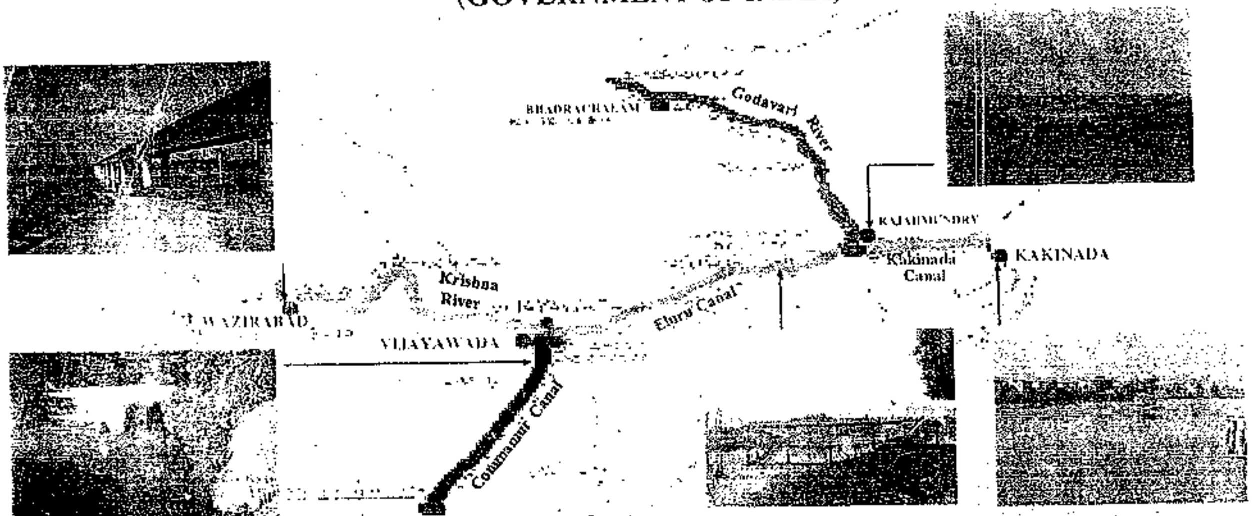
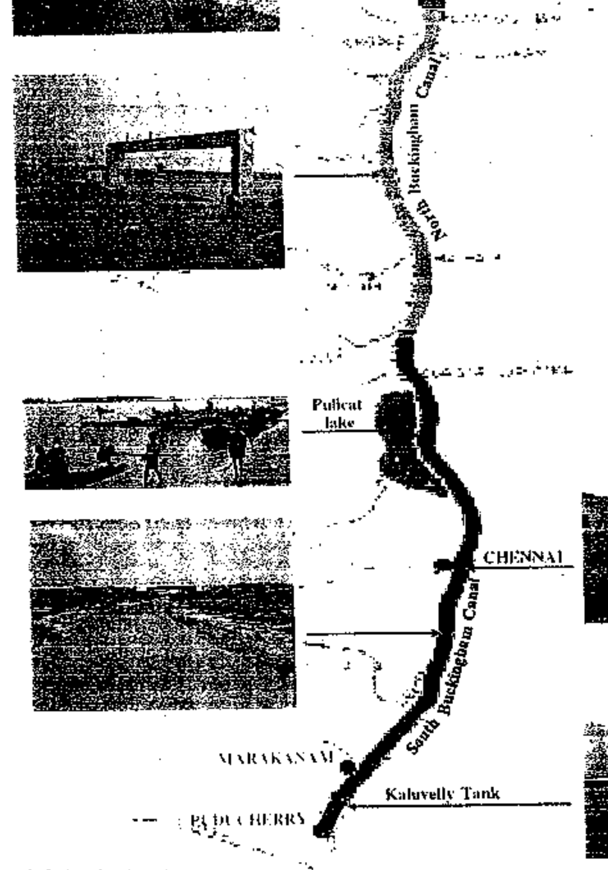
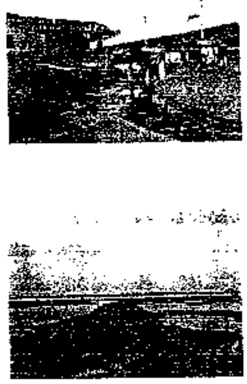
NW-4

INLAND WATERWAYS AUTHORITY OF INDIA

MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(GOVERNMENT OF INDIA)







DETAILED PROJECT REPORT

for

DEVELOPMENT OF NAVIGATION

in

KAKINADA - PUDUCHERRY CANAL ALONGWITH RIVER GODAVARI AND KRISHNA (NATIONAL WATERWAY-4)

FINAL REPORT

VOLUME- II : MAIN REPORT

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ISO 9001 : 2000

March, 2010

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INTRODUCTION

CHAPTER – 1

INTRODUCTION

1.0 BACKGROUND

India has an extensive network of rivers, lakes and canals, which if developed for shipping and navigation, can provide an efficient network of inland water transportation. An optimal mix of road, rail and inland waterway transport will provide an efficient transport infrastructure that is flexible and cost-effective. Although India has inland waterways with a navigable length of 14,544 km, only 37 per cent of this length (5,700 km) is currently used for navigation by mechanized vessels. Among these navigable waterways, five have been declared national waterways: the Ganga River from Haldia to Allahabad (1,620 km); the Brahmaputra River from Dhubri to Sadiya (891 km); the West Coast Canal from Kottapuram to Kollam including the Champakara and Udyogmandal canals (205 km); Kakinada-Puducherry Canals integrated with Godavari and Krishna Rivers; East Coast Canal integrated with Brahmani river and Mahanadi delta.

