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DPR – VECHOOR – ATHIRAMPUZHA CANAL (18.78 KM) NW-59

Our ref.: **P.010631-W-10305-03**

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RESTRICTED

Client: **INLAND WATERWAYS AUTHORITY OF INDIA**

Project: **CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER – 6 (KERALA) OF NATIONAL WATERWAYS**

Subject: **DETAILED PROJECT REPORT – VECHOOR – ATHIRAMPUZHA CANAL (18.78 km) NW-59**

Comments:

Revision No.	Date	Prepared / Revision By	Description
01	2019 07 29	B. C. Jha	Submitted for Review and Approval.
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04	21/03/03	Active	Sarika Kumari	Arun Kumar	Arun Kumar	B. C. Jha

LIST OF VOLUMES

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Inland Waterways Authority of India (IWAI) assigned the Consultancy Services for "Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 6 (Kerala) of National Waterways". The study has been carried out for this assignment and the result has been compiled in the present study.

The consultant would like to put on record their deep appreciation of cooperation and ready access to information and advice rendered by IWAI.

The consultants are grateful to Mr. S. K. Gangwar, Member (Technical), Mr. R. P. Khare (Ex. Member, Technical & Sr Consultant); Capt. Ashish Arya, (Hydrographic Chief) and Mr Rajeev Singhal (AHS) who provided their valuable guidance from time to time to make this report success.

(B. C. JHA)

Tractebel Engineering Pvt Ltd

DISCLAIMER / PROPREITORY RIGHTS

M/s Tractebel Engineering Pvt., Ltd., (M/s TEPL), Gurgaon has been assigned with the Consultancy Services for the “Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 6 (Kerala) of National Waterways” by Inland Waterways Authority of India (IWAI). Accordingly, the study on VECHOOR – ATHIRAMPUZHA CANAL (18.80 KM) NW – 59 has been carried out for this assignment / analysed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 21/03/2017 to 24/11/2017.

Traffic Survey was carried out, as detailed and summarized in Annexure 4.2.

Terminal Land Survey was carried out on 30/04/2017.

Geotechnical Borehole was carried out from 03/08/2017 to 07/08/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

Proprietary rights of the information contained herein belong to “Inland Waterways Authority of India (IWAI)”, Ministry of Shipping, Government of India. The information contained in this DPR is intended to be used for the mentioned purpose/project only, as permitted by IWAI. In case of misuse of information and any claim arising thereof, cost and consequence will be on the party misusing the information.

This Report can be updated at a later stage, when required by considering the fresh cargo analysis, change in requirement of the Government (or) Change in policy either of State Government or Government of India.

(B. C. JHA)
Tractebel Engineering Pvt Ltd

DETAILED PROJECT REPORT – VECHOOR – ATHIRAMPUZHA CANAL (18.78 KM) NW-59

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LIST OF ABBREVIATIONS

Abbreviations	Acronyms
BFL	Bombay Floating Light
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DMIC	Delhi Mumbai Industrial Corridor
DPR	Detailed Project Report
FSL	Full Supply Level
GAIL	Gas Authority of India Ltd.
HC	Horizontal Clearance
IO	Iron Ores
IOCL	Indian Oil Corporation Ltd.
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
KIOCL	Kudremukh Iron Ore Company Limited
KP	Km Points
LAD	Least Available Depth
MHWS	Mean High Water Spring
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NMPT	New Mangalore Port Trust
NW	National Waterway
OMPT	Old Mangalore Port Trust
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
UPCL	Udupi Power Corporation Ltd
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

SALIENT FEATURES

#	Particulars	Details		
A	**GENERAL**			
1	***Location***			
a	Cluster	Cluster-6		
b	State(s)	Kerala		
c	Co-ordinates & Name of Place	**Start**		**End**
	Place	Vechoor		Athirampuzha
	Latitude	09°40'00"N		09°40'04"N
	Longitude	76°24'11"E		76°31'54"E
B	**TECHNICAL**			
1	***Waterway***			
a	National Waterway Number	NW-59		
b	Class	III (up to 18.78km)		
c	Type (Tidal/Non-Tidal)	The survey Stretch of Vechoor - Athirampuzha Canal is partially tidal. During the survey period the Thannermukkam bund lock is close thus there is no influence of tidal force throughout the survey period. Therefore during survey period canal is non-tidal.		
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**
		18.78 km	18.78 km	---
d	Average Tidal Variation, if applicable	Non tidal during survey period due to gate closure of Thannermukkom. Therefore no tide variation.		
e	Chart Datum			
	Description/Basis	ATH-1	ATH-2	ATH-3
	Value (Chart Datum below MSL)	-0.500	-0.444	-0.400
f	LAD Status (w.r.t. CD)			
		Stretch-1 (km)	**Stretch-2 (km)**	**Total (km)**
	Stretch (From 1 To 2)	0.00 – 10.00	10.00-18.78	
	Length with LAD < 1.5 m	10.00	8.78	18.78
	With LAD from 1.5-1.8 m	0.00	0.00	0.00
	With LAD from 1.8-2.2 m	0.00	0.00	0.00
	With LAD from 2.2 -2.5 m	0.00	0.00	0.00
	With LAD > 2.5 m	0.00	0.00	0.00
	Total	**10.0km**	**8.78 km**	**18.78km**
g	Target Depth of Proposed Fairway (m)	1.70 m upto Ch 18.78 km		
h	Conservancy Works Required	17.48 Lakhs Cu. M of Dredging. 31 kms of Protection on both Banks.		
i)	Existing Cross Structures			
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal** / **Range of Vertical Clearance w.r.t.**

#	Particulars	Details			
				Clearance	**FRL/HFL**
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil
	Bridges	Road / Foot-Over	8	15-20m	2.5-6m
	HT/Tele-communication lines	LT/HT	25	15-45m	8-10m
	Pipelines, underwater cables, etc.	NIL	NIL	NIL	NIL
2	***Traffic***				
A	Present IWT Operations (type of services)	No cargo operation. At present, only one small ferry service for passengers is available between the Kumarakom – Cumbam road bridge and Vembanand lake. Apart from this, no other waterway related facilities are operational on the identified stretch.			
B	Major industries in the hinterland (i.e. within 25 km. on either side)	Midas Precured Tread, TCL, MRF, Cochin Cements & other small rubber-manufacturing units.			
C	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	✓ Major roads - Local roads runs parallel to the stretch. Kumarakom – Cumbam Road Bridge crosses river at the 5kms from the mouth. ✓ Major Railway - Ettumanoor station is just 3kms away from Athirampuzha.			
D	Commodities	**In-bound**		**Out-bound**	
		N/A		N/A	
5.	Passenger	N/A		N/A	
6.	Tourism	N/A		N/A	
E	Future Potential (‘00)	NA			
	Proposed IWAI Terminal on NW59				
1	Tourism	--			
3	***Terminals/Jetties***				
A	Terminal/Jetty	Ro-Ro			
	Location (Bank/city/district)	09°40'0.81" N and 76°31' 53.57" E near Athirampuzha in Kottayam District			
	Type/Services	Ro-Ro / Tourism			
	Facilities	Ambulance is provisioned			
	Approach	Road is available			
	Land Ownership				
	Area (ha.)	**Govt.**		**Private**	
		0.85 ha		NIL	
4	***Design Vessel***				
A	Type	Ro-Ro vessels			
B	No. & Size	1 Ro-Ro vessel 50 m – 55 m (LOA) x 9 m – 12 m (Breadth)			
C	Loaded Draft	1.6 m – 1.8 m			
D	Capacity	300 T – 500 T / 15 TEU – 21 TEU (Equivalent Ro-Ro)			
5	***Navigation Aids***				
a	Type	Buoy and Light			
b	Nos.	45			

#	Particulars	Details		
b	Communication Facilities	Not Suggested.		
C	**FINANCIAL**			
1	***Project Cost***			
a	Capital Cost	Fairway	Ro-Ro	
	Cost (INR)	123.79 cr	18.38 cr	
b	O & M Cost	Nil	Nil	
2	***User Charges***			
a	For IWAI	-		
b	For Operator	-		
3	***Financial Internal Rate of Return (%)***	Fairway	Ro-Ro Terminal	Whole Project
a	For IWAI	Non-existent	Non-existent	Non-existent
b	Operator	-		
4	***Economic Internal Rate of Return (%)***	Fairway	Ro-Ro Terminal	Whole Project
		Non-existent	Non-existent	Non-existent
5	***Any other Important Feature***			

EXECUTIVE SUMMARY

The Canal stretch from Vechoor to Athirampuzha is one of the waterways declared as National Waterway in March, 2016 as NW 59. The NW 59 stretch is having many natural and manmade canals in Vechoor which are being used for water transport and irrigation. Swamikkallu boat jetty on western coast of vechoor used to have regular services connecting Ernakulam, Vaikom, Thanneermukkom, Mannanam and Kottayam through Lake Vembanadu. National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar. The Vembanad Wet Land System covers an area of over 2033 km² thereby making it the largest wetland system in India.

M/s Tractebel has been assigned with the work of Preparation of the two stage DPR. Subsequent to the Stage 1 preliminary findings, the study of Second Stage Detailed Project Report (DPR) for Development of Vechoor – Athirampuzha canal NW – 59 in the stretch of 18.80 Kms from Vechoor joining the NW 3 (Lat 09°40'00" N, Long 76°24'11" E) to Athirampuzha Market (Lat 09°40'04" N 76°31'54" E) has been carried out so as to assess the required developments and the IWT Traffic potential along with inter alia activities including the working out of Cost / Return factors for taking a decision on developments / investments.

The major components in the DPR can be considered as Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement and Financial Analysis. Bathymetric Survey of the study stretch has been carried out along with the Topographical Survey so as to arrive at the conservancy requirements including Dredging; Channel demarcation and other Waterway requirements for safe navigation. The next one is Traffic Confirmations. The present Traffic scenario, possible divertible traffic to IWT is to be estimated. In sequence, Terminal Development, Vessel Requirement and Financial Analysis have been considered.

Based on the Hydrographic Survey inputs and other site data collected on NW 59, it has been noticed that 8 Nos. of Bridges (5 Nos RoB and 3 Nos FoB); 25 Nos. of Power Cables are present / crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 6 Nos of Bend locations have been identified in the study stretch, with 30 m as lowest at Ch. 10.7 km and @ Ch 11.1 km. 6 No. Bridges have been suggested for modification. Lump Sum provision has been catered for stringing Power Cables. 45 Nos. Day / Night Navigation system of Buoy & Light system is suggested. Land Acquisition of 24.5 Hectares is essential along with 31 kms of Bank Protection. Most of the Bends will vanish, while widening.

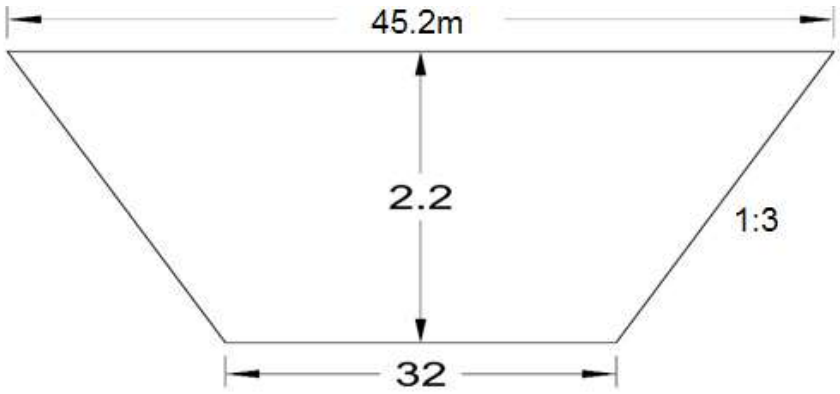
Present study stretch of NW 59 is not having any traffic (neither Cargo nor Passenger / Tourism). In the Vechoor area connecting Vembanad Lake, Tourist Boat mobility has been noted. Small Boats with 8 to 10 passenger capacity have also been observed in the study stretch, now and then. The Geographical advantage of NW 59 is that the same is inter connected with the existing NW 3 and inter alia connecting Kottappuram in the North and Kollam in the south and also the Kochi area including the ICTT, Kochi through Waterway. The Eastern / South Eatern part of the country will be the hinter land for Athirampuzha.

Keeping in view of the above, the possibility of Ro-Ro operation has been suggested, on thereotical basis that the mode shift to IWT may reduce the congestion on the road, especially in the land scarce Kerala. However, as a part of suggestion / recommendation for the development of NW 59, no recommendation is proposed. The development is suggested only with the observed positive growth confirmations through Ro-Ro mobility and such micro level observation is suggested till 2022. Development is estimated there upon in 3 yrs from 2022.

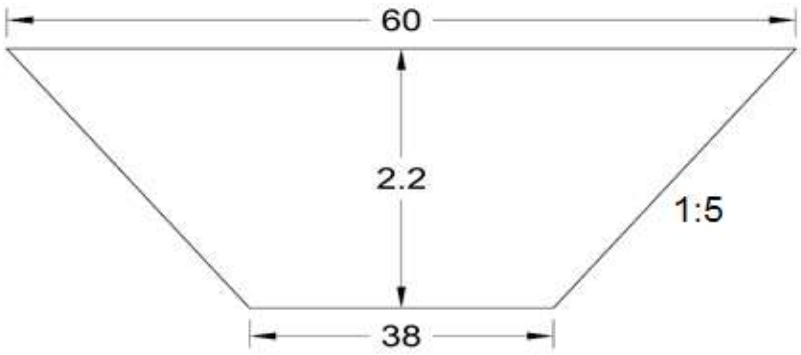
Considering the compatibility / throughput mobility, the possibility of vessel mobility has been considered with Class III standard of Waterway with 32 m Bottom Width of fairway in narrow reaches and 38 m Bottom Width of fairway in wider reaches however with 2.2 m Depth of fairway in both the reaches with a vessel requirement for Class III as 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each.

The fairway size and dredging quantities of the study stretch are placed below for Class III waterway for the study stretch of NW 59.

32m x 2.2m with side slope 1:3 (Class-3 for Narrow Reaches)



38m x 2.2m with side slope 1:5 (Class-3 for Wider Reaches)



CLASS-III

CLASS	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	0	10	4.7	-1.4	9850	327518.45	4.4	-1.9	10000	439039.73
	10	18.78	2.5	-2.3	8750.0	890422.63	1.7	-4.0	8750.0	1150074.35
Total					18600.0	1217941.08			18750	1589114.08

Accordingly, the entire study stretch is to be considered with Fairway improvement and majority of the length is to be widened. The estimated shoal length is of 18750 m and the respective Dredging quantity has been taken into consideration for 17.48 Lakhs Cu. M. Apart from the above Fairway developments, some Institutional Requirement has also been suggested.

IWAI Terminal requirement has been considered with 1 Roll-on Roll-off (Ro-Ro) IWT Terminal at Athirampuzha for entry / exit of the vehicles. The most probable location for such Berthing / Ro-Ro IWT Terminal at the other end (one end is Ro-Ro Terminal at Bolghatty, Kochi) is in Athirampuzha with approx Lat 09° 40' 0.81" N and Long 76° 31' 53.57" E. A tentative Land requirement has been worked out and arrived at with 8500 Sq. M at Athirampuzha. Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Athirampuzha Village; Kottayam Taluka; Kottayam District of Kerala state. Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 75 m and width as 12 m.

Preliminary Designs have been worked out for Bank Protection with Gabions; Bank Protection with Pile & Slab; Navigational Aids through Buoys (Polyethylene) and Lights (4 NM); Ro-Ro Jetty.

The following Vessel standard is suggested for a cautious deployment as per the requirement.

Ro-Ro Vessel:	**(15 TEU)**	**INR 700 Lakhs each**
LOA	50 m – 55 m	
Breadth	9 m – 12 m	
Loaded Draft / Depth:	1.6 m – 1.8 m / 2.2 m +	
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp	
Speed (with Load):	20 Kmph (Av)	

Initially the operation will be taken up with one vessel deployment and can be augmented with growth observation. These assumptions are being considered for theoretical working, since the development of NW 59 is not viable for recommendation (of development).

Regarding the Navigation & Communication System, it has been worked out the provision of RIS / AIS / Locating the Vessels / Buoys. An attempt has been made to ascertain the details on the Vessels Traffic Management System (VTMS), which is costlier than the RIS system and has not been discussed. The proposed navigation on “NW 59” is on a canal system. The cost details are worked out however Inland Waterways Authority of India (IWAI) is planning for installation of RIS in NW-3 West Coast Canal System (Kottapuram - Kollam, Udyogmandal & Champakara): 205 km. The system shall enhance swift electronic data transfer between mobile vessels and shore (Base stations) through advance and real-time exchange of information. As RIS ensures safety of vessels in navigation, as per the Inland Vessel Act, all the vessels are to be equipped with RIS compatible equipment. The range of RIS system shall normally be in the range of 100-125 kms surrounding the base station, hence there is no requirement of separate RIS for NW-59 as these waterways shall be covered by RIS system being planned under NW-3. The cost has not been included in the DPR cost.

With regard to the Environmental aspects, considering the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices. Since limited dredging is involved, impact on aquatic ecology is also anticipated to be negligible. No structures are present over the land identified for construction of terminals or related project components. Therefore, the project does not involve any dislocation of population. The entire project area falls under the tidal zone. As such the project shall require obtaining clearance under the CRZ Notification 2011. Consent to Establish and Consent to Operate from the SPCB shall be required under the Air and Water Acts. No other major clearances / approvals / permits relating to environmental and social aspects are applicable to the project. No wildlife clearance is envisaged for the proposed waterway. Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no

clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

Regarding the Institutional requirements, it has been proposed that NW 59 will be a part of the present Kochi office and as a supporting system for NW 3. Hence, a nominal provision of INR 40 Lakhs (approx) is only suggested.

The cost estimates have been worked out for development of Fairway with a capital cost of 123.79 Cr and Terminal with a capital cost of 18.38 Cr. Implementation of the above is suggested in 3 years from 2022. The FIRR and EIRR have been worked out and the critical indicators are placed.

The cost estimates have been worked out for development of Fairway with a capital cost of 123.79 Cr and Terminal with a capital cost of 18.38 Cr. This is Option-1 for the project development. Implementation of the above is suggested in 3 years from 2022. It is suggested for the observations and firming up of the Ro-Ro traffic volumes up to 2022 and the investment for development is suggested only after having positive growth trend and confirmation. There is another consideration as suggested by Govt. of Kerala regarding implementation of some new & reconstruction of cross over existing facilities/ structures and an option-2 has been mooted which will further add to the financial implication in light of suggestions received from Kerala Govt. The cost of Option-1 is 142.17 Crores with its breakup as below:

Parameter	Unit	Fairway	Ro-Ro Terminal	Whole Project
Project Cost	INR Cr.	123.79	18.38	142.17
Revenue	INR Cr.	Nil	Nil	Nil
FIRR	%	Non-existent	Non-existent	Non-existent
EIRR	%	Non-existent	Non-existent	Non-existent

The Cost of option -2 has been considered taking the financial impact of the suggestion of Govt. of Kerala vide their letter Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020. So this will entail the development cost as computed in the option-1 & considering the financial impact of structure suggested & by the Govt. of Kerala.

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-59) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
1)	Bridge	Cross Structure Under PWD	5	0	0
2)	Foot Bridges	Cross Structure Under PWD	0	1.2	0
2)	Foot Bridge	Cross Structure Under LSGD	3	1.2	3.6
3)	HT Lines	Kerala State Electricity Board	0	0.3	0
3)	LT Lines	Kerala State Electricity Board	25	0.01	0.25
4)	Regulator Cum Bridge &	Irrigation Dept. & Navigation	0	0	0

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-59) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
	Navigation Lock	Dept.			
5)	Water Pipe -line	Kerala water Authority	0	0	0
	Total				**3.85**

Therefore, the total cost as per the Option-2 shall be as detailed in the below table.

Sl No.	Parameter	INR (In Cr.)	Remarks
1	Fairway	123.79	Similar to as Per Option-1
2	Ro-Ro Terminal	18.38	Similar to as Per Option-1
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	3.85	As detailed in table above
	Total	**146.02**	

Hence the total cost of project development in case of Option-1 & Option-2 is Rs.142.17 Crores and Rs.146.02 Crores respectively.

The FIRR and EIRR have been worked out for Option-1 and the critical indicators are placed in the table below.

Parameter	Unit	Fairway	Ro-Ro Terminal	Whole Project
Project Cost	INR Cr.	123.79	18.38	142.17
Revenue (FY40)	INR Cr.			
FIRR	%	Non-existent	Non-existent	Non-existent
EIRR	%	Non-existent	Non-existent	Non-existent

Implementation / Development of NW 59 is not recommended till the confirmations of the Ro-Ro traffic with critical observation till 2022. Investment on Development is suggested only with positive growth confirmations to develop the stretch of NW 59 for about 29 Kms with Class III Canal system of the NW standards. Any cargo transportation in future could be handled through NW-8 and NW-9. This makes the development, of NW-59 at such large investment, a non-starter. However, considering the remote possibility in most optimistic scenario, total project cost for development of IWT on NW 59. Project cost had been included in the chapter:

CHAPTER 1 DEVELOPMENT OF NW 59 IS NEITHER SUGGESTED NOR RECOMMENDED INTRODUCTION

1.1 Project Background and Summary of previous study

Globally, the renewal of Inland Water Transport (IWT) is under serious consideration predominantly due to its energy efficient aspect and cheaper mode on comparison. Further overburdening of the Rail and Road network are also the dominant factors. Transport planners are now leaning towards the development of IWT system for transportation of bulk / IWT sensitive cargo.

India has about 14,500km of navigable waterways which comprise Rivers, Canals, Backwaters, Creeks, etc., out of which about 5200km of the river and 4000km of canals can be used by mechanized crafts. Yet, IWT mode remains underdeveloped / underutilized in India and its share in overall internal cargo transport remains abysmally low. IWT sector presently has a meager modal share of 0.1% in India compared to other large countries and geographic areas like the United States, China and the European Union.

Inland Waterways Authority of India (IWAI), a statutory authority under the Ministry of Shipping, came into existence on 27th October 1986 with the prime responsibility of development and regulation of inland waterways for shipping and navigation including the development and maintenance of IWT infrastructure on national waterways. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration. The head office of the Authority is at Noida (Uttar Pradesh). The regional offices of IWAI are at Patna (Bihar), Kolkata (West Bengal), Guwahati (Assam) and Kochi (Kerala) whereas sub-offices are at Farakka & Hemnagar (West Bengal); Prayagraj & Varanasi (Uttar Pradesh), Sahebganj (Jharkhand); Dhubri, Dibrugarh & Silchar (Assam), Kollam (Kerala), Vijayawada (Andhra Pradesh) and Bhubaneshwar (Orissa).

There are now one hundred and eleven national waterways (NW) across the country which includes five existing national waterways besides 106 waterways which have recently been declared as national waterways through a central legislation i.e., through a bill passed in the Parliament in March 2016.

NW 1, the Ganga – Bhagirathi – Hooghly river system between Haldia (Sagar) & Allahabad was declared in October 1986 for a Length of 1620 km.

NW 2, the Dhubri – Sadiya stretch of Brahmaputra River was declared in September 1988 for a Length of 891 km.

NW 3, the Kottapuram – Kollam stretch of the West Coast Canal along with the Udyogmandal Canal and Champakkara Canal was declared in February 1993 for a Length of 205 km.

NW 4, the Kakinada – Puducherry stretch consisting of canals and the Kaluvelly Tank along with Bhadrachalam – Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna was declared in November 2008 for a Length of 1095 km.

NW 5, the Talcher – Dhamra stretch of the Brahmani River, the Geonkhali – Charbatia stretch of the East Coast Canal, the Charbatia – Dhamra stretch of Matai river and the Mangalgadi – Paradip stretch of the Mahanadi River Delta was declared in November 2008 for a Length of 623 km.

Regarding the **106 Newly Declared National Waterways,** IWAI is carrying out feasibility studies / Detailed Project Report (DPR) preparation through a number of consultants. Two stage preparation of DPR for 53 Waterways have been initiated through 8 Clusters, whereas M/s Tractebel Engineering had been awarded with 2 Clusters i.e., Custer-VI (consisting of 11 waterways – 7 waterways in Karnataka & 4 waterways in Kerala) & Cluster-VII (consisting of 10 waterways – 7 waterways in Maharashtra & 3 waterways in Goa).

The Waterways considered for the study of DPR under Cluster VI are detailed herewith.

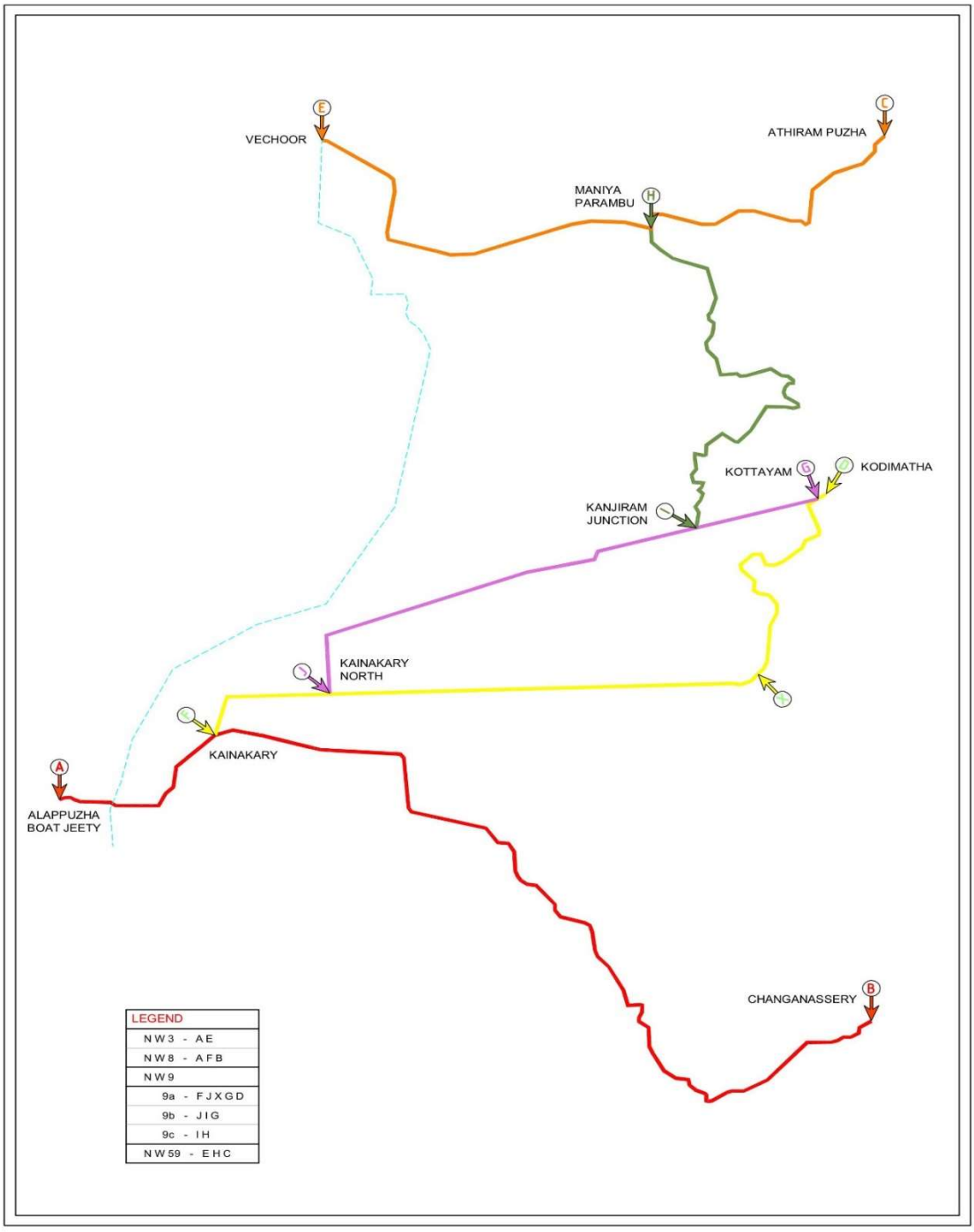
TABLE 1-1: LIST OF RIVERS/CREEKS OF UNDER CLUSTER VI IN THE STATES OF KARNATAKA AND KERALA (LENGTH-453.895KM)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
1.	West Coast Canal	NW-3	169.794	Kerala
2.	**Alappuzha - Changanassery Canal**	**NW-8**	**29.300**	**Kerala**
3.	Alappuzha- Kottayam – Athirampuzha Canal	NW-9	51.700	Kerala
4.	Kottayam-Vaikom Canal	NW-59	18.800	Kerala
5.	Gurupur River	NW-43	10.041	Karnataka
6.	Kabini River	NW-51	23.56	Karnataka
7.	Kali River	NW-52	53.415	Karnataka
8.	Netravathi	NW-74	30.000	Karnataka
9.	Panchagangavali (Panchagangoli) River	NW-76	23.000	Karnataka
10.	Sharavati River	NW-90	28.674	Karnataka
11.	Udayavara River	NW-105	16.000	Karnataka
	Waterways restricted to Stage I study.	**Total**	**453.895**	

Accordingly, the Stage II study for the Vechoor – Athirampuzha Canal (NW 59) is under consideration in the present DPR.

A portion of the existing NW 3 from Kollam to Kottappuram; NW 8; NW 9 and NW 59 are traversing through the Vembanad Lake in Kerala. The Vembanad Lake is one of the identified sites of the **Ramsar Convention,** which is an international treaty for the conservation and sustainable use of wetlands. It is also known as the **Convention on Wetlands**.

A Macro Level Route Map of the National waterways in Vembanad Lake along with the major points and the route traversing is presented herewith for more understanding.



LENGTH AND POINTS OF NATIONAL WATERWAYS IN VEMBANAD LAKE

ORIGINAL		REVISED	
Name of the Place	Latitude / Longitude	Name of the Place	Latitude / Longitude
NW – 8			
Alappuzha – Changanassery Canal			
From Boat jetty, Alappuzha (A) To Changanassery Jetty (B)	From 09°30'02.85"N, 76°20'37.05"E. To 09°26'41.61"N, 76°31'41.76"E	From Boat jetty, Alappuzha **(A)** To Changanassery Jetty **(B)**	From 09°30'03"N, 76°20'37"E. To 09°26'42"N, 76°31'42"E

NW – 9
Alappuzha – Kottayam – Maniyaparambu canal

From Boat jetty, Alappuzha (A) To Athirampuzha market (C)	From 09°30'02.85"N, 76°20'37.05"E To 09°40'04"N, 76°31'54"E	From Alappuzha **(F)** To Kottayam near Kodimatha **(D)**	From 09°31'01.31"N, 76°22'44.15"E To 09°34'39"N, 76°31'08"E
		From Kanjiram Junction **(I)** To Maniaparambu **(H)**	From 09°34'09.06"N, 76°29'21.91"E To 09°38'40.18"N, 76°28'42.71"E
		From Kainakary North **(J)** To Kottayam **(G)**	From 09°31'37.75"N, 76°24'19.33"E To 09°34'32.96"N, 76°30'53.39"E

NW – 59
Kottayam – Vaikom Canal

From Kottayam, near Kodimatha (D) To Vechoor joining National Waterway no. 3 (E)	From 09°34'38.67"N, 76°31'07.67"E To 09°40'00.19"N, 76°24'10.65"E	From Vechoor joining National Waterway-3 **(E)** To Athirampuzha Market **(C)**	From 09°40'00"N, 76°24'11"E To 09°40'04"N, 76°31'54"E

1.2 Brief Scope of Work and Compliance statement

The Scope of the Work for the present study is well defined in the Work allocation along with the Terms of Reference (ToR). The same is annexed herewith at Annexure 1.1.

The ultimate requirement from the study is to get a conclusion on the aspect of implementation. Whether the study stretch under consideration is amenable for implementation or not is the final derivative from the study. In order to get this conclusion, the study is subjected to the Infrastructure Requirement for development, the cost for the development with the Expenditure schedules and the viability of the project with the possible revenues and by meeting the social commitment and responsibilities.

The IWT project for development of a waterway stretch can be broadly segregated into the following aspects viz., Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement; Financial Analysis.

1.2.1 Fairway Development

In order to ascertain the existing condition of any waterway, the Bathymetric Survey data along the full stretch at the specified intervals and specified width and the Topographical Survey at important / appropriate locations are required. Based on these site surveys, Conservancy requirements including dredging; Channel demarcation requirements can be arrived at.

1.2.2 Traffic Confirmations

The present Traffic scenarios in the hinterland and along the waterway are to be ascertained and possible volumes of divertible traffic to IWT including the type of cargo are to be assessed for planning and development. The possibility of Passenger and Tourism potential are also to be ascertained.

1.2.3 Terminal Development:

Terminal development may have to be initiated with the Site confirmation linking up with various intricacies including the origin and destination of the Traffic. According to the type of cargo and quantum of cargo, the Terminal Infrastructure requirements are to be firmed up. The possibility of moulding the Terminal operation and maintenance as a separate business unit also can be looked into.

1.2.4 Vessel Requirement

Based on the type of cargo, quantum of cargo, distance to be moved etc., also keeping in view the travel time, the type of vessel and No. of vessels requirement are to be worked out. As per the existing / present industry standards, the vessel deployment and its operation and maintenance will not form part of the development except the projection of the requirements for the project, as a whole. Hence this aspect is only indicative.

1.2.5 Financial Analysis

Any project, without the mention of the Cost and economic viability will end up as incomplete. Hence, the detailed Cost analysis; Firming up of the cost for all the items indicated for development; implementation schedule and phasing of the project; operation and maintenance cost etc., are the key factors to be looked into. Working out the possible revenues will be the other key factor. Subjecting the above for a critical Financial and Economic analysis will provide clarity on the implementation of the project, as a whole.

1.3 Brief Methodology & Approach:

The Terms of Reference of the subject study, the scope of work defined for the study itself are indicative about the Methodology to be adopted for the study. Further, the Approach and Methodology had already been explained in the Stage I report and at this juncture, it is prudent to mention the sequential and systematic approach to the project. Accordingly, a flow diagram has been placed at Annexure 1.2, which is self-explanatory and by following the activities as specified, the project report will be in complete shape.

1.4 Project Location / Details of Study Area:

Stage 1 study was completed for all the 11 National Waterways under Cluster VI and the Feasibility Study Reports of individual National Waterways have been presented to IWAI. Based on the inputs of the FSR, IWAI asked M/s Tractebel to go ahead with the Stage II study on 9 out of 11 National Waterways i.e., 5 in the state of Karnataka and 4 in the state of Kerala, as detailed.

TABLE 1-2: WATERWAYS FOR STAGE II STUDY

Sl. No.	NW-No. / Name of the Waterway	Defined Limits
	Cluster 6 (Karnataka)	
1.	NW-43 / GURUPUR RIVER	10.041 kms from starting point Lat 12°50' 44.093" N, Long 74° 49' 44.783" E.
2.	NW-51 / KABINI RIVER	23.56 kms from starting point Lat 11°56'0.9311" N, Long 76°14'17.5004" E.
3.	NW-52 / KALI RIVER	53.415 kms from starting point Lat 14°50'33.5786" N, Long 74°07'19.7098" E.
4.	NW-74 / NETRAVATHI RIVER	30.00 kms from starting point Lat 12°50'44.6904" N, Long 74°49'33.3734" E.
5.	NW-90 / SHARAVATI RIVER	28.674 kms from starting point Lat 14°17'56.5621" N, Long 74°25'36.4534" E.
	Cluster 6 (Kerala)	
1.	NW-3 / WEST COAST CANAL	169.794 kms from starting point Lat 10°11'38.9421" N, Long 76°12'04.152" E.
2.	NW-8 / ALAPPUZHA – CHANGANASSERY CANAL	29.3 kms from starting point Lat 09°30'03"N, 76°20'37"E.
3.	NW-9 / ALAPPUZHA-KOTTAYAM-MANIYAPARAMBU CANAL	51.7 kms from starting point Lat 09°31'1.31"N, 76°22'44.15"E.
4.	NW – 59 / VECHOOR – ATHIRAMPUZHA CANAL	18.80 kms from starting point Lat 09°40'00"N, 76°24'11"E.

The present study about the Vechoor – Athirampuzha Canal – NW 59 is a canal in the Vembanad Lake, in the state of Kerala.

TABLE 1-3: DESCRIPTION OF VECHOOR – ATHIRAMPUZHA CANAL (NW-59)

Sl. No.	Introductory Consideration	Description of the Canal
1.	Name of the river / canal	Vechoor – Athirampuzha Canal (NW-59)
2.	State / District through which river passes	The present study stretch of the Vechoor-Athirampuzha Canal starts from Vechoor and ends at Athirampuzha Market district of Kerala State.
3	Length of the river / canal	The Total Length of Canal from Vechoor to Athirampuzha is 18.80km.
4	Map	The index map of Vechoor-Athirampuzha Canal showing proposed waterway stretch, topographic features and road networks are shown in **Figure1.1**. The section of the stretch of Vechoor-Athirampuzha Canal under feasibility study for inland waterway showing the surveyed route is presented in **Drawing**

Sl. No.	Introductory Consideration	Description of the Canal
		P. 010631-W-20301-A03.
	Characteristic of River	
5	River / Canal Course	The stretch of the Vechoor-Athirampuzha Canal NW-59 starts from Vechoor joining National Waterway no. 3 at Lat 09°40'00"N, Long 76°24'11"E and ends at Athirampuzha Market at Lat 09°40'04"N, Long 76°31'54"E. There are many natural and manmade canals in Vechoor nearby area which were used for water transport and irrigation. Swamikkallu boat jetty on western coast of Vechoor used to have regular services connecting Ernakulam, Vaikom, Thanneermukkom, Mannanam and Kottayam.
6	Tributaries / Network of Rivers / Basin	National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.
7	Catchment Area	The Vembanad Wet Land System covers an area of over 2033 km² thereby making it the largest wetland system in India.

FIGURE 1-1: INDEX MAP OF VICHOOR-ATHIRAMPUZHA CANAL

CHAPTER 2 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 Hydrographic Survey

Hydrographic survey is the science of measurement of Water depths and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration / offshore oil drilling and related activities. Hydrographic survey are being carried out for one or more of the following activities like measurement of tides for sea coast works (e.g. construction of sea defence works, harbours etc.), determination of bed depth of water bodies, by soundings (for navigation, location of rocks, sand bars, navigation light).

2.1.1 Waterway in General and Hydro-morphological Characteristics

Waterway in General

The Vechoor-Athirampuzha Canal or National Waterway No. 59 is an 18.8 km stretch of this inland navigational route located in Kerala, India and runs from Vechoor joining National Waterway-3 Lat 09°40'00"N, Long 76°24'11"E to Athirampuzha Market Lat 09°40'04"N, Long 76°31'54"E have been declared as new national waterway and proposed to undertake the two stage DPR. There are many natural and manmade canals in Vechoor which were used for water transport and irrigation. Swamikkallu boat jetty on western coast of vechoor used to have regular services connecting Ernakulam, Vaikom, Thanneermukkom, Mannanam and Kottayam.

Vechoor is a village in Vaikom taluk, Kottayam district in the state of Kerala, India. Vechoor is bordered by Vembanad Lake on the west and Kaipuzha River on south. Thanneermukkom Bund starts from Vechoor. Eastern part of vechoor includes rice fields. There are many natural and manmade canals in Vechoor which were used for water transport and irrigation. Swamikkallu boat jetty on western coast of Vechoor used to have regular services connecting Ernakulam, Vaikom, Thanneermukkom, Mannanam and Kottayam and on the other hand Athirampuzha is a small town in Kottayam district of Kerala state, India. It is situated 10 km north of Kottayam town.

Tributaries of Vechoor Athirampuzha River

No Major tributaries since NW 59 is traversing through the Vembanad Lake area.

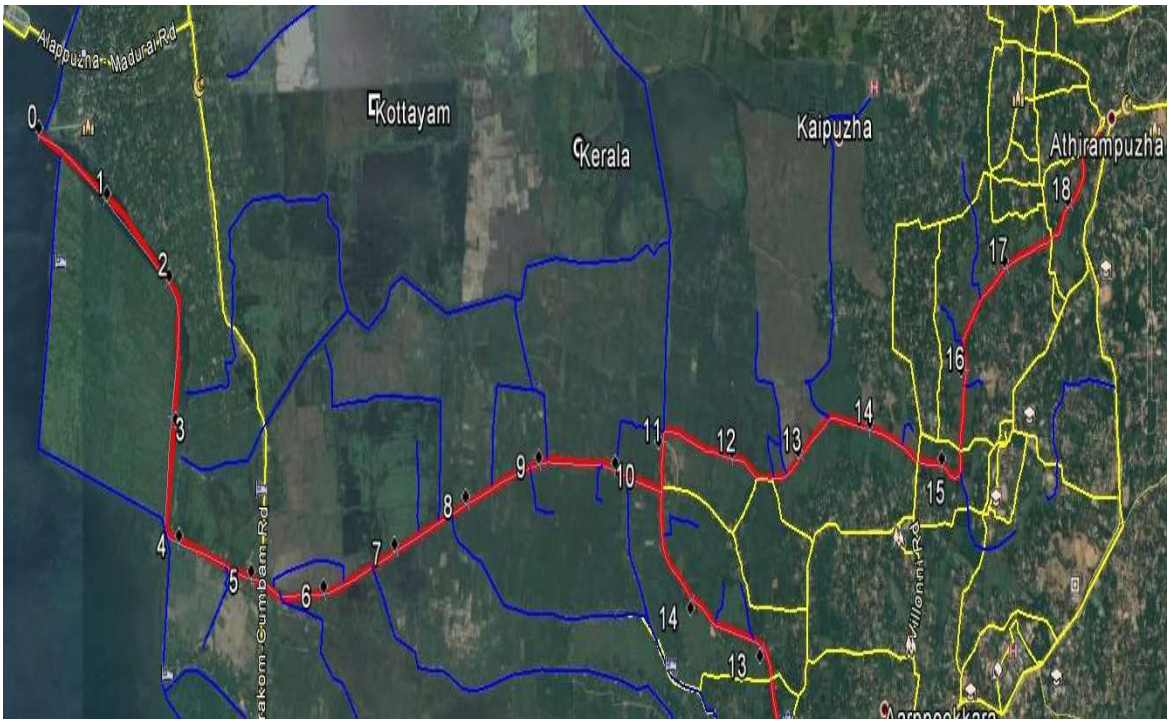


FIGURE 2-1: TRIBUTARIES/ NETWORK OF RIVERS/BASIN

As above, National Waterway NW 59 is traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. The Western Ghats plays a major role in the climatic conditions that prevail all along the state. The period of March to the end of May is the hot season, followed by South West Monsoon season that continued till the beginning of October. From October to December, it is the North East Monsoon season and two months, January and February, are the winter season. The state is extremely humid due to the existence of Arabian Sea in the west of it.

The annual rainfall ranges from 2435.9 to 3755.2 mm and the average annual rainfall of the district is 3169.28 mm. The South West monsoon contributes nearly 59 % of the total rainfall and while the North East monsoon contributes nearly 21% of the total rainfall in this area.

Ten broad groups of soils are red soil, laterite soil, coastal alluvial soil, riverine alluvial soil, grayish Onattukara soil, brown hydromorphic soil, hydromorphic saline soil, acid saline soil, black soil and forest soil. On the basis of morphological and physico-chemical properties, the Soil in Kottayam District, has been broadly grouped into (1) Lateritic soil. (2) Riverine alluvium, (3) Brown hydromorphic, and (4) Forest loams.

Vembanad Lake: National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List.

In this context, it is to state that the Ramsar Wet Land Convention was signed way back in 1971 (2nd February, 1971) named after the location of convention where it was signed i.e., Ramsar, Iran consisting of 169 parties. The **Ramsar Convention** is an international treaty for the conservation and sustainable use of wetlands, it is also known as the **Convention on Wetlands**.

In spite of the conventions, treaties and other hard line decisions, study after study demonstrates that wetland area and quality continue to decline in most regions of the world; 64% of the world's wetlands have disappeared in the last century. As a result, the ecosystem services that wetlands provide to people are compromised. Hence, managing wetlands is a global challenge, and the Convention's 169 Contracting Parties recognize the value of having one international treaty dedicated to a single ecosystem. By setting international standards for wetland conservation and providing a forum for discussing global wetland issues, the Convention enables Contracting Parties to share information on wetlands and address issues together.

Many studies have been taken up on the Wet Lands / Estuaries in the World and in India. These studies are in progress on the Hydro Dynamic and Geo Morphological Characteristics on the water body. Regarding the Morphological Characteristics of the estuaries, it may be considered as the long term changes in Sedimentological and Hydrodynamic features which tend to attain a steady state. Several factors including the Topography; Wave activity; Tides; Storms; Inflow Discharge; Hydrodynamics and Human Impacts seem to be the influencing factors on the Estuaries.

The study area of NW 8, NW 9 and NW 59 are within such identified zone of the wet land system viz., The Vembanad wetland system. It covers an area of over 2033.02 km² thereby making it the largest wetland system in India. Of this, an area of 398.12 km² is located below the MSL and a total of 763.23 km² area is located below 1 m MSL. The lake is bordered by Alappuzha, Kottayam and Ernakulam districts. It is separated from the Arabian Sea by a narrow barrier island.

The lake surrounds the islands of Pathiramanal, Perumbalam and Pallippuram. The Vembanad Lake is approximately 14 kilometres wide at its widest point. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

A unique characteristic of the lake is the 1,252 metres (4,108 ft)-long Thanneermukkom salt water barrier (Barrage) constructed as a part of the Kuttanad Development Scheme to prevent tidal action and intrusion of salt water into the Kuttanad low-lands. It is the largest mud regulator in India and essentially divides the lake into two parts, one with perennial brackish water and the other with fresh water from rivers draining into the lake. This barrier has helped farmers in Kuttanad by freeing the area of salinity and allowing them an additional crop in the dry season. The Thanneermukkom barrier is located at one of the narrower parts of the Vembanad Lake. Only two-thirds of the original number of gates is opened in July to release flood flow. These gates remain closed until mid-November. The main drawback of the structure has been the loss of opportunity for fish and prawns to migrate upstream, and also an increase in weed growth in the upstream, severely restricting the natural flushing of pollutants. In order to have the Navigation throughput, Locks have been provisioned in this Barrage.

The Vembanad Wetland system has formed an intricate network of estuaries, lagoons and canals which spans over 196 km in the north-south and 29 km in the east-west directions. Almost all villages in these areas can be accessed via water transport. The major rivers of Muvattupuzha, Meenachil, Pamba and Achencovil rivers, are all navigable up to distances of about 30 km upstream in the tidal reach.

The Kottappuram-Kollam segment of the west coast canal system – NW 3, has a major chunk passing through the Vembanad Lake.

The most popular location on the shores of the lake is the Kumarakom Tourist Village situated on the east coast of the lake. The Kumarakom Bird Sanctuary is located on the northern fringes of Kumarakom village. The Lake is at the heart of Kerala Backwaters tourism with hundreds of kettuvallams plied on it and numerous resorts on its banks. The Kumarakom Bird Sanctuary is located on the east coast of the lake. The lake has become a major tourist attraction. The Nehru Trophy Boat Race is conducted in a portion of the lake.

Waterway Classification: According to the classification of the waterway from class I to class VII, the minimum and maximum width and depth requirements have been circulated and accordingly, maximum width and depth required have been specified as 100 m and 2.75 m for two way navigation. The analysis in the present study is being relooked with the possibilities for a maximum possible width and depth. The NW 59 is having the connectivity to the existing NW 3, which is under operation and having connectivity to the Kochi Major Port. In view of the above, the class may have to be considered in line with the present movement of Class III standard to have the continuity of the mobility.

2.1.2 Existing Hydrological / Topographical Reference levels

The established benchmark value provided by IWAI office, Cochin at Alappuzha light house. Description of reference benchmark as given:

TABLE 2-1: REFERENCE BENCH MARK

Description	Height above		Benchmark No.
	MSL	CD	
In the middle of first stone step from Top of a flight leading to the entrance of light house at the port of Alappuzha.	11.109 ft (3.387m)	13.019 ft (3.969m)	6/5

TABLE 2-2 ACCEPTED STATION COORDINATES (WGS-84)

Station	Location	Chainage (KM)	Latitude (N) Longitude (E)	Easting Northing	Height above MSL (m)	Height above CD (m)
ATH-1	Vechoor	0.412	09°39'58.7516"N 076°24'25.3263"E	1068838.33N 654374.19E	0.774	1.274
ATH-2	Maniyaparamb	10.66	09°38'40.7778"N 076°28'50.4115"E	1066477.08N 662465.15E	3.281	3.725
ATH-3	Athirampuzha	18.72	09°40'02.2283"N 076°31'54.4389"E	1069004.11N 668064.13E	4.450	4.850

2.1.3 Chart Datum Sounding Datum /

The survey stretch of Vechoor-Athirampuzha Canal is tidal water body, during the survey period the Thannermukkam bund lock is close for irrigation purpose. Therefore no influence of tidal force throughout the survey period. However after discussed with IWAI, Cochin/Noida, CD was taken 0.5m below MSL at chainage 0.0km and 0.4m below MSL at Chaiange 18.8 km. The locations with coordinates of established gauge have been used to reduce the soundings along the surveyed stretch are tabulated below.

TABLE 2-3 CHART DATUM / SOUNDING DATUM AND REDUCTION TABLE

Sl#	Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data converted as depth for volume calculation wrt SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)
NW 59	TP-1	0.409	0.0-5.35	-0.500	-0.500	Details are given in Annexure-4. (Vol-III)	A separate xyz file is created in Vol III.
	TP-2	10.67	5.35-13.4		-0.444		
	TP-3	18.78	13.4-18.78	-0.400	-0.400		

2.2 Existing Waterway Structures

2.2.1 Bridges

There are 8 bridges in the whole stretch of survey. Details are given in table.

TABLE 2-4: DETAILS OF CROSS STRUCTURES

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
1	Road Bridge	5.133	RCC	Cheepppunkal	Left Bank: 09°38'18.1659"N 076°25'48.2941"E Right Bank 09°38'21.3522"N 076°25'48.4122"E	Left Bank: 1065758.8 N 656916.20 E Right Bank: 1065856.7 N 656919.39 E	95	7	4	20	4.0	Complete
2	Road Bridge	10.56	RCC	Maniyaparambu	Left Bank: 09°38'50.5825"N 076°28'44.3940"E Right Bank:	Left Bank: 1066777.5 N 662280.40 E Right Bank:	35	8	2	20	6.0	Complete

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
					09°38'50.7222"N 076°28'42.9397"E	1066781.6 N 662236.05 E						
3	Foot Over Bridge	11.20	RCC	Near Maniyaparambu	Left Bank 09°38'53.37"N 076°28'48.58"E Right Bank 09°38'54.07"N 076°28'48.76"E	Left Bank 1066863.8 N 662407.69 E Right Bank 1066885.5 N 662413.18 E	25	2	2	20	3.5	Complete
4	Foot Over Bridge	12.477	RCC	Near Maniyaparambu	Left Bank 09°38'42.80"N 076°29'28.08"E Right Bank: 09°38'43.38"N 076°29'28.07"E	Left Bank 1066544.2 N 663613.27 E Right Bank: 1066562.2 N 663612.9 E	22	2	2	15	4.0	Complete
5	Road Bridge	14.68	RCC	Kuttoompuram	Left Bank: 09°38'46.342"N 076°30'34.4406"E Right Bank: 09°38'48.06"N 076°30'34.90"E	Left Bank: 1066661.9 N 665635.78 E Right Bank: 1066715.0 N 665649.68 E	50	7	2	20	6.0	Complete
6	Road Bridge	15.44	RCC	Mannanam	Left Bank: 09°38'49.7593"N 076°30'53.1627"E Right Bank: 09°38'49.74"N 076°30'52.26"E	Left Bank: 1066769.4 N 666206.07 E Right Bank: 1066768.9 N 666178.56 E	25	5	2	15	5.0	Complete
7	Foot Over Bridge	16.954	RCC	Near Kaipuzha	Left Bank: 09°39'30.0715"N 076°31'11.9319"E Right Bank: 09°39'30.56"N 076°31'11.72"E	Left Bank: 1068010.4 N 666772.75 E Right Bank: 1068025.6 N 666766.36 E	18	2	2	15	3.8	Complete
8	Road Bridge	17.62	RCC	Liseiux	Left Bank: 09°39'30.4758"N 076°31'32.3781"E Right Bank: 09°39'37.68"N 076°31'32.39"E	Left Bank: 1068233.4 N 667395.99 E Right Bank: 1068247.0 N 667395.38 E	20	2	2	15	4.5	Complete

2.2.2 Electric Lines / Communication Lines

There are total 25 no. of Electric lines crossed including HT & LT lines along the waterways. The details of Electric lines/ Communication lines are crossing the NW 59 as given in the Table below.

