Details of cross-structures (bridges, aqueducts, electric lines, telephone lines, pipe lines, cables) and their clearances. Salient features of Dams / Barrages / Weirs.
6. Availability of water in different seasons. Also to correlate this with CWC / Irrigation datum's.

7. Ponding level and limit of Dams / Barrages / Weirs.
8. Encroachment in the waterway, width of the waterway, sharp bends.
9. Environmental impacts. CRZ or wildlife clearances.
10. Local/pronounced name of the rivers in different stretches.
11. Any Border issue with other country.
12. Incorporation of topographical features (outside survey limits) from Google Earth imageries.
13. Obstructions to the navigation and un-approachable areas.
14. Photographs of all cross-structures, gauges, obstructions - annotated with location & chainage. In report with lat/long, easting/northing, chainage details
15. Permanent structures located within this corridor.
16. All prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) and other conspicuous objects shall be fixed and indicated on the chart and included in the report.
17. Details of water intake/ structures shall be collected and shown on the charts and include in the report.
18. Availability of berthing place, existing jetty, ferry ghats, approach roads etc. in the area shall be indicated on the charts and include in the report.
19. During the survey, condition of the banks shall also be collected, whether that banks are pitched (protected) or not protected. The length of bank protection, where banks erosion is taking place shall also be estimated.
20. Positions and levels of corners of permanent structures within the corridor shall be physically surveyed and marked on survey charts.

2.6.3 Primary Data- Sources

A. Survey of India (SOI) Dehradun, during February & March 2016

Toposheets and satellite imageries are useful to obtain information such as extent of tidal reach, HTL & LTL, width of river and deep channel, important places, nature of river bed and bank along reach, channel bends, slope of river channel, and locations of various structures across and along river course and tendency of shifting of deep channel (general morphology of the deep channel of the river course).

As the coastal zone falls under restricted category, the restricted and non-restricted Toposheets of Survey of India /hydrographic charts and satellite imageries has been collected after taking approval from **Ministry of Water Resources, Govt. of India**. A total of 43 toposheets were procured from Survey of India (SOI) (39 no.'s toposheets of 1: 50000 scale and 04 No's toposheets of 1:25000 scale) and analyzed to study various aspects mentioned above. The satellite imageries of different years from Google are also analyzed. The details of toposheets for Palar River as collected from SOI are given as under:

Palar River	**57 P/5, 57 P/9, 57 P/13, 57 P/14, 57 P, 58 E/13, 66 D/2,66 D/3 and D/4, 66 D/3/NE, 66 D/3/NW**

Table 3: SOI Toposheets

B. Data from Site Visit and Reconnaissance survey during March & April 2016

The site visit and reconnaissance survey was carried out in March and April 2016.

The details of existing cross-structures, Weirs, Barrages, Anicut, Dams, HT/ LT line, Type of Crops, Soils, shore protection along the waterway, Historical and tourist places, existing ferry services were collected. The collected data and photographs have been detailed in Chapter 3.

The details of existing industries, major commodities, production were also collected from various industries located around main industrial clusters, important towns in the vicinity of waterways and important ports near river mouth. These details have been presented in Chapter 5.

2.6.4 Secondary Data- Sources

A. Central Water Commission (CWC), Govt of India and Water Resource Division (WRD), Chennai during February, March and April 2016

These data give most vital information on water availability in river reach and sediment concentration in river water.

Gauge- discharge, sediment and river cross section data (at gauging site) was collected from CWC for one gauging station on Palar River. Following Table gives details of gauging stations and data collected.

River	Gauging station	Data type	From	To	Frequency
Palar	Arcot, TN 12^0 54′ 90” N 77^0 20′ 00” E	Gauge- discharge	1979	2011	daily
		Sediment	-	-	daily
		Cross-section	2000	2012	2 days/year
	Avarankuppam,	Gauge- discharge	1978	2010	Daily
		Sediment	-	-	daily
		Cross-section	-	-	2 days/year

Table 4: Gauge Discharge Sediment data collected from CWC

2.6.5 Methodology

The studies are being carried out as detailed below:

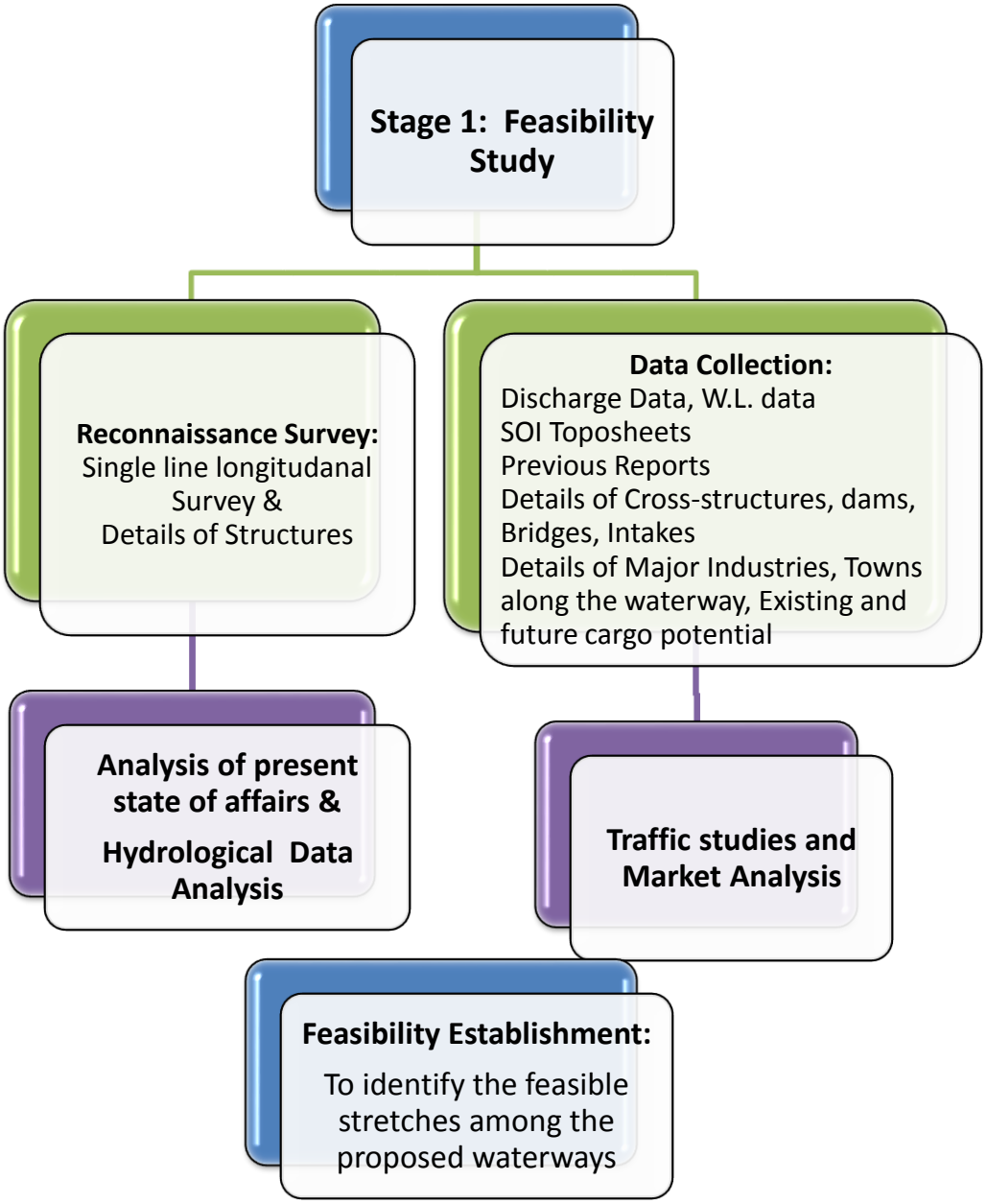


Figure 4: Feasibility Studies (Stage 1)

The detail methodology for reconnaissance survey, Hydrological data analysis and Traffic studies is given in their respective chapters. The feasibility of waterways is established after hydrological and traffic studies and analysis. Based on hydraulic conditions (depth, width, curvatures etc.) of the navigation channel, the class of the waterway is established in accordance with the classification notified by the Inland Waterways Authority of India (IWAI) vides Gazette Notification dated 26 January 2007. The same has been detailed below:

2.6.6 Classification of Waterways

In India, the inland waterways are classified into seven categories for rivers as well as canals by the Inland Waterways Authority of India (IWAI) vides Gazette Notification dated 26 January 2007 for safe passage of self-propelled vessels up to 2000 dead weight tonnage (DWT) and tug barge formation in push tow units of carrying capacity upto 8000 tonnes.

The classification of waterways is discussed below.

A. Classification of Inland waterways for Rivers

Class of Waterway	Rivers				
	Minimum Depth	Bottom Width	Bend Radius	Vertical Clearance	Horizontal Clearance
I.	1.2 m	30 m	300 m	4 m	30 m
II.	1.4 m	40 m	500 m	5 m	40 m
III.	1.7 m	50 m	700 m	7 m	50 m
IV.	2.0 m	50 m	800 m	10 m	50 m
V.	2.0 m	80 m	800 m	10 m	80 m
VI.	2.75 m	80 m	900 m	10 m	80 m
VII.	2.75 m	100 m	900 m	10 m	100 m

Table 5: Inland Waterway classification for Rivers

B. Classification of Inland waterways for Canals

Class of Waterway	Canals				
	Minimum Depth	Bottom Width	Bend Radius	Vertical Clearance	Horizontal Clearance
I.	1.5 m	20 m	300 m	4 m	20 m
II.	1.8 m	30 m	500 m	5 m	30 m
III.	2.2 m	40 m	700 m	7 m	40 m
IV.	2.5 m	50 m	800 m	10 m	50 m
V.	-	-	-	-	-
VI.	3.50 m	60 m	900 m	10 m	60 m
VII.	-	-	-	-	-

Table 6: Inland Waterway classification for Canals

The above classification for Rivers and Canals shall be effective if:

- Minimum depth of channel should be available for about 330 days in a year (about 90% days in a year).

- Vertical clearance at cross structures over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway.

C. Vertical Clearance for Power Cables / Telephone Lines for all Classes

- Telephone lines and Low Voltage lines 16.5 m
- High Voltage Transmission lines not exceeding 110 KV – 19 m
- High Voltage Transmission lines exceeding 110 KV – 19 m + 1 cm per each KV

In case of underground pipe / power lines and other cables norms to be decided as per conditions and navigational requirement

D. Reference level for vertical clearance for different types of channels

- For rivers – over navigational HFL which is highest flood level at frequency of 5% in any year over a period of last 20 years
- HTL for tidal channels
- For channels design FSL

E. Type of vessels to be used in different class waterways

Class	Self-propelled vessel	Tug with barges
I.	Self-propelled, carrying capacity 100 DWT, Size (32m X 5m), Loaded draft 1m	1 Tug + 2 barges – 200 DWT, length 80m X breadth 5m , draft 1m
II.	Self-propelled, carrying capacity 300 DWT, Size (45m X 8m), Loaded draft 1.2m	1 Tug + 2 barges – 600 DWT, length 110m X breadth 8m , draft 1.2m
III.	Self-propelled, carrying capacity 500 DWT, Size (58m X 9m), Loaded draft 1.5m	1 Tug + 2 barges – 1000 DWT, length 141m X breadth 9m , draft 1.5m
IV.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 12m , draft 1.8m
V.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 24m , draft 1.8m (moulded with 24 m)
VI.	Self-propelled, carrying capacity 2000 DWT, Size (86m X 14m), Loaded draft 2.5m	1 Tug + 2 barges – 4000 DWT, length 210m X breadth 14m , draft 2.5m
VII.	Self-propelled, carrying capacity 4000 DWT, Size (86m X 14m), Loaded draft 2.9m	1 Tug + 4 barges – 8000 DWT, length 210m X breadth 28m , draft 2.5m

Table 7: Type of vessels to be used in different class of waterways

All structures to be constructed across waterway classified should conform to respective requirement of vertical clearance and horizontal clearance before construction of any structure across the national waterway.

Wapcos has carried out hydrological studies to establish the feasibility of development of river stretches as national waterways. In cases where minimum depth (of 1.2m as per Govt. of India notification) is not available round the year, the no. of days of availability and available depth is calculated and presented in chapter 4. The project authorities may review the waterway classification. The feasibility of these stretches may be established for some part of the year after detailed studies in stage 2 after the approval. Measures to improve the depth are also stressed upon.

3. Analysis of present state of affairs

This chapter identifies the existing cross-structures viz. Dams, Weirs, Barrages, Locks, Bridges, Crossings, pipelines, cables, HT/LT line, National and State highways including railway lines in the river stretch collected during the site visit and reconnaissance survey. The details of all structures are tabulated in Annexure 2.

3.1 Existing Dams, Weir, Barrage, Anicut and Locks

An old dam (not in use) was observed at Lat. 12°52‟28.44”N, Long 79°22‟20.21”E at CH 110.460. None of the existing Check Dams have navigational lock.

3.2 Existing Bridges and Crossing Over River

Sl No	Structure Name	Chainage (km) as per Field Survey	Location	Position (Above survey track) WGS84 Datum; UTM Projection: CM 081°E , Zone 44N				Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
				Latitude [N]	Longitude [E]	Easting [m]	Northing [m]		
1	PUDUPATTINAM BRIDGE	3.5	KALPAKKAM City	12º 29' 00.8133	80º 07' 18.4261	404568.693	1380183.706	4	25
2	CROSS ROAD	10.5	KALPAKKAM City	12º 30' 37.575	80º 03' 36.6811	397885.399	1383179.293	Causeway	
3	DAMAGED PALAR BRIDGE	11.4	KALPAKKAM City	12°31’07.91”	80°03’43.79”	398103.139	1384110.288	Damaged	
4	IDAIYATHUR UNDER CONSTRUCTION BRIDGE	15.9	KALPAKKAM City	12º 32' 08.4209	80º 01' 22.8044	393854.73	1385984.835	2	15
5	VILLUPURAM BRIDGE	19.6	KALPAKKAM City	12º 32' 55.8058	79º 54' 33.2252	381498.789	1387489.035	0.5	3

Sl No	Structure Name	Chainage (km) as per Field Survey	Location	Position (Above survey track) WGS84 Datum; UTM Projection: CM 081°E , Zone 44N				Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
				Latitude [N]	Longitude [E]	Easting [m]	Northing [m]		
6	RAILWAY BRIDGE	26.6	CHENGALPATTU City	12º 35' 42.5973	79º 57' 23.6067	386661.363	1392592.4	2.5	18
7	RAILWAY BRIDGE	26.6	CHENGALPATTU City	12º 35' 42.7456	79º 57' 24.7951	386697.241	1392596.813	2.5	18
8	PV KALATHUR ROAD BRIDGE	27.3	CHENGALPATTU City	12º 36' 01.8090	79º 57' 15.3323	386414.031	1393183.617	2	18
9	CHENGALPATTU BRIDGE (NH-45)	33.7	CHENGALPATTU City	12º 39' 21.4694	79º 57' 05.0339	386127.826	1399318.866	1.5	27
10	PAZHATHOTTAM UNDER CONSTRUCTION BRIDGE	41	KANCHEEPURAM City	12º 43' 14.8458	79º 56' 44.4939	385537.154	1406491.241	1.5	35
11	KANCHEEPURAM BRIDGE	51.9	KANCHEEPURAM City	12º 45' 56.5534	79º 51' 55.6707	376847.683	1411496.072	1.5	20
12	PALAR WALAZABAD Causeway	57.9	KANCHEEPURAM City	12º 47' 28.5234	79º 49' 01.1503	371597.716	1414345.265	Causeway	
13	UTHRAMERUR BRIDGE	69.6	KANCHEEPURAM City	12º 47' 27.7265	79º 42' 54.1885	360532.253	1414373.552	2	15
14	ARCOT KANCHEEPURAM BRIDGE (MDR-143)	73.5	KANCHEEPURAM City	12º 47' 44.4201	79º 40' 38.2352	356435.246	1414907.126	1	12
15	PERUMBAKKAM GROUND BRIDGE	85.7	KANCHEEPURAM City	12º 50' 40.4394	79º 34' 29.8367	345356.07	1420374.609	Causeway	

Sl No	Structure Name	Chainage (km) as per Field Survey	Location	Position (Above survey track)				Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
				WGS84 Datum; UTM Projection: CM 081°E , Zone 44N					
				Latitude [N]	Longitude [E]	Easting [m]	Northing [m]		
16	PUDUR BRIDGE	93	ARCOT City	12º 51' 31.7425	79º 30' 36.5470	338331.485	1421990.807	1	15
17	ARCOT RANIPET BRIDGE 1	115.2	ARCOT City	12º 55' 08.2967	79º 19' 43.7305	318692.408	1428766.378	1.5	35
18	ARCOT RANIPET BRIDGE 2		ARCOT City	12º 55' 08.1342	79º 19' 44.2070	318706.739	1428761.291	1.5	25
19	ROAD BRIDGE	116.4	ARCOT City	12º 54' 55.4307	79º 18' 55.5906	317238.677	1428380.507	3.0	35
20	SIPCOT, BHEL BRIDGE(Under Construction)	120.7	ARCOT City	12º 55' 36.3927	79º 16' 38.2018	313105.579	1429666.834	2	30
21	ARCOT KATHPADI BRIDGE Cum Causeway	126.2	ARCOT City	12º 57' 20.9945	79º 14' 09.7811	308653.749	1432911.862	Causeway	
22	KATHPADI TO VELLORE BRIDGE	139.5	VELLORE City	12º 56' 29.8863	79º 08' 17.6756	298029.291	1431416.467	1	20
23	VELLORE TO KATHPADI BRIDGE	139.9	VELLORE City	12º 56' 28.8833N	79º 08' 06.1090E	297680.402	1431388.182	1	20
24	Sembakkam Madugu Rail BRIDGE	141	VELLORE City	12º 56' 14.0552	79º 07' 29.9806	296588	1430940.431	1.5	20

Note: Unless specified, all bridges may be considered as Road Bridges.

Note: Vertical clearance is measured above H.F.L. The HFL is calculated above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years of Gauge Discharge Data as collected from CWC.

Table 8: Details of existing Bridges and Crossings

3.3 Pipelines and cables

Sl No	Structure Name	Chainage (km) as per Field Survey	Location	Position (Above vessel track)				Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
				WGS84 Datum; UTM Projection: CM 081°E , Zone 44N					
				Latitude (E)	Longitude (E)	Easting [m]	Northing [m]		
1	Water pipeline from Vadalur to Chennai	18.7	KALPAKKAM City	12º 32' 29.3405N	79º 59' 53.8145E	391171.170	1386637.57	2	17

Note: Vertical clearance is measured above H.F.L. The HFL is calculated above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years of Gauge Discharge Data as collected from CWC.

Table 9: Details of Pipelines and Cables

3.4 Details of High Tension and Electric Lines across Palar River

Sl No	Structure Name	Chainage (km) as per Field Survey	Location	Position (Above vessel track)				Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
				WGS84 Datum; UTM Projection: CM 081°E , Zone 44N					
				Latitude (E)	Longitude (E)	Easting [m]	Northing [m]		
1	HT Line	8.2	KALPAKKAM City	12º 29' 48.6461	80º 04' 44.2511	399919.712	1381668.968	6	200
2	HT Line	17.6	KALPAKKAM City	12º 32' 14.7754	80º 00' 27.3105	392180.565	1386186.303	6	400
3	HT Line	17.8	KALPAKKAM City	12º 32' 17.9924	80º 00' 21.4496	392004.047	1386285.8	6	800
4	HT Line	25.1	CHENGALPATTU City	12º 35' 03.9846	79º 57' 55.9332	387632.153	1391402.283	6	400
5	HT Line	31.1	CHENGALPATTU City	12º 37' 59.3312	79º 56' 55.1406	385819.226	1396796.592	4	400

6	HT Line	40.3	CHENGALPATTU City	12º 42' 58.3670	79º 56' 58.1275	385946.307	1405983.309	3	350
7	HT Line	52.2	KANCHEEPURAM City	12º 45' 56.7756	79º 51' 46.7821	376579.668	1411504.073	6	300
8	HT Line	72.7	KANCHEEPURAM City	12º 47' 51.7420	79º 41' 08.9307	357361.99	1415127.376	6	300
9	HT Line	77.7	KANCHEEPURAM City	12º 48' 35.3992	79º 38' 25.9179	352453.514	1416494.187	6	150
10	HT Line	78.0	KANCHEEPURAM City	12º 48' 46.921	79º 38' 20.5738	352294.238	1416849.058	4	175
11	HT Line	123.5	VELLORE City	12º 56' 45.5173	79º 15' 31.3626	311105.243	1431804.739	5	150
12	HT Line	130.1	VELLORE City	12º 57' 12.1868	79º 12' 05.0603	304892.62	1432667.395	5	250
13	HT Line	130.2	VELLORE City	12º 57' 13.7035	79º 12' 00.1547	304745.086	1432715.047	3	150

Table 10: Details of High Tension and Electric Lines

Note: Vertical clearance is measured above H.F.L. The HFL is calculated above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years of Gauge Discharge Data as collected from CWC.

3.5 Horizontal and Vertical Clearances

Sl. No.	Structure Name	Chainage (km) as per Field Survey	Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
1	PUDUPATTINAM BRIDGE	3.5	4	25
2	HT Line	8.2	6	200
3	CROSS ROAD	10.5	Causeway	
4	DAMAGED PALAR BRIDGE	11.4	Damaged bridge	
5	IDAIYATHUR UNDER CONSTRUCTION BRIDGE	15.9	2	15
6	HT Line	17.6	6	400
7	HT Line	17.8	6	800
8	Water pipeline from Vadalur to Chennai	18.7	2	17
9	VILLUPURAM BRIDGE	19.6	0.5	3
10	HT Line	25.1	6	400
11	RAILWAY BRIDGE	26.6	2.5	18
12	RAILWAY BRIDGE	26.6	2.5	18
13	PV KALATHUR ROAD BRIDGE	27.3	2	18
14	HT Line	31.1	4	400
15	CHENGALPATTU BRIDGE	33.7	1.5	27
16	HT Line	40.3	3	350
17	PAZHATHOTTAM UNDER CONSTRUCTION BRIDGE	41	1.5	35
18	KANCHEEPURAM BRIDGE	51.9	1.5	20
19	HT Line	52.2	6	300
20	PALAR WALAZABAD Causeway	57.9	Causeway	
21	UTHRAMERUR BRIDGE	69.6	2	15
22	HT Line	72.7	6	300
23	ARCOT KANCHEEPURAM BRIDGE	73.5	1	12
24	HT Line	77.7	6	150
25	HT Line	78.0	4	175
26	PERUMBAKKAM GROUND BRIDGE	85.7	Causeway	
27	PUDUR BRIDGE	93	1	15
28	ARCOT RANIPET BRIDGE 1	115.2	1.5	35
29	ARCOT RANIPET BRIDGE 2		1.5	25
30	Road BRIDGE	116.4	3	35
31	SIPCOT, BHEL BRIDGE(Under Construction)	120.7	2	30
32	HT Line	123.5	5	150

Sl. No.	Structure Name	Chainage (km) as per Field Survey	Vertical clearance above H.F.L. (m)	Horizontal clearance (m)
33	ARCOT KATHPADI BRIDGE cum causeway	126.2	Causeway	
34	HT Line	130.1	5	250
35	HT Line	130.2	3	150
36	KATHPADI TO VELLORE BRIDGE	139.5	1	20
37	VELLORE TO KATHPADI BRIDGE	139.9	1	20
38	RAILBRIDGE	141	1.5	20

Table 11: Details of Horizontal and Vertical clearance

Note: Vertical clearance is measured above H.F.L. The HFL is calculated above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years of Gauge Discharge Data as collected from CWC.

3.6 Hindrances in conducting the reconnaissance survey

No hindrance was encountered in the river stretch while carrying out the reconnaissance survey.

Rocky strata was not observed/ encountered while carrying out the reconnaissance survey.

3.7 Encroachment to the waterway

There is no encroachment in the waterway.

3.8 Details of Protected Area, Wildlife, Defense

CISF defense land exists about 1.63 km form right bank near river mouth.

3.9 NH/SH/MDR along and/or in Vicinity

National highway numbers NH 46, NH 234, NH 4, NH 45, NH 48 and State highways No's SH 59, SH 129, SH 120 exist along the river in its 141 km reach. Kalathur-Vallipuram Road, Padalam GST Cheyyur Rd, Kancheepuram Chegalpattu Rd, Kancheepuram-Vandavasi Rd, MDR 143, Arcot Valur Kalavai Rd are the major roads along the Palar river in this stretch. The details of all bridges are given in Table 8.

3.10 Railway Line and stations in the vicinity

Vellore, Katpadi, Tiruvalam, Seevoor, Latteri, Palayasivaram, Walajabad, Ottivakkam, Padalam, Karunguzhi, Palur, Palayasivaram, Chengalpattu, Villiyambakkam and Peddypalayam Railway stations exists along the river stretch. All Railway bridges crossing the river are detailed in Table 8.

3.11 Geological sensitive areas

Rocky strata was not observed/ encountered while carrying out the reconnaissance survey.

3.12 Critical areas requiring detailed investigations

Detailed investigations shall be required at proposed ferry locations nearby temples, existing boating points and ghats.

4. Reconnaissance Survey

This chapter gives the stretch wise description of entire river stretches and presents the observed water level during survey. This chapter also covers the Hydrological analysis of the collected data viz. Minimum and maximum water levels, discharges, average 10 daily discharges, change in cross-section over the years and establishment of sounding datum in river. The route map of Palar River is given below:

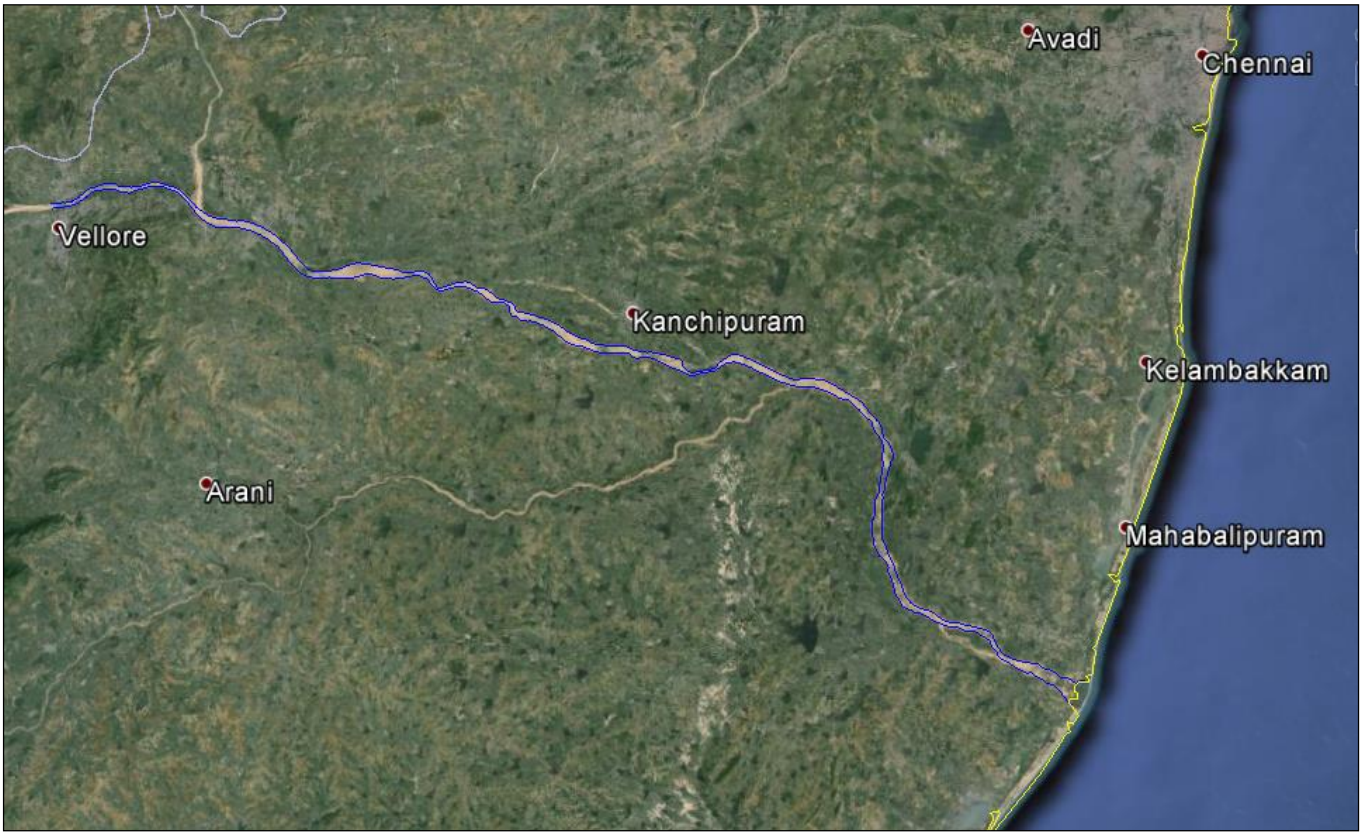


Figure 5: Route map of Palar River from its estuary up to Vellore city

4.1 Resources, Equipment used and Methodology adopted

4.1.1 Resources & Equipment used

Personnel Name	Function
Santosh Nag	Surveyor, Fugro Limited
Raib Maji	Asst. Surveyor, Fugro Limited
Lokesh	Asst. Surveyor, Fugro Limited

Table 12: Survey Personnel

Following equipment and systems were mobilised for the data acquisition.

Equipment / System	Description / Make / Model/Resolution /Accuracy
Software / Navigation	Starfix.Seis V. 10.1 PC based data acquisition and survey vessel navigation package and accessories
Positioning	12 Channel Single frequency (L1 & L2) DGPS System and accessories
Echo Sounder	ODOM Hydrotrac single Frequency Echo sounder, 210 KHz Transducer and accessories
Soil sample collection	Grab Sampler with accessories
Trimble Total station with accessories & Laser Distometer	

Table 13: Equipments for data acquisition

Survey Vessel

Locally Hired boat 'Mamatha' was used for carrying out the bathymetry survey.

4.1.2 Detailed methodology adopted for survey

a) Specifications for survey: Survey Geodesy

The survey was conducted in WGS84 datum; UTM Projection (Zone 44 N, CM 081° E). The geodetic parameters used during the survey are as follows:

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Inverse Flattening:	1/f = 298.257 223 563
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 44 N;
Central Meridian:	081° 00' 00" East
Latitude of Origin:	0° 00' 00" North
False Easting:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	Meter

Table 14: Global Positioning System Geodetic Parameters

b) *Field Calibrations & Verifications*

All survey equipments used for the survey were calibrated and bench tested prior to their mobilisation for this task. After installation on the survey vessel, field verification and tests were carried out as per standard survey methods. On completion of successful Mobilization, Calibration, Verification and Testing of all equipment as per the relevant work practices, the survey task was commenced.

c) *DGPS Calibrations*

In order to ensure the integrity of the horizontal control of survey the DGPS system was bench checked against a known point, prior to mobilisation to site, at workshop and found to be satisfactory.

d) *Single Beam Echo Sounder (SBES)*

Odom Hydrotrac single frequency (210 kHz) echo sounder was used for measuring water depths. The echo sounder system was bench calibrated at workshop prior to mobilization for the survey. The echo sounder transducer was side mounted on the survey vessel and its draft below the water-line was measured and recorded. The echo sounder system was interfaced with the Starfix.Seis navigation and survey system for logging the depth vs position data.

e) *Data Acquisition & Survey Run-Line Logs*

The Navigation and depth data from the Starfix.HP DGPS was logged continuously and monitored using the Starfix.Seis navigation suite. A survey run-line log book was maintained where the quality of data was noted. Details such as horizontal and vertical clearances above high flood level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route were assessed on the spot and recorded, and their coordinates and location were plotted on the chart and included in the report. Photographs of important structures along the route are included as part of this report.

f) *Soil Sampling and Visual Analysis*

Soil samples were collected from the river bed along the surveyed route at about 10 km intervals, and the nature and texture of the samples collected were visually analyzed and reported.

g) *On-line QC of Data Logged*

Real Time Graphs and QC Plots as provided by the Starfix survey software suite were used by experienced surveyors to monitor and control the quality of sensor data on-line, before they are logged. Time stamping on all the data was done by means of Starfix Timing Module through Navigation network synchronized with the GPS (high precision) 1PPS time signal. The data / record obtained from each survey sensor such as Navigation, Heading, SBES and Motion Sensor etc. were quality checked and an extract of the same were made available for verification and confirmation to proceed further.

h) *Survey of Data Processing and interpretation methods*

The survey data was logged in Binary Format (BF), and processed using the Starfix.Proc software. Heading, motion and position data were processed and checked to ensure good data quality.