Government of India is planning to extend the national waterway system by declaring one more waterway i.e. Barak River. This is in line with the Government's objective to revitalize inland waterways as a viable transport mode.

Out of these, the Kakinada Puducherry Canals integrated with Godavari and Krishna Rivers forms a very important and crucial link between East Coast of Andhra Pradesh and Southern coast of Tamilnadu and Puducherry in Bay of Bengal.

The integrated canal waterway viz. Kakinada Canal, Eluru Canal, Commamur Canal, Buckingham Canal and Kalluvelly tank alongwith river Krishna and Godavari provides navigational link between Kakinada and Chennai/Ennore ports upto Puducherry. The Detailed Project Report has to be submitted to Cabinet Committee on Economic Affairs, Government of India for Government sanction of the developmental project and to Ministry of Environment & Forests, Government of India for getting Environmental Clearances.

The techno-economic feasibility studies conducted earlier reveal that the whole waterway system between Kakinada and Puducherry integrated with Krishna river from Wazirabad to Vijayawada and Godavari river from Bhadrachalam to Rajahmundry and Kalluvelly tank beyond Marakanam linking Kakinada sea mouth and Kalluvelly sea mouth at Puducherry can be developed as a National Waterway. The present studies are aimed at assessing its viability in the present scenario and preparing detailed project report of the integrated waterway system.

Inland Waterways Authority of India (IWAI), Ministry of Shipping, Road Transport and Highways, Govt. of India, as nodal agency for development of infrastructure in National Waterways, entrusted Water and Power Consultancy Services (WAPCOS) (I) Ltd. with the job of preparation of Detailed Project Report (DPR) for the proposed national waterway.

WAPCOS Ltd. has carried out detailed Hydrographic, topographic and Traffic surveys and selection of Terminals needed for the Detailed Project Report study and has already submitted the various reports time to time alongwith presentations on various issues viz. the viability of immediate development of different stretches in the waterway alongwith the inputs of Traffic Survey, Selection of Terminals etc. WAPCOS has also interacted with Government of Andhra Pradesh, Tamilnadu and Puducherry and included their inputs in the report.

The present Final Detailed Project Report containing all the above inputs is accordingly submitted.

1.1 COMPOSITION OF WATERWAY

The total waterway of the project consists of:

a)	Kakinada Canal(Kakinada to Rajahmundry)	50 km
b)	Eluru Canal (Rajahmundry to Vijayawada)	139 km
c)	Krishna river (Wazirabad to Vijayawada)	157 km
d)	Godavari river (Bhadrachalam to Rajahmundry)	171 km
e)	Commamur Canal (Vijayawada to Peddaganjam)	113 km
f)	North Buckingham Canal (Peddaganjam to Central Station of Chennai)	316 km
g)	South Buckingham canal (Central Station of Chennai to Marakanam)	110 km
h)	Marakanam to Puducherry through Kaluvelly tank	22 km
	Total length of waterway -	**1078 km**

1.1.1 Distance between various stretches are given below for reference :

ANDHRA PRADESH

A.	**River Godavari**		
	Bhadrachalam to Pollavaram		127 km
	Pollavaram to Rajamundry		44 km
		Total	**171 km**
B.	**River Krishna**		
	Wazirabad to Pulichintala		86 km
	Pulichintala to Vijayawada		71 km
		Total	**157 km**
C	**Kakinada Canal**		
	Kakinada to Rajahmundry		50 km
D	**Eluru Canal**		
	Godavari Eluru (Rajahmundry to Eluru)		74 km
	Krishna Eluru (Eluru to Vijayawada)		65 km
		Total	**139 km**
E	**Commamur Canal**		
	Vijaywada to Peddaganjam		**113 km**
F	**North Buckingham Canal (AP)**		
	Peddaganjam to Tada Border (AP)		**258 km**

TAMILNADU

G	**North Buckingham Canal (TN)**		
	Tada Border(AP)/Arangam(TN)to Central Station of Chennai		58 Km
H	**South Buckingham Canal**		
	Central Station of Chennai to Marakanam		110 Km
		Total	**168 km**

I	**Marakanam to Pucucherry through Kaluvelly tank**	**22 km**
	Total Stretch of waterway	**1078 km**

A stretch of 50 km from Ennore South to Muthukadu [18km of North Buckingham Canal (Ennore South to Central Station of Chennai) and 32 km of South Buckingham canal (Central Station of Chennai to Muthukadu)] in Tamilnadu is not considered for waterway development. In this stretch multi-modal cargo transfer is proposed.