TABLE 2-5: DETAILS OF HIGH TENSION LINES

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Height w.r.t MSL	Remarks (complete / under - construction)
1	LT 11KV (HT)	4.130	Near jetty	Left Bank:	Left Bank:	2	45	10	Completed
				09°38'26.9190"N	1066023.61mN				
				076°25'16.120"E	655934.26mE				
				Right Bank:	Right Bank:				
				09°38'28.5475"N	1066073.72mN				
				076°25'16.74"E	655953.15mE				
2	LT-2 11KV (HT)	5.329	Near Cheppunkal bridge	Left Bank:	Left Bank:	2	40	10	Completed
				09°38'17.0045"N	1065723.85mN				
				076°25'54.00"E	657090.53mE				
				Right Bank:	Right Bank:				
				09°38'19.1853"N	1065790.97mN				
				076°25'54.98"E	657119.99mE				
3	LT Line	7.045	Near Cheppunkal bridge (1.7km)	Left Bank:	Left Bank:	2	28	8	Completed
				09°38'27.2155"N	1066044.55mN				
				076°26'48.69"E	658756.28mE				
				Right Bank:	Right Bank:				
				09°38'28.4143"N	1066081.31mN				
				076°26'48.16"E	658739.97mE				
4	LT Line	7.618	Near Cheppunkal bridge (2.3km)	Left Bank:	Left Bank:	2	31	10	Completed
				09°38'33.0963"N	1066227.52mN				
				076°27'06.55"E	659299.96mE				
				Right Bank:	Right Bank:				
				09°38'34.3676"N	1066266.50mN				
				076°27'05.973"E	659282.17mE				
5	LT Line	7.741	Near Cheppunkal bridge (2.450km)	Left Bank:	Left Bank:	2	32	8	Completed
				09°38'34.3059"N	1066265.17mN				
				076°27'10.32"E	659414.91mE				
				Right Bank:	Right Bank:				
				09°38'35.7346"N	1066309.01mN				
				076°27'09.92"E	659402.58mE				
6	LT Line	7.893	Near Cheppunkal bridge (2.6km)	Left Bank:	Left Bank:	2	29	10	Completed
				09°38'35.7713"N	1066310.83mN				
				076°27'15.29"E	659566.09mE				
				Right Bank:	Right Bank:				
				09°38'37.5704"N	1066365.06mN				
				076°27'14.13"E	659530.62mE				
7	LT Line	8.169	Near Cheppunkal bridge (2.86km)	Left Bank:	Left Bank:	2	28	10	Completed
				09°38'38.5067"N	1066395.95mN				
				076°27'23.66"E	659820.95mE				
				Right Bank:	Right Bank:				

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Height w.r.t MSL	Remarks (complete / under - construction)
				09°38'41.1436"N	1066476.88mN				
				076°27'23.05"E	659801.92mE				
8	LT Line 11 KV	8.423	Near Cheppunkal bridge (3.0km)	Left Bank:	Left Bank:	2	30	10	Completed
				09°38'40.9533"N	1066472.17mN				
				076°27'31.78"E	660068.19mE				
				Right Bank:	Right Bank:				
				09°38'43.1291"N	1066538.88mN				
				076°27'30.77"E	660037.14mE				
9	LT Line 11 KV	9.045	Near Jetty	Left Bank:	Left Bank:	2	31	10	Completed
				09°38'45.2126"N	1066605.53mN				
				076°27'51.05"E	660655.11mE				
				Right Bank:	Right Bank:				
				09°38'48.4865"N	1066706.15mN				
				076°27'51.38"E	660664.70mE				
10	LT Line 11 KV	9.705	Near Pump House	Left Bank:	Left Bank:	2	32	9	Completed
				09°38'46.0284"N	1066633.45mN				
				076°28'12.89"E	661320.78mE				
				Right Bank:	Right Bank:				
				09°38'47.9078"N	1066691.14mN				
				076°28'12.54"E	661309.93mE				
11	LT Line	10.145	Near Maniyaparambu	Left Bank:	Left Bank:	2	30	8	Completed
				09°38'43.4321"N	1066555.52mN				
				076°28'26.84"E	661746.38mE				
				Right Bank:	Right Bank:				
				09°38'44.5958"N	1066591.33mN				
				076°28'27.30"E	661760.23mE				
12	LT Line	10.738	Near Maniyaparambu Jetty	Left Bank:	Left Bank:	2	24	8	Completed
				09°38'43.2983"N	1066553.56mN				
				076°28'43.18"E	662244.56mE				
				Right Bank:	Right Bank:				
				09°38'43.2563"N	1066552.09mN				
				076°28'41.81"E	662202.72mE				
13	LT Line	11.104	Near Maniyaparambu Bridge	Left Bank:	Left Bank:	2	28	9	Completed
				09°38'53.4518"N	1066865.74mN				
				076°28'45.09"E	662301.28mE				
				Right Bank:	Right Bank:				
				09°38'54.5238"N	1066898.68mN				
				076°28'45.16"E	662303.29mE				
14	LT Line	11.181	Near Maniyapara	Left Bank:	Left Bank:		30	8	Completed
				09°38'53.2282"N	1066859.20mN				

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Height w.r.t MSL	Remarks (complete / under - construction)
			mbu Bridge	076°28'47.59"E	662377.56mE				
				Right Bank:	Right Bank:				
				09°38'54.3839"N	1066894.72mN				
				076°28'47.70"E	662380.73mE				
15	LT Line	11.556	Near Maniyapara mbu foot over Bridge	Left Bank:	Left Bank:	2	31	8	Completed
				09°38'49.9767"N	1066760.86mN				
				076°28'59.32"E	662735.66mE				
				Right Bank:	Right Bank:				
				09°38'50.9837"N	1066791.84mN				
				076°28'59.66"E	662745.79mE				
16	11KV LT Line	12.282	Near Maniyapara mbu 2nd foot over Bridge	Left Bank:	Left Bank:	2	25	10	Completed
				09°38'44.2336"N	1066587.42mN				
				076°29'21.91"E	663425.08mE				
				Right Bank:	Right Bank:				
				09°38'45.4153"N	1066623.82mN				
				076°29'22.64"E	663447.31mE				
17	LT Line	12.644	Near Maniyapara mbu 2nd foot over Bridge	Left Bank:	Left Bank:	2	24	10	Completed
				09°38'42.9625"N	1066549.91mN				
				076°29'33.50"E	663778.67mE				
				Right Bank:	Right Bank:				
				09°38'44.0860"N	1066584.43mN				
				076°29'33.52"E	663779.19mE				
18	LT Line	13.095	Near Maniyapara mbu 2nd foot over Bridge	Left Bank:	Left Bank:	2	26	8	Completed
				09°38'50.0928"N	1066770.65mN				
				076°29'46.17"E	664163.87mE				
				Right Bank:	Right Bank:				
				09°38'50.7618"N	1066791.08mN				
				076°29'45.25"E	664135.62mE				
19	LT Line132KV DC	14.159	Near Kuttompuram jetty	Left Bank:	Left Bank:	2	31	9	Completed
				09°38'52.7221"N	1066855.76mN				
				076°30'18.54"E	665150.38mE				
				Right Bank:	Right Bank:				
				09°38'53.9182"N	1066892.59mN				
				076°30'19.17"E	665169.25mE				
20	11 KV Line	14.602	Near Kuttompuram bridge	Left Bank:	Left Bank:	2	22	9	Completed
				09°38'47.8192"N	1066706.95mN				
				076°30'32.04"E	665562.62mE				
				Right Bank:	Right Bank:				
				09°38'48.5199"N	1066728.54mN				
				076°30'32.51"E	665576.90mE				
21	LT	15.43	Near	Left Bank:	Left Bank:	2	24	9	Completed

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Height w.r.t MSL	Remarks (complete / under - construction)
		9	Mannanam bridge	09°38'49.6270"N	1066765.31mN				
				076°30'52.98"E	666200.68mE				
				Right Bank:	Right Bank:				
				09°38'49.6059"N	1066764.56mN				
				076°30'52.22"E	666177.60mE				
22	LT 11KV	15.813	Near Mannanam bridge	Left Bank:	Left Bank:	2	22	8	Completed
				09°39'01.6363"N	1067134.49mN				
				076°30'54.70"E	666251.55mE				
				Right Bank:	Right Bank:				
				09°39'01.6949"N	1067136.15mN				
				076°30'53.67"E	666220.06mE				
23	LT 11KV	17.764	Near Athirampuzha market	Left Bank:	Left Bank:	2	19	8	Completed
				09°39'38.8419"N	1068283.20mN				
				076°31'36.62"E	667524.22mE				
				Right Bank:	Right Bank:				
				09°39'39.3165"N	1068297.70mN				
				076°31'36.01"E	667505.62mE				
24	LT	18.040	Near Athirampuzha market	Left Bank:	Left Bank:	2	17	8	Completed
				09°39'45.3456"N	1068483.77mN				
				076°31'42.20"E	667693.65mE				
				Right Bank:	Right Bank:				
				09°39'45.8366"N	1068498.81mN				
				076°31'41.88"E	667683.64mE				
25	LT 11KV	18.504	Near Athirampuzha market	Left Bank:	Left Bank:	2	15	8	Complete
				09°39'57.6734"N	1068863.42mN				
				076°31'48.92"E	667896.75mE				
				Right Bank:	Right Bank:				
				09°39'58.2396"N	1068880.70mN				
				076°31'48.08"E	667870.94mE				

2.2.3 Pipe Lines / Cables

There is no Pipeline and underwater cable present in the entire survey stretch of waterways.

2.2.4 Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

There are no Dams, barrages, weirs, anicut, Locks etc. in this entire survey stretch.

2.3 Bends

The Bend Radius observed in the stretch of NW 59 is tabulated here under.

TABLE 2-6: DETAILS OF BENDS

CHAINAGE (IN KM)	BEND RADIUS (IN METER)
2.2	185
3.8	75
10.7	30
11.1	30
13.5	165
15.25	65

2.4 Velocity and Discharge Details

The details of velocity and discharge in the NW-59 waterways are given below in Table, as observed.

TABLE 2-7: CURRENT METER DEPLOYMENT LOCATIONS AND DISCHARGE DETAILS

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
1	0.35	09°39'57.869"N 076°24'22.546"E	654289.55 1068810.89	2.7	1.35	0.18	259.686	46.743
2	10.66	09°38'41.061"N 076°28'42.883"E	662235.63 1066484.79	2.6	1.3	0.23	33.107	7.614
3	18.774	09°40'03.878"N 076°31'54.352"E	668061.26 1069054.79	1.4	0.7	0.13	34.321	4.461

2.5 Waterway description

2.5.1 Vechoor- Athirampuzha Canal Stretch (Ch 0.0km – Ch 10.0km)

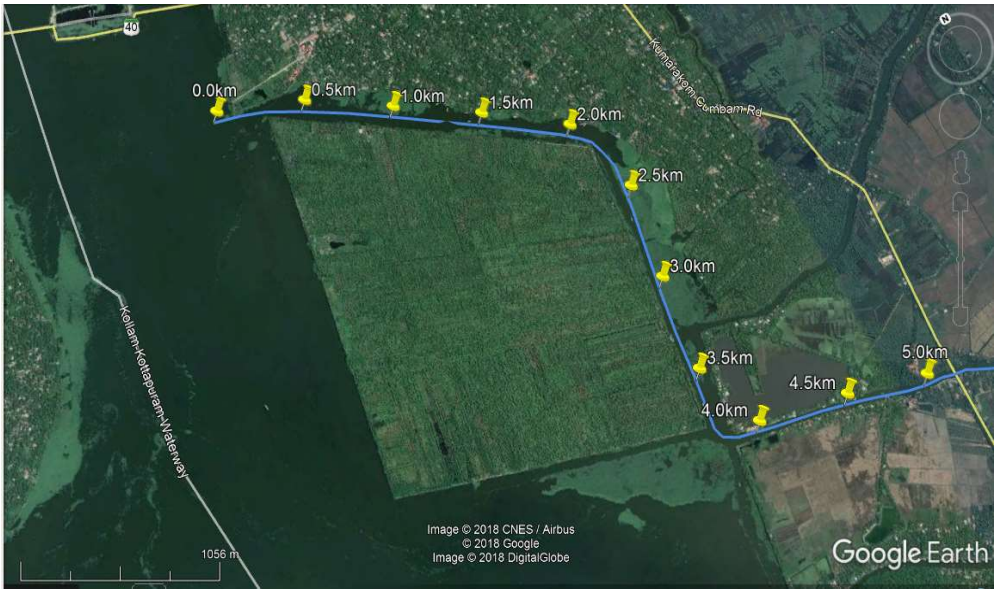


FIGURE 2-2: CH 0.00KM TO CH 5.00KM

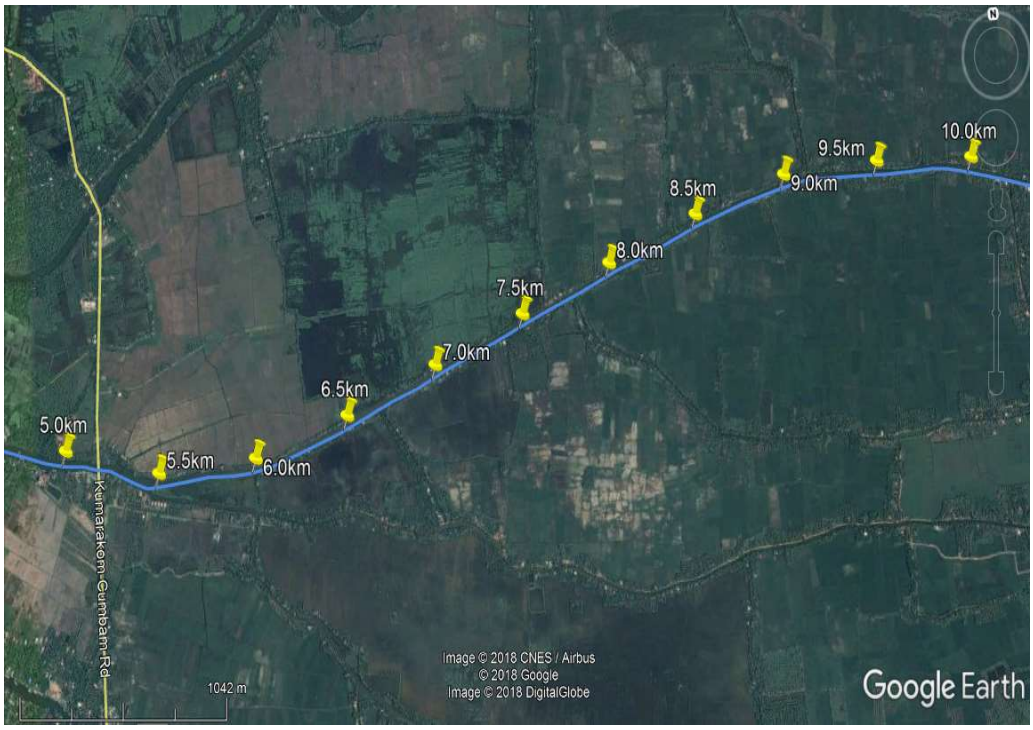


FIGURE 2-3: CH 5.0KM TO CH 10.0KM

TABLE 2-8: REDUCED DEPTH FROM CH 0.00KM TO CH 10.00KM

Chainage (km)		Observed					Reduced w. r. t. Sounding Datum				
		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)		Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	
From	To	Max.	Min.		Per km drg	Accumulative drg.	Max.	Min.		Per km drg	Accumulative drg.
0.00	1.00	4.0	1.0	950	18757.39	18757.39	3.6	0.7	1000	27538.31	27538.31
1.00	2.00	1.7	1.0	1000	27378.32	46135.71	1.4	0.7	1000	39486.99	67025.30
2.00	3.00	1.7	0.7	1000	37210.05	83345.76	1.4	0.4	1000	50982.94	118008.24
3.00	4.00	3.4	-1.2	1000	27108.90	110454.66	3.1	-1.5	1000	37213.02	155221.26
4.00	5.00	4.4	-1.2	900	13675.66	124130.32	4.1	-1.5	1000	15306.31	170527.57
5.00	6.00	4.7	-1.4	1000	29927.88	154058.20	4.4	-1.7	1000	38710.19	209237.76
6.00	7.00	3.5	-1.1	1000	39502.06	193560.26	2.9	-1.7	1000	51171.21	260408.97
7.00	8.00	2.8	-1.3	1000	38871.61	232431.87	2.3	-1.9	1000	55338.12	315747.09
8.00	9.00	2.2	-1.2	1000	48661.57	281093.44	1.6	-1.8	1000	66953.07	382700.16
9.00	10.00	2.1	-1.3	1000	46425.01	327518.45	1.7	-1.9	1000	56339.57	439039.73

The maximum and minimum LAD for the above-mentioned stretch is given in the above table (as per class III). In this stretch, the banks of canal are protected. There are 10 electric lines crossing over the canal including LT & HT. Fishing actives is carried out throughout the year. Water sport recreational facilities are available. No bulk/construction material available in this stretch. The waterway is being used for cargo movement (paddy crop). The whole stretch is protected. Four tributaries are in this stretch.

From stretch 0-5km, residential areas are present on the left bank of the canal and paady/ agricultural land on the right bank of the canal. There are 5 jetties in this stretch (2 jetties left side and 3 jetties right side). Starting of the stretch width of canal is more than 50.00m and afterwards it varies from 25 to 30m. After 5km of the canal marginal land acquisitions are required.

There were no prominent features like dams/barrages, tidal, stretch tidal range, pondage stretch, weirs, anicut, locks, hindrance, encroachment, wildlife, defence, industries, Ghats, sand mining, nala, polluted water discharge in to the canal and treatment plant found in the whole survey stretch. The whole stretch is protected.

2.5.2 Vechoor- Athirampuzha Canal Stretch (Ch 10.0 km – Ch 18.8 km)

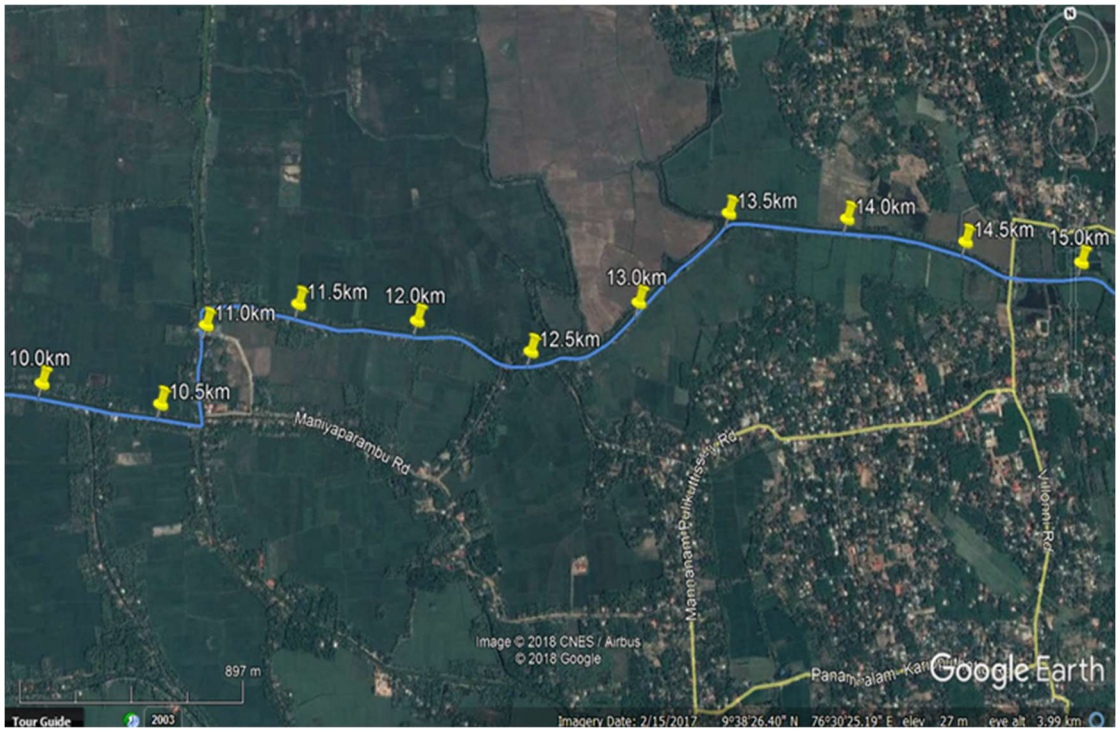


FIGURE 2-4: CH 10.0KM TO CH 15.0KM

FIGURE 2-5: CH 15.0KM TO CH 18.78KM

TABLE 2-9: REDUCED DEPTH FROM CH 10.0KM TO CH 18.78KM

Chainage (km)		Observed					Reduced w. r. t. Sounding Datum				
		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)		Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	
From	To	Max.	Min.		Per km drg	Accumulative drg.	Max.	Min.		Per km drg	Accumulative drg.
10.00	11.00	2.0	-1.9	1000	74814.28	402332.73	1.5	-2.5	1000	82894.83	82894.83
11.00	12.00	2.3	-2.1	1000	90087.85	492420.58	1.69	-2.7	1000	103304.85	186199.68
12.00	13.00	2.5	-2.3	1000	100198.26	592618.84	1.67	-2.9	1000	107218.66	293418.34
13.00	14.00	1.0	-2.0	1000	99431.03	692049.87	1.38	-2.6	1000	100785.38	394203.72
14.00	15.00	1.7	-2.2	1000	93997.34	786047.21	1.2	-2.8	1000	119060.13	513263.85
15.00	16.00	1.8	-0.7	1000	92915.74	878962.95	-0.5	-3.0	1000	155049.97	668313.82
16.00	17.00	2.1	-0.6	1000	98997.77	977960.72	-0.2	-2.9	1000	164424.32	832738.14
17.00	18.00	1.4	-0.9	1000	140674.90	1118635.62	-1.0	-3.2	1000	177587.02	1010325.16
18.00	18.78	0.9	-1.7	750	99305.46	1217941.08	-1.4	-4.0	750	139749.19	1150074.35

The maximum and minimum LAD for the above-mentioned stretch is given in the above table (as per class III). In this stretch, the banks of canal are protected. There are 15 electric lines crossing over the canal including LT & HT. In this stretch agricultural field can be seen on the both side of canal.

There is one jetty on the right of the canal. There is one temple on the right side of the canal at Ch 10.00km. There are 7 bridges in this stretch. Three foot over bridge can be seen at Ch 11.2km, Ch 12.477km (near Thommankavala Village) and at Ch 16.954km. Kuttompuram Road Bridge and Mannunam Bridge can be seen at Ch 14.68km and at Ch 15.44km. And at last a road bridge can be seen near Athirampuzha. In this sub stretch the width of canal is varying from 25.00m to 30.00m. In this Sub stretch marginal land acquisition is required.

There were no prominent features like dams/barrages, tidal, stretch tidal range, pondage stretch, weirs, anicut, locks, encroachment, Water sport recreational facilities, wildlife, defense, atomic power plants, industries, Ghats, sand mining, nala, polluted water discharge in to the canal and treatment plant found in the whole survey stretch. Fishing actives is carried out throughout the year. No bulk/construction material available in this stretch. The waterway is being used for cargo movement (paddy crop). Water weeds were obstructing to conduct the survey on either side of the bank up to 4 km.

2.6 Water and Soil Samples analysis and Results

Riverbed soil and water sampling was undertaken at every 10 Km. evenly distributed throughout the Vechoor- Athirampuzha Canal Stretch. The Vanveen grab and Naskin water bottles were kept standby for the collections of samples. The details of soil and water sample locations are as follows: -

TABLE 2-10: WATER TEST RESULT

#	Chainage (km)	Easting (m) Northing (m)	Lattitude (N) Longitude (E)	Sediment concentration (ppm)	ph
1	0.408	654363.01E 1068828.00N	09°39'58.4168"N 076°24'24.9582"E	17	6.72
2	10.666	662241.32E 1066482.20N	09°38'40.9760"N 076°28'43.0701"E	24	5.63
3	18.769	668057.82E 1069049.51N	09°40'03.7070"N 076°31'54.2386"E	19	7.59

TABLE 2-11: SOIL TEST RESULT

#	Chainage (km)	Easting (m) Northing (m)	Lattitude (N) Longitude (E)	Specific gravity	Fine Gravel (20mm to 4.75mm)	Coarse Sand (4.75 mm to 2.00mm)	Medium Sand (2.00mm to 0.425mm)	Fine Sand (0.425mm to 0.075mm)	Silt (0.075 mm to 0.002mm)	Clay (<0.002mm)	Cu	Cc
1	0.408	654363.01E 1068828.00N	09°39'58.4168"N 076°24'24.9582"E	2.62	47	18	18	7	4	6	74.930	5.9568
2	10.666	662241.32E 1066482.20N	09°38'40.9760"N 076°28'43.0701"E	2.59	0	18	19	72	2	6	3.059	1.3542
3	18.769	668057.82E 1069049.51N	09°40'03.7070"N 076°31'54.2386"E	2.69	5	11	49	22	7	6	14.286	2.8928

CHAPTER 3 FAIRWAY DEVELOPMENT

3.1 Proposed Class / Type of Waterway

The Fairway availability and its utilization along with the developments required etc., are to be concluded based on the detailed Hydrographic survey, Traffic mobilization including the hinterland requirement, future planning of the hinterland amenability and the stake holder's view point etc.,

The detailed Hydrographic survey and charts have been referred. As per the data available, the study stretch of the waterway is amenable for development up to class III of the waterway from the Fairway point of view, so as to have the inter connectivity with the existing / developed NW 3.

The NW 59 is having connectivity to ICTT, Kochi through NW 3 and hence it is most preferred to develop the fairway with Class III waterway and also to facilitate the Ro-Ro type of vessels, wherein the evacuation of ICTT, Kochi container Truck volumes towards south eastern part of the country can be diverted. This mobility will ease the road traffic in Kerala. The Road Traffic in Kerala already facing lot of constraints, in particular on the widening aspects. The traffic density on the road can be eased by this IWT mobility.

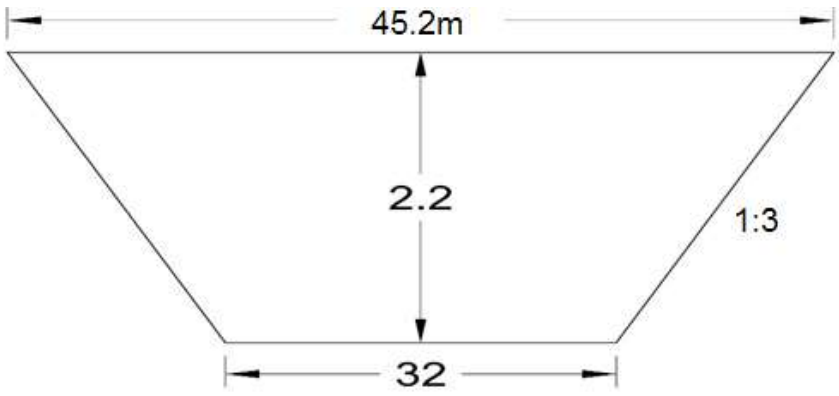
NW 59 is the waterway as a canal system not of the river system, which is having a distinct standard made available as per the Classification of Waterways.

The present Study stretch of NW 59 can be considered for development as a ***Class III*** waterway, for carrying out the Ro-Ro trucks mobility after having industry confirmations with meticulous observation. Accordingly, the observation period can be considered up to 2022 and the development of Infrastructure, on confirmations, can be considered as 36 months from 2022.

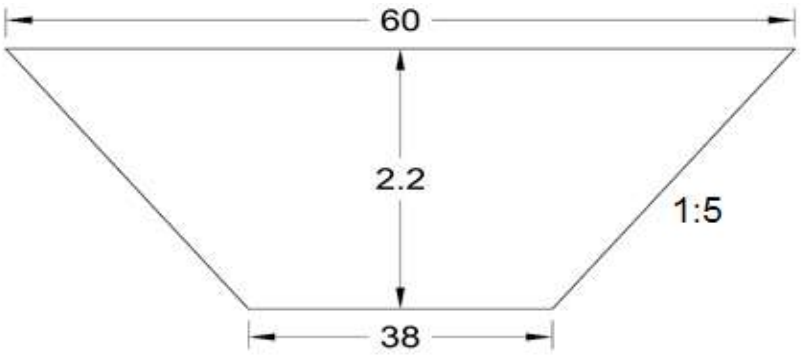
3.2 Details of Shoals (Length, Width and proposed development works)

Dredging quantities have been worked out for the suggested Class III Waterway standards for the canal system with 32 m in the Narrow Reaches and 38 m in the Wider Reaches. The canal Cross section for both the reaches are depicted herewith.

32m x 2.2m with side slope 1:3 (Class-3 for Narrow Reaches)



38m x 2.2m with side slope 1:5 (Class-3 for Wider Reaches)



CLASS-III

CLASS	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	0	10	4.7	-1.4	9850	327518.45	4.4	-1.9	10000	439039.73
	10	18.78	2.5	-2.3	8750.0	890422.63	1.7	-4.0	8750.0	1150074.35
Total					18600.0	1217941.08			18750	1589114.08

3.3 Proposed Conservancy Activities

The present study stretch of NW 59 is the Canal system in the Vembanad Lake area and as such no need of taking up of any River conservancy activity. However, to maintain the safe fairway, Widening / Dredging and side protection are required.

3.3.1 Dredging

“Dredging” is the removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies. It is a routine necessity in waterways around the world because of the sedimentation process (the natural process of sand and silt washing downstream and gradually fills channels and harbors). Dredging often is focused on maintaining or increasing the depth of navigation channels, anchorages, or berthing areas to ensure the safe passage of boats and ships. Vessels require a certain amount of water in order to float and not touch bottom. This water depth continues to increase over time as larger and larger ships are deployed and with the increased volumes of bulk cargo operation, dredging plays a vital role in the nation's economy.

Dredging is also performed to reduce the exposure of fish, wildlife, and people to contaminants and to prevent the spread of contaminants to other areas of the water body. Environmental dredging is often necessary because sediments in and around cities and industrial areas are frequently contaminated with a variety of pollutants. The sediment management and disposal of dredged material are also important issues to be managed and carried out effectively.

Dredging used to be carried out in the Sheltered Waterways by various types of Dredgers viz., Bucket and grab dredgers; Suction and cutter-suction dredgers; Trailing hopper dredgers etc., However, the most acceptable form of the dredger is “Cutter Suction Dredger” (CSD) being deployed on National Waterways by IWAI. The type of soil, if hard, may have to be tackled with the appropriate dredger. The advantage of “Cutter Suction” type of Dredger is that the spoil can be taken out from the fairway area to an appropriate specified location.

In the study stretch, Dredging has been identified along with Land Acquisition with widening. In order to meet the Ro-Ro operation, possibility with Class III standard has been considered. The shoal length for Class III is 18750 m with an estimated quantity of dredging as 15.89 Lakhs Cu. M. However, in the canal system, the Dredging volumes are allowed in the Tender for 0.3 m additional depth variation, which accounts for nearly 10% to 30 % of the volumes, therefore considering this quantity @ 10% shall entail the dredging quantity to be taken as 17.48 Lakhs Cu. M, which has been taken into account. The mode of measurement shall be in cum and as per the actual dredged quantity.

The dredged quantities may be mostly useful for reclamation in the Kuttanad area of Kerala, where the study stretch is traversing. Further, Dredged soil is having a good market, which is a consumption point. In kerala, as ascertained, the State Administration is channelizing the utility of the Dredged spoil, keeping in view the local prople requirement. Hence disposal of the dredged spoil is not a problem at all in Kerala.

3.3.2 River Training

NW 59 is basically a canal stretch available with a lesser natural width of the channel than the standard criteria. This is probing the Land Acquisition / Widening / Bank Protection etc.

In the present study stretch, there is no need of any Training requirements.

3.4 Bank Protection / Embankment Strengthening

In the rivers, wherever bends or curves exist, the concave side of the river will always be subjected to the erosion. The pace of erosion will depend on the soil condition and terrain and also the velocity of the flow at the location.

NW 59 is a canal system proposed for development of Class III standards. The majority of the stretch is under thick habitation. Since the Land Acuisition is involved in this stretch, a micro level analysis has been considered and a Km wise LA / Bank Protection requirement has been worked out. The below given Table is being provided with the details for the same.

TABLE 3-1: LIST OF LAND ACQUISITION AND BANK PROTECTION REQUIREMENTS

Sl. No.	Chainage (in Km) From------ To----------	Existing Width (in m)	Extra Width Requirement (L / R in m)	Length (in m)	Area of Land Acquisition (in Sq. m)	Bank Protection Requirement (L in m / R in m)	Remarks, if any
(1)	(2)	(3)	(4)	(5)	(6) = (4) x (5)	(7)	(8)
1	0 to 1	*			9000	=	* > 50 m
2	1 to 2	*				=	
3	2 to 3	*				=	= No B P
4	3 to 4	50	0	800	0	1600	

Sl. No.	Chainage (in Km) From------ To----------	Existing Width (in m)	Extra Width Requirement (L / R in m)	Length (in m)	Area of Land Acquisition (in Sq. m)	Bank Protection Requirement (L in m / R in m)	Remarks, if any
5	4 to 5	40	10	1000	10000	2000	
6	5 to 6	50	0	1000	0	2000	
7	6 to 7	40	10	1000	10000	2000	
8	7 to 8	40	10	1000	10000	2000	
9	8 to 9	40	10	1000	10000	2000	
10	9 to 10	40	10	1000	10000	2000	
11	10 to 11	40	10	1000	10000	2000	
12	11 to 12	30	20	1000	20000	2000	
13	12 to 13	20	30	1000	20000	2000	
14	13 to 14	30	20	1000	20000	2000	
15	14 to 15	25	25	1000	25000	2000	
16	15 to 16	30	20	1000	20000	2000	
17	16 to 17	25	25	1000	25000	2000	
18	17 to 18	25	25	1000	25000	2000	
19	18 to 18.8	25	25	700	17500	1400	
					242500 Say 24.5 Ha	31,000 Say 31 kms	

As above, the Bank Protection requirement has been worked out to 31,000 m. In canals, the usual types of Bank Protection in Kerala are Revetment / Rip-Rap or Pile & Slab. Since the NW 59 is traversing through the Lake area and keeping in view the Land Acquisition requirement, the preferred type is Pile & Slab for which a preliminary Drawing with the details are provisioned in the Chapter 6. Accordingly, 31,000 m of Pile & Slab Bank Protection is suggested and recommended herewith.

3.5 Navigation Markings / Navigation Aids

Keeping in view the River width / Channel width etc., the Navigational Markings can be considered, either in the Shore or in the River with floating condition. The Shore Markings can be considered with a reasonable Beacon type structure fitted with Light at the top, whereas, the marking in the river can be considered with the floating Buoys as per the IALA standards fitted with Light at the top.

NW 59, being a canal system, the beacon type structure is not amenable and not suggested. i.e., suggested with Buoy & Light system.

Regarding the Buoy & Light system, it is proposed to consider the same type of Buoy and Light deployed in NW 3. The Technical specifications of Buoy & Light, as available in the Market as a proprietary item are detailed in Chapter 6.

Considering 500m interval and in Zigzag position (i.e., 1 Left then 1 Right Mark and 1 Left Mark), it is estimated to provide 45 Nos. in the stretch for 18.80 kms {18800 / 500 + 10 % approx. + 4 Bends etc).

3.6 Modification Requirement in existing Bridges / Cables / Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

In the present study stretch of NW 59, 8 Bridges are existing i.e., 5 Nos. RoB (at Ch. 5.133 km; Ch. 14.68 km; Ch. 15.44 km; Ch. 16.954 km and Ch. 17.62 km) and 3 Nos. are FoB (at Ch. 10.56 km; Ch. 11.2 km and Ch. 12.477 km). Modifications are required at 6 locations and details are placed in the below given Table, wherein the cost is working out to INR 276 Lakhs.

TABLE 3-2: COST OF MODIFICATION OF BRIDGES

For Class III Vessel, with single lane operation, the critical clearances in horizontal direction is taken as 13.5m to 15m

Horizontal Clearance = 13.5 m
Vertical Clearance = 6.0 m

SL No	Chainage	Center Position		Location	Type of structure	Type of super structure	Width	No of span(Nos) x Length of Span(m)	Hz clearance	Height wrt MSL	Modification Required		Estimated Cost of Modification
		Latitude	Longitude								Hz	Vt	
1	5.133	9°38'19.64"	76°25'48.20"	Cheeppunkal	Road Bridge	RCC	7	4 x 20	20	4	No	Yes	55,00,000
2	10.56	9°38 '50.24"	76°28 '43.30"	Maniyaparambu	Foot Over Bridge	RCC	8	2x20	20	6	No	No	
3	11.2	9°38 '53.57"	76°28'48.53"	Near Maniyaparambu	Foot Over Bridge	RCC	2	2x20	20	3.5	No	Yes	33,00,000
4	12.477	9°38 '42.76"	76°29'28.07"	Near Maniyaparambu	Foot Over Bridge	RCC	2	2x15	15	4	No	Yes	33,00,000
5	14.68	9°38 '46.93"	76°30'34.65"	Kuttoompuram	Road Bridge	RCC	7	2x20	20	6	No	No	
6	15.44	9°38 '49.75"	76°30 '52.60"	Mannanam	Road Bridge	RCC	5	2x15	15	5	No	Yes	50,00,000
7	16.954	9°39 '30.09"	76°31'11.78"	Near Kaipizha	Road Bridge	RCC	2	2x15	15	3.8	No	Yes	55,00,000
8	17.62	9°39 '37.26"	76°31'32.38"	Liseiux	Road Bridge	RCC	2	2x15	15	4.5	No	Yes	50,00,000
												Total Cost	**2,76,00,000**

NOTES:

NOTE 1 Road bridges which need modification are at Chainage 5.133, 14.68, 15.43, 16.954 and 17.62.
NOTE 2 Since, this is single span, the road level is increased to make vertical clearance of 6m and suitable gradient is provided at both ends. The Abutments will increase by required heights at both ends. Foundation will also need modification as per the increased height.
NOTE 3 Foot Over Bridges which require modification are at chainage 11.2 and 12.477.
NOTE 4 Foot over Bridges may be modified / replaced according to condition of bridge at site.
NOTE 5 The cost of modification may have to be updated before construction at Detailed Engineering Stage.

Further, 25 Nos. of Power Cables are in existence. Most of the cables may not require any modification. However, anticipated stringing of Cables for which L. S provision has been catered.

No cross structures viz., Dams / Barrages & Locks / Weirs / Anicuts / Aqueducts are observed in the present study stretch. Hence, modification doesn't arise.

3.7 Proposed Dams / Barrages / Locks / Weirs to improve depth

In order to improve the fairway, including the depth, there is no requirement of Dams / Barrages & Locks / Weirs in the present study stretch.

3.8 Land Acquisition

NW 59 stretch is in the Vembanad Lake and majority of the stretch is having very less width and depth and Land Acquisition is required for Fairway Development. The Km wise requirement has already been tabulated and accordingly, the requirement has been worked out to an extent of 24.50 Hectares and the approx. cost involved is about INR 21.34 Cr. Land Acquisition requirement for Terminal purpose is being considered, as a part of Terminal development, wherever required.

3.9 Fairway Costing

3.9.1 Capital Cost

The identified Traffic for IWT for this Waterway is of Ro-Ro operation and however the same is only being considered on Thereotical basis, since no traffic volumes are identified. Investment is suggested with Positive growth and confirmations, if any, in the long run.

The Capital Cost for the fairway has been considered for 17.48 Lakhs Cu. M of Dredging in soils (INR 56.11 Cr); 31,000 m of Bank Protection at the identified chainages (INR 44.96 Cr); Land Acquisition of about 24.5 Hectares (INR 21.34 Cr); 45 Nos. of Buoy with Light (INR 1.61Cr) and Modification of Structure i.e., at 6 Bridges and Stringing of 10 HT Lines (INR 2.89 Cr). Cost estimates are placed with details in Chapter 11. An option-2 had also been discussed in light of some suggestions obtained from Govt. of Kerala vide their letter dated 07.03.2020.

3.9.2 O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined, by IWAI, which have been analysed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 4 TRAFFIC STUDY

4.1 General

The study stretch of National Waterway 59 (Vechoor- Athirampuzha Canal) originates at Vechoor i.e. near Vembanad Lake and extends till Athirampuzha of Kottayam taluka. Vembanad Lake is the passage for NW 3 (Kollam to Kottapuram). The proposed NW 59 connects Athirampuzha with the existing NW 3 at Vechoor; it also connects Athirampuzha to Cherthala, Alappuzha District via Vembanad Lake. NW 59 is also connected to NW 9c at Maniyaparambu. The total length of the proposed waterway from Vechoor to Athirampuzha is 19 km. The existing NW 3 connects proposed NW 59 to Cochin Port in north & Kollam in south.

The waterway lies in Kottayam district. As stated earlier, the proposed waterway serves as an access to existing NW 3 at Vechoor (Vaikom Taluka), which further enhances the connectivity of the study stretch to districts of Cochin & Kollam, through IWT.

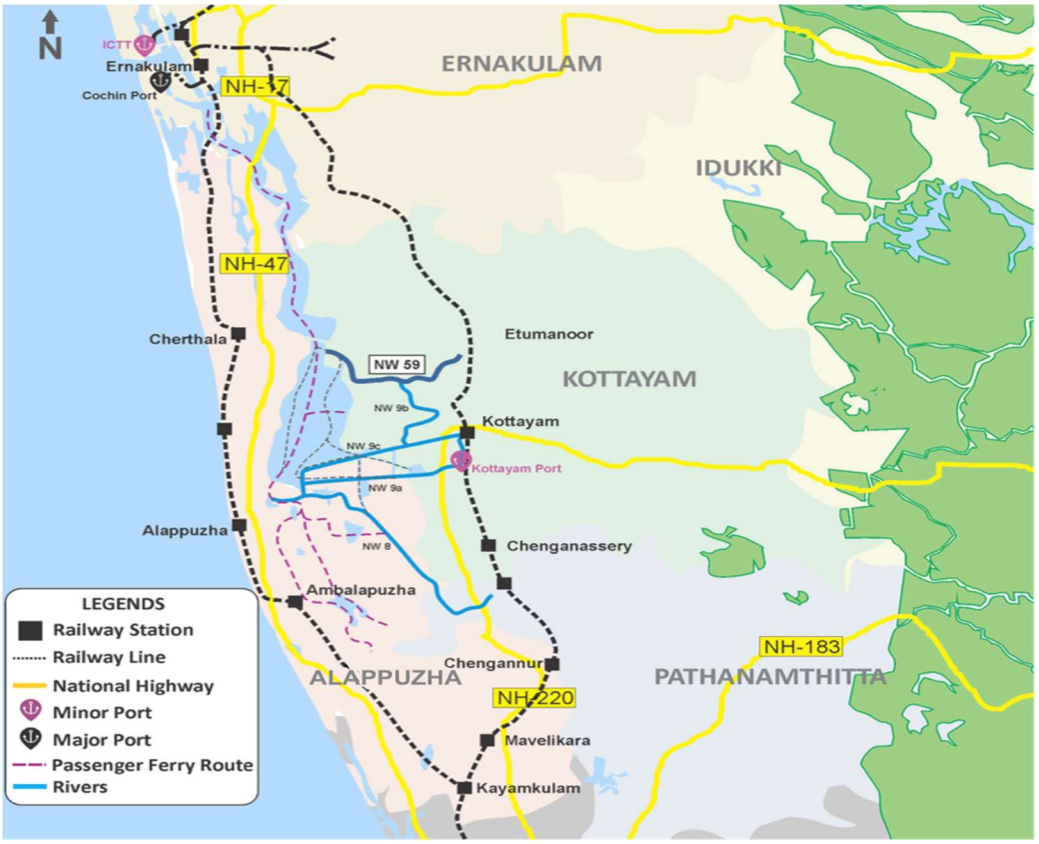


FIGURE 4-1: HISTORIC TRAFFIC HANDLED AT NW 3

4.2 Hinterland Analysis

Primary catchment area of NW 59 covers Kottayam, Alappuzha & South Ernakulum district, which come within 25 km from the proposed waterway, NW 59. However part of North Ernakulum and Pathanamittha come in secondary catchment area as they are far from the canal, i.e. more than 25 km from NW 59. The identified stretch of the canal, i.e. NW 59 flows from Kottayam district. It is the only district, having no borders with either Western Ghats or sea. Southern region of NW 59 covers two more proposed waterways, namely NW 8 & NW 9. NW 9 shares the hinterland of NW 59, as both the canals are connected at Maniyaparambu.

Vembanad Lake is located on the west side of NW 59, from where the canal starts. This lake is also the passage for NW 3. NW 3 is the extension of West Coast Canal from Kottapuram to Kollam, having 181 km of stretch. The stretch of other two canals, namely Champakara & Udyogamandal adds 49 km to the NW 3, making the total length of NW 3, 230 km. IWAI has installed night navigation facilities in 168 km stretch just for reduction in turnaround time and increase the loops of vessel movement. It is the only waterway in India to have navigational facilities for 24 hrs. /day. However, only Champakara & Udyogamandal canals are operational in the entire NW 3 for cargo movement. These two canals are located more than 40 km away from the mouth of NW 59. This whole stretch of NW 3 has 11 terminals; however only 7 amongst them are developed. Rests of the terminals are either in developing stage or sanctioned. NW 3 is developed only till Maradu, starting from Kottapuram and further the stretch is underdeveloped.

Following are the stakeholders of NW 3

- Kerala Minerals Metals
- India Rare Earth
- Kochi Refinery
- FACT
- Travancore Cochin Chemicals
- Bennani Zinc
- Philips Carbon

Fertilizer & Chemical Travancore Ltd (FACT) mainly utilizes the existing waterway, NW 3. Commodities, like Phosphoric Acid, Sulphur, Zinc, Furnace oil, Rock Phosphate, various commodities in containers, Furnace oil- Bunkering, POL, Potable Water, Lime shell with clay and other impurifies, Liquid effluent are moved in NW 3. Following figure shows the historic traffic handled at NW 3 and its growth trend.

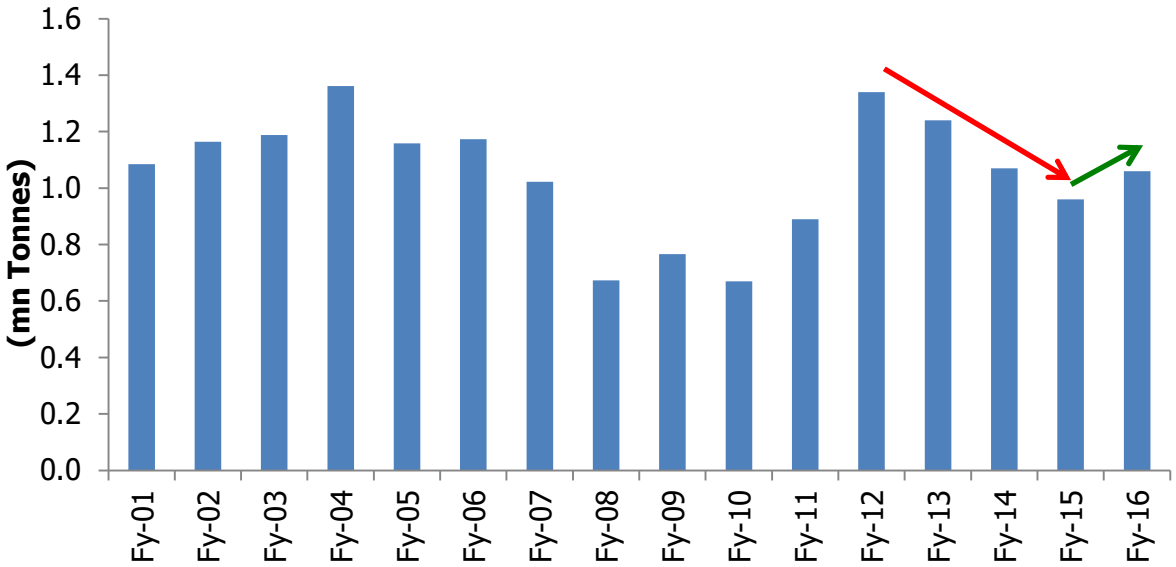


FIGURE 4-2: TRAFFIC HANDLED AT NW 3

Source: data.gov.in, IWAI

It can be clearly seen in the above graph that from Fy 12 till Fy 15, traffic handled at NW 3 has decreased because of the operational failure of FACT. FACT had temporarily closed its operations in January, 2013 for some development purpose. Although traffic has gradually declined, in Fy 15, but in Fy 16, it has witnessed some growth. Traffic in Fy 16 was 1.1 mn Tonnes, which was more than the previous year.

IWAI intends to develop other canals/ rivers of Kerala, namely NW 59, NW 9, NW 8 & WCC. The main objective of this development is to divert traffic from road & rail to rivers/canals in order to reduce road congestion and other logistics issues on land transport and provide environmental friendly & cost-effective support. Cargo opportunity for NW 59 is studied further. The below map shows the location of the proposed waterways NW 8, 9, 59 and NW 3 and connectivity to Cochin Port through these waterways.

FIGURE 4-3: CONNECTIVITY OF NW 3 WITH OTHER PROPOSED NATIONAL WATERWAYS

Hinterland of NW 59 is marked on the above map, along with different points where NW 59 connects to NW 9 & NW 3. Industries are mostly located between NW 9 & NW 59; traffic diversion from these industries is analysed in following sections. At present, Kottayam Port receives cargo from nearby industries and transports to Cochin Port via road. Cargo from Cochin Port moves to Kottayam Port through the same route. Traffic diversion of this route to the proposed waterway 59 is further analysed in this study.

4.2.1 Demography Profile of Hinterland

For the study of the hinterland, only those talukas are considered, which come within 25 km from the canal NW 59. The study covers entire Kottayam district, Alappuzha district (except 3 southern talukas) and 2 talukas of Ernakulam that touch Kottayam district.

Kottayam district ranks 10th in population, 8th in total density and 6th in Urban Density amongst the districts of Kerala. Population growth rate of Kottayam over the last decade (2001-2011) was 1.32%. The district is bordered by hills on the east and Vembanad Lake and paddy fields of Kuttanad on the west. The district is famous for Kumarakom, which is a beautiful tourist spot. Kottayam is also famous for its rubber plantations.

Alappuzha is the smallest district in Kerala in terms of area. It ranks 9th amongst the populated districts of Kerala. Though Alappuzha's backwaters are famous for tourism purpose, considering standard of living of people it is a backward district. Majority of population in Alappuzha are agricultural labour and coir workers. It is the only district having no land under forest area. Population growth rate of Alappuzha over the last decade (2001-2011) was 0.61%.

Majority of people residing in Pathanamthitta (taluka of Alappuzha) have migrated to foreign countries for employment opportunities. Inward remittance plays an important role in the state economy.

Only two talukas of Ernaulam district, namely Kanayannur & Muvattupuzha come under the primary hinterland of NW 59. While 12% of Kerala's population resides in Ernakulam, it is also known as commercial capital of Kerala as it is the highest revenue-generating district. It ranks 3rd amongst the population of districts in Kerala. Economy of Muvattupuzha is primarily dependent upon agriculture & small-scale industries.

The below table shows population living in the catchment area of NW 59. District wise population is presented on the table.

TABLE 4-1: TALUKA/ VILLAGE WISE POPULATION AROUND NW 59

District	Taluka	Population
Kottayam	Kottayam	631,885
	Changanassery	355,736
	Meenachil	406,471
	Vaikom	310,414
	Kanjirappally	270,045
Alappuzha	Cherthala	542,657
	Ambalappuzha	454,864
	Kuttanad	193,007
Ernakulum	Kanayannur	32,974
	Muvattupuzha	294,251
Total		4,793,304

Source: Census 2011

4.2.2 Economic profile of Kerala

Kottayam's Economy is contributed by Agriculture and other industries of cities and surrounding region. Rubber industry and spice exports are major contributors to Kottayam's economy. These industries in Kottayam district have improved the infrastructure of cities and act as backbone of the economy.

Alappuzha District is the commercial and trade center of Kerala. Its economy is based on tourism and exports, specifically spices, coconut oil, coir, sugar etc. Cargo transportation takes place using all modes of transportation, including IWT routes. All the business and economy is dependent upon Agriculture, Marine Product, Coir Product, Coconut and Tourism. Alappuzha is traditional home of coir industry.

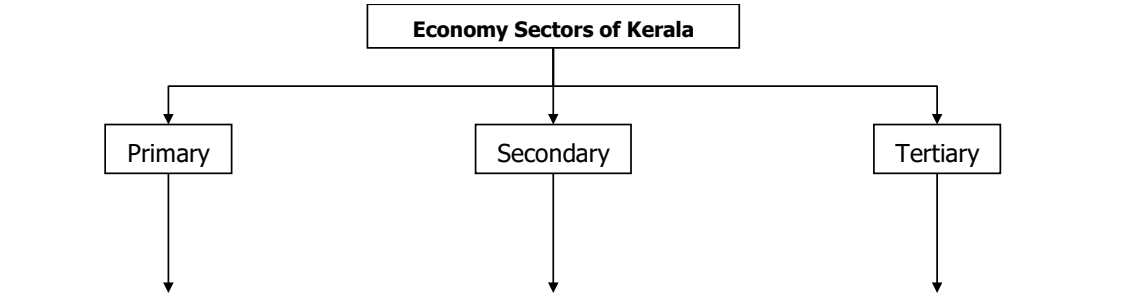
Ernakulum district's economy growth is mainly based on its geographical area. 70% of the district area is used for cultivation. Woodcarvings, handicrafts are famous in the district. Agriculture & small- scale industries are the major contributors to the economy of Muvattupuzha taluka of Ernakulam district. Following table shows the annual growth of primary, secondary & tertiary sector of Kerala.

TABLE 4-2: SECTOR WISE HISTORIC ANNUAL GROWTH RATE (%)

Sectors	FY 13	FY 14	FY 15	FY 16
Primary	9	9	13	12
Secondary	24	20	26	26
Tertiary	67	71	61	62

Source: Economics Statistics, Kerala Govt.

It can be seen in the above table that growth in primary sector is very slow, growth is between 9% to 13% year on year. Secondary sector has shown sudden upward growth in Fy 15 by 6%, as compared to the growth rate of Fy 14, while in Fy 15 & Fy 16, it remained constant. Fy 15 has witnessed considerable decline in Tertiary sector. Detailed study of economy sectors is done in following section.



Inland **fishing** is popular in Kerala. Inland fish catch gets consumed in local market. Multi crop **farming** is more popular in Kerala, where fish and rice could be grown simultaneously. Kottayam & Ernakulam are rich in Graphite. Only one **mineral** based company exists in hinterland of NW 59. Alappuzha does not have reserved **forests**. 5% of total geographical area of Kottayam is forest area in the district.

All types of **manufacturing industries** come under secondary sector. Pallippuram, Cherthala is the only major industrial zone in Alappuzha district. Lots of medium & small scale industries, engaged in coir, food processing, manufacturing of industrial material, rubber, textile etc. are found in the catchment area of NW 59. Very few large scale industries exist in Kottayam & Alappuzha and all of them are closer to NW 9 as compared to NW 59.

All other service providing industries, like **banking & insurance, Hotels and resorts, Communications, Tourism etc**. come under this sector. Ernakulam, Alappuzha and Kottayam districts are famous for tourism. Backwaters of Alappuzha is famous for pilgrim centers and rural tourism. Majority of the contribution to Kerala's state comes from tertiary sector.

FIGURE 4-4: CONTRIBUTION OF DIFFERENT SECTORS IN ECONOMY OF HINTERLAND OF NW 59

4.2.2.1 PRIMARY SECTOR

Primary sector consists of Agriculture, Forestry, Fishing and Mining.

TABLE 4-3: DISTRICT WISE CONTRIBUTION IN PRIMARY SECTOR (INR IN 10 MILLIONS)

Primary Sector	Alappuzha	Kottayam	Ernakulam
Agriculture	587	1,856	1,431
Forestry	145	138	234
Fishing	377	18	240

Primary Sector	Alappuzha	Kottayam	Ernakulam
Mining	21	44	96
Total	1,130	2,056	2,001

Source: Directorate of Economics and Statistics, Kerala

a. Agriculture

In Kottayam district, annual crops like pineapple and plantain, seasonal crops like tubers and ginger are grown in large scale. Jackfruit and mango are also grown in the district and nearby areas. Farming is the major occupation of people and rice is the main agriculture product. About 90% of total land area of Ernakulm district is used for cultivation; main crop of the district is paddy. Government of Kerala is planning to become self-sufficient in cultivating vegetables.