The measured offsets for all survey sensors was entered into the navigation system and processed using Starfix.Proc to enable track charts was plotted and 'corrected' navigation files was integrated with other sensor data at a later stage. These included:

- GPS position absolute of the primary & secondary positioning systems.
- Common Reference Point.
- Single beam echo sounder.

i) *Bathymetry Data Analysis and Presentation*

Starfix.Proc and Starfix. Workbench was used to import and process the navigation, bathymetry, tides and sound velocity data. The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set that has been corrected for tides and sound speed.

j) *Equipment Layout Diagram*

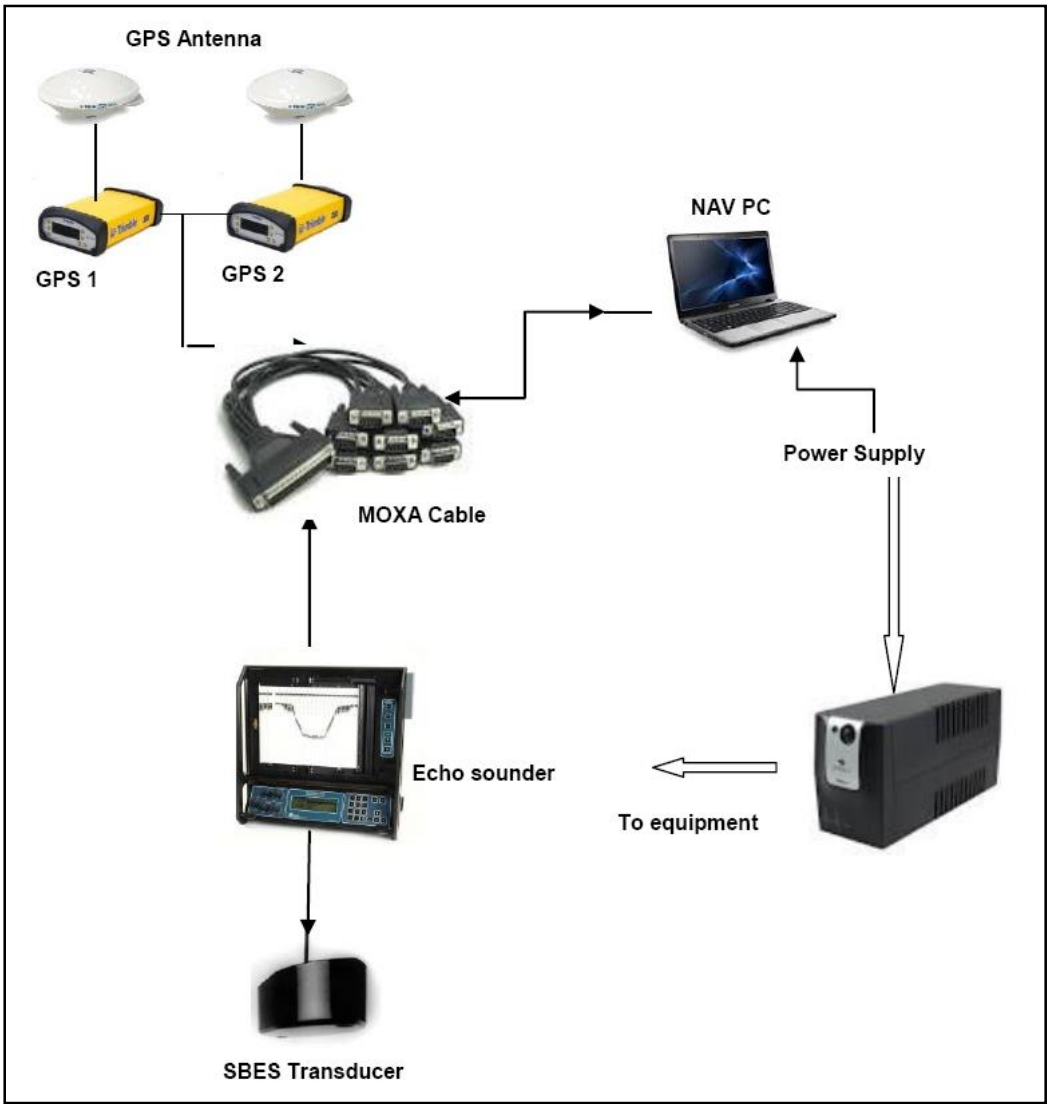


Figure 6: Equipment layout diagram

4.2 Description of bench marks (B.M.)/ authentic reference level used

A CWC benchmark MTBM was successfully recovered on the river stretch at the Chengalpattu Township. The value of this BM was 31.775 m above the MSL. A second GTS BM recovered at the same Chengalpattu town ship. However, this had no information on its height above MSL.

A third GTS BM was recovered at the Arcot Township whose height was 161.74 m above the MSL. There were no other bench marks available along the river stretch. Therefore, all the heights of the riverbed obtained from the current topographic survey are referred to MSL by linking it to the nearest recovered bench mark.

Fugro Survey (India) Pvt. Ltd. D-222/30, TTC Industrial Area, MIDC, Nerul, Navi Mumbai Pin - 400 075 (India)	Reccee report on Geodetic Station/Bench Mark		
	Job No. :	J-MAR-16-020	Station Name/ID:
	Client :	WAPCOS LTD	
	Location :	CHENGALPATTU, MAMANDUR, TAMILNADU	MTBM, CHENGALPATTU
	Date of Reccee:	22-Apr-16	

Brief Narrative on the Recovery of the Station	
a) What is the Source of Station Description Data;	CWC site office, Chengalpattu
b) Was the station recovered successfully?	Yes
c) What were the differences in Coordinates after verification using Starfix.HP?	No earlier coordinates available
d) Give Link to Starfix Mean Posn/Final Fix Report.	Mean Position Report_CWC_MTBM_PALAR.pdf

Final Coordinates in WGS84 Datum after verification using Starfix.HP

GEOGRAPHICAL COORDINATES:			UTM COORDINATES:	Zone No:	44	CM:	081 °E
LATITUDE :	12° 39' 12.2599"	N	EASTING:	385 231.18	m	(+/-0.07 m)	
LONGITUDE :	79° 56' 35.3503"	E	NORTHING:	1 399 039.54	m	(+/- 0.05 m)	
ELLIPSOIDAL HEIGHT :	-59.57	m	Ht above MSL/~~CD~~	31.775	M		

Describe the General Location & Access to the Station :	The station is situated on a stone inside a concrete well (*2.17m x 2.17m x 0.7m*). The well is also filled with sand. The well is situated inside a graveyard in *Wadapadi* village in Mamandur. The graveyard is on the southern bank of the river Palar. The station is approximately 300 mtrs East of the bridge on NH 45 over Palar river.
Describe how the Stn is marked on the Ground	The station is marked by a stone on ground.
Expected durability of the Station (in Years) :	10

DETAILED DIAGRAM :

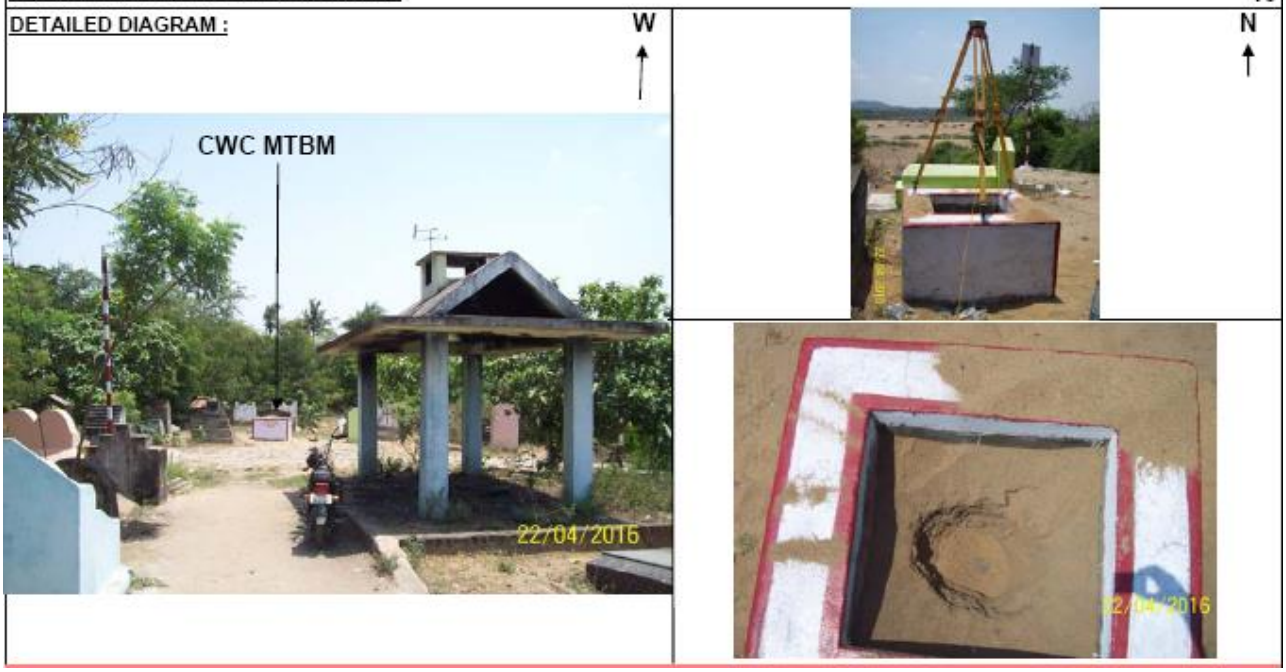
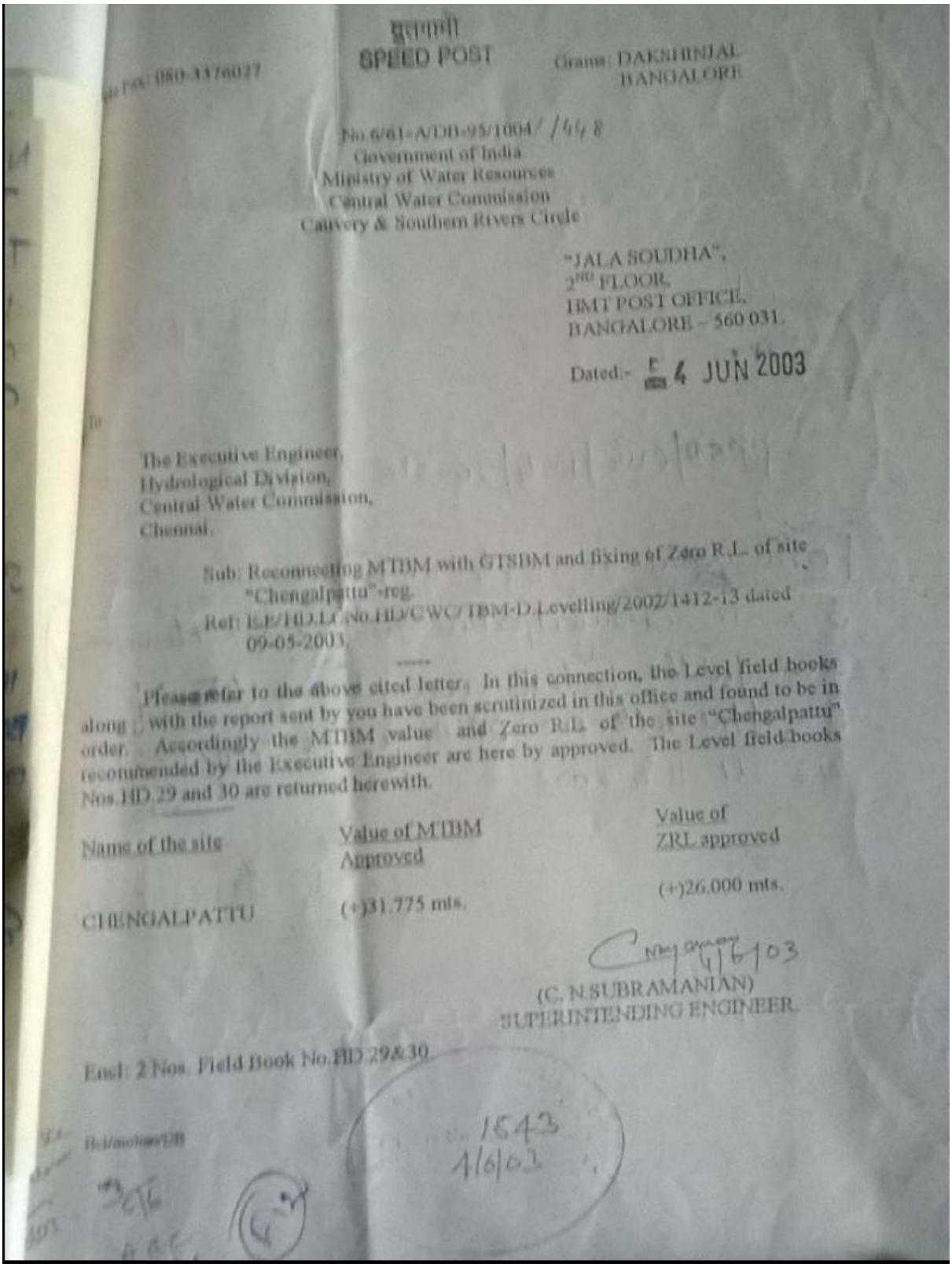


Figure 7: Details of Benchmark at Chengalpattu



SPEED POST

Grams: DAKSHINJAL
BANGALORE

No.6/61-A/DB-95/1004/ /448
Government of India
Ministry of Water Resources
Central Water Commission
Cauvery & Southern Rivers Circle

"JALA SOUDHA",
2ND FLOOR,
HMT POST OFFICE,
BANGALORE – 560 031.

Dated:- 4 JUN 2003

To

The Executive Engineer,
Hydrological Division,
Central Water Commission,
Chennai.

Sub: Reconnecting MTBM with GTSBM and fixing of Zero R.L. of site "Chengalpattu"-reg.

Ref: E.E/HD.LC No.HD/CWC/IBM-D.Levelling/2002/1412-13 dated 09-05-2003.

Please refer to the above cited letter. In this connection, the Level field books along with the report sent by you have been scrutinized in this office and found to be in order. Accordingly the MTBM value and Zero R.L. of the site "Chengalpattu" recommended by the Executive Engineer are here by approved. The Level field books Nos.HD.29 and 30 are returned herewith.

Name of the site	Value of MTBM Approved	Value of ZRL approved
CHENGALPATTU	(+)31.775 mts.	(+)26.000 mts.

4/6/03
(C. N.SUBRAMANIAN)
SUPERINTENDING ENGINEER.

Encl: 2 Nos. Field Book No.HD.29&30

1643
1/6/03

Figure 8: CWC Details of Benchmark at Chengalpattu

Figure 9: Chengalpattu CWC Benchmark

Fugro Survey (India) Pvt. Ltd. D-222/30, TTC Industrial Area, MIDC, Nerul, Navi Mumbai Pin - 400 075 (India)	Reccee report on Geodetic Station/Bench Mark		
	Job No. :	J-MAR-16-020	Station Name/ID:
	Client :	WAPCOS LTD	
	Location :	ARCOT, TAMILNADU	CWC MTBM, ARCOT
	Date of Reccee:	23-Apr-16	

Brief Narrative on the Recovery of the Station	
a) What is the Source of Station Description Data;	CWC site office, Arcot
b) Was the station recovered successfully?	Yes
c) What were the differences in Coordinates after verification using Starfix.HP?	No earlier coordinates available
d) Give Link to Starfix Mean Posn/Final Fix Report.	Mean Position Report_CWC_MTBM_PALAR_ARCOT.pdf

Final Coordinates in WGS84 Datum after verification using Starfix.HP

GEOGRAPHICAL COORDINATES:			UTM COORDINATES:			Zone No:	44	CM:	081 °E
LATITUDE :	12° 54' 28.4827"	N	EASTING:	319 561.62	m	(+/-0.04 m)			
LONGITUDE :	79° 20' 12.8293"	E	NORTHING:	1 427 537.19	m	(+/- 0.01 m)			
ELLIPSOIDAL HEIGHT :	71.51	m	Ht above MSL/~~CD~~	161.74	M				

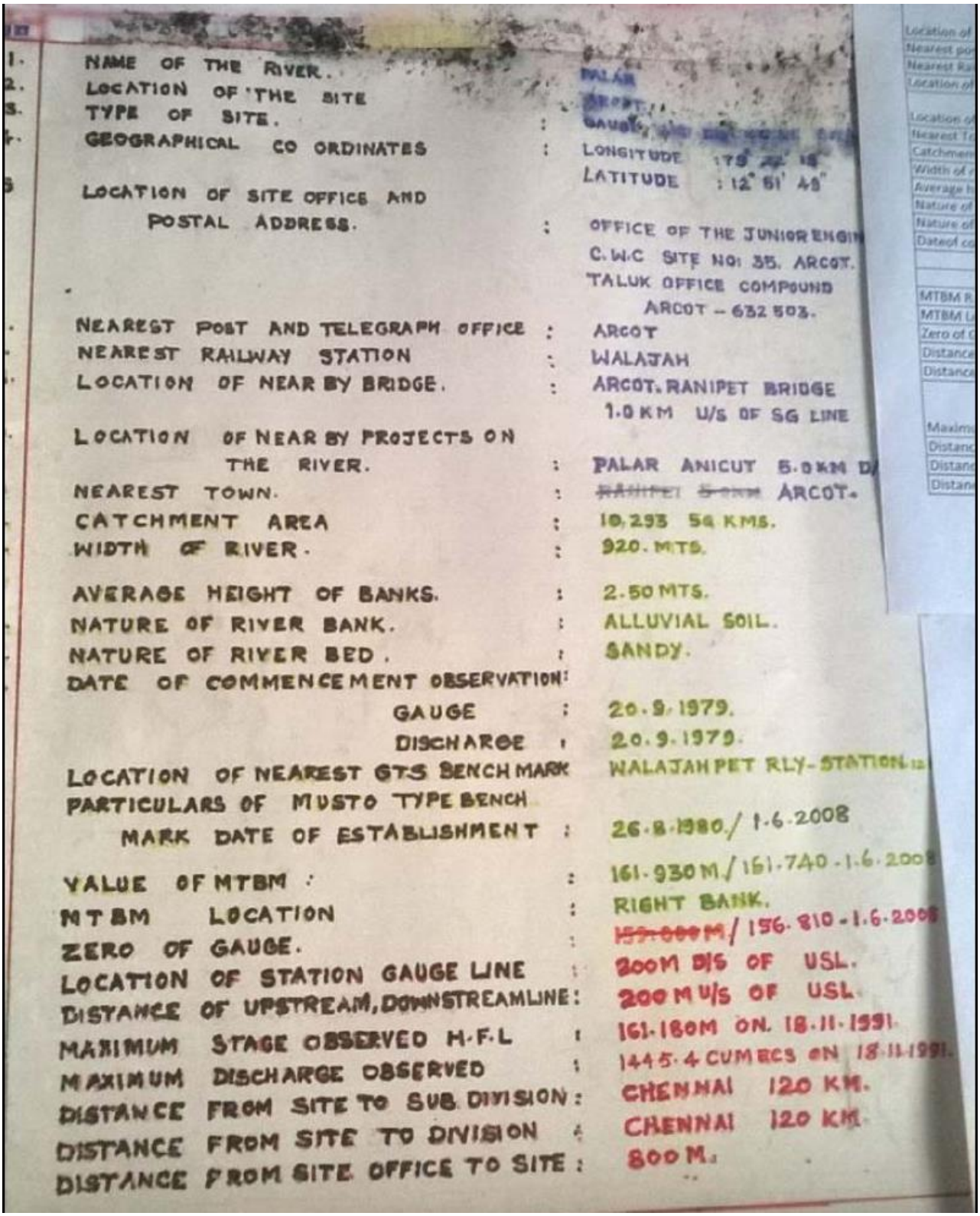
Describe the General Location & Access to the Station :	The station is situated on a stone inside a concrete well (*2.17m x 2.17m x 0.7m*). The well is also filled with sand. The well is situated inside a graveyard in *Wadapadi* village in Mamandur. The graveyard is on the southern bank of the river Palar. The station is approximately 300 mtrs East of the bridge on NH 45 over Palar river.
Describe how the Stn is marked on the Ground	The station is marked by a stone on ground.
Expected durability of the Station (in Years) :	10

DETAILED DIAGRAM :

W

N

Figure 10: Details of Benchmark at Arcot



1.	NAME OF THE RIVER.	PALAR
2.	LOCATION OF THE SITE	[illegible]
3.	TYPE OF SITE. :	GAUGE [illegible]
	GEOGRAPHICAL CO ORDINATES :	LONGITUDE [illegible]
		LATITUDE : 12° 51' 45"
	LOCATION OF SITE OFFICE AND POSTAL ADDRESS. :	OFFICE OF THE JUNIOR ENGIN C.W.C SITE NO: 35. ARCOT. TALUK OFFICE COMPOUND ARCOT – 632 503.
	NEAREST POST AND TELEGRAPH OFFICE :	ARCOT
	NEAREST RAILWAY STATION :	WALAJAH
	LOCATION OF NEAR BY BRIDGE. :	ARCOT. RANIPET BRIDGE 1.0 KM U/S OF SG LINE
	LOCATION OF NEAR BY PROJECTS ON THE RIVER. :	PALAR ANICUT 5.0 KM D/
	NEAREST TOWN. :	~~RANIPET 5 KMS~~ ARCOT.
	CATCHMENT AREA :	10,293 SQ KMS.
	WIDTH OF RIVER. :	920. MTS.
	AVERAGE HEIGHT OF BANKS. :	2.50 MTS.
	NATURE OF RIVER BANK. :	ALLUVIAL SOIL.
	NATURE OF RIVER BED. :	SANDY.
	DATE OF COMMENCEMENT OBSERVATION:	
	GAUGE :	20.9.1979.
	DISCHARGE :	20.9.1979.
	LOCATION OF NEAREST GTS BENCH MARK	WALAJAH PET RLY-STATION
	PARTICULARS OF MUSTO TYPE BENCH MARK DATE OF ESTABLISHMENT :	26.8.1980./ 1.6.2008
	VALUE OF MTBM : :	161.930 M./ 161.740 - 1.6.2008
	MTBM LOCATION :	RIGHT BANK.
	ZERO OF GAUGE. :	~~159.000 M~~ / 156.810 - 1.6.2008
	LOCATION OF STATION GAUGE LINE :	200M D/S OF USL.
	DISTANCE OF UPSTREAM, DOWNSTREAMLINE:	200 M U/S OF USL
	MAXIMUM STAGE OBSERVED H.F.L :	161.180M ON. 18.11.1991.
	MAXIMUM DISCHARGE OBSERVED :	1445.4 CUMECS ON 18.11.1991.
	DISTANCE FROM SITE TO SUB DIVISION :	CHENNAI 120 KM.
	DISTANCE FROM SITE TO DIVISION :	CHENNAI 120 KM.
	DISTANCE FROM SITE OFFICE TO SITE :	800 M.

Figure 11: CWC Benchmark value at Arcot

Figure 12: CWC Benchmark at Arcot

4.3 Tidal Influence Zone and Tidal Variation

From the analysis of survey of toposheets for the coastal zone, it was found that the tidal reach of the river is small 1-2 km.

The Nearest Port is Chennai. The tidal variation between MLLW springs (0.1) and MHW springs (1.1) is 1.0 m.

4.4 Chart datum / Sounding datum and reduction details

4.4.1 Horizontal control

Worldwide Starfix.HP DGPS was used for positioning the survey vessel during this survey. The accuracy of the x, y, z position data obtained from the Starfix.HP DGPS system is +/- 10 cms at 95% assurance levels. Starfix software suite was used for navigation, data logging, and online quality control of the survey data logged.

4.4.2 Vertical control

a) Chart Datum at the River Estuary

During the survey at the estuarial part of the river, it was found that there were a few patches of water in the Palar river delta from the coast line up to the East Coast Road crossing. It was also observed that the river mouth was fully closed by coastal land formation, thereby not allowing the sea water to enter into the estuary. Information published by the Survey of India in their Coastal Bench Mark pamphlet, it was evident that there are no established bench marks available anywhere near the estuary of the Palar River. In view of the above, the CD value at river Estuary (Kp 0) was taken as 0.65 m below the MSL (from the Admiralty Tide Table (ATT) Vol-3 for the nearest Chennai Port).

b) Chart Datum for the upstream part of the River

Data was collected from gauge station at Arcot. No other gauge station was found on the Palar River in its 141 km stretch. As directed by the Client, the average height of last six years Minimum Water Levels at Arcot gauge station was to be taken as the Chart Datum for the survey of the entire stretch of the Palar River, from the estuary till the last chainage upstream. This is detailed in Para 4.17.

4.5 Hydrographic Survey

4.5.1 Hydrographic Survey

The bathymetry survey was not possible in this river even at river mouth. The river mouth was entirely closed and the nearby water depth was very shallow. The soundings were taken manually.

4.5.2 Topographic Survey

a) Length of stretch for which bathymetry survey has been carried out

Since the water depths are shallow even at the river mouth and bathymetry survey was not possible, therefore the topography survey has been carried out from chainage 0.0 km to 141.0 km from Palar river mouth.

b) Minimum and Maximum Depths

As per IWAI suggestion, following sign convention is adopted

(+) : Riverbed below CD
(-) : Riverbed above CD
(+) : Water Depth below CD
(-) : Water Depth above CD

River Stretch from CH 0.0 to CH 8.0:-

The Palar River meets the sea forming a delta between CH 0.0 to CH 3.0 at Lat. 12°27'52.16" N, Long 80° 9'13.47" E. East Coast Road crosses the river at CH 4.2. There are agricultural fields seen on either side of the river bank and on the delta. The water depths shown plotted are referenced to the interpolated CD levels.

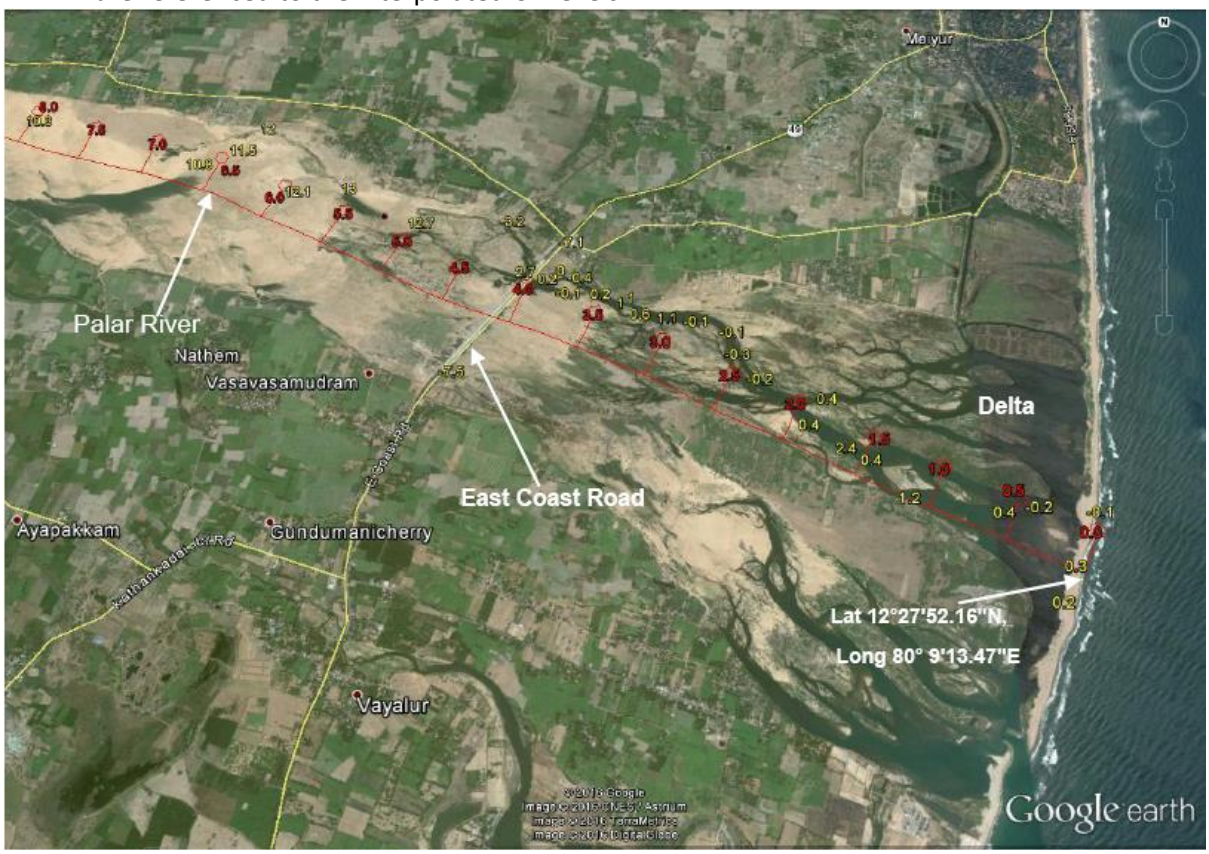


Figure 13: Palar River from CH 0.0 to CH 8.0

River Stretch from CH 8.0 to CH 19.5:-

Pakkam to Periayakattupakkam road crosses the river at CH 12.20. Budur – Esoor Road crosses the river at CH 19.2. High Tension line crosses the river on west at CH 8.419 and old damaged bridge at CH 12.113. There are fields seen on both side and vegetation cover in the middle of the river.

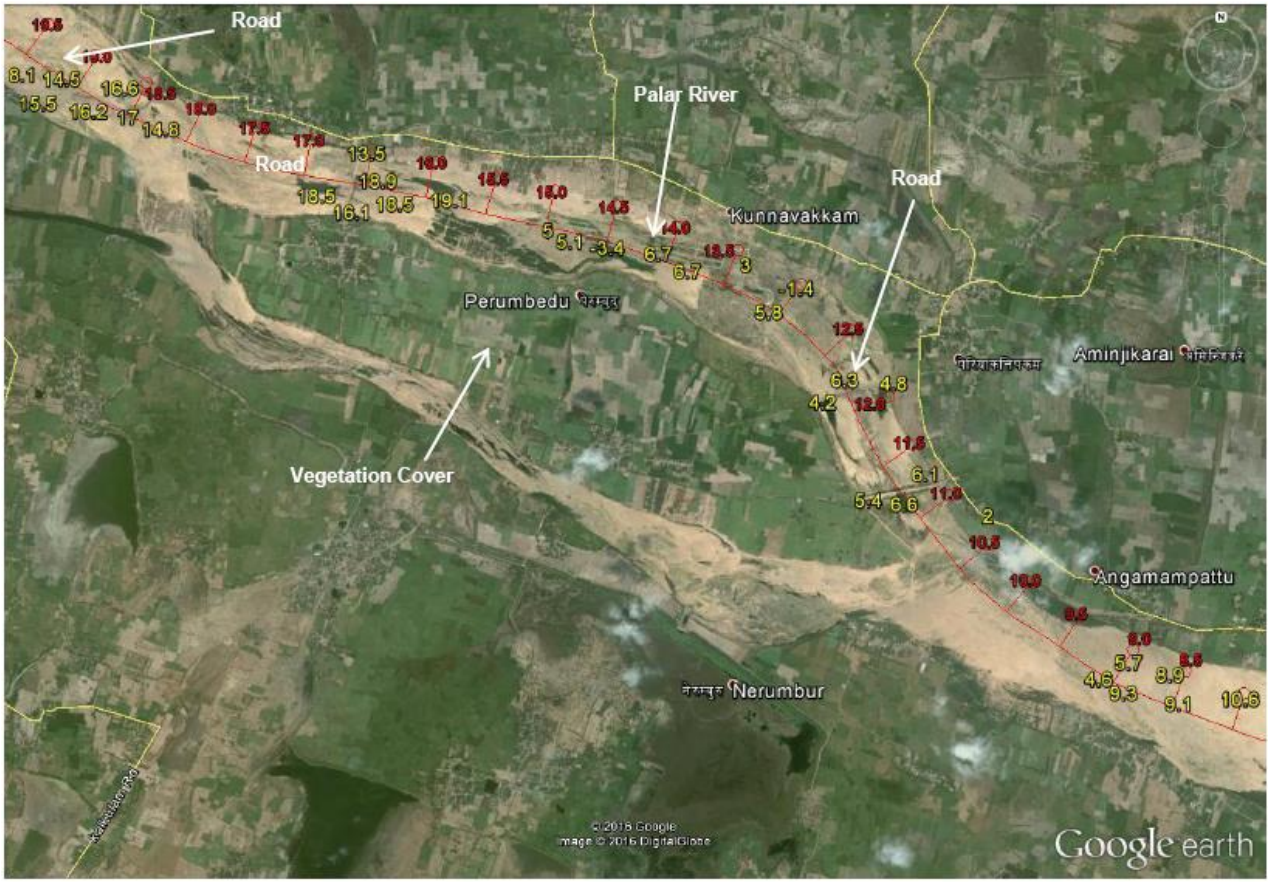


Figure 14: Palar River from CH 8.0 to CH 19.5

River Stretch from CH 19.5 to CH 28.5

The Vallipuram – Palar Road Bridge crosses the river at CH 20.30. Railway Bridge crosses river at CH 27.3 from Padalam Railway station to Otthivakkam. The vertical clearance is 8.5 m and Horizontal Clearance is 18 m. Both sides of the river have open fields flanking on the river banks.