A stretch of 39 km of North Buckingham canal (excluding 18 km stretch from Ennore South to Central Station of Chennai) and 78 km of South Buckingham Canal (excluding 32 km stretch from Central Station of Chennai to Muthukadu) has been considered in Tamilnadu.

Stretch of waterway not navigable in Tamilnadu between Ennore South and Muthukadu	**50 km**
Total stretch of navigable waterway	**1028 km**

1.2 SCOPE OF WORK

The scope of work for Detailed Project Report as per TOR is as follows:

1. Collect and study the techno-economic feasibility study reports and hydrographic survey charts of the project available with IWAI.
2. Collect and study the available data regarding water level, depth, velocity, discharge, cross section bed and bank material, hydrographic, topographic data etc. of Kakinada canal, Commamur Canal, Eluru Canal, Buckingham canals, Kaluvelly tank, Bhadrachalam - Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna from various sources like CWC, State Departments, National Remote Sensing Agency, Survey of India, Chennai/Ennore Port Trusts, CWPRS, NHO etc. and also identify the missing data to be collected in the field.
3. Carry out necessary topographic and hydrographic surveys of the entire waterway and study/identify necessary bed regulation and/or water level/discharge regulation for at least 14 m bed width and 1.6 m depth in Kakinada. Eluru and Commamur canals and 32m bed width and 1.8 m depth in rivers Godavari and Krishna, Buckingham

canals and Kaluvelly tank in Phase – I and 32m bed width and 2 m depth for the entire waterway in Phase-II for maintaining navigation for a period of at least 330 days in a year.

3.1 Cross-section sounding lines to be taken at 250m interval along canal and river portion. If the width of the river/canal portion is more than 500 metres, then the sounding lines to be limited for 500 m width. (i.e. 250 m on either side of the center-line, which shall be the deepest route). In case of canals, the consultant need to verify the findings with that of the TEF report/Irrigation Dept. of the concerned State Govt.

4. To study and suggest vulnerable stretches, if any, identified for one-way traffic. Identify suitable locations for providing waiting dolphin/parking bays including its design, ~~costing~~ etc.

5. To conduct a detailed topographical survey for the narrow portion proposed for widening. Detailed estimate in respect of widening of canal including cost of land acquisition (land + structures), excavation/dredging, modification of cross-structures, roads, irrigation structures, cross-drainage structures, shifting of power line, telephone lines, cable etc. to be taken into account.

6. Assess the depth of the flow in the river in the leanest period, the depth requirements for 100 t, 300 t and 500 t vessel and minimum flow to be assured to ensure this depth in the entire stretch proposed for navigation.

7. To select tentative location and carryout preliminary topographic surveys for

- River training works in different stretches of the river
- Structures such as Navigation locks and cross drainage works
- IWT terminals on the proposed waterway
- Bridges and crossings on the river and canal
- On shore facilities and berthing facilities

8. The tonnage, origins and destinations of the primary and secondary cargo identified in the earlier studies shall be updated taking into account the past trend, interaction with nearby agencies, nearness to sea route, possibilities of handling large volumes of dry bulk, liquid, bulk liquid, setting up of industries in the hinterland, connection to port, terminal operations, road and rail linkages etc. based on these studies, make traffic projections for a time horizon of 10, 15, 20 & 25 years.

9. To select suitable types of cargo vessels for the cargo as assessed under item (10), workout the details of the type of vessels their number and cost.

10. Study the river morphological, hydrological, hydrographical conditions silt and water balancing and operation and maintenance requirements to identify works in sufficient details that are required in respect of,

    Hydrographic survey

    - River conservancy including river training, bank protection, dredging etc.
    - Navigational aids and communication facilities
    - Locks, bridges, new/improvements with reference to horizontal and vertical clearances
    - Other infrastructural facilities such as repair facilities, channel patrol, security, enforcement of rules, and regulations, pilotage, issue of navigational notices, navigation charts, warnings, rescue and salvage etc.
    - Avoiding adverse interference of shipping and navigations on other users of water (like irrigation, power, drinking water, fisheries etc.)

11. Conduct necessary bore hole drilling and preliminary geo technical investigations at proposed terminal locations along the waterway, at major cross drainages, locks, etc. At least one bore hole test to be done at each terminal site.

12. Prepare detailed engineering designs and estimates for the optimum structure features of river training and bank protection measures to develop and maintain a navigable channel for the waterway system.

13. Prepare detailed layout, design and drawings for the lock systems.

14. Review of the location of terminals suggested in the feasibility report, and work out details based on cargo origin and destination including waiting berths, handling facilities, storage facilities, bunkering, repair facilities, road and rail transport linkage etc.

15. Plan and design of terminals taking into consideration, the environmental conditions viz. wind, wave/current, and also the physical conditions like characteristics of the site conditions and available construction material, cargo to be handled, their movements/conveyance and proper zoning and minimum safety distances for ship and ship to shore and on shore operations.