TABLE 4-4: AGRICULTURE PRODUCTION IN THE CATCHMENT AREA OF NW 59 (FY 15)

Production ('000 T)

District	Taluka	Rice	Spices	Others
Alappuzha	Cherthala	1,029	23	248
	Ambalappuzha	11,000	10	255
	Kuttanad	60,762	5	618
	Municipalities	6,048	12	83
Kottayam	Kottayam	1,398	343	638
	Changanassery	6,529	225	314
	Meenachil	1,067	864	1,379
	Vaikom	11,701	79	866
	Kanjirappally	26,203	382	1,013
	Municipalties	2,494	34	239
Ernakulam	Kanayannur	1,228	44	409
	Muvattupuzha	1,817	366	1,103
Total		131,276	2,387	7,165

Source: Department of Economics and Statistics Kerala

TABLE 4-5: HORTICULTURE PRODUCTION IN THE CATCHMENT AREA OF NW 59 (FY 15)

('000 T)

District	Taluka	Fruits	Coconut (Nuts)	Others
Alappuzha	Cherthala	623	44,000	1
	Ambalappuzha	338	19,000	1
	Karthikapally	712	62,000	10
	Mavelikkara	1,814	27,000	45
	Chengannur	2,090	15,000	29
	Kuttanad	299	27,000	0
	Municipalities	675	24,000	3
Kottayam	Kottayam	2,996	21,000	44
	Changanassery	1,851	14,000	20

('000 T)

District	Taluka	Fruits	Coconut (Nuts)	Others
	Meenachil	4,958	35,000	106
	Vaikom	1,407	35,000	10
	Kanjirappally	2,788	28,000	36
	Municipalties	1,147	7,000	3
Ernakulam	Kanayannur	682	13,000	4
	Muvattupuzha	2,110	22,000	39
Total		24,490	393,000	351

Source: Department of Economics and Statistics Kerala

b. Forestry

Forest plays very important role in the development of Kottayam district's economy, by influencing various sectors like agriculture, industry, climate, employment etc. The district has 8,141 ha. of forest land, which is 3.7% of total land area. Out of this, 54 sq. km. is covered under plantation crops. Kottayam high range circle has 4 forest divisions, namely Kottayam, Munnar, Kothamangalam and Mankulam. Alappuzha has very less land covered under forest area, as the district is commercial & trading center of Kerala. Northern & Northeastern part of Muvattupuzha formed the forest area of Ernakulum district. Below table shows the land pattern under forest cover.

TABLE 4-6: DISTRICT WISE FOREST COVER (HA.)

District	Geographical area ('000 Ha.)	Very dense forest	Moderate dense forest	Open forest	Total
Alappuzha	1,414	0	12	26	38
Kottayam	2,203	12	542	335	889
Ernamkulam	2,407	12	298	385	695

Source: iesenvis.nic.in, Kerala database

It can be seen from the above table that Alappuzha does not have dense forest cover area at all and total forest cover of the district is also very less, compared to other districts. Kottayam has moderate forest cover and open forest area. Forest products, like timber would not provide any opportunity for the proposed waterway.

c. Fishing

Fishing is a major activity in Ernakulum and Alappuzha district. Fisheries department has created 20 houses in Thycattusserry village in Cherthala taluka of Alappuzha district. Feeder road, connecting the district roads with seacoast for fishermen has been developed to carry out their activity and help community. There are more than 1,30,000 fishermen in Alappuzha district. More than 60% of fishermen are engaged in sea farming and rests are carrying out inland fishing activity. Majority of fishermen are indirectly engaged in fishing operation. Marine fishing season is from October to May and inland fishing is done throughout the year.

TABLE 4-7: MINOR FISH LANDING CENTERS IN ALAPPUZHA & KOTTAYAM

District	Taluka	Panchayath	Landing center
Alappuzha	Ambalappuzha	Alappuzha	Punnamada Jetty Kadavu
	Cherthala	Thanneermukkam	Thanneermukkam Kadavu

District	Taluka	Panchayath	Landing center
			Kasnnankkarajetty Kadavu
			Puthanangadi Kadavu
		Muhamma	Depokadavu, S N Kavalayku Kezhzkku, Muhamma panchayathu Kadavu, Kovilakom Resort Kadavu, Perumthuruthu Kadavu, Ambalakadavu, Kalluchirakadavu, Madayanthodukadavu, Shanmughan Jetty Kadavu, Purity Resort Kadavu
		Panavally	Panavally
		Perumbalam	Perumbalam
		Pallippuram	Makkekadavu & Thavanakkadavu
		Aroor	Arukkutty
Kottayam	Vaikom	Chempu	Murinjapuzha
		Udayanapuram	Nerekadavu
		Vaikom Muncipality	Kolothum Kadavu

Source: Kerala Inland fisheries statistics, 2013

Majority of inland fish production is sold in domestic market and consumed locally. Following table shows district wise fishing villages & Fish production in the hinterland of NW 59.

TABLE 4-8: FISH PRODUCTION IN THE HINTERLAND OF NW 59

	Number of Fishing Villages		Annual Fish (MT) Fy 16	
District	**Marine**	**Inland**	**Marine**	**Inland**
Alappuzha	30	24	44,388	34,930
Kottayam	-	8	-	12,308
Ernakulam	21	15	80,394	38,951
Total	51	50	1,24,782	89,714

Source: Directorate of Fisheries, Kerala

Volume of Inland fishing in Alappuzha and Kottayam is 47,238 MT, which is slightly higher than marine production. None of the above listed landing centres for fish catch are situated on the identified stretch i.e. NW 59. Hence, fishing does not create any opportunity for waterway movement.

d. Mining

Kottayam & Ernakulam districts are rich in Graphite. Lime shell is also majorly found mineral in Kottayam. Deposits of Lime shells are exploited by cement & chemical industries for industrial purpose. Vembanad Lake is the major reserve of lime shell in the catchment area, but at present, extraction from the lake is banned as the lake is declared a wetland.

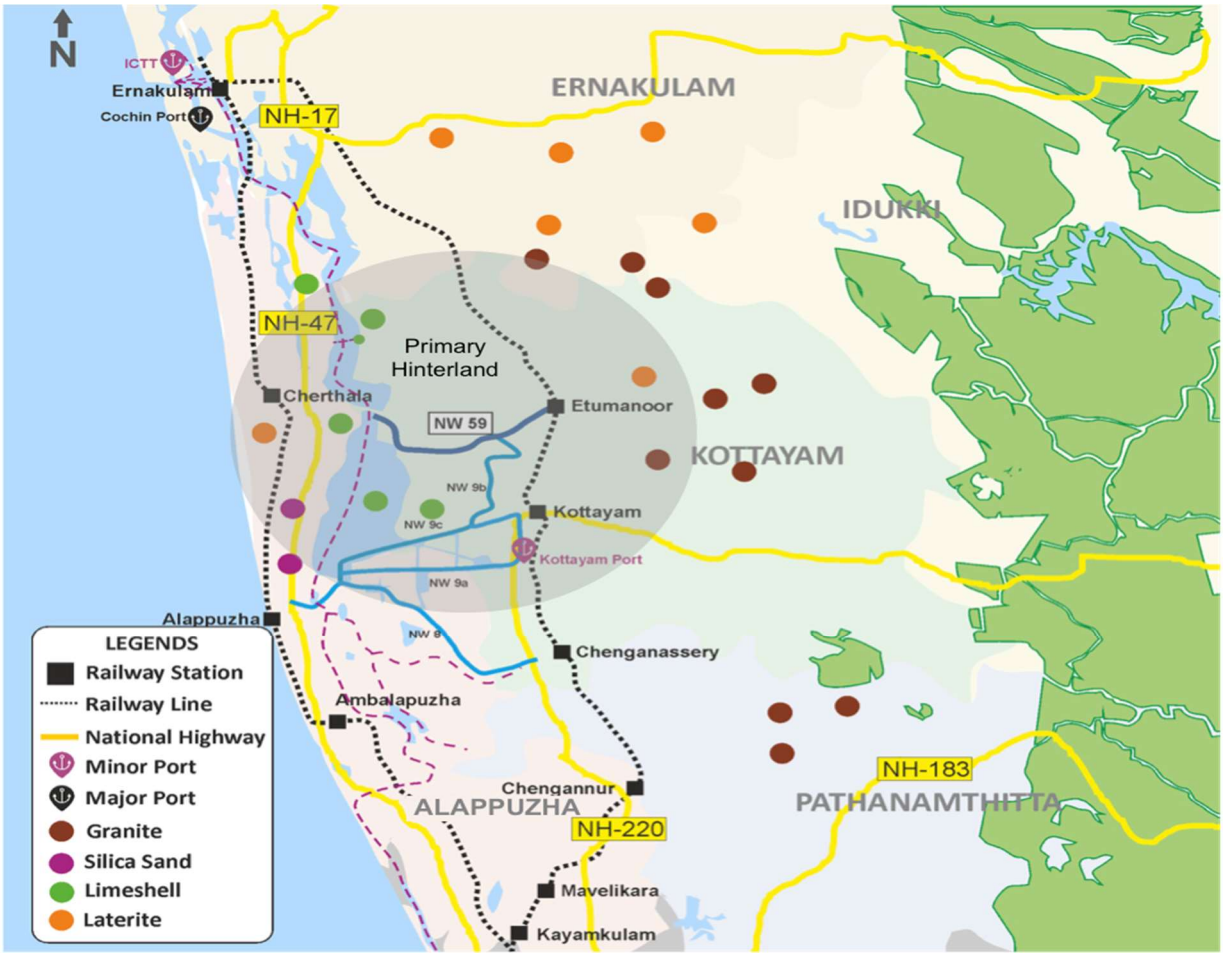


FIGURE 4-5 MINERALS RESERVES IN HINTERLAND OF NW 59

Below table shows the district wise minerals production in catchment area of NW 59.

TABLE 4-9: DISTRICT WISE MINERAL PRODUCTION IN THE CATCHMENT OF NW 59 (FY 16)

District	Type of Mineral	Production ('000 T)
Major Mineral		
Alappuzha	Granite Building Stone	2
Kottayam	Lime Shell	28
Ernakulam	Granite Building Stone	6,659
Total		**6,969**
Minor Mineral		
Alappuzha	Laterite	11
	Sand	266
	Silica Sand	66
Kottayam	Granite Building Stone	1,821
	Sand	5
	Ordinary Earth	1,347
	Laterite	19
	Brick Clay	60
Ernakulam	Laterite	393

District	Type of Mineral	Production ('000 T)
	Ordinary Sand	57
	River Sand	5
	Ordinary Earth	1,304
	Brick Clay	1
Total		**5,415**

Source: Department of Economics and Statistics, Kerala

4.2.2.2 SECONDARY SECTOR

There exist commercial crop and agro based industries in Kottayam district. Small and medium size industries are scattered in the district. Such industries are mainly processing rubber latex or products. The table below shows different types of industries and their contribution in GSDP.

TABLE 4-10: SECONDARY SECTOR CONTRIBUTION TO ECONOMY (FY 13)

(Cr.)

Sector	Alappuzha	Kottayam	Ernakulam
Manufacturing	1,020	758	5,539
Medium	456	339	2,474
Small	565	419	3,065
Construction	1,994	1,891	6,251
Other	450	481	650
Total	3,239	2,889	12,115

Source: Directorate of Economics and Statistics, Kerala

Alappuzha is the main industrial growth center compared to other 2 districts, namely Kottayam & Ernakulum. Industrial growth center Cherathala is less than 10 km away from the mouth of NW 59, but located on the other side of Vembanad Lake. This is the largest industrial park in Alappuzha district and got basic infrastructure facility and direct road connectivity with Cochin port. Seafood and coir industry is found in the coastal region and concentrated in Alappuzha district.

4.2.2.3 TERTIARY SECTOR

Tourism and other sectors like transportation, communication etc. come in the tertiary sector. Government of Kerala has projected that tourism sector will contribute 20% to GSDP in the next five years. At present, tourism contributes about 12% to GSDP. Kerala's backwaters are famous worldwide. Large number of foreign tourists visits Kerala, along with domestic tourists every year.

TABLE 4-11: TYPES OF INDUSTRIES IN TERTIARY SECTOR

(INR in Lacs)

Sr. No.	Industry Of Origin	Pathanamttitha	Alappuzha	Kottayam	Ernakulam
1	Transport, Storage & Communication	181,521	203,811	254,102	506,073
1.1	Railways	579	5,279	4,699	7,407
1.2	Transport by other means	82,434	87,618	99,802	206,977
1.3	Storage	105	1,158	2,002	1,476
1.4	Communication	98,402	109,755	147,599	290,214
2	Trade, Hotel & Restaurants	111,206	265,910	256,454	480,757
3	Banking & Insurance	98,658	119,527	136,257	249,919
4	Real estate ownership, Business, Legal	108,015	169,277	151,314	232,383
5	Public administration	36,982	56,683	61,525	90,076
6	Other Services	125,013	16,966	169,473	258,308
	Total Of Tertiary Sector	661,393	985,173	1,029,125	1,817,516

Source: Directorate of Economics and Statistics, Kerala

4.2.2.4 INFRASTRUCTURE ANALYSIS

Infrastructure is crucial in the development of a region. It is also essential to understand various types of existing and upcoming infrastructures around NW 59, as they would provide support and connectivity for waterway with other modes of transportation. It becomes backbone for any new development.

4.2.2.5 CONNECTIVITY ANALYSIS

Railway, roadway and airports around the waterway help in evacuation of cargo and passengers. It helps to determine best multimodal route for evacuation.

a. Roadways

Kottayam district is connected to other towns in the state of Kerala by a network of State & National Highways. NH 183 connects the district with Tamil Nadu in the East and Changanassery in the South, SH 42 connects Kottayam city with Vechoor and further with NH 66 at Cherthala in Alappuzha, SH 15 connects the district with Thrissur & Calicut/Kozhikode and SH 32 connects Kottayam with Pala.

Athirampuzha is not connected to a State or National Highway directly, but is connected by secondary roads to SH 1 at Ettumanoor.

b. Railways

The Southern Railway network of Indian Railways serves Alappuzha & Kottayam districts. NW 59 is in between and railway passes through both the sides. Both the railway lines nearly run parallel to each other. Eastern part of the canal is closer to railway station as compared to western part. Direct passenger rail connectivity is

available at Alappuzha and Kottayam, but direct rail accessibility is not available at Vechoor & Athirampuzha town. Thiruvananthapuram division of Southern Railways connects the catchment of NW 59. This division connects to Palakkad division at Thrissur, connecting the region to Mangalore and further towards North. The nearest railhead for Vechoor is at Cherthala (Alappuzha District) and for Athirampuzha is at Ettumanoor (Kottayam District). Ettumanoor, Kuruppumthara, Kumaranalloor & Kottayam are few more passenger railway stations, which are closer to NW 59. There is no major freight loading stations on the railway line. Only Kottayam railway station has a provision for goods shed. Chengannur, Kayamkulam, Mavelikkara railway stations are used for transporting goods to another place. These stations are en route of Alleppey- Ernakulam railway route; however they do not come under catchment area of NW 59, as they are located more than 40 km away from NW 59.

c. Airways

Cochin International Airport is located more than 72 km away from NW 59. There does not exist any operational airport within the catchment area of NW 59.

d. Waterway

In the backwaters of Kottayam, many ferry services for passenger movement are operational from/to Alappuzha. But none of the ferry terminal exists on the identified river stretch. At present, there is no waterway movement in NW 59.

4.2.2.6 EXISTING INFRASTRUCTURE

There exists only one bridge (Kumarakom- Cumbam road) that crosses over the NW 59. It is 5 km away from the mouth of NW 59. Following images show NW 59 and Bridge on Kumarakom – Cumbam Road.

Source: Site Visit

FIGURE 4-6: BRIDGE ON NW 59 – KUMARAKOM – CUMBAM ROAD

As shown in the above images, vertical clearance of the bridge is too less for movement of passenger boats. The passenger boats (as shown in the image) do not cross the bridge; they take passengers for 30-45 mins. tour towards Vembanad Lake and come back. This ferry movement is done within 5 km stretch from the mouth of NW 59 and this bridge.

4.2.2.7 UPCOMING INFRASTRUCTURE

Five sites are shortlisted in Kottayam and Pathanamthitta district for developing Greenfield International Airport at a project cost of INR 2,500 cr. These five locations are namely Kootickal, Cheruvally Estate, Laha Estate, Malayalapuzha- Kumbazha Estate and Kalleli. All these locations are at a distance of more than 50 km from the identified stretch of NW 59. Exact location for the same has not been decided yet.

At the beginning of Fy 17, State Government has started Solar ferry service, which runs between Vaikom to Tavanakkadavu (near Vembanad Lake). Ferry route distance is about 2.5 km, whereas roadway distance between the two locations is 27 km. Seating capacity of this new boat is 75. Total 22 ferries would ply on this route between 7 am to 7 pm. Additional 10 solar ferryboat proposal is in the pipeline of State Government.

4.2.3 Existing & Proposed Industries

4.2.3.1 EXISTING INDUSTRIES

Majority of industrial and commercial centres in Kerala are located in the coastal area. Alappuzha is the center of exporting coconut oil, spices, sugar etc. Roadways and inland waterway carry trade in the region. Railway is also being used for transportation of goods. Chengannur, Mavelikkara and Kayamkulam railway stations are the main stations from where goods are loaded and dispatched to other regions. Apart from these stations of Alappuzha, three Kottayam Railway stations are also used for unloading Fertilizer.

FIGURE 4-7: INDUSTRIES AROUND NW 59

Below listed are the existing industries, located in the catchment area of NW 59 and the potential they would provide to the proposed waterway in NW 59.

TABLE 4-12: INDUSTRIES OF KOTTAYAM DISTRICT

Sr. No.	Name	Location	Type	Distance from NW59 (km)	Distance from NW9 (km)	Capacity (T)	Potential	Reasoning
1	Travancore Cements	Nattakom	Cement	9	0	50,800	X	The company has its own jetty on NW 9. Raw material is imported by Cochin Port, using roadways. If waterway gets developed, then the company is ready to move its cargo via NW 9. It is located on NW 9, so it does not create any opportunity for NW 59.
2	Oil Palm India	Kodimatha	Oil	9	0	20 T/Hour	X	The company is not into EXIM trade; it distributes its finished products in domestic market only. At present, transportation is done by roadways, using lorries. Volume traded is too less to get diverted to the proposed waterway. The company is not willing to shift to waterways.
3	Midas Precured Tread	Kottayam	Rubber	5	1	NA	X	At present, the company is using Kottayam Port to export products. Cargo is moved to the port through roadways. The company does not create any opportunity for NW 59, as it is located nearer to NW 9.
4	Diamond Roller Flour mill	Pallom	Flour milling	14	2	66,000	X	The company is located on the bank of NW 9; it imports raw material, using Cochin Port and also procures from North India via rail/coastal shipping. Finished products are locally distributed in Kerala & Tamil Nadu. Export is also done by Cochin Port. Volume of cargo movement between Cochin Port & the industry for EXIM trade

Sr. No.	Name	Location	Type	Distance from NW59 (km)	Distance from NW9 (km)	Capacity (T)	Potential	Reasoning
								is too less to get diverted to the waterway. Hence, no opportunity for NW 59.
5	MRF	Kottayam	Tires, Tubes	9	4	NA	X	The company is using Kottayam port for EXIM trade. Roadways is used for cargo movement between Kottayam Port & ICTT. MRF is located nearer to NW 9. Hence, it does not create any opportunity for NW 59.
6	Perumacheril Casting	Kottayam	Machines	8	2	NA	X	Production volume of these companies is very less. Movement of small volume would not make waterway commercially viable; hence no opportunity exists from this company for cargo movement in NW 59.
7	Ceyenar Chemicals	Kottayam	Rubber	8	2	NA	X	Ceyenar Chemicals exports rubber to other countries, but volume is very low. For such low volume, shifting from roadways to waterways is not commercially viable.
8	Hi-tech Cast Iron Industries	Kottayam	Cast Iron	4	2	NA	X	Production of these companies is very less in volume. Movement of small volume would not make waterway commercially viable; hence no opportunity exists from these companies for cargo movement in NW 59.
9	TJP Rubber	Kottayam	Rubber	14	3	NA	X	
10	Sanson Chemical	Poovanthuruthu	Chemical	9	3	NA	X	
11	Rubberwood India	Manganam	Rubber	13	8	8250 Cu. M	X	

Sr. No.	Name	Location	Type	Distance from NW59 (km)	Distance from NW9 (km)	Capacity (T)	Potential	Reasoning
12	Kottayam Textiles	Vedagiri	Textile	3	12	25,000 spindle/day	X	Raw Material of this company is procured from other states and finished products are distributed in domestic market by using roadways & waterways. Production volume is too less to get diverted to the proposed waterway; hence, there is no opportunity for NW 59.
13	Canara Paper Mills	Changanacherry	Kraft paper	27	13	25,000	X	The company is in domestic trade only. It is located between NW 8 & NW 59; it does not create any opportunity for cargo movement in NW 59.
14	Integrated Power Loom Industrial Co-Op Society Ltd	Ayarkunnam	Powerloom	11	13	NA	X	Production of the company is very less in volume; hence no opportunity exists for cargo movement in NW 59.
15	Modern Rice Mill	Vechoor	Processed Rice	2	22	14,600 (approx.)	X	The company is located on the mouth of NW 59 near Vembanad Lake. Direct road connectivity to Cochin Port exists; hence NW 59 does not have potential for moving cargo of this company.
16	Cochin Cements	Mevelloor	Grey cement	26	40	NA	X	The company is located between Cochin Port & NW 59 and has got direct road connectivity to the port by roadways. Due to the location, diversion from the company is not possible.

TABLE 4-13: INDUSTRIES OF ALAPPUZHA DISTRICT

Sr. No.	Name	Location	Type	Distance from NW59 (km)	Distance from NW9 (km)	Capacity (T)	Potential	Reasoning
1	Kanti Floor Furnishers	Alappuzha	Coir	26	11	20 mn Sq. Ft	X	All the companies of Alappuzha are located on the other side of Vembanad lake. There is direct road rail & waterway connectivity to reach to Cochin Port or Kollam. NW 3 is directly connected from Kollam to Cochin Port; companies would use this route rather than NW 59. Industries of Alappuzha do not create any opportunity for cargo movement in the proposed waterway.
2	VKL Seasoning	Alappuzha	Food & Spices	29	13	NA	X	
3	Palm Fibre, Pathirappally	Pathirappally	Fibre	22	18			
4	BABU Coir Works	Alappuzha	Coir	22	18			
5	Detilish Rugs	Kalavoor	Mats and Rugs	19	21			
6	Petrogas	Alappuzha	Catalyst	-	19			
7	The Alleppey Company	Alappuzha	Coir products	13	24			

Source: Consultant's Analysis

Cherthala is the biggest industrial cluster in Alappuzha district. Industries located in Cherthala have got direct connectivity by national highway to Cochin port, in order to export finished goods or to import raw materials. These industries do not create any opportunity for NW 59 because all of them are situated on the other side of Vembanad Lake, while NW 59 is on the opposite side. If industries are ready to use waterways, then they will prefer the existing waterway NW 3, which is passing through Vembanad Lake from Kollam to Cochin Port.

Diversion from Industries

All the companies listed above would not create any opportunity for cargo movement on NW 59. Few companies, which are located in the catchment area, are closer to NW 9 than NW 59. These companies would prefer NW 9 for waterway movement because of the close proximity. Rest of the industries do not trade in large volume, which can be diverted from roadways to waterways. Waterway movement is viable for large volume trading. For the companies who trade in less volume, road transportation is better option than waterways. However, if in future these companies come up with volume to use IWT, then this can be diverted to NW 9. Hence cargo traffic opportunity for NW 59 is nil at present and in coming future as well.

Proposed NW 59 is not viable for handling cargo traffic, because the width of the river is too narrow for a vessel to pass by. Whole stretch of the river is surrounded by agricultural land. This is a major problem for vessel movement on NW 59.

4.2.4 Traffic from Major & Non Major Ports

There exists a major port, i.e. Cochin Port and a non-major port, i.e. Kottayam Port & Container Terminal in the catchment area of NW 59. Industries located within 25 km use Cochin Port for import/export of their raw material or finished goods. At present, preferred mode of transportation between industries and ports is roadways. Both, Cochin Port and Kottayam Port are further studied in detail in order to identify the potential commodities for NW 59 and its diversion from Roadway to waterway.

4.2.4.1 NON MAJOR PORTS

Kottayam Port comes under the catchment area of NW 59. Industries located nearby use these ports to trade internationally. Existing mode of transportation for the movement between these two ports is roadways only.

Kottayam Port & Container Terminal (KPACT)

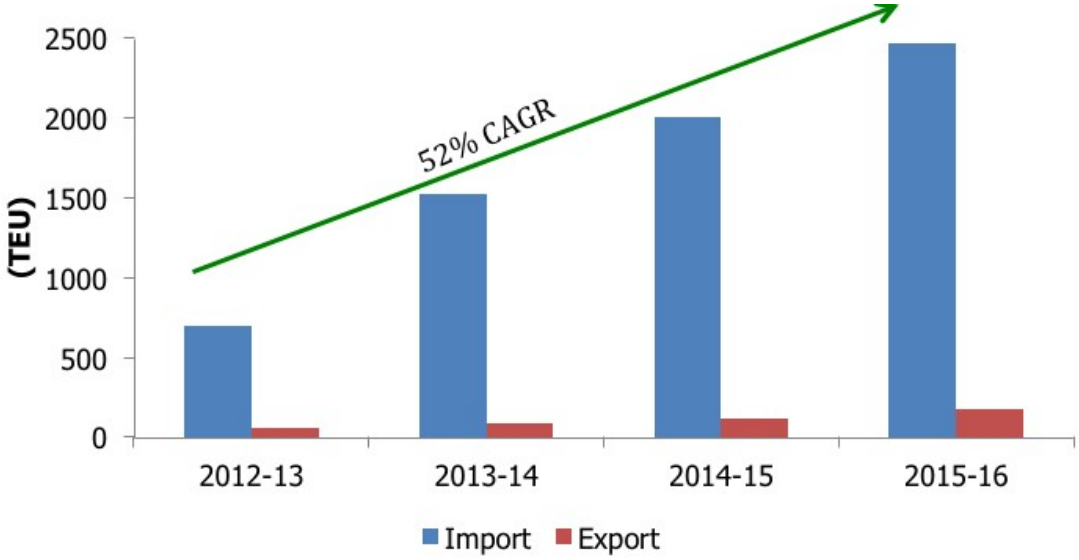
Kottayam Port is an Inland Container Terminal & minor Inland port located at Nattakom, Kottayam. This port is connected with Cochin Port by roadways & inland waterways. The primary objective of this port is to connect nearby industries with ICTT, Cochin. At present, containers from Kottayam port & hinterland are moved in trucks to ICTT by roadways.

Inland water transportation is not operational yet because of non-availability of cranes & re-stacker for Container handling. If Kottayam Port gets operational for handling barges with all required equipments, then this could create big opportunity for cargo movement using waterway route. Traffic, which is moving by roadways at present, would get diverted to the proposed waterway, to access the ICTT terminal at Vallarpadam. Malayala Manorama, MRF etc. are few users of Kottayam Port.

Expansion plans of the port are listed below

- The port has acquired additional 7 acres of land for 2nd phase expansion, which is adjacent to the existing facility.
- Commencement of empty container yard by MAERSK would help in storing empty containers at the yard, so that exporters could pick their nominated export containers. MAERSK has approved the port's proposal.

- Double Grinder Gantry crane would be installed. Shortage of loading equipment creates hindrance for starting barge movement on waterway; therefore 45 Tons capacity of cranes would be used for loading and unloading of containers from barges.
- Commencement of domestic cargo movement, as it is 10 times higher than EXIM cargo. Loading platform, hydra cranes, forklifts and covered cargo storage would be developed.
- Additional warehouse of 20,000 sq. ft. would be constructed. As existing warehouse of 40,000 sq. ft. is fully utilized and there is a need for additional storage on an urgent basis.



Source: KPACT

FIGURE 4-8: ANNUAL CONTAINER TRAFFIC HANDLED AT KOTTAYAM PORT

The above graph shows the historic traffic handled at Kottayam Port. In last 3 years, traffic has grown at CAGR of 52% and it is expected to grow more in future, when the port would start handling barges and proposed waterways become operational.

4.2.4.2 MAJOR PORTS

Cochin Port is the only Port, which comes under the catchment area of NW 59. The port is located at a distance of more than 25 km from the waterway; still detailed study is conducted for the port to find the potential cargo for waterway movement. Industries located around NW 59 are using Cochin port for EXIM trade.

a. Cochin Port

Cochin Port is the only Major Port in Kerala. It is an all-weather port, which handles all types of commodities, including POL & non-POL products. Total area of Port Trust is 2,133 Acres, which includes Willingdon Island, Vallarpadam, Puthuvypeen, Palluruthy, Fort Cochin, Bolgatty, Thevera Foreshore, Ernakulam and Pachalam. There are 7 berths namely 1. Cochin Oil Terminal (COT), 2.North Tanker Berth (NTB), 3.South Tanker Berth (STB), 4.South Coal Berth (SCB), 5.Boat Train Peir Berth (BTP), 6.Single Poing Mooring and 7.LNG Berth storing/handling the petroleum products.

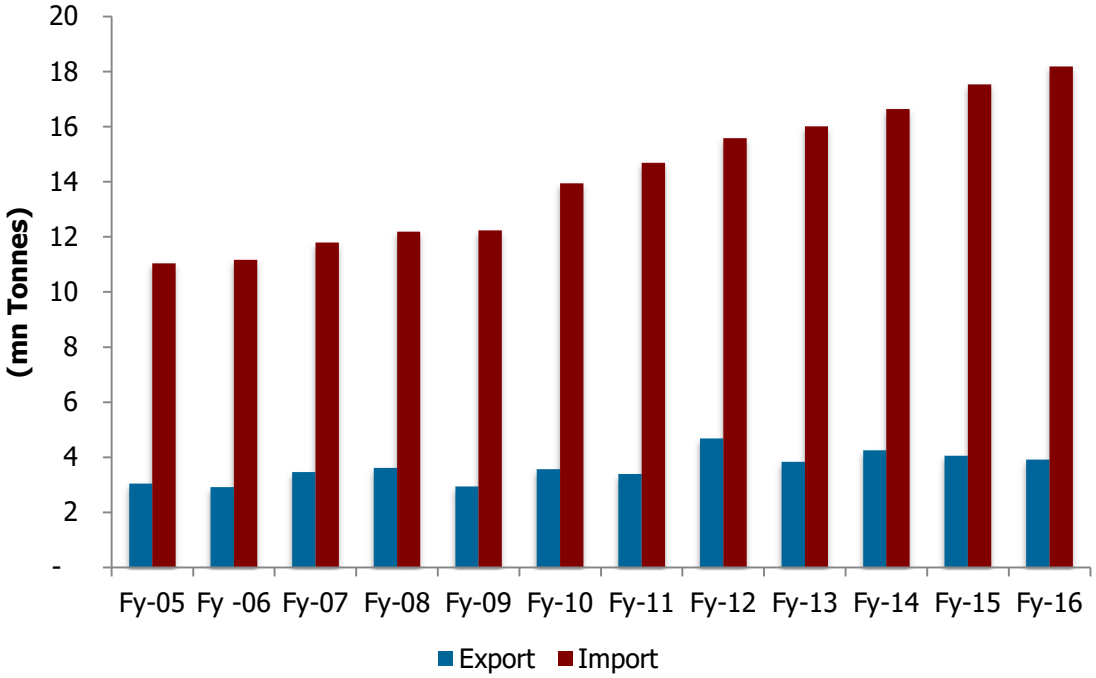


FIGURE 4-9: GROWTH TREND OF TRAFFIC HANDLED AT COCHIN PORT

The above graph shows the growth trend of traffic handled at Cochin Port in last 10 years, i.e. from Fy 05 to Fy 16. 22.10 MMTPA of cargo has been handled at Cochin Port in Fy 16, which is 2% higher than the previous year. Overall traffic has grown at a CAGR of 5% from Fy 05 to Fy 16. Following graph shows commodity wise export traffic handled at Cochin port in last ten years.

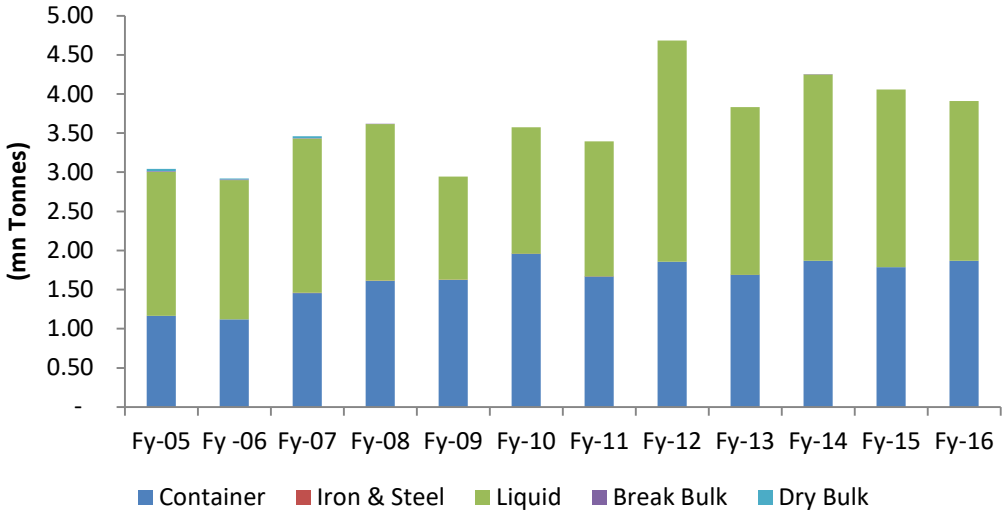


FIGURE 4-10: COMMODITIES EXPORTED FROM COCHIN PORT

At present, Cochin Port only handles import of POL & Containers. No other commodity is imported at this port. Other commodities like Dry Bulk & Iron & Steel had been handled at the port till Fy 07; however the volume of these commodities was negligible.

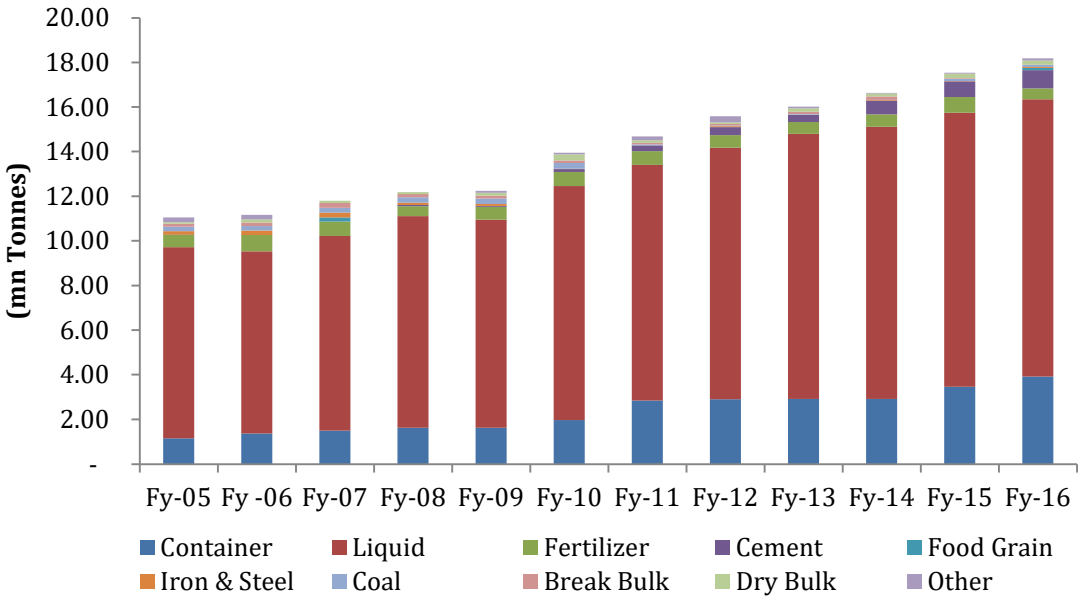


FIGURE 4-11: COMMODITIES IMPORTED AT COCHIN PORT

Container & other liquid cargo are the majorly handled commodities at Cochin Port. Fertilizer & Cement are also exported, but their volume is very low. In last 5 years, there has been steady growth in container trade, while there is increase in Cement exports.

The proposed waterway NW 59 is 50 km away from Cochin Port via the existing NH 66. The hinterland of NW 59 has got direct road connectivity to Cochin port. NH 47, NH 49 & other city roads connect industries located in the catchment area with Cochin Port. Transportation between industries & the port is done either directly or indirectly using Kottayam Port. The movement of cargo from Kottayam Port to Cochin Port takes place by roadways only.

- **ICTT Cochin Traffic**

ICTT – Inland container Transshipment Terminal also called, as Vallarpadam Terminal is a part of Cochin Port. Terminal is operated by DP world. An Inland container transshipment terminal is available at Cochin. The terminal currently handles approximately 4 lakh TEU's of traffic annually. Most of the traffic from Kerala is coming to the transshipment terminal using trucks. ICTT is located 54 kms away from the mouth of identified stretch by roadways. The Terminal has excellent road connectivity using NA 17 & NA 47. Once barging operation at Kottayam Port gets operational then this existing container movement by roads is expected to increase because of the improved road connectivity with Cochin Port via inland waterway.

Diversion from Major/Minor Port

EXIM cargoes handled at Kottayam Port are destined to/ originates from ICTT. These cargoes are moved by roadways to/from ICTT. At present, Water movement between Kottayam Port & ICTT is not operational. Width of the river on NW 59 is too narrow to accommodate even a small vessel, which restricts the vessel movement in NW 59. Whole stretch of NW 59 is surrounded by agricultural land; hence there is no scope of traffic generation even in future. As Kottayam Port itself is located on the bank of NW 9, industries coming to the port would directly move ahead using NW 9 and then NW 3.

4.3 Commodity Composition

4.3.1 Minerals

In the catchment area of NW 59, Travancore Cement Company is the only mineral based company. The company is located at Nottakom. Earlier the company used to extract lime shell from Vembanad Lake and transport to its plant by barges, using Alappuzha-Kottayam-Maniyaparambu Canal, i.e. NW 9. Vembanad Lake has got 2.5 mn Tones of reserves of lime shell, which is the highest amongst all the reserves of lime shell. But, since Vembanad Lake is declared a wetland, extraction is banned. Now the company imports its raw material from Cochin Port. So, diversion of minerals on NW 59 is not viable because now the company has stopped using lake's minerals. Other minerals are either found in very less volume or not extracted for industrial purpose.

4.3.2 Cement

Travancore Cement Ltd. (TCL) is the only major cement manufacturing company in the catchment area of NW 59. The company has its own jetty in Kadoor River & barging system, which is part of NW 9. The company imports raw material for cement production from Gulf Countries. Clinker/limestone are loaded in trucks and moved from Cochin Port to the unit by roadways. The company also exports grey & white cement using Cochin Port. Roadway is used for cargo movement between TCL & Cochin Port for import & export. Earlier the company used to extract lime shell from Vembanad Lake, but now extraction is banned. Lime shell is also one of the major raw materials in cement production. The company has excellent road connectivity with Cochin Port. At present, the company has stopped its production and most likely would resume production from June 2017. The company would not provide any opportunity for NW 59, as it is located closer to NW 9. Traffic diversion from this company is considered for NW 9.

4.3.3 Fertilizer

The following table describes fertilizer consumption in two districts, Alappuzha & Kottayam, which fall in the catchment area of NW 59. Agricultural field surrounds the maximum area of the identified stretch, where there is requirement for fertilizer. However, there is no fertilizer manufacturing plant in the defined catchment area.

TABLE 4-14: FERTILIZER CONSUMPTION IN ALAPPUZHA & KOTTAYAM

District	Fertilizer Consumption					
	Urea	SSP	MOP	NPK	DAP	City Compost
Alappuzha	-	-	753	5,060	-	8
Kottayam	38,119	174	22,407	16,422	11,483	102
Total	38,119	174	23,160	21,482	11,483	110

Source: Fertilizer Monitoring System, Govt. of India

Fertilizer imported at Cochin port is not directly transported to the hinterland of NW 59. Small co-operative societies are made, where this imported fertilizer is stored and agricultural labours visit to these places & purchase the required quantity. Apart from these societies, fertilizers are procured from neighboring state i.e. Tamil Nadu through Railways, to meet the demand of fertilizers in Alappuzha & Kottayam. Rakes

originating from VOC Port & Salem are destined to Kottayam railway station loaded with MOP and imported fertilizers respectively. Consigner & Consignee of IMOP is Indian Potash Limited & IMFT (imported fertilizer) is Southern Petrochemicals Industrial Corporation Limited.

The fertilizer movement cannot be diverted to the proposed waterway because the fertilizer arriving at Kottayam is consumed locally. There does not exist any requirement for waterway movement. Also, volume is too less because fertilizer consumed here is not for industrial purpose, it is used by the local agricultural labours. Hence, no potential exists for fertilizer movement in NW 59.

4.3.4 Fisheries

There are total 3 landing points in Kottayam district. Below table shows the name of inland fishing points in Kottayam. All the landing points are located far away from NW 59.

TABLE 4-15 INLAND FISH LANDING CENTRES IN THE CATCHMENT AREA OF NW 59

Sr. No	District	Taluka	Panchayat	Landing Points
1	Kottayam	Vaikom	Chempu	Murinjapuzha
2			Udayanapuram	Nerekadavu
3			Vaikom Municipality	Kolothum Kadavu

Source: Kerala Inland Fishery Statistics, Govt. of Kerala

Following table shows the inland fish production in the three districts, which come under the catchment area of NW 59. It can be seen from the table that fish production in Kottayam is least amongst other districts. This district contributed 5% in the overall production of Inland fishing in Kerala.

TABLE 4-16 INLAND FISH PRODUCTION IN HINTERLAND OF NW 59

District	Fy 14	Fy 15	Fy 16
Alappuzha	32,216	31,081	34,930
Kottayam	9,166	11,345	12,308
Ernakulam	70,158	37,674	38,951
Total Kerala	**204,706**	**201,545**	**210,762**

Source: Govt. of Kerala, Department of Fisheries

At present there is no landing point in NW 59 and fish production is nil. Hence, fish would not provide any opportunity for the proposed waterway.

4.3.5 Rubber & Products

Rubber is an important agricultural plantation in Kerala. It is mainly raised under smallholding and involves huge number of farmers. Due to the economic importance, farmers are more attracted towards this cash crop and rubber production is growing continuously in the state. Kottayam district has highest production of rubber in the catchment area of NW 59. The table below shows area under rubber production in the districts, which fall in the catchment area of NW 59.

TABLE 4-17 DISTRICT WISE AREA UNDER RUBBER PLANTATION

District	Area (Ha.)					
	Fy 71	Fy 81	Fy 91	Fy 01	Fy 11	Fy 14
Alappuzha	3,584	4,273	2,901	3,801	4,380	4,480
Kottayam	55,444	66,926	107,937	111,301	113,730	114,260
Ernakulam	26,459	23,334	51,163	56,644	59,030	59,740
Total Kerala	**179,259**	**244,112**	**410,471**	**474,469**	**534,230**	**548,226**

Source: Data from Planning Board

The table below shows production of rubber in the catchment area of NW 59 since FY 71. Rubber production in Alappuzha, Kottayam & Ernakulam districts have witnessed growth. It can also be seen in the below table that 21% of total production is concentrated in Kottayam alone, followed by Ernakulam, which is 11%. Alappuzha is the district that contributes least amongst all districts in rubber production of Kerala, which is less than 1%.

TABLE 4-18 DISTRICT WISE PRODUCTION OF RUBBER

District	Production (MT)					
	Fy 71	Fy 81	Fy 91	Fy 01	Fy 11	Fy 14
Alappuzha	1,713	2,771	240	4,003	6,740	64,065
Kottayam	26,907	36,145	82,852	140,766	172,200	136,540
Ernakulam	11,907	13,929	37,586	73,557	91,700	74,445
Total Kerala	**88,128**	**140,333**	**307,521**	**579,866**	**770,580**	**648,220**

Source: Data from Planning Board

Midas Precured Tread & MRF are the two major industries located in Kottayam district, which produce Rubber products like tires, tubes, procured threads etc. There are other industries like Ceyenar Chemicals, Rubberwood India, TJP Rubber, St. Marys Rubbers Pvt. Ltd. etc., which are also involved in manufacturing of rubber products. Few of the above listed companies are also in internal trading. Rubber & products could be moved via inland waterways, as most of the rubber industries use Cochin Port. But this could be diverted to NW 9, not NW 59. As most of the industries use Kottayam Port for trade to Cochin Port & Kottayam Port itself is located on NW 9. There does not exist any potential for movement of rubber products in the proposed waterway on NW 59.

4.3.6 Agro Products

There is gradual growth in Kottayam's Agro based industries. The district produces sufficient spice, meat, milk, paddy etc. Production of these commodities is locally consumed. Kottayam does not trade these commodities outside the district. Even though there is growth in Agro based industries, it does not create any scope for cargo movement in NW 59. If in future, the district trades Agro commodities in large volume to other districts and states, then there would be some potential to divert this cargo from roadways to waterways. But at present, agriculture and agro based industries do not provide any opportunity for NW 59.

4.3.7 Other Bulk & Break Bulk Commodities

In the primary and secondary catchment area of NW 59, there does not exist any iron & steel or thermal power plant. Thereby there exist no scope for waterway movement of other bulk commodities like coal, coke or break bulk commodities like steel etc.

4.4 Originating & Terminating commodities

The below table shows commodities handled at ports in the hinterland, which could be potential market for the proposed waterway in NW 59. The table also presents reasoning for targeting these commodities and potential they would provide for the waterway.

TABLE 4-19: OPPORTUNITIES FOR NW 59 FROM COMMODITIES HANDLED AT PORTS

Cargo	Volume	Potential for Proposed terminal	Reasoning
Container	2,643 TEU	X	No container-based industries exist in the hinterland of NW 59.
Liquid Cargo	NA	X	Liquid cargo is transported between Cochin Port & nearby located plants/industries. 60% of this movement is done through pipeline and rest by road/rails. Hence, Liquid cargo would not provide potential for inland waterway movement.
Fertilizer	NA	X	Fertilizers handled in Cochin Port are not transported directly to the hinterland of NW 59 in large volume. Agricultural labours, who use fertilizer for agriculture, visit co-operative society and purchase fertilizer as per their requirement. Moving such small volume to waterways is not commercially viable.
Cement	20,000 T	X	Only one major cement company exists in the hinterland of NW 59, i.e. TCL. Transportation between TCL & Cochin Port is done in trucks by roadways. If waterway gets developed, then this company is ready to shift to waterways on NW 9, as NW 9 is closer. NW 59's narrow width is a major hindrance for any kind of cargo movement on it. Hence, cement does not create any opportunity for cargo movement in NW 59.
Raw Material for Cement	NA	X	Cochin Port imports raw material like Clinker or limestone from Gulf countries. Clinker is loaded in trucks

Cargo	Volume	Potential for Proposed terminal	Reasoning
			and moved from Cochin Port to Kottayam Port by roadways. TCL is the user of this raw material, but it is located nearer to NW 9 and would prefer NW 9 for transportation. Hence this commodity does not create any opportunity for cargo movement on NW 59.

Source: Consultant's Analysis, based on interaction with prospective stakeholders (Kottayam Port & Container Terminal and Travancore Cement Ltd)

4.5 Passenger Traffic

At present, passenger ferry services are operational in both Alappuzha & Kottayam districts. Passenger services are operated by State Water Transport Department, Government of Kerala. The water transport department has total 14 stations under its control, out of which 8 falls under Alappuzha district & 2 fall under Kottayam District. However, out of these 11 stations, not a single station exists in the catchment of NW 59. NW 59 does not have any passenger movement on it.

4.6 Tourism Traffic

Apart from cargo movement, inland waterways also provide opportunity for the development of tourism. Tourism traffic would increase remarkably, if inland water transport & tourism infrastructure were developed together. Tourism section includes only tourist places of Kottayam as they come in the catchment area of NW 59. Tourist spots of Alappuzha & Ernakulam are located far from NW 59. Only Kottayam district would be considered for tourism potential for NW 59. The table below presents a list of tourist spots, located in and around NW 59.

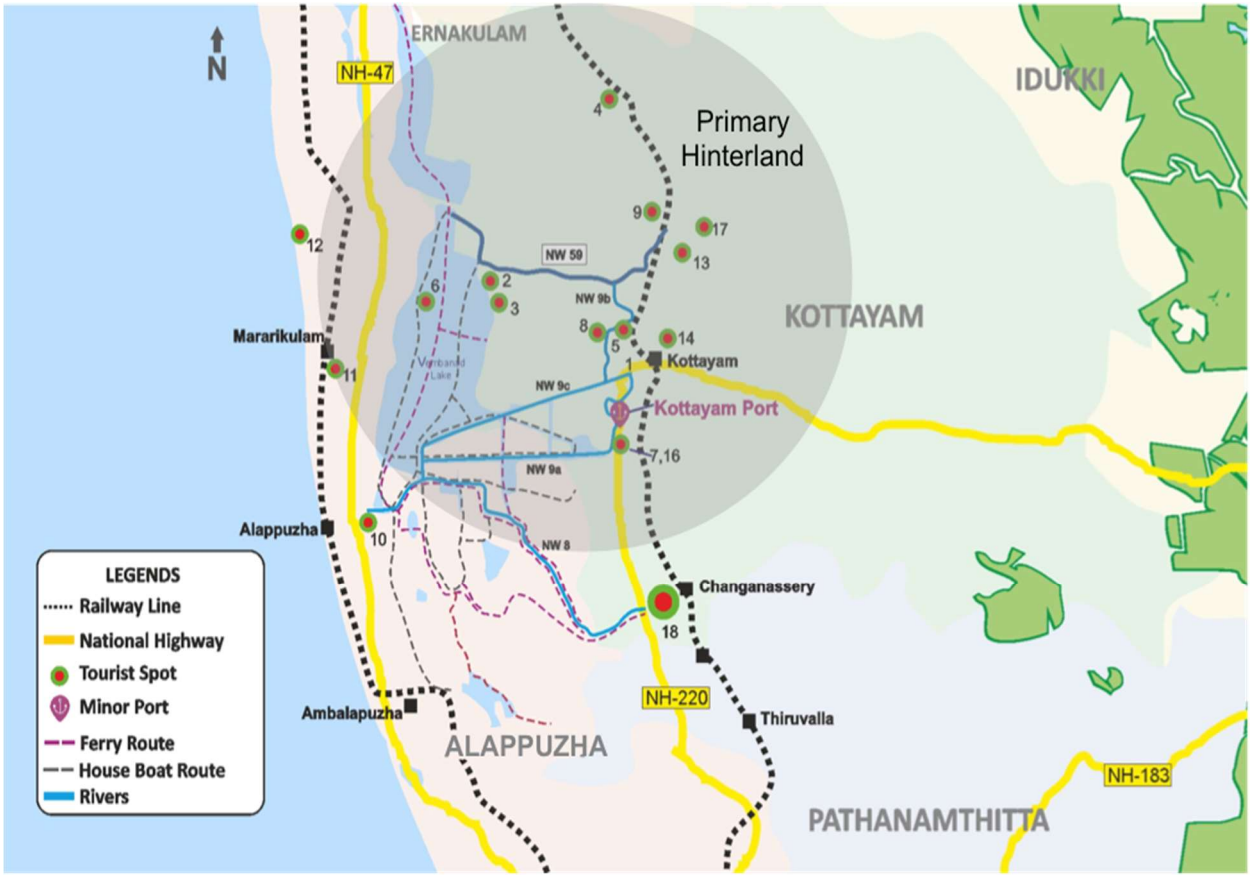


FIGURE 4-12: TOURIST SPOTS AROUND NW 59

TABLE 4-20: TOURIST PLACES IN THE CATCHMENT AREA OF NW 59

Sr. No.	Tourist Place	Distance from NW 59 (km)
1	Thirunakkara Mahadev Temple	6
2	Kumarakom Bird Sanctuary	1
3	Bay Island Driftwood Museum	2
4	Malliyoor Sri Maha Ganapathi Temple	9
5	Thazhathangady Juma Masjid	5
6	Island of Pathiramanal	4
7	Pallippurathu Kavu temple	7
8	Mozart Art Gallery	4
9	St Mary's Forane Church	8
10	Mullakkal Vishnu Temple	18
11	International Coir Museum	13
12	St. Andrews Basilica	12
14	Municipal Jubilee park	6
15	Mullackal Rajarajeshwari temple	19

There are several tourist spots in Kottayam, which come under the catchment area of NW 59. Most of the spots are located closer to NW 9; hence these tourist spots would not provide any opportunity for NW 59. Some tourist places are discussed below which are located closer to the proposed waterway in NW 59.

4.6.1 Kumarakom Village

Kumarakom Village is a famous tourist spot, which attracts international tourists. It is located 16 km from Kottayam city and is a part of Kuttanad region. Located on the bank of Vembanad Lake, it is famous for beautiful mangrove forest. People who want to explore other places around Kottayam, also visit this place. Visitors can reach Kumarakom by using roadway or waterways. This backwater destination contains best heritage homes, many meditation & Ayurveda centres.

Small boating facilities are available in NW 59 stretch, which are located next to Kumarakom- Cumbam Road Bridge. Wooden motorized boats ply between this bridge and Vembanand Lake, i.e. mouth of NW 59. This boat tour takes about 30-45 mins. The figure below shows boat ride in NW 59. Such types of wooden motorized boats have seating arrangement of 8-10 people. Tariff for each passenger is INR 50 for single ride, i.e. starting from the location near bridge sailing till mouth of the canal and coming back to the start point.

Source: Site Visit

FIGURE 4-13: PASSENGER BOAT PLYING ON NW 59 (BRIDGE - VEMBANAD LAKE)

In Kumarakom Backwaters, many houseboats and boating facilities are available but in the identified stretch of NW 59, only above shown small ferry service for passengers is available on west side of the bridge. No other facilities were seen during site visit on either side of the bridge.

4.6.2 Kumarakom Bird Sanctuary

Kumarakom Bird Sanctuary is located on Vembanad Lake. It is one of the favorite places for migratory birds. The sanctuary is spread across 14 acres of land. Major attraction of the sanctuary is Siberian Stork, Egret, Darter, heron and teal. The best time to watch birds is between June and August. To watch Migratory birds, November to February is the best time. The Sanctuary can be reached through waterways Kollam- Kottapuram, being major water route to reach. It is 13 km away from the nearest railway station, i.e. Kottayam. Admission fee per person in the sanctuary is INR 50.