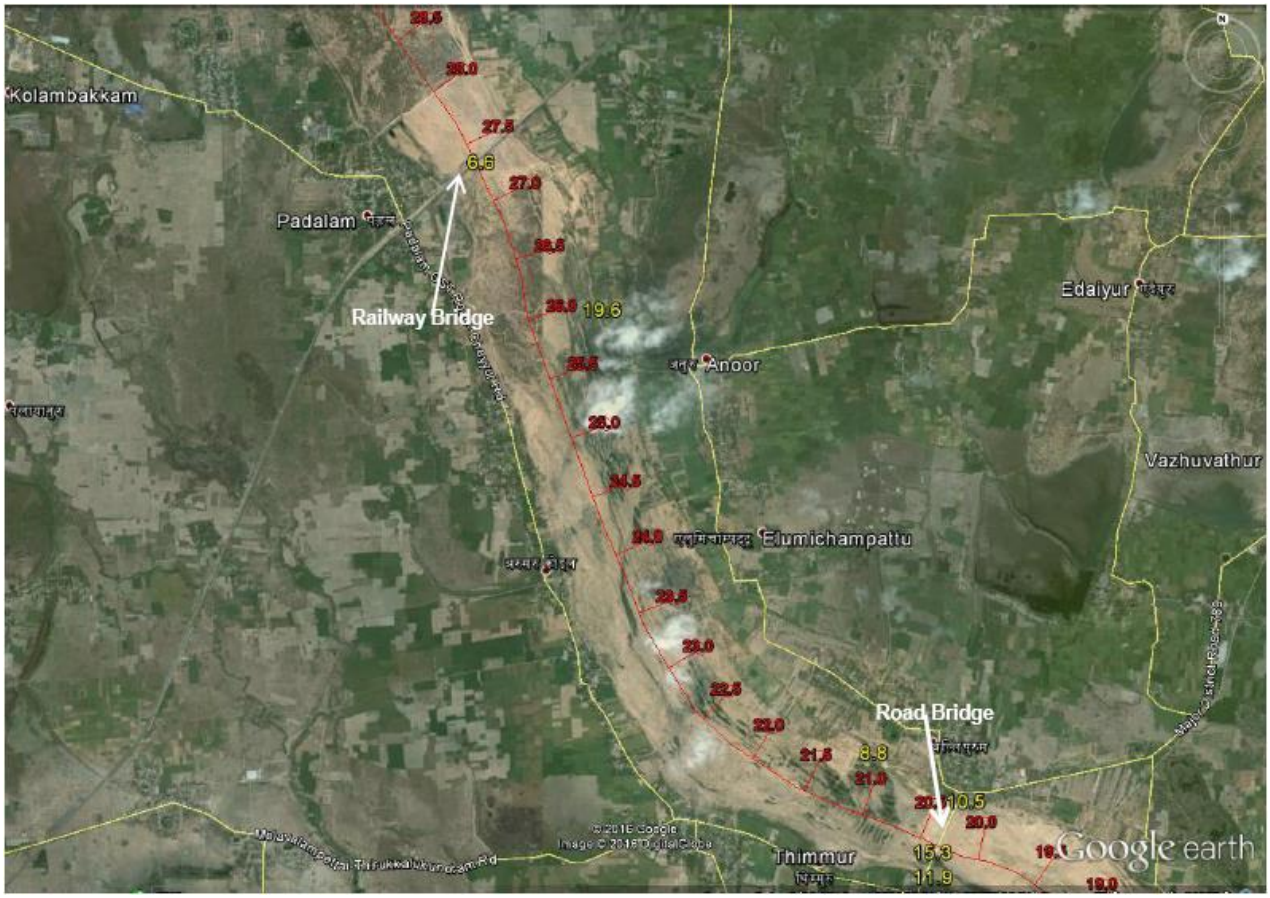


Figure 15: Palar River from CH 19.5 to CH 28.5

River Stretch from CH 28.5 to CH 37.5

National highway 45 crosses the river at CH 34.5. There are mostly fields seen along both the banks. The flood plains are covered with vegetation and open fields.

Figure 16: Palar River from CH 28.5 to CH 37.5

River Stretch from CH 37.5 to CH 52.0

A Meandering of river channel recorded between CH 44.0 to CH 52.0. Sattancheary Road crosses the river at CH 45.0. A tributary, Cheyyar River meets Palar River and contributes to the meandering of channel.

Figure 17: Palar River from CH 37.5 to CH 52.0

River Stretch from CH 52.0 to CH 61.0

Confluence of Cheyyar River and Palar River were seen at CH 53.0. Palar to Walajabad Bridge crosses the river at CH 58.563 and the banks are mostly covered with vegetation. Confluence of Cheyyar River with Palar River is seen at CH 53.0.

Figure 18: Palar River from CH 52.0 to CH 61.0

River Stretch from CH 61.0 to CH 71.0

In this section, the banks of the river are mostly covered with vegetation with few agricultural fields. A bridge on Uthiramerur Road (SH 118A) crosses the river at CH 70.407.

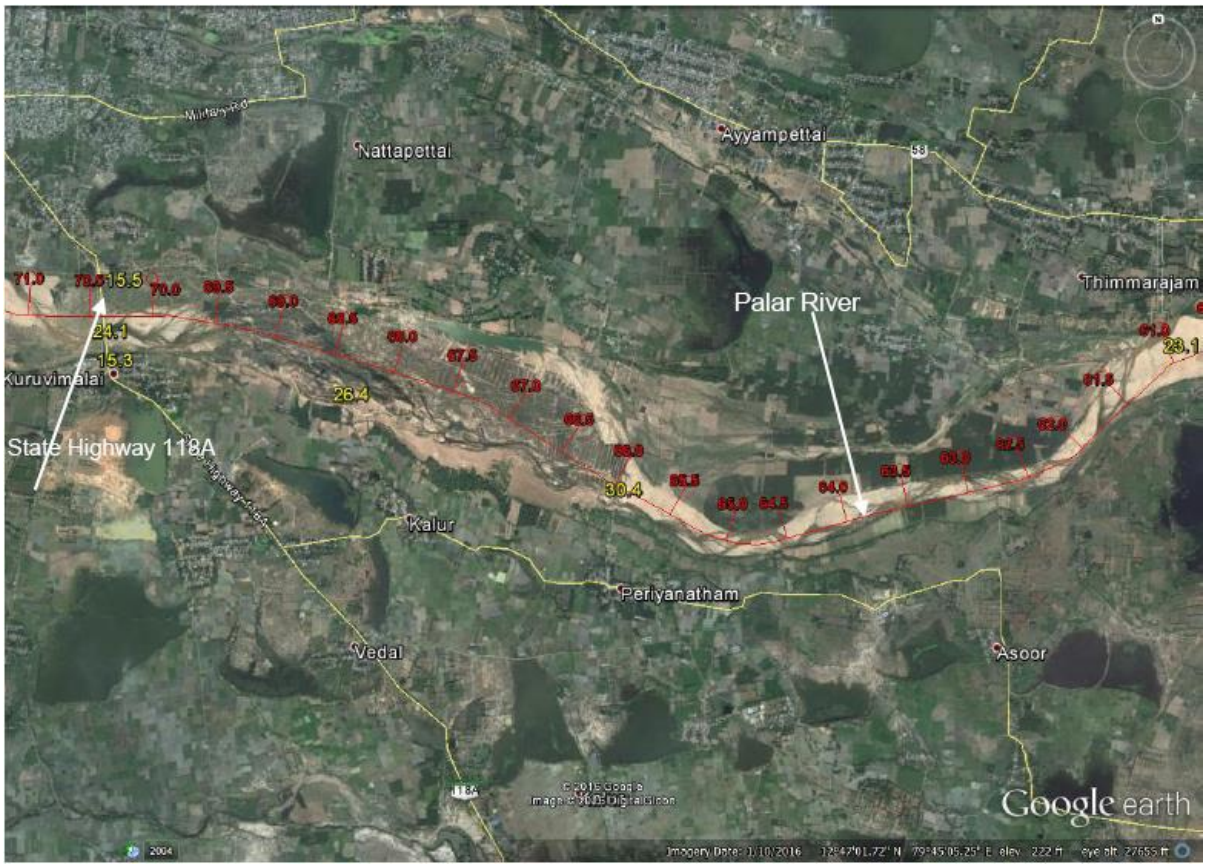


Figure 19: Palar River from CH 61.0 to CH 71.0

River Stretch from CH 71.0 to CH 81.0

Kanchipuram to Vandavasi Road is crossing Palar River at CH 74.5 Lot of vegetation on both the sides of bank. Few farm lands can be seen in the middle of river bed. A bridge on Arcot to Kanchipuram Road crosses the river at CH 74.559.

Figure 20: Palar River from CH 71.0 to CH 81.0

River Stretch from CH 81.0 to CH 94.0:-

Dry River bed noticed along the entire stretch form CH 81.0 to CH 94.0.

Figure 21: Palar River from CH 81.0 to CH 94.0

River Stretch from CH 94.0 to CH 100.5

This section has farming vegetation on both sides of the river. A bridge on Manmandur Road crosses the river at CH 94.7.

Figure 22: Palar River from CH 94.0 to CH 100.5

River Stretch from CH 100.5 to CH 110.0

From CH 104.0 to CH 108, the river bed sees lot of agricultural fields. This section has farming vegetation on both sides of the river.

Figure 23: Palar River from CH 100.5 to CH 110.0

River Stretch from CH 110.0 to CH 120.0

National Highway 48 & AH 45 crosses the river through Palar Bridge at CH 117.3. Thick vegetation at CH 114.0 and agricultural fields from CH 111.0 to 113.0 were recorded. An old dam (not in use) can be seen at CH 110.460.

Figure 24: Palar River from CH 110.0 to CH 120.0

River Stretch from CH 120.0 to CH 133.0

Confluence of Rivers Palar and Poini at CH 124.0 were observed. High tension lines towards South bank can be seen at CH 125.800. Arcot – Kathpali Ground Bridge towards west can be seen at CH 128.546 with vertical clearance of 2 m, Horizontal Clearance 6 m, width 8 m and length 250 m.

Figure 25: Palar River from CH 120.0 to CH 133.0

River Stretch from CH 133.0 to CH 141.281

Villupuram – Mangalore Road (National Highway 234) crosses the palar river through two bridges at CH 140.0. Human settlements on the north bank of the river near Viruthampattu from CH 138 to CH 140.

Figure 26: Palar River from CH 133.0 to CH 141.281

c) Water levels Topographic survey

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
0.11	407949.74	1378133.42	-0.95	-	-	-
0.12	407831.17	1377906.18	-0.81	1.10	-	-
0.12	408069.13	1378419.76	-0.51	1.20	-	-
0.42	407784.55	1378517.85	-0.49	1.10	-	-
0.56	407604.29	1378472.76	-0.27	1.00	-	-
1.14	407014.74	1378572.56	-0.11	1.80	-	-
1.46	406799.83	1378831.81	0.06	1.00	-	-
1.63	406647.12	1378915.35	0.23	3.00	-	-
1.91	406419.31	1379083.15	0.39	1.00	-	-
1.93	406486.51	1379270.63	0.56	1.00	-	-
2.27	406131.55	1379331.86	0.73	0.70	-	-
2.45	406038.32	1379486.08	0.89	0.50	-	-
2.56	405980.31	1379602.56	1.06	0.40	-	-
2.66	405954.42	1379772.06	1.23	0.60	-	-
2.84	405800.34	1379855.86	1.40	0.60	-	-

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
3.00	405585.17	1379883.25	1.56	1.70	-	-
3.18	405395.99	1379917.38	1.73	1.20	-	-
3.40	405194.27	1380004.09	1.90	1.60	-	-
3.29	405298.97	1379972.02	2.06	1.60	-	-
3.54	405079.06	1380094.13	2.23	2.50	-	-
3.55	405054.69	1380075.91	2.40	0.80	-	-
3.68	404923.58	1380085.02	2.56	0.60	-	-
3.71	404910.94	1380136.85	2.73	0.30	-	-
3.77	404842.03	1380197.21	2.90	0.30	-	-
3.83	404780.44	1380193.89	3.06	0.70	-	-
3.84	404744.49	1380144.30	3.23	0.60	-	-
3.89	404686.36	1380127.48	3.40	0.80	-	-
3.91	404814.51	1380508.50	3.56	1.10	-	-
3.98	404602.62	1380183.59	3.73	3.30	-	-
4.00	404568.69	1380183.71	3.90	1.30	-	-
4.01	404576.99	1380183.57	4.07	1.30	-	-
4.02	404561.18	1380190.84	4.23	0.50	-	-
4.06	404508.50	1380156.39	6.51	1.10	-	-
4.28	404008.81	1379497.40	6.84	1.10	-	-
4.29	404000.42	1379515.32	6.47	1.10	-	-
4.40	404383.32	1380686.55	2.55	1.10	-	-
5.09	403638.73	1380608.03	1.52	-	-	-
5.67	403139.53	1380908.31	1.16	-	-	-
5.76	403017.29	1380912.47	1.35	-	-	-
5.96	402820.60	1380959.34	2.08	-	-	-
6.41	402487.66	1381444.18	2.18	-	-	-
6.53	402285.12	1381252.98	2.72	-	-	-
6.72	402068.52	1381202.89	3.35	-	-	-
8.05	400805.26	1381606.12	3.60	-	-	-
8.42	400441.72	1381668.75	5.07	-	-	-
8.78	400149.83	1381895.30	5.31	-	-	-
8.78	400103.67	1381787.07	3.90	-	-	-
8.86	400002.07	1381754.68	4.89	-	-	-
9.00	399798.36	1381669.39	9.57	-	-	-
9.01	399933.06	1381894.56	8.47	-	-	-
10.72	398836.05	1383054.54	12.21	-	-	-
11.15	398460.26	1383286.49	8.05	-	-	-
11.22	398281.73	1383247.44	7.62	-	-	-
11.39	397884.77	1383179.34	8.81	-	-	-
12.11	398102.55	1384110.35	9.37	0.50	-	-
12.19	397529.34	1383962.50	10.02	0.50	-	-
12.32	397601.83	1384138.41	7.93	-	-	-
13.10	397188.81	1384775.67	15.54	0.60	-	-

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
13.13	397104.76	1384685.44	8.37	0.60	-	-
13.45	396922.09	1385065.43	11.20	0.60	-	-
13.80	396564.33	1385116.03	7.49	-	-	-
14.13	396221.03	1385158.86	7.51	0.50	-	-
14.41	395943.00	1385209.59	17.58	0.50	-	-
14.74	395621.29	1385259.81	9.14	0.50	-	-
15.00	395371.57	1385351.26	9.19	-	-	-
15.88	394532.79	1385599.76	8.65	0.80	-	-
16.33	394083.00	1385671.21	9.25	0.80	-	-
16.61	393854.06	1385984.86	14.21	0.30	-	-
16.62	393789.76	1385659.34	8.79	0.30	-	-
16.64	393741.90	1385504.56	11.61	0.30	-	-
16.79	393610.29	1385639.76	9.21	1.20	-	-
18.31	392180.35	1386186.08	12.97	-	-	-
18.51	392003.29	1386285.83	10.76	-	-	-
18.76	391745.88	1386335.32	11.57	-	-	-
18.86	391689.36	1386427.26	11.09	-	-	-
19.14	391336.17	1386403.42	12.20	-	-	-
19.30	391215.12	1386502.15	13.22	-	-	-
19.41	391168.56	1386638.01	19.68	-	-	-
20.33	390286.64	1386845.60	15.83	-	-	-
20.33	390552.59	1387452.80	17.21	0.60	-	-
20.33	390346.91	1386998.87	12.41	-	-	-
20.41	390283.81	1387045.24	12.40	-	-	-
21.13	389813.44	1387847.98	18.97	-	-	-
25.91	387632.17	1391402.30	21.68	-	-	-
27.37	386662.91	1392588.43	34.69	0.40	-	-
30.52	385755.32	1395454.62	22.26	-	-	-
31.88	385818.52	1396796.67	23.41	-	-	-
31.89	385818.78	1396814.32	24.88	-	-	-
34.13	385924.21	1399032.43	25.16	-	-	-
34.31	386015.20	1399196.49	24.04	-	-	-
34.45	386127.44	1399319.24	35.52	-	-	-
34.52	385558.55	1399494.63	26.32	-	-	-
35.42	385656.85	1400391.00	28.03	-	-	-
36.06	385932.52	1401006.82	27.54	-	-	-
37.26	386021.27	1402192.91	29.46	-	-	-
40.44	386219.85	1405175.05	30.99	0.80	-	-
40.60	386246.32	1405359.18	30.96	-	-	-
40.90	386166.27	1405671.45	31.29	-	-	-
41.02	386111.95	1405777.70	32.26	-	-	-
41.29	385945.68	1405983.33	32.76	1.00	-	-
41.92	385536.17	1406491.60	33.00	-	-	-

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
42.49	385673.65	1407167.77	33.58	0.50	-	-
43.86	384693.38	1408226.24	34.77	0.50	-	-
45.34	383709.54	1409300.89	36.67	-	-	-
47.21	382216.92	1410625.62	39.88	0.50	-	-
47.91	381538.57	1410777.63	39.78	1.20	-	-
49.85	379793.25	1411766.25	48.89	-	-	-
49.92	379694.74	1411709.26	46.04	-	-	-
50.94	378636.77	1411938.62	41.81	1.00	-	-
50.99	378603.27	1412029.69	41.54	1.00	-	-
51.97	377531.79	1411913.51	43.71	-	-	-
52.22	377288.83	1412079.41	46.54	-	-	-
52.24	377271.85	1411915.26	44.62	-	-	-
52.59	376927.66	1411512.34	47.05	-	-	-
52.65	376880.83	1412011.25	53.88	-	-	-
52.69	376814.39	1411210.62	52.92	-	-	-
52.94	376557.92	1411504.78	46.63	-	-	-
54.02	375697.08	1412263.38	48.12	-	-	-
55.61	374179.28	1412776.33	56.45	-	-	-
57.04	372919.16	1413424.61	56.31	-	-	-
58.13	371925.81	1413905.02	54.10	-	-	-
58.56	371429.27	1413849.62	56.28	-	-	-
58.57	371340.59	1413647.70	58.12	-	-	-
58.60	371603.21	1414338.58	57.88	-	-	-
58.61	371597.11	1414345.42	57.86	-	-	-
59.37	370718.83	1414534.12	56.11	-	-	-
59.45	370623.14	1414348.43	57.05	-	-	-
60.88	369141.06	1414118.83	58.81	-	-	-
65.97	364568.80	1413113.85	65.05	-	-	-
68.35	362417.30	1413997.32	69.00	-	-	-
70.38	360531.46	1414373.60	80.14	1.00	-	-
70.41	360512.20	1414607.84	71.35	-	-	-
70.45	360491.53	1415115.21	79.98	-	-	-
71.38	359496.04	1414693.32	69.37	0.60	-	-
73.67	357343.56	1415124.27	75.29	0.80	-	-
74.35	356685.96	1415752.40	84.60	-	-	-
74.56	356434.64	1414907.13	84.07	-	-	-
74.57	356437.25	1415181.91	78.41	-	-	-
74.79	356218.20	1415249.82	79.09	-	-	-
77.10	354060.69	1416158.44	82.46	-	-	-
78.69	352487.57	1416457.18	83.93	-	-	-
78.74	352452.72	1416494.19	84.17	-	-	-
79.07	352286.06	1416857.82	86.67	-	-	-
79.84	351708.58	1417355.84	86.35	0.90	-	-

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
81.17	350525.85	1417998.57	89.98	-	-	-
81.33	350776.04	1419041.39	95.57	-	-	-
83.42	348404.84	1418787.32	93.11	-	-	-
85.52	346476.91	1419413.10	97.08	-	-	-
87.07	345489.22	1420590.83	103.29	-	-	-
87.07	345444.61	1420497.92	99.42	-	-	-
87.11	345355.99	1420374.62	102.72	-	-	-
90.06	342711.56	1421483.68	107.31	-	-	-
94.62	338391.38	1421661.06	122.34	-	-	-
94.70	338340.96	1421861.59	120.39	-	-	-
94.79	338330.38	1421992.46	127.59	-	-	-
95.74	336171.19	1421767.98	129.13	-	-	-
96.54	337119.29	1423164.28	116.24	-	-	-
96.93	336812.06	1423393.35	118.43	-	-	-
97.82	335942.87	1423476.75	119.31	-	-	-
98.35	335422.21	1423369.43	120.71	-	-	-
98.77	334996.64	1423302.77	122.27	-	-	-
100.94	332836.84	1423517.59	128.38	-	-	-
101.79	332220.86	1424292.39	136.76	-	-	-
101.84	332008.33	1423846.83	131.67	-	-	-
103.64	330181.18	1423353.77	130.98	1.20	-	-
105.87	328075.54	1423458.01	136.74	-	-	-
106.63	327310.53	1423256.30	139.35	-	-	-
107.30	326625.93	1423287.89	140.00	-	-	-
108.33	325625.13	1422517.72	149.01	-	-	-
108.88	325012.11	1423260.25	150.56	-	-	-
110.46	323377.50	1423823.70	147.41	-	-	-
110.47	323417.66	1423884.78	148.87	1.10	-	-
111.54	322553.93	1424620.12	150.18	-	-	-
112.83	321849.53	1425755.27	150.11	-	-	-
113.94	321171.89	1426510.23	160.13	-	-	-
114.81	320588.29	1427149.65	157.11	-	-	-
115.74	319813.18	1427670.75	158.45	-	-	-
117.09	318751.91	1428564.57	158.79	-	-	-
117.19	318517.40	1428178.63	168.12	-	-	-
117.28	318635.50	1428791.34	167.36	-	-	-
117.31	318537.86	1428591.70	160.39	-	-	-
117.44	318301.81	1428261.05	167.26	-	-	-
118.54	317238.29	1428380.53	165.16	-	-	-
119.59	316268.31	1428712.04	164.36	-	-	-
119.62	316246.29	1428491.67	169.76	-	-	-
121.30	314557.06	1429056.83	168.80	-	-	-
122.62	313261.39	1429465.45	169.65	-	-	-

Chainage (km)	Easting (m)	Northing (m)	River Bed Level w.r.t MSL (m)	Observed Water Depths (m)	Adopted CD	Reduced Depth
122.87	313105.03	1429668.53	173.18	-	-	-
123.48	312599.71	1430013.80	172.88	-	-	-
124.11	311589.00	1429849.66	180.75	-	-	-
124.88	311043.57	1430609.44	180.03	-	-	-
125.80	311105.30	1431804.63	176.45	-	-	-
126.73	310381.04	1432360.58	178.33	-	-	-
127.76	309450.24	1432763.49	181.44	-	-	-
128.55	308702.50	1433009.11	181.42	-	-	-
128.55	308781.36	1433247.83	183.84	-	-	-
128.56	308653.78	1432911.90	184.34	-	-	-
129.23	307941.07	1431812.86	189.20	-	-	-
130.13	307176.56	1433057.33	184.30	-	-	-
130.82	306497.46	1432939.57	185.84	-	-	-
130.92	306413.36	1432867.08	185.84	-	-	-
132.45	304902.47	1432664.98	189.71	-	-	-
132.61	304745.09	1432715.05	190.10	-	-	-
133.39	303953.96	1432719.15	190.14	-	-	-
134.03	303336.39	1432869.49	193.14	-	-	-
135.00	302390.19	1432845.65	193.79	-	-	-
135.81	301572.44	1432818.28	195.27	-	-	-
137.44	300137.80	1432053.65	198.29	-	-	-
137.86	299815.38	1431788.05	207.38	0.30	-	-
138.28	299385.02	1431704.36	199.90	-	-	-
139.75	298029.28	1431416.47	209.76	-	-	-
139.81	298002.60	1431273.80	201.04	0.30	-	-
139.84	298068.62	1430783.86	208.30	0.30	-	-
140.15	297719.80	1430749.62	211.79	-	-	-
140.16	297680.42	1431388.36	210.59	-	-	-
140.18	297678.21	1430984.47	204.85	-	-	-
141.28	296584.95	1430940.63	207.99	0.30	-	-

Table 15: Topographic survey Water levels (Observed and Reduced)

4.6 Observed and reduced bed profile along the river

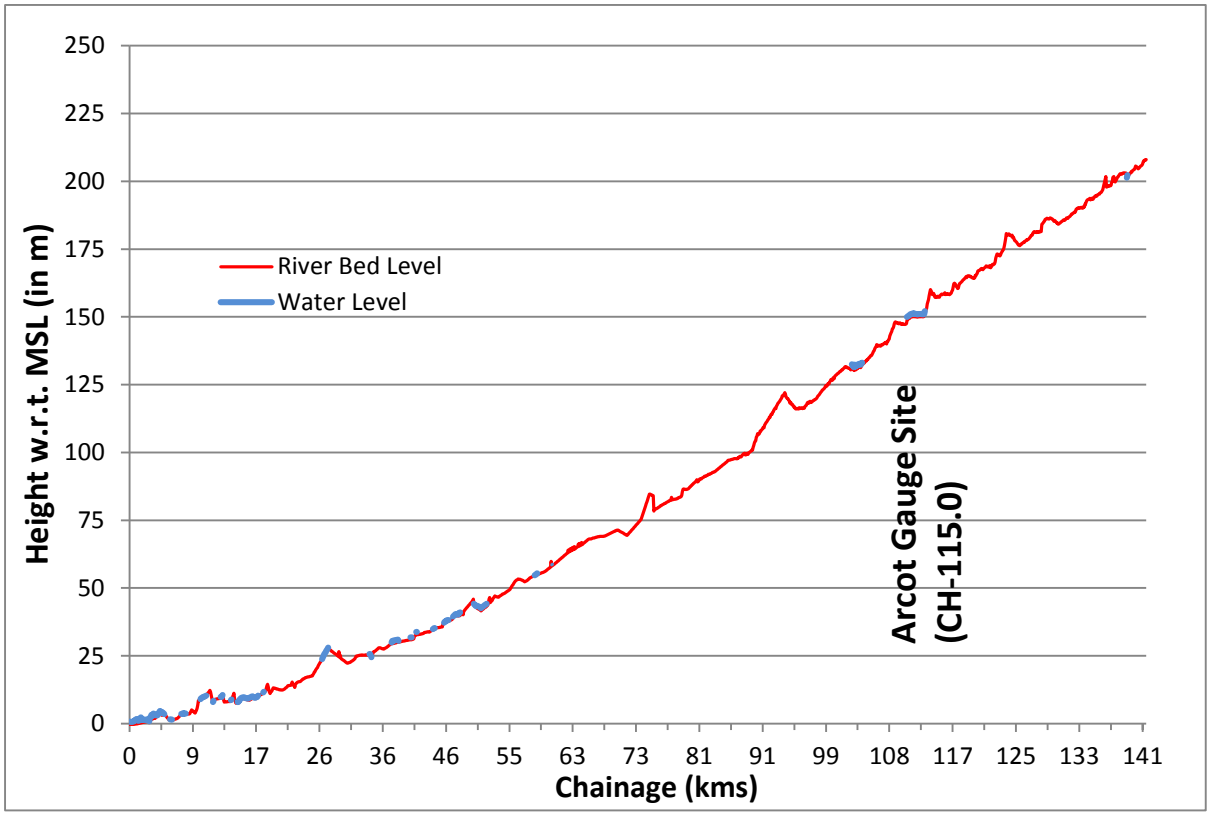


Figure 27: Riverbed profile (full river stretch) from the Delta area Kp 0 till the end at Kp 141.0.

4.7 Results from Hydrographic/Topographic Survey

- The surveyed 140 Km of the Palar River was generally observed to be dry, with a few shallow water patches on its entire stretch.

4.8 Soil characteristics

The details of CH vs soil textures are tabulated in **Annexure 1.**

From visual observation, there is formation of sand bars at the mouth of most of the river. In general the river bed material is mostly medium and coarse sand with some silt and clay. In upper reaches the river bed comprises of coarse sand. Rocky and hard strata is not observed while carrying out the reconnaissance survey.

Crtical areas requiring detailed investigations

Detailed investigations shall be required at proposed ferry locations nearby temples, Existing boating points and Ghats.

4.9 Water characteristics

The major stretch of River was found dry. In the tidal zone, clear water was observed. In some reaches, patches of clear water were also observed.

4.10 Condition of banks

Condition of banks has been depicted in chapter 3 (Annexure 2).

4.11 Details of collected water level and Discharge data

The details of gauging stations and collected data as detailed in chapter 2 (refer 2.6.3 and 2.6.4) is again given below:

Name	Chainage	Location	
		Lat.	Long.
Arcot Gauging station, Tamilnadu	115 km	12^0 54′ 90” N	77^0 20′ 00” E

Table 16: Location details of gauging station

The details of Gauge station, jurisdiction, establishment and data availability are presented in the tables below:

General Details	
Station Name	Arcot
Station Code	CQ000I7
Operational Status	Existing
Activity	HO
Station Type (Current)	GDQ
Tehsil/Taluk	Arcot
District	Vellore
State	Tamil Nadu
Latitude (DMS)	12°54'42"N
Longitude (DMS)	79°20'13"E
Altitude (m)	161.00
Distance to Outlet (km)	-
Toposheet No.	57P5
Catchment Area (sq. km)	10174.00

Table 17: Arcot GD site- General details

Jurisdiction Details	
Owner Agency	CWC
State/Regional Office	C&S RO, Coimbatore
Circle Office	S.E.(C&SR), Bangalore
Divisional Office	Hydrology Division, Chennai
Sub Divisional Office	Palar Ponnaiyar SD, Chennai
Section Office	Arcot
Nearest Airport	Chennai
Town	Arcot
Railway Station	Walajapet
Bus Stand	Arcot
Station Bank	Right
Zero of Gauge (m)	-

Table 18: Arcot GD site- Jurisdiction details

Establishment Details		
Date of establishment	20/9/1979	
Date of closure	-	

Parameters	Start Date	End Date
Gauge	20/9/1979	
Discharge	20/9/1979	
Sediment	-	
Water Quality	1/6/1988	
Rainfall(ORG)	22/9/1978	
Rainfall(SRG)	-	
Temperature	20/9/1979	
Wind Velocity	1/7/2008	
Evaporation	-	
Humidity	-	
Sunshine	-	

Table 19: Arcot GD site- Establishment details

Parameters	Start Date	End Date
Water Level	20/9/1979	20/1/2011
Discharge	20/9/1979	20/1/2011
Sediment	Not Available	
Water Quality	1/6/1995	1/5/2013
Rainfall	Not Available	
Temperature	20/9/1979	31/5/2009
Climatic	Not Available	

Table 20: Arcot GD site - Data availability

4.12 Methodology for analysis of Gauge- Discharge Data

The gauge-discharge data available for number of years for all gauging stations were analyzed in different ways as given below:

10 Daily average discharges

The ten daily average discharges in each month for each year were worked out and then the average of average 10 daily discharges over the entire period of data were worked out to get idea about availability of 10 daily average discharge during different months of the year. Based on these average 10 daily discharges it will be possible to work out available depth of flow for natural or design cross section of river. These data analysis will be helpful for navigation feasibility in given stretch of river. The outcome from this analysis will also be useful for mathematical model studies(to be carried out in stage II) to predict longitudinal water surface profiles for different discharges along given reach of river and also to design section of navigation channel on river bed.

Maximum minimum discharges and water levels

The yearly maximum discharge and water level for the entire period of data were extracted and then these data were statistically analysed using Gumbel extreme value distribution to estimate flood discharges for different return periods such as 2,5, 10, 25 ,50 and 100 years. Similarly high flood levels were analysed. The minimum flow and minimum water level data was also analysed. The estimated HFLs and Minimum water levels will be useful for planning navigation as well as for design of terminals for cargo and passenger traffic.