16. Assess the requirement of water, power and their sources of supply. Study shall also cover the requirements of electric generators, their numbers and capacity and the places where the generators have to be installed.

17. The road and rail bridges and footbridges crossing the navigation routes shall be studied and recommendation made on measures required to permit uninterrupted navigation.

18. Study the draught requirement at the various terminals with reference to the vessel sizes that may call in terminal port for the next 25 years and also plan the depth and dredging requirements, river conservancy works, dredging equipment and the period of dredging and usage of dredging material for and the period of dredging and usage of dredged material for backfilling of proposed terminal indicate the inter modal cargo transfer facilities that are required at proposed terminals.

19. Prepare cost estimates for various possible alternatives for the entire proposed infrastructure, handling, and other allied facilities. While comparing the different alternatives, the cost and economy factors shall also be evaluated. The most suitable alternative recommended shall have detailed costing for all the components of the project.

20. Prepare detailed time schedule for the whole project indicating the time requirement of the various components of the project from inception till commissioning of the same. Suggestion shall also be given for executing the project in different phases with spilt up details of the works and the costs thereto.

21. Study and recommend the necessary organizational structure and manpower requirement to built and operate the fairway including office, residential accommodation for initial development, maintenance and management duly providing for future expansion.

22. Identify the areas to deposit the dredged material. The extent of displacement of persons involved in this both in land and water to be assessed. Alternate locations of accommodate these should be identified. The toxity of the dredged material and the likely impact of this on land and water in the neighbouring areas to be studied.

23. Workout the transport cost for cargo, commodity wise per ton km between origin and destination of traffic as at present and also project the transport cost using IWT, wherein origin and destination are located on the front and in combination where origin and destination are not located on the river front as the case may be, along with the cost benefit analysis.

24. Suggest short and long-term measures, which will attract shippers to the IWT mode of transport on a continuing basis, including identification of industries that could be located on banks.

25. Recommend a freight structure together with its basis and subsidies, if any that may be necessary in the initial years also tariff rates for using terminal and other infrastructural facilities.

26. Suggest minimum horizontal and vertical clearances to be made mandatory for structures crossing waterway (such as bridges, high tension cables etc.) for the time frame of 50 years.

27. Identify individual projects/activities that can be taken up under private sector participation/BOT/JV basis.

28. Economic and Financial Analysis

a. **Economic Analysis** –Economic Internal Rate of Return (EIRR)

Economic analysis shall be carried out for the following three assumption:

- Investing in the development of Inland Water Transport services in the IWT routes under this project.
- Investing in improved rail/road connections; to cater for the same volume of traffic
- Not investing in any improved transport system (base case)

The economic internal rate of return (EIRR) of project shall be established by discounting project costs and benefits to the base year, which shall be considered to be 2006 AD, the year in which the first major infrastructural investments may be made. Costs shall be exclusive of all duties, taxes, levies or charges and shall be discounted from the date of expenditure. Benefits shall include lower transport costs as well as benefits to the national economy and related developments in the coastal areas and that in the hinterland.

SWOT analysis shall be carried out to test the sensitivity of the EIRR with respect to changes in key parameters such as cost variations in estimates, short falls; or under estimation in benefits, slippage in implementation, shadow prices for specified inputs, such as fuel, cement steel and labour, Foreign exchange surcharges etc.

Based on the results of the economic analysis, recommendations shall be made on the development options for Government consideration.

b. **Financial Analysis** – Financial Internal Rate of Return (FIRR)

In the financial analysis economic costs and benefits shall be replaced by construction, purchase, operation and maintenance costs subject to market forces and by equivalent freight rates and charges and other benefits, in so far as they can be reasonable established.

A table showing annual expenditure and benefits shall be prepared and the net present value of the IWT project established by discounting costs and benefits by discount rates ranging from 10 to 20%. The benefit cost ratio shall be established for each discount rate.

The financial analysis will workout the financial internal rate of return (FIRR) for the IWAI's share of investment. Terminal facility and vessel operation will be considered as expected to be provided through private participation. The activity will consider two aspects; revenue mobilization and reforms in tax structure. The tasks under this activity are;