4.6.3 Bay Island Driftwood Museum

Located in the village of Kumarakom, it has a huge collection of root and driftwood sculptures, prepared in an artistic way, in a modern art form. Proprietor and curator Raji Punnoose holds nation record certified by Limca book of record and India book of record, for certifying the only museum to showcase this kind of objects. The Museum attracts tourists who seek knowledge and information about this type of art. There is no entry fee to visit this museum.

4.6.4 Island of Pathiramanal

The island of Pathiramanal is located in the middle of Vembanad Lake on the backwaters of Alappuzha district. It is spread over 20 acres of land. The entire island can be covered on foot in a day. The island offers a great view for watching birds. The island is only accessible by boat and it takes around 1½ hour by a motorboat and 30 minutes by a speedboat from Alappuzha to reach the island.

4.6.5 St. Mary's Forane Church

St. Mary Forane Church in Alappuzha is one of the oldest churches in India and was built in 1870. It is a famous Marian Pilgrim Center, located in Cherthala in Alappuzha district. It is situated on the bank of the backwaters, about 11 kilometers from Alappuzha. It is famous for its beautiful murals and sculptures. It has 14 churches under its forane Administration.

4.6.6 Vembanad Lake

Vembanad is the longest lake in the country and also the largest lake in Kerala. It covers an area of 2,003 Sq. Km, has length of 96.5 km., width of 14 km. and depth of 39 ft. The nearest Railway station is Kottayam station, which is about 13 km away. Nearest airport is Cochin International Airport, which is 63 km away. The lake is also home to various migratory birds, which attracts large number of tourists.

The table below shows tourist arrival in Kottayam district. The table also shows historic tourist traffic at Kumarakom, which is located in Kottayam and would provide potential for NW 59.

TABLE 4-21: TOURIST ARRIVAL IN THE CATCHMENT AREA OF NW 59

Year	Fy 10	Fy 11	Fy 12	Fy 13	Fy 14	Fy 15
International						
Kottayam	32,561	37,537	40,926	40,932	44,366	49,976
Kumarakom	NA	NA	NA	34,387	34,961	43,363

Year	Fy 10	Fy 11	Fy 12	Fy 13	Fy 14	Fy 15
Domestic						
Kottayam	301,599	334,747	354,270	382,197	413,182	458,101
Kumarakom	NA	NA	NA	313,470	358,886	375,643
Total						
Kottayam	334,160	372,284	395,196	423,129	457,548	508,077
Kumarakom	NA	NA	NA	347,857	393,847	419,006

Source: Kerala Tourism Statistics, 2014 (Govt. of Kerala)

International & Domestic tourists' arrival in Kottayam district and also Kumarakom is shown in the above table. It can be seen that there is steady increase in tourist arrival. International tourist traffic in Fy 15 has increased by 11% and Domestic tourist traffic has increased by 10% in Kottayam district as compared to previous year Fy 14. Kumarakom, which is a famous tourist place in Kottayam, contributes more than 82% of the total tourist traffic in Kottayam district. Compared to Fy 14, international tourist traffic in Kumarakom has increased by 19% and Domestic traffic has increased by 4% in Fy 15 in Kumarakom.

There exist few tourist places near NW 59; which are discussed above. None of the places would provide opportunity for tourism, as NW 59 is surrounded by paddy fields and local market. The location of the identified stretch does not attract tourists. Also, more than 80% of famous places are located closer to NW 9 & NW 8 than NW 59. Hence, NW 59 does not have any potential for tourism.

4.7 Growth Trend

4.7.1 Passenger Growth for NW 59

At present, no passenger movement is found on NW 59. Open fields & agricultural land surround both sides of the waterway. Two city roads, few internal roads & some bridges are already there on waterway for crossing the canal. There are internal roads that move parallel to the stretch, along the canal. At present, there is no requirement for additional development for passenger movement. Hence, opportunity for passenger movement in the proposed waterway NW 59 does not exist.

4.7.2 Tourism Growth for NW 59

Backwater tourism is the major attraction for tourists in Kottayam. There exists a group of islands on Vembanad Lake. Facilities like houseboats and ferry rides are already developed in the region. Kumarakom contributes more than 82% in total tourist arrival in Kottayam and it is the only famous tourist place around NW 59, apart from few small temples.

Apart from Kumarakom Backwaters, there are lot many spots in southern region of NW 59, but all of them are closer to NW 9. Southern & western region of the identified stretch is already well developed for tourism. Every year this region attracts huge number of tourist arrivals. NW 59 shares the hinterland with NW 8 and NW 9; hence ferry Routes & House boats, which are operational at NW 8 & NW 9, would also be considered for NW 59. Developing tourism related facilities in NW 59 is not

advisable, because Paddy fields cover 80% of the river stretch and rest is covered by residential area. Tourism segment would not provide potential for NW 59.

4.7.3 Cargo Growth for NW 59

All the industries in the catchment area of NW 59 are closer to NW 9 particularly 9A (within 8 kms) so if these industries use waterways, they would prefer NW 9A not NW 59 (within 30kms). Hence, cargo movement in NW 59 is not commercially viable.

4.7.4 Comparison of FSR & DPR study

The below table shows identified commodities and potential they would provide for NW 59. Few commodities like Food Grains, Horticulture, Fertilizers, and Cements etc. were considered as potential cargo for NW 59 in feasibility study; however at DPR stage it is found that these commodities would not provide opportunity for the proposed waterway. The table below shows the commodities, which would provide opportunity for the proposed waterway and commodities, which would not provide any opportunity. The table also presents suitable reasoning for potential commodities.

TABLE 4-22 ANALYSIS OF FSR STUDY

Commodity	Source	DPR Consideration	Reasoning
Containers	Kottayam Port	X	No container based industries exist in the catchment area of NW 59.
Rubber & Products	Industries	X	There exist 2 major rubber producing industries, operating in the catchment area. These two industries are the main users of Kottayam Port, but both the industries use Kottayam Port. As Kottayam Port is located on NW 9, it would not generate any cargo traffic for NW 59.
Food Grains & Horticulture	Local Production	X	Food grains & horticulture are produced in very small volume, which is consumed locally; hence there exist no potential for NW 59.
Fertilizer	Local Consumption	X	Fertilizer is basically used for agriculture in the hinterland and not for industrial purpose. Consumption of Fertilizer is less and this less volume could not be shifted to the waterway. Also, all the consuming centers of fertilizers have direct road connectivity with Kottayam Railway station, which is used to procure fertilizer from other states. Hence, diversion of this commodity from road/rail to the proposed waterway is not viable.
Cement & its raw material	Travancore Cements Ltd.	X	TCL is the only major cement company in the hinterland of NW 59. But it is located on NW 9. Diversion from roadways to waterways exists for NW 9, not for NW 59. Hence, no opportunity exists for cargo movement.

Commodity	Source	DPR Consideration	Reasoning
Tourism	Domestic	X	No potential exists for NW 59 in tourism segment. There already exist passenger ferry & house Boat facilities in the hinterland of NW 59. Apart from water movement, a cluster of tourist spots is located around NW 9c & Kumarakom, i.e. Bank of Vembanad lake. These tourist spots would provide opportunity for NW 9 not NW 59.

Source: Consultant's Analysis

4.8 Forecasting & Potential IWT Assumption

As can be seen in the below figure, agricultural land and few villages surround the whole stretch of NW 59. Existing roads and bridges facilitate easy transportation for across and along the river movement. Narrow width of the canal restricts the waterway movement for any type of traffic. Though in future, passenger, tourism and cargo traffic would get generated, but movement on this canal would not be possible because of its less breadth. Hence, it is recommended to IWAI not to develop NW 59 for handling any kind of traffic, as it does not hold any potential for waterway movement.

FIGURE 4-14 NW 59 STRETCH AND THE SURROUNDING AREA

4.9 Terminal wise IWT Traffic analysis

Development of terminal on NW 59 is not viable because there exists no opportunity for cargo, passenger and tourism movement on waterway. In future, if any new industries come up within the hinterland of NW 59 and potential for waterway transportation through them exists, then this trade can be diverted to NW59.

Annexure

Abbreviation	Full Form
NW	National Waterway
IWT	Inland Water Transport
IWAI	Inland Waterways Authority of India
KM	Kilometer
FACT	Fertilizer & Chemical Travancore Ltd
WCC	West Coast Canal
ha.	Hectare
MT	Metric Ton
GSDP	Gross State Domestic Product
SH	State Highway
NH	National Highway
Cr.	Crore
ICTT	International Container Transshipment Terminal, Kochi
KPACT	Kottayam Port and Container Terminal
EXIM	Export Import
sq. ft	Square Feet
CAGR	Compound Annual Growth Rate
MMTPA	Million Metric Tons per annum
TCL	Travancore Cements Ltd
VOC	V.O. Chidambaranar Port Trust

CHAPTER 5 TERMINALS

5.1 General Review

Terminals act as a connecting center for shift of cargo and passengers from one mode to other mode. Inland Waterway Terminal (IWT) is a hub centre with a facility of connecting transport mode from / to the vessels on the water body to land provisioned with all the related infrastructure facilities like structure for berthing of vessels; facilities for loading / unloading of cargo; embarkation / disembarkation of passengers; storing / resting of cargo / passengers; connectivity to other modes of transport etc.

5.2 Identification and Site Location

Planning of the Inland Water Terminal location predominantly depends on the Traffic Origination and Traffic Destination criteria, which gives impetus to movement of traffic in inland waterways. Subsequent to the above, the site location in the vicinity can be considered duly taking into consideration of various influencing parameters, as below. In most of the cases the site location may not fulfil the idealistic scenario. However, the possibility of zeroing to a most suitable site may be possible based on certain basic parameters, as detailed.

Backup Land availability / Stability of Bank / Water Depth availability in Lean season / Velocity & Discharge both in Lean season and Flood season / Approach Road / Possibility of Rail connectivity / Nearness to City or Town / Availability of essential services / Impact of Social, Ecological & Environmental aspects etc.

The Vechoor-Athirampuzha Canal (NW-59) is greatly depended for discharging water from the paddy polders to the Pallathuruthy River with Agricultural plots on either side of the canal. Vechoor is bordered by Vembanad Lake on the west and Kaipuzha River on south. Thanneermukkom Bund starts from Vechoor.

Eastern part of vechoor includes rice fields. There are many natural and manmade canals in Vechoor which were used for water transport and irrigation. Swamikkallu boat jetty on western coast of Vechoor used to have regular services connecting Ernakulam, Vaikom, Thanneermukkom, Mannanam and Kottayam and on the other hand Athirampuzha is a small town in Kottayam district of Kerala state, India. It is situated 10 km north of Kottayam town.

In the morphological rivers, due to seasonal precipitation there are fluctuations in river flow and the rapid changes in water flow causes shift in the location of the deep channel and also results in erosion of banks and siltation. Accordingly, the basic requirement of an inland terminal is to ensure a permanent access to the navigational channel throughout the year. Keeping in view the above all, the terminal site location has been considered at Athirampuzha on NW-59.

The River in the study stretch is well connected with both Rail & Road network. Local roads run parallel to the stretch. Kumarakom – Cumbam Road Bridge crosses river at the 5kms from the mouth. The nearest railway station is Ettumanoor station and is just 3 kms away from Athirampuzha.

Important industries within 50 km are Midas Precured Tread, TCL, MRF, Cochin Cements & other small rubber-manufacturing units, lies within the hinterland.

Taking into the consideration the origin and destination and fairway, the most probable location has been considered at approx. Lat 09°40'0.81" N and Long 76°31' 53.57" E, at approx. Ch. 18.7 km.

The traffic volumes, as identified at NW-59 (Vechoor – Athirampuzha) Canal is nil. An attempt is being made, keeping in view the anticipated Ro-Ro mobility, in future for Terminal and inter-alia Development with 1 Roll-on Roll-off (Ro-Ro) Berthing facility, which may be a type of Thereotical exercise with Academic interest. The development of this stretch and Terminal development are not suggested / recommended.

A tentative Land requirement has been worked out before undertaking the Land Survey etc., duly considering the following requirements for the proposed Ro-Ro operation as shown in **Table 5.1.**

Table 5-1-**Terminal Land Area Requirement for Vechoor-Athirampuzha Ro-Ro Terminal**

S.No.	Facility	Nos.	Size	Area (m2)
1	Open Mobility Area	1	-	2500
2	Parking for Handling equipments	1	-	2000
3	Main Parking Area	1	-	500
4	Public Utility	1	6m x 4m	24
5	Weigh bridge	1	8m x 3m	24
6	Utility Room (Near Weigh Bridge)	1	3m X3m	9
7	Area under internal Roads	1	7m x 100m	700
8	Bank Protection			
9	Administration building	1	12 m x 15 m	180
10	Business Area	1	10m x 3m	30
11	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
12	Staff Parking Area-2 wheelers	1	8m x 2m	16
13	Security shed for watch and ward	2	4m x 4m	32
14	Electrical facility	1	5m x 5m	25
15	Fuel Bunkers	1	10m x 5m	50
16	Water Supply Room	1	3m x 4m	12
17	Fire and Safety Room	1	3m x 4m	12
18	DGPS receiver & transmitter shed	1	8m x 4m	32
19	DG shed	1	5m x 5m	25

Table 5-1-**Terminal Land Area Requirement for Vechoor-Athirampuzha Ro-Ro Terminal**

S.No.	Facility	Nos.	Size	Area (m2)
20	Canteen with Store	1	12m x 8m	96
21	Sewerage Treatment Plant (STP)	1	15m x 15m	225
22	Overhead Tank	1	10m dia	100
23	Green Area	1	-	750
24	Future Requirement	1	-	1000
				8423 m2

5.3 Terminal Layout / Master Planning including phases of development

The Terminal layout of the identified site based on the site land survey data available has been prepared. Refer Volume-II Drawing No. P.010631-W-20351-X03. With regard to the Land, there is no need of consideration of any phased development, since the ground development shall be taken up at initial phase itself.

Accordingly, a layout plan demarcating the infrastructure requirement is developed Refer Volume-II Drawing No. **P.010631-W-20301-A03** for details.

5.4 Land Details

The Land area identified is at Location as below:

TABLE 5-2: TERMINAL LAND DETAILS

Coordinates (UTM) N/E	**1068960.42**	**668037.84**
Coordinates (DMS) N/E	09°40'0.81" **N**	76°31'53.57"**E**
Village	Athirampuzha	
Taluka	Kottayam	
District	Kottayam	
State	Kerala	
Nearest Town	Kottayam	
Distance of town (km)	10	
Land use	Kuttanad Area	
Ownership	Govt. Land / Patta Land	
Water Distance	50m	
Nearest Road	Athirampusha medical college road	
Road Distance (m)	200	
Nearest Railhead	Ettumanoor station	
Railhead Distance	3 km	
Nearby major Structure	Athirampuzha Market Jetty	

Terrain	Water logged land
Soil/Subsurface strata	Blackish Medium Dense to Dense Clayey Silty Sand
Surveyed Area (Approx.)	8500 (m2)

5.5 Geotechnical Investigations

Geotechnical investigation has been carried out at the proposed terminal location to find out the subsoil stratification in the project area and to collect data for deciding type of foundation and the design foundation. The scope of geotechnical investigation work consists of one bore hole at terminal estimated up to a depth of 3.0m in bedrock. Borehole has been terminated at a depth of 19.0m below EGL.

5.5.1 Regional Geology

The geology of Kerala is a part of the south Indian Precambrian terrain, which is composed of granulites, gneisses, granites and greenstones. The granulites and associated gneisses belong to the Precambrian in Kerala state. The younger Meso-Cenozoic dykes and pegmatites are found to intrude late Precambrian rocks. The tertiary sedimentary formations belong to Neogene period only (Soman, 2002). The geology map of Kerala state is shown as Figure 5.1.

The Charnockites and charnockitic gneisses are the oldest rock complex units of Kerala state. Charnockitic gneisses, gneisses and the pyroxene-bearing granulites occupy the major parts of the Western Ghats and the midland regions located within Kerala state. The granulitic gneisses are very well spatially connected with lineaments and faults in Kerala state (Soman, 2002). Khondalites are yet another major rock formation of south Kerala and are associated with garnet-biotite gneiss and garnetiferous quartzofeldspathic gneiss.

The presence of intrusives especially, the dykes, have hydrogeological role to find good zones of water bearing fractures. Intrusive formation dykes of Lower-Middle Proterozoic age, pegmatites of Middle Proterozoic age, host of younger granites (Late Precambrian-early Palaeozoic age) and later dolerite dykes, contemporaneous with Cretaceous-Paleocene Deccan Basalt magmatism, are the common elements seen in granulitic terrain of this state.

The western parts of the State consists of sedimentary formations of Neogene period and quaternary period having four distinct beds viz. Alleppey, Vaikom, Quilon and Warkali. In midland regions, the Tertiary and crystalline formations are found as lateritized units which act as good aquifer. Along the coastal regions, alluvial deposits of recent origin are found. The stratigraphic succession of the Kerala is given under **Table 5.2**.

TABLE 5-3: GENERAL STARTIGRAPHIC SUCCESSION OF KERALA

(after Poulose and Narayanaswami 1968)

Recent to Sub Recent	Soils and alluvium Beach sand deposits Lime shell deposits of backwaters Old and red Teri sands of sub recent marine and lacustrine formations Peat beds with semi carbonised woods Calcareous clays with shell Laterite
------Unconformity------	
Warkallai formation (Mio-pliocene)	Current bedded friable variegated sandstone interbedded with plastic & variegated clays Carbonaceous and alum clays with(Mio-Pliocene)Lignite seams Gravel and pebble beds. Base marked by gibbsitic clay
Quilon formation (Middle Miocene)	Fossiliferous shell limestone alternating with thick beds of sandy clays, calcareous clays. Base unknown
------Unconformity------	
Archaean	Crystallaine Rocks

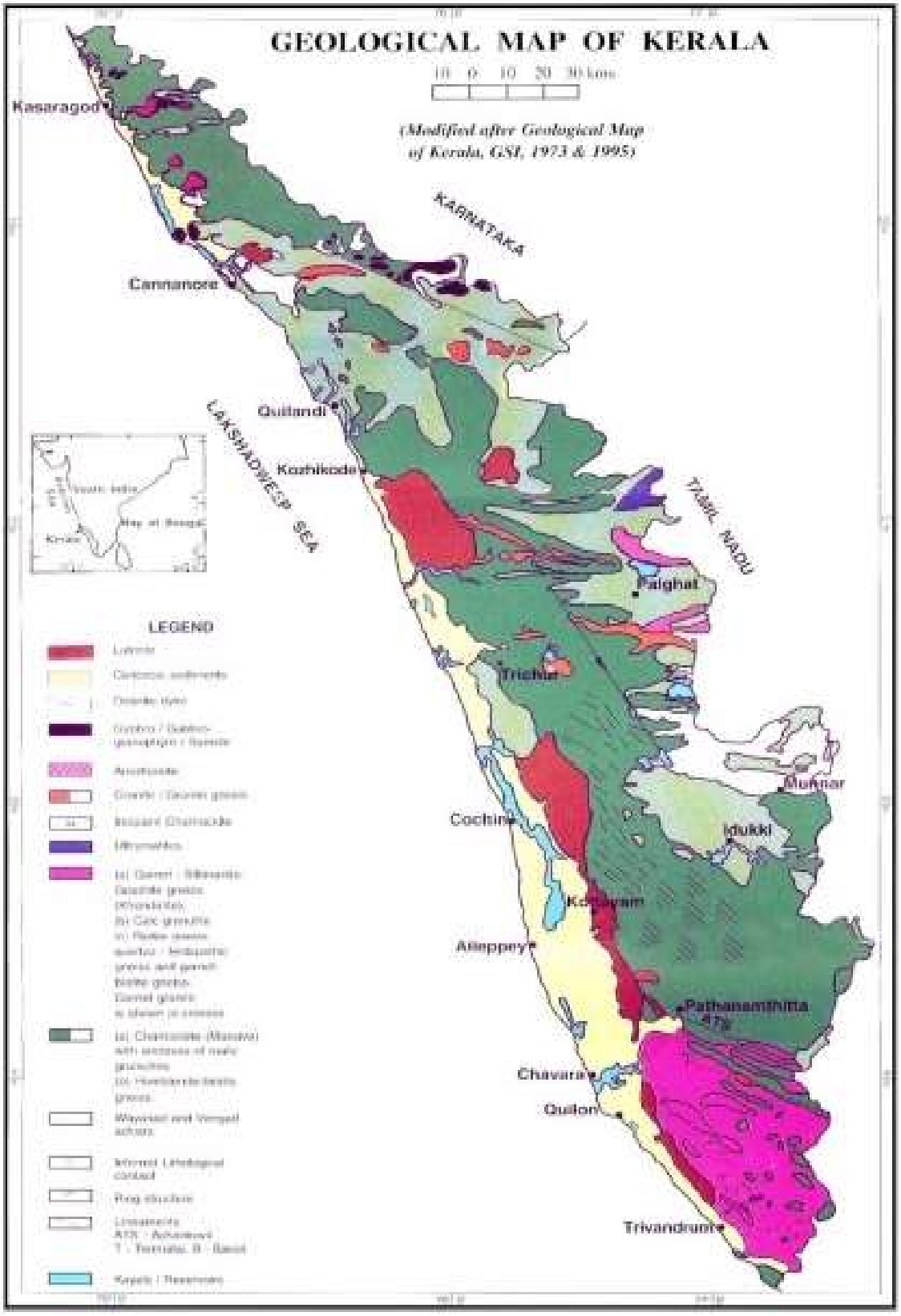


FIGURE 5-1: GEOLOGICAL MAP OF KERALA

5.5.2 Physical Condition and Drainage

Physiographically the state can be divided into four domains from east to west, viz., the Western Ghats, the foothills, the midland and the coastal low- land.

The Western Ghats, bordering the eastern boundary of the State, form an almost continuous mountain wall, except near Palakkad where there is a natural mountain pass known as the Palakkad Gap. The average elevation of the Ghats is about 1500 meters above sea level, occasionally soaring to peaks of 2000m to 2500m. From the Ghats, the land slopes to the west on to the plains, into an unbroken coastline.

The foothills of the Western Ghats comprise the rocky area from 200 to 600m.above MSL. It is a transitional zone between the high-ranges and midland. The strip of hills and valleys on the eastern edge, close to the Ghats, comprises of steep mountains and deep valleys, covered with dense forests. Almost all the rivers of the state originate here.

In the Midland Plains of central region, the hills are not very steep and the valleys are wide. This forms an area of gently undulating topography with hillocks and mounds. Laterite capping is commonly noticeable on the top of these hillocks. The low, flat-topped hillocks forming the laterite plateau range in altitude from 30-200m and are observed between coastal low-land and the foothills. The valleys have been developed as paddy fields and the elevated lands and hill slopes are converted into estates of rubber, fruit trees and other cash crops like pepper, arecanut and tapioca. Tea and coffee estates have cropped up in the high ranges during the last two centuries.

Coastal low-land is identified with alluvial plains, sandy stretches, abraded platforms, beach ridges, raised beaches, lagoons and estuaries. The low- land and the plains are generally less than 10m above MSL. The Coastal Belt strip is comparatively plain. Extensive paddy fields, thick groves of coconut trees and picturesque backwaters, interconnected with canals and rivers, are the features of this region. No wonder, Alappuzha an old sea port town of this region is known as the 'Venice of the East'. In the southern and northern parts of the state, the coastal belt also has some small hillocks.

Drainage:

The State is drained by 44 rivers, of which 3 are east flowing **(Figure 5.2)**. Rivers are generally swift flowing having very steep gradient in their higher reaches. Absence of delta formation is characteristics if Kerala rivers. The general drainage pattern of these rivers is dendritic, although at places trellis, sub-parallel and radial occur. The segments of river courses are nearly straight, indicating structural control, coinciding with prominent lineament directions (NW-SE and NE-SW). Many of the rivers do not have a continuous flood plain. As per national norm (Rao, 1979), there are no major rivers in Kerala.

The four medium rivers, namely Chaliyar, Bharathapuzha, Periyar, and Pamba have a total drainage area of only 8250 km^2 with length 169 km, 244 km and 176 km respectively. The length of rest of the rivers varies from 16 km to 130 km, with an average length of 62 km and total drainage area of 19,485 km^2. The river flow is modulated by about 30 reservoirs, mostly located in highlands (KSLUB, 2002; CWRDM, 1995). Apart from the 44 rivers, there are few streams with separate watersheds draining an area of about 900 km2 with lengths falling short of the 15 km limit set for the categorization as river (Anon, 1974).

FIGURE 5-2: DRAINAGE MAP OF KERALA

A chain of Kayals (backwaters), lying parallel to the coastline is a characteristic feature of Kerala coast. These are mostly interconnected by natural or man-made canals. There are 27 estuaries and 7 lagoons listed in Kerala (Anon, 1974). The project area/selected site form a part of Vechoor – Athirampuzha canal. The location of the selected site on Google earth is shown as **Figure 5.3** while the enlarged view of the same is shown as **Figure 5.4.**

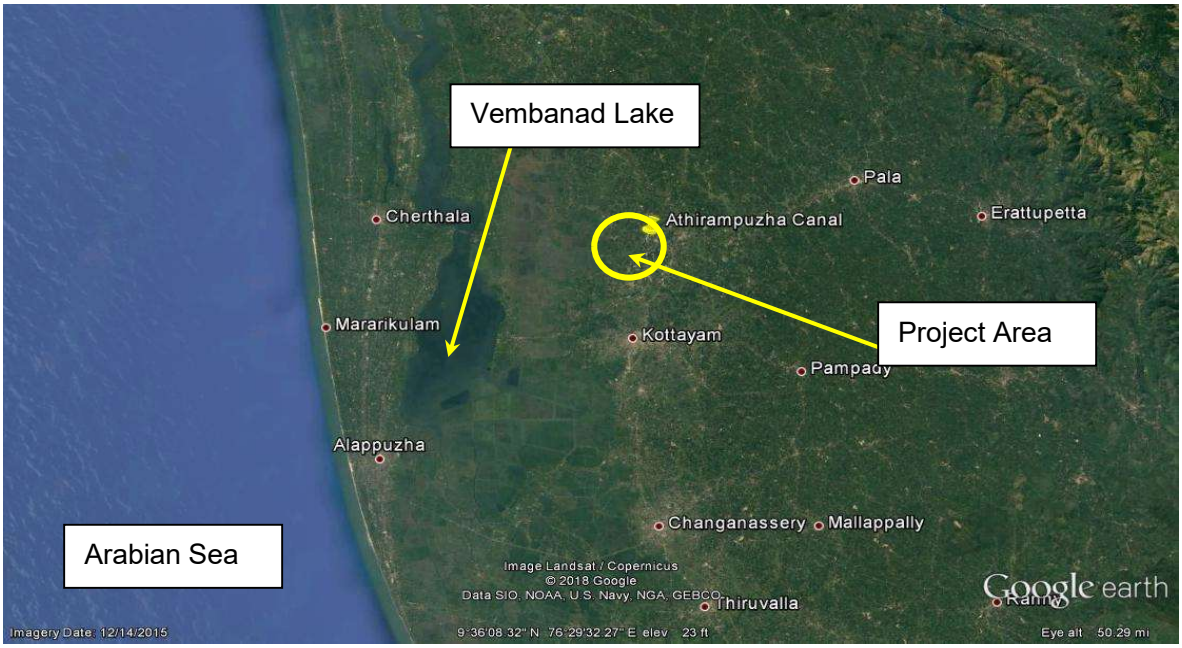


FIGURE 5-3: GOOGLE EARTH IMAGE SHOWING PROJECT AREA

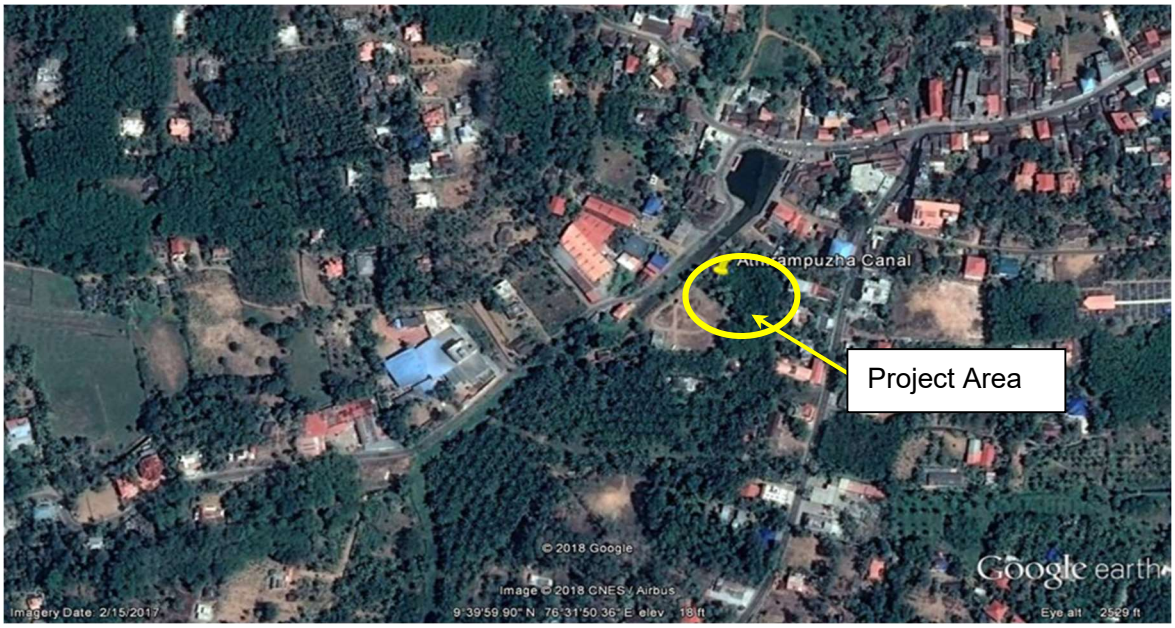


FIGURE 5-4: ENLARGED VIEW OF GOOGLE EARTH IMAGE SHOWING PROJECT AREA

5.5.3 General Geology and Stratigraphy

This area shows a very interesting correspondence between the major rock classes and their physiographic expression. The east comprises Precambrian metamorphic rocks and forms hilly ground. The central part is a low plateau, where Tertiary sediments containing lignite occur. These are followed by further west by a low plain, which is underlain by Quaternary Formations, fluvial or partly marine. The Charnockite Group dominates in areal distribution with charnockite, charnockite gneiss and diopside gneiss occupying the major part. Pyroxenen granulite (with hornblende granulite), magnetitie quartzite and cordierite gneiss occur as concordant bands within charnockite. The linear bands of quartzite (Khondalite Group) are the oldest rock of the area. Biotite geniss (composite gneiss) representing the Migmatite Complex has a limited areal extent, west of Ettumanur and along the eastern boundary. Three major granite bodies are emplaced in the district, two along the southwest and other in the east. Numerous dolerite and gabbro dykes trending NW-SE traverse the older basement rocks in the central and eastern parts. A prominent gabbro dyke extends from north to south with a NNW-SSE trend. Tertiary sediments comprising sandstone, clay with lignite intercalations are confined to the west and they occur as small patches, especially as capping on hillocks. Both the Archaean and Tertiary rocks are lateritised. Quaternary alluvial deposits occur to the west. They have been classified into various morphostratigraphic units, based on their environment of formation, as Guruvayur Formation (palaeo-marine), Periyar Formation (fluvial) and Viyyam Formation (fluvio-marine).

The drill hole completed within the project area reveals the stratification as below:

Strata I: Back Filled Material

Strata II: Blackish Medium Dense to Dense Clayey Silty Sand

Strata III: Greyish Highly to Moderately Weathered Diorite

5.5.4 Sub-surface Investigations

The selected site has been investigated by one drill hole (59 B1) which has been drilled for depth of 19.0 m. The detail of the drill hole is tabulated below in **Table 5.3.**

TABLE 5-4: SUMMARY OF DRILL HOLE

Sl. No	Hole No.	Location	Total Drilled Depth (m)	Depth		Thickness (m)	Description of Strata	N-Value	Core	RQD	Remarks
				From (m)	To (m)				%	%	
1.	59 B1 (NGL – 6.50 m)	Athirampuzha canal **(09^{0}40'00.81'' N, 76^{0}31'53.57'' E)**	19.0	0	2.5	2.5	Back Filled Material	24	-	-	Water Table 1.95 m below GL
				2.5	13.72	11.22	Blackish Medium Dense to Dense Clayey Silty Sand	14-R	-	-	R stand for Refusal
				13.72	19.0	5.28	Greyish Highly to Moderately Weathered Diorite		20 - 65	-	0-14

The description of the drill hole is as given below.

59 B1: Drill hole 59 B1has been drilled over the terminal location area on the Left bank of Canal, Athirampuzha, Kottayam, Kerala. The drill hole has been drilled vertically down to the depth of 19.0m from EL.6.5 m to EL.-12.5 m. The drill hole encountered 2.5m thick Back Filled Material, 11.2m thick Blackish Medium Dense to Dense Clayey Silty Sand, 5.28m thick Greyish Highly to Moderately Weathered Diorite.

The drill hole log and photographs of execution of drill hole and core box are appended in Volume IV- Geotechnical Investigation Report.

5.5.5 Geotechnical Results and Analysis

In-situ Test Results

Seven Standard penetration test (SPT) has been carried out in accordance of IS 2131 in the drill hole to ascertain the consistency of the different soil strata. The depth wise N-values from the SPT for soil strata are as tabulated in **Table 5.4**.

TABLE 5-5: SUMMARY OF IN-SITU TEST RESULTS

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Back Filled Material	1.5	2.1	24
2	Blackish Medium Dense to Dense Clayey Silty Sand	3.0	3.6	34
		4.5	5.1	14

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
		6.0	6.6	15
		7.5	8.1	21
		9.0	9.6	22
		10.5	11.1	30
		12.0	12.6	35
		13.5	13.72	R

Laboratory Test Results

Testing on soil samples from SPT & Undisturbed Samples (UDS)

5 SPT soil samples has been collected from the drill hole from different depths and has been tested in laboratory to know the engineering properties of sub-surface strata like Mechanical analysis, Consistency Limits (atterberg limits), Shear strength parameters, consolidation test, Natural Moisture content, Density, soil classification, specific gravity etc. The details of the soil sample collected and summary of results of the various tests are tabulated in **Table 5.5**.

TABLE 5-6: SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Bore Hole	Strata Description	Depth		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistency Limits				IS Soil Classification	Shear Strength			Consolidation		Specific Gravity
					Wet	Dry		Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index, I_p	Shrinkage, S_L		Type	Cohesion	Friction	Compression Index	Initial Void Ratio	
		From	To		Kg/cm^3		%	%	%	%	%	%	%	%	%			Kg/cm^2	degree	C_C	e_0	G
59B-1	Blackish Medium Dense to Dense Clayey Silty Sand	3.0	3.6	SPT	1.756	1.53	14.50	0	68	20	12	Non - plastic				SM-SC	UU		26			2.64
		6.0	6.6	SPT	1.763	1.54	14.56	0	42	44	14	Non - plastic				ML	UU	0.02	27			2.62
		9.0	9.6	SPT	1.777	1.54	15.62	0	42	40	18	Non - plastic				ML	UU	0.01	30			2.63
		12.0	12.6	SPT	1.806	1.57	14.71	2	47	26	25	Non - plastic				ML	UU	0.02	30			2.67
		13.5	13.72	SPT	1.820	1.62	12.68	15	64	21	25	Non - plastic				SM-SC	UU		32			2.64

Testing on Rock Core Samples

Five core samples of bed rock recovered from the drilling has been tested in laboratory to know the engineering parameters of the bed rock like crushing load, Point load index, UCS, Water absorption, porosity, Dry density & rock type. The details of the rock sample collected and results of the various tests are tabulated in **Table 5.6**.

TABLE 5-7: SUMMARY OF LABORATORY TEST RESULTS ON ROCK SAMPLES

Bore Hole	Strata Description	Depth		Crushing Load	Point load Index	Uniaxial Compressive Strength	Modulus of Elasticity	Poisson's Ratio	Water Absorption	Porosity	Dry Density
		From	To	Kg	Kg/cm^2	Kg/cm^2	Kg/cm^2		%	%	gm/cm^3
59B-1	Greyish Highly to Moderately Weathered Diorite	16.0	17.0	15600	---	697.97	2.23 E+05	0.23	0.57	0.87	2.67
		16.0	17.0	650	21.96						
		17.0	18.0	12500	---	548.27	1.77 E+05	0.24	0.98	1.56	2.58
		17.0	18.0	350	11.96						
		18.0	19.0	17500	---	770.52	2.67 E+05	0.21	0.32	1.02	2.81
		18.0	19.0	730	24.94						

Bearing Capacity Calculations

The bearing capacity and pile load capacity is worked out based on following soil parameters adopted for the analysis.

TABLE 5-8: SOIL PARAMETERS ADOPTED FOR THE ANALYSIS

Depth		Strata Type	Average N Value (observed)	Thickness (m)	Unit Weight (kN/m^3)	Cohesion (kN/m^2)	Angle of Internal Friction (Degrees)	Core Recovery (CR)	RQD (%)	UCS of Rock (CR)
From (m)	To (m)									
0	2.5	Filled up soil	24	2.5	17	0.00	26	-	-	
2.5	4	Dense Sand	34	1.5	17.5	0.00	26			
4	9	Medium Dense Sand	15	5	17	2.00	27			
9	12	Dense Sand	30	3	17.7	1.00	30	-	-	
12	13.72	Very Dense Sand	52	1.72	18.2	0.00	32	-	-	
13.72	15	Greyish Highly to Moderately Weathered Diorite		1.28	-			20	0	
15	16			1.0	-			27	0	
16	17			1.0	26.7			32	0	69.7
17	18			1.0	25.8			48	0	54.8
18	19			1.0	28.1			65	14	77.05

The bearing capacity is calculated for different size of isolated footing at different proposed depth. The details are given below. The sample calculations are given in **Annexure-5.1.**

TABLE 5-9: SUMMARY OF BEARING CAPACITY CALCULATIONS (KN/M^2)

S. No	Size of Isolated Footing	Depth of Footing (m)		
		2.5	3.0	4.0
1.	1.5 m x 1.5 m	59	72	119
2.	2.0 m x 2.0 m	59	70	113
3.	2.5 m x 2.5 m	59	70	110

S. No	Size of Isolated Footing	Depth of Footing (m)		
		2.5	3.0	4.0
4.	3.0 m x 3.0 m	60	71	109

5.6 Terminal Infrastructure including equipment

The land area identified is measuring to about 8500 Sq.m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities for each terminal has been worked out to 8423 Sq.m, which can be accommodated within the Land proposed to be taken on Acquisition.

Considering the Class III waterway classification, Ro-Ro facility shall be planned for each of the location.

5.7 Berthing Structure

The berthing structures shall be designed such that they provide safe berthing of barges/vessels without damaging the barges/vessels as well as the structure. The requirements of the berth differ depending on the nature of traffic being handled at the berth. The size of the structure shall depend on the largest vessel likely to use the berth. The berth shall be designed for all possible loads that are likely to act on the structure as per BS 6349 & IS 4651. The total number of berths required for the proposed terminal shall be fixed based on the nature of cargo (if any), traffic, and water level variation. The Ro-Ro berth has been designed for 40ft container loading as per IRC classification.

Deck Level

As per IS 4651 _IV, the deck level of the berthing structure shall be fixed based on the variations in water levels during the monsoon and non-monsoon season. Keeping this in view, the deck of Ro-Ro is maintained in a slope of 1:12, maintaining the deck level at the shore side at 1m above the highest water level .On the river side, the deck level is fixed maintaining under keel clearance of 0.5 m below the vessel. The position of vessel approaching the berth shall vary corresponding to the water depth available at site. The fixed ramp shall be submerged in water corresponding to the variations in water level available at site.

Deck Dimensions

The dimensions of the berthing structure are decided on the basis of the dimensions of the largest vessel that are likely to use the terminal facilities as well as the function of the terminal.

TABLE 5-10: SALIENT FEATURES OF RORO STRUCTURE

Description	Length(m)	Width (m)
Ro-Ro	75	12

The structural arrangement of the berth including the preliminary design has been explained in the chapter 6. (Refer Volume-II Drawing No. **P.010631-W-20341-E03**)

Note: The suggested Terminal details are only to the extent of Preliminary Engineering / Design. At this juncture, it is pertinent to mention that the Appropriate provisions and infrastructure are to be catered for “Disposal of Operational waste including the waste oil from vessels berthing at the terminal locations” and the related aspects are to be addressed to / attended to in accordance with the Gazette Notification vide No. 480 dt. 13/07/2016 of Ministry of Shipping {GSR No. 687 (E)} at the stage of Detailed Engineering / Design. In the similar way, the collection and disposal of Pollutants generated, on board vessel, also to be addressed during the Detailed Engineering / Design.

5.8 Terminal Costing

5.8.1 Capital Cost

The Capital Cost for Ro-Ro Terminal consisting of Land (85.98 Lakhs); Riverine Components (499.41 Lakhs); Infrastructure (including internal road) (493.84 Lakhs); Approach Road (External) (3.5 Lakhs) and Provision of Ambulance (18 Lakhs) with a total cost is working out to 18.38 Crores. The proposed cost is only indicative.

5.8.2 O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined by IWAI, which have been analyzed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 6 PRELIMINARY ENGINEERING DESIGNS

6.1 River Training (including Barrages and Locks, if proposed)

River training in Canal stretches is not required, wherein the Bank Protection may be essential in the widening reaches.

6.2 Bank Protection

6.2.1 Typical Revetment

All the banks are within a floodplain and made up by sand, silt and clay. This soil type may present different failure modes, such as scour, loss of fines, erosion, piping, etc. A special attention is to be paid to overall and local geotechnical failures. It is suggested to consider the required investigations at site and Detailed Engineering Designs etc., based on the soil parameters at the site. Typical detail is shown in Figure 6.1.

There are many materials available in the market to be used for revetments, i.e., box gabions, block stone, cabled concrete blocks, dense stone asphalt, gabion mattresses, grouted stone, hand-pitched stone, in-situ poured concrete, loose concrete blocks, precast concrete slabs, open stone asphalt, soil reinforcement systems, etc… The selection of the type of material is based on a trade-off between hydraulic/geotechnical performances, construction related aspects (availability and supply, equipment and labor, access and infrastructure, etc…) and costs.

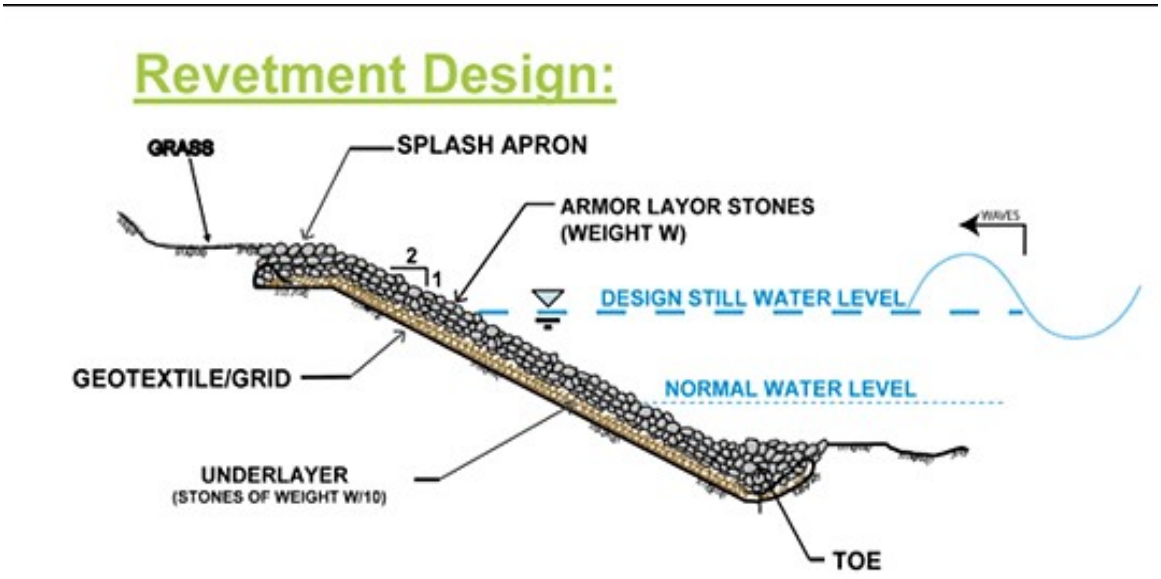


Figure 6-1: Typical Arrangement of Revetment

Gabion revetments is not suggested in the present study stretch. As the gabions do not need special equipment nor high-skilled labour for execution, their maintenance is not cumbersome and further they are more durable and economical than geotubes or geobags.

6.2.2 Typical Pile and Slab

The present study stretch of NW 59 is a canal amenable for Class III Waterway and similar to that of present NW 3 waterway and having connectivity. Further, the NW 59 is traversing through the Kuttanad area and hence the Pile & Slab type of Bank Protection is most suitable. The typical drawing is placed below.

The entire material is of M 40 grade concrete with standard steel components and Geo Filter Membrane.

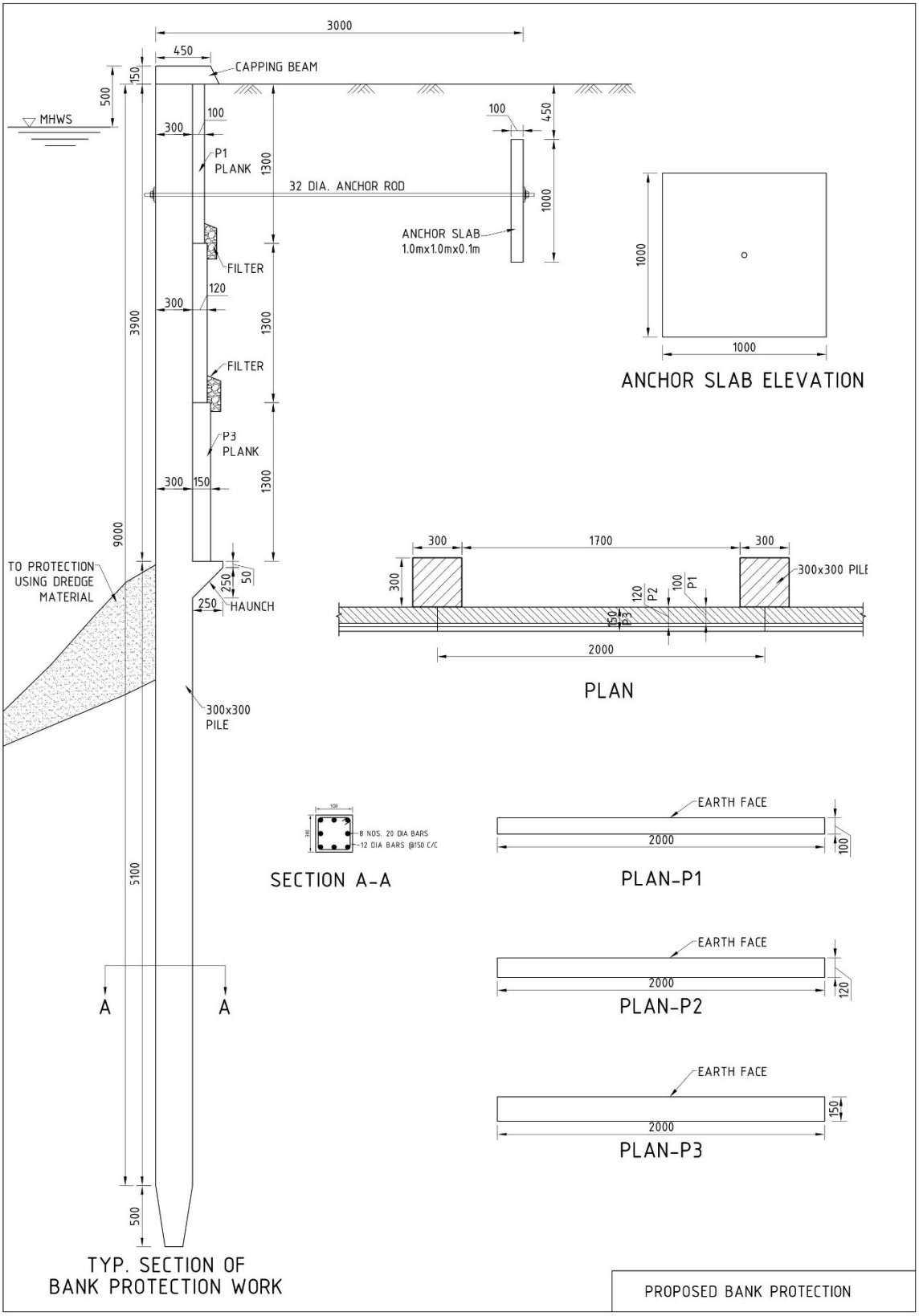


Figure 6-2: Typical section of Pile and Slab type bank protection,

6.3 Navigation Aids

The detailed Drawing and Specifications are reproduced herewith for consideration.

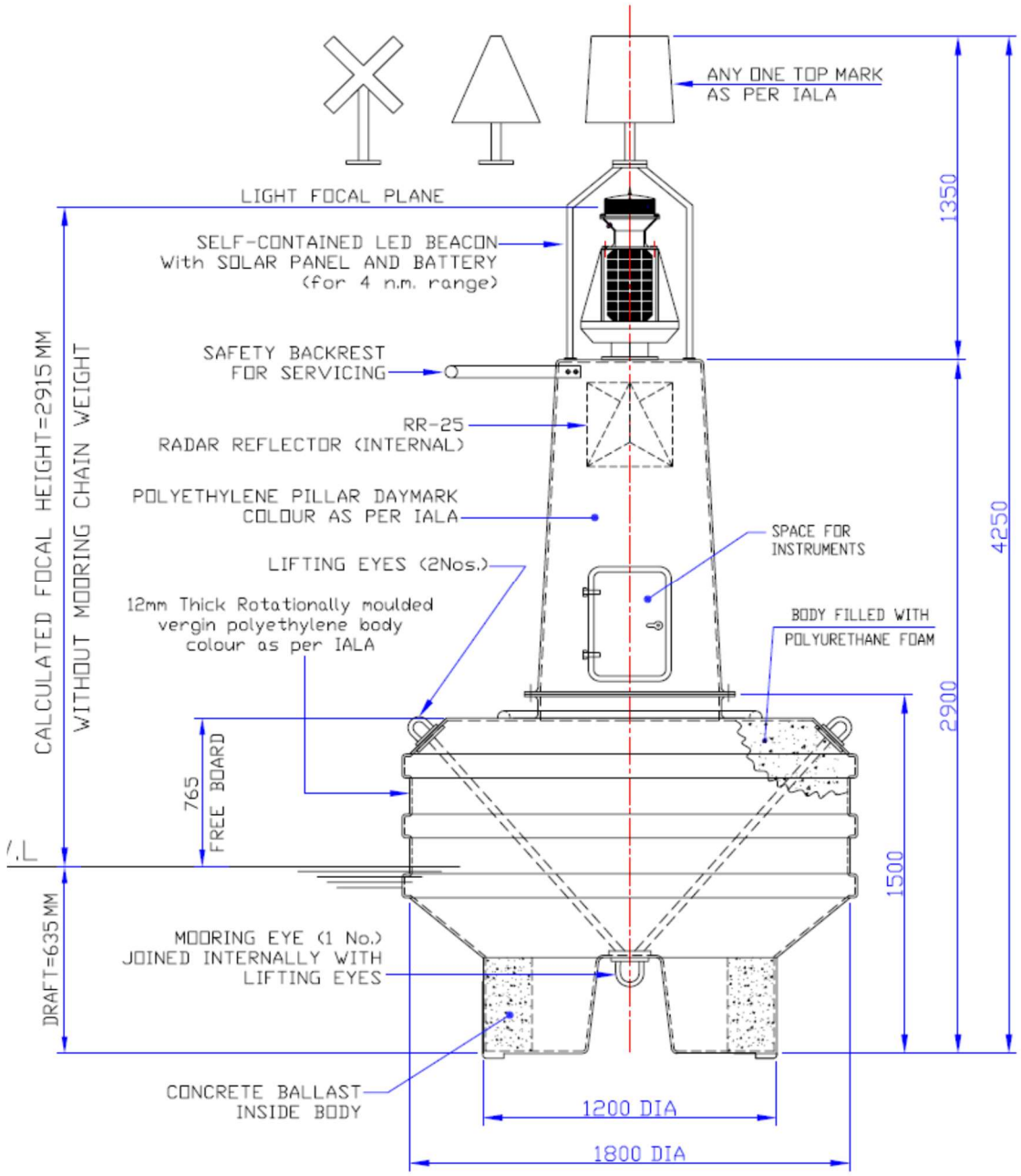


Figure 6-3: Typical section of Navigational Aids

POLYETHYLELENE CHANNEL MARKING BUOYS: (PORT HAND) 1 No. - PEB/1 800 Polyethylene Buoys, each complete with Day mark, Top Mark and Radar Reflector. Main features are as given below:

Body Diameter: 1800 mm / Wall Thickness : 12 mm thick body / Body Material : Rotationally moulded in low density UV-Stabilized virgin polyethylene / Foam : Body filled with Closed Cell Polyurethane Foam / Weight without Mooring : 645kg (approx.) / Focal Height : 29 15 mm / Draft : 635 mm / Free Board : 765 mm / Reserve buoyancy : 1893 kgs / Displacement : 26.0 kg./cm of immersion / Mooring Eyes : 1 No. of Steel / Lifting Eyes : 2Nos / Body Colour : As per IALA system, UV- stabilised colour pigments mixed thoroughly with polyethylene powder before moulding operation / Daymark : P E Module (as per IALA system) / Radar Reflector : RR - 25 as specified (25M2).

1 Set - Mooring gear – Each set comprised of the following:

1 No. - 3M x 26 mm dia open link chain with enlarged end links.

1 No. - 15M x 26 mm dia open link pendant chain with enlarged end links.

4 Nos. - 26 mm nom. dia forelock end shackles.

1 No. - 26 mm nom. dia swivel piece with end links.

1 No. - 250 kg. M.S. stockless Anchor.

Note: The chains shall be made as per 1S4692, shackles and swivel as per IS 4484 and stockless steel Anchor. The chain shackles and swivel shall carry proof load test certificate witnessed by the IRS. All the above shall be given one coat of coaltar paint.