Gauge discharge curves

Using available gauge discharge data G-Q curves were developed for each gauge station. These will be helpful to compute water level for any discharge. Also for calibration and validation of mathematical model (studies required in stage II) this data will be very useful.

Comparison of River Cross Section Data:

The river cross sections at gauging stations on different station were available for different years. For a given gauging station the cross sections for different years including the latest cross section were superimposed to study changes in river bed levels and shifting of the deep channel if any over the period of data.

Period of availability for range of discharges

For a navigation channel to be feasible it is necessary that adequate discharge is available to maintain required depth/draft for fairly longer duration during the year. The data for each gauge station was analyzed to find out period of availability for the different range of discharges. Based on past 20 to 30 years of data, % of days in a year for availability of different range of discharges were worked out. These data will be very useful to estimate number of days for which minimum discharge required to facilitate navigation will be available in different rivers.

Discharge- sediment flow data

These data was analyzed to prepare discharge v/s sediment concentration plot for each gauging station. This analysis will be useful to understand sediment concentration in reach for range of discharges.

4.13 Bed Slope

The average bed slopes for Palar River for the reach under consideration are given in table below:

River	Reach		River Bed Level Change	Distance	Slope
	From	To			
Palar	Avarankuppam RBL 365.73 m	Arcot RBL 158.07 m	207.66 m	99.11 km	1/477
	Arcot RBL 158.07 m	Mouth RBL 0.0 m	158.07 m	114.35 km	1/723

Table 21: Bed Slopes of Palar River

RBL – River Bed Level (These are taken from CWC river cross sections at gauging sites)

4.14 River Cross sections

The CWC data of river cross sections at gauging sites on Palar river was available for number of years. The river cross sections at a gauging site for different years were compared to understand morphological changes over the longer period.

Figure 28 and Figure 29 show plots for two gauging stations on Palar river indicating comparison of cross sections in different years. Following table shows abstract of review of these studies.

River & Gauge location	General Description & Bank to Bank width	River bed level in 2012	Bank Levels	Comments/ observations
Palar at Avarankuppam	Well defined c/s width - 220 m, deep channel on left bank (Figure 28)	365.73m	369m	Cross section more or less remains same during 2000 to 2012 with marginal lowering of deep channel bed by 0.50 m
Palar at Arcot	Wide c/s with sand bars, width 935 m, deep channels on left & right bank (Figure 29)	158.07m	161.5 to 163.5m	2012 bed levels are 0.5 to1 m lower than 2001 levels. No shift in deep channel positions

Table 22: River cross-sections over different years

4.15 Ten- Daily average Discharges

4.15.1 Arcot Gauge data analysis

Analysis of 10 daily average flows is presented in (-) ***Stands for Data not available*** ***Table 23***. Figure 30 shows bar chart indicating variation in 10 daily average discharges round the year. It could be seen from these data that practically negligible or no discharge in river during February to September. On an average some flow is observed during October to December. The results of this analysis indicate range of average 10 daily flows in different period of year as follows.

- ➔ June to August 0 to 3 m^3/s
- ➔ September to December 15 to 60 m3/s
- ➔ January to May 5 to 2 m^3/s

The gauge- discharge curve derived from the daily discharge data during periods of high floods is presented vide Figure 31.

4.15.2 Avarankuppam Gauge data analysis

Analysis of 10 daily average flows is presented in (-) ***Stands for Data not available*** ***Table 24***. Figure 32 shows bar chart indicating variation in 10 daily average discharges round the year. It could be seen from these data that practically negligible or no flow in river during February to September. The results of this analysis indicate range of average 10 daily flows in different period of year as following.

June to August 0 to 2 m^3/s
October to December 7 to 4 m^3/s
January to May less than 1m^3/s

The gauge- discharge curve derived from the daily discharge data during periods of high floods is presented vide Figure 33.

YEAR	JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH			APRIL			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1979-1980	-	-	-	-	-	-	-	-	-	-	-	62.82	18.52	7.60	0.23	5.14	223.39	256.49	72.74	32.41	10.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1980-1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.50	1.29	0.38	-	-	-	-	-	-	-	-	-	-	-	-
1981-1982	-	-	-	-	-	-	-	-	-	-	190.14	11.39	41.46	22.18	48.03	102.44	30.19	3.02	14.23	1.26	0.68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982-1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983-1984	-	-	-	-	-	-	-	-	-	-	57.88	1.31	0.84	-	0.27	0.39	0.00	-	-	-	19.64	0.27	-	-	-	24.01	1.44	13.67	1.27	0.17	-	-	-	-	-	-
1984-1985	-	-	-	-	-	0.46	0.13	-	-	-	-	-	5.10	1.52	0.00	-	5.26	0.55	4.13	0.14	0.14	0.89	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-
1985-1986	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	-	-	35.28	2.58	1.06	0.06	-		4.67	0.35	-	0.30	0.03	-	-	-	-	-	-	-	-	-
1986-1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987-1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988-1989	-	-	-	-	-	-	-	-	-	10.38	37.20	37.62	34.94	9.74	0.45	0.93	0.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1989-1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990-1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991-1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	970.90	428.68	475.96	201.39	43.32	10.17	4.81	2.13	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-
1992-1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			0.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993-1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	130.05	86.85	11.03	71.69	34.07	10.11	3.26	1.51	0.07	-	-	-	-	-	-	-	-	-	-	-	-
1994-1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.06	3.27	1.75	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.93
1995-1996	-	-	1.80	0.41	-	-	2.26	3.38	8.40	1.85	10.34	6.06	5.00	2.98	3.90	9.91	3.43	0.69	0.35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-1997	-	-	-	-	-	-	-	-	0.69	60.79	67.46	73.43	65.44	67.23	111.91	33.48	20.92	32.10	19.71	247.69	97.07	19.74	15.16	8.96	1.23	0.53	-	-	-	-	-	-	-	-	-	-
1997-1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.83	8.50	20.60	18.26	8.86	1.87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998-1999	-	-	-	-	-	-	-	-	-	-	-	-	16.50	17.64	0.64	14.80	7.54	3.62	1.54	8.25	2.86	0.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999-2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-	-	-	-	-	-	-	23.92	24.61	20.71	12.04	7.78	4.37	0.26	0.00	2.23	0.00	0.00	0.00			-	-	-	-	-	-	-	-	-	-
2002-2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79.54	47.70	8.97	33.19	41.53	29.79	10.91	3.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006-2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.21	2.95	0.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008-2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.18	0.03	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.52	0.66	0.56	2.96	1.80	0.58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-2011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.03	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAXIMUM	0.00	0.00	1.80	0.41	0.00	0.46	2.26	3.38	8.40	60.79	190.14	73.43	65.44	67.23	970.90	428.68	475.96	256.49	72.74	247.69	97.07	19.74	15.16	8.96	1.23	24.01	1.44	13.67	1.27	0.17	0.00	0.00	0.00	0.00	0.00	0.93
MINIMUM	0.00	0.00	1.80	0.41	0.00	0.46	0.13	3.38	0.69	1.85	10.34	1.31	0.84	0.00	0.00	0.17	0.00	0.28	0.03	0.00	0.14	0.00	0.00	0.00	1.23	0.30	0.03	13.67	1.27	0.17	0.00	0.00	0.00	0.00	0.00	0.93
AVERAGE	-	-	1.80	0.41	-	0.46	1.19	3.38	4.54	24.34	72.60	32.11	23.52	17.06	112.41	56.59	53.88	35.08	19.64	28.08	13.19	3.29	3.25	1.95	1.23	8.28	0.73	13.67	1.27	0.17	-	-	-	-	-	0.93

(-) Stands for Data not available

Table 23: Mean 10 daily discharges in cumecs at Arcot

YEAR	JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH			APRIL			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1978-1979	2.70	1.30	0.77	0.00	1.84	0.69	-	-	0.42	2.57	5.69	31.77	13.42	5.53	1.83	8.63	3.17	2.02	2.84	2.52	2.30	1.78	0.93	0.65	0.42	0.39	2.25	0.46	0.24	0.14	0.08	0.08	0.10	0.08	0.20	0.09
1979-1980	0.75	0.46	0.20	0.10	-	3.27	0.28	0.05	1.96	3.46	33.93	25.78	25.08	6.70	2.73	5.68	58.70	42.91	9.84	3.63	2.52	2.11	2.00	1.28	1.04	0.92	0.44	0.33	0.47	0.14	0.10	0.10	0.11	0.21	0.23	0.09
1980-1981	0.36	0.10	0.04	0.00	0.00	0.02	-	-	-	-	-	0.05	0.00	0.00	0.24		0.07	0.03	0.01	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00
1981-1982	3.23	0.08	-	-	-	3.60	0.20	-	2.23	11.03	82.07	10.30	35.05	9.24	13.31	43.67	10.25	4.23	3.82	2.30	1.65	1.17	0.99	0.85	0.70	0.44	0.40	0.19	0.13	0.50	0.13	0.01	0.10	1.66	1.01	0.33
1982-1983	2.06	0.61	0.11	0.00	-	0.00		-	-	-	1.85	0.45	0.02	0.00	0.06	0.52	0.30	0.06	0.02	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	1.10
1983-1984	0.70	1.13	0.00	-	-			-	1.04	11.84	19.25	1.84	0.99	3.49	0.86	0.90	0.28	0.23	0.22	0.22	1.82	0.48	0.36	0.15	0.23	0.67	0.17	0.61	0.45	0.08	0.09	0.16	0.01	0.00	-	0.58
1984-1985	0.00	-	-	-	-	1.17	0.08	-	-	-	0.56	1.45	7.86	0.94	1.14	0.12	0.55	0.35	0.37	0.09	0.00	0.12	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-	-
1985-1986	0.36	0.01	-	-	-	0.11	0.00	-	1.44	2.53	7.12	5.37	5.36	3.09	1.13	1.38	3.18	1.84	0.69	0.29	0.17	0.14	0.16	0.09	0.15	0.23	0.09	0.00	0.01	-	-	-	0.50	0.11	0.00	0.11
1986-1987	1.08	0.37	0.03	-	-		1.05	-	0.82	0.84	13.58	8.36	13.39	3.06	1.33	8.16	2.71	1.04	1.01	0.70	0.49	0.37	0.31	0.15	0.11	0.07	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-
1987-1988	-	-	1.20	0.09	0.00	2.45	0.09	-	-	-	0.00	0.55	8.63	9.02	1.53	0.82	0.60	0.65	0.35	0.66	1.16	0.23	0.10	0.05	0.02	-	-	0.17	-	-	-	-	-	0.12	0.04	0.98
1988-1989	0.03	-	-	2.00	0.27	0.05	16.90	5.00	8.64	6.11	21.48	36.97	7.14	3.27	1.44	1.55	1.04	0.61	0.54	0.71	0.21	0.17	0.14	0.08	0.04	0.02	-	-	-	-	-	-	-	-	-	-
1989-1990	0.93	0.02	-	10.16	4.21	0.61	0.02			0.83	3.67	8.43	18.12	2.48	0.86	0.62	1.68	0.77	0.53	0.26	0.11	0.12	0.13	0.01	0.00	0.02	0.01	-	0.14	2.24	-	-	-	-	-	-
1990-1991	0.04	1.03	1.87	-	-	-	-	-	-		1.03	1.87	0.08	1.56	0.10	0.11	0.05	0.07	0.06	0.01			-	-	-	-	-	-	-	-	4.42	-	-	-	-	-
1991-1992	0.19	0.15	-	-	-	-	-	-	-	0.49	2.84	0.00	2.97	0.33	33.43	40.49	69.60	17.57	5.82	3.41	1.78	1.56	1.01	0.52	0.38	0.26	0.10	0.14	0.18	0.10	0.10	0.13	0.13	0.40	0.94	0.59
1992-1993	1.92	1.59	0.09	0.12	0.05	-	-	-	-		1.15	0.34	1.15	3.86	1.03	0.58	2.75	2.79	0.76	0.38	0.10	0.10	0.05	0.03	0.02	-	-	-	-	-	-	-	-	-	-	-
1993-1994	1.73	0.08	-	-	0.65	0.12	0.38	-	-	0.67	0.03	0.15	0.17	2.55	7.09	8.14	14.31	1.15	17.64	3.75	1.08	0.34	0.16	0.09	0.06	0.06	-	-	-	-	-	-	-	-	-	0.40
1994-1995	0.11	-	-	1.01	0.11	-	-	-	0.03	-	0.97	0.14	0.28	1.05	1.12	3.07	1.58	0.50	0.22	0.12	0.13	0.08	0.06	0.05	0.00	-	-	-	-	-	-	-	-	0.19	0.03	0.36
1995-1996	0.05	-	-	-	-	-	0.88	0.44	12.00	2.21	8.35	3.65	7.23	3.75	5.69	21.32	1.90	0.82	0.33	0.15			-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996-1997		2.73	0.10	-	-	-	-	4.32	2.00	25.58	15.96	42.63	17.17	52.50	20.58	6.16	4.41	5.53	3.21	49.76	11.06	3.87	2.72	1.14	0.82	0.51	0.28	0.14	0.00	0.00	1.54	0.49	0.00	-	-	-
1997-1998	-	-	-	-	-	-	-	-	-	1.81	5.95	0.78	3.77	0.64	2.58	2.37	5.00	4.43	2.60	2.33	1.30	0.70	0.38	0.22	0.11	0.07	0.02	0.01		-	-	-	-	-	-	-
1998-1999	-	-	-	-	-	-	0.35	3.53	2.18	1.93	0.43	2.16	13.95	34.06	6.03	20.93	11.69	6.91	3.41	7.53	2.15	1.02	0.79	0.47	0.25	0.17	0.12	0.05	0.02	-	-	-	-	0.00	0.99	0.51
1999-2000	0.00	0.00	0.00	-	-	-	-	-	-	-	-	2.75	0.41	0.89	3.13	0.47	0.16	0.48	0.42	0.13	0.36	0.08	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	-	-	-	-	0.44	0.35	0.74	0.06	0.00	0.02	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-	2.94	0.00	0.00	-	1.72	8.47	45.32	65.02	34.08	8.43	6.75	2.87	1.29	1.13	1.26	0.37	0.31	0.30	0.20	0.07	0.03	0.01	-	-	0.14	-	-	-	-	-
2002-2003	0.81	0.13	0.13	0.05	-	-	-	-	-	-	0.00	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	0.00	0.00	0.15	0.00	-	-	-	-	-	-	-	-	-	0.00	0.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13
2004-2005	0.70	0.30	-	-	1.11	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2005-2006	-	-	-	-	-	-	-	-	-	-	-	-	3.40	4.41	103.38	31.86	8.13	22.09	28.01	10.72	5.40	3.20	2.00	1.04	0.65	0.46	0.14	0.11	1.36	0.42	0.26	0.31	0.26	0.12	0.17	0.32
2006-2007	0.11	0.85	1.11	0.28	0.00		0.42	0.20	0.17	1.30	0.17	1.30	6.12	3.44	1.37	2.26	1.79	1.35	0.70	0.64	0.38	0.20	0.09	0.05	0.02	0.00	-	-	-	-	-	-	-	-	-	-
2007-2008	-	-	-	-	-	-	-	-	0.27	0.10	0.52	0.17	0.09	0.03	0.57	0.42	0.22	0.19	0.04	0.51	0.74	0.32	0.18	0.06	0.03	0.01	0.01	-	-	-	-	-	-	-	-	-
2008-2009	-	-	-	-	-	-	-	-	-	1.25	0.28	0.04	-	0.59	9.05	0.92	0.45	3.72	3.05	0.87	0.55	0.30	0.17	0.06	0.05	0.00	-	-	-	-	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	-	-	-	-	10.68	5.35	0.73	0.24	0.20	0.64	1.30	0.63	0.31	0.30	0.19	0.06	0.05	0.02	0.02	0.01	0.00	-	-	-	-	-	-	-	-	-
2010-2011	0.15	0.11	0.02	0.01	0.10	0.01	0.00	0.00	0.00	0.00	-	-	-	0.03	0.01	3.61	1.92	2.39	1.45	1.33	0.73	0.33	0.18	0.10	0.02	0.01	0.05	0.57	0.00	-	-	-	0.04	0.00		-
2010-2011	0.16	0.02	0.00	0.03	0.00			9.91	0.70	0.21	0.42	0.16	0.52	0.66	0.29	0.99	0.25	0.42	0.30	0.29	0.08	0.19	0.03	0.00	0.00	0.00	-	-	-	-	-	-		0.12	0.00	-
MAXIMUM	3.23	2.73	1.87	10.16	4.21	3.60	16.90	9.91	12.00	25.58	82.07	42.63	45.32	65.02	103.38	43.67	69.60	42.91	28.01	49.76	11.06	3.87	2.72	1.28	1.04	0.92	2.25	0.61	1.36	2.24	4.42	0.49	0.50	1.66	1.01	1.10
MINIMUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
AVERAGE	0.76	0.53	0.36	0.99	0.70	1.01	1.69	2.60	2.12	3.94	8.88	7.19	8.24	6.96	8.05	7.50	6.93	4.15	2.90	3.16	1.35	0.72	0.51	0.30	0.21	0.20	0.26	0.20	0.25	0.40	0.69	0.18	0.14	0.23	0.33	0.40

(-) Stands for Data not available

Table 24: Mean 10 daily discharges in cumecs at Avarankuppam

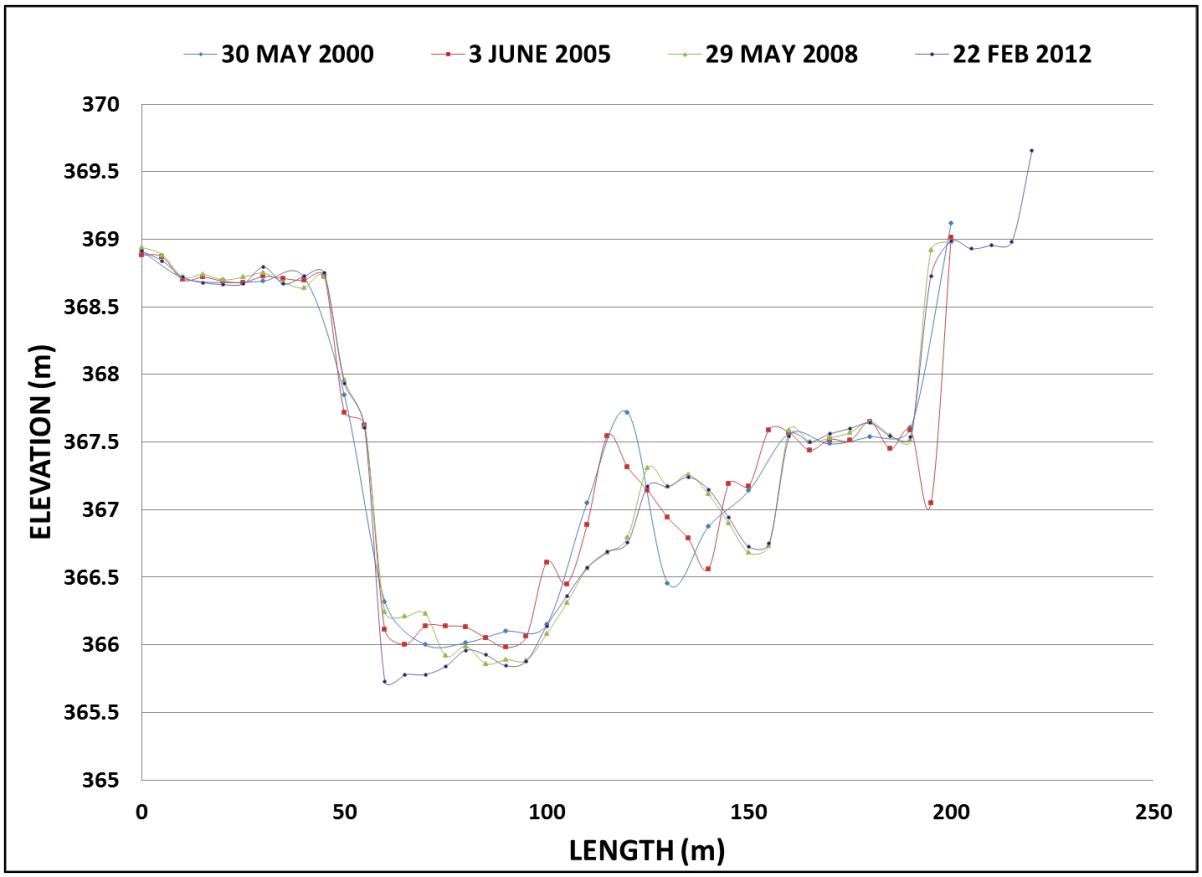


Figure 28: Comparison of Palar river cross-section in different years at Avarankuppam gauging station

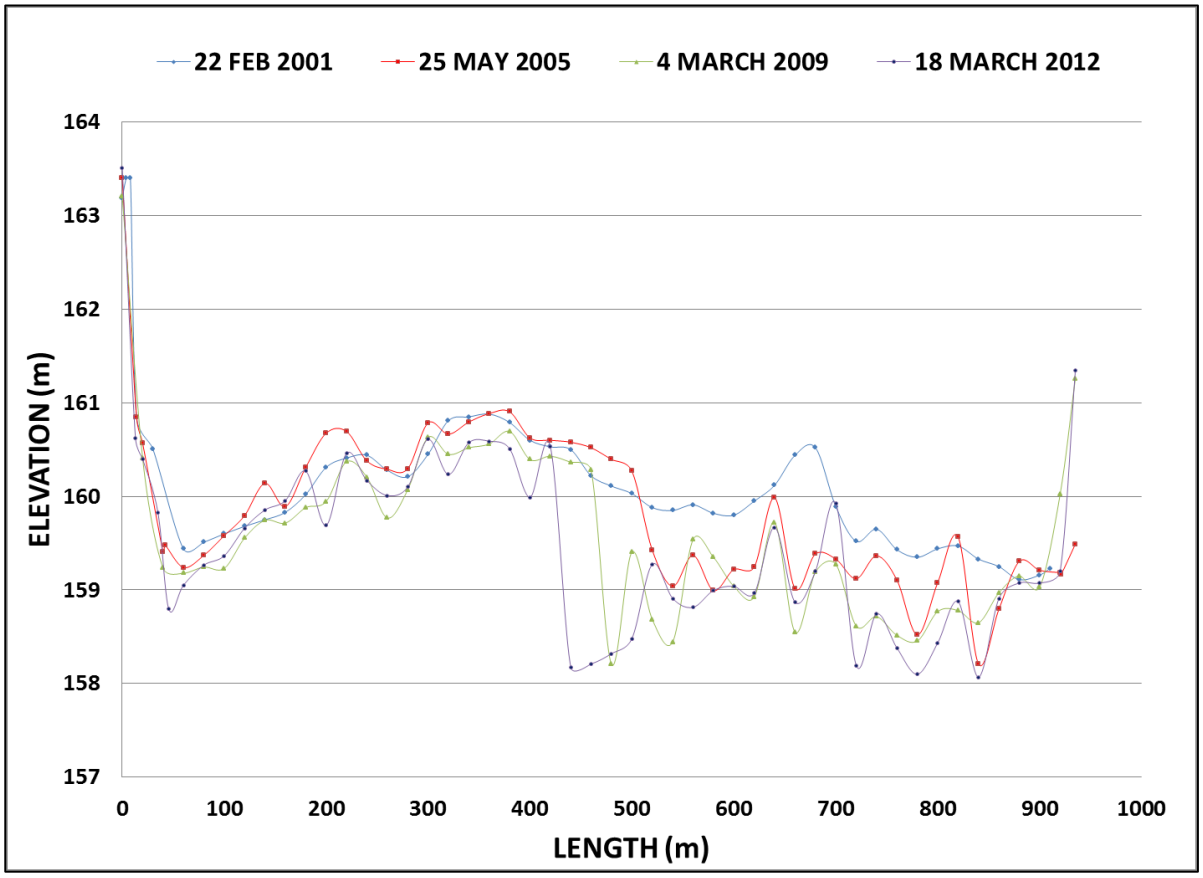


Figure 29: Comparison of Palar river cross-section in different years at Arcot gauging station

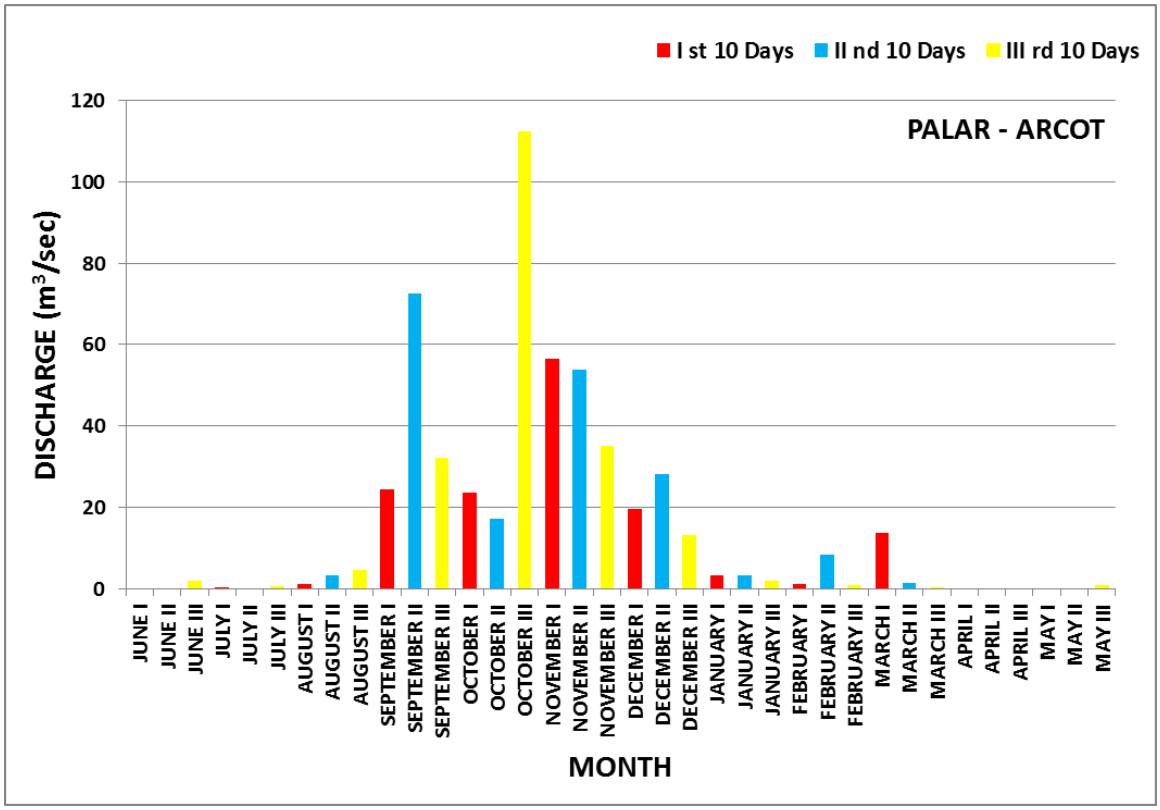


Figure 30: Average 10 daily discharges at Arcot gauging site on Palar River

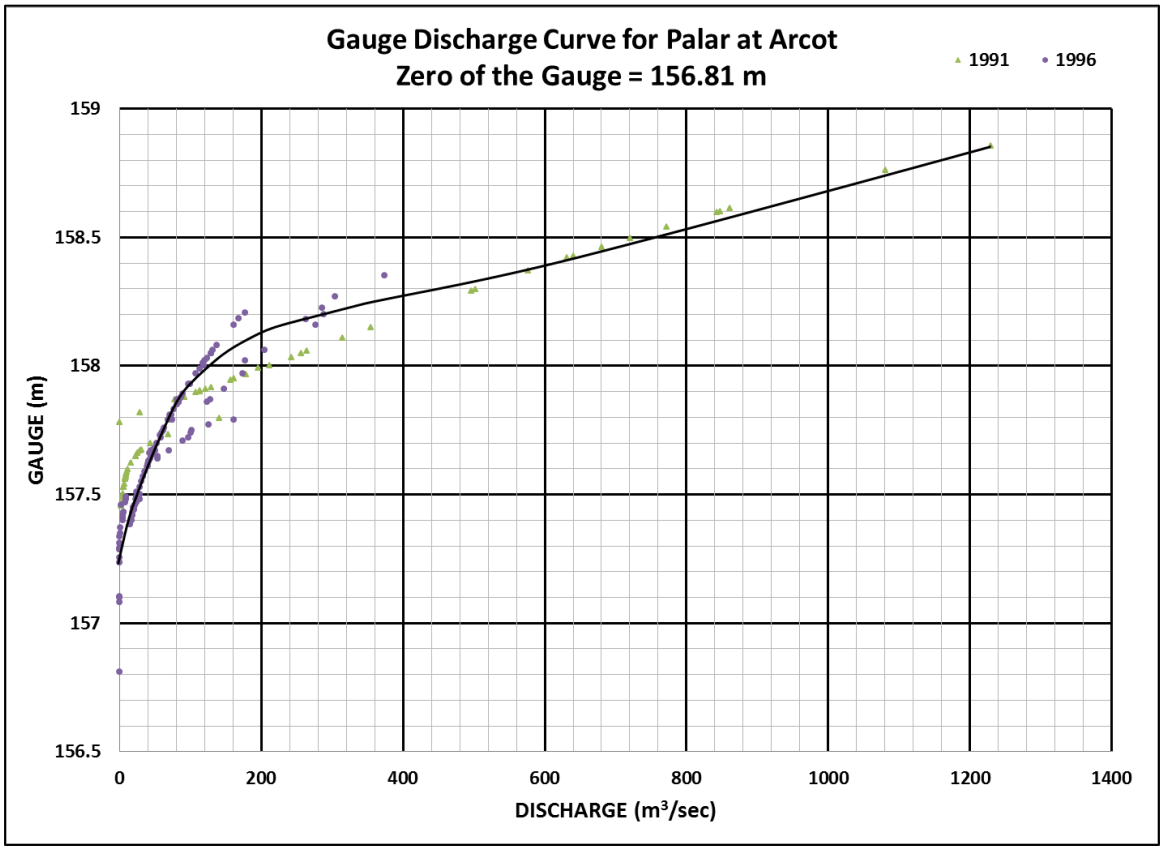


Figure 31: Gauge discharge curve for River Palar at Arcot gauge station

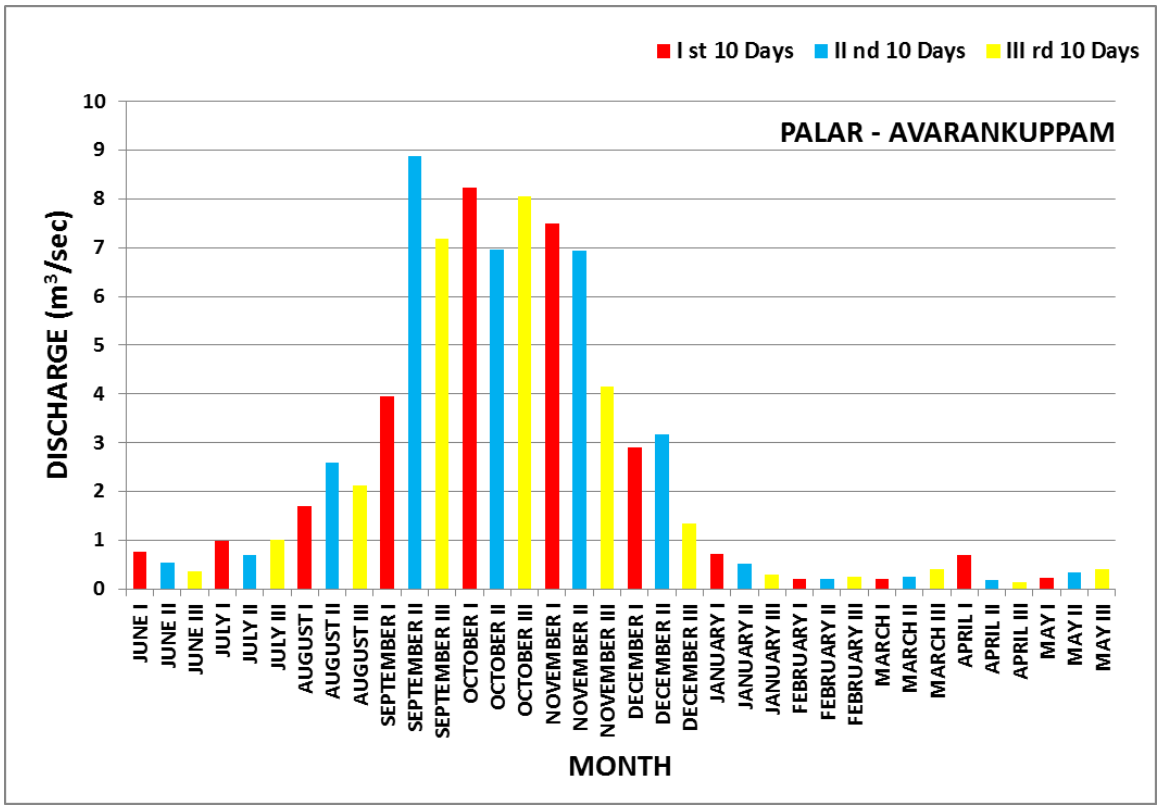


Figure 32: Average 10 daily discharges at Avarankuppam gauging site on Palar River

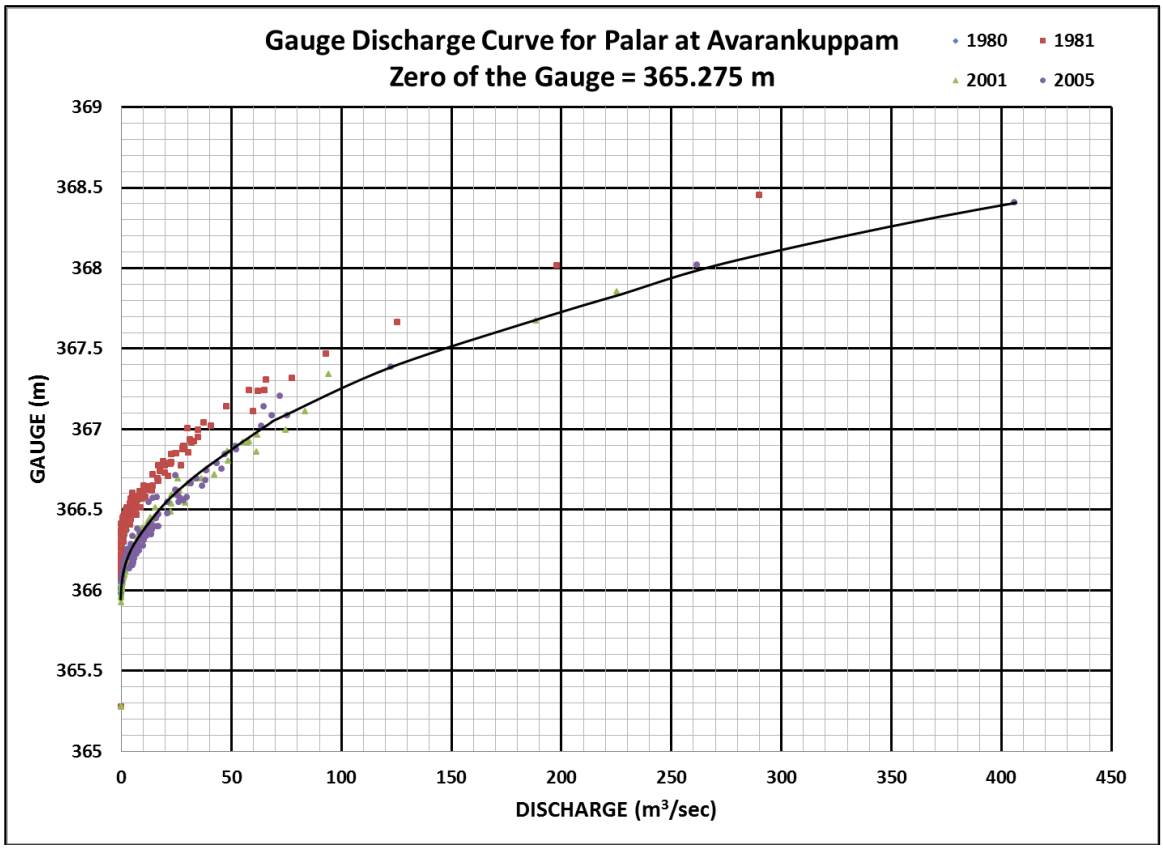


Figure 33: Gauge discharge curve for River Palar at Avarankuppam gauge station

4.16 Monthly minimum and Maximum Water levels

The gauge-discharge data at Palar available is analyzed in different ways. The monthly minimum and maximum water levels for the entire period of data were extracted for both Arcot and Avarankuppam GD sites and are tabulated below.