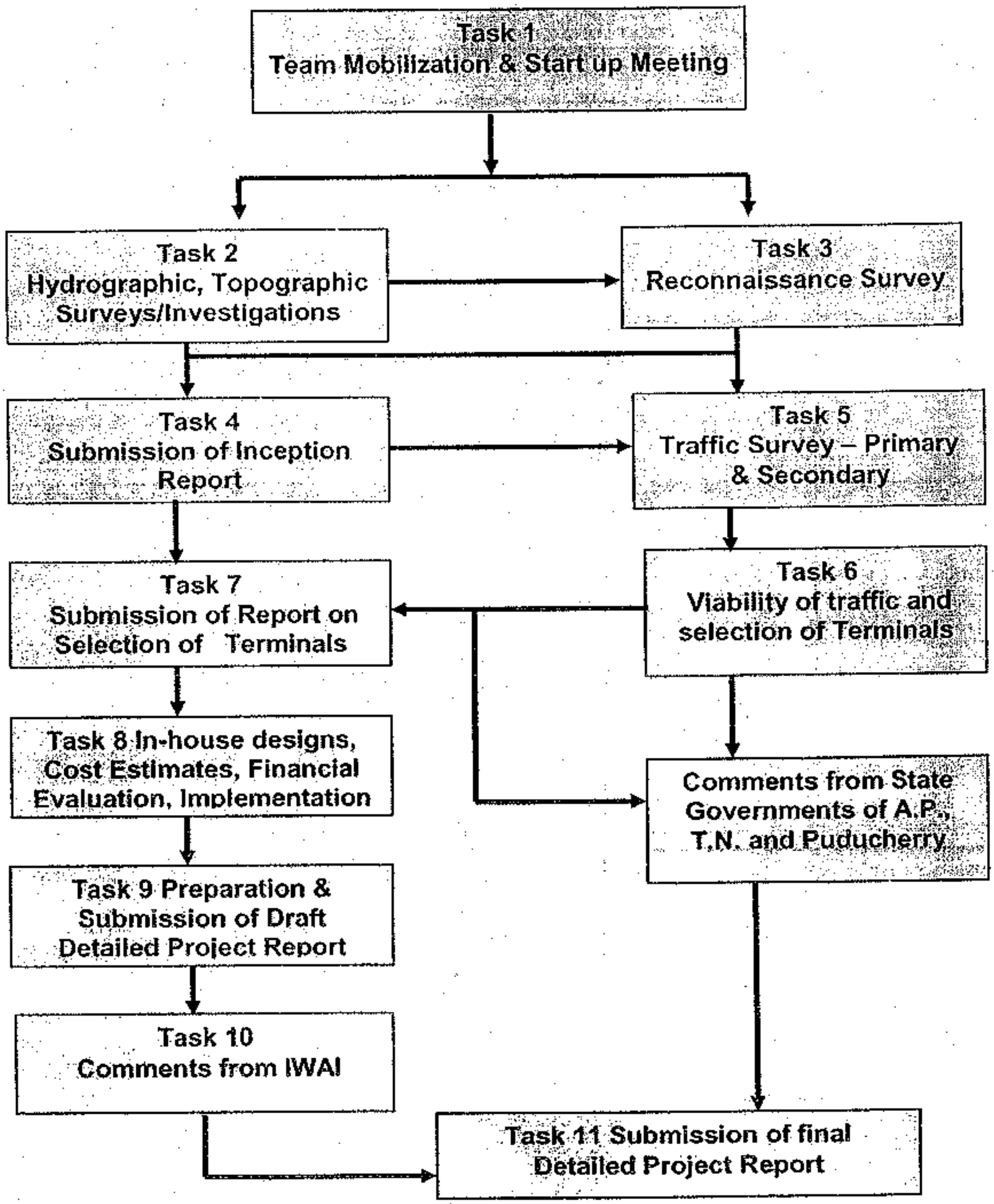
- To propose a tax system for the vessels operating in National Waterway.
- To propose a tax on the quantity carried without disturbing the advantage diver ability in terms of total transport coast. cost ?? ?
- To propose a rental value to the terminal locations.
- To explore realization of other means of revenue from the assets owned by the IWAI
- To work out the FIRR

29. Prepare the DPR covering all the above items.

30. The TOR of the study is appended herewith.

1.3 APPROACH AND METHODOLOGY FOR SURVEY

The activities followed are as under :



1.3.1 Methodology for Survey

A detailed hydrographic survey was carried out to assess the navigability of the Kakinada - Puducherry Canal alongwith rivers Krishna and Godavari from December'05 to February '06. Power driven boats with crew were used for sounding work. Godavari river was navigable throughout while Krishna river was not navigable at some places. Boats could be used for sounding only at some places along the canals, wherever available. GTS Bench Marks and GTS connected Bench Marks provided by Survey of India along the Rivers and Canals were picked up on the ground. Where these BMs were not available new BMs were established by levelling from GTS BMs. In this process the entire length of the rivers and canals was covered by providing numbers of BMs along the banks and shown on 1:50,000 charts. These charts were rigorously verified on the ground during survey. In the areas of shallow water, closed water and rapids where boats could not ply, depths were measured by leveling staff. Hydrographic survey was carried out as per the methodology detailed below. Temperory Bench Marks were established on the river banks at an interval of 20 KM approx. for undertaking the surveys.

As 1:50,000 Topo Sheets of the entire region were made available, Geodetic network by precision traversing/triangulation were not required. Daily observations of water levels of specific areas of surveys were carried out for reduction of soundings to chart datum. Soundings are shown on Thalweg survey charts as best as could be accommodated within the available space of the water channel.

Based on the request of IWAI the Hydrographic survey charts were re-plotted to 1:5000 scale for entire canal portion and 1:10000 scale for river portion. They have been submitted to IWAI.