Solar Operated LED lighting 1 No. MLB-200-4 Self-contained LED beacon fitted with PLC-12 programmable LED controller. Specification of Each Light is as detailed below:

Luminous range: 4 n. miles. (T 0.74) / Light Colour: as per IALA System. (Red) / Light Source : High intensity Light Emitting diodes (LEDs) with UEP to 60,000 hrs of burning life / Optical system : 200 mm dia clear polycarbonate UV stabilized diffuser lens / Lantern Body : High impact polystyrene / Cable entry : M l6 Cable glands fitted / Fixing : 4 fixings for Ml 0 bolts at 200 mm PCD / Lantern weight : 3.0 kg (approx.).

1 No. - PLC 12 programmable microprocessor based LED controller (fitted in the base of the Lantern). Main description is given as below:

Input Voltage: 12 V to 18 V d. c / Output Voltage: Switch-mode stabilized to suit LED operating current / LED load (max): upto 12 Amp. at 12 V d.c / Light Character: Any of the 256 IALA character can be selected / Solar charge regulator: Provided in the PLC-12 circuit / Light control: Automatic ON/ OFF by Photo diode / Protection: Against reverse polarity and excessive input voltage / Temperature range : -20°C to + 60°C.

SOLAR SUPPLY SYSTEM FOR MLB-200-4 LED Light: 1 Set — Solar supply system as detailed below:

4 Nos. - 12V 5 watt solar panel / 1 No. – 12 V 42 AH sealed, maintenance free battery / Autonomy period = 21 days Light Assembly : Lantern, Solar panel and battery are mounted on the GRP box, all assembled and wired as one self-contained unit, ready for fitting on top of buoy structure.

6.4 Cargo Terminals and River Ports

Design Criteria

All structures shall be designed using limit state design approach. 3-D structural analysis of the structure shall be carried out under all specified loads and load combinations as per Indian Standards as explained in this report using STAAD Pro software. The design shall be done manually using the results of the analysis obtained from STAAD.

Design Life

All permanent structures shall be designed for a design life of 50 years.

Material Properties

Density of reinforced concrete 25.0 kN/m³

Density of Steel 78.5 kN/m³

Density of plain concrete 24.0 kN/m³

Density of Backfill soil 18.0 kN/m3 (May vary based on soil fill proposed during detail design)

Structural Steel

Minimum yield stress: 250 N/mm²

However, higher grade of steel (310/355 Mpa) shall be used based on the availability during the detailed design stage and subject to owner's approval.

Reinforcing Steel (Corrosion Resistant)

The grade of steel to be used as reinforcement in the structural concrete members shall comply with IS 1786 and will have minimum strength and elongation as mentioned below.

Yield Strength 500 Mpa

Elongation 14.5%

However, use of higher grade steel in the detail design is subject to availability of higher grade steel meeting the ductility requirements (as per revised latest code).

Cover to Reinforcement

The clear cover to main reinforcement shall be as follows:

Piles 100 mm

Deck Slab 75 mm

Longitudinal beams: 75 mm

Columns: 75 mm

Cross Beams	75 mm

Concrete Grades

Grade of RCC members	M40 for Piles
	M40 for Beams and Slab
	M40 for all precast elements
Grade of reinforcement	Fe500 confirming to IS 1786

Overall Deflection Criteria

The criteria for deflection shall be so limited that it shall not produce difficulties in serviceability condition nor shall it cause damage to the structures and its components.

Deflection limits

Pile deflection at the deck level is normally considered as H/350 under extreme condition, where H is the distance from the point of fixity of piles to the top elevation of deck.

Crack Control

The crack width criteria shall comply with the provisions of IS: 4651(Part 4).

However, the assessed surface width of cracks (for service load combinations only) at points nearest to the main reinforcement will be restricted to 0.004 times the cover to the main reinforcement.

Corrosion Protection Painting

All steel surfaces in the splash zone and atmospheric zone shall be painted in accordance with the painting specifications. Areas and joints that are inaccessible for maintenance and thereby susceptible to corrosion shall be suitably sealed by methods such as boxing with plates.

All appurtenances such as walkway bridges shall be painted as per technical specifications of corrosion resistance suitable for the environment.

Classification of Loads

A. General Loading

The Self weight of the structure shall be calculated using the following

Density of reinforced concrete	25.0 kN/m3
Density of Steel	78.5 kN/m3
Density of plain concrete	24.0 kN/m3
Density of Backfill soil proposed during detail design)	18.0 kN/m³ (May vary based on soil fill

In addition superimposed dead load and live load shall be considered

The various loads acting on the berthing structure are classified as:

1. Loads from the River Side:

The loads from the river side include the horizontal forces caused by the river currents and the forces caused by berthing and vessel's pull from bollard. The forces caused by the berthing of the vessels are determined from the velocity and angle of approach of the vessels.

2. Loads from Deck

The important loads from the deck are the vertical loads caused by self-weight of the deck and the superimposed loads from handling equipments. Also horizontal loads due to wind and seismic forces are considered.

3. Loads from Shore

Seismic loading

Earthquake loads shall be adopted as applicable for the site as per IS 1893 – 2002. All districts in the state lie in Zone III as per the seismic map of India shown in IS 1893-2002. Design horizontal seismic coefficient shall be evaluated as per procedure detailed in IS 1893-2002.

The horizontal seismic coefficients are as follows:

TABLE 6-1: SEISMIC LOADING

Seismic zone	III
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.10
Importance factor, I	1.5
Response Reduction Factor, R	3 (for ordinary RC moment resisting frame)
Average response acceleration coefficient Sa/g	Depending on time period of Structure

Time period of specified structures shall be evaluated by STAAD analysis considering Dead Load + 50% Live load.

Scour

Scour depth is considered in calculating the total length of the pile.

$R = 0.473 (Q/f)^{1/3}$

Where R = depth of scour below HFL

Q = discharge m^3/s

f = silt factor (=1)

Max scour around piers = 2 R.

Hence, scour depth of 5 m has been considered from the HFL.

Pile Length is calculated as 5m +3*Dia of pile socketed into rock (i.e. 1.3m). The depth of pile is computed from G.L (6.5m) at exploratory Bore hole (BH) location.

Loads & Load Combinations

All the structural members shall be designed to sustain safely the effect of the combination of various loads/forces and stresses that can possibly co-exist. The load combinations shall comply with the requirements of Indian reference standards both for limit state of collapse & serviceability.

Structural Design of Berthing Structure

Structural Arrangement

The RO-RO berthing structure shall consist of a concrete deck supported on piles i.e., the sub structure shall comprise of piles at 5.1 m c/c in transverse direction, whereas the super structure shall comprise of the pile caps and concrete deck & precast planks supported on longitudinal beams and cross beams. The pile caps span in the transverse direction with the longitudinal beams resting on the pile caps.

The structure shall be designed for its self-weight and also for forces arising due to wind / seismic loads, current forces, vehicular loads etc as explained below.

For RO-RO berthing structure, an overall width of approx. 12 m is provided

The deck of RO-RO shall be submerged in water with varying water levels, depending on the season. Expansion loops shall be provided along the stretch at almost every 35-40 m.

Towards the terminal facility i.e. the shore end the deck has been considered at approx. 1 m above FRL.

A staged construction approach is assumed in the design viz:

- Piles,
- Precast pile caps and placement of cross head beams,
- Placement of precast longitudinal beams with precast planks for slab
- Placement of concrete for cast-in-situ ties between beams and deck slab.

The RO-RO berthing structures considered in design has salient features as below:

TABLE 6-2: SALIENT FEATURES OF RO-RO

Description	Total Length(m)	Total Width (m)
RORO	75	12

Design Loads on Berthing Structures

a) Dead Load

The dead load comprise of the weight of all components of the structure as well as the weight of all permanent connections.

For RO RO berthing structures, the member load has been defined directly by STAAD Pro using the self-weight command. The weight of concrete slab & precast panels has been applied in STAAD Pro software using floor load command.

b) Live Load

In general, the vertical live loads comprise of loads from vehicular traffic of all kinds including trucks and trailers. The vertical live loads as defined in IS 4651 (III) shall be considered in the analysis and design of the berthing structure.

TABLE 1 TRUCK LOADING AND UNIFORM LOADING

Function of Berth	Truck Loading (IRC Class)	Uniform Vertical Live Loading T/m²
(1)	(2)	(3)
Passenger berth	B	1·0
Bulk unloading and loading berth	A	1 to 1·5
Container berth	A or AA or 70 R	3 to 5
Cargo berth	A or AA or 70 R	2·5 to 3·5
Heavy cargo berth	A or AA or 70 R	5 or more
Small boat berth	B	0·5
Fishing berth	B	1·0

Note — The relevant Indian Road Congress (IRC) codes may be referred for axle load. The spacing of the loads may be changed to suit individual design requirements.

For Ro-Ro berthing structure, vehicular loading as per IRC 6 Class 70R as defined below shall be considered

1. A Tracked vehicle of 70 ton load or
2. Wheel load of 100 ton or
3. Bogie axle load of 40 ton, whichever is critical.

Moving loads has been applied in STAAD Pro software for all the three load cases defined above to obtain the maximum value of bending moment and shear force.

c) Seismic Forces

All districts in the state lie in Zone III as per IS 1893:2002(part I). Dynamic analysis has been done to calculate the time period of the structure. The spectral acceleration is calculated based on the time period of the structure obtained for its mode as per IS 1893:2002 for rocky soils types.

The maximum mass participation is observed for mode 1 in X direction and for mode 2 in Z direction.

The time period obtained is of the order of 3 sec in X direction and 3 sec in Z direction

Hence based on the acceleration value the horizontal seismic coefficient is worked out as

Ah = (Z/2) x (I/R) x (Sa/g).

Z = zone factor =0.10

I= importance factor =1.5

R = reduction factor =3

Sa/g= spectral acceleration based on time period

50 % Live load is considered for the dynamic analysis of the structure.

Thus Ah = 0.04 (in X direction) and Ah = 0.04 (in Z direction)

d) Wind Forces

Wind loads on the structure shall be applied according to IS: 875 (Part 3) -1987

Wind Pressure $Pz = 0.6\ Vz^2$

Where

Pz = Design Wind Pressure in N/m2 at height Z

Vz = Design wind speed at any height in m/s

Vb = Basic wind speed at any height in m/s

K1 = Probability factor (risk coeff)

K2= Terrain height and structure size factor

K3 = Topographic factor

Pz is calculated as 1.59 KN/m2 taking Vb as 39 m/s

The wind force is applied on piers and deck slab in both X and Z direction in STAAD Pro software.

e) Mooring Load

The Mooring loads are the lateral loads caused by the mooring lines when the vessel is pulled into or along the deck or hold it against the forces of wind or current. The maximum mooring forces are due to wind force, on exposed area, on the board side of the vessel.

IS 4651_III, gives Bollard Pulls of vessel as below:

For 2000 Tonnes displacement Line pull = 100 KN (total)

TABLE 4 BOLLARD PULLS

(Clauses 5.3.4 and 6.1)

DISPLACEMENT (TONS)	LINE PULL (TONNES)
(1)	(2)
2 000	10
10 000	30
20 000	60
50 000	80
100 000	100
200 000	150
Greater than 200 000	200

NOTE 1 — For ships of displacement tonnage 50 000 and over the value of line pulls given above should be increased by 25 percent at quays and berths where there is a strong current.

NOTE 2 — Main bollards at the ends of individual large vessel berths at river structures should be designed for a line pull of 250 tons for ships up to 100 000 tons displacement and for double the values given above for larger ships.

f) Current Forces

As per IS 4651 III, pressure due to current is applied to the area of vessel below the water line when fully loaded.

Current force $F = w\ v^2/2g$ per m^2

Where v = velocity =2.6 m/s

W= 10 kN/m^2

F = 3. 5 kN/m^2

Load Combinations

The load combinations as per IS 4651(IV): General Design Considerations are considered in design of structure. Suitable partial safety factors as per IS: 4651 - 1989 applied to the loads for limit state design are considered.

All operational load combinations will be checked to satisfy the serviceability criteria.

TABLE 6-3: PARTIAL SAFETY FACTORS FOR LOADS IN LIMIT STATE DESIGN

Loading	Partial Safety Factor					
	Limit State Serviceability		Limit State of Collapse			
Dead load [4.1(a)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Vertical live load [4.1(b)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Earth Pressure [4.1(f)]	1.0	1.0	1.0	1.0	1.0	1.0
Hydrostatic and hydrodynamic forces [4.1(g)]	1.0	1.0	1.0	1.2	1.0	1.0
Berthing and mooring forces [4.1(h) and 4.1(j)]	-	1.0	1.5	-	-	-
Secondary stresses [4.1(m)	1.0	-	-	-	-	-
Wind forces [4.1(k)	-	-	-	-	1.5	-
Seismic forces [4.1(p)	-	-	-	-	-	1.5

NOTE : For the limit states of serviceability, the values given in the table are applicable for short terms effects. While assessing the long term effects due to creep, the dead load and the part of the live load, likely to be permanent, may only be considered.

Structural Analysis and Design of Berthing Structures

Based on the structural arrangement and loadings described above, a 3-D model was developed in Staad Pro software for the RO-RO Berthing structure. The structure is modelled with its deck (long & cross beams) along with piles at every 5.1 m in transverse direction.

Linear elastic analysis has been carried out using the Staad model for estimating the actual forces in structural length of the pile for all loads considered. The design is carried out the most critical load combination.

RCC members are designed manually considering limit state design approach as per latest available Indian standards.

A one-third increase in permissible stresses shall be allowed in seismic case as per clause 6.3.5.1 of IS 1893 part-1 2002.

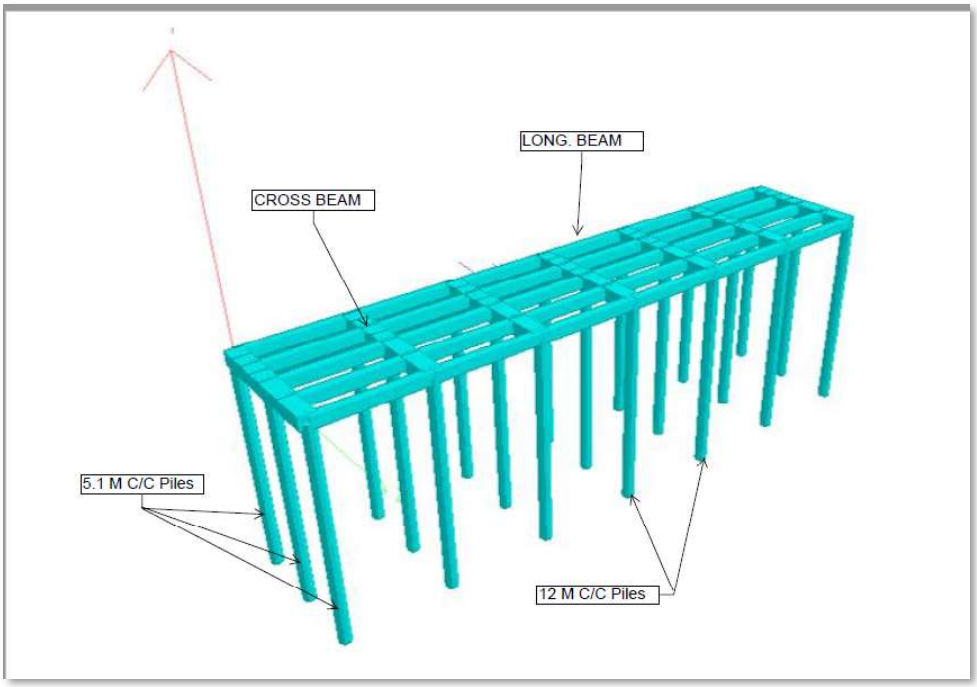


FIGURE 6-4: PERSPECTIVE VIEW OF 3 DIMENSIONAL MODEL PREPARED IN STAAD FOR RO-RO

SIZING OF RO-RO

Member Description	Length(m)	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	5.1	1.8	1.5		Concrete
Longitudinal Beams	12	1.0	1.25		Concrete
CastIn situ Slab				0.15	Concrete
Pile Diameter, OD		1.3	16.5*		Concrete

* Including socket length of 6.5 m

The pile capacity calculation for socketed pile into rock is provided in the table below.

TABLE 6-4: CALCULATION OF SOCKETED PILE CAPACITY

Rock Socketed Pile : NW-59:Vechoor

1. **METHOD 2 : UCS < 10 MPa or RQD is 0, IRC 78-2014**

1.1.	**Input**			
	Rock Quality Designation, RQD		0	%
	Core recovery, CR		27	%
	Uniaxial Compressive Strength (UCS), qc		67	MPa
	N-Value below base		120	
	Average shear strength below base of pile (based on N-value), Cub		0.9	MPa
	N-Value along Socket		100	
	Ultimate shear strength along pile socket (based on N-value), Cus		0.7	MPa
	Coefficient, Nc		9.0	
	Dia of Pile		1.3	m
	Area of base, Ab	$Pi^* d^2/4$	1.33	m^2
	Length of Socket		6.5	m
	Area of socket, As	Pi*d*L	26.55	m^2
	Load on Pile		6500	KN
	Scour Depth		5	m
	Weignt of Pile, W	$Pi^* d^2/4 * L$	328.5	KN
1.2.	Pile Capacity			
	Ultimate end bearing capcity of socketed pile, Re	$C_{ub}*N_c*A_b$	11229.15	KN
	Ultimate side socket shear, Raf	$A_s* C_{us}$	18583	KN
	Ultimate capcity of socketed pile, Qu	$R_e + R_{af}$	29811.67	KN
	Allowable capcity of socketed pile, Qallow	$R_e/3 + Raf/6-W$	6511.6	KN

6.5 Construction Schedule

Construction schedules of different structures will be discussed and elaborated as a part of the implementation schedule in the appropriate chapter.

CHAPTER 7 VESSEL DESIGN

7.1 General Review

The design of a vessel is dependent on various factors viz., Waterway / Fairway structure; Flow pattern in the Fairway for different seasons; Waterway morphological behaviour in different seasons; Cross structures across the fairway; Navigational constraints (Presence of Locks); Cargo volumes to be handled; Type of cargo to be handled; Cargo handling facilities available at Origin and destination; Turnaround time; Capacity of the fairway.

In the above, the predominant factors are Fairway and Cargo i.e., the Fairway availability and Cargo Volumes to be transported. The Fairway details have been discussed in Chapter 03 and the IWT Cargo scenario has been discussed in Chapter 04. Further the present status on the vessels plying in the study stretch also have been collected and placed in subsequent chapters, which will also have bearing in the vessel deployment.

There are not many countries internationally in which IWT is a significant industry, so skills and techniques in IWT vessel research and development are globally scarce. The countries that have significant IWT industries can therefore gain by learning from each other. Vessel design, including vessel loading/unloading methods, is expected to be a fruitful area for USA, EU and China to utilize international experience, particularly in newer, more specialized vessel types.

7.2 Design Basis

The design waterway channel width / depth is usually determined according to the following information: Design Width / depth = f {vessel size, vessel steering characteristics, traffic density, vessel speed, water depth, channel type, flow currents, waves and winds}

Further, the determination of the vessels will be based on traffic / freight projection. The higher the amount of traffic / volumes and lesser the freight cost, the more transport capacity can be foreseen, either in the form of larger vessels or by using more vessels.

7.2.1 Vessel Classification adopted in Indian Inland Waterway

Ministry of Shipping, Road Transport and Highways (Inland Waterways Authority of India) has classified the Inland waterways into seven categories for rivers and canals for safe plying of self-propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in Push Tug + 4 barges units of carrying capacity up to 8000 tonne (Ref: IWAI, Gazette Notification 2006).

The classification criteria of waterways are mentioned in **Table 7.1** for Rivers and in **Table 7.2** for canals.

TABLE 7-1: CLASSIFICATION OF INLAND WATERWAYS FOR RIVERS

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

TABLE 7-2: CLASSIFICATION OF INLAND WATERWAYS FOR CANALS

Class of Waterways	Canals				
	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
I	**1.5**	**20**	**300**	**4**	**20**
II	**1.8**	**30**	**500**	**5**	**30**
III	**2.2**	**40**	**700**	**7**	**40**
IV	**2.5**	**50**	**800**	**10**	**50**
V	-	-	-	-	-
VI	**3.5**	**60**	**900**	**10**	**60**
VII	-	-	-	-	-

Vertical clearance for power cables or telephone lines or cables for any transmission purpose for all the classes of waterways mentioned shall be as follows:

i) Low voltage transmission lines including telephone lines -16.5 metres

ii) High voltage transmission lines, not exceeding 110 kilo volt-19.0 metres

iii) High voltage transmission line, exceeding 110 kilovolt- 19.0 metres+1centimetres extra for each additional kilovolt

The vessel sizes for self-propelled or tug and barge combination for different classes of waterways are described in **Table 7.3**.

TABLE 7-3: CLASSIFICATION OF VESSEL SIZE

Class of waterways	Self-Propelled Vessel Tonnage (Size, L x B x Draft in m)	Tug and Barges Combination Tonnage (Size, L x B x Draft in m)
I	100 (32 x 5 x 1)	200 (80 x 5 x 10)
II	300 (45 x 8 x 1.2)	600 (110 x 8 x 1.2)
III	500 (58 x 9 x 1.5)	1000 (141 x 9 x 1.5)
IV	1000 (70 x 12 x 1.8)	2000 (170 x 12 x 1.8)
V	1000 (70 x 12 x 1.8)	4000 (170 x 24 x 1.8)
VI	2000 (86 x 14 x 2.5)	4000 (210 x 14 x 2.5)
VII	2000 (86 x 14 x 2.5)	8000 (210 x 28 x 2.5)

In general, total weight of the vessel considered to be 1.4 X DWT. Refer Figure 7.1 below for proposed dimensions of one way navigation channel.

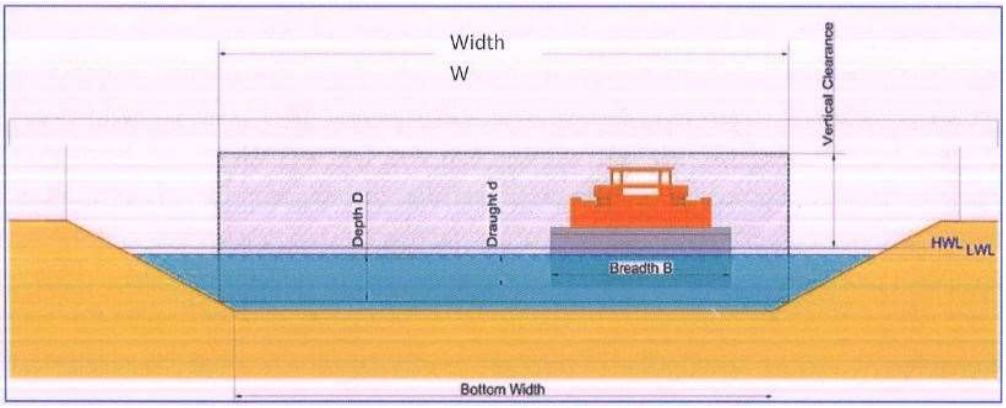


FIGURE 7-1: Dimensions – one way navigation Channel

Proposed dimensions of two ways navigation channel has been shown in **Figure 7.2** below.

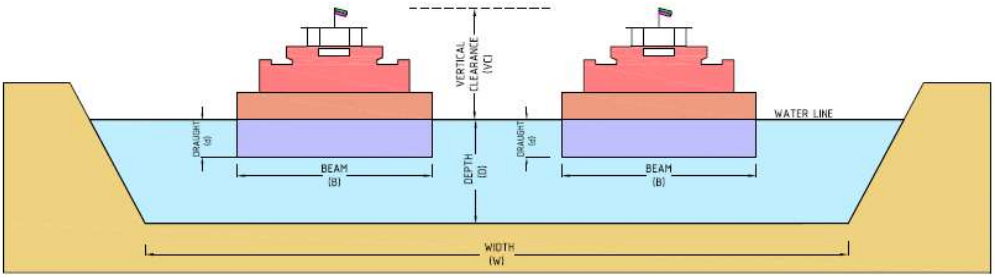


FIGURE 7-2: Dimensions – Two way navigation Channel

7.2.2 Vessel Classification of USA Inland Waterway

As per American Association of State Highway and Transportation Officials (AASTHO) standards, vessels with following dimensions referred in **Figure 7.3** below is under consideration with the characteristics as given in **Table 7.4** and **Table 7.5**.

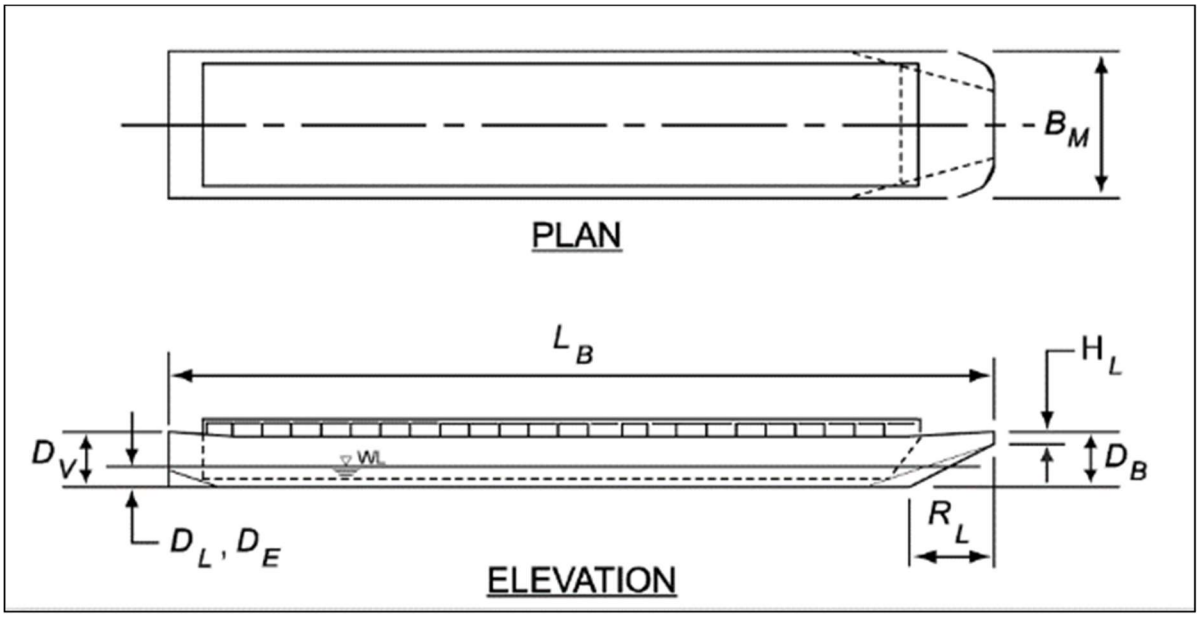


FIGURE 7-3: Plan and Elevation of vessel

TABLE 7-4: TYPICAL BARGE TOW CHARACTERISTICS

Particulars	Symbol	Unit	Jumbo Hopper	Oversize Tank	Special Deck
Width	BM	ft/m	35 / 10.67	53 / 16.15	72 / 21.95
Length	LB	ft/m	195 / 59.44	290 / 88.39	250 / 76.20
Head log Height	HL	ft/m	2-3 / 0.61-0.91	2-3 / 0.61-0.91	3-5 / 0.91-1.52
Depth of Vessel	DV	ft/m	12 / 3.66	12 / 3.66	17 / 5.18
Depth of Bow	DB	ft/m	13 / 3.96	13 / 3.96	18 / 5.49
Bow rake length	RL	ft/m	20 / 6.10	25 / 6.10	30 / 9.14
Loaded Draft	DL	ft/m	8.7 / 2.65	8.7 / 2.65	12.5 / 3.81
Empty (light) draft	DE	ft/m	1.7 / 0.52	1.7 / 0.52	2.5 / 0.76
Cargo Capacity	CC	tons	1700	3700	5000
Empty Displacement	WE	tons	200	600	1300
Loaded Displacement	WL	tons	1900	4300	6300

TABLE 7-5: TYPICAL CHARACTERISTICS OF BARGES ON THE INLAND WATERWAYS SYSTEM

Barge Type	Size	Length (ft/m)	Width (ft/m)	Draft (ft/m)	Capacity (tons)
Open Hopper	Small	120 / 36.58	30 / 9.14	7 / 2.13	630
Open Hopper	Standard	175 / 53.34	26 / 7.92	9 / 2.74	1060
Open Hopper	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Open Hopper	Oversize	245 / 74.68	35 / 10.67	10 / 3.05	2400
Covered Hopper	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Deck Barge	Small	100/150 ------- 30.48/45.72	26/32 ------- 7.92/9.75	6 / 1.83	350/600
Deck Barge	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Deck Barge	Oversize	200 / 60.96	50 / 15.24	9 / 2.74	2050
Tank Barge	Small	135 / 41.15	40 / 12.19	9 / 2.74	1300
Tank Barge	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Tank Barge	Oversize	185/290 ------- 56.39/88.39	53 / 16.15	9 / 2.74	2530/3740

7.2.3 Vessel Classification of European Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7.6** (Ref: SMART Rivers 2015-PIANC).

TABLE 7-6: CLASSIFICATION OF EUROPEAN INLAND WATERWAYS-1992

Type of Inland Waterways		Classes of Navigable waterways	Motor Vessels and barges					Pushed Convoys					Minimum Height under Bridges
			Type of Vessels Characteristics					Type of convoys: General Characteristics					
			Designation	Maximum Length	Maximum Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage	
				L (m)	B (m)	d (m)	T (t)		L (m)	B (m)	d (m)	T (t)	H (m)
1		2	3	4	5	6	7	8	9	10	11	12	13
Of Regional Importance	To West of Elbe	I	Barge	38.5	5.05	1.80-2.2	250-400						4.0
		II	Campine barge	50-55	6.6	2.50	400-650						4.0-5.0
		III	Gustav Koeings	67-80	8.2	2.50	650-1000						4.0-5.0
	To East of Elbe	I	Gross Finow	41	4.7	1.40	180						3.0
		II	BM-500	57	7.5-9.0	1.60	500-600						3.0
		III		67-70	8.2-9.0	1.60-2.00	470-700		118-132	8.2-9.0	1.6-2.0	1000-1200	4.0
Of International Importance		IV	Johann Welker	80-85	9.5	2.50	1000-1500		85	9.5	2.5-2.8	1250-1450	5.25 or 7.0
		Va	large Rhine Vessel	95-110	11.4	2.50-2.80	1500-3000		95-110	11.4	2.5-4.5	1600-3000	5.25 or 7.0 or 9.1
		Vb							172-185	11.4	2.5-4.5	3200-6000	
		VIa							95-110	22.8	2.5-4.5	3200-6000	7.0 or 9.1
		VIb		140	15.0	3.90			185-195	22.8	2.5-4.5	6400-12000	7.0 or 9.1

7.2.4 Vessel Classification of China Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7.7.** (Ref: SMART Rivers 2015-PIANC)

TABLE 7-7: CHARACTERISTICS OF REFERENCE MOTOR CARGO VESSELS- CHINESE CLASSIFICATION

Class	Type of vessel: General Characteristics					Type of convoy : General Characteristics				
		Length	Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage
		m	m	m	T	Push tows	m	m	M	T
II	Barge	75	14	2.6	2000	1) 2P. barge -2 rows *1 columns	180	14	2.6	4000
		65	15.8	2.6-2.9		2) 2P. barge -2 rows *1 columns	160	15.8	2.6-2.9	
	Motor Vessel	90	15.4	2.6		3)1 motor vessel	90	15.4	2.6	2000
		65	13	2.6-2.9		3)1 motor vessel	65	13	2.6-2.9	
III	Barge	65	10.8	1.9-2.2	1000	1) 2 P. barge -2 rows *1 columns	160	10.8	1.9-2.2	2000
		55	10.8	2.5		2) 6 T. barges	357	10.8	2.5	6000
	Motor Vessel	68	10.8	2.6		3) 1 motor vessel	68	10.8	2.6	1000
IV	Barge	42	9.2	1.9	500	1) 2 P. barge -2 rows *1 columns	108	9.2	1.9	1000
		42	8.2	1.9-2.1		2) 7 T. barges	320	8.2	1.9-2.1	3500
	Motor Vessel	52	9.6	2.2		3) 1 motor vessel	52	9.8	2.2	500
V	Barge	30	8	1.8-1.9	300	1) 2 P. barge -2 rows *1 columns	82	8	1.9	600
		35	6.8	1.7-2.0		2) 8 T. barges	303	6.8	1.7-2.0	2400
	Motor Vessel	42	8.2	1.8-2.2		3) 1 motor vessel	42	8.2	1.8-2.2	300

After having elaborate analysis over the important ratios, the following comparison has been found as an apt requirement to arrive at the Channel vessel relationship and the same has been compared with the present Classification of IWT vessels considered by IWAI.

TABLE 7-8: WATERWAY RATIOS OF DIFFERENT COUNTRIES

Relative Waterway Dimensions from Guidelines for different Countries

Location	Ship	Two-lane			One-lane		Driving Quality
	(B x L x D)	F/B	D/d	N	F/B	D/d	category
China Canel	Average (Class III-VII)	4.4	1.3	7	-	-	A-B
China Cannel	Average (Class II-VII)	4.4	1.4	6-7	-	-	A-B
China River	Average (Class I-VII)	4.4	1.2	-	2.3	1.2	A-B
Dutch normal	11.45 x 185 x 3.5	4.0	1.4	8.7	2	1.3	A-B
Dutch narrow	11.45 x 185 x 2.8	3.0	1.3	6.7	-	-	B-C
France	11.45 x 105 x 2.5	3.1	1.4	5.8	-	-	B-C
Germany	11.45 x 185 x 2.8	3.3	1.4	5.6	1.8	1.4	B-C
Russia	16.5 x 135 x 3.5	2.6	1.3	-	1.5	1.3	C
US River	10.7 x 59.5 x 2.7	3.3	1.3	4.9	2.2	1.3	B-C

TABLE 7-9: WATERWAY RATIOS OF INDIAN IWT (RIVERS)

Relative Waterway Dimensions (in Rivers) from Guidelines in vogue in India

Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d Waterway F x D
	F/B	D/d	n	F/B	D/d	
Class I	6.00	1.20	7.20	6.00	1.20	32 x 5 x 1.0 / 80 x 5 x 1.0 30 x 1.2
Class II	5.00	1.17	5.83	5.00	1.17	45 x 8 x 1.2 / 110 x 8 x 1.2 40 x 1.4
Class III	5.56	1.13	6.30	5.56	1.13	58 x 9 x 1.5 / 141 x 9 x 1.5 50 x 1.7
Class IV	4.17	1.11	4.63	4.17	1.11	70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.0
Class V	6.67	1.11	7.41	3.33	1.11	70 x 12 x 1.8 / 170 x 24 x 1.8 80 x 2.0
Class VI	5.71	1.10	6.29	5.71	1.10	86 x 14 x 2.5 / 210 x 14 x 2.5 80 x 2.75
Class VII	7.14	1.10	7.86	3.57	1.10	86 x 14 x 2.5 / 210 x 28 x 2.5 100 x 2.75

TABLE 7-10: WATERWAY RATIOS OF INDIAN IWT (CANALS)

Relative Waterway Dimensions (in Canals) from Guidelines in vogue in India						
Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d Waterway F x D
	F/B	D/d	n	F/B	D/d	
Class I	4.00	1.50	6.00	4.00	1.50	32 x 5 x 1.0 / 80 x 5 x 1.0 20 x 1.5
Class II	3.75	1.50	5.63	3.75	1.50	45 x 8 x 1.2 / 110 x 8 x 1.2 30 x 1.8
Class III	4.44	1.47	6.52	4.44	1.47	58 x 9 x 1.5 / 141 x 9 x 1.5 40 x 2.2
Class IV	4.17	1.39	5.79	4.17	1.39	70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.5
Class V	--	--	--	--	--	70 x 12 x 1.8 / 170 x 24 x 1.8 --
Class VI	4.29	1.40	6.00	4.29	1.40	86 x 14 x 2.5 / 210 x 14 x 2.5 60 x 3.5
Class VII	--	--	--	--	--	86 x 14 x 2.5 / 210 x 28 x 2.5 --

The parameters of Horizontal clearance and Vertical clearance considered in the Indian Waterway classification guidelines are related to the Cross Structures in the particular waterway. These aspects can be modified for the requirement of Vessel / Waterway size, on need basis.

Further, the Bend Radius criterion is related to the terrain, which can be taken care by Cutting / Protection in the curves.

Hence, the basic Vessel design criteria is related to the Cross Section of the Waterway and accordingly, the factors on Breadth (F / B); Depth (D / d) and Cross Section Area (n), which is now being considered for comparison i.e., the Indian IWT classification with the Waterway classifications of other countries, with reference to the Tables above.

The Range variation on the Factors – Width F / B; Depth D / d and N have been tabulated herewith for an overview.

TABLE 7-11: RANGE VARIATION OF THE FACTORS

Factor on Width "F / B"	
Indian classification – Rivers – SPV / Single Channel	4.17 to 7.14
Indian classification – Canals – SPV / Single Channel	3.75 to 4.44
Others – Waterways – SPV / Single Channel	1.50 to 2.30
Indian classification – Rivers – Convoy	3.33 to 6.00
Indian classification – Canals – Convoy	3.75 to 4.44
Others – Waterways – Convoy	2.60 to 4.44
Factor on Depth "D / d"	
Indian classification – Rivers – SPV / Single Channel	1.10 to 1.20
Indian classification – Canals – SPV / Single Channel	1.39 to 1.50
Others – Waterways – SPV / Single Channel	1.20 to 1.40
Indian classification – Rivers – Convoy	1.10 to 1.20

Indian classification – Canals – Convoy	1.39 to 1.50
Others – Waterways – Convoy	1.20 to 1.40
Factor on Cross Section Area "n"	
Indian classification – Waterways – SPV / Single Channel	4.63 to 7.86
Indian classification – Canals – SPV / Single Channel	5.63 to 6.00
Others – Waterways – Convoy	4.90 to 8.70

Note:

Other Waterways, only Chinese waterways are having the segregation available between Rivers and canals. However, the same has not been taken into consideration.

Indian IWT classification has not been provided with "n" value for convoy system, which is essential.

Other Waterways has not been provided with "n" value for SPV / Single Channel.

In the above, the range of Indian IWT Classification on Width factor "F/B" and Cross Section area factor "n" are well within the safer range. Whereas, the Depth factor "D/d" may have to be relooked into and this will have larger implication on the West flowing rivers i.e., the present study stretch areas.

7.3 Type of proposed Vessels

The most suitable river vessel is to be considered based on the following aspects viz., Fairway availability; Availability of Day / Night navigation system; Obstructions enroute like Locks; Navigational clearances free cross structures; Haulage distance; Type and Nature of Cargo; Terminal facilities etc.

Kerala State Inland Navigation Corporation Ltd., Kochi is the prime utilizer of the existing NW 3. The vessels being deployed in NW 3 by KSINC are placed below. There is a possibility of plying these vessels on NW 59 after its development to Class III standards.

KERALA SHIPPING AND INLAND NAVIGATION CORPORATION LIMITED
KOCHI -20, KERALA

DETAILS OF CARGO FLEET OWNED BY KSINC / PLYING ON NW-3

Sl. No.	Name of the vessel	Year Built	Length (LOA) (in m)	Width (in m)	Draft / Depth (in m)	Cargo Capacity (in T)	Engine Make	Engine X HP (No x HP)	Other details, if any
1.	**Archana**	1982	36.45	7.98	1.80 / 2.60	300	Ashok Leyland 370	ALHM, KFEM, 2 x 98 HP	POL barge
2.	**Bhama**	1994	35.37	7.40	1.80 / 2.20	213	Ashok Leyland	AWHM26392, 26454 2 x 160 HP	POL
3.	**Bharatha**	1994	35.25	7.37	1.80 / 2.19	201	Ashok Leyland	22220610431 426, 2x156HP	POL
4.	**Ocean Breeze**	2013 Dec.	53.00	10.00	1.80 / 3.00	498 Gross 175 Net	Cummins India Ltd.	25365721; 25365722 2 x 325 HP	POL - operates only in port area
5.	**Athulya**	2010 March	52.285	10.00	1.80 / 2.80	425	Ashok Leyland	KXHM – 575397 KXHM – 575398 2 x 156HP	Bulk
6.	**Orion**	2017	49.00	9.00	1.80 / 2.75	349	Ashok Leyland 60T19	HFHM 408150; 408151 2 x 220 HP	Bulk
7.	**Amla**	1987	34.09	7.45	1.80 / 2.64	276	Ashok Leyland ALMU 402	LKEM 0423801; 042383 2 x 88 HP	Phosphoric Acid

ALL BARGES OPERATE ONLY IN THE UDYOGAMANDAL AND CHAMPAKKARA CANALS OF NW-3

In brief, the study stretch of NW 59 is being considered for Ro-Ro operation with Class III canal standard, which can operate Ro-Ro vessel

Vessel Requirement for a waterway can be segregated mainly into two parts i.e., Waterway maintenance vessels and Cargo vessels. There are many vessels required for maintenance of waterway viz., Dredgers; Tugs; Survey vessels; Navigational Equipment maintenance vessels; Patrol Boats; Pilot Boats; Inspection Vessels etc.,. The said abundant types of vessels may not be required for the proposed stretch and neither suggested nor recommended.

With regard to the Ro-Ro vessel, it is suggested the deployment of 1 No. vessel at initial stages and may be considered with augmentation, on observing the Growth.

7.4 Proposed Vessel Size and Specifications

Keeping in view the non-availability of any cargo and with an anticipated Ro-Ro, in the long run, the following vessel specifications are preferred and indicative.

With regard to the Ro-Ro operation, the vessel size proposed for such mobility will be considered at the initial stage with 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. Initially the operation will be taken up with ONE vessel deployment and can be augmented with growth observation.

These assumptions are being considered for theoretical working, since the development of NW 59 is not viable for recommendation (of development).

7.5 Turn around Time

Turn Around Time (TAT) for the Inland Navigation is a most critical analysis, involving many practical issues, linked with the Fairway constraints; Terminal Operational Constraints; Availability of Day / Night Navigation system; Vessel speed etc.,.

In the existing study stretch of NW 59, the Origin / Destination may be from ICTT, Kochi, which may be of about 80km. Not suggested any time span at this stage.

7.6 Number of Vessels Required

Since, there is no suggested development, experimental deployment can be considered to ascertain / assess the potential.

1 Ro-Ro vessel may be required at the initial stages i.e., by 2022.

7.7 Vessel Repair facilities

Vessel Repair facility in close proximity always will have added advantage for ease and timely operation of IWT Vessels. On board Minor repairs can be considered, while the vessel under mobility, wherein the Major repairs and Dry Dock repairs may have to be attended only in the Ship Yards.

In the NW 59 reach, i.e. in Vembanad Lake area, No repair yard exists to attend the Dock type of Repairs of IWT Vessels plying in this region.

The “Cochin Ship Yard” in Kochi Kochi is the Public Sector Undertaking under the Ministry of Shipping, Government of India.The Ship Yard is catered for undertaking the Construction and Repair of the Sea going ships. It may attend the construction of IWT Vessels. However, undertaking the repair of IWT Vessels may not be cost effective for such big Ship Yard. CSY,

KSINC is having a Boat Yard in Perumanoor area of Kochi adjacent to Venduruthy (Rail) Bridge connecting Wellingdon Island, Kochi with main Ernakulam city. KSINC has been constructing passenger boats, speed boats, house boats, tourist boats and small seagoing vessels. It constructs the vessels using wood, steel or FRP as per the requirements of customers. KSINC also has experience in repair (both hull and machinery) of large variety vessels. KSINC has a slipway, where vessels of weight up to 200 MTs can be hauled up and repaired. There are facilities to dock six vessels at a time. Facilities for manufacture, repair and servicing of seagoing and inland navigation vessels are available. This location is about 60 Kms. North of NW 8 study area.

Kerala Water Transport Department is having a Boat Repair Yard at Alappuzha, which attends only the repair and docking of Department / Govt. of Kerala Vessels.

The following are certain repair yards in KOCHI area, attending the repair of IWT Vessels, as ascertained.

Sl.no	Name of company	Address	email id	Phone number
1	J Pee Marine	14/548 Nazreth, Kochi - 682002	jpeemarine@gmail.com	91-9496072700
2	Unotech Marine Engineering and service Pvt Ltd	39/2394 C First floor veejay towers, Salim - Rajan road Gandhinagar, Kochi - 682017	mail@unotechmarine.com	91-484-2206033
3	Cochin Marine Engineering	Door No.7/472 Kochangadi Road, Kochi - 682002	cinmarine@gmail.com	91-9895480901
4	Sea Blue Shipyard Ltd	1/212, VP Road, Azheekal PO, Vypin, Kochi – 682510	josejames@seablueshipyard.com	91-484-4567890
5	Krishna Marine Engineering	40/7818, Anjaly T.D Rd, Ernakulam, Kochi – 682035	appuajay93@gmail.com	91-9388850888
6	Western Marine Engineering	Near St.Lawrence school, P.Box. 915 Edakochi, Kochi - 682010	westernmarine@gmail.com	91-9895186610
7	Walrus Marine And Engineering Co.Pvt.Ltd	Anjikkattu Towers, Near Metro Pillar 363,Koonamthai, Edappally, Kochi - 682024	navneeth@walrusmarine.com	91-9746475712
8	Sea Max Marine Service Pvt Ltd	Thoppil tower, 2nd Floor, Opp.St.Joseph Church, N.F.Gate, Tripunithura, Kochi - 682301	ops@seamax.co.in	91-9947107775
9	4.Square Marine	61/589, Zaabil Building, R. Madhavan Nair Road (Old Thevara Road), Kochi, - 682016	info@4squaremarine.com	91-9496252868

7.8 Vessel Costing

7.8.1 Capital Cost

At the outset, it is to place that the Capital Cost of the vessel may not form part of the Financial / Cost analysis, since the deployment of vessels will be considered by the Vessel Owners, who will deploy the required type of vessel. It has been noted that the Capital Vessel Building Subsidy is under consideration by IWAI / Administrative Ministry of Shipping, which is being recommended herewith to give boost to this sector.

Hence, the indicative cost, as ascertained from the Market, is being furnished herewith.

The SPV / Ro-Ro vessel is suggested with 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 700 Lakhs each.**

7.8.2 O&M Cost

The Operation & Maintenance cost (O & M Cost) for the Vessels being considered in the IWT project, in general, consists of Running Cost of the vessels; Crew Cost; Repair Cost; Depreciation Cost; Insurance factor and Interest Factor. The vessel mobility is under consideration of 1 Ro-Ro Vessel, for which working the O & M Costs will not have any bearing at this point of time. The following cost factors are only indicative.

1 Ro-Ro Vessel (For 1 Year)

- 1 vessel running cost for 300 days operation for 8 Hrs / day (Optimum running).
- 300 days x 8 Hrs x {0.1 Liter per hour x 3 Engines x 375 Bhp} x INR 70 per Litre = **INR 189 Lakhs Per Annum**.
- 8 Nos. Crew on 1 Vessel @ INR 0.50 Lakhs per month.
- Crew cost for 12 months will be 12 x 8 x 0.5 = **INR 48 Lakhs Per Annum** per Unit.
- Repair Cost is @ 2 % P. A of CAPEX i.e., 0.02 {1 x 700} = **INR 14 Lakhs per Annum.**
- Depreciation is proposed by considering the life of vessels as 20 Yrs.
- Interest factor is proposed as per the industry norms.
- Insurance factor is proposed as per the industry norms.

Note: Depth + is an indication for provision of increased depth for the vessel mobility.

CHAPTER 8 NAVIGATION AND COMMUNICATION SYSTEM

8.1 General Requirements

A fool proof communication system in the River Navigation is a most important requirement in order to maintain the safety of the entire system. Safety is one of the important parameters that have to be considered for the development of the inland navigation along with the protection of the environment and efficiency. In order to have undisturbed and uninterrupted development and maintenance of Inland navigation System, safe communication is most important.

Safety implies that navigation risks on the waterway stretch need to be at an acceptable level. In particular, the risks of:

- Ship-to-ship collisions;
- Ship-bridge collisions;
- Groundings;

need to be minimised, rather to be nullified. Accordingly, to accomplish, an adequate visual marking of the fairway have to be done. Even if more advanced and potentially more accurate systems are deployed, visual fairway markings are used to verify proper navigation and are also a necessary backup in case of system failures.

8.1.1 VHF / HF

Communication is essential for navigation in Inland Waterways. Due to the VHF the captains of the vessel can communicate with each other. The VHF communication can be recorded if the system will be equipped with VHF-transceiver. The recordings of the VHF can be used to investigate incidents or near-incidents to prevent future incidents.

8.1.2 GPS

The DGPS system provides the RIS-system with a correction value. This correction value increases the accuracy of the AIS transponders on-board of the vessels. The AIS base station transmits the correction signal through the designated AIS message or DGPS correction.

8.1.3 RIS / AIS / Radar / VTMS

RIS is a concept for harmonised information services which supports traffic and transport management in inland navigation, including interfaces to other transport modes.

The general technical solution is depicted in Figure below.

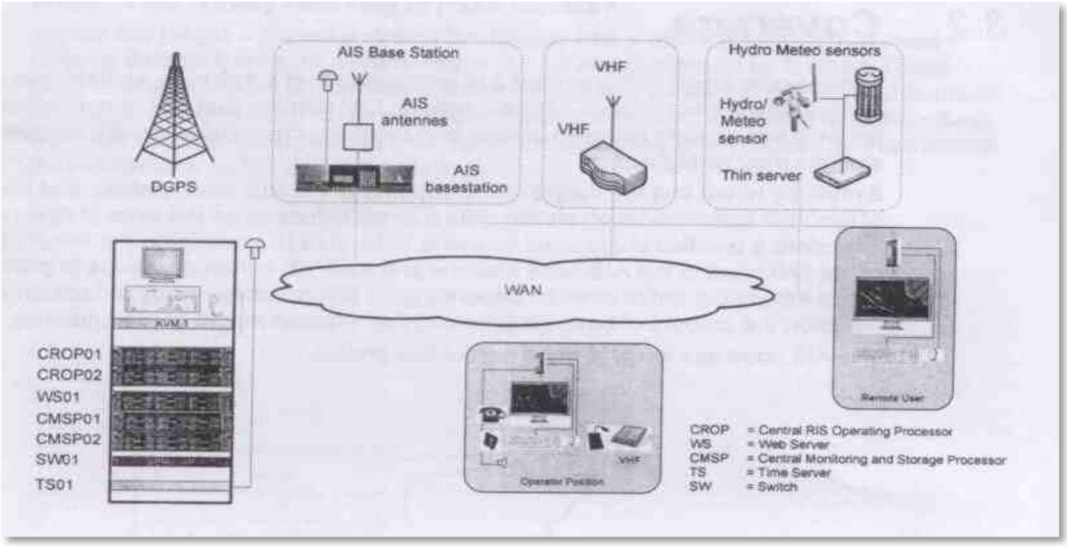
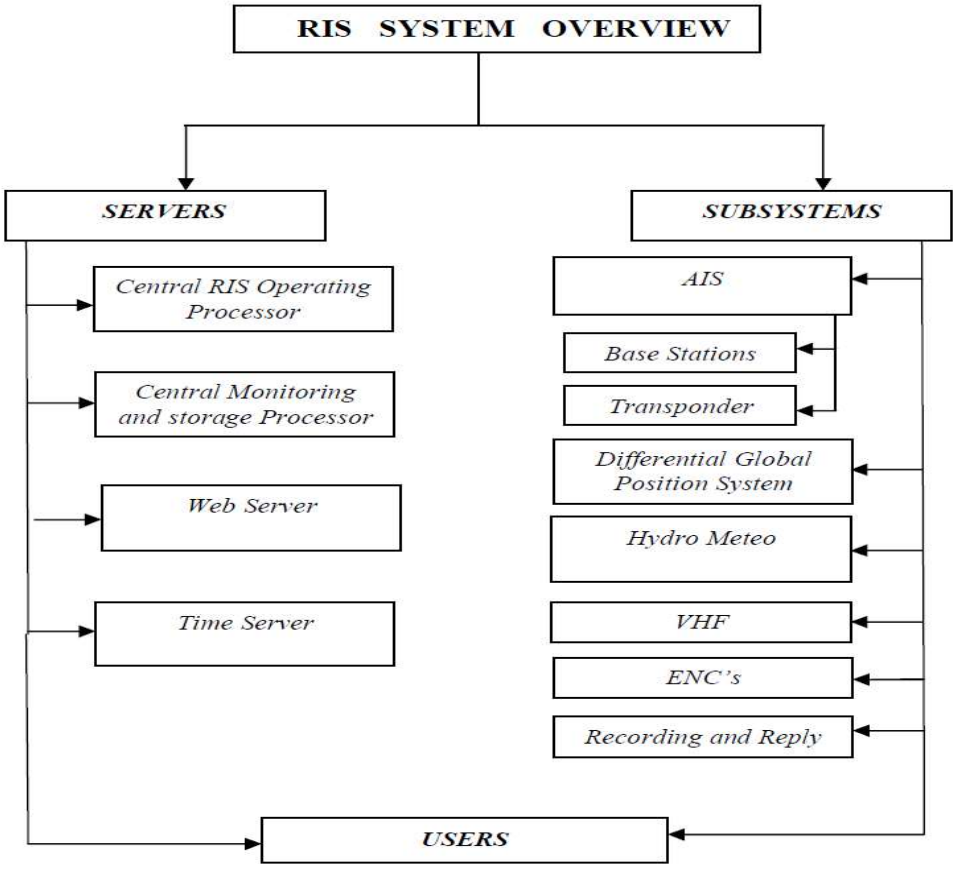


Figure 8-1: Main components of the RIS system are given below in flowchart:



River Information Service (RIS) system is one among the latest technology introduced in Inland Water Transport sector, which is in nascent stage in India. It has been ascertained that the system is suitably designed keeping in view the PIANC and IALA guidelines for setting up of RIS.

In the RIS system, a group of base stations is connected by LAN through lease line. Each of the stations is located at 50-60Kms intervals. These base stations will have 30 Kms (approx.) radial coverage and two way communication between vessels plying in their region and management authority. The goal of safe and efficient transportation can be achieved by avoiding navigational risks like ship to ship collision, ship to bridge collisions and vessel groundings. In addition, RIS system provides fairway information, traffic information, calamity abatement support etc. Efficiency of this system gets greatly increased when there are multiple users of the waterway with different type of vessels and different types of cargo.