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN		MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1978-1979	366.57	366.43	366.61	365.28	366.48	365.28	367.96	366.42	367.27	366.48	366.79	366.46	366.56	366.43	366.52	366.34	366.55	366.32	366.37	366.17	366.265	365.975	366.32	366.14
1979-1980	366.49	366.27	366.87	365.28	366.63	366.21	368.14	366.28	367.12	366.47	368.36	366.46	366.70	366.39	366.38	366.36	366.36	366.30	366.375	366.255	366.26	366.055	366.325	366.13
1980-1981	366.32	366.10	366.11	365.99	-	-	366.07	366.04	366.40	365.28	366.20	366.10	366.16	366.08	-	-	-	-	-	-	-	-	366.41	365.275
1981-1982	366.51	366.12	366.61	366.38	366.60	366.28	368.45	366.31	367.32	366.38	367.67	366.47	366.58	366.44	366.46	366.43	366.46	366.38	366.525	366.36	366.39	366.205	366.555	366.265
1982-1983	366.67	366.34	366.34	366.31	-	-	366.62	366.35	366.40	366.31	366.50	366.31	366.34	366.27	366.30	366.28	-	-	-	-	-	-	366.475	366.275
1983-1984	366.66	366.29	-	-	366.72	366.43	367.41	366.41	366.62	366.35	366.47	366.36	366.58	366.58	366.42	366.34	366.48	366.32	366.49	366.305	366.385	366.305	366.545	366.29
1984-1985	366.31	366.30	366.69	366.35	366.37	366.31	366.71	365.28	366.89	366.38	366.50	366.35	366.42	366.29	366.36	366.27	366.28	366.23	-	-	-	-	-	-
1985-1986	366.41	366.25	366.35	365.28	366.73	365.28	366.98	366.27	366.77	366.44	366.69	366.43	366.45	366.38	366.40	366.34	366.47	366.32	366.34	366.285	366.405	366.405	366.435	366.295
1986-1987	366.48	365.28	-	-	366.56	366.31	367.16	366.29	367.29	366.44	366.90	366.39	366.43	366.32	366.33	366.26	366.29	366.24	366.275	366.185	366.215	366.16	366.595	365.275
1987-1988	366.60	365.28	366.53	366.28	366.39	366.23	366.51	365.28	367.52	366.28	366.40	366.27	366.48	366.24	366.25	366.13	366.16	366.03	366.35	366.11	-	-	366.38	366.1
1988-1989	366.20	366.11	366.67	366.10	367.21	365.28	367.75	366.44	366.57	366.29	366.37	366.28	366.34	366.23	366.26	366.20	366.23	366.17	-	-	-	-	-	-
1989-1990	366.47	365.28	366.95	366.15	366.14	366.09	366.80	365.28	367.12	366.29	366.43	366.25	366.28	366.17	366.26	366.11	366.17	366.11	366.195	366.115	-	-	366.585	366.27
1990-1991	366.26	365.28	-	-	-	-	366.65	366.25	366.67	365.28	366.33	366.33	366.28	366.23	-	-	-	-	-	-	366.545	366.545	-	-
1991-1992	366.55	366.29	-	-	-	-	366.77	366.23	367.93	366.23	367.85	366.38	366.38	366.27	366.28	366.16	366.20	366.12	366.167	366.125	366.193	366.113	366.308	366.1
1992-1993	366.53	366.13	366.18	366.10	-	-	366.29	366.15	366.65	366.18	366.44	366.19	366.29	366.20	366.21	366.18	366.18	366.14	-	-	-	-	-	-
1993-1994	366.40	366.19	366.41	366.20	366.23	366.23	366.41	366.18	366.75	366.20	366.98	366.27	367.28	366.24	366.26	366.15	366.16	366.11	-	-	-	-	366.315	366.215
1994-1995	366.25	366.19	366.36	366.14	366.15	366.10	366.48	366.16	366.74	366.21	366.60	366.22	366.23	366.19	366.18	366.11	366.10	366.09	-	-	-	-	366.305	366.1
1995-1996	366.19	366.13	-	-	367.16	366.16	366.98	366.29	366.78	366.41	366.78	367.62	366.28	366.24	366.15	-	-	-	-	-	-	-	-	-
1996-1997	366.65	366.18	-	-	366.62	366.17	367.98	366.35	368.04	366.30	366.50	366.31	366.89	366.28	366.38	366.25	366.26	366.19	366.2	366.075	366.455	365.275	-	-
1997-1998	-	-	-	-	-	-	366.68	366.17	366.56	366.20	366.79	366.26	366.39	366.26	366.25	366.17	366.17	366.11	366.115	366.07	-	-	-	-
1998-1999	-	-	-	-	366.59	366.03	366.39	366.11	367.50	366.31	367.10	366.29	366.52	366.17	366.16	366.04	366.05	365.97	365.965	365.895	-	-	366.225	365.89
1999-2000	365.90	365.88	-	-	-	-	366.43	365.28	366.79	365.95	366.13	366.04	366.12	366.02	366.06	365.93	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	366.16	365.28	365.96	365.28	365.92	365.90	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	366.70	365.28	366.51	366.01	367.86	366.21	366.43	366.13	366.14	366.05	366.10	366.00	366.03	365.96	365.96	365.875	365.985	365.965	-	-

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN		MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
2002-2003	366.10	365.96	366.00	365.95	-	-	365.28	365.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	366.14	365.97	366.00	365.95	-	-	-	-	366.16	365.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-2005	366.25	365.93	366.25	365.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-2006	-	-	-	-	-	-	-	-	368.41	366.06	366.90	366.14	367.09	366.21	366.20	366.06	366.06	365.98	366.265	365.975	366.135	366.02	366.105	366.005
2006-2007	366.16	365.98	366.03	365.97	366.19	365.95	366.31	365.94	366.74	366.07	366.21	366.07	366.07	366.00	366.00	365.91	365.91	365.85	-	-	-	-	-	-
2007-2008	-	-	-	-	366.07	365.99	366.26	365.88	366.12	365.86	366.03	365.94	366.28	365.92	366.05	365.96	365.96	365.92	-	-	-	-	-	-
2008-2009	-	-	-	-	-	-	366.17	365.28	366.92	365.94	366.42	365.92	366.26	365.93	365.93	365.81	365.84	365.81	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	366.62	365.28	366.08	365.95	366.13	365.95	366.13	365.92	366.10	365.88	365.88	365.78	-	-	-	-	-	-
2010-2011	365.94	365.70	365.89	365.71	365.74	365.69	365.69	365.69	365.78	365.72	366.51	365.73	366.25	366.01	366.01	365.90	365.91	365.86	365.855	365.755	365.885	365.785	365.815	365.775
2011-2012	366.02	365.81	365.92	365.83	366.85	365.94	366.06	365.80	366.03	365.88	366.07	365.90	365.97	365.85	365.94	365.82	365.82	365.76	-	-	-	-	365.995	365.84
MAXIMUN	366.67	366.43	366.95	366.38	367.21	366.43	368.45	366.44	368.41	366.48	368.36	367.62	367.28	366.58	366.52	366.43	366.55	366.38	366.53	366.36	366.55	366.55	366.60	366.30
MINIMUN	365.90	365.28	365.89	365.28	365.74	365.28	365.28	365.28	365.78	365.28	365.96	365.28	365.92	365.85	365.93	365.81	365.82	365.76	365.86	365.76	365.89	365.28	365.82	365.28
- **Stands for data not available**																								

Table 25: Monthly Minimum and Maximum Water levels at Avarankuppam GD site

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1979-1980	-	-	-	-	-	-	158.46	158.04	158.13	157.84	158.84	157.82	158.24	158.01	157.99	157.83	-	-	-	-	-	-	-	-
1980-1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981-1982	-	-	-	-	-	-	158.48	157.83	158.34	156.81	158.39	157.93	158.13	157.83	157.82	157.82	-	-	-	-	-	-	-	-
1982-1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983-1984	-	-	-	-	-	-	158.40	156.81	157.97	156.81	157.90	157.64	158.19	157.91	157.88	157.78	158.25	157.82	158.205	157.77	-	-	-	-
1984-1985	-	-	157.85	157.85	157.82	157.77	-	-	158.11	156.81	158.11	156.81	157.94	157.68	157.82	157.72	-	-	-	-	-	-	-	-
1985-1986	-	-	-	-	-	-	-	-	157.72	157.71	158.33	156.81	157.73	157.61	157.92	157.59	157.73	157.57	-	-	-	-	-	-
1986-1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987-1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988-1989	-	-	-	-	-	-	158.26	157.33	158.11	157.45	157.63	157.42	-	-	-	-	-	-	-	-	-	-	-	-
1989-1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990-1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991-1992	-	-	-	-	-	-	-	-	-	-	158.86	157.78	157.80	157.46	157.48	157.32	-	-	-	-	-	-	-	-
1992-1993	-	-	-	-	-	-	-	-	-	-	157.57	157.33	-	-	-	-	-	-	-	-	-	-	-	-
1993-1994	-	-	-	-	-	-	-	-	-	-	158.04	157.52	158.06	157.43	157.42	157.24	-	-	-	-	-	-	-	-
1994-1995	-	-	-	-	-	-	-	-	-	-	157.57	157.27	157.41	157.29	-	-	-	-	-	-	-	-	159.48	157.42
1995-1996	157.47	157.44	159.42	157.42	157.64	157.43	157.58	157.34	157.53	157.32	157.56	157.30	157.29	157.25	-	-	-	-	-	-	-	-	-	-
1996-1997	-	-	-	-	157.46	156.81	158.21	157.08	158.19	157.59	157.70	157.39	158.35	157.40	157.62	157.34	157.34	157.24	-	-	-	-	-	-
1997-1998	-	-	-	-	-	-	-	-	-	-	157.71	157.45	157.70	157.42	157.47	157.27	-	-	-	-	-	-	-	-
1998-1999	-	-	-	-	-	-	-	-	158.06	157.50	158.15	157.48	157.81	157.46	157.49	157.47	-	-	-	-	-	-	-	-
1999-2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-	-	-	157.76	157.50	157.47	157.17	157.24	156.98	157.11	156.98	-	-	-	-	-	-	-	-
2002-2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-2006	-	-	-	-	-	-	-	-	157.93	156.81	157.53	156.86	157.64	156.99	156.99	156.91	-	-	-	-	-	-	-	-
2006-2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-2008	-	-	-	-	-	-	-	-	-	-	-	-	157.17	156.96	156.92	156.86	-	-	-	-	-	-	-	-
2008-2009	-	-	-	-	-	-	-	-	-	-	159.19	159.11	159.11	158.73	-	-	-	-	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-2011	-	-	-	-	-	-	-	-	-	-	159.02	158.96	159.24	158.89	158.89	158.81	-	-	-	-	-	-	-	-
MAXIMUN	157.47	157.44	159.42	157.85	157.82	157.77	158.48	158.04	158.34	157.84	159.19	159.11	159.24	158.89	158.89	158.81	158.25	157.82	158.21	157.77	0.00	0.00	159.48	157.42
MINIMUN	157.47	157.44	157.85	157.42	157.46	156.81	157.58	156.81	157.53	156.81	157.47	156.81	157.17	156.96	156.92	156.86	157.34	157.24	158.21	157.77	0.00	0.00	159.48	157.42
- **Stands for data not available**																								

Table 26: Monthly Minimum and Maximum Water levels at Arcot GD site

4.17 Yearly minimum and maximum Water levels

Below table shows yearly maximum and minimum water levels at Arcot and Avarankuppam gauging sites.

YEAR	MAXIMUM WATER LEVEL (m)	MINIMUM WATER LEVEL (m)
1979-1980	158.84	157.82
1980-1981	0	0
1981-1982	158.475	156.81
1982-1983	0	0
1983-1984	158.4	156.81
1984-1985	158.11	156.81
1985-1986	158.325	156.81
1986-1987	0	0
1987-1988	0	0
1988-1989	158.26	157.33
1989-1990	0	0
1990-1991	0	0
1991-1992	158.857	157.32
1992-1993	157.565	157.328
1993-1994	158.06	157.237
1994-1995	157.57	157.27
1995-1996	157.64	157.25
1996-1997	158.35	156.81
1997-1998	157.71	157.27
1998-1999	158.15	157.46
1999-2000	0	0
2000-2001	0	0
2001-2002	157.76	156.98
2002-2003	0	0
2003-2004	0	0
2004-2005	0	0
2005-2006	157.93	156.81
2006-2007	0	0
2007-2008	157.17	156.86
2008-2009	159.19	158.73
2009-2010	0	0
2010-2011	159.24	158.81
MAXIMUM	159.24	158.81
MINIMUM	0	0

Table 27: Yearly minimum and maximum Water Levels at Arcot

YEAR	MAXIMUM WATER LEVEL (m)	MINIMUM WATER LEVEL (m)
1978-1979	367.955	365.275
1979-1980	368.363	365.275
1980-1981	366.4	365.275
1981-1982	368.45	366.12
1982-1983	366.665	366.27
1983-1984	367.405	366.285
1984-1985	366.887	365.275
1985-1986	366.975	365.275
1986-1987	367.285	365.275
1987-1988	367.515	365.275
1988-1989	367.75	365.275
1989-1990	367.115	365.275
1990-1991	366.67	365.275
1991-1992	367.854	366.1
1992-1993	366.645	366.1
1993-1994	367.278	366.105
1994-1995	366.6	366.085
1995-1996	367.155	366.13
1996-1997	368.035	365.275
1997-1998	366.785	366.07
1998-1999	367.495	365.89
1999-2000	366.79	365.275
2000-2001	366.16	365.275
2001-2002	367.855	365.275
2002-2003	366.095	365.275
2003-2004	366.155	365.275
2004-2005	368.405	365.925
2005-2006	367.085	365.975
2006-2007	366.735	365.845
2007-2008	366.275	365.855
2008-2009	366.915	365.275
2009-2010	366.62	365.275
2010-2011	366.51	365.685
2011-2012	366.845	365.755
MAXIMUN	368.45	366.285
MINIMUM	366.095	365.275

Table 28: Yearly minimum and maximum Water Levels at Avarankuppam

4.18 Chart Datum/ Sounding Datum

As per discussion with IWAI, Sounding datum in rivers is taken as Average of minimum yearly water level for Last six years (having data for maximum period in an year) at Arcot gauging site. The gauge-discharge data of Arcot was collected from CWC. Accordingly, the C.D. at Arcot G.D. Site has been arrived as below:

C.D. at Arcot G.D. Site = [157.46 + 156.98 + 156.81 + 156.86 + 158.73 + 158.81] / 6
= **157.608 m**

River name	CD Value at the Arcot Gauge Station	Gauge Station Position	
		Latitude	Longitude
Palar	157.608 meters above MSL at CH 115 km	12^0 54.9' N	77^0 20' E

Since the river is dry & intermittent, CD is not required.

4.19 High Flood Levels and Discharges

Tidal Reach

In Tidal Reach, MHWS at Chennai as per Admiralty Tide Table (ATT Vol 3) has been adopted as High Flood Level.
MHWS: 1.1 (w.r.t. C.D.)
MSL: 0.6 (w.r.t. C.D.)
MHWS (w.r.t. MSL): 1.1 - 0.6 = 0.5 m (w.r.t. MSL)

Non Tidal Reach

Gauge Site: HFL is computed from last twenty years Gauge discharge data collected from CWC for gauge site. The maximum water level in last twenty years from the collected data has been adopted as HFL

Arcot

Maximum flood discharge & HFL (during period of data) were 1229 m^3/s and 159.24 m respectively in December 2010.
Frequency Analysis of yearly maximum flood data using Gumbel distribution indicate following flood discharges for different return periods.

Return Period in years	2	5	10	20	25	50	75	100	200
Disch (m^3/s)	76.89	317.39	476.62	629.36	677.81	827.06	913.81	975.21	1122.82

The 100 year return flood at Arcot will be 975 m^3/s.

Avarankuppam

Maximum flood discharge & HFL (during period of data) were 405 m^3/s and 368.45 m respectively in October 2005.
Frequency Analysis of yearly maximum flood data using Gumbel distribution indicate following flood discharges for different return periods.

Return Period in years	2	5	10	20	25	50	75	100	200
Disch (m^3/s)	66.25	163.14	227.28	288.81	308.33	368.46	403.4	428.14	487.6

The 100 year return flood at Avarankuppam will be 428 m^3/s.

4.20 Monthly minimum and maximum Discharges

The monthly minimum and maximum discharges at Avarankuppam GD Site for the entire period of data were extracted and are tabulated below.

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1978-1979	4.00	0.10	5.20	0.00	1.30	0.00	172.50	0.20	65.10	1.20	16.20	1.50	5.20	1.20	3.40	0.40	5.90	0.20	0.9	0.1	0.2	0	0.4	0
1979-1980	2.00	0.10	15.00	0.00	5.60	0.00	243.30	0.10	48.50	2.30	4.50	2.30	15.80	2.30	2.50	1.10	0.70	0.40	1.4	0.1	0.2	0	0.6	0
1980-1981	0.70	0.00	0.00	0.00	-	-	0.10	0.00	1.90	0.00	0.10	0.00	0.10	0.00	-	-	-	-	-	-	-	-	0	0
1981-1982	8.70	0.00	8.30	0.70	5.00	0.00	125.40	0.30	77.70	2.10	125.40	2.90	5.70	0.90	1.50	0.70	0.90	0.30	3.4	0.1	0.3	0	4.6	0
1982-1983	9.10	0.00	0.00	0.00	-	-	8.40	0.00	0.20	0.00	2.10	0.00	0.10	0.00	0.00	0.00	-	-	-	-	-	-	0	0
1983-1984	8.00	0.00	-	-	8.70	0.00	82.50	0.30	6.60	0.20	1.70	0.10	4.90	4.90	0.70	0.10	1.30	0.00	2.1	0	0.5	0	3.1	0
1984-1985	0.00	0.00	7.90	0.10	0.20	0.00	8.10	0.00	20.10	0.20	1.60	0.10	0.60	0.00	0.20	0.00	0.00	0.00	-	-	-	-	-	-
1985-1986	0.90	0.00	0.30	0.00	9.30	0.00	27.20	0.10	9.80	0.80	6.80	0.70	0.90	0.00	0.40	0.00	1.10	0.00	0.1	0	0.5	0.5	0.7	0
1986-1987	1.50	0.00	-	-	3.30	0.00	33.70	0.00	48.00	1.10	22.50	0.50	1.40	0.40	0.40	0.10	0.20	0.00	0	0	0	0	4	0
1987-1988	4.00	0.00	2.45	0.00	0.46	0.00	2.10	0.00	51.65	0.20	1.40	0.20	2.94	0.20	0.36	0.02	0.06	0.00	0.984	0	-	-	1.805	0
1988-1989	0.09	0.00	7.09	0.00	42.73	0.00	139.60	2.48	11.05	1.19	3.30	0.43	1.14	0.09	0.21	0.03	0.05	0.00	-	-	-	-	-	-
1989-1990	4.80	0.00	30.70	0.13	0.04	0.00	18.19	0.00	45.26	0.70	3.79	0.44	0.65	0.06	0.27	0.00	0.02	0.00	0.093	0	-	-	6.78	0.152
1990-1991	0.10	0.00	-	-	-	-	9.17	0.04	9.27	0.00	0.30	0.01	0.10	0.00	-	-	-	-	-	-	4.423	4.423	-	-
1991-1992	4.42	0.00	-	-	-	-	14.56	0.00	155.20	0.00	182.90	14.21	9.89	1.63	1.85	0.21	0.54	0.07	0.283	0.065	0.573	0.062	3.236	0.072
1992-1993	7.35	0.04	0.28	0.04	-	-	1.63	0.08	12.23	0.24	5.11	0.38	0.91	0.07	0.14	0.02	0.05	0.01	-	-	-	-	-	-
1993-1994	4.71	0.02	3.68	0.04	0.38	0.38	3.38	0.02	14.84	0.04	27.06	0.56	58.20	0.40	0.50	0.05	0.06	0.05	-	-	-	-	1.129	0.213
1994-1995	0.28	0.04	3.02	0.04	0.06	0.00	5.30	0.00	2.10	0.03	9.87	0.30	0.31	0.09	0.09	0.01	0.00	0.00	-	-	-	-	1.057	0
1995-1996	0.14	0.00	-	-	46.50	0.00	23.47	0.90	14.00	14.00	2.49	146.60	0.65	0.44	0.09	-	-	-	-	-	-	-	-	-
1996-1997	9.85	0.03	-	-	9.63	0.14	189.90	2.42	212.00	2.50	9.00	3.75	83.00	1.75	4.73	0.90	0.96	0.18	0.3	0	2.801	0	-	-
1997-1998	-	-	-	-	-	-	13.40	0.22	8.90	0.40	18.10	1.35	3.29	0.86	0.83	0.10	0.14	0.02	0.025	0	-	-	-	-
1998-1999	-	-	-	-	10.82	0.00	4.94	0.00	109.60	3.19	57.88	3.50	10.55	1.25	1.45	0.25	0.33	0.11	0.085	0	-	-	1.604	0
1999-2000	0.00	0.00	-	-	-	-	8.42	0.00	19.34	0.00	1.10	0.10	0.78	0.03	0.21	0.00	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	2.19	0.00	0.13	0.00	0.02	0.00	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	25.82	0.00	15.48	0.18	225.20	3.90	12.33	1.74	1.85	0.49	1.20	0.11	0.31	0.02	0.024	0	0.093	0.04	-	-
2002-2003	0.81	0.02	0.10	0.00	-	-	0.00	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	1.46	0.00	0.00	0.00	-	-	-	-	2.10	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-2005	2.92	0.07	3.00	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
2005-2006	-	-	-	-	-	-	-	-	405.87	0.34	51.77	3.76	75.34	4.16	4.10	0.74	0.71	0.08	2.759	0.017	0.751	0.099	0.485	0.065
2006-2007	2.25	0.00	0.40	0.00	2.95	0.04	7.01	0.02	40.52	0.78	3.49	0.78	0.87	0.35	0.35	0.04	0.04	0.00	-	-	-	-	-	-
2007-2008	-	-	-	-	0.45	0.17	1.29	0.00	1.12	0.01	0.58	0.13	4.80	0.01	0.40	0.03	0.04	0.01	-	-	-	-	-	-
2008-2009	-	-	-	-	-	-	2.60	0.00	43.37	0.44	12.16	0.38	5.73	0.34	0.35	0.03	0.07	0.00	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	32.81	0.00	2.00	0.17	2.27	0.17	0.52	0.06	0.06	0.01	0.04	0.00	-	-	-	-	-	-
2010-2011	0.63	0.00	0.70	0.01	0.01	0.00	0.00	0.00	0.11	0.01	17.16	0.01	3.79	0.48	0.48	0.05	0.14	0.01	0.008	0	0.123	0	0.013	0
2011-2012	0.63	0.00	0.10	0.00	43.09	0.10	0.71	0.07	1.82	0.04	2.49	0.12	0.81	0.00	0.48	0.00	0.00	0.00	-	-	-	-	1.07	0
MAXIMUN	9.85	0.10	30.70	0.70	46.50	0.38	243.30	2.48	405.87	14.00	182.90	146.60	83.00	4.90	4.73	1.10	5.90	0.40	3.40	0.10	4.42	4.42	6.78	0.21
MINIMUM	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.11	0.00	0.10	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
- **Stands for data not available**																								

Table 29: Monthly Minimum and Maximum Discharges at Avarankuppam GD site

The monthly minimum and maximum discharges at Arcot GD Site for the entire period of data were extracted and are tabulated below.

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1979-1980	-	-	-	-	-	-	193.50	14.30	54.00	0.20	856.20	0.10	120.00	5.50	5.10	0.10	-	-	-	-	-	-	-	-
1980-1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981-1982	-	-	-	-	-	-	528.20	0.40	215.00	0.00	310.00	0.50	33.10	0.10	0.00	0.00	-	-	-	-	-	-	-	-
1982-1983	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983-1984	-	-	-	-	-	-	183.30	0.00	6.70	0.00	1.10	0.00	56.50	1.68	0.80	0.00	100.40	0.30	63.1	0	-	-	-	-
1984-1985	-	-	1.10	0.00	0.40	0.00	-	-	31.80	0.00	24.70	0.00	8.70	0.00	1.50	0.00	-	-	-	-	-	-	-	-
1985-1986	-	-	-	-	-	-	-	-	0.00	0.00	105.00	0.00	1.60	0.00	11.00	0.20	0.50	0.00	-	-	-	-	-	-
1986-1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1987-1988	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988-1989	-	-	-	-	-	-	103.80	0.54	70.04	0.18	1.92	0.10	-	-	-	-	-	-	-	-	-	-	-	-
1989-1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990-1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991-1992	-	-	-	-	-	-	-	-	-	-	1229.00	0.00	140.90	3.04	4.11	0.00	-	-	-	-	-	-	-	-
1992-1993	-	-	-	-	-	-	-	-	-	-	0.72	0.15	-	-	-	-	-	-	-	-	-	-	-	-
1993-1994	-	-	-	-	-	-	-	-	-	-	139.50	4.36	150.90	4.80	3.58	0.07	-	-	-	-	-	-	-	-
1994-1995	-	-	-	-	-	-	-	-	-	-	10.54	0.00	1.23	0.00	-	-	-	-	-	-	-	-	1.718	0
1995-1996	2.48	1.19	0.82	0.00	22.39	0.00	20.60	0.67	13.08	1.50	20.67	0.41	0.41	0.25	-	-	-	-	-	-	-	-	-	-
1996-1997	-	-	-	-	2.52	0.00	177.50	0.16	168.00	36.00	53.00	14.87	374.00	4.90	36.46	2.54	2.00	0.15	-	-	-	-	-	-
1997-1998	-	-	-	-	-	-	-	-	-	-	18.55	1.00	37.40	3.23	9.34	0.00	-	-	-	-	-	-	-	-
1998-1999	-	-	-	-	-	-	-	-	38.06	0.38	51.20	0.30	16.79	1.12	1.38	0.51	-	-	-	-	-	-	-	-
1999-2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000-2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001-2002	-	-	-	-	-	-	-	-	32.81	16.56	14.69	1.94	6.36	0.00	0.00	0.00	-	-	-	-	-	-	-	-
2002-2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003-2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004-2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005-2006	-	-	-	-	-	-	-	-	139.90	0.00	76.28	2.09	88.90	5.99	5.99	0.00	-	-	-	-	-	-	-	-
2006-2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007-2008	-	-	-	-	-	-	-	-	-	-	-	-	9.91	0.77	0.85	0.00	-	-	-	-	-	-	-	-

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
2008-2009	-	-	-	-	-	-	-	-	-	-	1.65	0.24	0.24	0.00	-	-	-	-	-	-	-	-	-	-
2009-2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010-2011	-	-	-	-	-	-	-	-	-	-	3.07	0.00	6.46	0.17	0.19	0.00	-	-	-	-	-	-	-	-
MAXIMUM	2.48	1.19	1.10	0.00	22.39	0.00	528.20	14.30	215.00	36.00	1229.00	14.87	374.00	5.99	36.46	2.54	100.40	0.30	63.10	0.00	0.00	0.00	1.72	0.00
MINIMUM	2.48	1.19	0.82	0.00	0.40	0.00	20.60	0.00	0.00	0.00	0.72	0.00	0.24	0.00	0.00	0.00	0.50	0.00	63.10	0.00	0.00	0.00	1.72	0.00
- **Stands for data not available**																								

Table 30: Monthly Minimum and Maximum Discharges at Arcot GD site

4.21 Yearly minimum and maximum Discharges

Below table shows yearly maximum and minimum discharges at Arcot gauging site.

YEAR	MAXIMUM DISCHARGE (m^3/sec)	MINIMUM DISCHARGE (m^3/sec)
1979-1980	856.2	0.1
1980-1981	0	0
1981-1982	528.2	0
1982-1983	0	0
1983-1984	183.3	0
1984-1985	31.8	0
1985-1986	105	0
1986-1987	0	0
1987-1988	0	0
1988-1989	103.8	0.1
1989-1990	0	0
1990-1991	0	0
1991-1992	1229	0
1992-1993	0.715	0.154
1993-1994	150.9	0.072
1994-1995	10.54	0
1995-1996	22.39	0
1996-1997	374	0
1997-1998	37.4	0
1998-1999	51.2	0.297
1999-2000	0	0
2000-2001	0	0
2001-2002	32.81	0
2002-2003	0	0
2003-2004	0	0
2004-2005	0	0
2005-2006	139.9	0
2006-2007	0	0
2007-2008	9.913	0
2008-2009	1.65	0
2009-2010	0	0

YEAR	MAXIMUM DISCHARGE (m^3/sec)	MINIMUM DISCHARGE (m^3/sec)
2010-2011	6.46	0
MAXIMUM	1229	0.297
MINIMUM	0	0

Table 31: Yearly minimum and maximum Discharges at Arcot

Below table shows yearly maximum and minimum discharges at Avarankuppam gauging site.