1.3.2 Chart Datum

All the gauge stations of C.W.C. falling in the working area were visited. Historical Lowest Low Water values of each station were collected. The water level data were analysed on scientific basis and thereafter the chart datum was derived at. The gradient of Godavari & Krishna Rivers are very steep, hence datum also keeps on changing. Therefore, necessary allowances have been made for reduction of soundings (depths) in every cross section in order to depict true picture of the river bed. The Datum (Local Zero) has been shown in the chart at an interval of 5 KM all along rivers and canals.

Systematic ground verification of existing details along the rivers were carried out. All details were picked up and entered in maps/charts on scale 1:50,000.

After ground verification of details, originals were prepared on AutoCAD for each sheet. Entire Hydrographic and Topographic data were systematically entered in these sheets. For Northing and Easting 5000 meters grids were drawn for each sheet and spherical ticks were entered at the edge within the boarder of each map. Necessary remarks also were entered on maps/charts. Vertical clearance of main structures over the canal and river are shown on charts.

Systematic ground verification of existing details along the rivers were carried out. All details were picked up and entered in maps/charts on scale 1:50,000.

Cross Sections, Longitudinal Section, Chart Datum, Graph, Water level graph during the period of survey, graphs for tidal portion during the period of survey are prepared and submitted along with charts of rivers and canals to IWAI. IWAI requested to carry out certain modifications on survey charts that has also been carried out and submitted. The selection of terminals was carried out by expert team of WAPCOS alongwith expert team of Environmental Consultants, M/s CES India Private Limited during the month of July, 2006. The topographic survey of selected terminal sites was carried out by WAPCOS at 14 locations during October, 2006 and the survey charts were submitted to IWAI during November, 2006.

1.4 WATERWAY

Rivers Godavari and Krishna are two major rivers in India, Both are flowing North to South and their flow stopped at two barrages. Upper region of two rivers is rocky while lower regions are sandy. Both are channellised from barrages through canals for agricultural fields. Rivers and canals are approachable in places by roads. The canals forming the proposed waterway are Kakinada, Eluru, Commamur and Buckingham Canal. Out of these canals, Buckingham Canal is an abandoned Canal. In some places it is having water, in some places it is dry, in places it is blocked by salt pans. In places it is tidal, a dirty drain in Chennai and finally ended up at Marakanam before Kaluvelly tank which is dry and under aquaculture of shrimps.

The waterway is proposed to be developed in two Phases as per the TOR of IWAI as given below. However in **Phase I** it has been proposed to develop the waterway in two stages based on the request of Government of Andhra Pradesh (GoAP).

Phase – I - Buckingham canal 32 m wide and depth of 1.8 m, Godavari and Krishna River 32 m wide and depth of 1.8 m. Other Irrigation Canal (Eluru, Commamur and Kakinada Canals) 14 m wide and depth of 1.6 m

Stage I : North Buckingham canal between Peddaganjam (A.P) and Ennore (South) (T.N), South Buckingham canal between Muthukadu and Marakanam including Kaluvelly Tank, Godavari river between Polavaram and Rajahmundry, Kakinada canal between Rajahmundry and Kakinada, Godavari Eluru canal between Rajahmundry and Eluru

Stage II: Commamur canal between Peddagangam and Vijayawada, Krishna river between Wazirabad and Vijayawada, Krishna Eluru canal between Vijayawada and Eluru and Godavari river between Bhadrachalam and Polavaram

Phase – II - Width of 32 m and depth of 2.0 m for the entire stretch of canal/river systems

1.5 TRAFFIC SURVEY

Our approach to the study was a combination of secondary research and primary survey followed by data collation and analysis.

Based on the traffic data collected, the traffic potential for the entire watwerway has been projected. The details of the traffic survey have been explained in Chapter- 2.

1.6 STRUCTURE OF THE DETAILED PROJECT REPORT

1.6.1 The Detailed Project Report is submitted in Four Volumes as given below :

Volume I	Executive Summary (Self Contained)
Volume II	Chapter 1 to Chapter 11 (Write up and Tables)
Volume III	Annexures (Correspondence with Govt. of AP and Tamilnadu)
Volume IV	Drawings and Photographs

1.6.2 All the findings and observations have been furnished in Volume II in various chapters as given below:

Chapter 1: Introduction: This chapter covers the background of the project, scope of the work, the approach and methodology and structure of Detailed Project Report.

Chapter 2: Traffic studies: This chapter covers descriptions about Major Cargo Belts, Important Cargo, Future Cargo Potential and Likely Traffic, Cargo traffic at different terminals, Traffic Projections etc.

Chapter 3: Waterway: This chapter covers brief description of present status of whole waterway, Hydro-Morphological characteristics, Availability of Draft and Structures falling in various stretches of waterway etc.

Chapter 4: Vessel Size: This chapter deals with analysis and recommendation of design vessel to be used in waterway.

Chapter 5: Planning of Terminals: This chapter deals with the Influencing factors for selection of Terminals, suggested locations of Terminals with alternatives and recommendations about the best suitable alternative from Technical considerations with their traffic allocations.