Components of RIS systems: The River Information Services (RIS) System consists of (a) base stations, (b) control stations and (c) Mobile /user stations.

a. Base station: Deploy series of sensors for exchange of electronic data between the control station and the vessels. Two porta cabin at each stations are equipped with latest version of the sophisticated electronic equipment's transmit the waterway information namely navigable depth in their jurisdiction, channel limits with virtual buoys, terminal facilities, port clearance etc. The AIS and VHF antennae and meteorological sensors are installed on the mono pole tower of 30 meter height at each station to provide update weather information. The basis of height calculation will be considered based on the geographical position including the Antenna height and the vessel Antenna elevation.

The list of equipment's include

- Automatic Identification Systems (AIS) equipment
- Meteorological equipment.
- VHF equipment's with Tx/Rx installed on 30 mtr mono pole.
- Gen Set 10 KVA with UPS 5 KVA for 2 hours backup.

b. Control station: The control station is responsible for situational awareness of waterway for undertaking coordinated actions to ensure safe passage of vessels through the waterway. The control station has been set up along with any one of the base station suitability near to the Regional Office. As the name indicates, control station carry out all standing orders and collect the data of cargo/vessel movement and keep back up for analysis and further improvement of efficiency. The control centers include 2x control Centers Servers for AIS data record and display, WEB Servers which provide traffic situation presentation via Web interface. This also includes Operator Workstations. Operator have comprehensive tabular information about traffic, wide variety of navigational alarms, traffic management tools like zones, reporting lines, routes, traffic prediction tools, control of AIS base stations. Tools such as Playback are available for each Operator. All above mentioned system components interact between each other via TCP/IP protocol i.e. proposed system is completely IP based. The control station consists of the following computer hardware:-

- Central RIS Operating Processor
- Central Monitoring and Storage Processor
- Web Server & Time Server
- Workstation

- Operator Display 52” LED wide Screen+ with operator display
- RIS software

c. Mobile/user station;- The state of art equipment installed on board each vessel for her safe navigation and smooth sailing for 24x7 in clock.

- AIS Transponder Inland Class – A
- VHF Sets with Antenna
- Echo Sounder
- DGPS Receiver
- Short Range Radar
- Laptop (Tough Book) - 14” with 5 KVA UPS
- MFD Multi-Function Display 19” size

d. Manpower: Each of the base stations and control station are manned 24x7 round the clock by 3 operators and 3 security personnel. Accommodation facilities have been provided in the porta cabins. The manpower deployments are covered under Operation and Maintenance of RIS system.

As ascertained, IWAI has already initiated the implementation of RIS system in phased manner.

Observations:

1. AIS receiver is must on board the vessels utilizing the Waterway.

2. Preferred to provide the RADARs installed at selected locations, for easy tracking of vessels.

3. Trained Operators can effectively be utilized for ensuring proper running of RIS system.

8.1.4 Vessel / Hydrographic Survey equipment

The RIS-system also requires that certain systems are available and working on the used vessels. The system should be connected and integrated with each other. The required systems are:

- AIS transponder
- VHF
- Radar
- Hydro and meteo sensors
- Echo sounder
- Electronic chart display capable of displaying virtual buoys.

8.2 Existing System

IWAI is already having the communication system on NW 1 / NW 2 along with Day / Night Navigation system which have been developed considering the AIS and DGPS stations. Further, the adaptable Digitized charts are already being used linked with Survey Equipments viz., Echo-sounders and GPS with a provision for updating the charts. Provision also is under consideration to link up with the Day / Night Navigation Buoys.

8.3 Additional requirement

The communication system technology is rapidly changing with Technology change. Accordingly, within a short gap of time, the existing system is leading to an obsolete scenario. Hence, development of a sustainable system is very difficult. However, an attempt has been made and a workable rather reliable system has been worked out and placed as Annexure 8.1. This is only indicative.

Further to the above, an attempt has been made to ascertain the details on the alternative real time ship tracking system viz., Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed.

Subsequent to the discussions with the stakeholders' viz., Maharashtra Maritime Board and Mumbai Port Trust, it was noticed that the Ministry of Shipping, Govt. Of India has already initiated the working about feasibility and implementation of "National Coastal Grid of VTMS", in which a considerable distance of the Rivers joining the sea also is under consideration. This proposal is from the strategic safety point of view and is expected to take some more time. It is suggested to have a dialogue at later date by IWAI for a full proof communication / navigation system in the National Waterways joining the sea in both West / East coast.

Regarding the RIS on "NW 59", this stretch is nothing but a canal system and not amenable for provision of RIS. However, the cost details are provisioned for taking up the same, at later date, if the need is judicious.

At this stage, it is recommended to proceed ahead with the available Mobile Networking system and later on an amenable system can be adopted, subsequent to the considerable progress on "National Coastal Grid of VTMS".

8.4 Specifications of certain equipment's of the system

The following indicative specifications on various equipment's proposed for developing the RIS unit are placed. A system context Diagram is placed at the end.

VHF sets with Antenna

- Channel Capacity minimum - 100
- Frequencies 156.00 - 161.50 Mhz (Marine Universal frequency band)
- Rx @ Rated Audio 2 A max
- Tx @ Rated Audio 14.5 A max
- Power Supply 12 VDC to 24 VDC

- Channel Spacing :- 12.5 kHz/ 25 kHz
- Audio Response:- + 1, -3 dB
- Adjacent Channel Selectivity:- 60 dB @ 12.5 kHz 70 dB @ 25 kHz

Metrological Equipment's (Anemometer, Barometer, Relative Humidity)

Wind Speed

- Range: 0 to 60 m/s
- response time 250 ms
- accuracy : 0 to 35 m/s: ±0.3 m/s or ±3%, whichever is greater
- Output resolution and unit: 0.01m/s
- Protection IP66
- Serial Output:RS232/485

Wind Direction

- Azimuth: 0 to 360°
- Response time: 250 ms
- Accuracy: ±3°
- Output resolution and unit: 1°
- Protection IP66
- Serial Output:RS232/485

Air temperature

- Range: - 50 3 to +60 °C
- Accuracy for sensor at +20 °C: ±0.3 °C
- Output resolution and unit: 0.1 °C

Barometric pressure

- Range: 600 to 1100 hPa
- Temp: -50 to +60 °C
- Accuracy: ±0.5% of analog pressure range, digital accuracy 0.2 hPa (25°C)
- Output resolution: 0.2hPa

Relative humidity

- Range: 0 to 100 %RH
- Accuracy: ±3 %RH within 0 to 90 %RH ±5 %RH within 90 to 100 %RH

Output resolution and unit: 0.1 % RH

Control Station Servers (CROP / CMSP / WS / TS)

Central RIS Operating Processor (Application cum Data base Server)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 2TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- 52" LED Display. The Operator console should be minimum 21” size.

Central Monitoring and Storage Processor (Web Server / GIS Software)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 10TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition

Web Server & Time Server (Application cum Data base Server)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 4TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- Concurrent 50 web users

Operator Console

• Processor :-	Intel® Core™ Xeon Processor or Better
• Operating System :-	Latest Windows operating system 64 bit (English)
• Display :-	24. 0" (min)
• Memory :-	16 GB RAM (min)
• Hard Drive :-	2.0 TB SATA Hard Drive (min)
• Optical Drive :-	DVD +/- RW

• USB Ports	4 Ports minimum
• Memory card	Standard Memory Card Reader
• Warranty :-	3 Year Complete Cover

Operator Display

- 52” LED Display wide Screen

General Features for RIS Software/ Application

1. Provide the situational awareness and Traffic overview of channel to the Traffic Operators in the Control centre.

2. Facilitate planning of the river Channel activities on a ‘Time-line’ view of the Traffic Display.

- The GUI (Graphical User Interface) should be capable of displaying the arrival and departure information of vessels entering and exiting the Channel with date and time indicators.
- List all important activities being undertaken in the Channel
- Should Display various important activities being undertaken in the Channel, which includes activities of the ‘previous Operator Watch’, ‘current Watch’ and the activities being planned for the ‘next Watch’.
- It must be possible to define start and end-point of the time line
- It must be possible to choose the waterway for the time line.

3. Facilitate the Operator to ‘Define’ the conditions for generating Alerts / Warnings by the system and automatic generation of Alerts / Warnings in the event of any abnormality

4. Facilitate escalation of the alerts / warnings to all important stakeholders using SMS / email.

5. Undertake Incident management during emergencies

6. Receive AIS messages from Base stations and store important AIS messages. Data storage facilities should be able to store data for a period of one year. AIS messages received by multiple stations shall be stored only once.

7. Send out AIS messages broadcast and individual to Vessels in the river channel

8. Disseminate met data on case to case basis to vessels in the system.

9. Facilitate communications between the Traffic operator and captains of the vessels using VHF.

10. Provide the situational awareness and Traffic overview of the river channel to important stakeholders over the web using web access. Web Access shall be planned for minimum 50 stakeholders which shall be scalable at later date.

11. Application should be web based and available on PC, tablet and smartphone (Android and IoS). Application must be available as App for Android Users.

12. BITE facility to provide system status to the Operators to detect any abnormality in the functioning of the sensors integrated with the system.

13. Support integration with other Command and Control systems of security agencies of Police, Navy / Coastguard etc. for building up a collaborative contingency plan in case of emergencies.

14. Should facilitate Storing of important information being received from the sensors such as:-

- Storing of display scenarios
- AIS messages
- VHF data
- Warning / Alerts

Minimum one year data shall be stored.

15. Facilitate automatic detection of the abnormal behaviors of Vessels such as over speeding, vessel entering or leaving demarcated non-entry area, Anchor watch etc. This automatic detection shall be done based on AIS data in the system.

16. Should be able to Zoom, and navigate to any geographical area in the Channel.

17. Should be possible to switch between ENC and Google Maps presentation.

18. Should have the facility for inserting temporary charts (such as plotting point, lines, circle etc.) on the map.

19. Should be able to search any vessel on the geographical location at the given instant.

20. Should have tools to calculate “Closest Point of Approach, TCPA, Range & Bearing Line, ETA, Distance between 2 Vessels or points” etc. in the Channel.

21. Facilitate geo fencing.

22. Capability to provide Virtual Buoys / Aids to Navigation inputs. This according international standard for ATON via AIS.

Based on the market survey, the cost implications are placed herewith.

8.5 Costing

8.5.1 Capital Cost / O & M Cost

Provision of RIS is not suggested, at this point of time. However, cost implications are placed.

COST FOR RIS SYSTEM ON “NW 59”

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
A.	**CAPITAL COST**			
1	AIS Base Station (Hot standby for 2 locations)	2	30,00,000	60,00,000

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
2	RADAR	1	50,00,000	50,00,000
3	Meteo Sensor	1	8,00,000	8,00,000
4	ATG	2	11,90,000	23,80,000
5	VHF	2	5,00,000	10,00,000
6	DG Set 10 KVA	1	7,00,000	7,00,000
7	UPS	1	5,00,000	5,00,000
8	RIS Software	1	65,00,000	65,00,000
9	RIS Hardware	1	120,00,000	1,20,00,000
10	Installation Testing & Commissioning	1	20,00,000	20,00,000
11	Porta cabin	2	12,00,000	24,00,000
12	Trestle Tower	2	10,00,000	20,00,000
13	Land Cost	-	Lump Sum	34,20,000
14	Buildings etc.,	-	Lump Sum	74,00,000
			Total	**5,21,00,000**
B.	**MANPOWER COST**			
	1ST YEAR			
	1 Engineer * 1 NW * 12 months p. a	12	35,000	4,20,000
	3 Operators * 2 Sites * 12 months p. a	72	20,000	14,40,000
	3 Security * 2 Sites * 12 months p. a	72	15,000	10,80,000
	Total for 1st year			**29,40,000**
	Total for 2nd year (10 % on the previous year)			**32,34,000**
	Total for 3rd year (10 % on the previous year)			**35,57,400**
	Total for 4th year (10 % on the previous year)			**39,31,140**
D.	**CAMC for 4 years**			
	1st year			**-Nil-**
	2nd year (10 % on the Capital Cost)			**52,10,000**
	3rd year (+ 10 % on the previous year Cost)			**57,31,000**
	4th year (+ 10 % on the previous year Cost)			**63,04,100**
D.	**LICENSE COST (per annum)**			
	Wireless etc.,			33,00,000
	VHF	2	5,000	10,000
	Other Miscellaneous		Lump Sum	90,000
			Total	**34,00,000**

A. Equipment Cost has been ascertained from the Market, in consultation with IWAI.

B. Man Power Cost has been worked out as per the requirement and only indicative.

C. Cumulative Annual Maintenance Cost is indicative.

D. The Annual License Cost may vary according to the policy of the Licensing Authority.

E. The above cost is not being considered for any cost analysis, since it is only optional.

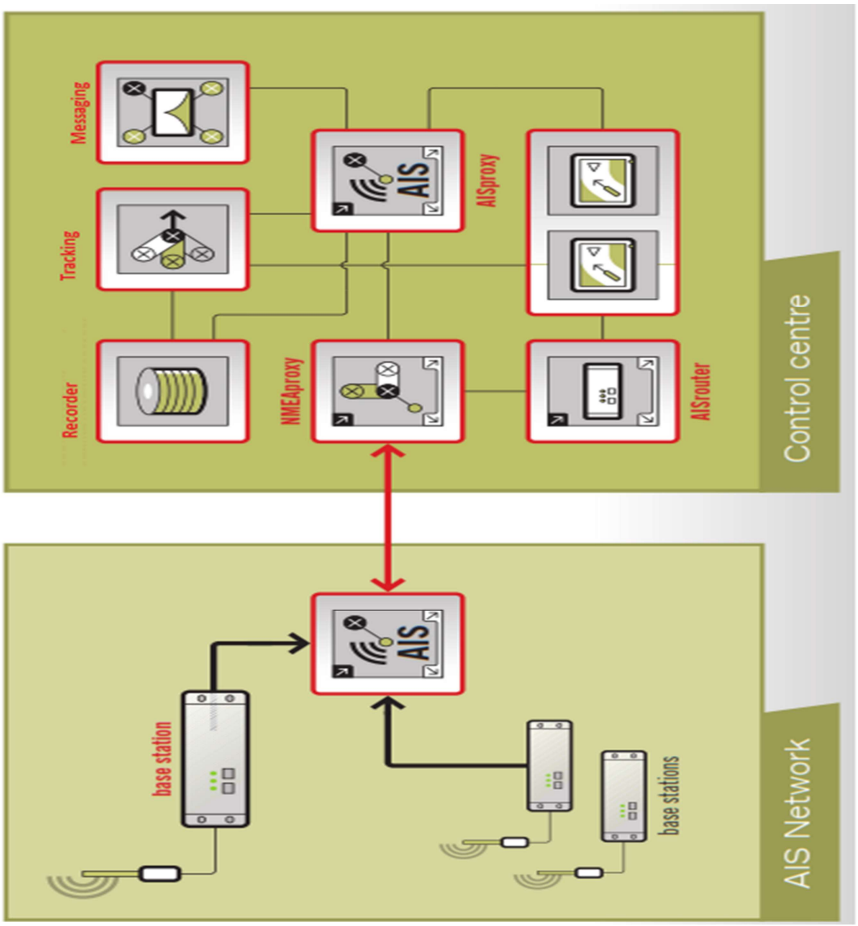
F. If RIS is planned for implementation, additional cost of INR 0.5 Lakhs / Buoy may have to be added.

Further, Typical Automatic Identification System (AIS) and its connectivity to Control Centre and a typical line diagram showing the interface of other systems with the Radar system are placed herewith.

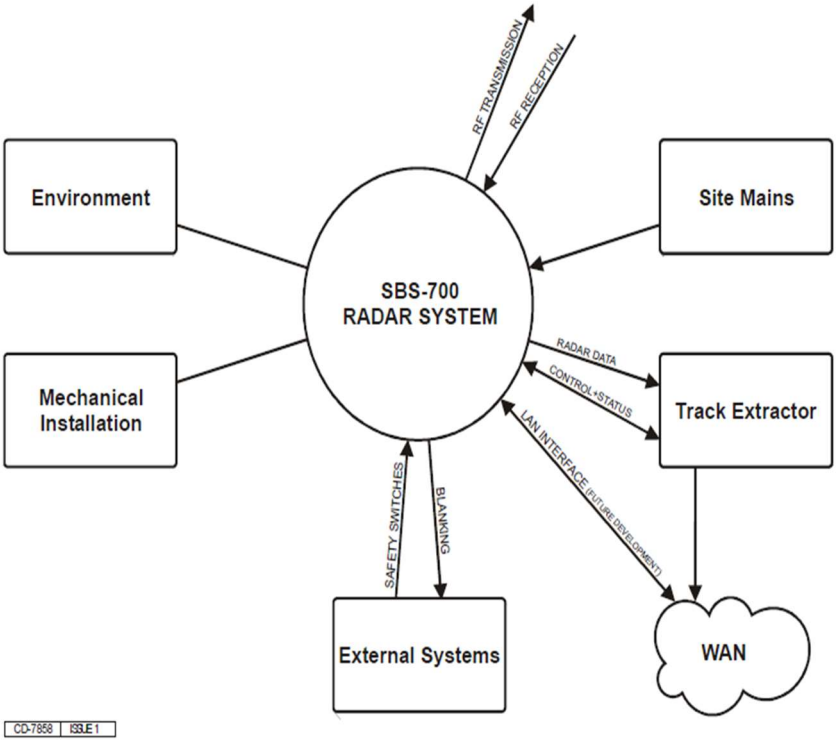
AIS (Automatic Identification System)

Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

The AIS Base Stations installed in VTS will receives ships information and send to data processing for process and display on Display Terminals



AIS (Automatic Identification System)



The proposed navigation on “NW 59” is on a canal system. The cost details are worked out only for taking up the same at later date, if the need be required. Inland Waterways Authority of India (IWAI) is planning for installation of RIS in NW-3 West Coast Canal System (Kottapuram- Kollam, Udyogmandal & Champakara): 205 km. The system shall enhance swift electronic data transfer between mobile vessels and shore (Base stations) through advance and real-time exchange of information. As RIS ensures safety of vessels in navigation, as per the Inland Vessel Act, all the vessels is to be equipped with RIS compatible equipment. The range of RIS system shall normally be in the range of 100-125 kms surrounding the base station, hence there is no requirement of separate RIS for NW-59 as these waterways shall be covered by RIS system being planned under NW-3. The cost has not been included in the DPR cost.

CHAPTER 9 ENVIRONMENTAL & SOCIAL ASPECTS

9.1 Objective of Environmental and Social Studies

The objective of the environmental and social studies is to assess the environmental and social impacts due to the proposed development works and suggest a suitable environmental management plan (EMP) to mitigate adverse impacts, if any, including its cost. In addition, Consultant has to identify the authorities who will give the clearance for EIA / EMP.

9.2 Environmental Setting in the Project Area

The proposed project is designated as national waterway no. 59 (NW-59) under the National Waterways Act 2016 and is located on Vechoor-Athirampuzha Canal in Kottayam district of Kerala State. It is a 18.80 km stretch beginning from Vechoor at Lat 09°40'00"N, Lon 76°24'11"E to the Athrampuzha market at Lat 09°40'04"N, Lon 76°31'54"E.

Nearly 340 m (0.34 km) of the NW-59 stretch falls within the Vembanad Lake in Kerala, which is designated as a Ramsar wetland site. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

The Vembanad wetland system covers an area of over 2033.02 km² thereby making it the largest wetland system in India. The lake is bordered by Alappuzha, Kottayam and Ernakulam districts. It is separated from the Arabian Sea by a narrow barrier island.

A unique characteristic of the lake is the 1,252 metres (4,108 ft) long Thanneermukkom salt water barrier (Barrage) constructed as a part of the Kuttanad Development Scheme to prevent tidal action and intrusion of salt water into the Kuttanad low-lands. It is the largest mud regulator in India and essentially divides the lake into two parts, one with perennial brackish water and the other with fresh water from rivers draining into the lake.

This barrier has helped farmers in Kuttanad by freeing the area of salinity and by allowing them an additional crop in the dry season. The Thanneermukkom barrier is located at one of the narrower parts of the Vembanad Lake.

An Index Map of Vechoor-Athirampuzha Canal (NW 59) is shown in Figure 9.1 below.

Figure 9-1: Index Map of Vechoor-Athirampuzha Canal

The environmental setting in the project area is described in the sections that follow. It may be noted that since NW-8, 9 and 59 are located close to each other, their environmental setting remains largely the same.

9.2.1 Physiography

Kerala State is situated between 8°8' and 18°48' North latitude and 74°4' to 77°50' East longitude, along the windward side of the Western Ghats of Indian Peninsula. The State is located in the tropical region of Indian Peninsula and extends to an area of about 38863 km2, which accounts for about 1. 2 per cent of the total geographical area of the country. The State has a total coastline of about 560 km and from sea level it rises to about 2694 m above msl.

The State is bordered by the Arabian Sea on the western side and the Western Ghats on the eastern side. Kerala shares it borders with Karnataka State at the extreme north and with Tamil Nadu in the remaining eastern and southern sides.

Physiographically, the terrain has three natural regions namely: (i) the highlands (600–1800 m high), (ii) the midlands (300–600 m high) and (iii) the lowlands (6–300 m high). These three zones lie parallel to one another in the south-north direction. The broadest part of Kerala is at the middle, which is nearly 130 km wide and towards the north and south, it narrows down to about 30 km.

(i) The Highlands

The mountain terrains of the Western Ghats constitutes the highlands. Around 48% of Kerala's land area is taken up by the Western Ghats. The main hill range covers more than 20,000 sq km of land in Kerala. The average height of the Western Ghats in Kerala is 900 m but there are a number of peaks above 1800 m and the highest

peak, Anaimudi, has a height of 2694 m. The highlands have dense forest cover and also have large tracts of plantations of cardamom tea and coffee.

(ii) The Midlands

The midlands lying between the highlands and the lowlands form roughly 40% of the land area. The midlands have a topography of undulating hills and valleys. Here natural forests are sparse and most areas are under cultivation of crops such as cashew, coconut, areca nut, tapioca, banana, rubber and different varieties of vegetables.

(iii) The Lowlands

The lowlands comprise the western coastal plains which are made up of 81 lagoons, river deltas, backwaters and the shores of Arabian Sea. Coconut and rice are widely cultivated in these areas.

Kerala has 44 perennial rivers, of which three are east flowing and the remaining 41 are emptied into the Lakshadweep Sea, along the western side of the State. Rivers are generally swift flowing having very steep gradients in their higher reaches. Absence of delta formation is characteristic of Kerala Rivers. As per national norm (Rao, 1979), there are no major rivers in Kerala. The four medium rivers, namely Chaliyar, Bharathapuzha, Periyar and Pamba have a total drainage area of only 8250 km2 with length 169 km, 209 km, 244 km and 176 km respectively. The length of rest of the rivers varies from 16 km to 130 km, with an average length of 62 km and total drainage area of 19,485 km2.

There are two fresh water lakes in the State namely the Pookot and Sasthamkottah. The State is also having a total of 46.13 km2 of estuaries and backwaters. The important backwaters are Vembanad and Ashtamudi lakes.

The major rivers in Kottayam district are the Meenachil River, the Muvathupuzha River and the Manimala River. The Meenachil River flows through Meenachil, Vaikom and Kottayam taluks. The total catchment area of Meenachil River is 1272 sq km and is formed by several streams originating from the Western Ghats in Idukki district. The Poonjar river join at Erratupetta, the Chittar River join at Kondur and the Payapparathodu join at Lalam. Finally the river confluences with Vembanad Lake. The Muvattupuzha River originates from Idukki district flowing mostly through Vaikom taluk and joins with Vembanad Lake. The Manimala river flows through Kanjirapally and Chanaganacherry taluks. The Chittar joins it on its course further down the west as it flow towards Alappuzha district.

(Sources: 1. http://www.kerenvis.nic.in/Database/ENVIRONMENT_821.aspx;

2. http://shodhganga.inflibnet.ac.in/bitstream/10603/87093/9/09_chapter%204.pdf

3. http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_ala.pdf

4. http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.2.2 Geology and Seismicity

Geologically, Kerala is occupied by four major rock formations namely, crystalline rocks of Precambrian age, sedimentary rocks of Tertiary confined to Neogene period,

laterites capping the crystalline and sedimentary rocks and recent and sub recent sediments forming the low-lying areas and river valleys. There are sporadic Paleozoic granites and pegmatite and Meso-Cenozoic dykes intruding these rocks. The oldest rocks so far dated in Kerala are the charnockites, which yielded an age of 2930 ± 50 Ma (Soman, 1997& 2002). The varied rock formations under different geological domains harbour different mineral deposits and the transformed rock strata stockpile copious groundwater resource. (Source: State of Environment Report, Kerala 2007, Volume I, Kerala State Council for Science, Technology and Environment, Government of Kerala).

Kottayam district shows a very interesting correspondence between the major rock classes and their physiographic expression. The east comprises Precambrian metamorphic rocks and forms hilly ground. The central part is a low plateau, where Tertiary sediments containing lignite occur. These are followed by further west by a low plain, which is underlain by Quaternary Formations, fluvial or partly marine.

The Charnockite Group dominates in areal distribution with charnockite, charnockite gneiss and diopside gneiss occupying the major part. Pyroxenen granulite (with hornblende granulite), magnetitie quartzite and cordierite gneiss occur as concordant bands within charnockite. The linear bands of quartzite (Khondalite Group) are the oldest rock of the area. Biotite geniss (composite gneiss) representing the Migmatite Complex has a limited areal extent, west of Ettumanur and along the eastern boundary.

Three major granite bodies are emplaced in the district, two along the southwest and other in the east. Numerous dolerite and gabbro dykes trending NW-SE traverse the older basement rocks in the central and eastern parts. A prominent gabbro dyke extends from north to south with a NNW-SSE trend. Tertiary sediments comprising sandstone, clay with lignite intercalations are confined to the west and they occur as small patches, especially as capping on hillocks. Both the Archaean and Tertiary rocks are lateritised. Quaternary alluvial deposits occur to the west. They have been classified into various morphostratigraphic units, based on their environment of formation, as Guruvayur Formation (palaeo-marine), Periyar Formation (fluvial) and Viyyam Formation (fluvio-marine). (Source:

http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

As per the seismic zoning map of India, the project area falls under seismic zone III and indicates moderate seismicity. Kerala has experienced occasional mild tremors since historical times. A seismic hazard map with 10% probability of exceedance in 50 years assigns low-level hazard to regions falling in Kerala. However pockets of higher ground acceleration have been identified in central Kerala.

In Kerala, several deep seated faults exist, the notable among them are Periyar fault, Idamalayar fault, Muvattupuzha fault, Bhavali fault and Kuthuparamba fault. Besides there are many more minor faults and fractures that can generate minor tremors as a result of crustal readjustment. Minor tremors in Kerala are also explained by hydroseismicity model wherein pressure transients generated due to sudden increase in hydrostatic heads especially after rains results in increased pore pressure and movement along pre-existing faults (Radhakrishnan, 2007). (Source: Kerala State Disaster Management Plan Profile, Kerala State Disaster Management Authority, Government of Kerala as available on http://documents.gov.in/KL/16344.pdf).

9.2.3 Climate

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. The Western Ghats plays a major role in the climatic conditions that prevail all along the state.

The year may be divided into four seasons. The period of March to the end of May is the hot season which is the summer month and is uncomfortable due to high temperature and humidity. This is followed by South West Monsoon season that continued till the beginning of October. From October to December is the North East Monsoon season and two months, January and February, are the winter season. The climate is pleasant from September to February. The state is extremely humid due to the existence of Arabian Sea in the west of it.

The annual precipitation varies between 100 cm (around Chinnar) to 500 cm (around Neriyamangalam), with a state average of about 300 cm. March to May is the hottest with maximum temperature reaching more than 32°C and the minimum is attained during December to January. Winds over the state are seasonal; diurnal variation is felt owing to the maritime influence. Annual relative humidity varies between 79 – 80% in the morning and 73 – 77% in the evenings. (Source: http://www.moef.gov.in/sites/default/files/KERALA%20STATE%20ACTION%20PLAN%20ON%20CLIMATE%20CHANGE.pdf)

Kottayam district has, in general, wet type of climate and four seasons are seen in this district. The hot summer season from March to May, the South West monsoon season from June to September, the North East monsoon season from October to December and cool climate prevails during January and February.

The major contribution of rainfall in Kottayam district is during South West monsoon followed by the North East monsoon. The analysis of rainfall data reveals that the distribution of rainfall increases from west to east. The highest rainfall recorded at Pala while the lowest recorded at Ettumanur. The annual rainfall ranges from 2435.9 to 3755.2 mm and the average annual rainfall of the district is 3169.28 mm. The South West monsoon contributes nearly 59 % of the total rainfall and while the North East monsoon contributes nearly 21% of the total rainfall in the district. (Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.2.4 Soils

Ten broad groups of soils based on morphological features and physico-chemical properties have been identified in Kerala (Anon, 1978). They are red soil, laterite soil, coastal alluvial soil, riverine alluvial soil, grayish Onattukara soil, brown hydromorphic soil, hydromorphic saline soil, acid saline soil, black soil and forest soil. (Source: http://www.kerenvis.nic.in/Database/ENVIRONMENT_821.aspx)

Soils of Kottayam District

The soil types occurring in Kottayam district can be broadly grouped into four types on the basis of their physico-chemical properties and morphological features. They are (1) Lateritic soil. (2) Riverine alluvium, (3) Brown hydromorphic, and (4) Forest loams.

Lateritic soil

The lateritic soil is the pre-dominant soil type, which covers almost the entire midland areas of the Kottayam district. The surface soil is mostly reddish brown to yellowish

red in colour and the texture ranges from gravelly loam to gravelly clay loam. Heavy rainfall and high temperature prevalent in the area are conducive to the process of formation of this soil type. It is well drained and the presence of organic content is low. This soil is poor in nitrogen, phosphorous and potassium. It is acidic in nature with a pH value ranging from 5.0 to 6.2.

Riverine alluvium

The occurrence of these soils is restricted along the river courses and their tributaries. They show wide variation in their physico-chemical properties depending on the nature of the alluvium that is deposited and the characteristics of the catchments area drained by the river. They are very deep soils with surface textures ranging from sandy loam to clay loam. These soils are characterised by moderate amount of organic matter, nitrogen and potassium. Presence of mica flakes has been observed in the alluvial soils.

Brown hydromorphic soil

These soils are mostly confined to valley bottoms between undulating topography in the midland and in low-lying areas. They have been formed as a result of transportation and sedimentation of material from adjoining hill slopes and also through deposition by local streams. These soils are very deep and brownish in colour and exhibiting wide variation in physico-chemical properties and morphological features. The surface soil texture varies from sandy loam to clay. Their pH value ranges between 5.2 and 6.4 and are acidic in nature.

Forest loam

These soils are the products of weathering of crystalline rocks under forest cover. They are occurring in the eastern hilly areas. These are dark reddish brown to black in colour. The surface texture varies from loam to silt loam. They are characterised by a surface layer very rich in organic matter. Generally they are acidic, rich in nitrogen and their pH ranging from 5.5 to 6.3.

(Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.2.5 Land Use Pattern

Land use is the surface utilization of all developed and vacant lands on a specific space at a given time. Lands are used for forest, pastures, transportation, settlements, industrial and commercial purposes. Whereas, uncultivable waste land, barren and fallow land are unused lands.

Kerala has a diverse land use and cropping pattern. The data on land use pattern of Kerala for the year 2009-10 reveals that out of a total geographical area of Kerala, net sown area is about 56 per cent. Forest occupies around 28 per cent. Agriculture and forest sectors together account for over 84 per cent of the land area. There was an increase in the area under current fallow (9186 ha) and a decrease in the area under fallow other than current fallow (581 ha) during 2009-10 over 2008- 09. The area under cultivable waste increased by 1821 ha. and barren and uncultivated land declined by 7019 ha.

(Source:http://www.moef.gov.in/sites/default/files/KERALA%20STATE%20ACTION%20PLAN%20ON%20CLIMATE%20CHANGE.pdf)

Land Use in Kottayam District

Kottayam District has an area of about 2204.42 sq km. It accounts for 5.68 percentage of the total area of the State (38862.87 sq km). According to agricultural statistics for 2010-11, the data on land use pattern of the district reveals that forest occupies around 3.69 per cent. In view of the high density of population, the pressure for non-agricultural use is increasing. Land under non-agricultural use which was 11.86 per cent in 2000-01 has decreased to 11.74 % during 2010-11. The net cropped area decreased from 1734.94 sq km to 1644.51 sq km during the period. There was an increase in the area under current fallows (58.08 sq km) and increase in area for fallows other than current fallows (30.46 sq km).

Table 9-1: Classification of Area on the basis of Land utilization in Kottayam District

Sl. No.	Type of Land	Area in sq km
1	Total area	2204.42
2	Forest area	81.41
3	Land put to non-agricultural use	258.93
4	Barren & uncultivable	14.69
5	Permanent pastures and grazing land	0
6	Land under miscellaneous tree crops	1.33
7	Cultivable waste	48.9
8	Fallow other than current fallow	30.46
9	Current fallow	58.08
10	Still water	63.62
11	Waterlogged area	1.59
12	Social forestry	0.9
13	Net sown area	1644.51
14	Area sown more than once	423.38
15	Total cropped area	2067.89

(Source: District Census Handbook, Alappuzha District, Series 33, Part XII A, Directorate of Census Operations, Kerala, Census of India, 2011)

The project area is characterized by mixed land use on both banks of the designated stretch of NW-59 comprising residential use, agricultural land jetties, temples and

transmission lines and towers. The chainage wise details of land use and land cover along the entire NW-59 stretch is provided in the hydrographic survey report prepared as part of the present DPR.

9.2.6 Ambient Air and Noise Quality

The Air (Prevention & Control of Pollution) Act, 1981 of India describes air pollutants as *'Any solid, liquid or* gaseous *substance (including noise) present in the atmosphere in such concentration as may or tend to be injurious to human beings or other living creatures or plants or property or environment'*. The condition of air quality in the surroundings is the ambient air quality.

In India the Central Pollution Control Board (CPCB) coordinates the air quality monitoring regime through its nationwide programme known as National Air Quality Monitoring Programme (NAMP). CPCB has been monitoring ambient air quality through 363 stations in 139 cities across the country as of November, 2009.

Ambient air is monitored by the Kerala State Pollution Control Board for Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_X) from stations located in industrial, residential and sensitive areas. Observations at these stations show that SPM and RSPM regularly exceed allowable limits. SO_2 and NO_X levels are observed to be almost always within the prescribed limits.

Even increasing use of fossil fuel in the transportation and industrial sectors is adversely affecting the air quality in Kerala. These driving forces are also responsible for the increase in ambient noise.

The number of vehicles on the roads in Kerala has increased more than 20 times since 1975. Vehicular emission and noise from this vehicles are sever in the three major cities of Kerala namely, Thruvananthapuram, Kochi and Kozhicode.

Kerala's industrial growth has been very low when compared to the rest of India. The number of industries, which can be categorized as Large or Medium, is about 640. Most of these units are in the private sector and a majority of them are located at Kochi. There are about 2.5lakh SSI units, which are dispersed in the different districts of the state. Kerala state pollution control board brought nearly 600 large/medium scale industries and about 2500 SSI units under the consent regime of Air (Prevention and Control of Pollution) Act. Majority of the smaller units, comprise of stone crusher.

(Source: http://www.kerenvis.nic.in/Database/Air_Pollution_835.aspx)

Primary data on ambient air and noise quality monitoring in the project area is to be collected as part of the EIA study for the project to be carried out separately by IWAI.

9.2.7 Ambient Water Quality

Surface water quality analysis has been done at three sample locations in the project stretch as part of the hydrographic survey carried out for the present DPR study. The sample locations for water quality analysis include Maniyaparambu, Vechoor and Athirampuzha. The pH values for the three locations are 6.72, 5.63 and 7.59 respectively, which indicates that the water near Maniyaparambu and Vechhor is slightly acidic in nature while that near Athirampuzha is slightly alkaline in nature.

Kerala is one of the most thickly populated regions in the world and the population is increasing at a rate of 14% per decade. The rivers of Kerala have been increasingly polluted from the industrial and domestic waste and from the pesticides and fertilizer in agriculture. Industries discharge hazardous pollutants like phosphates, sulphides, ammonia, fluorides, heavy metals and insecticides into the downstream reaches of the river. The river Periyar and Chaliyar are very good examples for the pollution due to industrial effluents. It is estimated that nearly 260 million litres of trade effluents reach the Periyar estuary daily from the Kochi industrial belt.

The major water quality problem associated with rivers of Kerala is bacteriological pollution. The assessment of river such as Chalakudy, Periyar, Muvattupuzha, Meenachil, Pamba and Achenkovil indicates that the major quality problem is due to bacteriological pollution and falls under B or C category of CPCB classification. There are local level quality problems faced by all rivers especially due to dumping of solid waste, bathing and discharge of effluents.

With regard to groundwater, water quality characteristics of wells in Kerala are found to be affected by chemical and biological contaminants. The ground water quality problems in the coastal areas are mainly because of the presence of excess chloride. The chloride concentration >250mb/l was detected in the well water samples of Azhicode, Kakkathuruthy, Edathinjil, Kadalundi, Chellanum, nallalam, Mankombu and Haripad.

Open well of Kerala are under threat of bacteriological contamination. In Kerala about 60% of the population relies on ground water for drinking. At the same time studies have shown that faecal contamination is present in 90% of drinking water wells. The open character of the wells, and conventional maintenance habits, and use of buckets and rope to draw water, kitchen wastes and pit latrines with average family load factor of 5 members at a distance of less than 5 meters from wells are some of the factors, which are contributing to the bacteriological contamination.

Ground water contamination due to industrial pollution has been reported from places of Kochi (eastern part of Aluva), Palakkad and some parts of Kollam, Kozhikode and Kannur.

(Source: http://www.kerenvis.nic.in/Database/Waterpollution_834.aspx)

The Central Pollution Control Board (CPCB) has established a network of monitoring locations on aquatic resources across the country. The present network operated under Global Environmental Monitoring System (GEMS) and Monitoring of Indian National Aquatic Resources System (MINARS) covers 445 rivers in 29 States and 6 Union territories having 1275 locations.

Based on an analysis of the water quality data for the years 2009-2012, CPCB published a report in February 2015 titled ‘River Stretches for Restoration of Water Quality’ (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15).

In the said report, the rivers have been prioritized based on the concentration of BOD in five classes from Priority I to V. The criteria of each priority are elaborated indicating the concentration range of BOD in mg/l. The degree of violation is with respect to water quality criteria for drinking water source with conventional treatment with respect to BOD. The polluted locations in a continuous sequence are defined as polluted river stretches.

Criteria for Priority I

Monitoring locations exceeding BOD concentration 30 mg/l.

Criteria for Priority II

Monitoring locations having BOD between 20-30 mg/l.

Criteria for Priority III

Monitoring locations having BOD between 10-20 mg/l.

Criteria for Priority IV

Monitoring locations having BOD between 6-10 mg/l.

Criteria for Priority V

Monitoring locations having BOD between 3-6 mg/l.

According to this report, there are 73 monitoring locations on 55 rivers in Kerala out of which 18 locations are exceeding the Water Quality Criteria limit with respect to BOD. These 18 non-complying locations are situated on 13 rivers. The names of the rivers are; Chitrapuzha, Kadambayar, Kallai, Karamana, Keecheri, Kuppam, Manimala, Neeleswaram, Periyar, Pullur, Puzhckal, Thirur and Uppala. These rivers are classified in three priority classes (Class – I, IV and V).

The details of the polluted river stretches in Kerala are provided in Table 9-2.

Table 9-2: Details of Polluted River Stretches in Kerala

Sl. No.	River Name	Stretch Identified	Towns Identified	Approx. Length of the Stretch (in km)	BOD Range / Max. Value	Priority Class
1.	Chitrapuzha	Irumpanam to Karingachira	Chittethukara	15	8	IV
2.	Kadambyar	Manckakadavu to Brahmapuram	Kakkattikara, Thengumthuruthu	8	4.4-8.0	IV
3.	Kallai	Thekepuram to Arakkinar	Kozhikode, Mananchira	5	6	V
4.	Karamana	Malekkdu to Thiruvallam	Trikkannapuram	4	80	I
5.	Keecheri	Puliyannor to Kechery	Thrissur	6	3.8	V
6.	Kuppam	Thaliparamba to Velichangool	Marathakkad, Kuttiyeri	12	5.4	V
7.	Manimala	Kalloopara to Thondra	Mallappally, Vaipur	10	4.2-4.4	V
8.	Neeleswaram	Nambiarkal Dam to Hosdurg	Puthukai	8	3.3-3.8	V
9.	Periyar	Alwaye-Eloor to	Muttinakam,	5	3.7-6.0	V

Sl. No.	River Name	Stretch Identified	Towns Identified	Approx. Length of the Stretch (in km)	BOD Range / Max. Value	Priority Class
		Kalamassery	Edampaadam			
10.	Pullur	Ramnagar to Kannoth	Kottapara,	2	3.1	V
11.	Puzhackal	Olarikkara to Puzhackal	Puthurkara, Chettupuzha	3	5.4	V
12.	Thirur	Naduvilangadi to Thalakkadathur	Chembra, Thazhepalam, Mangalam, Thiruthummal	8	4.4	V
13.	Uppala	Poyya to Mulinja	Manjeshwar, Hosabettu	3	3.3	V

(Source: River Stretches for Restoration of Water Quality, CPCB, 2015 (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15).

Part of the NW-59 stretch traverses through Vembanad Lake. As per information provided in National Wetland Atlas prepared as part of the project on National Wetland Inventory and Assessment (NWIA) by Space Application Centre (ISRO), Ahmedabad and Kerala State Remote Sensing & Environment Centre, Thiruvanathapuram and published in February 2010, turbidity of the lake water is low.

Additional primary data on water quality in the project area may be collected at a later stage as part of the EIA study to be carried out separately by IWAI.

9.2.8 Susceptibility to Natural Hazards

According to the Kerala State Disaster Management Plan Profile prepared by the Kerala State Disaster Management Authority, Government of Kerala, the State of Kerala is prone to a host of natural hazards such as coastal erosion, flood, drought, lightening, landslide and earthquake. All most all districts of Kerala are multi-hazard prone. In Kerala lightning, landslides (debris flows) and floods are the most commonly occurring natural hazards. Droughts and minor earth tremors also occur occasionally.

Kerala is prone to high incidence of lightning, especially during the months of April, May, October and November. It is estimated that about 70 people die every year due to lightning.

In Kerala, riverine flooding is a recurring event consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and flow capacity of streams and rivers. About 14.8% of the state is prone to flooding. Kerala has been experiencing seasonal drought conditions every year during summer months. Between 1871-2000, the state experienced 12 moderate drought years.

Apart from floods the mountain regions of the state experience several landslides during the monsoon season. Landslides commonly occur in localised areas of the Western Ghats region where the slope is steep and the soil is over saturated as a result of prolonged rainfall. The landslides in the state include rock falls, rock slips, debris flow and in a few cases rotational types of slides. But the most prevalent recurring and disastrous type of earth or tectonic movement noted in Kerala are the debris flow (urulpottal) characterized by the swift and sudden down slope movement

of highly water saturated overburden ranging in size from soil particles to boulders destroying and carrying with it everything that is lying in its path. About 1500 sq km area in the Western Ghats is prone to landslides. A total of 65 fatal landslides occurred between 1961 and 2009 causing the death of 257 individuals.

With a length of 570 km and covering about 15% of state‘s total area, the coastal zone of Kerala is an important physiographic unit. Hazards in the coastal zone are erosion, monsoon, storm surges, sea level rise etc. More than 300 km of sea shore is erosion prone. Extensive sea wall construction along with gabion-box and groins has failed to arrest the erosion in many cases. The tsunami of 2004 which was experienced along most of the coastal regions of the state has added a new dimension to the disaster scenario of the state.

(Source: Kerala State Disaster Management Plan Profile, Kerala State Disaster Management Authority, Government of Kerala; Website: http://documents.gov.in/KL/16344.pdf)

9.2.9 Estuary and Coastal Zone

The Kerala coast extends from Manjeswaram in north to Pozhiyur in the south. Well-developed sandy beaches are in Chittari, Kappad, Ponnani, Calicut, Cochin, Alleppey and Kovalam. The beach consists of sands of different fractions along with broken molluscan shells. In addition to this, crescent shaped pocket beaches are observed at Ezhimals, Dharmadom, Tellicherry, Kadur point and Ealthur.

Spits are seen at the estuarine of Vambanad, Asthamudi, Shiriys, Bypore and Veli. At some places during the lean season opening of small estuaries got blocked by the growth of the spits.

Cliff and rocky coasts are observed at many places on the Kerala coast. The rocky shores are made up of laterites or Precambrian crystalline such as Khondalites or Charnockites. Some of the prominent rocky coasts are near Bekal, Ezhimala, Azhikode and Kadalur point in the north and Vizhinjam, Varkala and Tangasseri in the south.

The mangrove vegetation in the coastal area of Kerala is very sparse and thin. The Kerala coast has a number of islets or islands. Most of them are populated. Locally the islands are called thuruths. Man-made thuruths are also common. The Vembanad, the Asthamudi, and Kakavvayi estuaries show more islands. The islands in the Vembanad estuary in central Kerala are large in size compared to the islands in the Kavvayi estuary. The major islands are Wellington, Kumbalam, Nettur, Madavana, Cheppanam and Perumbalam. Dharmadom, a large island with mangroves is situated in the northern Kerala. Mudflat occupies 41.61 sq km and Habitation with vegetation occupies 4903.70 sq km.

(Source: Coastal Zones of India, Space Application Centre, ISRO, Ahmedabad, 2012)

The coastal plain of Kerala also constitutes a special ecological mosaic. The Coastal Zone in Kerala is the low land fringing the sea extending over 560 km with a height of less than 8m from the MSL, covers about 15 % of the state's total area of 38,863 sq km. A chain of water bodies, locally known as kayals running parallel/ oblique to the coastline is a characteristic feature of Kerala coast. These are mostly interconnected by natural or man-made canals, facilitating internal navigation almost for the entire length of the coast. Numerous perennial rivers discharge into these kayals. Southern

half of the Kerala coast harbours more of larger backwaters. The kayals of the Kerala coast are mostly separated from the sea by elongated sandbars and based on this they can be treated as "coastal lagoons".

(Source: http://kerenvis.nic.in/Database/Coastal_and_Environment_1204.aspx)

The entire National Waterway 59 project area falls in the tidal zone.

9.2.10 Archaeological and Heritage Locations

No structures of archaeological, cultural or historical importance will be impacted due to the proposed project.

As per the information available on the website of the Department of Cultural Affairs, Government of Kerala, there are eight (08) State Protected Monuments in Kottayam District. These monuments have been declared as Protected by the State Archaeological Department, Government of Kerala. The list of the State Protected Monuments in Kottayam district, where NW-59 is located, is provided in Table 9-3 below.

As can be noted from Table 9-3, none of the State Protected Monuments are located close to the project site. The nearest protected monument from the project site, which is Old Seminary in Kottayam District, is located at a distance of 4.94 km from the project site. Therefore, no clearance requirement is envisaged with respect to protected monuments.

Table 9-3: Protected Monuments Located In Kottayam District, Kerala

Sl. No	MONUMENTS	LOCATION (District)	SHORTEST DISTANCE FROM PROJECT ALINGMENT (Km)
1.	Pundareekapuram Devaswam	Kottayam	15.74
2.	Thrikkodithanam Sri Mahavishnu Temple	Kottayam	23.53
3.	Old Seminary	Kottayam	4.94
4.	House of freedom fighter Chembilarayan	Kottayam	Not traceable in Google Earth/Google Map
5.	St. Mary's Church, St. Augustian's Church & two storied building in which Thoma Kathanar was residing	Kottayam	33.83
6.	Menhir, Kottayam	Kottayam	6.25
7.	Venniamala Sree Rama Lakshmana Swami Temple, its Pond & Cave	Kottayam	13.04
8.	Sree Dharma Sastha Temple, Poonjar	Kottayam	29.06

Source: http://www.keralaculture.org/keralaasi-protected-mounments/628

Prohibited and Regulated Areas are defined in the Ancient Monuments and Archeological Sites and Remains (Amendment and Validation) Act, 2010, and the definition of the two terms is as follows:

Prohibited Area: Every area, beginning at the limit of the protected area or the protected monument, as the case may be, and extending to a distance of one hundred metres in all directions shall be the prohibited area in respect of such protected area or protected monument.

Regulated Area: Every area, beginning at the limit of prohibited area in respect of every ancient monument and archaeological sites and remains, declared as of national importance and extending to a distance of two hundred metres in all directions shall be regulated area in respect of every ancient monument and archeological site and remains.

As per the information available on the website of the Department of Cultural Affairs, Government of Kerala, there are a total of 27 Centrally Protected Monuments in the State of Kerala. These are the monuments that have been declared as Protected by the Archaeological Survey of India, Government of India. As per the list available in the above mentioned website (http://keralaculture.org/protected-monuments-asi/627), none of the 27 Centrally Protected Monuments in Kerala are located in the districts of Alappuzha and Kottayam. Therefore, no clearance requirement is envisaged with respect to these structures.

9.2.11 Flora and Fauna

The Western Ghats region, wherein the state is situated, is one of the 25 biodiversity hotspots in the whole world. The state contains more than 4,500 species of flowering plants of which above 1,500 taxa are endemic in nature. There is also equally rich fauna belt in the state. The diversity of lower plants and animal groups, and the marine flora and fauna in particular even though not fully known, is remarkably rich in the state. (Source: http://www.kerenvis.nic.in/Database/Hotspot_1804.aspx)

Flora of Kerala comprises of a total of 11,840 taxa of plants (SoE, 2007). Among them, angiosperms comprises the dominant group, composed of 4968 taxa, of which about 900 are those endemic to Western Ghats. Among the Western Ghats endemics, 252 taxa are those confined to Kerala State.

The flora comprises of 866 species of algae, 4800 species of fungi, 520 species of lichens, 350 species of bryophytes, 332 species of pteridophytes, 4 species of gymnosperms and 4968 species of angiosperms or flowering plants.

Habitat wise, algal species are mostly confined to aquatic or damp conditions whereas the other plant groups in the State ate mostly terrestrial in habit. Habit or life form-wise, there are herbs, shrubs, trees, lianas, epiphytes, lithophytes, saprophytes, etc. within the plant kingdom. Based on this the habitats are also different for different species.

Table 9-4 below gives the details of the representation of different plant groups in the flora of Kerala.

Table 9-4: Total Number of Plant Taxa Belonging to Different Groups Recorded from Kerala

Sl. No.	Plant Groups	No. of Taxa
1	Algae	866
2	Fungi	4800
3	Lichens	520
4	Bryophytes	350

Sl. No.	Plant Groups	No. of Taxa
5	Pteridophytes	332
6	Gymnosperms	4
7	Angiosperms	4968
	Total	**11,840**

Apart from this there are hundreds of cultivated species either on plantations or crop levels or as garden plants, ornamentals, etc. There are also 850 species and varieties of cultivars growing the State with their origin in mostly tropical parts of the globe. Due to various reasons, many of them are in various threat categories of IUCN Red List of flora and fauna (2004), prepared at global level.

(Source: http://www.kerenvis.nic.in/Database/Flora-Kerala_1399.aspx)

Medicinal Plants constitute an important component of the plant resource spectrum of Kerala. Recent analysis shows that out of estimated 4600 flowering plants in Kerala, about 900 possess medicinal values. Of these, 540 species are reported to occur in forest ecosystems. Over 150 species of plants that are either indigenous or naturalized in Kerala are used in the Indian system of Medicine like Ayurveda and Sidha. The rural folk and tribal communities make use of about 2,000 species of lesser-known wild plants for various medicinal uses. About 60 to 65% of plants required for Ayurvedic medicine and almost 80% of plants used in Sidha medicine are found in the forests of Kerala. (Source: http://www.forest.kerala.gov.in/index.php/forest/flora)

Fauna

The Western Ghat's encompassing the forests of Kerala is one of the 34 Biodiversity hot spots in the World and Kerala has close to 90 % of its vertebrate fauna. Very high levels of species diversity and endemism provide importance to the faunal wealth of Kerala.

Table 9-5: Faunal Wealth of Kerala

Sl.No	Group	No.of.Species
1	Mammals	145
2	Birds	486
3	Reptiles	164
4	Amphibians	85
5	Freshwater Fishes	196
6	Insects	4027
	TOTAL	**5103**

(Source: http://www.forest.kerala.gov.in/index.php/forest/fauna)

According to one estimate, 285 species of Vertebrate are reported to be endemic to Western Ghats, which include 12 mammals, 16 birds, 89 reptiles, 87 amphibians, and 84 fresh water fishes. Among large mammals, no species is endemic to Kerala. However, birds such as White breasted laughing thrush, Wayanad laughing thrush,

White bellied shortwing, Southern treepie, Rufous babbler are possible endemic birds which may slightly overlap state boundaries in the southern Western Ghats. (Source: http://www.forest.kerala.gov.in/index.php/forest/fauna)

Table 9-6: Fauna Endemic to Western Ghats - Found In Kerala

Group	Nos.
Amphibians	61
Reptiles	57
Birds	16

9.2.12 National Parks, Forests, Wildlife Sanctuaries and Reserves

The geographical area of the state is 38,863 sq km of which 11309.50 sq km (29.10%) is forest area. By legal status, the entire forest area of Kerala is divided into the following three categories:

i) Reserved Forests,

ii) Proposed Forests and

iii) Vested Forests and ecologically Fragile Lands

The area falling under the above mentioned three categories of forests in Kerala is provide in Table 9-7 below.

Table 9-7: Forest Areas in Kerala

Forest Area	
Total Forest Area	**11309.5032 Sq.Km**
Percentage of forest area to the total area of the state	**29.101 %**
By Legal Status(Area as per records)	
Reserved Forests	**9107.2006 Sq.Km**
Proposed Reserve	**364.5009 Sq.Km**
Vested Forests & Ecologically Fragile Lands	**1837.7957 Sq.Km**
TOTAL	**11309.5032 Sq.Km**

(Source: http://www.forest.kerala.gov.in/index.php/forest/forest-area).

There are two Biosphere Reserve in Kerala namely Nilgiri Biosphere Reserve and Agasthyamalai Biosphere Reserve. Parts of these biopspheres reserves fall in other adjoining States too. The parts of the biosphere reserves falling in Kerala are delineated in Table 9-8 below.