YEAR	MAXIMUM DISCHARGE (m^3/sec)	MINIMUM DISCHARGE (m^3/sec)
1978-1979	172.5	0
1979-1980	290.9	0
1980-1981	1.9	0
1981-1982	290	0
1982-1983	9.1	0
1983-1984	82.5	0
1984-1985	20.1	0
1985-1986	27.2	0
1986-1987	48	0
1987-1988	51.65	0
1988-1989	139.6	0
1989-1990	45.26	0
1990-1991	9.271	0
1991-1992	182.9	0
1992-1993	12.23	0.014
1993-1994	58.2	0.017
1994-1995	9.868	0
1995-1996	46.5	0
1996-1997	212	0
1997-1998	18.1	0
1998-1999	109.6	0
1999-2000	19.34	0
2000-2001	2.188	0
2001-2002	225.2	0
2002-2003	0.81	0
2003-2004	2.097	0
2004-2005	405.87	0.069

YEAR	MAXIMUM DISCHARGE (m^3/sec)	MINIMUM DISCHARGE (m^3/sec)
2005-2006	75.34	0.017
2006-2007	40.521	0
2007-2008	4.801	0
2008-2009	43.37	0
2009-2010	32.813	0
2010-2011	17.155	0
2011-2012	43.087	0
MAXIMUM	405.87	0.069
MINIMUM	0.81	0

Table 32: Yearly minimum and maximum Discharges at Avarankuppam

5. Preliminary Traffic studies and Market Analysis

This chapter deals with the status of land use pattern, crops, agriculture existing industries, cargo, jetties and terminals, passenger ferry services along the river route.

5.1 Land use Pattern along waterway

The total length of the river is 348 km up to Bay of Bengal.

Figure 34: Palar River and its nearby Talukas

District	Taluka	Population
Kancheepuram	Tirukalukundram	151,950
	Chengalpattu	62,579
	Maduranthakam	1,23,070
	Cheyyur	10,664
	Uthiramerur	122,939
	Kanchipuram	169,321
Vellore	Arcot	1,04,548
	Arakonam	78,938
Tiruvannamalai	Cheyyar	94,259

Table 33: Population & Literacy of nearby Talukas as per Census 2011

Vellore and Kanchipuram are the districts within our scope of study.

5.1.1 Land Utilization Pattern

Of the total area of Kanchipuram, a large part is uncultivable barren land. The second largest use of land is for non-agricultural purposes. The district also has some forests which occupy some portion of the land. Cultivable barren land in the district is really low at only 11,000 hectares.

District	Total Area	Forest	Non Agriculture	Cultivable Barren land	Uncultivable Barren Land
Kanchipuram	443,210	23,856	147,350	11,008	260,996
Thiruvannamalai	631,205	151,863	96,315	20,630	362,397
Vellore	5,952,018	162,286	79,928	5,689,359	20,445

Table 34 Land use Pattern (in Ha.)

A large proportion of the total land in Vellore district is cultivable barren land. The district also has a vast spread of forests. The forest area in Vellore is more than the forest area in Tamil Nadu. The district has very little uncultivable barren land. The net area sown in the district is 228,279 hectares. Current fallow in Vellore is nearly 30,000 hectares and other fallow is over 50,000 hectares. Cultivable waste land and permanent pastures & other grazing land take up a small portion of the total land in Vellore. Miscellaneous tree crops & groves not included in net area sown are around 1,800 hectares.

Vellore has a highly skewed land holdings distribution pattern. Marginal and small farmers, who constituted more than 90% of total number of farmers in the district, were holding less than 2 hectares of land. These farmers operated 61 percent of the total arable land in the district. The district's average size of holding was only 0.82 hectares. There's some animal husbandry activity in the district. Out of the total cattle and buffalo population in the state of Tamil Nadu, 5% is in Vellore. Also, since Vellore is a land-locked district, only inland fisheries are happening. Inland fishing catchment from Vellore accounted for 10% of the total inland fishing catchment in Tamil Nadu.

In Thiruvannamalai, a vast portion of the land is uncultivable barren land. Forests take up the second most land in the district, followed by non-agriculture. The state has very little cultivable barren land. Reserve forests and hills take up nearly one-sixth of the area in the district. Among all the districts in Tamil Nadu, Thiruvannamalai is a leader in brown and white revolution. The district has one dairy, two co-op milk chilling plants, one private dairy and six private milk-chilling plants. There are not many industries in Thiruvannamalai district. The district has some cotton spinning mills and sugar mills. However, the district has a lot of medium and small scale industries like modern rice mills, weaving factories, coir manufacturing, beedi manufacturing, and cotton, silk & mat weaving.

5.1.2 Major districts along the river

A. Kancheepuram

Kanchipuram district is situated on the northern east coast of Tamil Nadu. It is bounded byChennai and Thiruvallur in the north, Vellore and Thiruvannamalai in the west and Villupuram in the southan Bay of Bengal on the east. The coastal line of the district is 87 km. The total geographical area of the district is 4,433 sq km.

B. Vellore

Vellore is the second most populous district of Tamil Nadu. The geographical area of the district is 5,920 sq km. Out of the total MSMEs; textile companies receive a staggering share of 59% in the district. Leather industry is also one of the prominent sectors Vellore is known for. This is also due to the reason that they have contributed significantly in polluting the riparian bed of PalarRiver and the underground water near the river.

The district is a hilly region. Javadhu Hills with an elevation of 2,500 m above sea level forms the highest mountain in the district. Palar and Ponnai are the major rivers, which are almost dry throughout the year. Other rivers flowing through the district are Malattar, Koundinya, Goddar, Pambar, AgaramAru, Ponnai, Kallar and Naga. Vermiculate and quartz is found in the major mineral category. Black granite, colour granite, rough stone and brick earth are the other minor minerals found in the district.

C. Tiruvannamalai

Tiruvannamalai district is located at a distance of 125 km to southwest of Chennai. The total geographical area of the district is 6188 sq. km. It shares its borders in the north and west to Vellore. Krishnagiri and Dharmapuri districts are situated in the southwest. In the south, Thiruvannamalai, Javadhu Hills and Kailasagiri are the prominent hills of the district with an average elevation of more than 2,500 feet above sea level. One sixth of the district is covered with dense forest and hilly areas of Eastern Ghats.

The district predominantly has red loamy soil. However, sandy loamy, ferruginous loamy and black loamy soil is also present here. Ponniyar, Chheyar, Naganathi and Kamandala are the major rivers flowing through the district.

5.2 Crops/Agriculture in the region

5.2.1 Kancheepuram

47% of the population is engaged in agricultural activities. Paddy is the major crop grown in the district. Other crops include groundnuts, sugarcane, cereals, millets and pulses. The district receives an average rainfall of 1,133 per annum throughout the year, which is higher than the state average. Northeast and south-west monsoons contribute 54% and 36% respectively to the total rainfall of the district. The coastal region receives higher rainfall as compared to the interior region.

5.2.2 Vellore

Average rainfall in the district is 910 mm, which is below the average rainfall in the country. It receives rainfall from both northeast and southwest monsoons. Paddy, Jowar, Ragi and Bajra are the major food crops grown in the region. Major non-food crops grown in the district are cotton, sugar and groundnut. Major horticulture crops cultivated in this district are fruits crops like mango, banana, guava, jack and sapota, vegetables like tomato, brinjal, greens and tapioca, spices like coriander, tamarind and turmeric and flower crops like jasmine, mullai, jathimalli and crossandra.

5.2.3 Tiruvannamalai

Paddy is the major crops cultivated in the district. Millets and pulses are the other food crops grown in the district. Groundnut is the major cash crop grown in the district. Sugarcane is also widely cultivated in the district. Tamil Nadu Warehousing Corporation has developed warehouses at Tiruvannamalai, Polur and Arni with a total capacity of 54 metric tonnes in the district. It has also developed 7 cold storages at Cheyyar, Chengam, Chetpet, Tiruvannamalai, Vettavalam, Vandavasi and Polureach with a capacity of 25 metric tonnes. There are 3 spinning mills in the district located at Tiruvannamalai, Polur and Arni.

5.3 Availability of Bulk / Construction Material

River transportation would be viable for movement of bulk commodities like coal and minerals. Coal is a major import commodity from Tamil Nadu ports. Kamarajar Port and VOC Port act as gateway for import of indigenous and foreign coal to the state. Major share of the coal is consumed inthe power plants located in the state. Tamil Nadu is a mineral rich state. There is abundant reserve of limestone, rough stone, silica and granite in the state. There is huge volume of export of minerals from VOC Port. The minerals are mostly sourced from the southern part of the state. They are exported to Maldives, Sri Lanka and other South East Asian countries.

5.3.1 Minerals

Following map shows location of mineral belt of Tamil Nadu with respect to Palar River as well as the port infrastructure. Mines located closer to river would have potential for shift of minerals to river route from existing road route.

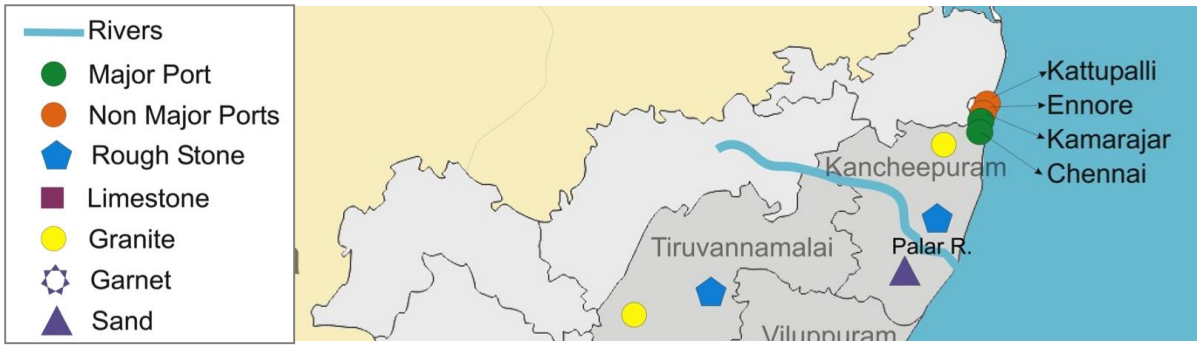


Figure 35: Minerals exported from Tamil Nadu

A. Kancheepuram

The district is abundant in minerals like sand, stone, silica sand, white clay and black granite. It has collective reserve of 12 mn tonnes of stone and sand. Other minerals found in the district are silica sand, white clay and black granite.

S. No.	Name of mineral	Reserve (M.T)
1	Silica Sand	6,00,000
2	White Clay	5,00,000
3	Black Granite	3,75.000
4	Stone	75,00,000
5	Sand	45,00,000

Table 35: Availability of Minerals

Source: Department of Mines and Geology (2012-13)

B. Tiruvannamalai

Black granite and rough stone is majorly mined in the district. There are 17 mining operations of Balck granite in Thamdrampattu. Rough stone is mined more or less throughout the district. There are a total 136 mining operations carried out all over the district for rough stone which accounts for more than 80% of the mining operation in the district. Tirvannamalai leads the number with 29 mining operations followed by Chheyar and Vandavasi. However, Chengam, Thnadrampattu, Polur and Arni also contribute significantly in the number.

Name of Taluka	Fire Clay	Black granite	Coloured granite	Rough stone	Total
Tiruvannamalai		6	1	29	36
Chengam		3		11	14
Thandrampattu		17	1	19	37
Polur			1	15	16
Cheyyar	1			25	26
Arni			1	17	18
Vandavasi		2		20	22
Total	1	27	4	136	169

Table 36: Number of mining and quarrying units in the district as of 2014-15

Source: Assistant Director of Geology and Mining

The district produced close to 1 million tonnes of blue metal and earth collectively in Fy15, out of which Blue metal contributed to 80% of the volume. Black granite and coloured granite was also produced significantly in the district from 31 different mining operations throughout the year.

Name of Mineral	Production (in Cum)
Black granite	4,314
Multi colored granite	460
Blue metal	803,002
Earth	194,876

Table 37: Production Volume of Minerals in the district

Source: Assistant Director of Geology and Mining

5.3.2 Commodities Opportunities

Table given below describes location of mines with respect to the port exporting the commodities and the river flowing closer to the port.

District	Minerals	Units	Production	Nearby Port	Distance from Industrial Area (Km)			Opportunity	Reasoning
					To River	River-Port	Direct to Port		
Kancheepuram	Sand	Tonnes	5,100,000*	Kamarajar	5	146	77	No	Route following multimodal transportation is twice as large compared to the movement of distance by road or railways. Hence, it is commercially not viable to shift.
	Granite	Tonnes	375,000*						
	Rough Stone	Tonnes	7,500,000*						
Tiruvannamalai	Granite	Cubic M.	4,774	Cuddalore	10	95	117	No	Negligible volume. No economy of scale for barge movement to port
	Rough Stone		NA						

Table 38: District wise minerals production and opportunity for river movement

Note:*marked numbers are availability of minerals

A. Rough Stone

Rough stone is the other major mineral mined in Tiruvannamalai. There are total 136 mining operations carried out all over the district, which accounts for more than 80% of mining operation in district. Minerals in the hinterland of Palar River cannot be transported via river, as the deposits are located adjacent to port. They can be transported directly to the port via roadways. The volume of production from hinterland of Palar River is quite low which does not make it feasible to be transported to the ports via waterways.

B. Granite

Granite is produced in numerous districts in Tamil Nadu. There are 17 operationall mining units in Tiruvannamalai. Black granite is majorly mined in this district. Other major districts into production of granite are Tamaraparani, Tiruchirappalli, Erode, Kancheepuram and Tuticorin. However the volume is not enough to make river movement commercially viable.

C. Sand

Kancheepuram district has a reserve of about 4.5 mntonnes of river sand, 6 mn silica sand and 5 mntonnes white clay. Most of these is transported to Maldives by sea. Though reserves are too high near Palar River, exports cannot happen because Chennai Port does not handle dirty cargo and Kamarajar Port is quite far from river. Hence no potential exists for cargo movement.

5.3.3 Coal requirement for Thermal Power Stations

Coal is one of the prime commodities imported in the state. There are 6 coal based thermal power plants in Tamil Nadu. 5 of them are located close to the ports. Indigenous coal is transported from states like Orrisa, Jharkhand and West Bengal by sea to Ennore Port and VOC Port. Kamarajar Port is one of the major destinations of coal from these states. It accounts for more than 70% of the coal import in Tamil Nadu. There are three coal based thermal power plants close to Kamarajar Port with a collective installed capacity of 4,340 MW. They altogether consume nearly 10 mn tonnes of coal every year. This is more than 41% of the total coal import from the port.

Sr. No	TPS	Capacity (MW)	Requirement ('000 T)	Nearby Port	Distance from Industrial Area (km)			Opportunity
					To River	River-Port	Direct to Port	
1	Ennore	450	584	Kamarajar	NA	NA	10	No
2	North Chennai	1830	5,110	Kamarajar	NA	NA	5	No
3	Vallur	1500	4,380	Chennai	NA	NA	24	No

Table 39: Coal requirement in Thermal Power Plants of Tamil Nadu

Figure 36: Coal based Thermal Power Plants in Tamil Nadu

D. Ennore TPS

Ennore Thermal plant is a coal based thermal power plant located close to Ennore Port. The plant operates on 100% indigenous coal. Coal is received from Talcher and Ib Valley mines

of Mahanadi Coal Fields Ltd located in Orrisa and Ranikanj mines of Eastern Coal Fields Ltd located in West Bengal. The coal is transported to Ennore ports from Haldia and Paradip ports through sea. Ennore Port is connected to the power plant with a conveyor belt for transportation of coal. There cannot be use of rivers in transportation of coal to the power plants

E. North Chennai TPS

North Chennai Thermal Power plant is located close to Kamarajar Port. It consumes an approximate volume of 5.1 mn tonnes of coal. It consumes about 3.3 mn tonnes of indigenous coal and 1.8 mn tonnes of imported coal. Mahanadi Coal Fields and Eastern Coal Fields are the major suppliers of indigenous coal for the thermal plants. Major part of imported coal is sourced from Indonesia. Coal is transported by waterways to Ennore Port. The power plant is connected with a conveyor belt to carry coal to the power plant.

There cannot be use of rivers to transport coal to the power plant as the existing infrastructure for movement of coal from the port to the power plant is already quite efficient.

F. Vallur TPS

Vallur Thermal Power plant is located in Vallur village near Ennore Port. The plant consumes an approximate volume of 4.4 mn tonnes of coal. Indigenous coal forms major share of about 53%. It is transported via Haldia, Paradip and Vizag ports to Ennore Port. Ennore port is connected to the Power plant with a conveyor belt. The coal conveyor system includes 4.4 km long pipe conveyor with a capacity of 4000 tonnes /hour. This is assumed to be the world's largest pipeline conveyor.

The power plant is already connected with an efficient pipeline infrastructure. Since the power plant is located close to port, rivers cannot be used for transportation of coal to the power plant.

5.4 Existing Industries along Waterway

5.4.1 Existing Industries

The industrial areas in Tamil Nadu are located in the hinterlands far off from the ports. The industries transport their cargo via roadways to the ports in the states. The objective of the study is to show the linkage of industrial areas located on the banks of the rivers in Tamil Nadu with the ports in the states via waterways. In this section, we shall discuss the strategic location and infrastructural advantages of the ports in brief and analyse the amalgamation of river routes with these ports. Palar river discussed in the study do not have adequate water. Following is the broad breakup of growth of cargo on the ports of Tamil Nadu and Puducherry.

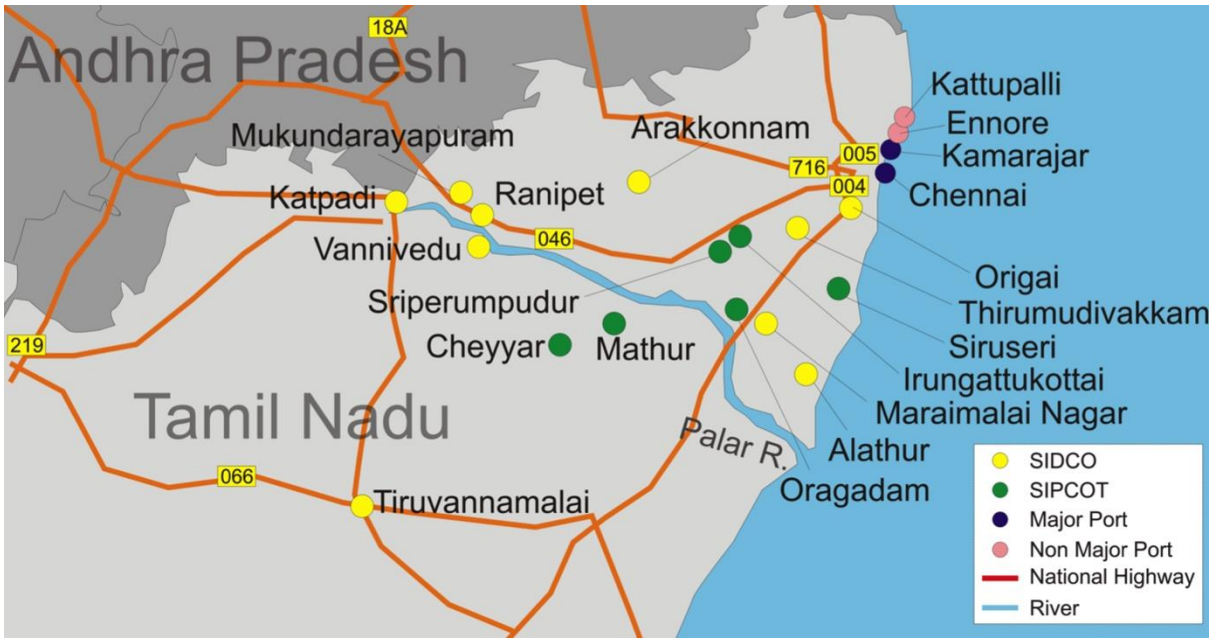


Figure 37: Port connectivity of Major Industrial Clusters via Palar River

District	Industrial Area	Distance from Industrial Area (km)			Opportunity
		To River	River - Port	Direct to Port	
Kancheepuram	SIPCOT, Irungattukottai	40	112	42	No
	SIPCOT, Sriperumbudur	24	112	49	No
	SIPCOT, Siruseri	34	80	51	No
	SIPCOT, Oragadam	23	112	58	No
	SIDCO, Origai	1	112	80	May be
	SIDCO, Maraimalainagar	17	113	53	No
	SIDCO, Alathur	30	80	40	No
	SIDCO, Thirumudivakkam	44	113	34	No
	SIDCO, Perungudi	64	80	15	No
Vellore	SIDCO, Ranipet	2	200	116	May be
	SIDCO, Mukundarayapuram	2	200	123	May be
	SIDCO, Katpadi	5	220	142	May be
	SIDCO, Arakkonam	38	150	81	No
	SIDCO, Vannivedu	1	200	120	May be

Table 40: Distance Comparison between Roadways & Waterways (Palar River)

Road is considered to be most expensive mode of transportation with uncertainty in delivery of cargo due to congestion at Road. Hence, the potential to shift cargo from Road to Rivers would be maximum in case of road.

A. Kancheepuram

Industries	No. of Units

Textile based	7,045
Engineering	1,879
Repairing & Servicing	1,690
Metal Based Products	1,450
Mineral based	1,419
Forest based	1,008
Food and agro based	931
Leather	914
Jute	876
Paper based and printing	785
Plastic and rubber based	700
Chemical based	674
Electronics	522
Soda Water	164

Table 41: Shares of manufacturing units in Kancheepuram District

47% of the population is engaged in agricultural activities. Paddy is the major crop grown in the district. Other crops include groundnuts, sugarcane, cereals, millets and pulses.

The district is the manufacturing engine of the state. It has developed at a fast rate due its proximity to two major ports of the state – Chennai and Ennore. Also it evolved as an alternate of already congested Chennai city. It is home to major automobile manufacturers Ford, Nissan, Hyundai and BMW. Other major products manufactured in the district are auto spare parts, RMG goods, electronic components, leather products etc.

The district has been equally been given focus by two major industrial schemes of the state – TIDCO and SIPCOT. TIDCO has contributed in development of six industrial estates in Origai, Maraimalainagar, Alathur, Thirumudivakkam, Perungudi and Tiruvanmiyur. SIPCOT has built 4 industrial complexes in Irungattukottai, Sriperumbudur, Siruseri, Oragadam. Chennai Export Processing Zone has been developed under the SEZ scheme.

Industrial Area	Acquired land (Acres)	No of units
SIPCOT, Irungattukottai	1,844	208
SIPCOT, Sriperumbudur	2,138	124
SIPCOT, Siruseri	1,137	76
SIPCOT, Oragadam	3,037	130
TIDCO, Origai	38	54
TIDCO, Maraimalainagar	40	36
TIDCO, Alathur	150	137
TIDCO, Thirumudivakkam	201	361
TIDCO, Perungudi	NA	NA

Table 42: Major Industrial Areas

In the above, we see that large chunks of land have been acquired under SIPCOT industrial areas for setting up of big companies. SEZ has been developed for companies focused to exporting goods. Major exportable items from the district are cars, auto components, software products, electronic components, RMG goods, leather products, silk sarees etc.

Products	Major clusters	No of units	Turnover (Rs. In Cr)

Engineering Products/auto components	Perungudi, Sriperumputhur, Thirumudivakkam, Porur, Maraimalainagar	2,000	50
Plastic products/ Plastic auto components	Perungudi, Sriperumputhur, Thirumudivakkam, Porur, Maraimalainagar&Palavakkam	1,000	500
Leather Garments, Footwear	Chromepet, Pallavaram, Porur	100	100
Rice Mill	Kancheepuram, Madhuranthagam	195	140
Silk Saris	Kancheepuram	7,356	60
Natural Fibre	Anakaputhur	180	3

Table 43: Major Industrial Clusters

Major clusters in Perungudi, Palavakkam, Porur, Chromepet, Anakaputhur are located in the vicinity of the sea. However, some clusters like Maraimalai Nagar and Madhuranthagamare in proximity to Palar River. Madhuranthagam is located on the bank of the river while Maraimalai Nagar is 15 km away from Palar River.

B. Vellore

Industries	No. of Units
Textile based	1,650
Leather	450
Gold	300
Electronics	250
Coir	125

Table 44: Shares of manufacturing units in Vellore District

Vellore is a highly industrialised district of the state. There are five areas developed under TIDCO in the district. TIDCO Industrial Estate, Ranipet is the largest industrial estate spread in 113 acres. It is located at a distance of 5 km from Palarriver. Mukundarayapuram is situated on the bank of Ponnairiver at a distance of 5 km from Ranipet Industrial Estate. However, Ponnai river confluences with Palar at Maniyambattu. The confluence of Palar and Ponnai rivers is 4 km away from Mukundarayapuram industrial area. Katpadi is located on the bank of the river. It is situated the river traverses through Katpadi to meet Ponnai river at Maniyambattu. Vannivedu is located on the southern bank of Palarriver at a distance of 12 km towards east from Ponnai-Palar confluence. It is on the opposite bank of Ranipet town. Arakkonam is situated at a distance of 42 km from the river which is far off from the river.

TIDCO Area	Area (acres)	No.of work sheds	No.of developed plots
Ranipet	113	162	71
Mukundarayapuram	86	30	38
Katpadi	19	52	9
Arakkonam	56	16	19
Vannivedu	16	NA	12

Table 45: Major Industrial Areas in District

An industrial area at Ranipet has been developed by SIPCOT. SIPCOT Industrial area is located adjacent to Ranipet TIDCO Industrial area. 730 acres have been allotted for the

industrial estate under the aegis of SIPCOT. Phase-I of the industrial estate is developed at Mukundarayapuram. Phase-II and Phase-III are located in Ranipet and Walajahtalukas respectively.

The leather industry, one of the prime-manufacturingsectors is concentrated in Alangayam, Madhanur and Wallajah blocks. The district is the largest exporter of finished leather goods and accounts for more than 30% of leather export of the country. Textile mills are majorly located in Sholinger, Gudiyatham ,Kaveripakkam, and Arakkonam blocks. Some of the prominent companies of the district are Tamil Nadu Industrial Explosive Ltd, BHEL, The Brakes India Ltd, EID Parry Ltd, Ambur Co-operative Sugar Mills Ltd etc.

Industries	Clusters	Products	No of Units
Handloom	Kaveripakkam, Gudiyatham	Lunki, Towel, readymade garments, Dothi and sarees	850
Chamki work	Arakkonam	Embroidry and Chamki work	800
Leather goods	Melvisaram, Vellore, Pernampet	Leather Chapel, Shoes	450
Auto Servicing	Mukaikur	Serving of all type of vehicles	250
Agarbathi	Kaveripakkam	Agarbathies	186
Gold Ornaments	Vellore	Gold ornaments	150
Coir	Gudiyatham, Pernampet, K.V.Kuppam, Tirupattur.	Coir De-fibring, Curled Coir, Coir Ropes.	125
Brick	Arakkonam	Country Brick	60

Table 46: Major Industrial Clusters

Above chart shows the major clusters of MSEs in the district. We see that handlooms are located in Kaveripakkam and Gudiyatham. Both these clusters are located in the vicinity of the river. Kaveripakkam also produces substantial quantity of agarbathi. Major leather clusters, Melvisaram and Vellore lie in proximity of the river. Coir segment, an important small scale industry in the district, is concentrated in Gudiyatham and KV Pukkam which are located within 10 km distance from the river. Thus we see that commodity wise; we have leather, coir, textile products and agarbathi that can be simulated with waterways for transportation. The major markets, which can be targeted for waterways simulation, are Kaveripakkam, Gudiyatham, Melvisaram, Vellore and KV Pakkam.

C. Tiruvannamalai

Major clusters of industries are located in Tiruvannamalai, Vandavasi, Cheyyar, Arni, Janmamaruthur etc. Silk weaving is done majorly in Arni and Devikapuram. Handlooms are located are densely located in Vandavasi and Cheyyar blocks in the district. Kilkodungalur, Vazoor, Ponnur, Kannagampoondipudur, Cittaragavurpudur, Vedal, Ammaiyappattu, Koviloor, Cheyyar, Vadamanapakkam and Hasanamapettaiare the hereditary handloom villages. The local population has been in the weaving profession since more than 100 years. There are more than 300 units operational in manufacturing of Korai mat in Cheyyar and Vandavasi with a composite turnover of Rs. 50 lakhs per annum. Rice mills located in the Cheyyar account for an annual turnover of Rs. 4Cr. There are rare herbs and medicinal plants available in Javadhu hills and Melchengam.

Products	Clusters
Stone & Wood Carving	Tiruvannamalai
Silk weaving	Arni, Devikapuram
Handloom	Vandavasi, Cheyyar
Korai Mat	Avoor, Vandavasi
Rice Mill	Cheyyar
Mushroom & Honey Processing	Janmamaruthur
Herbal extraction	Janmamaruthur

Table 47: Products and its clusters in the district

2 Major commodities exported from the district are silk saris, handloom lungies, palm rosa oil, ponni rice and herbal products.

5.4.2 Interaction held with officers of different industries along Palar River

Sr.No	Industry Name	Person Name	Designation
1	ATV Precision Components	Mr. Adinarayanan	Logistic Officer
2	DONG-AH	Mr. Krishnan S	Logistic Manager
3	The Best Electollite System	Mr. Lokeshwran	-
4	Indrad Auto Components	Mr. Pratik Mukherjee	-
5	IBEX Products Pvt Ltd	Mr. Ravi	-
6	OM Logistics Pvt Ltd	Mr. Prasad	-
7	Reep Industries Ltd	Mr. Kannan	-
8	Madras Carbons Pvt Ltd.	Mr. Rajendra	-
9	-	Mr. Ramesh	-

Table 48: List of officers interacted

D. Kancheepuram

1. **ATV Precision Components**

   Add: No 19, New SIDCO Industrial area, Maraimalainagar, Kancheepuram, TamilNadu

   Contact person: Mr. Adinarayanan (Logistic Officer)

   Contact No: 8939866550

- The company is into manufacturing of auto components. Major components manufactured are automotive sheet metal pressed components, fine blanking, conventional blanking, deep drawing, tig welding, mig welding etc.
- The annual production of the company is about 1800 tonnes.
- It transports its goods all over India. It transports its goods majorly to Pune, Delhi and Chennai.
- It takes about two hours to reach Chennai by road.
- It takes about 4 to 5 days to reach Pune and 6 to 7 days to reach Delhi
- Its major exporting region is Europe, USA, China, Japan etc.
- It transports its goods by roadways, railways and airways.

- The components are stuffed in boxes and transported to the destination.
- It transports its goods through third party logistics. Major transporters for the company are DHL, Palanpena, Om Logistics, FedEx
- The river cannot transport goods, as the river does not have water at all.
- It can go to Chennai Port by roadways and then exported by ships.

2. DONG-AH

Address: A-1, New SIDCO Industrial area, Maraimalainagar, Kancheepuram, Tamil Nadu
Contact Person: Mr. Krishnan S (Logistic Manager)
Contact No: 9944350884

- The company manufactures auto components for Hyundai Motors.
- The major parts manufactured here are cylinder heads, head covers, gasket components, exhaust components etc.
- Per day production of the company is 25 to 30 kg.
- The goods are transported to Sriperumbuthur plant of Hundai Motors by hired vehicles.
- The transportation is not more than 30 km from the company. It takes about one hour to reach Sriperumbuthur plant.
- The river cannot be utilized for movement of goods as it does not have water.
- There is sheltered water at places in the river area.
- The river remains dry even during mansoons.
- Chengalpattu lake and Madhurandhagam lake are connected to the river near Chengalpattu. But that cannot be used for transportation purpose.

3. The Best Electolite System

Add: DP No.1, SIDCO Industrial area, Maraimalainagar, Kancheepuram, Tamil Nadu
Contact Person: Mr. Lokeshwaran
Contact No: 9789957121

- The company provides electrolysis services to the companies located nearby.
- The clients are located within a radius of 30 km from the company.
- The transportation requirements are taken care by the clients themselves.
- They transport their goods to the company by Lorries or trucks and carry their goods back after the service.
- The transportation by rivers is not possible, as the rivers in Tamil Nadu do not contain enough water.
- There is no other option other than roadways for local movement of goods.
- The roads are enough good in the area and there is no congestion on the roads.