Chapter 6: Description & Design Basis for Engineering Works: This chapter deals with various engineering works required in entire stretch of waterway.

Chapter 7: Land Acquisition for Development: This chapter describes about area of land required to be acquired for canals involved in the project.

Chapter 8: Cost Estimates: This chapter describes about cost estimates of various items involved in the project.

Chapter 9: Financial and Economic Evaluation: This chapter depicts the IRR of the project so as to decide its viability.

Chapter 10: Project Construction/Implementation: This chapter describes the implementation and time schedule for selected options.

Chapter 11: Conclusions & Recommendations: This chapter describes the conclusions drawn for various options and recommendations.

CHAPTER 2
TRAFFIC STUDIES

CHAPTER – 2

TRAFFIC STUDIES

2.0 INTRODUCTION

The Kakinada - Puducherry Canal stretch, subject for the current traffic study consists of a system of rivers and canals. River Godavari is the largest peninsular river in the southern region of India. It originates in Maharashtra State, western India, near the city of Nasik in the Western Ghats. It flows 1,400 km (900 m) southeast to its delta on the Bay of Bengal. On this river a stretch of 171 Km from Bhadrachalam to Rajahmundry has been considered for the traffic. River Krishna which rises near Mahableshwar in Maharashtra and flows through Maharashtra, Karnataka before entering the Bay of Bengal at Machilipatnam. A Stretch of 157 Km from Wazirabad to Prakasam Barrage has been identified for the traffic study. The canal system consists of the Kakinada Canal, Eluru canal, Commamur Canal, North Buckingham Canal South Buckingham Canal. The waterway from Marakanam to Puducherry passes through kaluvelly tank surrounded with a number of fisheries, shrimp and aquaculture shrimp farms.

The proposed waterway for development between Kakinada and Puducherry with river inter-linkages of Krishna and Godavari flows through the districts of East Godavari , West Godavari, Krishna, Guntur, Nellore, Prakasam, Khammam and Nalgonda in Andhra Pradesh and Villupuram, Kanchipuram, Tirivallur, Puducherry and areas of Cuddalore district in Tamilnadu.

The earlier traffic studies conducted in the techno economic feasibility for development of navigation on South Buckingham Canal including integration from Kakinada to Marakanam integrated with Godavari – Krishna rivers during the year 1999 have been reviewed. Further, WAPCOS appointed M/s A. F. Ferguson, an experienced firm in traffic studies, to carry out traffic survey for proposed waterway in 2005-06 . It involved an in-depth desk study through Trade Journals, Annual Reports, Statistical abstracts of the states, Cement Statistics, Fertiliser Statistics and in house database to assess the profile of hinterland that could be catered to by the proposed waterway, major industries in the hinterland, raw material and products consumed and manufactured by such industries, review of various government plans, trend in traffic at major ports etc. A field survey has also been carried out which involved discussions with various Government Authorities, Association of industries such as Cement Manufacturer's Association, Fertiliser Association, Sugar Mills

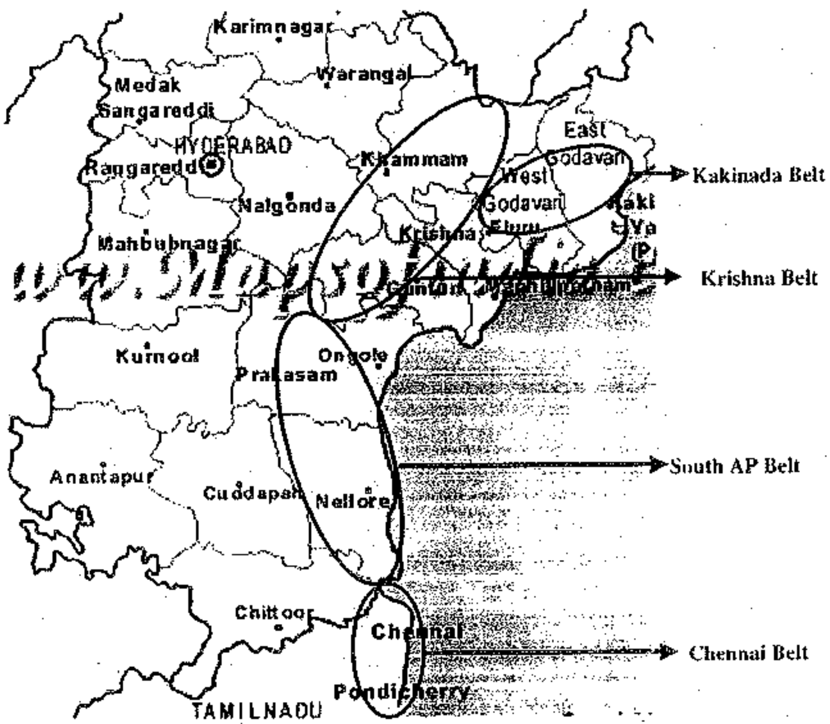
Association and talking to the Marketing Departments of various industries in the hinterland of the waterway. The field visits were made to Kakinada, Guntur, Vijayawada, Kothagudem, Bhadrachalam, Ennore Port and Vishakhapatnam. The consultants met potential customers primarily Cement, Fertilisers, Rice Mills, Paper Industries, Ports etc. The data so obtained has been analysed and led to the cargo traffic projections for proposed waterway.