Table 9-8: Biosphere Reserves in Kerala

S.No.	Name of Biosphere Reserve	Extent (sq km)	Forest Areas falling in Kerala
1.	Nilgiri Biosphere Reserve	1455.40	Wayanad Wildlife Sanctuary Silent valley National Park Nilambur South (New Amarambalam, Karimpuzha) Mannarkkad (Attappady) Palakkad (Siruvani Reserved Forests) Nilambur North, (Chakkikuzhy, Kozhipara, Punchakolly, Ex.Karulai Range (Nilambur Kovilakom) Kozhikode (Kuttyadi, Thamarassery, Vested Forests) Wayanad South (Kalpetta)
2.	Agasthyamalai Biosphere Reserve	1828	Neyyar Peppara and Shendurney wildlife sanctuaries Achencoi Thenmala Konni Punalur and Thiruvananthapuram territorial divisions and Agasthyavanam Biological Park Range

There are five National Parks, 17 Wildlife Sanctuaries and one Community Reserve in the State spread across an area of 3213.24 sq km, out of which, two WLSs have been declared as Tiger Reserves. The wildlife sanctuaries that have been declared as Tiger Reserves are Parambikulam and Periyar wildlife sanctuaries.

(Source: http://www.forest.kerala.gov.in/index.php/wildlife/2015-03-16-09-50-24/introduction)

The proximity of the project alignment / site to the National Parks and Wildlife Sanctuaries in Kerala has been verified on Google Earth and it is found that the project area is not located close to any of these National Parks or Wildlife Sanctuaries. Mangalavanam Bird Sanctuary and Idukki Wildlife Sanctuary are the nearest protected areas from the project site and the respective disatnce of even these two WLSs is 38 km and 49 km (approximately) from the project site. Therefore, no Wildlife Clearance is envisaged for the project.

The list of National parks and Wildlife sanctuaries in the State has been provided in Table 9-9 below.

Table 9-9: Protected Areas in Kerala

Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the NW-59 Project Site (in km) as measured on Google Earth
	National Parks				
1	Eravikulam	G.O.(MS)142/78 dated 19-	1978	97.0000	76.39

Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the NW-59 Project Site (in km) as measured on Google Earth
	National Park	05-1978			
2	Silent Valley National Park	GO-5462/FSA3/82/AD dated 15.11.84	1984	237.5200	154.51
3	Anamudi Shola National Park	G.O.12876/F2/2003/F&WLD dated 14-12-2003	2003	7.5000	91.55
4	Mathikettan Shola National Park	GO(MS)No.50/2003/F&WLD dated 10-10-2003	2003	12.8170	85.87
5	Pambadum Shola National Park	G.O.12875/F2/2003/F&WLD dated 14-12-2003	2003	1.3180	93.95
	Wildlife Sanctuaries				
6	Parambikulam Wildlife Sanctuary (Tiger Reserve)	GO(P)39/73/AD dated 12..02..1973 GO(P) No. 443/06/F&WLD dated 31..10..2006	1973	643.6600	84.45
7	Periyar Wildlife Sanctuary (Tiger Reserve)	F1-2854/AD dated 11-08-1950 G-11025/34/FRY(PT) dated 29-08-1977	1950	925.0000	80.63
8	Neyyar WLS	GO(MS)871/58 dated 06..08..1958	1958	128.0000	142.52
9	Peechi-Vazhani WLS	GO(MS)871/58 dated 06..08..1958	1958	125.0000	91.95
10	Wayanad WLS	GO(MS)182/73/AD dated 30..05..1973	1973	344.4400	222.79
11	Idukki WLS	GO.7898/FM3/76/AD dated 09.02.76	1976	70.0000	49.08
12	Peppara WLS	GO(P)379/83/AD dated 21..12..1983	1983	53.0000	133.08
13	Thattekkad B.S	GO.35743/FM3/83/AD dated 27..08..83	1983	25.0000	54.27
14	Shendurney WLS	GO(P)258/84/AD dated 25..08..1984	1984	171.0000	117.25
15	Chinnar WLS	GO(P)229/84/AD dated 04..08..1984	1984	90.4400	102.18
16	Chimmony WLS	GO(P)259/84/AD dated 25..08..1984	1984	85.0000	84.64
17	Aralam WLS	GO(P)300/84/AD dated 15..10..1984	1984	55.0000	259.36
18	Mangalavanam Bird Sanctuary	G.O(MS) No.42/04/F&WLD dated 31..08..2004	2004	0.0274	38.60
19	Kurinjimala Sanctuary	G.O.(P)36/2006/F&WLD dated 06-10-2006	2006	32.0000	102.04

Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the NW-59 Project Site (in km) as measured on Google Earth
20	Choolannur Pea Fowl Sanctuary	G.O.(P) 24/2007/F&WLD dated 15-05-2007	2007	3.4200	117.73
21	Malabar Sanctuary	G.O (P) 26/2009 / F&WLD dated 05-06-2009	2009	74.2150	218.05
22	Kottiyoor Wildlife Sanctuary	G.O (P) 17/2011 / F&WLD dated 01-03-2011	2011	30.3798	254.18
	Community Reserve				
23.	Kadalundi-Vallikunnu Community Reserve	G.O(MS)No.66/2007/F&WL dated 17-10-2007	2007	1.5000	173.10
	TOTAL			3213.2372	

(Source: http://www.forest.kerala.gov.in/index.php/wildlife/2015-03-16-09-50-24/introduction)

9.2.13 Socio-economic Profile

The NW-59 project is located in Kottayam district of Kerala.

The present Kottayam District was previously a part of the erstwhile Princely State of Travancore. Then the Travancore State consisted of two Revenue Divisions, viz., the Southern and Northern Divisions under the administrative control of 'Diwan Peshkar' for each Division. Thereafter in 1868, two more Divisions – Quilon and Kottayam were constituted. Though the fifth division – Devicolam came next, in course of time, it was added to Kottayam.

At the time of the integration of the State of Travancore and Cochin in 1949, these Revenue Divisions were renamed as Districts and Diwan Peshkars gave way to District Collectors and that marked the birth of the District of Kottayam.

There are two systems of administrative set up in the District – Revenue and Local Self Government. Under the Revenue System, the District is divided into two Revenue Divisions, five Taluks and 95 Villages. The two Revenue Divisions are Palai, comprising Meenachil and Vaikom Taluks with 42 Villages and Kottayam, comprising Kottayam, Kanjirappally and Changanassery Taluks with 53 Villages.

Under the Local Self Government System, the District is divided into four Statutory Towns and 14 Development Blocks, consisting of 75 Panchayats.

District Highlights -2011 Census: Kottayam District

- Kottayam district was formed on the 1st July 1949 at the time of the integration of the States of Travancore and Cochin.

- Kottayam district was formed on the 1st July 1949 at the time of the integration of the States of Travancore and Cochin.
- Kumarakam is a beautiful tourist spot, 10 Kms away from Kottayam on the beaches of the Vembanad Lake. Kumarakom Bird Sanctuary is noted for its rare species of birds arriving from Siberia in the winter season.
- The district with 2206 sq km of area ranks the 10th among the districts.
- Kottayam district is devoid of Coastal line.
- The district stands first in rubber production in the state.
- In Literacy rate, Kottayam district has the 1st position in 2011 Census also with the highest female literacy (96.48 per cent) among the districts.
- The important rivers of the district are the Meenachil River, The Muvattupuzha River, and the Manimala River. The Vembanad Lake, the largest backwater in the state forms the Western boundary of Kottayam district.
- With 19,74,551 persons, Kottayam district ranks the 10th in population among the districts.
- The district ranks the 8th in total density (895) and 6th in Urban density (2066).
- In sex ratio, the district ranks the 11th with 1039 females per 1000 males.
- The district has the 8th rank in Child Sex ratio with 964 female children per 1000 male children.
- In the percentage of Scheduled Caste population to total population, the district ranks the 9th with 7.8 per cent.
- It ranks the 6th in the percentage of Scheduled Tribes Population to total population (1.1 per cent).
- The total work participation rate of the district is 37.3 per cent and has the 6th position among the Districts.
- In the District, 82.2 per cent of the workers are main workers and 17.8 per cent are marginal workers.
- Kottayam district ranks the 6th position in Female Work Participation rate with 20.4 per cent.

(Source: District Census Handbook: Kottayam, Series 33, Part XII-B, Directorate of Census operations, Kerala, Census of India, 2011)

Agriculture is a predominant sector of the District economy. Food crops as well as cash crops are cultivated here. Paddy and Tapioca are the main food crops while rubber, coconut and pepper are the main cash crops. Annual crops like plantain and pineapple, seasonal crops like ginger, tubers, vegetables and a wide range of perennial crops like jack, mango, etc. are also grown.

Paddy is the most important food crop. Kayal land cultivation is a peculiarity of the District and the neighbouring District of Alappuzha. Kayal lands are below mean sea level.

Rubber is the major cash crop in the District. The District has the credit of largest content of area under this crop. Meenachil Taluk has maximum area under rubber cultivation. Indian Rubber Board has its Headquarters at Kottayam.

Meenachil Irrigation Project is the major irrigation project. This project was started in 1980. Besides this, lift irrigation projects and other minor irrigation projects help to irrigate the cultivable area in the District.

The main species of livestock in the District are cows, buffaloes, goats and pigs. The majority of cattle found in the District is Rangayam, Hallikyr and cross breeds of Jersey, Sindhi and Swiss Brown. There are fairly large number of cross breed Jersey and Swiss Brown animals in the District. The two other breeds found here are Murrah and Surabhi.

The District is deprived of sea coast. But it has abundant lakes and rivers which are the base of inland fishing. The main sources of fish in the District are the Vembanad Lake and the Muvattupuzha and Meenachil Rivers.

Industrially, Kottayam District is not highly advanced.

The main modes of transport in the district are by roads and railways. The inland water transport is negligible. In the District, there is only one National Highway, which is NH-220 i.e., Kottayam–Kumily passing through Manarcad, Pampady, Kanjirappally, Mundakayam, etc. SH-1 popularly known as MC Road passes through Changanassery, Kottayam and Meenachil Taluks. It enters the District from the South in Changanassery Taluk. The main roads branching from MC Road are; Changanassery – Alappuzha, Changanassery – Kumily, Ettumanoor – Palai – Erattupetta – Thekkedy (i.e., SH-14) and Ettumanoor – Kuruppumthara – Kaduthuruthy – Thalayolaparambu (i.e., SH – 15).

A part of the traffic and cargo is borne by the Vembanad Lake and the rivers flowing into it. There are also a few navigable canals in Changanassery, Kottayam and Vaikom Taluks. Kottayam Town is connected by a canal to the Vembanad Lake.

The District with 5.7 per cent of the total geographical area of the State accommodates 5.9 per cent of the total population of the State.

In the District, the three predominant religious groups are Hindus, Christians and Muslims. Other religious communities such as Sikhs, Buddhists and Jains etc. are insignificant as their percentage to the total population is very negligible. Hindus, Muslims and Christians constitute about 99.7 per cent of the total population. 49.81 per cent of the populations are Hindus, closely followed by Christians (43.48 per cent). Muslim population accounts for only 6.41 per cent.

According to 2011 Census, the population of the Scheduled Castes in the District is 153,909 with 75,503 males and 78,406 females. They accounted for 5.06 per cent of the total Scheduled Castes in the State.

The population of the Scheduled Tribes in the District in 2011 was 21,972 with a break-up of 10,974 males and 10,998 females. They formed 4.53 per cent of the total Scheduled Tribe population in the State.

(Source: District Census Handbook: Kottayam, Series 33, Part XII-A, Directorate of Census operations, Kerala, Census of India, 2011)

9.3 Potential Environmental and Social Impacts of the Project

Development of NW-59, which shall be for a stretch of 18.8 km, (If proposed for development) shall involve dredging of about 18.3 Lakhs Cu. M of river material, construction of one terminal at Athirampuzha in Kottyam District, construction of a 7.5m wide approach road connecting the Terminal (with Highway), 31 kms of Pile & Slab bank protection works are envisaged under the project.

Thus, the development of NW-59 envisages the following major construction activities:

- Construction of a terminal building.
- Construction of access roads leading to the terminal.
- Bank protection works – Nil.
- Dredging of the river for development of fairway.

These activities will involve mobilization of manpower and equipment at site, movement of vehicles, use of existing water resources and use of DG sets for construction power. The proposed construction period is of three years.

Taking into consideration the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices.

As has been mentioned above, a terminal is proposed to be constructed at Athirampuzha for operation of NW-59. The proposed terminal is located near village Athirampuzha; at Ch 18.7 km (Lat 09°40'0.81" N and Long 76°31' 53.57" E).

A total of 24.5 Ha of Land for Fairway (Widening) and 0.85 Ha of land will be required for the terminal building. The land identified for the construction of terminal is Government land. Anticipated a partial dislocation for which Land Acquisition provision has been catered. The ownership of land identified for Fairway and construction of terminal are to be confirmed at the time of Acquisition.

Since limited land is required for construction of terminal and access roads, no significant adverse impact on account of land use change is anticipated due to the project.

Development of NW-59 also envisages dredging for creation of a navigable channel. The estimated quantity of dredged material for NW-59 is about 18.30 lakhs cu m. All the dredged material is proposed to be disposed of on the banks of the river, which will be used by local people, since the soil is a scarce material in Kerala. As such there is no impact on the land environment due to disposal of dredged material. Impacts on aquatic ecology due to dredging and disposal of the dredged material within the canal need to be established as part of the EIA study to be carried out separately for the project by IWAI.

Taking into consideration the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices.

Impacts on air and noise, arising out of vehicular movement and fugitive dust emission, will be largely limited to the construction period.

Potential impacts on water quality of the river can be suitably mitigated by constructing the labour camps away from the river banks and by not allowing any debris to be thrown into the river during the construction and operation phases.

The positive impacts on the project will include improved waterway facilities and other allied infrastructure facilities the local population. It will also generate some employment and small business opportunities for the local population.

9.4 EMP and Mitigation of Environmental Effects

As already stated most of the potential impacts will be limited to the construction period.

The management measures required to mitigate the potential impacts of the project on the ambient air quality during construction period include suppression of fugitive dust by water sprinkling, transportation of construction debris in covered vehicles, maintaining the specified stack height of DG sets under use and ensuring that the vehicles and equipment used during the construction period are in well maintained condition. To ensure that the ambient air quality remains within the prescribed standards by the Central Pollution Control Board (CPCB), periodic monitoring of ambient air quality should be undertaken through an accredited laboratory. Suitable corrective measures should be implemented if the ambient air quality is found to exceed the prescribed limits.

The measures to ensure that there is no adverse impact on the water quality on account of the project during the construction period would include setting up of labour camps at a safe distance from the river banks. In addition, no construction debris should be allowed to flow or be thrown into the river. The batching pants and concrete mixing plants should be located away from the river banks and these should be set up and operated strictly in accordance with the conditions stipulated by the SPCB.

To mitigate land, air and water contamination by the construction workers, adequate fuel, water and sanitation facilities should be provided to the construction workers. Hunting or poaching of wildlife should be strictly prohibited by any of the construction workers or employees. Also, it should be ensured that no unauthorized tree / forest cutting is undertaken by anyone engaged on the project.

Minimum required land should be acquired for the project. The private land owners, if any, whose land is to be acquired for the project, should be compensated adequately in accordance with law.

The project should take care that the traditional fishing rights of the local population are not impacted adversely in any manner. Adequate consultation with the local population should be undertaken as required.

The project authorities should ensure that the Contractors engaged on the project have an approved environment management plan in place and that this management plan forms a part of the Contract document so as to ensure its effective implementation by the Contractors.

9.5 Applicable Legal and Regulatory Framework

The Kerala State Pollution Control Board (KSPCB) acts as the nodal agency for environmental management, prevention & control of pollution and for the enforcement of following important acts & rules:

- Water (Prevention & Control of Pollution) Act, 1974
- Water (Prevention & Control of Pollution) Cess Act, 1977
- Air (Prevention & Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Notifications issued under Environment (Protection) Act, 1986
- Noise Pollution (Regulation & Control) Rules, 2000

Key legal and regulatory provisions as applicable to the project are described below.

Consent to Establish and Consent to Operate

The project will require obtaining the Consent to Establish from the SPCB under the Air and Water Acts prior to commencement of construction. Prior to commencement of operation, it shall require obtaining the Consent to Operate from the SPCB under the same Acts.

CRZ Clearance

The entire project area falls in tidal zone. As such the project shall require clearance under the CRZ Notification 2011.

Forest Clearance

Forest Clearance from the MoEF is required only if the project involves diversion of any forest land. No Forest Land requirement is contemplated for this project.

9.5.1 Need for Environmental Clearance

Inland waterways are not listed as an activity that requires prior environmental clearance under the EIA Notification 2006. The Notification, as amended in 2009, includes 'Dredging' as an activity for which prior environmental clearance is required.

However, **as per the MoEFCC letter dated 21 December 2017, National Waterway projects are exempt from the requirement of prior Environmental Clearance on account of maintenance dredging for creation of navigational channel.** The project, therefore, does not need to obtain Environmental Clearance from the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The MoEFCC letter to this effect is enclosed as Annexure 9.1 of the DPR.

The project shall, however, have to comply with the conditions stipulated in the said letter.

9.5.2 Other Major Clearances / Approvals / Permits Applicable to the Project

Other clearances required for the project shall include those that need to be obtained by the Contractors such as the Certificate of Registration from the Labour Department under various applicable labour laws, permission from SPCB for setting up of batching plants, license for storing petroleum / diesel etc.

The project area is not located close to any Protected Areas. Therefore, the project shall not require Wildlife Clearance from the MoEF, Government of India.

Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

Table 9-10: Major Clearances / Approvals / Permits and Their Applicability to the Project

S. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
1.	Environmental Clearance	No	EIA Notification 2006	Exempted by MoEFCC vide its letter dated 21 December 2017.
2.	Forest Clearance	Not Applicable.	Forest Conservation Act, 1980	--
3.	Wildlife Clearance	No	Wildlife Protection Act, 1972	The project is not located close to any of the Protected Areas in Kerala.
4.	CRZ Clearance	Yes	CRZ Notification, 2011.	The entire project falls in tidal zone.

9.6 Cost Implications

As per the scope of services for further environmental and social impact assessment (EIA & SIA) studies and requirement of obtaining all mandatory statutory clearances for the project approximately 1 to 1.5 year is adequate period for consultancy services (1 year for non-CRZ and 1.5 year for CRZ waterways) related to EIA & SIA studies. In this regard, the project authority may engage to QCI/NABET accredited EIA consultant for Category – A projects, who shall conduct rapid EIA & SIA studies and shall prepare a stand-alone EMMP (EMP & EMoP) for inclusion in the contractor bid documents. The generation of environmental baseline data at pre-construction stage along with environmental monitoring during construction and operation stages

shall be carried out by the NABL/MoEF&CC approved laboratory to assess the project performance during entire project cycle.

The estimated cost for conducting EIA-EMP & SIA studies along with obtaining all mandatory statutory clearances at pre-construction stage and timely and effective implementation of EMMP (EMP & EMoP) during construction and operation stages have been described in the following sections.

9.6.1 Estimated Cost at Pre-Construction Stage

The statutory fee shall be paid by the project authority for obtaining all mandatory statutory clearances. The estimated environmental and social budget for EIA-EMP & SIA studies have been summarized below:

Table 9-11: Summarized Estimated Cost for Consultancy Services

Sl. No.	Particulars of Estimated Budget	Amount (in Rs. Lakh)	Remark (if any)
1.	Salary of 12 Professionals/Domain Experts on intermittent based input (as per QCI/NABET scheme)	40	Lump-sum cost on intermittent basis
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	2.40	To be done for one season **(Table – 9-12).**
3.	Public Consultation Meeting (PCM)	4	Lump-sum cost
4.	Reports / Document Printing	1	Lump-sum cost without break-up
5.	Travelling Cost for Site Visits (Bus, Taxi, Boat *etc.*)	5	Lump-sum cost
6.	Lodging & Boarding Cost	5	Lump-sum cost
7.	Cost for collection of metrological data and other information like Maps *etc.*	5	Lump-sum cost
	Grand Total (Rs)	**62.40**	
	In words: *Rs. Sixty Two Lakhs Fourty Thousand only*		

Note: No. of Key Experts: 12 as per QCI/NABET Scheme on intermittent basis. Which may increase or decrease by the project proponent as per actual scope of work.

(i) Above consultancy Fee is without Service Tax.

(ii) The breakup of Sl. No. 2 is given in Tables 9-12.

Table 9-12: Estimated Sub-Cost for One Time Baseline Data Generation at Pre-Construction Stage

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling	Per Sample	3	20,000	60,000

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
			(Day & Night time) to be done at each location.	with various parameters			
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per Sample with various parameters	3	15,000	45,000
3.	Noise Quality monitoring	Day & Time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	3	10,000	30,000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per Sample with various parameters	3	10,000	30,000
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.	-	3	25,000	75,000
	Sub-Total (Baseline Environmental Data Generation Cost)						**240,000**
	In Words: *Rs. Two Lakh Fourty Thousand only*						

Note: 1 monitoring station @ 9 Km/station = tentatively 3 locations shall be monitored.

9.6.2 Estimated Cost at Construction Stage

The civil work contractor during construction stage shall depute a well experience environmental & safety Officer (ESO), who shall conduct Environmental Monitoring at Construction Stage as per stipulated conditions in the contractor documents. He shall also prepare environmental monitoring report that to be submitted timely to the project proponent and statutory authorities as per project requirement.

Table 9-13: Estimated Cost for Environment Management during Construction

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Construction Stage once in a year for three years	7.20	Shall be carried on yearly basis for entire construction period (**Table 9-14**)
2.	Greenbelt Development nearby terminal Premises by Contractor	6	Lump-sum cost
3.	Solid Waste Management	6	Lump-sum cost
4.	Sanitary facilities at labour camps	6	Lump-sum cost
5.	Disaster Management Plan	5	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**32.20**	
	In Words: *Rs. Thirty Two Lakh Twenty Thousand only*		

Table 9-14: Environmental Monitoring Cost for Construction Stage

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per sample with various parameters	3X3 = 9	20,000	180,000

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per sample with various parameters	3X3 = 9	15,000	135,000
3.	Noise Quality monitoring	Day & Time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per sample location with various parameters	3X3 = 9	10,000	90,000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per sample with various parameters	3X3 = 9	10,000	90,000
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.		3X3 = 9	25,000	225,000
Total (Rs)							**720,000**
		In Words: *Rs. Seven Lakh Twenty Thousand only*					

9.6.3 Estimated Cost at Operation Stage

Like pre-construction stage, the environmental monitoring and supervision to be done by the project proponent.

Table 9-15: Estimated Environment Management Cost during Operation

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Operational Stage once in a year.	2.40	Shall be carried for one season as per Table 9-12 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost
3.	Solid Waste Management	2	Lump-sum cost
4.	Sanitary facilities nearby terminals	2	Lump-sum cost
5.	Disaster Management Plan (if applicable)	2	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**12.40**	Per Year
	In Words: *Rs. Twelve Lakh Fourty Thousand only*		

9.6.4 Summary of Estimated Environmental & Social Budget

This covers the consultancy fee at pre-construction stage along with implementation of EMMP (EMP & EMoP) during construction and operational stages of the project. The statutory fee along with the cost of private and government land acquisition shall be borne by the project proponent. This has been summarized in Table 9-16 given below:

Table 9-16: Summary of Estimated Environmental & Social Costs for Various Stages

Sl. No.	Project Stages	Cost (Rs. Lakh)	Remark
1.	Pre-Construction Stage	62.40	Lump-sum
2.	Construction Stage	32.20	
3.	Operational Stage	12.40	
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		107.00	
In Words: *Rs. One Crore Seven Lakh only*			

Provision has already been catered in the proposed estimates appropriately.

CHAPTER 10 INSTITUTIONAL REQUIREMENTS

10.1 Organizational Set up / Establishment

The Inland Waterways Authority of India (IWAI) has been carved out duly taking over the responsibilities etc., of the erstwhile Inland Water Transport (IWT) directorate under Ministry of Surface Transport / Ministry of Shipping with a vision of more thrust on the IWT sector along with more Autonomy, by an Act of Parliament (IWAI Act 82 of 1985). Accordingly, IWAI is vested with the functions / duties and responsibilities connected to the safe navigation in the National Waterways and in the interconnected waterways, where IWT is considered for development. The Para 14 of IWAI ACT 82 of 1985 is provisioned with the Functions and Powers of authority, as detailed, which is self-explanatory.

Functions and Powers of the authority:

14. (1) The Authority may-

(a) carry out surveys and investigations for the development, maintenance and better utilization of the national waterways and the appurtenant land for shipping and navigation and prepare schemes in this behalf;

(b) provide or permit setting up of infrastructural facilities for national waterways;

(c) carry out conservancy measures and training works and do all other acts necessary for the safety and convenience of shipping and navigation and improvement of the national waterways;

(d) control activities such as throwing rubbish, dumping or removal of material, in or from the bed of the national waterways and appurtenant land, in so far as they may affect safe and efficient, shipping and navigation, maintenance of navigable channels, river training and conservancy measures;

(e) remove or alter any obstruction or impediment in the national waterways and the appurtenant land which may impede the safe navigation or endanger safety of infrastructural facilities or conservancy measures where such obstruction or impediment has been lawfully made or has become lawful by reason of long continuance of such obstruction or impediment or otherwise, after making compensation to person suffering damage by such removal or alteration;

(f) provide for the regulation of navigation and traffic (including the rule of the road) on national waterways; (g) regulate the construction or alteration of structures on across or under the national waterways;

(h) disseminate navigational meteorological information about national waterways;

(i) ensure co-ordination of inland water transport on national waterways with other modes of transport; and (j) establish and maintain pilotage on national waterways;

(k) enter into joint ventures concerning inland shipping by way of equity participation.

14. (2) The Authority may also-

(a) advise the Central Government on matters relating to inland water transport;

(b) study the transport requirement with a view to co-coordinating inland water transport with other modes of transport;

(c) carry out hydrographic surveys and publish river charts;

(d) assist, on such terms and conditions as may be mutually agreed upon, any State Government in formulation and implementation of scheme for inland water transport development;

(e) develop consultancy services and provide such services, on such terms and conditions as may be mutually agreed upon, in India and abroad in relation to planning and development of waterways for shipping and navigation or any facility thereat;

(f) conduct research in matters relating to inland water transport including development of craft design mechanization of country crafts, technique of towage, landing and terminal facilities, port installations and survey techniques;

(g) lay down standards for classification of inland waterways;

(h) Arrange programme of technical training for inland water transport personnel within and outside the country; and

(i) Perform such other functions as may be necessary to carry out the provisions of this Act.

14. (3) Any dispute arising out of or concerning the compensation referred to in clause(e) of subsection(1) shall be determined according to the law relating to like disputes in the case of land required for public purposes.

14. (4) Every scheme, prepared by the Authority to carry out functions under sub-sections(1) and (2), involving capital expenditure exceeding the amount as may be prescribed, shall be submitted to the Central Government for approval.

14. (5) The Central Government may either approve the scheme submitted to it under sub-section (4) without modification or with such modifications as it may consider necessary or reject the scheme with directions to the Authority to prepare a fresh scheme according to such directions.

In order to consider a planned and systematic implementation with the assigned functions of the authority, a strong Institutional mechanism is required.

If we keenly observe the Institutional systems of similar administrations / establishment globally and the parallel administrations / establishments nationally, the key factor emerging out of the same is only the Policy and procedure of implementation of the assigned responsibilities. It is yet a debatable aspect i.e., whether to have a full pledged organization so as to undertake the works through contractual agencies or to have a mechanism of Out Sourcing the work along with supervision to different contractual agencies (Out Sourcing the work to an agency and the Project Management to other agency).

10.2 Man Power Requirement

It is suggested that the Outsourcing the work to a contractual agency is the best alternative for the subject study and accordingly, the Manpower requirement is under consideration

As ascertained, IWAI is having an Institution Mechanism consisting of a Board along with Functional Manpower having the inverted conical organization pattern. The major functional aspects have already been segregated as Project; Planning; Survey; Marine; Traffic; Finance and Administration. Hence, dislocation of the existing system is not suggested. The present requirement within the study stretch should be unique, which should be amenable to the existing system in the office of Policy making with Control.

Accordingly, the Controlling office (at NOIDA) has been depicted in the pictorial form and will have 1 Chief Engineer to look after the Central part of the country (Hyderabad) to deal with the Waterways / National Waterways in the states of Maharashtra; Goa; Karnataka; Orissa; Telangana; Andhra Pradesh; Tamilnadu & Kerala (including NW 3). Refer the Annexure 10.1.

The present study stretch of Cluster 6 having 03 National Waterways in the state of Kerala will be looked after by the existing Directorate of IWAI at kochi within its geographical zone, for a better control on the project implementation. No additional organizational requirement has been envisaged.

10.3 Training Requirement / Capacity Building

IWAI is having various disciplines within the organization viz., Civil Engineering; Mech. Marine Engineering; Hydrographic Survey; Traffic; Administration / Establishment; Finance etc.

It is suggested and recommended to have an intra-discipline and inter discipline training for all the employees of the IWAI at entry level i.e., at Technical Assistant / Assistant Director; Junior Hydrographic Surveyor / Assistant Hydrographic Surveyor; Junior Accounts Officer / Accounts Officer; Section Officer / Assistant Secretary Etc. The National Inland Navigation Institute (NINI) of IWAI at Patna premises can be used for such training. It is preferred to have such Trainings as onsite training, while the works are under progress.

10.4 Infrastructure

The Infrastructure for the Institution will not have much implication, except the Land for the Office premises, if at all to have the own building of IWAI. However, the infrastructure for functional aspects may be essential within the accessibility of the site controlling office viz., the office of the Director.

The functional requirement can be identified as Survey Vessels; Survey Instruments in order to carry out the mandatory periodical Survey works on the National Waterways. Likewise, to maintain the Night Navigation system, there should be a powerful Tug – cum – Buoy maintenance vessel should be available within the bounds of the office. Further, to have quick inspections and also to have periodical visits, Speed Boats are to be available as an Infrastructure within the controlling office.

Accordingly, 2 Nos. of Survey Vessels; 2 units of Survey Instruments with Software; 2 Nos. of Tug – cum – Buoy maintenance vessel; 2 Nos. of Speed Boats are suggested / Recommended for each Directorate office to look after approximately 6 Nos. of the National Waterways within its jurisdiction.

10.4.1 Immovable

The immovable asset, Land is not suggested at this point of time. In the Long run, even if identified the need of having own office, this will be considered at one of the Terminal Locations, amenable with ease approach. Hence there is no suggestion / recommendation of Land / immovable asset under Institution.

10.4.2 Movable

As discussed above, the asset requirement for attending the functions and responsibilities catered will be considered for procurement. The details have been tabulated directly as a financial Implication with segregation of Capital Cost Implication and Monthly Cost Implication, including the Manpower monthly implication in the forth coming Paras. Keeping in view the Organization requirement, as derived, the implication has been worked out duly taking into consideration of the 7th Pay commission Pay system, so as to have an implementable approach.

10.5 Cost Implications

The cost implication for the apportioned project has been worked out and placed herewith.

TABLE 10-1: MANPOWER FINANCIAL IMPLICATION PER MONTH

Sl. No.	Name of the Post	Nos. of the Post	Basic Pay (INR)	Implication per month @ 95 % extra (INR)	Remarks
1.	Director	1	78800	153,660	Annexure 10.2 may be referred.
2.	Asst. Director Civil / Mechanical	3	56100	328,185	
3.	Asst. Hy. Surveyor	1	56100	109,395	
4.	Junior Hy. Surveyor	1	47600	92,820	
5.	Junior Accounts Officer	1	47600	92,820	
6.	Supervisor	3	35400	207,090	
7.	Steno / P. A	1	35400	69,030	
8.	Upper Divisional Clerk	1	25500	49,725	
9.	Data Entry Operator	6	21700	253,890	
10.	Driver	1	21700	42, 315	
11.	Attendant	6	21700	253,890	25 % extra for statutory allowances and 20 % extra for perks have been taken into consideration.
	Total	25		1,652,820	
	Chief Engineer's Office Component				
1.	Deputy Director	1	67600	131,820	
2.	Technical Assistant	1	47600	92,820	
3.	Data Entry Operator	1	21700	42,315	
	Total	3		266,955	
	Grand Total	28		1,919,775	

TABLE 10-2: FINANCIAL IMPLICATION – CAPITAL AND MAINTENANCE

Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
1.	Office premises	*	75,000	* In the initial stages, office will function on rented premises only
2.	Furniture etc.,	1,000,000	--	L. S.
3.	Pay and Allowances for 28 Nos.	--	1,919,775	As per the Table 10.1
4.	Vehicle 1 No.	500,000	--	
5.	Running & Maintenance of the Vehicle	--	50,000	
6.	Computer Systems including UPS etc., 6 Nos. @ 1 lakh each	600,000	60,000	
7.	Printers 4 Nos. @ 0.5 lakhs each	200,000	*	* Taken into General Office maintenance
8.	Laptops 6 Nos. @ 1 lakh each	600,000	*	* Taken into General Office maintenance
9.	Drawing Printer 1 No. @ 5 lakhs each	500,000	*	* Taken into General Office maintenance
10.	High Speed Printer 1 No. @ 3 lakhs each	300,000	*	* Taken into General Office maintenance
11.	Alternate Uninterrupted Power Supply with D. G set 1 No @ 10 Lakhs per no.	1,000,000	50,000	
12.	2 Nos. Survey Vessels (2 engines of 175 Bhp each) @ 350 lakhs each	70,000,000	1,000,000	Inclusive of Staff charges, on board.
13.	2 Units of Survey Instruments (9.5 lakhs each) + Software (6.5 lakhs each) + Laptop (1 lakh each) etc.,	3,400,000	200,000	Maintenance is inclusive of Survey Stationery and Consumables.
14.	2 Nos. Tug – cum – Buoy Maintenance vessel (2 engines of 375 Bhp) @ 750 lakhs each	150,000,000	1,200,000	Inclusive of Staff charges, on board.
15.	2 Nos. Speed Boats (2 engines of 75 Bhp) @ 75 Lakhs each	15,000,000	150,000	Inclusive of Staff charges, on board.
16.	Other General Office maintenance including stationery, consumables etc.,	--	500,000	
	Total	**243,100,000**	**5,204,775**	

+ The Cost implications for segregated functions like Fairway Development Cost; Terminal Development Cost; Vessel maintenance Cost; Navigation and Communication system implementation cost etc., have been taken into consideration at the appropriate heads, whereas the item Nos. 12 to 15 above are being provisioned for undertaking the requisite functions under the Institution requirements.

+ Here, in Cluster 6, the West Coast Canal has been taken as equal to 2 Modules of 6 Waterways, wherein, Kabini Dam area will be segregated as separate one by not bringing into the overall system due to its far proximity of other 6 Waterways of Cluster 6.

+ Since the NW 59 is of 19 Kms, and within the existing NW 3 jurisdiction, it is not suggested / recommended with any expenditure on Infrastructure

+ However, the limited Manpower requirement of 1 AD + 1 Supr + 1 JAO + 1 DEO + 1 Attendant can be taken as skeleton staff and the same is suggested for the initial stages duly meeting the cost from the suggested provisions. It can be reviewed from time to time based on the volume of the work requirement.

CHAPTER 11 PROJECT COSTING

11.1 General and Financial assumptions

Project Costing is an important aspect, which is to be worked out rationally to assess the apt requirement of the project with a reasonable costing structure so as to ascertain the end result of returns and also will play a vital role in decision making on the implementation of various project components.

It is also essential to define certain financial requirements, in terms of assumptions for the project, which are to be rational i.e., not to be irrational.

In this context, certain parameters, as defined, by IWAI have been analyzed and considered in the financial analysis. The circulated data has been placed at Annexure 11.1. However, the same may not suffice the requirements in working out the cost / returns and hence some more assumptions have been considered appropriately, wherever required.

11.2 Basis of Costing

In general, the costing used to be worked out based on the quantity requirements along with rate per unit quantity. The quantities for the subject project have been arrived at based on the actual item wise requirements. The estimated costs have been worked out based on CPWD Schedule of Rates (SoR) published in Dec-2018 and updated with WPI till March-2020 as new SOR has not been published.. Rates for the non-available items have been proposed based on the Market Rates or based on the realistic budgetary quotations, to the extent possible.

11.3 Development Cost

The NW 59 canal stretch is having scarce IWT mobility by local Boats carrying about 8 to 10 passengers, not on regular basis. However, there is a possibility of establishing the Ro-Ro mobility for the traffic destined to the hinterland of South East part of the country (originating from ICTT, Kochi and the nearby area). This may ease the Road traffic density. The Ro-Ro mobility is only theoretical at this point of time and accordingly working is under consideration. FIRR / EIRR could not be worked, since there is no estimated revenue, while firming up of the report.

11.4 Capital Expenditure

As explained above, the Fairway related development cost has been worked out and placed herewith in two conditions. There were some observations received from Ministry of Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020. The letter described the requirement of modification of existing structures as well as requirement of new structures. Modification of structures have already been considered in the DPR however in light of suggestion received from Govt. of Kerala and its financial impact has been incorporated in the DPR. There are two situations and may be referred as Option-1 and Option-2. These are referred as below:

1. **Option-1** -The project cost does not include the financial impact as suggested vide Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020.
2. **Option-2** -The project cost includes the financial impact as suggested vide Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020.

11.4.1 Option-1

The cost computation and the abstract of cost under option-1 in as below:

TABLE 11-1: ABSTRACT OF COST FOR NW 59 FAIRWAY DEVELOPMENT FOR CAPTIVE TERMINAL OPERATIONS (OPTION 1)

Sl. No.	Item Description	Amount (in Lakh Rs.)	Schedule/ Reference
A	**Fairway**		
1	**Dredging**		
(i)	General Soil	4282.66	Phase 1/ Annexure 11.3
(ii)	Hard Soil	0.00	Phase 1
2	**Low Cost River Structures**		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	**River Training Works**		
(i)	Spurs		
(ii)	Bank Protection Works for river	4496.69	Phase 1/ Annexure 11.4
(iii)	Porcupine		
4	**Night Navigation**		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	158.88	Phase 1/ Annexure 11.5
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	0.00	Phase 1
5	**Land Acquisition**	**2323.93**	**Annexure 11.6**
	Sub-total (A)	**11262.16**	**0.00**
B	**Modification of Structures**		
(i)	Bridges	276.00	Annexure 11.15
(ii)	Cables	12.50	

Sl. No.	Item Description	Amount (in Lakh Rs.)	Schedule/ Reference
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**288.50**	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	
	Sub-total (C)	0.00	
D	**Institutional Requirement**		
(i)	Office Development Cost	40.00	
(ii)			
	Sub-total (D)	**40.00**	
	Sub-total (A)+(B)+(C)+(D)	**11590.66**	
E	Environmental Management Plan as per Chapter-9 of the DPR	93.17	
F	Project Management & consultancy Charges @3% of Prime cost	347.72	
G	Contingencies and Unforeseen Items of Works @ 3% of Prime cost	347.72	
	Project total Hard Cost	**12379.26**	
		123.79	**Crores**

The Ro-Ro facility requirement has been worked out and placed herewith.

TABLE 11-2: ABSTRACT OF COST FOR NW 59 RORO FACILITY

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference
A	**Terminals**		
	Terminal		
(i)	Land	93.39	Annexure 11.10

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference
(ii)	Riverine Components	499.31	Annexure 11.11
(iii)	Infrastructure Components including internal roads	493.84	Annexure 11.12
(iv)	Approach Road (External) Cost	3.50	Annexure 11.13
(v)	Bank Protection Works for terminal	613.17	Annexure 11.14
	Sub-total (A)	**1703.21**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Equipments for Both Terminals**		
(i)	Ambulance - 1 no.	18.00	
(ii)	Dumper Trucks 16 T Capacity - 1 no.	0	
(iii)	Cranes with 50 T Capacity - 1 no.	0	
(iv)	Fork lift trucks 20 T Capacity - 1 no.	0	
	Sub-total (C)	**18.00**	
	Sub-total (A)+(B)+(C)	**1721.21**	
D	Environmental Management Plan as per Chapter-9 of the DPR	13.83	
E	Project Management & consultancy Charges @3% of Prime cost	51.64	
F	Contingencies and Unforeseen Items of Works @ 3% of Prime cost	51.64	
	Project total Hard Cost	**1838.32**	
		18.38	**Cr.**

The total cost of Option-1 has been compiled in table 11.3 as given below.

TABLE 11-3: TOTAL COST (OPTION-1)

Sl No.	Parameter	INR (In Cr.)
1	Fairway	123.79

Sl No.	Parameter	INR (In Cr.)
2	Ro-Ro Terminal	18.38
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	0.00
	Total	**142.17**

11.4.2 Option-2

The cost computation and the abstract of cost under option-2 in as below. As explained, option -2 has ben considered taking the financial inpact of the suggestion of Govt. of Kerala vide theit letter Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020. So, this will entail the development cost as computed in the option-1 & considering the financial impact of the suggested measures by the govt. of Kerala.

TABLE 11-4: FINANCIAL IMPACT AS SUGGESTED BY GOVT. OF KERALA (OPTION-2)

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-8) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
1)	Bridge	Cross Structure Under PWD	5	0	0
2)	Foot Bridge	Cross Structure Under PWD	0	1.2	0
3)	Foot Bridge	Cross Structure Under LSGD	3	1.2	3.6
4)	HT Line	Kerala State Electricity Board	0	0.3	0
5)	LT Lines	Kerala State Electricity Board	25	0.01	0.25
6)	Regulator Cum Bridge & Navigation Lock	Irrigation Dept. & Navigation Dept.	0	0	0
7)	Water Pipe - line	Kerala water Authority	0	0	0
	Total				**3.85**

Therefore, the total cost as per the Option-2 shall be as detailed in the below table.

TABLE 11-5: TOTAL COST (OPTION-2)

Sl No.	Parameter	INR (In Cr.)	Remarks
1	Fairway	123.79	Amount as Per Option-1
2	Ro-Ro Terminal	18.38	Amount as Per Option-1
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	3.85	As Detailed in Table 11.4.
	Total	**146.02**	

Hence the total cost of project development in case of Option-1 & Option-2 is Rs. 142.17 Crores and Rs. 146.02 Crores respectively.

11.5 Operational and Maintenance Expenditure

The operation & Maintenance expenditure has been considered as at Annexure 11.1 and as per the industrial standards.

11.6 Phasing of Expenditure

As explained above, the project is proposed to be considered after having the possibility of Ro-Ro vessel / Ro-Ro Trucks mobility from the industry. The confirmations are to be firmed up by 2022 and the implementation is being suggested in 3 years from 2022, however, only on positive confirmations.

CHAPTER 12 IMPLEMENTATION SCHEDULE

12.1 Time Frame

The present utility of Vechoor – Athirampuzha NW – 59 is limited to the mobility of small boats carrying 8 to 10 passengers here and there. No regular movement has been observed. In the Vechoor area, in the Vembanad Lake, some tourist boat mobility has been noted. Hence, there is no significant use of this waterway. Keeping in view of its connectivity to NW 3, a theoretical working has been initiated, which also could not be established with any fruitful conclusions. However, it is suggested in this study to have a reasonable utilization of NW 59 with an estimated diversion of road traffic destined to East / South east part of the country from ICTT, Kochi and from surrounding areas. Ro-Ro traffic mobility with the possibility of diversion to IWT is to be observed / confirmed, before taking any investment / implement decision. There may be a possibility in the long run, especially in the state of Kerala, where lot of problems is being faced in the Land availability for Acquisition for Road development. Besides Kerala is facing lot of problems with the Road accidents and this suggested Ro-Ro IWT mobility will become a boon once established, though economically is not viable without support system, as worked out.

12.2 Phasing

The development of Fairway and Ro-Ro Terminal are suggested only after having positive confirmations on the Truck volumes, which is to be observed till 2022 and there upon the development is proposed to be completed in 36 months.

The Vessel requirement will be taken care by Entrepreneurs i.e., 1 Ro-Ro vessel may be required at the initial stages for deployment on experimental basis and Other Ro-Ro vessels may be deployed based on the requirement at that point of time.

12.3 Suggested Implementation Mechanism

The implementation will be considered through the Project Management Consultancy, as provisioned. However, it is suggested that the overall supervision will be under the control of the IWAI supervision mechanism.

CHAPTER 13 ECONOMIC AND FINANCIAL ANALYSIS

Venchoor – Athirampuzha Canal (NW-59) is shown in the map below. The detailed traffic study undertaken in chapter 4 could not identify any cargo opportunities for the river. The need and benefit of developing NW-59 for transportation could not be established. Moreover, NW 59 shares the hinterland with NW 8 and NW 9. Both the waterways have better suitability to be developed for transportation. Any prospect of cargo transportation in future, unlikely looking at present scenario, could be handled at NW-8 and NW-9. This makes development of NW-59 redundant.

All the industries in the catchment area of NW 59 are closer to NW 9, so if these industries use waterways, they would prefer NW 9, not NW 59. Hence, cargo movement in NW 59 is not commercially viable.

FIGURE 13-1 MACRO MAP OF NW-59

There are open fields & agricultural land, which has surrounded both sides of the waterway. Two city roads, few internal roads & some bridges are already there on waterway for crossing the canal. There are many internal roads that move parallel to the stretch, along the waterway.

FIGURE 13-2 ATHIRAMPUZHA POND & CHANNEL OF NW 59

Developing tourism related facilities in NW 59 is not advisable. At present, there is no passenger movement going on in NW 59. The hinterland around contains Paddy fields covering around 80% of the river stretch. The rest area has residences on the banks of the river. The concrete boundary of residences touches the banks at locations with width of river ranging between 10 m to 20. Hence, any prospect of widening the river is also rulled out. Tourism segment would not provide potential for NW 59.

FIGURE 13-3 MARKET PLACE AROUND ATHIRAMPUZHA POND

Apart from Kumarakom Backwaters, there are many more places in southern region of NW 59, but all they are also closer to NW 9. Southern & western region of the identified stretch is already well developed for tourism. Every year this region attracts huge number of tourist arrivals.

The financial assessment cannot be undertaken for this stretch of waterways in the absence of any revenue sources or prospects. There is no prospect of cargo movement or passenger movement. Hence, development this waterways is not required.

However considering the remote possibility in most optimistic scenario, the section below presents the total project cost for development of IWT on NW 59. Project cost is derived under two different options i.e Option 1 and Option 2. The following table shows these cost-heads for both the core business operations:

Table 13-1 Project Cost for NW 59 – Option 1

Description (Option 1)	Total Investment Cost (INR Lakhs)			
	Total	1st Year	2nd Year	3rd Year
Fairway Development				
Fairway	11,262.16	4,504.86	3,378.65	3,378.65
Structure Modification	288.5	115.40	86.55	86.55
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	93.17	37.27	27.95	27.95
Project Management & consultancy Charges @ 3% of Prime cost	347.72	139.09	104.32	104.32
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	347.72	139.09	104.32	104.32
Total Project Cost	**12,379.26**	**4,951.70**	**3,713.78**	**3,713.78**
Ro-Ro Terminal				
Terminal	1,703.21	681.28	510.96	510.96
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	13.83	5.53	4.15	4.15
Project Management & consultancy Charges @ 3% of Prime cost	51.64	20.65	15.49	15.49
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	51.64	20.65	15.49	15.49
Total Project Cost	**1,838.32**	**735.33**	**551.50**	**551.50**

Table 13-2 Project Cost for NW 59 – Option 2

Description (Option 2)	Total Investment Cost (INR Lakhs)			
	Total	1st Year	2nd Year	3rd Year
Fairway Development				
Fairway	11,262.16	4,504.86	3,378.65	3,378.65
Structure Modification (DPR-Rev.01)	288.50	115.40	86.55	86.55
Structure Modification (Suggested By Kerala Govt.)	385.00	154.00	115.50	115.50
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	93.17	37.27	27.95	27.95
Project Management & consultancy Charges @ 3% of Prime cost	347.72	139.09	104.32	104.32
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	347.72	139.09	104.32	104.32
Total Project Cost	**12,764.26**	**5,105.70**	**3,829.28**	**3,829.28**
Ro-Ro Terminal				
Terminal	1,703.21	681.28	510.96	510.96
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	13.83	5.53	4.15	4.15
Project Management & consultancy Charges @ 3% of Prime cost	51.64	20.65	15.49	15.49
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	51.64	20.65	15.49	15.49
Total Project Cost	**1,838.32**	**735.33**	**551.50**	**551.50**

Any cargo transportation in future could be either handled through NW-8 or NW-9. This makes the development, of NW-59 having such large investment, a non-starter. There is absolutely no revenue stream and hence no financial assessment could have been forecasted for this stretch of waterway. The development of this waterway is not recommended.

However, considering the remote possibility in most optimistic scenario, total project cost for development of IWT on NW 59 had been included in the chapter:

CHAPTER 14 CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Vechoor – Athirampuzha canal NW – 59 in the stretch of 18.80 Kms from Vechoor joining the NW 3 (Lat 09°40'00" N, Long 76°24'11" E) to Athirampuzha Market (Lat 09°40'04" N 76°31'54" E) has been carried out as per the Terms of Reference (ToR) and the details of the study are given in the preceding chapters.

A summary of the recommendations and conclusions as a result of the study is placed herewith:

- Detailed Hydrographic Survey has been carried out and based on the Survey carried out / Site data collected / subsequent to the Morphological analysis etc., the required developments in the Fairway along with interrelated activities have been identified. A part of the study stretch is in the "Vembanad Lake" area in Kerala, which is one of the identified sites under Ramsar Convention of wet land. Since it is in the Lake area, as such there is no major Regime disturbance in the study stretch.
- NW 59 has been considered for Class III waterway in line with the requirement of connectivity for mobility through existing NW 3 so as to have throughout, if proposed for development. However, there is no cargo mobility in the stretch. The passenger and tourism mobility is also found not practicable.
- The National Waterway 59 (NW 59) is to be widened to a major extent of about 15 Kms to achieve the Class III waterway standard. The Vechoor area of NW 59 is having connectivity with the existing NW 3 i.e., with Kottappuram and Kollam including the Kochi area and ICTT, Kochi. Accordingly, Ro-Ro vessel mobility is suggested connecting ICTT, Kochi and Kochi area for movement of vehicles through Athirampuzha towards the Eastern / the South Eastern part of the hinterland. This aspect is to be carefully observed up to 2022 and with the positive confirmations, development of NW 59 can be considered there upon with 3 years span of time.
- Accordingly, the possibility of vessel mobility has been considered with Class III standard of Waterway with 32 m Bottom Width of fairway in narrow reaches and 38 m Bottom Width of fairway in wider reaches however with 2.2 m Depth of fairway in both the reaches with a vessel requirement for Class III as 50 m – 55 m LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry either 300 T – 500 T of Bulk / Break Bulk Cargo or 15 Nos. – 21 Nos. TEU. The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each.
- No development is suggested till a critical and micro level analysis with observation of positive growth trend amenable for Ro-Ro operation till 2022. Development period may take 3 years from 2022, if growth is confirmed.
- As a part of development, in order to provide a class III safe navigable fairway, Dredging of 17.48 Lakhs Cu. M in Soils along with the Land Acquisition of 24.5 Hectares and Bank Protection of 31 kms have been suggested. Day / Night Navigation through 45 Nos. Buoy / Light system and Modification of 6 Bridges are also suggested. One Ro-Ro Terminal development is also suggested at Athirampuzha.
- The most probable location for Berthing, Ro-Ro IWT Terminal at the other end (one end is Ro-Ro Terminal at Bolghatty, Kochi) is suggested at Athirampuzha with approx. Lat 09° 40' 0.81" N and Long 76° 31' 53.57" E.

- A tentative Land requirement has been worked out and arrived at with 8500 Sq. M at Athirampuzha. Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Athirampuzha Village; Kottayam Taluk; Kottayam District of Kerala state.
- Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 75 m and width as 12 m.
- In order to facilitate the Ro-Ro operation, the following Vessel type and size have been considered to handle as Ro-Ro Vessel of 50 m – 55 m LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry either 300 T – 500 T of Bulk / Break Bulk Cargo or 15 Nos. – 21 Nos. TEU. Propulsion is with Marine Diesel Engines of 3 x 375 Bhp and with Average Speed (with Load) of 20 Kmph. The indicative cost is about INR 700 Lakhs. Not suggested for any deployment without Traffic confirmations.
- It is suggested for the observations and firming up of the Ro-Ro traffic volumes up to 2022 and the investment for development is suggested only after having positive growth trend and confirmation.
- The cost estimates have been worked out for development of Fairway with a capital cost of 123.79 Cr and Terminal with a capital cost of 18.38 Cr. Implementation of the above is suggested in 3 years from 2022.
- The FIRR and EIRR is non-existent as the revenue is zero due to no visibility of cargo movement on this water way.

Option-1 Parameter	Unit	Fairway	Ro-Ro Terminal	Whole Project
Project Cost	INR Cr.	123.79	18.38	142.17
Revenue	INR Cr.	Nil	Nil	Nil
FIRR	%	Non-existent	Non-existent	Non-existent
EIRR	%	Non-existent	Non-existent	Non-existent

- Option-2

Parameter	Unit	Fairway	Ro-Ro Terminal	Whole Project
Project Cost	INR Cr.	127.64	18.38	146.02
Revenue (FY40)	INR Cr.			
FIRR	%	Non-existent	Non-existent	Non-existent
EIRR	%	Non-existent	Non-existent	Non-existent

- Development of NW 59 is neither suggested nor recommended.