- Congestion problems occur when transportation is done in major cities like Chennai.

4. Indrad Auto Components

Address: A1,F5Industrisal Estate, Maraimalainagar, Kancheepuram, Tamil Nadu

Contact Person: Mr. Pratik Mukherjee

Contact No: 044-27451853/3365

- The company has an association of Lucas TVS Ltd. Other major clients of the company are Delphi TVS, Nippon Electricals, Jaipan India Lighting etc.
- Other plants of Lucas TVS are located at Rewari, Pondicherry, Pune and Udhamsingh Nagar, Uttaranchal
- The company is into manufacturing of radiator cooling fans, blower alternator, wiper motor etc. for auto companies.
- The logistics is done by the third party majorly by Chetak Logistics.
- All the transportation is done by roadways only. This ensures door to door delivery and less time.
- The rivers in Tamil Nadu do not have water at all. No transportation is feasible by the inland waterways in the state.

5. IBEX Products Pvt Ltd

Address: A1 F5Industrisal Estate, Maraimalainagar, Kancheepuram, Tamil Nadu

Contact Person: Mr. Ravi

Contact No: 044-47400244

- It manufactures its components for UCAL Industries Ltd.UCAL Industries is an associate of Hyundai Motors.
- The transportation is done within 2 km from the company.
- The products are packed in boxes and transported to the destination by lorries.
- The transportation of the raw materials and finished products is done by UCAL Industries.
- There is no use of development of rivers for the company.
- The rivers do not contain water so it cannot fulfill the transportation requirements of the companies.

6. Om Logistics Pvt Ltd

Address: A1,25 Industrial Estate, Maraimalainagar, Kancheepuram, Tamil Nadu

Contact Person: Mr. Prasad

Contact No: 09282170458

- The company provides end to endlogistic solution to household and corporate products.
- It provides roadways, railways and airways logistic solutions all over India.

- There are more than 100 branch offices around the country.
- 99% of the clients of Maraimalainagar branch are into auto component manufacturing.
- It transports goods from few hundred grams to few hundred kilograms.
- The auto component goods are packed in boxes of different dimensions and transported to the destination. Heavy goods are transported in customized packages.
- The cost of transportation depends on weight and dimensions of the boxes.
- It takes 4 to 5 days to transport goods from Maraimalainagar to Mumbai. To Delhi, it takes about 6 to 7 days.
- The cost of transportation by railways is Rs 17 per kg for minimum of 50 kg of goods.
- The cost of transportation by roadways is Rs 6.5 per kg for minimum of 100 kg of goods.
- The cost of transportation by airways is Rs 70 to 75 per kg for minimum of 30 kg of goods.
- The company does not utilise waterways for transportation.

7. Reep Industries Ltd

Add: Plot No.A1,F4 Industrial Estate, Maraimalainagar, Kancheepuram, TamilNadu
Contact Person: Mr. Kannan
Contact No: 044-42901111

- The company is an associate of Power Gear Ltd located in Tambaram near Chennai.
- The major markets of the company are located in Haryana, Himachal, Chennai and Pune.
- Goods movement occurs by roadways only.
- The goods are stuffed in boxes with dimensions 40x8x8. These boxes are loaded into trailers and transported to the destinations. Each trailer accommodates a quantity of 16 to 20 tonnes.
- It takes about 4 to 5 days to reach Maharashtra and about a week to reach Delhi, Haryana and Himachal.
- The rivers in Tamil Nadu do not have enough depth. They are of no use to the company.

8. Madras Carbons Pvt Ltd

Add: Plot No.A3,A1/3 Industrial Estate, Maraimalainagar, Kancheepuram, Tamil Nadu
Contact Person: Mr. Rajendra
Contact No: 044-47400372/37414121

- The company is into manufacturing of metal sheets for roofing purpose.
- The customers are located within a radius of 40 km from the company.
- The goods are transported by own vehicles. Sometimes the vehicles are hired as per the demand.
- It takes not more than one hour to transport the goods.

- The company produces about 1 to 2 tonnes of metal sheets per day.
- The destinations are very short hence the river transportation is not beneficial for the company.
- This will be beneficial for big companies who have large volumes.

9. **Mr. Ramesh - Local**

   Address: SIDCO Industrial Estate, Maraimalainagar, Kancheepuram, Tamil Nadu

- Most of the rivers in Tamil Nadu are ephemeral in nature.
- Palar River does not have water even during monsoons.
- A maximum of 50 tonnes can be transported by large boats. This is a very small quantity which makes traffic amalgamation unfeasible.

5.5 Existing Jetties and Terminals (with conditions & facilities)

5.5.1 Chennai Port

Chennai port is situated in the coromondel coast of South east India. It handled an annual traffic of about 53 million tonnes in Fy15. Out of this, container volume was about 30 million tonnes. Tamil Nadu, Southern Andhra Pradesh and parts of Telangana, Kerala and Karnataka are the prominent hinterlands of the port. The port has a state of the art infrastructure with a maximum permissible draft of about 11 m. Car terminal of the port has led to a boom in the automobile sector of the state. Also known as the Detroit of Asia, Chennai is home to several car making companies like Hyundai, Nissan, Renault, Dailmer, Ford, BMW etc. The prominent commodities handled at the port are containers, general cargo, cars, granite, steel and food grains.

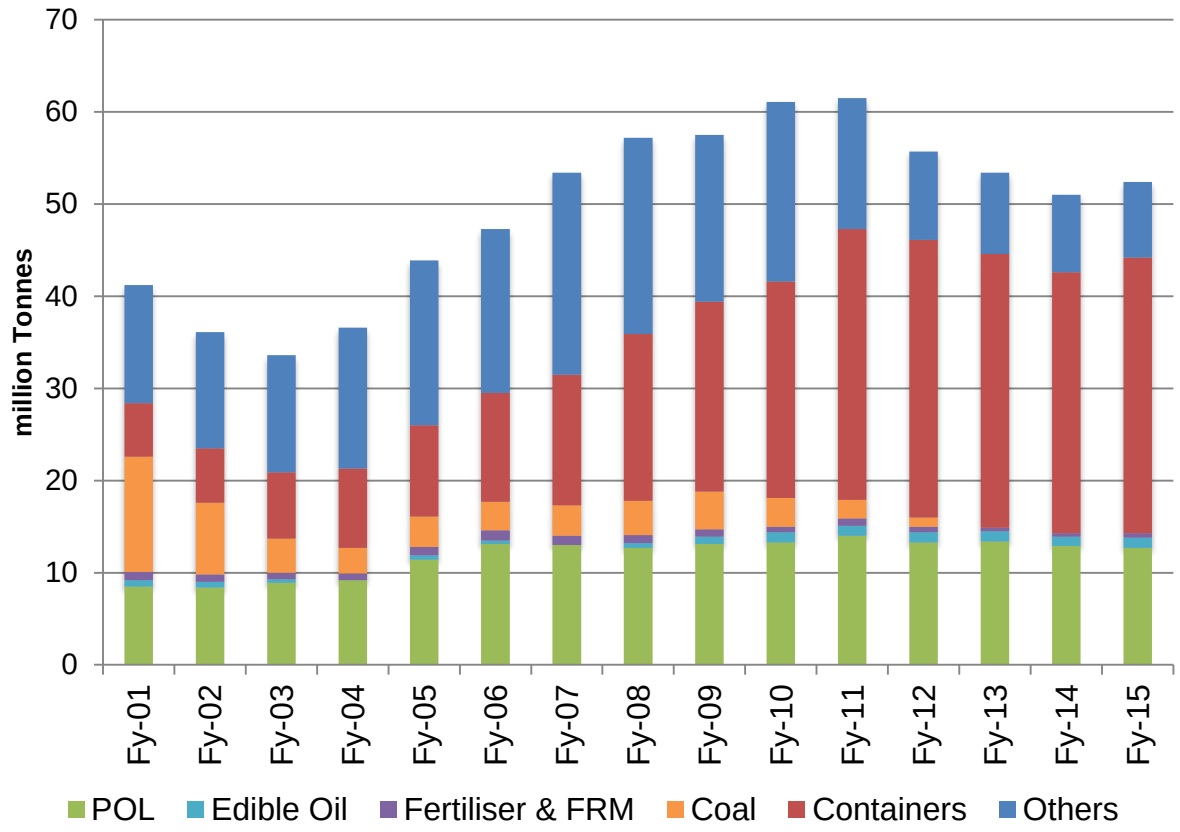


Figure 38: Commodity wise cargo growth of Chennai Port

Commodity	Volume (mn T)	Attractive	Reasoning
Pol & Other Products	12.7	No	Petroleum products handled at Chennai Port are for local refinery located in the port area. It is not possible to shift them. Very small volume of products is imported using Chennai Port. A substantial share of it gets consumed locally in the city. Hence, it does not offer any opportunity for rivers in Tamil Nadu.
Edible Oil	1.1	No	Districts like Kancheepuram & Thiruvannamalai do not have oil extraction units near rivers, Hence scope for oil imports in this region is not possible
Fertiliser& FRM	0.5	No	
Containers	29.9	No	Chennai Port trust has balance of trade for containerized cargo. Number of containers exported is equal to number of containers imported. The containerized trade is generated from the industrial units located in Chennai and around chennai. Containers traded at Chennai Port have high inventory value. The shippers ship them as soon as they get stuffed in their factories or CFS.
Others	8.2	No	
Total	52.5		

Table 49: Opportunity for river movement of commodities handled at Chennai Port

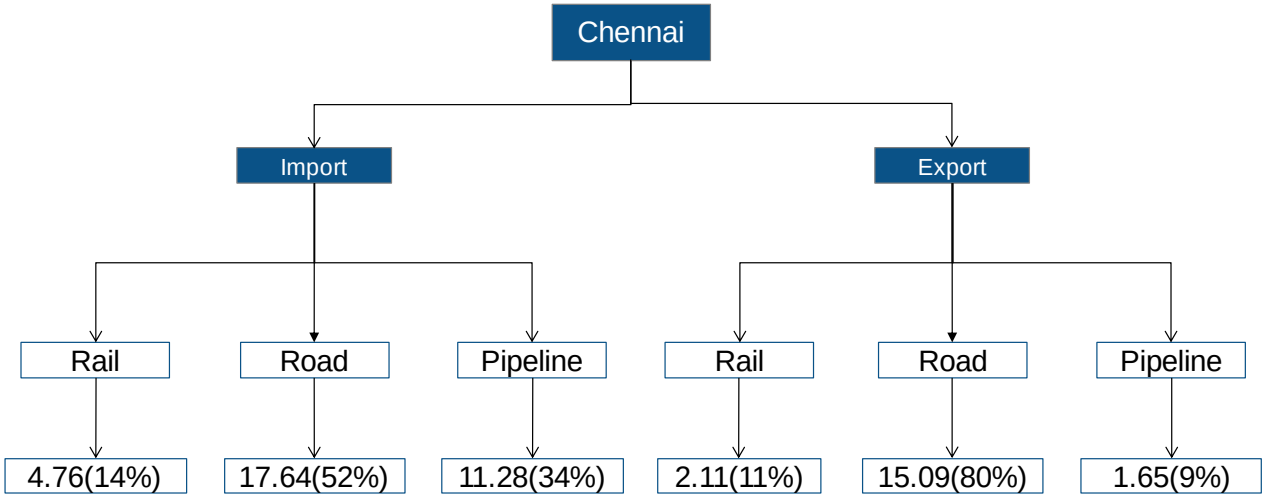


Figure 39: Modal Spilt of Traffic at Chennai Port

5.5.2 Kamarajar Port

Kamarjar Port is located about 24 km in the north of Chennai Port. It was developed as a satellite port of Chennai Port to decongest traffic at Chennai. It has now evolved as a full-fledged port and has the honour of being the first Corporatized Major Port of the country. It is an all weather port with round the clock operations. It poses to become a numerouno destination for Liquid Bulk Cargo. In Fy15, the port handled a traffic of more than 30 mn tonnes. Thermal coal constituted about 80% of total cargo followed by liquid cargo with more than 10% share.

Kamarajar Port and Chennai Port are located about 25 km apart. Hence, the logistics advantage for shift of cargo from land route to multimodal transportation using river route remains same. Chennai port trust has stopped handling large volumes of dirty cargo, predominantly minerals such as coal and iron ore. Located in the centre of city, all the dirty cargo handled at Chennai Port has been stopped and shifted to Kamarajar Port. Hence, for all mineral products Kamarajar Port can act as an alternate of Chennai Port. The shift of cargo using Kamarajar port, instead of Chennai Port, would require industries located in hinterlands near Palar river will have to move additional 35 km to reach Kamarajar Port. This will further increase logistic cost.

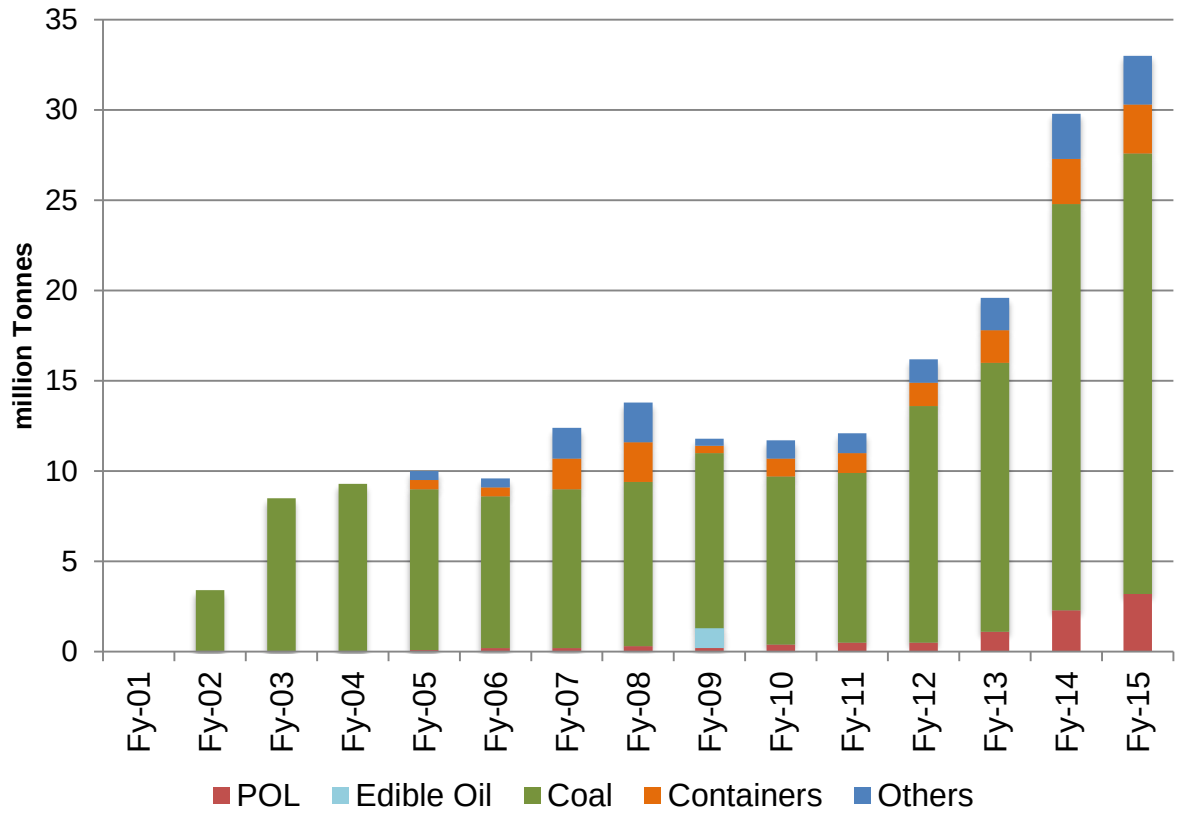


Figure 40: Commodity wise cargo growth of Kamarajar Port

Thiruvannamalai has a single industrial estate in Cheyyar. This is located close to Palar river. Commodities from this industrial area can also utilise Palar river for its cargo movement.

Commodity	Volume (mn T)	Attractive	Reasoning
Pol & Other Products	3.2	No	Liquid commodities evacuates from port using pipeline, hence shifting is not possible
Coal	24.4	No	Consumption centers are too far located from river route. Evacuation of coal from port is using Railways
Others	2.7	No	
Total	30.3		

Table 50: Opportunity for river movement of commodities handled at Kamrajar Port

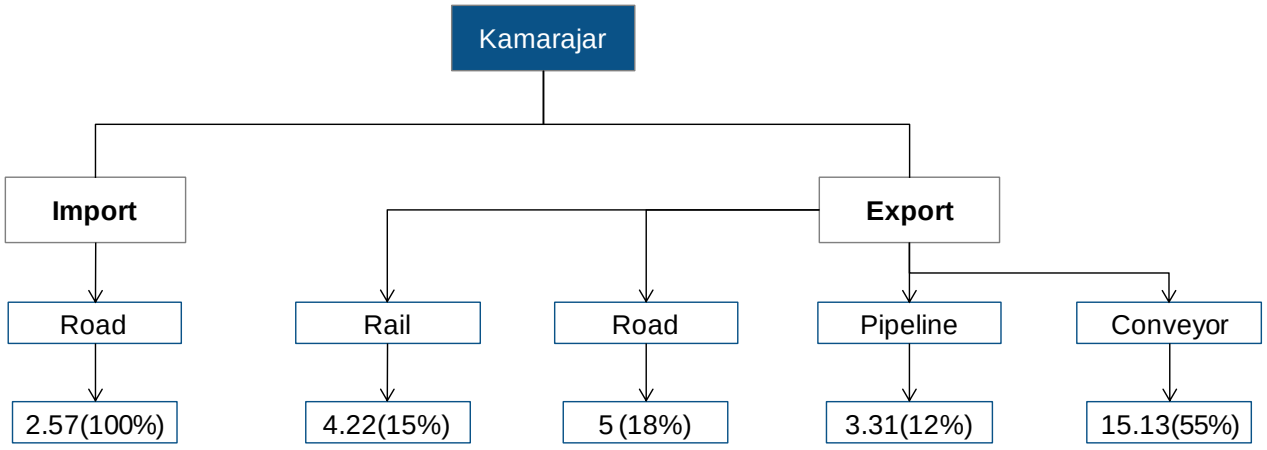


Figure 41: Modal Spilt of Traffic at Kamarajar Port

5.5.3 Kattupalli Port

Kattupalli Port is located at Kattupalli village in Thiruvallur district. L&T Shipbuilding Ltd has developed a shipyard cum minor port at the site. It is all weather, deep-water port. Besides shipbuilding and ship repairs, it is also involved in building offshore plateforms. In Fy15, the port attracted traffic of 0.1 million tonnes. It chiefly handles containers and general cargo.

Kattupalli Port can act as an option of Chennai Port. However, industries located in hinterlands near Palar River will have to move additional 30 km to reach Kattupalli Port. This will increase further to the logistic cost, which makes Kattupalli Port unattractive.

5.5.4 Ennore Minor Port

Ennore Minor Port is located 17 km north of Chennai Port. It is situated in Ponneritaluka of Tiruvallur district. It is a captive port of Coromondel International Ltd. The port is used for handling Liquid Ammonia for the fertilizer plant of the company. The port consists of a Pipeline End Manifold (PELM) and a Four Point Mooring System located about 1.8 km from the coast at a depth of 15 m. Cargo is pumped from the vessel directly to the shore storage tanks through the pipelines.

The port is a captive liquid port. Hence, cargo meant for the hinterlands close to rivers cannot be moved via the port.

5.6 Preliminary traffic identified – within 50km

Palar River flows in the south of Chennai Port which is located at a distance of about 75 km from the river. Chennai and Kancheepuram are the major producers of cars and auto components. Kancheepuram lies on the bank of Palar River. Kancheepuram acts as an extension of Chennai in terms of industrialization. There are 9 industrial areas in the district and most of them are located within a 50 km of distance. Many of them are into auto component manufacturing. Auto component manufacturers supply automobile parts to the car manufacturers located in the district. Also a large part of these is transported to car manufacturing clusters located in Pune, Delhi-NCR and other parts of the country. Chennai port acts as gateway to automobile sector. They are transported by roadways to the port which results in congestion in the city. Also there are certain guidelines from Municipal Corporation that the trailers cannot ply within specific time. **Palar River can act as an option**

for movement of cargo to the ports. This would avert the congestion of the city and would reduce the carbon emission due to movement by trailers.

5.7 Existing cargo movement

Palar River has higher penetration in the hinterland. Maximum SIDCOs around river are located within a 50-kilometer distance. This means there's a lot of traffic around the river. But Palar River has been dry for a long time. The river saw some water in 2015 after a long gap of 10 years. For this reason, no cargo movement is happening on this river. Presently the evacutation of cargo is undertaken through land route. These land routes passes through congested cities. Hence, there exists a potential for shift of cargo in Tamil Nadu from port to river route. River could be evaluated to compliment ports in evacuating cargo to the hinterland.

5.8 Prominent City / Town / Places of Worship / Historical places for Tourism

The prominent cities located on the banks of the Palar River are described as under:

Vellore City

Vellore is one of the largest districts in Tamil Nadu. The headquarters of the district is Vellore city, which is a popular destination of medical tourism in India. Two of India's top ten educational institutions --Christian Medical College & Hospital and VIT University -- are based in Vellore.

Vellore is also known as the top exporter of finished leather goods in India. In terms of industries, several prominent names like Bharat Heavy Electricals Limited, MRF Limited, TVS-Brakes India,and Mitsubishi Heavy Industries (Japan) are present in Vellore. The city of Vellore is situated 3 kilometers from Palar River.

Kancheepuram City

Kancheepuram district is known for its capital – Kancheepuram town – which is counted among the 7 holiest towns in India. The city has several historical monuments. Kancheepuram is 72 kilometers from Chennai. Apart from the various pilgrimage centres, Kancheepuramis also known for its silk sarees and weaving industry. As of 2011, there were 25 silk and cotton yarn industries and 60 dyeing units in Kancheepuram. From Palar river, Kancheepuram city is 5 kilometers away.

Popular places of worship and historical places of tourism along Palar river are as follows:

Ekambareshvara Temple

This is one of the very old temples of Lord Shiva, being in existence since 600 A.D. The temple has several carvings, pillars, and architecture built with granite stones. The gateway tower, or gopuram, of the temple is 59 meters tall, making it one of the tallest gopurams in India. The campus of the temple is spread across 25 acres and has 5 courtyards and a thousand-pillared hall. In total, the temple covers an area of more than 40 acres. Ekambareshvara Temple is 5 kilometers from Palar river.

Kanchi Kailasanathar temple

This ancient temple was built during 685-705AD by a ruler of the Pallava dynasty. The temple is known for its Vimana, or dome over the sanctum. The temple also has numerous panels depicting Lord Shiva as Nataraja in different postures. The temple is also a delight for calligraphy lovers as it has one of the earliest instances of calligraphy. Kanchi Kailasanathar temple is situated 5 kilometers from Palar river.

Shri Kanchi Kamakoti Peetham

This is a Hindu monastic institution situated in Kanchipuram. It is one of the five temples denoting the five elements. According to their website, Shri Kanchi Kamakoti Peetham was established by Sri Adi Sankara in the year 482 B.C.The place has a distinction of an unbroken line of 70 Acharyas or spiritual leaders. Shri Kanchi Kamakoti Peetham is located at a distance of 5 kilometers from Palar river.

Vedanthangal Bird Sanctuary

It is one of the oldest and smallest bird sanctuaries in the country. While the sanctuary is spread across a small area of 30 hectares, each year nearly 30,000 birds come to this place. The best time to visit the place is between October and January. Some of the birds sighted in this sanctuary are herons, egrets, storks, ibises and spoon bills.Vedanthangal BirdSanctuary is 12 kilometers from Palar river.

Sri Ulagalandar Temple

This huge temple has a 35 feet statue of Lord Vishnu. There are four temples inside the Sri Ulagalandar Temple. This temple was made during the Chola period. The temple is located at a distance of 5 kilometers from Palar river.

Kanchi Kudhil

It is a heritage house, situated very close to Kailasnathar temple, thus making it a popular choice for visitors to the Kanchipuram Temple. The 100-year old house has all the items used by the joint families living in it, intact. Kanchi Kudhil is 5 kilometers away from Palar River.

Jain Temple

The temple is situated at Thiruparuthikundram in Kanchipuram. Within the temple, there are three temples – one each for Varthamana, for Pushpathantar and for Padma Prabha and Vasu Pujya. The Jain temple is 4 kilometers from Palar River.

Vellore Fort

This 16th century fort was built by the Vijaynagara kings. The highlights of the fort are the grand walls, broad moat, and strong masonry. The fort has several other popular landmarks like the Jalakanteswarar Hindu temple, the Christian St. John's Church and a Muslim mosque. The fort is known for the first major military rebellion against the British, in 1806. Vellore fort is 3 kilometers from Palar River.

Government Museum, Vellore

This multipurpose museum is housed inside the Vellore Fort and is maintained by the Government of Tamil Nadu. It has several ancient items related to anthropology,art, archaeology, botany, geology, and zoology. The museum's gallery depicts historical monuments from the erstwhile North Arcot District (that was split in 1989 into Tiruvannamalai District and Vellore Districts.)

Kavalur Village

It is a village in Vellore, known for the Vainu Bappu astronomical observatory. The place has a wide variety of telescopes of different apertures, including 15 inches (38 cm), 30 inches (75 cm), and 40 inches (1 metre). The place also has a 2.3 metre aperture telescope, which is controlled by a computer. Kavalur is 60 kilometers from Palar river.

Elagiri Hills

Situated 75 kilometers from Vellore and 80 kilometers from Palar River, Elagiri hills are known as the Ooty of Vellore district. It stands among 4 mountains at a height of 3,500 feet above sea level. Other popular places on the hill are Mangalam Fishing Pondand Poly Garden House (Lake side).

Jalagamparai Waterfalls

These waterfalls run through the valleys of Elagiri hills. It is a popular picnic spot and trekking destination. The best time to visit the waterfalls is between November and February. During summers, the waterfall is a little dry. Jalagamparai Waterfalls is 69 kilometers from Palar River.

Muthu mandapam or Pearl Palace

The place is a memorial built around the tombstone of Vikramaraja Singh, the last of four kings to rule the kingdom of Kandy. Apart from the memorial, there's an aquarium, a children's park, a lawn and three decorative arches in Muthu mandapam. The palace is situated on the bed of the Palar river, and is only 0.35 kilometers away from the river.

Mordhana Dam

The dam, which is constructed between two hills, is a popular picnic spot. The dam is 31 kilometers from Vellore city. The dam, considered as an engineering marvel, is 33 meters high and 220 meters long. Mordhana dam is 53 kilometers from Palar River.

Ratnagiri temple

The temple is 12 kilometers, east of Vellore. This famous temple on a small hill is dedicated to Lord Balamurugan. The temple was built around the 14th century. Ratnagiri temple is hardly 2 kilometers away from Palar River.

Amirthi forest

It's a popular picnic spot, situated 25 kilometers from Vellore. The highlights of the forest are a steam running through it and also a zoo. The forests are also a popular choice for trekkers. The best time to visit the Amirthi forest is after monsoon. The forest also has some wild animals.

Amirthi Zoological Park

This zoological park has built in 1967. The park is spread across 25 hectares.Some of the animals in this park are spotted deer, mongoose, reason monkeys, red headed parrots, love birds and more. Amirthi Zoological Park is 23 kilometers from Palar River.

Mosque of Nawab Chanda Sahib

This ancient mosque was built in 1750 A.D. Its pillars have a width of 2.5 feet on the facing side and nearly 1 foot on the sides. There is a big dome at the centre of the mosque. Also, the mosque has minars on the side; particularly, the minars on the northern and southern side of the mosque are very big. Mosque of Nawab Chanda Sahib is located 5 kilometers from Palar River.

5.9 Availability of Passenger Ferry Services

Palar River had been dry for a long time. In November 2015, water flowed into Palar after almost 10 years. For this reason, there are no passenger ferry services along Palar River.

5.10 Available and probable Water Sport Recreational Facilities

Palar River flows only during monsoon, there are no water sport recreational facilities around the river.

However, there are some watersports activities at Kanchipuram, around 34 kilometers away from the river. Covelong Point is the first surfing village of India, and has produced over 40 surfers.

6. Observations, Inferences and Conclusions

6.1 Waterway

The total length of the river under present studies is detailed below:

141 km length of the river from rail bridge at Virudampattu, Vellore to confluence with Bay of Bengal at Sadurangapattinam (National Waterway 75)	**From: 12°56'14.07"N 79° 7'29.70"E**	**Up to: 12°27'52.16"N, 80° 9'13.47"E**

6.2 Length

The length of waterway under present studies under consideration is 141 km.

6.3 LAD

Since the river remains dry throughout the year and has a very less Water availability, that too for Very short duration (about 18 days in a year), therefore the river is not suitable for navigation.

6.4 Cross-Structures

Nos.	Horizontal clearance	Vertical clearance
Bridges/Railway Lines		
21 existing 3 under construction bridge between chainage 3.5 to 141 km	Varying from 6 to 35 meters	Varying from 0.5 to 4 meter
HT Lines		
13 HT lines between chainage 8 to 130 km	Varying from 150 to 800 meters	Varying from 3 to 16 meters
Pipe Lines		
1 Water pipeline from Vadalur to Chennai	17 meters	2 meters

6.5 Water availability

In general Palar River receives some flow from North-East monsoon only during period October to December. The period for which some flow is experienced in river varies from only 8 to 10 days to about 30 days. Most of rainwater from the catchment is trapped in hundreds of storage tanks for water supply. Also river water during flow period is diverted to such large storage reservoirs. This results in less flow in the river. River remains dry for most part of the year.

6.5.1 Arcot Gauge data analysis

Daily gauge- discharge at Arcot for period 1980 to 2012 was analyzed in different ways as discussed in Chapter 4. Results of analysis of data for assessing period of availability (% days during rainy season) for different discharge ranges is presented in Table 53. Flow in Palar river is experienced during few days in Noth-East monsoon (October to December). Percentage of days during monsoon in year for availability of discharge at this gauge site in excess of certain values is presented on a plot in Figure 42. These results indicate following.

Sr	Discharge(m^3/s) in excess of	Availability period (% days) during monsoon period (about 50 rainy days)	Likely depth estimated at Arcot gauging site
1	10 m^3/s	36 % (about 18 days)	0.60 m
2	20 m^3/s	26 % (about 12 days)	0.70 m
3	40 m^3/s	16 % (about 8 days)	0.80 m
4	100 m^3/s	7 % (about 4 days)	1.10 m

Table 51: Water availability in Palar River at Arcot GD Site

The table 51 shows that discharge in excess of 10 cumecs occurs only for 36 % of days in a year. Similarly, discharges in excess of 20 cumecs, 40 cumecs and 100 cumecs occurs only for 26%, 16% and 7% of days in a year respectively. The estimated depths for 10, 20, 40 and 100 cumecs are also shown in the above table 51. Table 53 shows the breakup of discharges in a particular year from 1979 to 2011. It shows a range of discharge eg. 0-10 occurring for how many days in a particular year. As the data is not available for whole year, Total no of days for some years does not add up to 365.

6.5.2 Avarankuppam Gauge data analysis

Results of analysis of data for assessing period of availability (% days in rainy season) for different discharge ranges is presented in Table 54. Percentage of days in year for availability of discharge at this gauge site in excess of certain values is presented on a plot in Figure 43. These results indicate following.

Sr	Discharge(m^3/s) in excess of	Availability period (% days) during monsoon period (about 50 rainy days)	Likely depth estimated at Avarankuppam gauging site
1	5 m3/s	11.5 % (about 6 days)	1.00 m
2	10 m3/s	6.5 % (about 4 days)	1.10 m
3	20 m3/s	3.7 % (about 2 days)	1.25 m
4	40 m3/s	1.6 % (about a day)	1.50 m

Table 52: Water availability in Palar River at GD Site

The table 52 shows that discharge in excess of 5 cumecs occurs only for 11.5 % of days in a year. Similarly, discharges in excess of 10 cumecs, 20 cumecs and 40 cumecs occurs only for 6.5%, 3.7% and 1.6% of days in a year respectively. The estimated depths for 5, 10, 20 and 40 cumecs are also shown in the above table 52. Table 54 shows the breakup of discharges in a particular year from 1978 to 2012. It shows a range of discharge eg. 0-2 occurring for how many days in a particular year. As the data is not available for whole year, Total no of days for some years does not add up to 365.