CHAPTER 15 TEMPLATES

15.1 Environmental & Social Screening Template

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site			
a) National Park		✓	
b) Wildlife/ Bird Sanctuary		✓	
c) Tiger or Elephant Reserve		✓	
d) Biosphere Reserve		✓	
e) Reserved / Protected Forest			No Forest Land is contemplated for this project
f) Wetland	✓		Approximately 340 m of the project is located in Vembanad Lake which is a Ramsar Wetland Site. Clearance shall be obtained in accordance with CRZ Notification 2011.
g) Important Bird Areas		✓	
h) Mangroves Areas		✓	
i) Estuary with Mangroves		✓	
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration		✓	
k) World Heritage Sites		✓	
l) Archaeological monuments/ sites (under ASI"s Central / State list)		✓	
2. Is the project located in whole or part in / near any Critically Polluted Areas identified by CPCB?		✓	
3. Is, there any defense installations near the project site?		✓	

Screening Question	Yes	No	Details / Remarks
4. Whether there is any Government Order/ Policy relevant / relating to the site?	✓		Wildlife Protection Act, 1972 Water Act, 1974, Air Act 1981 CRZ Notification 2011 Wetland Rules, 2010
5. Is the project involved clearance of existing land, vegetation and buildings?	✓		For construction of terminal building and access roads.
6. Is the project involved dredging?	✓		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)		✓	
8. Is the project located in whole or part within the Coastal Regulation Zone?	✓		CRZ Clearance shall be applicable.
9. Is the project involved any demolition of existing structure?			No.
10. Is the project activity require acquisition of private land?			Yes. This will be considered as per the LA with LR and related regulations.
11. Is the proposed project activity result in loss of direct livelihood / employment?		✓	No.
12. Is the proposed project activity affect schedule tribe/ caste communities?		✓	To be considered at Detailed stage / EIA / EMP Study

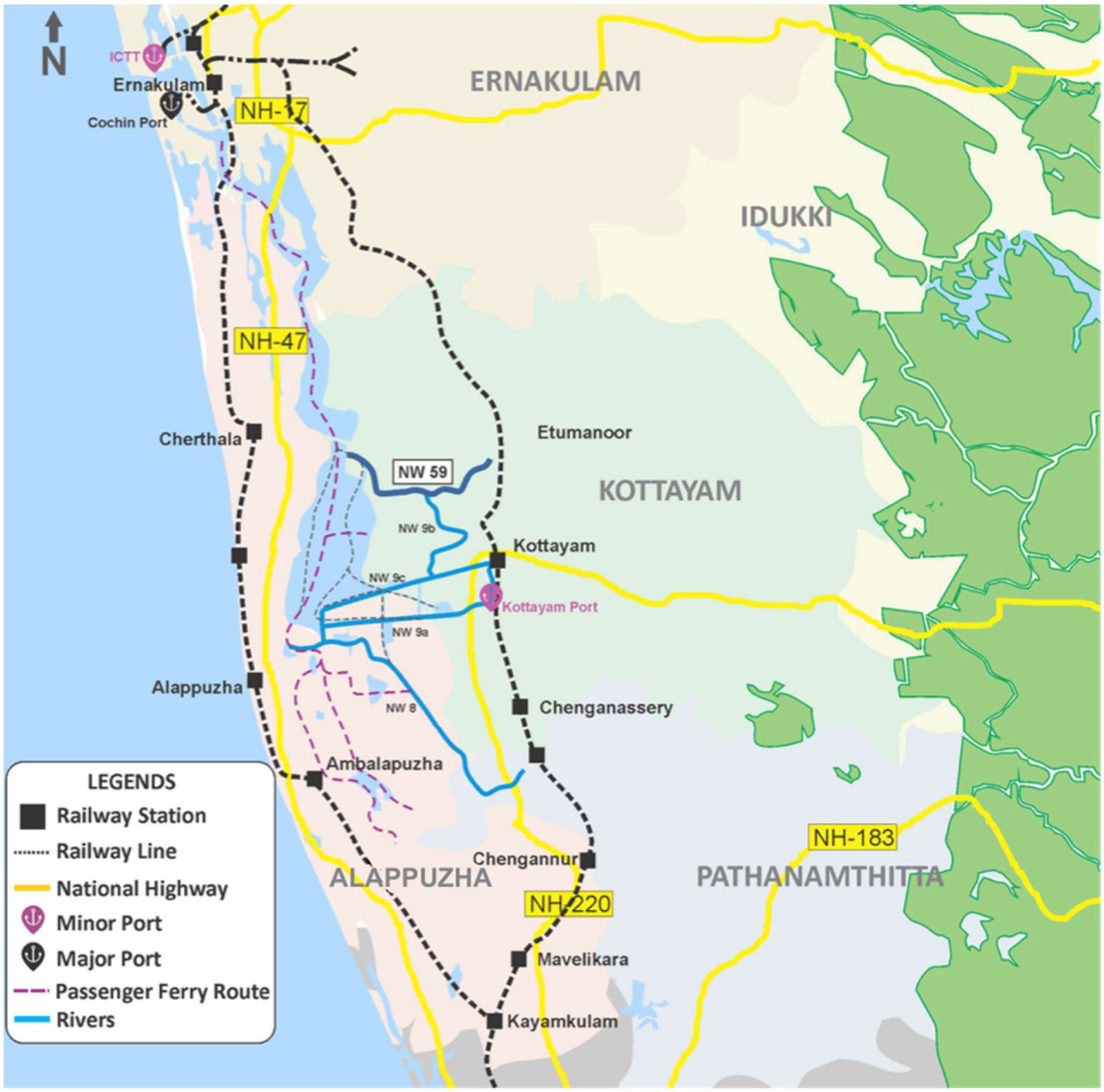
S. N.	Result of Screening Exercise	(Yes / No)
1.	Environment Impact Assessment is Required	Yes
2.	CRZ Clearance is Required	Yes
3.	Environmental Clearance is Required	No
4.	Forest Clearance is required	No Forest Land is contemplated.
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	Only as part of EIA study
8.	Abbreviated RAP is required	No
9.	Full RAP is required	No
10.	Any other clearance is required	Other clearances required for the project shall include those that need to be obtained by the

S. N.	Result of Screening Exercise	(Yes / No)
		Contractors such as the Certificate of Registration from the Labour Department under various applicable labour laws, permission from SPCB for setting up of batching plants, license for storing petroleum / diesel etc.

15.2 Traffic Template

15.2.1 Catchment Baseline

- Local economic geography – Originates at Vechoor i.e. near Vembanad Lake and extends till Athirampuzha of Kottayam taluka
- Catchment area – Kottayam, Alappuzha & South Ernakulam districts of Kerala
- Population – As per census 2011, total population residing in Kottayam taluka is 631,885, Changanassery taluka 355,736, Meenachil taluka 406,471 and Vaikom taluka 310,414 & Kanjirappally taluka 270,045 of Kottayam district, Cherthala taluka 542,657, Ambalappuzha taluka 454,864, Kuttanad taluka 193,007 of Alappuzha district & Kanayannur taluka 32,974, uvattupuzha taluka of Ernakulum district.
- Economic activities – Major contributors to Kottayam's economy are Rubber industry & spice exports & Alappuzha's economy are Tourism & exports of spices, coconut oil, coir, sugar etc.
- Industrial Cluster - Midas Precured Tread, TCL, MRF, Cochin Cements & other small subber manufacturing units.
- Connectivity
  - ✓ Major roads – Local roads runs parallel to the stretch. Kumarakom-Sumbam Road Bridge crosses river at the 5kms from the mouth.
  - ✓ Major railway – Konkan Railway line is just 2kms away from Athirampuzha.
- Specific Developments
  - ✓ At the beginning of Fy 17, State Government has started solar ferry service, which runs between Vaikom to Tavanakkadavu (near Vembanad Lake). Seating capacity of this new boat is 75. Total 22 ferries would ply on this route between 7 am to 7 pm. Additional 10 solar ferryboat proposal is in the pipeline of State Government.
  - ✓ Two sites are shortlisted in Kottayam for developing Greenfield International Airport namely Kootickal & Cheruvally estate. Both the locations are more than 50kms away from identified stretch i.e. NW59.
- Catchment area Map



15.2.2 Navigation Baseline

- Existing Waterway Usage: -NIL-

  (Technical details like vertical clearance, number of jetties, barrages etc. need to be added by analysing other chapters.)

In the identified stretch of NW 59, only small ferry service for passengers is available between west side of the Kumarakom-Cumbam Road bridge & Vembanand Lake. Wooden motorized boats are used by the local operators with carrying capacity of 8-10 people. This boat tour is for about 30-45 mins covering distance of 5kms at one side & than coming back to bridge. No other facilities were seen during site visit on either side of the bridge.

15.2.3 Market Baseline

- Potential Market

NW 59 does not have potential for any kind of traffic; let it be Cargo, Passenger or Tourism.

15.2.4 Forecasting Years

No opportunity exists for any kind of waterway movement.

15.2.5 Presentation of Forecast

Invalid

15.2.6 Market Success Factors

The Market success factor for development of NW59 is the Geographical location with its connectivity with the existing NW 3 i.e., to ICTT, Kochi. The Trucks destined to South Eastern part of the country can move through IWT by reducing the road density in Kerala. This is only the theoretical approach.

15.2.7 Forecasting Methodology

Invalid

15.3 Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	□ Land, compensation and resettlement: 24.17 cr □ Capital dredging: 17.48 lakhs cu.m Soils – 42.82 cr □ River training/bank protection: 44.96 cr □ Locks: No □ Barrages: No □ Channel market: No □ Night navigation: 1.59 cr □ Other: Modification of Structures– 2.89 cr

Cost type	Cost categories	Components to be itemized
Terminal Infrastructure		Ro-Ro facility □ Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) □ Loading/uploading and other equipment (itemized) □ Buildings: Considered in infrastructure □ Other: -- } Considered
Operation and maintenance (O & M) costs	Waterways	□ Maintenance dredging □ Markings and nav.-aids □ Bank maintenance □ Other } Considered as per standard
	Terminals	□ Terminal operations □ Terminal maintenance □ Other } Considered as per standard
	Vessel: (NB vessel operating costs/tons-km fall sharply with larger capacity vessel, when there is sufficient traffic to utilize them)	□ Crew □ Fuel □ Maintenance □ Registration & insurance □ Fees and charges □ Vessel capital amortization (or leasing cost equivalent) □ Total costs } Considered as per standard □ (Cost/tons-km for use in evaluation)
Recurrent costs		Periodic major capital costs that may occur over life of assets: Considered as per standard
Price levels		All costs to be expressed of 2020 price levels
Value engineering		Not all investments will be necessary in all projects. Value engineering should be applied to project scoping and specification to avoid “gold-plating” of costs and undermining viability of project
Value engineering		Costs that are estimated on a “bottom-up” basis should be verified or tested for reasonableness against actual costs for such activities evidenced in the market place: Considered as per standard.

15.4 Economic Evaluation Template

NIL

15.5 Financial Evaluation Template

NIL

ANNEXURES

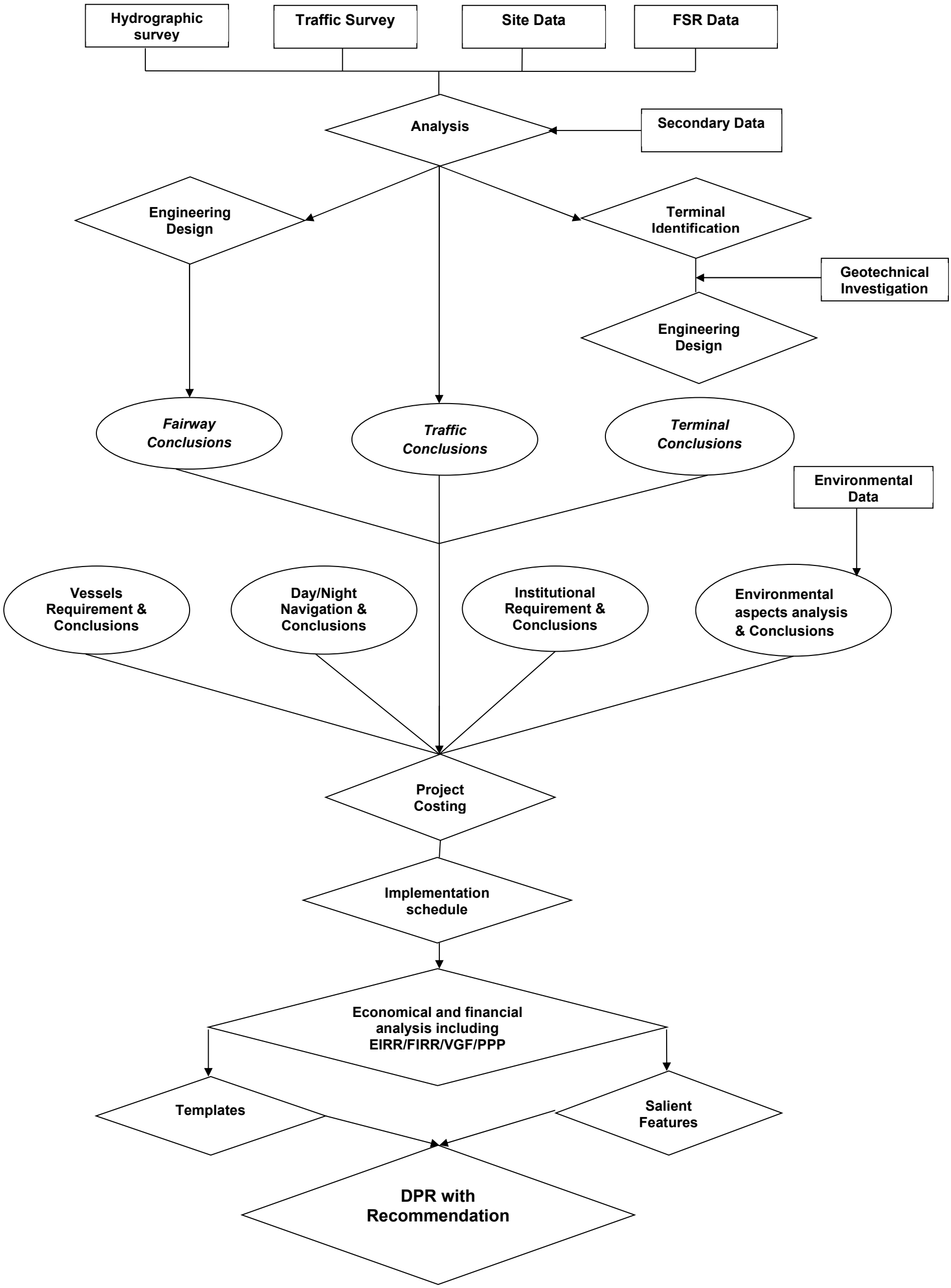
ANNEXURE 1.1 – TOR OF THE AGREEMENT

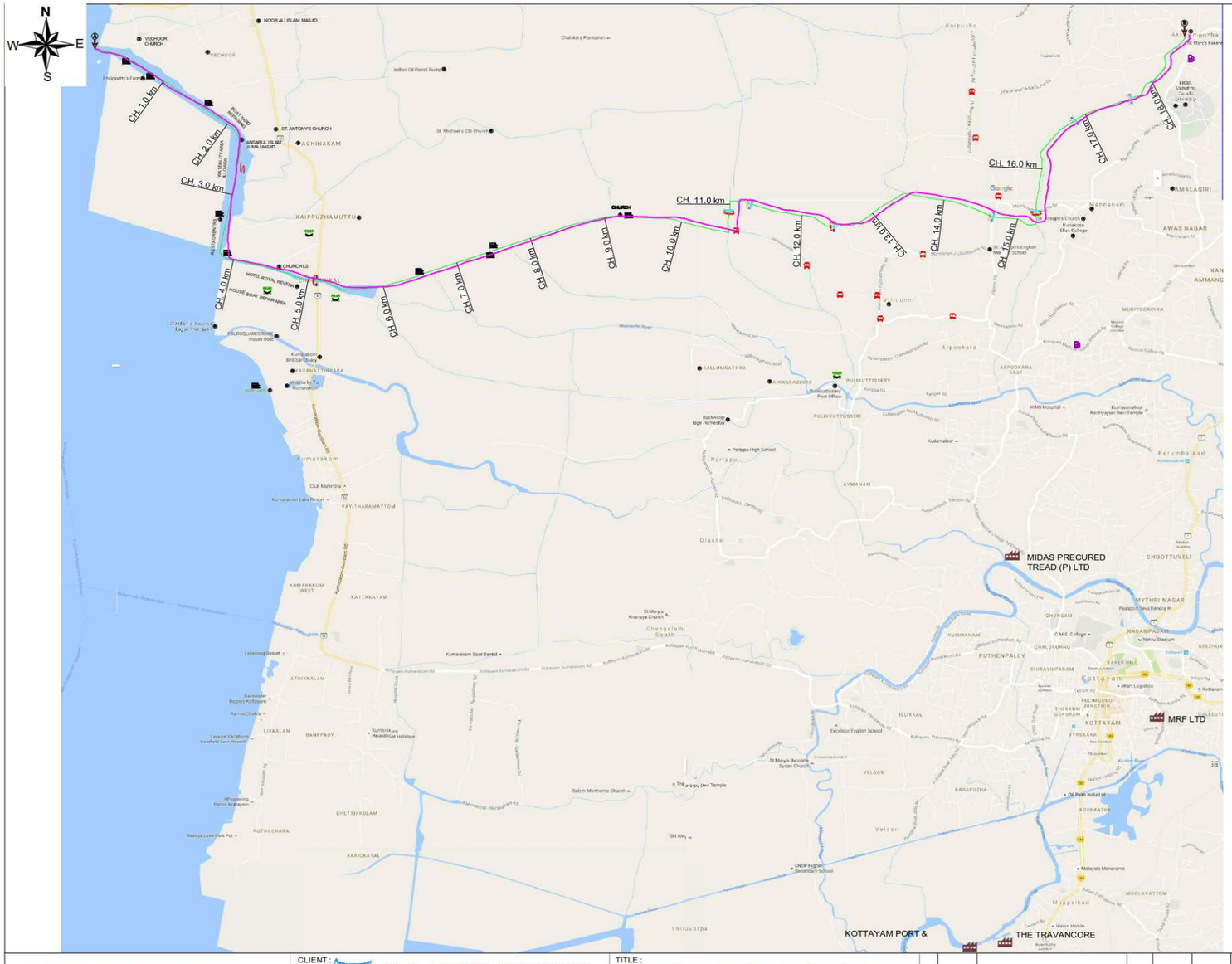
ANNEXURE 1.2 – COMPLIANCE

COMPLIANCE ON THE TERMS OF REFERENCE

VECHOOR – ATHIRAMPUZHA CANAL (18.78 KM) NW-59

Brief of ToR	Compliance
1.0 OBJECTIVE OF THE STUDY: The study would consist of 2 stages: Stage-1 &Stage-2	
1.1 STAGE-1 1.1.1 Reconnaissance Survey – i) to xii) 1.1.2 Collection and Review of Available Data 1.1.3 Feasibility Report 1. Introductory considerations: 2. Analysis of present state of affairs: 3. Market Analysis: 4. Reconnaissance Survey:	Stage I has been completed and based on the same, Stage II Work Order was provided by IWAI.
1.2 STAGE-2 1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY (i) The detailed hydrographic survey is to be carried out in WGS"84 datum. (ii) The horizontal control is to be made using DGPS with minimum 24 hours observations at some platform/base. The vertical control is to be established with respect to the chart datum / sounding datum	Detailed Hydrographic Survey was completed and the data compiled / analysed (including the Charts) have been submitted under Volume III of the report. Further, the analysed data have been taken into Volume I and Volume II of the Report appropriately.
1.2.1.1 BENCH MARK PILLARS – a)	-do-
1.2.1.2 WATER LEVEL GAUGES i) & ii)	-do-
1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY – a) to k)	-do-
1.2.1.4 CURRENT VELOCITY AND DISCHARGE MEASUREMENT – a) to e)	-do-
1.2.1.5 WATER AND BOTTOM SAMPLES – a) – i) to vi)	-do-
COLLECTION OF TOPOGRAPHICAL FEATURES – a) to j)	-do-
1.2.1.6 SURVEY CHART PREPARATION – a) to n)	-do-
1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY	Submitted in Chapter 4 and in the inter related chapters
1.2.3 DETAILED PROJECT REPORT The scope of works is as follows: in paras a) to k)	Submitted the Volume I of the DPR.
2.0 PERIOD OF SERVICES	
2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:	Delay observed, as narrated from time to time.
NOTE: - The consultants are required to submit the following outputs in Stage-II i) Traffic Template: at Annex-IV ii) Project Costing Template: at Annex-V iii) Financial Evaluation Template: at Annex-VI iv) Economic Evaluation Template: at Annex-VII v) Environmental & Social Screening Template: at Annex-VIII	Submitted at Chapter 15 – Templates in the DPR Volume I.





Sr. No.	Industries Shown in This Map
1	Travancore Cements
2	Midas Precured Tread
3	MRF
4	kottayam Port & Container Terminal
Sr. No.	**Industries Beyond The Map**
1	Diamond Roller Flour mill
2	Oil Palm India
3	Perumacheril Casting
4	Ceyenar Chemicals
5	Hi-tech Cast Iron Industries
6	TJP Rubber
7	Sanson Chemical
8	Rubberwood India
9	Kottayam Textiles
10	Canara Paper Mills
11	Integrated Power Loom Industrial Co-Oprative Society Ltd
12	Modern Rice Mill
13	Cochin Cements

LEGEND

- BUS STOP
- PLACE NAME
- FUEL STATION/PUMP
- BRIDGE
- JETTY
- INDUSTRY
- RESORT
- NATIONAL/STATE HIGHWAY (Hwy)
- ROAD
- FERRY LINE
- ROOT PROVIDED BY IWAI
- SURVEY (VESSEL TRACK) / THALWEG
- (A) START POINT FROM, VECHOOR NW-3 AT LAT. 9°40'00" N LON. 76°24'11" E
- (B) END POINT ATHIRAMPUZHA MARKET AT LAT. 9°40'04" N LON. 76°31'54" E
- CH. 12.0 km CHAINAGE MARK

TRACTEBEL

TRACTEBEL ENGINEERING PVT. LTD.
Intec House, 37
Institutional Area, Sector 44
122002 Gurgaon-INDIA

CLIENT : INLAND WATERWASYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

CONTRACTOR :

PROJECT NAME : CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -6 OF NATIONAL WATERWAYS

TITLE : VECHOOR-ATHIRAMPUZHA CANAL (KERALA) NW 59
LAYOUT MAP SHOWING EXISTING INDUSTRIES

STATUS OF DRAWING:- ISSUED FOR DPR

DRAWING NO:- ANNEXTURE 4.1 | SHEET 1 OF 1 | SCALE 1:150 | SIZE A3

SCALE 0 2.0 4.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

TOTAL WATERWAY LENGTH FROM POINT 'A' TO POINT 'B' 18.80Km

ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

Summary of Interviews on NW 8 / NW 9 / NW 59

Sr. No.	Name of Port/Industries	Designation
1	Cochin Port	Deputy Traffic Manager / Sr. Asst. Traffic Manager
2	Kottayam Port & Container Terminal	Chief Executive Officer
3	State Water Transport Department	Director
4	Travancore Cements Ltd.	Deputy Manager
5	MRF	Sr. Manager
6	Petrogas India	Plant Manager
7	Diamond Roller Flour Mill	General Manager

Name of Company: Cochin Port

Contact Person: Mr. Girish Thomas / Mr. D Anil Kumar

Designation: Deputy Traffic Manager / Sr. Asst. Traffic Manager

Coal handling at Cochin Port has reduced to 44,000 T. Coal from Cochin Port is transported to Malabar Cement and Hindustan Newsprint Ltd. in Kottayam. There is some scope to transport cement to Kozhikode but due to some unknown reasons, industries are not using waterways for cement transport. Electronics, Garments, Tiles & Timber are the major goods for container movement. It can also be transported through waterways if industries demand it.

Name of Company: Kottayam Port & Container Terminal

Contact Person: Mr. Cherian K. Varghese

Designation: Chief Executive Officer

As per discussion with the Chief Executive Officer of KPACT, Mr. Cherian K. Varghese, KPACT needs IWAI to develop certain facilities, which includes a jetty, cranes for handling cargo and smooth navigation in the proposed waterway.

Name of Company: State Water Transport Department

Contact Person: Mr. Shaji V Nair

Designation: Director

Mr. Nair shared his inputs regarding the existing ferry services in Alappuzha, Kottayam & Changanassery. SWTD has witnessed increasing growth in the demand of ferries for passengers/tourists. SWTD has a plan to move Catamaran boat for passengers and tourists. When asked about the potential of Ro-Ro in the existing ferry routes, Mr. Nair shows optimism for Ro-Ro; however he showed concern about less draft problem in some places in the waterway.

He said that if the problem of less draft is solved then there is good potential for Ro-Ro in the waterway.

Name of Company: Travancore Cements Ltd.
Contact Person: Mr. P. Ashok Kumar / Mr. Kanan
Designation: Deputy Manager (Marketing)/ Deputy Manager (Maintenance & Internal Projects)

In 2017: As per Mr. Kanan, at present the company does not use Vembanad Lake for lime shell, which was the major raw material for manufacturing cement. Earlier, TCL used to procure limestone from Tirunelveli, Tamil Nadu through roadways, however at present TCL stopped using lime shell and limestone as raw materials. TCL now uses clinker as substitute because Limestone and lime shell are calcium carbonate and clinker also is made of the same material. TCL imports clinker from Gulf countries through Cochin Port and the company's expansion plans are also depended on clinker as raw material. According to Mr. Kanan, the plant of TCL is shut down now; however it would start operation form June 2017. The plant produces around 2,000-2,500 tonnes of white cement per month.

TCL has shared some concerns about using IWT Waterway, they are listed below.

- According to Mr. Kanan, the draft of the existing NW in some places is less, i.e. 2 mtrs. only, which is very less for even medium size vessels.
- Mr. Kanan also shared his concern about Thanneermukkom Bund, which is a gate type structure in Vembanad Lake and used as salt water barrier. This barrier essentially divides the lake into two parts. This barrier opens when any ship or vessel crosses; however the breadth of the barrier is very less and is not enough for bigger vessels. TCL plans to transport 500-1,000 metric tonne clinkers in one go through vessels in waterway. This means the size of their vessel would be bigger and the opening structure would not be sufficient for the vessel to cross. If IWAI solves this problem, then TCL would like to use waterway extensively in future for its plant.
- The proposed waterway would stretch till Kollam in South; however TCL is interested to use waterway further ahead in South, if IWAI develops waterway in South.
- TCL has an expansion plan to increase production of grey cement to 10,00,000 tonnes (1 mn T) and white cement to 60,000 tonnes.. The raw material for this plant would be clinker.
- However, in future the company may consider using limestone also. The expansion plan is at DPR stage now.

- TCL has offered IWAI a parcel of land on its premise for the development of a terminal and additional infrastructure. This development would be based on mutual agreement and revenue profit sharing with IWAI.

In 2018 According to Mr. Kanan, the plant of TCL is operational now. At present, the plant consumes 1000 tonnes clinker per month for manufacturing white cement. It produces 1000 tonnes of white cement per month. It is expected that the production of white cement would increase to 1200 – 1500 tonnes per month.

- The production of grey cement depends on future market demand. Therefore, as of now, it is not certain.

Name of Company: MRF, Kottayam
Contact Person: Eapen George
Designation: Sr. Manager

Mr. George shared that the annual capacity of MRF, Kottayam plant is 56,000 tonnes. The plant produces around 160 tonnes per day and they have 350 working days in a year. The plant uses Cochin Port for EXIM trade. Synthetic rubber is used as raw material and is imported from Russia, Japan & USA. Natural rubber is imported from Malaysia. The company also uses Cochin Port for export to different countries. At present, MRF is using roadways to transport cargo to/from Cochin Port. The company faces road congestion problems on highways on a daily basis. As per Mr. George if the waterway is developed by IWAI and the transportation cost by waterways is cheaper, then definitely they would prefer waterway for their cargo transportation.

Name of Company: Oil Palm India
Contact Person: V.M. Jaisar

As per the discussion with Mr. Jaisar, the company produces 20 tonnes per hour palm oil. The company's annual production is around 0.17 million tonnes/annum. The finished product, refined oil is distributed in different states of India through roadways, using lorries. The company does not export its products to different countries. Oil Palm India is not willing to use waterways for transportation of its cargo.

Name of Company: Petrogas India
Contact Person: Mr. A.V. Varghese
Designation: Plant Manager

Petrogas India doesn't import anything. However, the company exports its products to different countries. For export, Cochin Port is used. The company also distributes its products in domestic market through roadways. Export quantity varies according to order; on an average the company exports 30 tonnes product per month.

Name of Company: Diamond Roller Flour Mill
Contact Person: Mr. E.K. Shajahan
Designation: General Manager

As per discussion with Mr. Shajahan, the company is involved in EXIM trade. The annual capacity of the plant is 66,000 MT. The plant procures raw material from Rajasthan, Gujarat, MP, UP and sometimes imports from other countries too through Cochin Port. The plant distributes the finished product to Kerala and Tamil Nadu; it also exports to other countries. Rail & Coastal Shipment is used for raw material movement, whereas road is used for transporting finished products.

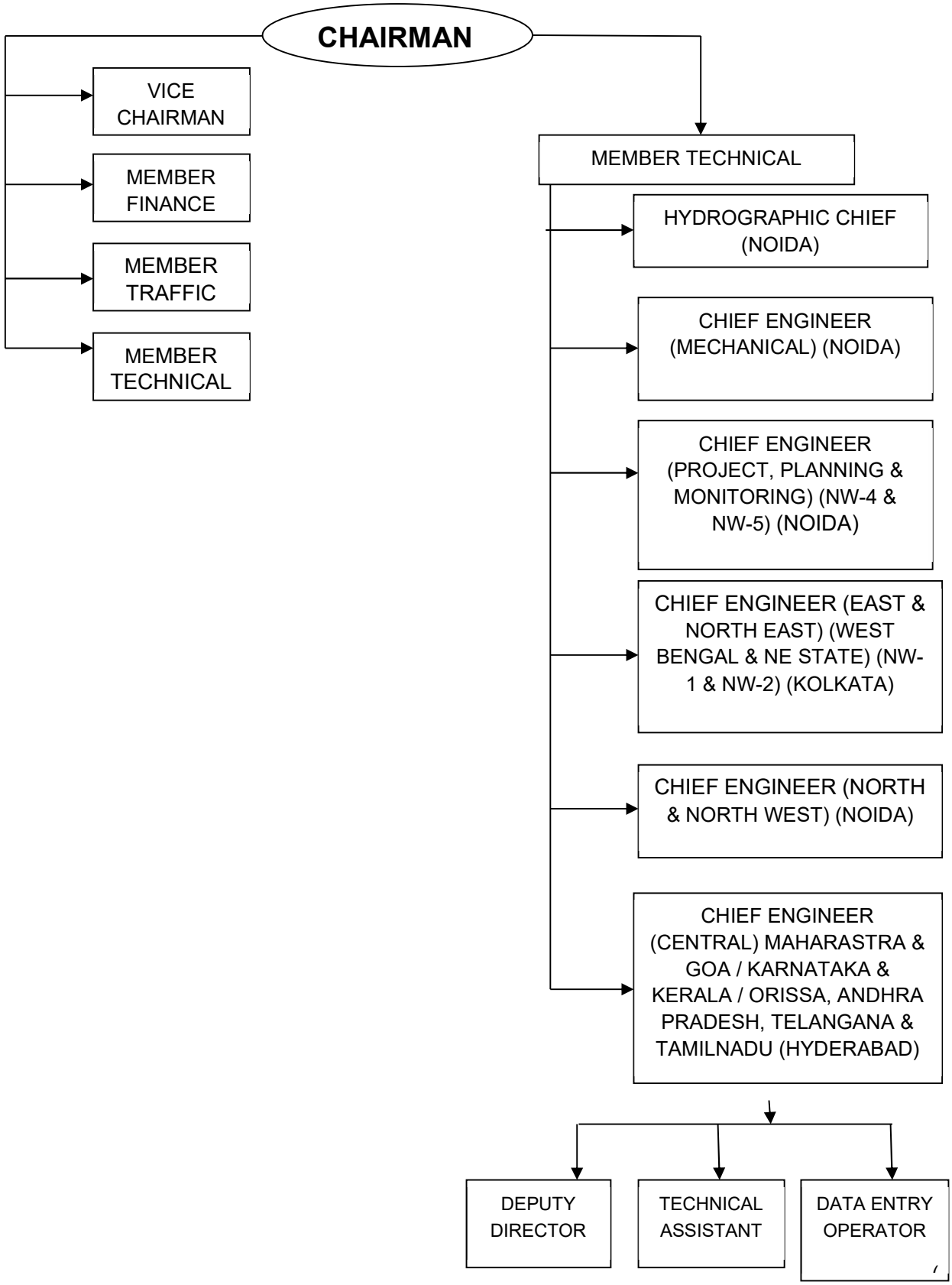
As per discussion with the company representative, the major hurdle of present mode of transportation cargo is that Rail transportation in full rake load entails demurrage. The company is willing to use waterway if it is cost effective. Mr. Shajahan was concerned that multiple handling may add to transportation cost.

ANNEXURE 5.1– CALCULATION OF SAFE BEARING CAPACITY

ANNEXURE 8.1– RIS / AIS

ANNEXURE 9.1 – LETTER OF MoEFCC

ANNEXURE 10.1 – INSTITUTIONAL REQUIREMENT HEAD OFFICE COMPONENTS



ANNEXURE 11.1 – COSTING/FINANCIAL ASSUMPTIONS

ANNEXURE 11.2 – ABSTRACT OF COST FOR FAIRWAY DEVELOPMENT

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
A	**Fairway**		
1	Dredging		
(i)	General Soil	4282.66	Phase 1
(ii)	Hard Soil	0.00	Phase 1
2	Low Cost River Structures		
(i)	Bandaling	0.00	0.00
(ii)	Bottom Paneling	0.00	0.00
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	4496.69	Phase 1
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	158.88	Phase 1
(ii)	Shore Marking with Latiice Bridge & Lighting Equipments	0.00	Phase 1
5	Land Acquisition	2323.93	0.00
	Sub-total (A)	**11262.16**	0.00
B	**Modification of Structures**		
(i)	Bridges	276.00	0.00
(ii)	Cables	12.50	0.00
(iii)	Dams	0.00	0.00
(iv)	Barrages	0.00	0.00
(v)	Locks	0.00	0.00
(vi)	Others	0.00	0.00
	Sub-total (B)	**288.50**	0.00
C	**Communication System**		
(i)	RIS Centre	0.00	0.00
(ii)	AIS Base Station	0.00	0.00
(iii)	Vessels - Survey vessel & Other Vessel	0.00	0.00

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
(iv)	Buoys	0.00	0.00
	Sub-total (C)	**0.00**	0.00
D	**Institutional Requirement**		
(i)	Office Development Cost	40.00	
(ii)			
	Sub-total (D)	40.00	0.00
	Sub-total (A)+(B)+(C)+(D)	**11590.66**	0.00
E	Environmental Management Plan Cost as per chapter-9 of the DPR	93.17	0.00
F	Project Management & consultancy Charges @ 3% of Prime cost	347.72	0.00
G	Contingencies and Unforeseen Items of Works@ 3% of Prime cost	347.72	0.00
	Project total Hard Cost	**12379.26**	0.00
		Say 123.79	**Crores**

ANNEXURE 11.3 –COST OF DREDGING

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	17,48,025	245	4282.66
2	Dredging in Hard Soil	Cum	0	900	0.00
	Total Cost of Dredging				**4282.66**

ANNEXURE 11.4 – COST OF BANK PROTECTION WORKS FOR FAIRWAY

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
1.0	**RCC Concrete Works (M40 grade concrete)**					
1.1.	3 Stages of slab of given sizes shall be considered:					
a)	1500x120x3000 =		0.54			
b)	1250x105x3000 =		0.39			
c)	1000x90x3000 =		0.27			
	Total Slab	**cum**	**1.20**			
1.2	Total depth of pile (from founding level)	m	8000.00			
	Pile section	sqm	250x250			
	Total Piles	**cum**	**0.50**			
	Total (1.1+1.2)	cum	1.70			
	Additional 10% for Filter		0.17			
	Additional 10% for Anchor		0.17			
	Total		**2.04**	**8297**	**16923.34**	DSR 2018, Cl.no. 5.33.1 & 5.34.3 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (1.89%) till march 2020. The combined effect is 1.011%.
2.0	**Steel Reinforcement**					
	Reinforcement (@0.15/cum)	MT	0.30	**84419**	**25325.55**	DSR 2018, Cl.no.5.22.4 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.011%.
	Total				**42248.89**	
	Additional 3% PS/Labour/Contingencies				**1267.47**	
	Grand Total				**43516.36**	

	Cost/m				**14505.45**	
				Say	**14505**	
3.0	**Cost of Bank Protection Works for 31000 m**				**4496.69**	

* Rates worked out based on the DSR rates (inclusive of GST) duly considering related items.

ANNEXURE 11.5 – COST OF NIGHT NAVIGATION WORKS

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	45	3,53,063	158.88
	Cost of Night Navigation Works				**158.88**

Rates based on Quotation / Market Rates inclusive of GST

ANNEXURE 11.6 – COST OF LAND FOR FAIRWAY DEVELOPMENT

LAND ACQUISITION AND BANK PROTECTION REQUIREMENTS (NW-59)- Detailed in Chapter 3 of DPR							
Sl.	**Chainage**	**Existing Width**	**Extra Width Requirement**	**Length**	**Area of Land Acquisition**	**Bank Protection Requirement**	**Remarks,**
No.	**(in Km)**	**(in m)**	**(L / R in m)**	**(in m)**	**(in Sq. m)**	**(L in m /**	**if any**
	From------					**R in m)**	
	To----------						
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6) = (4) x (5)**	**(7)**	**(8)**
1	0 to 1	*			9000	=	* > 50 m
2	1 to 2	*				=	
3	2 to 3	*				=	= No B P
4	3 to 4	50	0	800	0	1600	
5	4 to 5	40	10	1000	10000	2000	
6	5 to 6	50	0	1000	0	2000	
7	6 to 7	40	10	1000	10000	2000	
8	7 to 8	40	10	1000	10000	2000	
9	8 to 9	40	10	1000	10000	2000	
10	9 to 10	40	10	1000	10000	2000	
11	10 to 11	40	10	1000	10000	2000	
12	11 to 12	30	20	1000	20000	2000	
13	12 to 13	20	30	1000	20000	2000	
14	13 to 14	30	20	1000	20000	2000	
15	14 to 15	25	25	1000	25000	2000	
16	15 to 16	30	20	1000	20000	2000	
17	16 to 17	25	25	1000	25000	2000	
18	17 to 18	25	25	1000	25000	2000	
19	18 to 18.8	25	25	700	17500	1400	
					242500 Sq-m	31,000	31 kms
					24.25	Ha	
Costing of 24.5 land @ 871.20 per Sq-m =				**INR.**	**2323.926**	Lakhs.	
The fairvalue of land shown in "Department of Registration-Govt. of Kerala" website is the value per Are (i.e 720 INR/ Are) as per SRO No.698/2014 dated 14.11.2014 The 10% increase as per the Gazette Notification SRO No.186/2018 dated 31.03.2018 is to be applied on all the fairvalue in this website.							
The New Revised rate is	2018-19	792.0					
	2019-20	871.2					
	2020-21	958.3					

ANNEXURE 11.7 – ESTIMATED ENVIRONMENTAL (EMP) & SOCIAL COSTS FOR VARIOUS STAGES - NW-59

Sl. No.	Project Stages	Cost (Rs. Lakh)	Remarks
1	Pre-Construction Stage	62.40	As provisioned in Chapter-9 of the DPR
2	Construction Stage	32.20	
3	Operational Stage	12.40	
	Total Estimated Budget	107.00	(Statutory Fee, Land Acquisition cost and R&R Costs are not included)
	Estimated EMP Budget for Ro-Ro terminal & Fairway development (Separately)		The project has two components which consists of fairway development & RoRo terminal construction. The cost of INR.107.0 Lakhs shall be distributed in proportion to the capex for each of the components. Provision has already been catered in the proposed estimates appropriately.

India - Wholesale price index

1. Figure 0 may be treated as Index for particular item not available.
2. Figures for the latest two months are provisional. Latest two months are to be reckoned with reference to the latest monthly press release issued.

Base Year: 2011-12 = 100 (Revision of base year of All-India Wholesale Price Index (WPI) from 2004-05 to 2011-12 vide Press release by GOVERNMENT OF INDIA MINISTRY OF COMMERCE & INDUSTRY DEPARTMENT OF INDUSTRIAL POLICY & PROMOTION OFFICE OF ECONOMIC ADVISOR Udyog Bhawan, New Delhi, Dated 12th May 2017) https://eaindustry.nic.in/choose_item_201112.asp

Yearly Wholesale Price Index
Name of Commodity : ALL COMMODITIES
Type : Group Item
Weight : 100
Base Year : 2011-12 = 100

Calendar Year	Index
2020 - March	122.23
2019	121.2
2018	118.9

Source - Office of the Economic Adviser, Govt. of India, Ministry of Commerce & Industry Department for Promotion of Industry and Internal Trade (DPIIT)

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2018	116	116.1	116.3	117.3	118.3	119.1	119.9	120.1	120.9	122	121.6	119.7	118.9417

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2019	119.2	119.5	119.9	121.1	121.6	121.5	121.3	121.5	121.3	122	122.3	122.8	121.1667

% Increase in the Year 2019 = (122.8-119.2)/119.2 = 3.02%

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2020	123.4	122.2	121.1										122.23

% Increase/Decrease in the Year 2020 (Three Months) = (121.1-123.4)/123.4 = 1.86%

The combined effect of WPI from January 2019 to March 2020 shall be = (1+3.02%) X (1-1.86%) = 1.011%

ANNEXURE 11.9 – ABSTRACT OF COST FOR Ro-Ro FACILITY

S.No.	Item Description	Amount (in Lakh Rs.)
A	**Terminals**	
	Terminal	
(i)	Land	93.39
(ii)	Riverine Components	499.31
(iii)	Infrastructure Components including internal roads	493.84
(iv)	Approach Road (External) Cost	3.50
(v)	Bank Protection Works for terminal	613.17
	Sub-total (A)	**1703.21**
B	**Vessels**	
(i)	Vessel Size	0.00
(ii)	Vessel Capacity	0.00
	Sub-total (B)	**0.00**
C	**Equipments for Both Terminals**	
(i)	Ambulance - 1 no.	18
(ii)	Dumper Trucks 16 T Capacity - 1 no.	0
(iii)	Cranes with 50 T Capacity - 1 no.	0
(iv)	Fork lift trucks 20 T Capacity - 1 no.	0
	Sub-total (C)	**18.00**
	Sub-total (A)+(B)+(C)	**1721.21**
D	Environmental Management Plan Cost as per chapter-9 of the DPR	13.83
E	Project Management & consultancy Charges @ 3% of Prime cost	51.64
F	Contingencies and Unforeseen Items of Works@ 3% of Prime cost	51.64
	Project total Hard Cost	**1838.32**
		18.38 Cr.

ANNEXURE 11.10 – COST OF LAND FOR Ro-Ro TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks
A	**Terminal (T)**					
1	Land Area Cost					
(i)	Land inside the terminal area	m^2	8500.00	958.32	81.46	
(ii)	Land required for Road Extension or construction of external approach road	m^2	0.00	0.00	0.00	
(iii)	Area under Mangrooves clearance	m^2	0.00	0.00	0.00	
2	Land Cutting/Excavation for 1.5 m depth	m^3	12750.00	93.57	11.93	DSR-2018, 2.1 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till March 2020. The combined effect is 1.01%.
	Total Cost of Land				**93.39**	

The fairvalue of land shown in "Department of Registration-Govt. of Kerala" website is the value per Are (i.e. 87120 INR/ Are)

ANNEXURE 11.11 – COST OF RIVERRINE STRUCTURES AT NW-59 RO-RO FACILITY AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
1.0	**RCC Concrete Works (M40 grade concrete)**					
	CONCRETE - Reinforced Cement Concrete of specified Grade M40 in different structural members above pile cut-off level.					
1.1	Providing and laying Vertical M40 Grade Concrete Piles of 1.3 m diameter					
	Vertical Piles					
	Grid A	No	7			
	Grid B	No	7			
	Grid C	No	7			
	Total Piles	cu.m	557			
1.2	Pile Caps (2000x1800x600)	cu.m	45.36			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	90.00			
	Grid A1	cu.m	90.00			
	Grid B	cu.m	90.00			
	Grid B1	cu.m	90.00			
	Grid C	cu.m	90.00			
1.4	Cross Beams (1800x1500)					
	grid 1 to 7	cu.m	226.80			
1.5	Deck Slab	Cu.m	302.40			
	Total Concrete	**Cu.m**	**1582.04**	8296.77	131.26	DSR 2018, Cl.no. 5.33.1 & 5.34.3 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till March 2020. The combined effect is 1.011%.
2.0	**Steel Reinforcement**					

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
	REINFORCEMENT - High yield strength deformed bars Reinforcement Grade Fe500 in reinforcing cage including ring bars as detailed on the drawings					
2.1	Vertical Piles 1.3 m dia	MT	83.62			
2.2	Pile Caps (2000x1800x600)	MT	3.63			
2.3	Longitudinal Beams (1000x1250)					
	Grid A	MT	16.20			
	Grid A1	MT	16.20			
	Grid B	MT	16.20			
	Grid B1	MT	16.20			
	Grid C	MT	16.20			
2.4	Cross Beams (1800x1500)					
	grid 1 to 7	MT	40.82			
2.5	Deck Slab	MT	36.29			
	Total Reinforcement	**MT**	**245**	84418.50	207.13	DSR 2018, Cl.no.5.22.4 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till March 2020. The combined effect is 1.011%.
3.0	**Structural Steel works**					
3.1	Structural Steel handrail with steel grade Fy=240 Mpa	MT	120	1,02,869	123.44	DSR 2018, Cl.no.10.2 - - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till March 2020. The combined effect is 1.011%.
4.0	**Bollards**					
	Supply and fix in position cast steel bollards of working loads capacity of 40 ton, twin horn type of approved make, including galvanized holding down bolts, nuts, washers (80microns zinc coating) and painting as per specification and drawings.	MT	3	82,688	2.48	As per Market rate. 7% escalation per annum

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
5.0	**Fenders**					
	Supply and fix in position fender system in the rear side of jetty structure from an approved manufacturer meeting the berthing energy absorption and reaction forces requirements given in technical specification and drawings for the following type of fenders. The rate includes design, supply, installation, testing and commissioning of fenders and necessary fixtures such as chains, U bolts, fasteners etc., complete.	LS			35.00	
	Total cost of Riverrine Structures at Ro-Ro Terminal				**499.31**	

The Kerala state cost is assumed 10% more than available cost (SOR Karnataka)

* Rates worked out based on the DSR rates (inclusive of GST) duly considering related items.

ANNEXURE 11.12 – COST OF STRUCTURES AT TERMINAL

S.No.	Facility	Nos.	Size	Area (in m2)	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Open Mobility Area	1	-	2500	7,973	197.16
2	Covered Storage Godown (Nominal)	1			23,057	0.00
3	Parking for Handling equipments	1	-	2000	1,510	30.21
4	Main Parking Area	1	-	500	1,222	6.11
5	Public Utility	1	6m x 4m	24	37,495	9.00
6	Weigh bridge	1	8m x 3m	24	2,52,750	60.66
7	Utility Room (Near Weigh Bridge)	1	3m X3m	9	37,495	3.37
8	Area under internal Roads	1	7m x 100m	700	15165	15.17
9	Bank Protection				0	
10	Administration building	1	12 m x 15 m	180	24,735	44.52
11	Business Area	1	10m x 3m	30	24,735	7.42
12	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1,510	1.22
13	Staff Parking Area-2 wheelers	1	8m x 2m	16	1,564	0.25
14	Security shed for watch and ward	2	4m x 4m	32	8,594	2.75
15	Electrical facility	1	5m x 5m	25	27,803	6.95
16	Fuel Bunkers	1	10m x 5m	50	5,617	2.81
17	Water Supply Room	1	3m x 4m	12	27,887	3.35
18	Fire and Safety Room	1	3m x 4m	12	32,099	3.85
19	DGPS receiver & transmitter shed	1	8m x 4m	32	17,511	5.60
20	DG shed	1	5m x 5m	25	13,497	3.37
21	Canteen with Store	1	12m x 8m	96	17,902	17.19
22	Sewerage Treatment Plant (STP)	1	15m x 15m	225	26,134	58.80
23	Overhead Tank	1	10m dia	100	1,944	1.94
24	Green Area	1	-	750	809	6.07
25	Future Requirement	1	-	1000	607	6.07
	Total cost of Other Components					**493.84**

* Rates worked out based on the DSR rates (inclusive of GST) duly considering related items.

ANNEXURE 11.13 – COST OF APPROACH (EXTERNAL) ROADS

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
A	**Terminal (T)**				
1	External Roads				
(i)	Pacca Road (7m wide road)	m	0.00	15750	0.00
2	Pipe Culvert on External Road			LS	3.50
	Sub-total 1				**3.50**
	Total Cost of Approach Roads				**3.50**

ANNEXURE 11.14 – COST OF BANK PROTECTION WORKS AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ reference
A	**Terminal (T)**					
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	14426.10	3623.88	522.78	DSR 2018, Cl.no. 16.95 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
2	Providing and laying geotextile as per technical specifications	Sqm	10676.25	641.732	68.51	DSR 2018, Cl.no. 14.91 & 14.92 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	285	7673.94	21.87	DSR 2018, Cl.no. 6.4.2 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
	Sub-total 1				**613.17**	
	Cost of Bank Protection Works				**613.17**	

* Rates worked out based on the DSR rates (inclusive f GST) duly considering related items.

ANNEXURE 11.15 – COST OF RENOVATION OF EXISTING STRUCTURES

For Class III Vessel, with single lane operation, the critical clearances in horizontal direction is taken as 13.5m to 15m.

Horizontal Clearance = 13.5 m

Vertical Clearance = 6 m

SL No	Chainage	Center Position		Location	Type of structure	Type of super structure	Width	No of span(Nos) x Length of Span(m)	Hz clearance	Height wrt MSL	Modification Required		Estimated Cost of Modification
		Latitude	Longitude								Hz	Vt	
1	5.13	9°38'19.64"	76°25'48.2"	Cheeppun	Road Bridge	RCC	7	4 x 20	20	4	No	Yes	55,00,000
2	10.97	9°38 '50.24"	76°28 '43.3"	Maniyapa	Foot Over Bridge	RCC	8	2x20	20	6	No	No	
3	11.215	9°38 '53.57"	76°28'48.53"	Near Man	Foot Over Bridge	RCC	2	2x20	20	3.5	No	Yes	33,00,000
4	12.485	9°38 '42.76"	76°29'28.07"	Near Maniyap arambu	Foot Over Bridge	RCC	2	2x15	15	4	No	Yes	33,00,000
5	14.68	9°38 '46.93"	76°30'34.65"	Kuttoom puram	Road Bridge	RCC	7	2x20	20	6	No	No	
6	15.45	9°38 '49.75"	76°30 '52.6"	Mannana m	Road Bridge	RCC	5	2x15	15	5	No	Yes	50,00,000
7	16.955	9°39 '30.09"	76°31'11.78"	Near Kaipizha	Road Bridge	RCC	2	2x15	15	3.8	No	Yes	55,00,000
8	17.62	9°39 '37.26"	76°31'32.38"	Liseiux	Road Bridge	RCC	2	2x15	15	4.5	No	Yes	50,00,000
												Total Cost	**2,76,00,000**

Notes

Note 1 Road bridges which need modification are at Chainage 5.13, 14.68, 15.45, 16.955 and 17.62.

Note 2 Since, this is single span, the road level is increased to make vertical clearance of 6m and suitable gradient is provided at both ends. The Abutments will increase by required heights at both ends. Foundation will also need modification as per the increased height.

Note 3 Foot Over Bridges which require modification are at chainage 11.215 and 12.485.

Note 4 Foot Over Bridges may be modified / replaced according to condition of bridge at site.

Note 5 The cost of modification may have to be updated before construction at Detailed Engineering Stage.

ANNEXURE 11.16 – FAIRVALUE OF LAND COST IN KERELA

ANNEXURE 11.17 – KERELA GOVERNMENT LETTER FOR ADDITIONAL STRUCTURE

ANNEXURE 11.17 A – FINANCIAL CONSIDERATION DUE TO KERLA GOVERNMENT LETTER ON NW 59

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-59) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
1)	Bridge	Cross Structure Under PWD	5	0	0
2)	Foot Bridges	Cross Structure Under PWD	0	1.2	0
2)	Foot Bridge	Cross Structure Under LSGD	3	1.2	3.6
3)	HT Lines	Kerala State Electricity Board	0	0.3	0
3)	LT Lines	Kerala State Electricity Board	25	0.01	0.25
4)	Regulator Cum Bridge & Navigation Lock	Irrigation Dept. & Navigation Dept.	0	0	0
5)	Water Pipeline	Kerala water Authority	0	0	0
	Total				**3.85**

ANNEXURE 11.17 B – FINANCIALS OF OPTION 1

Fairway Development (NW-59)				
Fairway	11,262.16	4,504.86	3,378.65	3,378.65
Structure Modification	288.5	115.40	86.55	86.55
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	93.17	37.27	27.95	27.95
Project Management & consultancy Charges @ 3% of Prime cost	347.72	139.09	104.32	104.32
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	347.72	139.09	104.32	104.32
Total Project Cost	**12,379.26**	**4,951.70**	**3,713.78**	**3,713.78**

Ro-Ro Terminal - (NW-59)				
Terminal	1,703.21	681.28	510.96	510.96
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	13.83	5.53	4.15	4.15
Project Management & consultancy Charges @ 3% of Prime cost	51.64	20.65	15.49	15.49
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	51.64	20.65	15.49	15.49
Total Project Cost	**1,838.32**	**735.33**	**551.50**	**551.50**

ANNEXURE 11.17 C – FINANCIALS OF OPTION 2

Description (Option-2)	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
With Development				
Fairway Development (NW-59)				
Fairway	11,262.16	4,504.86	3,378.65	3,378.65
Structure Modification (DPR-Rev.01)	288.50	115.40	86.55	86.55
Structure Modification (Suggested By Kerala Govt.)	385.00	154.00	115.50	115.50
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	93.17	37.27	27.95	27.95
Project Management & consultancy Charges @ 3% of Prime cost	347.72	139.09	104.32	104.32
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	347.72	139.09	104.32	104.32
Total Project Cost	**12,764.26**	**5,105.70**	**3,829.28**	**3,829.28**

Ro-Ro Terminal - (NW-59)				
Terminal	1,703.21	681.28	510.96	510.96
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	13.83	5.53	4.15	4.15
Project Management & consultancy Charges @ 3% of Prime cost	51.64	20.65	15.49	15.49
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	51.64	20.65	15.49	15.49
Total Project Cost	**1,838.32**	**735.33**	**551.50**	**551.50**

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE Ro-Ro

LIST OF DRAWINGS

S. No.	DRAWING NAME	DRAWING NUMBER	SHEETS
1	VECHOOR – ATHIRAMPUZHA CANAL (KERALA) NW59 LAYOUT PLAN	P.010631-W-20301-A03	3
2	VECHOOR – ATHIRAMPUZHA CANAL (KERALA) NW59 TERMINAL LOCATION MAP AT ATHIRAMPUZHA	P.010631-W-20351-X03	1
3	VECHOOR – ATHIRAMPUZHA CANAL (KERALA) NW59 TERMINAL LAYOUT PLAN AT ATHIRAMPUZHA (WITH PROPOSED INFRASTRUCTURE FACILITY	P.010631-W-20311-A03	1
4	VECHOOR – ATHIRAMPUZHA CANAL (KERALA) NW59 RO-RO TERMINAL AT ATHIRAMPUZHA PLANS & SECTIONS	P.010631-W-20341-E03	2
5	VECHOOR – ATHIRAMPUZHA CANAL (KERALA) NW59 BANK PROTECTION TYPICAL SECTION	P.010631-W-20303-X03	1