No of Days / Year	Range of Discharge (m^3/s)													
	0 to 10	11 to 20	21 to 40	41 to 60	61 to 80	81 to 100	101 to 120	121 to 140	141 to 150	151 to 200	201 to 300	301 to 500	501 to 1000	1001 to 1500
1979	27	16	11	6	10	4	4	3	0	4	3	0	4	0
1980	29	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	56	12	15	5	11	4	1	0	1	2	1	2	2	0
1982	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	39	2	2	3	1	0	1	1	0	1	0	0	0	0
1984	130	4	4	0	1	0	1	0	0	0	0	0	0	0
1985	51	2	2	0	1	1	1	0	0	0	0	0	0	0
1986	26	1	0	0	0	0	0	0	0	0	0	0	0	0
1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	39	10	13	9	1	0	2	0	0	0	0	0	0	0
1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	19	3	8	1	2	1	3	2	1	4	4	3	10	2
1992	24	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	13	14	7	4	3	2	1	7	1	1	0	0	0	0
1994	55	1	0	0	0	0	0	0	0	0	0	0	0	0
1995	121	12	4	0	0	0	0	0	0	0	0	0	0	0
1996	23	6	21	26	11	13	8	10	1	6	5	2	0	0
1997	46	46	10	0	0	0	0	0	0	0	0	0	0	0
1998	71	16	9	1	0	0	0	0	0	0	0	0	0	0
1999	5	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	51	15	19	0	0	0	0	0	0	0	0	0	0	0
2002	21	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-

No of Days / Year	Range of Discharge (m^3/s)													
	0 to 10	11 to 20	21 to 40	41 to 60	61 to 80	81 to 100	101 to 120	121 to 140	141 to 150	151 to 200	201 to 300	301 to 500	501 to 1000	1001 to 1500
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	11	8	22	8	7	4	0	1	0	0	0	0	0	0
2006	8	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	12	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	27	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2010	54	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	20	0	0	0	0	0	0	0	0	0	0	0	0	0
N	980	168	147	63	48	29	22	24	4	18	13	7	16	2
ƐN	1541													
% occurrence	63.60%	10.90 %	9.54 %	4.09 %	3.11%	1.88%	1.43%	1.56%	0.26%	1.17%	0.84%	0.45%	1.04%	0.13%

Table 53: Availability for days for discharge in different range at Arcot gauge station on Palar River

(- Data not available)

No of Days / Year	Range of Discharge (m^3/s)												
	0 to 2	2 to 5	5 to 10	10 to 20	20 to 40	40 to 60	60 to 80	80 to 100	100 to 120	120 to 140	140 to 150	150 to 200	200 to 500
1978	78	55	14	8	3	2	1	0	0	0	0	1	0
1979	222	51	30	19	19	3	1	0	0	1	0	1	2
1980	255	7	0	0	0	0	0	0	0	0	0	0	0
1981	47	43	24	17	20	3	5	1	0	1	0	1	1
1982	293	8	2	0	0	0	0	0	0	0	0	0	0
1983	136	19	9	4	2	0	1	1	0	0	0	0	0
1984	245	11	7	1	1	0	0	0	0	0	0	0	0
1985	150	36	10	3	2	0	0	0	0	0	0	0	0
1986	213	18	18	4	5	1	0	0	0	0	0	0	0
1987	203	17	2	1	2	1	0	0	0	0	0	0	0
1988	188	27	16	14	7	5	1	0	0	1	0	0	0
1989	172	13	10	10	1	2	0	0	0	0	0	0	0
1990	149	4	4	0	0	0	0	0	0	0	0	0	0
1991	64	20	6	16	7	3	2	1	1	2	1	2	0
1992	274	24	4	1	0	0	0	0	0	0	0	0	0
1993	121	23	12	11	7	1	0	0	0	0	0	0	0
1994	174	12	3	0	0	0	0	0	0	0	0	0	0
1995	113	42	21	9	3	1	0	0	0	0	1	0	0
1996	17	37	34	20	17	11	6	2	0	0	0	1	1
1997	150	64	7	6	0	0	0	0	0	0	0	0	0
1998	111	42	34	15	7	3	1	0	1	0	0	0	0
1999	217	4	1	1	0	0	0	0	0	0	0	0	0
2000	65	1	0	0	0	0	0	0	0	0	0	0	0
2001	71	17	17	12	12	6	3	2	0	0	0	1	1
2002	99	0	0	0	0	0	0	0	0	0	0	0	0
2003	37	1	0	0	0	0	0	0	0	0	0	0	0

No of Days / Year	Range of Discharge (m^3/s)												
	0 to 2	**2 to 5**	**5 to 10**	**10 to 20**	**20 to 40**	**40 to 60**	**60 to 80**	**80 to 100**	**100 to 120**	**120 to 140**	**140 to 150**	**150 to 200**	**200 to 500**
2004	19	2	0	0	0	0	0	0	0	0	0	0	0
2005	10	13	21	20	15	5	5	0	0	1	0	0	2
2006	282	35	3	1	0	1	0	0	0	0	0	0	0
2007	176	1	0	0	0	0	0	0	0	0	0	0	0
2008	131	15	5	1	1	1	0	0	0	0	0	0	0
2009	137	8	4	1	2	0	0	0	0	0	0	0	0
2010	210	14	1	1	0	0	0	0	0	0	0	0	0
2011	259	2	0	0	0	1	0	0	0	0	0	0	0
2012	58	0	0	0	0	0	0	0	0	0	0	0	0
N	5146	686	319	196	133	50	26	7	2	6	2	7	7
ƐN	6587												
% occurrence	78.12%	10.41%	4.84%	2.98%	2.02%	0.76%	0.39%	0.11%	0.03%	0.09%	0.03%	0.11%	0.11%

Table 54: Availability for days for discharge in different range at Avarankuppam gauge station on Palar River

(- Data not available)

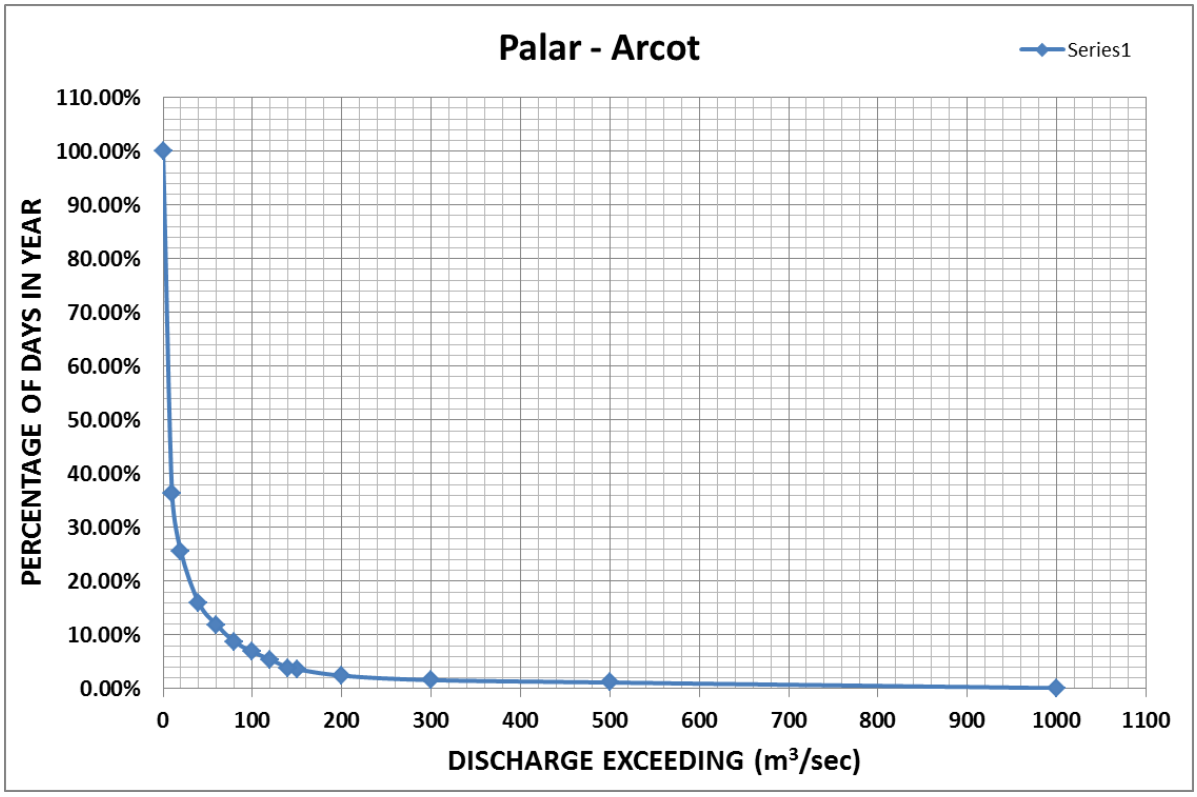


Figure 42: Period of exceedance of discharge in percentage of days in year for Palar River at Arcot gauging station

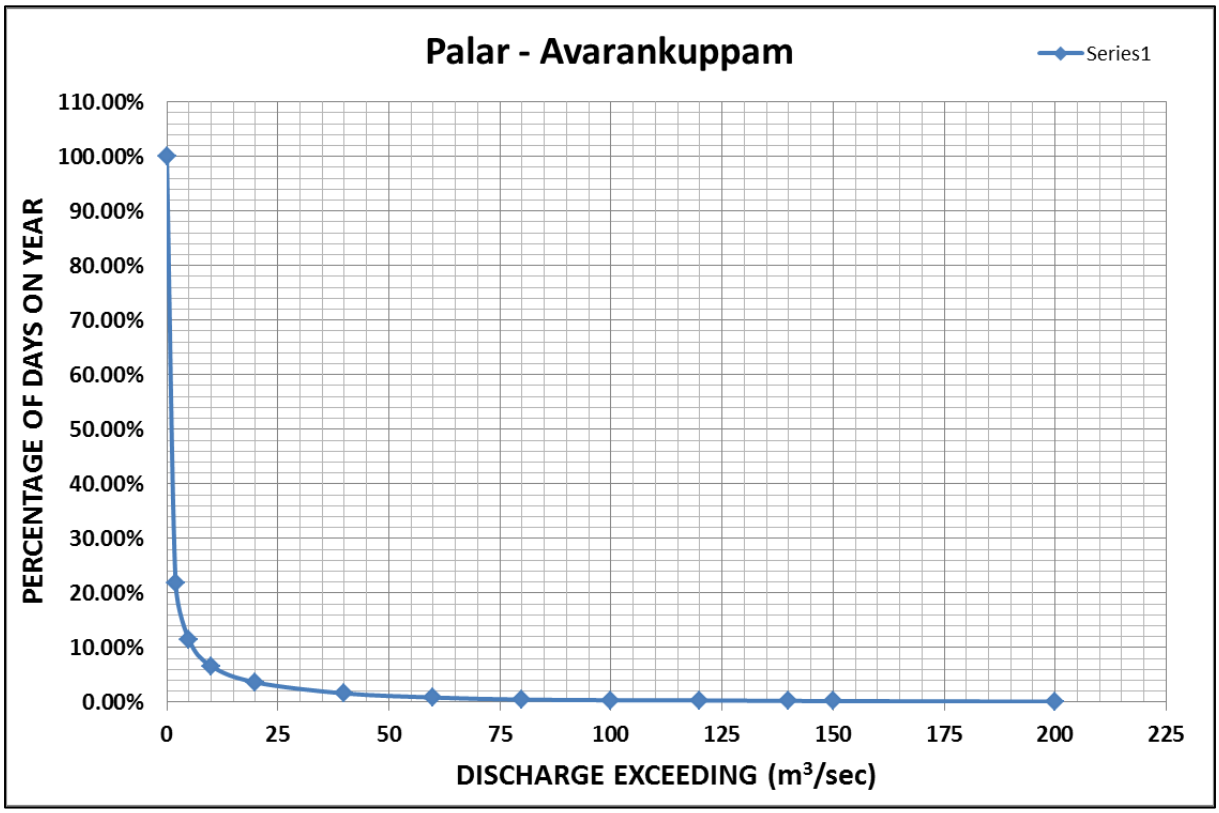


Figure 43: Period of exceedance of discharge in percentage of days in year for Palar River at Avarankuppam gauging station

6.6 Cargo / Passenger / Tourism / Ro-Ro Facility

As can be seen in chapter 5, there does not exist any possibility of shifting cargo (POl and others, Edible oil, fertilizers and FRM and containers) from Chennai port and karamajar port. Route following multimodal transportation is twice as large as compared to roadways. No potential exists for river movement. Hence, It is commercially not viable to shift to waterways

6.7 Classification of waterway: Suitable for Navigation

The present stretch of 141 km of Palar River is Not Feasible for Inland Navigation due to:

- Hydraulic Conditions: Remains dry throughout the year, Very less Water availability, that too for Very short duration (18 days in a year)
- Traffic Studies and Market Analysis: No potential cargo and passenger traffic.

6.8 Proposed alternative methods for making waterway feasible

Tidal reach of the river is very small. So, even by dredging, only 2-4 km stretch from river mouth may become feasible. Moreover, the river mouth closes every year due to littoral drift. Annual maintenance dredging is required in this stretch to keep the river mouth open. This may upset the financial viability as the stretch is very small. Hence, dredging is not recommended for this small reach of 2-4 km.

6.9 SWOT Analysis

Strength	**Weakness**
None	• **Very less water availability (About 18 days in a year)** • **No potential cargo and passenger traffic**
Opportunity	**Threats**
None	• **Closure of river mouth in the absence of River flow due to littoral drift.** • **Dredging the small tidal reach of 2-4 km may be financially not viable.**

6.10 Recommendation for going into Stage II

Presently, Govt. of Andhra Pradesh has started studies to divert the flood water of Godavari River to Palar and Pennar Rivers. Till these studies get completed and unless a big dam/reservoir is constructed over Palar River, it is not feasible for navigation. Hence, it is not recommended for Stage II.

Annexure 1: Soil characteristics

Chainage (km)	Texture
0 – 20 km	Coarse SAND
20 – 45 km	Coarse SAND
45 – 55 km	Coarse SAND with granules
55 – 85 km	Coarse SAND
85 – 95 km	Coarse SAND with granules
95 – 105 km	Fine SAND
105 – 115 km	Coarse SAND
115 – 125 km	Fine SAND
125 – 130 km	Sandy CLAY
130 – 141 km	CLAY

Annexure 1: Soil Characteristics

Annexure 2: Inventory of structures in Palar River

Sl No.	Chainage(km)	Max Water Level	Min. Water Level	Utility/ Pipelines		Historical and tourist places		Bridges Name with VC & HC		HT /Electric Line	Permananent Structure in River Corridor		Bank Condition	Critical Areas/Not approachable areas		Local Name of River	Dams		HFL/Gauge station station details		Types of Crops & Industry	Ferry/Prominent Towns City/Jetty/Terminal	Remarks	Other Details
				Name	Position	Name	Position	Name	Position	Position	Details	Position		Details	Position		Details	Position	Details	Position				
1	0												Natural										Palar river gets divided into about 7-8 creeks at delta	Bushes and Trees on banks
2	3.5	3.3 m(Raw Water Depth)	0.3m(Raw Water Depth)	-	-	-		PUDUPATTINAM ROAD BRIDGE	12º 29' 00.8133N 80º 07' 18.4261E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT		Stone pitching on right bank to prevent erosion	-
3	7.3	Dry River Bed	Dry River Bed	-	-	-		-	-	-	Well	12º 29' 46.7092N, 80º 05' 13.6222E	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		Completely dry sandy bed with very less vegetation
4	8.0	Dry River Bed	Dry River Bed	-	-	-		-	-	-	Well	12º 29' 52.5112N, 80º 04' 50.3520E	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		
5	8.2	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 29' 48.6461N 80º 04' 44.2511E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		
6	10.5	Dry River Bed	Dry River Bed	-	-	-		CROSS ROAD OVER THE RIVER	12º 30' 37.5754N 80º 03' 36.6811E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		
7	11.4	Dry River Bed	Dry River Bed	-	-	-		DAMAGED PALAR BRIDGE(CAUSEWAY)	12º 31' 07.9050N 80º 03' 43.7853E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		Water flowing in patches, bushes & coconut trees on both banks
8	15.9	Dry River Bed	Dry River Bed	-	-	-		IDAIYATHUR UNDER CONSTRUCTION BRIDGE	12º 32' 08.4209N 80º 01' 22.8044E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		

Sl No.	Chainage(km)	Max Water Level	Min. Water Level	Utility/ Pipelines		Historical and tourist places		Bridges Name with VC & HC		HT /Electric Line	Permananent Structure in River Corridor		Bank Condition	Critical Areas/Not approachable areas		Local Name of River	Dams		HFL/Gauge station station details		Types of Crops & Industry	Ferry/Prominent Towns City/Jetty/Terminal	Remarks	Other Details
				Name	Position	Name	Position	Name	Position	Position	Details	Position		Details	Position		Details	Position	Details	Position				
9	17.6	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 32' 14.7754N 80º 00' 27.3105E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		Completely dry sandy bed
10	17.8	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 32' 17.9924N 80º 00' 21.4496E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		
11	18.1	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WELL 1 WELL 2	12º 32' 19.5750N, 80º 00' 12.9351E 12º 32' 20.9033N, 80º 00' 09.7767E	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City		
12	18.7	Dry River Bed	Dry River Bed	Waterpipeline from Vadalur to Chennai VC=6M HC=17M	12º 32' 29.3405N 79º 59' 53.8145E	-		-	-	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		Completely dry sandy bed with light vegetation
13	19.6	Dry River Bed	Dry River Bed	-	-	-		VILLUPURAM ROAD BRIDGE	12º 32' 42.45N 79º 59' 27.33E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	KALPAKKAM City		Dry Ssandy bed light vegetation
14	25.1	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 35' 03.9846N 79º 57' 55.9332E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT, GROUND NUT	CHENGALPATTU City		Graveyard nearby on right bank
15	26.6	Dry River Bed	Dry River Bed	-	-	-		PADALAM RAILWAY BRIDGE RAILWAY BRIDGE,	12º 35' 42.5973N 79º 57' 23.6067E 12º 35' 42.7456N 79º 57' 24.7951E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City	Church nearby	Water flowing in patches, Bouldery strata, Guage well, Stone Pitching

Sl No.	Chainage(km)	Max Water Level	Min. Water Level	Utility/ Pipelines		Historical and tourist places		Bridges Name with VC & HC		HT /Electric Line	Permananent Structure in River Corridor		Bank Condition	Critical Areas/Not approachable areas		Local Name of River	Dams		HFL/Gauge station station details		Types of Crops & Industry	Ferry/Prominent Towns City/Jetty/Terminal	Remarks	Other Details
				Name	Position	Name	Position	Name	Position	Position	Details	Position		Details	Position		Details	Position	Details	Position				
16	27.3	Dry River Bed	Dry River Bed	-	-	-		PV KALATHUR ROAD BRIDGE (DAMAGED CAUSEWAY) NO VC AND HC	12º 36' 01.8090N 79º 57' 15.3323E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City		LT line passing across the bridge
17	31.1	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 37' 59.3312N 79º 56' 55.1406E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City		
18	33.7	Dry River Bed	Dry River Bed	-	-	-		CHENGALPATTU BRIDGE (Chennai-Trichi Highway)	12º 39' 21.4694N 79º 57' 05.0339E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City		Water flowing in a SMALL CREEK,Heavy bushes in bed and banks
19	40.3	Dry River Bed	Dry River Bed	-	-	MAHABALI PURAM		-	-	12º 42' 58.3670N 79º 56' 58.1275E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	CHENGALPATTU City		
20	41.0	Dry River Bed	Dry River Bed	-	-	-		PAZHATHOTTAM UNDER CONSTRUCTION BRIDGE	12º 43' 14.8458N 79º 56' 44.4939E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	KANCHEEPURAM City		Dry sandy bed, dense vegetation
21	51.9	Dry River Bed	Dry River Bed	-	-	-		KANCHEEPURAM ROAD BRIDGE	12º 45' 56.5534N 79º 51' 55.6707E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	KANCHEEPURAM City	Lakshmi Narsimha Temple nearby	Dry Sand bed with less vegetation
22	52.2	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 45' 56.7756N 79º 51' 46.7821E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	KANCHEEPURAM City		
23	57.5	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WELL 1 WELL 2	12º 46' 11.2103N 79º 52' 54.9544E 12º 46' 14.1701N 79º 52' 53.8361E	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	KANCHEEPURAM City		
24	57.6	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WELL	12º 47' 14.2434N 79º 49' 12.1176E	ERODED	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City		
25	57.9	Dry River Bed	Dry River Bed	-	-	-		PALAR WALAZABAD GROIUND BRIDGE NO VC	12º 47' 28.5234N 79º 49' 01.1503E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY, COCONUT	KANCHEEPURAM City	Ariantham primary school just u/s	Dry sandy bed, LT line passing parallel to bridge

Sl No.	Chainage(km)	Max Water Level	Min. Water Level	Utility/ Pipelines		Historical and tourist places		Bridges Name with VC & HC		HT /Electric Line	Permananent Structure in River Corridor		Bank Condition	Critical Areas/Not approachable areas		Local Name of River	Dams		HFL/Gauge station station details		Types of Crops & Industry	Ferry/Prominent Towns City/Jetty/Terminal	Remarks	Other Details
				Name	Position	Name	Position	Name	Position	Position	Details	Position		Details	Position		Details	Position	Details	Position				
26	69.6	Dry River Bed	Dry River Bed	-	-	-		UTHRAMERUR ROAD BRIDGE	12º 47' 27.7265N 79º 42' 54.1885E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City	Road Bridge @7.5+1.5x2, Kanchi Mandapam temple 500m u/s	Dry sandy bed, with light bushes
27	72.7	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 47' 51.7420N 79º 41' 08.9307E	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City		
28	73.5	Dry River Bed	Dry River Bed	-	-	-		ARCOT KANCHEEPURAM BRIDGE	12º 47' 44.4201N 79º 40' 38.2352E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City	Road Bridge @7.5+1.5x2	
29	77.7	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 48' 35.3992N 79º 38' 25.9179E	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City		
30	78.0	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 48' 46.9212N 79º 38' 20.5738E	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City		
31	85.7	Dry River Bed	Dry River Bed	-	-	KAMATCHI AMMAN TEMPLE		PERUMBAKKAM GROUND BRIDGE(CAUSEWAY)	12º 50' 40.4394N 79º 34' 29.8367E,	-	-	-	GOOD	-	-	PALAR	-	-	-	-	WATER MELON, PADDY	KANCHEEPURAM City		Completely dry sandy bed, coconut trees on both banks
32	93.0	Dry River Bed	Dry River Bed	-	-	-		PUDUR BRIDGE	12º 51' 31.7425N 79º 30' 36.5470E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City	Road Bridge @7.5+1.5x2	Completely dry sandy bed
33	99.9	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WATERINTAKE VC=5M HC=8M	12º 52' 45.4566N 79º 27' 13.4315E	GOOD	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		
34	105.2	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WELL	12º 52' 26.4713N 79º 27' 05.5572E	GOOD	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		
35	108.6	Dry River Bed	Dry River Bed	-	-	-		-	-	-	-	-	GOOD	-	-	PALAR	SAKKARAMALLUR DAM	12º 52' 28.4423N 79º 22' 20.2131E	HFL= 492.98 Ft	12º 52' 28.4423N 79º 22' 20.2131E	PADDY AND SUGAR CANE	ARCOT City		
36	115.2	Dry River Bed	Dry River Bed	-	-	-		ARCOT RANIPET BRIDGE 1 ARCOT RANIPET BRIDGE 2	12º 55' 08.2967N 79º 19' 43.7305E 12º 55' 08.1342N 79º 19' 44.2070E	-	-	-	ERODED	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City	2 Road Bridges @7.5+1.5x2	Completely dry sandy bed
37	115.4	Dry River Bed	Dry River Bed	-	-	-		ARCOT RANIPET BRIDGE	12º 55' 09.0969N 79º 19' 41.8363E	-	-	-	ERODED	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		Completely dry sandy bed

Sl No.	Chainage(km)	Max Water Level	Min. Water Level	Utility/ Pipelines		Historical and tourist places		Bridges Name with VC & HC		HT /Electric Line	Permananent Structure in River Corridor		Bank Condition	Critical Areas/Not approachable areas		Local Name of River	Dams		HFL/Gauge station station details		Types of Crops & Industry	Ferry/Prominent Towns City/Jetty/Terminal	Remarks	Other Details
				Name	Position	Name	Position	Name	Position	Position	Details	Position		Details	Position		Details	Position	Details	Position				
38	116.4	Dry River Bed	Dry River Bed	-	-	-		RAILWAY BRIDGE	12º 54' 55.4307N 79º 18' 55.5906E	-	-	-	ERODED	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		Completely dry sandy bed,medium vegetation
39	117.5	Dry River Bed	Dry River Bed	-	-	-		-	-	-	WATERINTAKE VC=7M HC=8M	12º 55' 05.9931N 79º 18' 23.4252E	ERODED	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		
40	120.7	Dry River Bed	Dry River Bed	-	-	DELHI CAVE		SIPCOT, BHEL BRIDGE, BRIDGE UNDER CONSTRUCTION	12º 55' 36.3927N 79º 16' 38.2018E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	ARCOT City		Water flowing in about 300m width in the middle, Coconut trees at banks
41	123.5	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 56' 45.5173N 79º 15'	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY AND SUGAR CANE	VELLORE City		
42	126.2	Dry River Bed	Dry River Bed	-	-	-		ARCOT KATHPADI BRIDGE	12º 57' 20.9945N 79º 14' 09.7811E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY	VELLORE City	Road Bridge @7.5m	Completely dry bed with heavy bushes on banks
43	130.1	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 57' 12.1868N 79º 12' 05.0603E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY	VELLORE City		
44	130.2	Dry River Bed	Dry River Bed	-	-	-		-	-	12º 57' 13.7035N 79º 12' 00.1547E	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY	VELLORE City		
45	139.5	Dry River Bed	Dry River Bed	-	-	-		KATHPADI TO VELLORE BRIDGE, (POINT OVER THE BRIDGE)	12º 56' 29.8863N 79º 08' 17.6756E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY	VELLORE City		Water flowing in about 300m width in the middle, Coconut trees on banks
46	139.9	Dry River Bed	Dry River Bed	-	-	-		VELLORE TO KATHPADI BRIDGE	12º 56' 28.8833N 79º 08' 06.1090E	-	-	-	GOOD	-	-	PALAR	-	-	-	-	PADDY	VELLORE City		Water flowing in about 300m width in the middle, Coconut trees on banks
47	141.0	Dry River Bed	Dry River Bed	-	-	VELLORE FORT		RAILBRIDGE (POINT UNDER THE BRIDGE)	12º 56' 14.0552N, 79º 07' 29.9806E	-	-	-	GOOD	-	-	PALAR	-	-	HFL LINE FOUND ON RAIL BRIDGE PILLAR, NO VALUE MENTIONED	12º 56' 14.0552N 79º 07' 29.9806E	PADDY	VELLORE City		Water flowing in about 225m width in the middle, Coconut trees and heavy bushes on banks

ANNEXURE 3:- PHOTOGRAPHS OF CROSS-STRUCTURES ON PALAR RIVER

1: Tide marking pole

2: View of Palar river mouth from Right Bank

3: Pudupattinam Road Bridge at Chainage 3.5 km

4: Shallow patches towards West at Chainage 3.83 km

5: Damaged Causeway at Chainage 11.4 km

6: Idaiyathur under Construction Bridge at chainage 15.9 km

7: Idaiyathur under Construction Bridge at chainage 15.9 km

8: High Tension line with HC-400m, VC-15m at Chainage 17.8 km

9: water Pipeline Bridge Vertical clearance-6m, HC-17m, Length-800m at ch 18.7 km

10: **Vallipuram Bridge HC 2.5m VC 3m at chainage 19.6 km**

11: Padalam Railway Bridge Length-700m, VC-8.5m, HC-18m at Chainage 26.6 km

12: View of HFL mark on Padalam Railway Bridge at Chainage 26.6 km

13: **PV kalathur road bridge (Damaged Causeway) at chainage 27.3 km**

14: **CHENGALPATTU BRIDGE (Chennai-Trichi Highway) at chainage 33.7 km**

15: HT Line crossing Palar River at Chainage 40.3 km

16: ROW of wells in half of the Width of the River 250m apart at Ch 57.5 km

17: Palar Walazabad ground bridge at Chainage 57.9 km

18: UTHRAMERUR BRIDGE at chainage 69.6 km

19: HT line VC-18m, HC-300m at Chainage 72.7 km

20: Arcot - Kanchipuram Bridge VC-5m, HC-12m and Length -700m at Chainage 73.5 km

21: KANCHIMANDAPAM TEMPLE at chainage 85.7 km

22: Pudur Mamandur Bridge extn, VC-4m, HC-15m, Length-300m at Ch 93.0 km

23: Eastern view of the river at Chainage 99 km

24: Palar River, Water present upto 1 km east and 1 km west from this point at Ch 104 km

25: View of Old Dam (not in use) towards South and HFL values at Chainage 108.6

26: View of Old Dam at Chainage 108.6 km

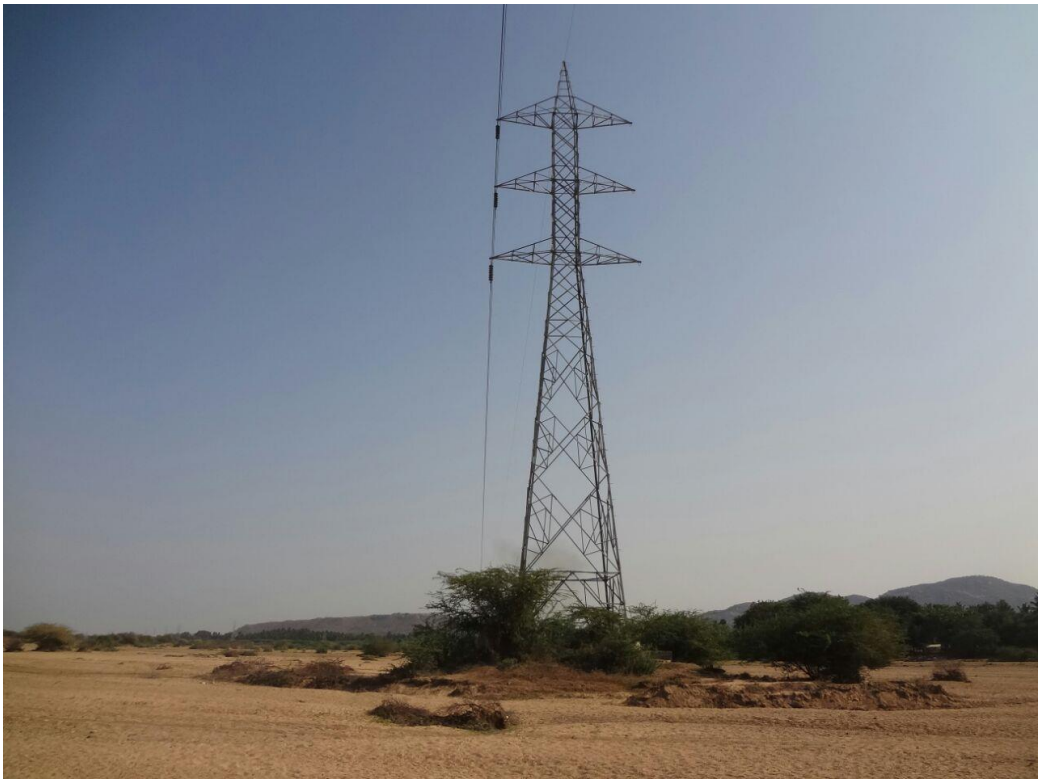
27: Electric line and two bridges (Arcot-Ranipet) at Chainage 115.2 km

28: Two bridges (Arcot-Ranipet) at Chainage 115.2 km

29: Railway Bridge at Chainage 116.4 km

30: Old water Intake from mid of river, VC-7m, HC-8m at ch 117.5 km

31:SIPCOT, BHEL BRIDGE (BRIDGE UNDER CONSTRUCTION) at Ch 120.7 km



32: High Tension Line, VC-15m, HC-150m at Chainage 123.5 km

33: Arcot-Kathpali ground bridge, VC -2m, HC -6m, Length -250m at Ch 126.2 km

34: HFL mark on pillar of Rail Bridge at Chainage 141 km

35: Rail Bridge VC 7m and HC 20m at Chainage 141 km