2.1 MAJOR CARGO BELTS

The hinterland of Kakinada - Puducherry Inland waterway has been divided into four major cargo belts viz. Kakinada belt, Krishna belt, South AP belt, and Chennai belt. The location of various cargo belts in the hinterland are shown in **Exhibit 2.1**.

Exhibit 2.1

Profile of Hinterland-Cargo Belts



2.1.1 River System

2.1.1.1 Godavari River

River Godavari is the largest peninsular river in the southern region of India. It originates in Maharashtra State, western India, near the city of Nasik in the Western Ghats. It flows 1,400 km (900 m) southeast to its delta on the Bay of Bengal. On this river a stretch of 171 Km from Bhadrachalam to Rajahmundry has been considered for the traffic study.

The stretch consists of the following districts and Mandals:

Sr. No.	Revenue Mandal	District	Area (In Sq.Km.)	No. of Villages
1.	Bhadrachalam	Khammam	289.00	71
2.	Burgampad	Khammam	339.20	18
3.	Kukunuru	Khammam	283.44	20
4.	Konnavaram	Khammam	76.89	50
5.	Valairpadu	Khammam	185.68	20
6.	V.R. Puram	Khammam	132.38	62
7.	Devipatnam	E. Godavari	311.00	44
8.	Pollavaram	W.Godavari	105.00	23
9.	Korukonda	E.Godavari	182.00	19
10.	Seethanagaram	E.Godavari	156.00	17
11.	Kovvur	W.Godavari	105.00	17
12.	Tallapudi	W.Godavari	99.00	18
13.	Rajahmundry	E.Godavari	427.00	32
		TOTAL	**2691.59**	**411**

2.1.1.2 Krishna River

River Krishna rises near Mahableshwar in Maharashtra and flows through Maharashtra, Karnataka before entering the Bay of Bengal at Machilipatnam. A Stretch of 157 Km from Wazirabad to Vijayawada (Prakasam Barrage) has been identified for the traffic study.

The Mandal wise details of stretch in Krishna river from Wazirabad to Vijayawada are as under :

S. No.	REVENUE MANDAL	DISTRICT	AREA IN SQ.KM.	NO. OF VILLAGES
1.	AMRAVATHI	GUNTUR	194.77	17
2.	ATCHAMPETA	GUNTUR	212.99	18

S. No.	REVENUE MANDAL	DISTRICT	AREA IN SQ.KM.	NO. OF VILLAGES
3.	BELLAMKONDA	GUNTUR	304.48	13
4.	CHANDRALPADU	KRISHNA	223.01	33
5.	DACHEPALLI	GUNTUR	270.45	12
6.	DEMERCHERLA	NALGONDA	349.80	17
7.	GURAZALA	GUNTUR	251.51	10
8.	HUZOOR NAGAR (WAZIRABAD)	NALGONDA	110.40	18
9.	IBRAHIMPATNAM	KRISHNA	113.54	18
10.	JAGAYYAPETTA	KRISHNA	362.87	25
11.	KANCHI KACHERLA	KRISHNA	162.49	16
12.	KODAL	GUNTUR	214.30	15
13.	MACHERLA	GUNTUR	442.33	12
14.	MACHAVAKAM	GUNTUR	198.60	9
15.	MANGALAGIRI	GUNTUR	133.65	12
16.	RENTACHINTALA	GUNTUR	159.75	10
17.	TADEPALLI	GUNTUR	79.90	9
18.	MEDLACHERUVU	NALGONDA	324.00	14
19.	MATTAM PALLI	NALGONDA	176.60	10
20.	MIRYALAGNDA	NALGONDA	219.80	23
21.	NANDIGAMA	KRISHNA	190.29	26
22.	NEREDUCHERLA	NALGONDA	267.30	27
23	VIJAYAWADA	KRISHNA	229.50	29

2.1.2 Canal System

The canal system consists of the Kakinada Canal, Eluru canal, Commamur Canal, North Buckingham Canal, South Buckingham Canal and Kaluvelly Tank extending to Puducherry.

2.1.2.1 Kakinada Canal

The following mandals are located in this stretch of Kakinada canal as given below.

S.No.	Mandal	District
1	Rajahmundry	East Godavari
2	Anarapati	East Godavari
3	Kakinada	East Godavari
4	Samalkot	East Godavari
5	Peddapuram	East Godavari
6	Rangampeta	East Godavari

S.No.	Mandal	District
7	Rajanagram	East Godavari
8	Kadiyam	East Godavari

2.1.2.2 Eluru Canal

The following mandals are located in Eluru canal as given below:

S. No.	Mandal	District
1	Rajahmundry	West Godavari
2	Kovvuru	West Godavari
3	Chagallu	West Godavari
4	Nidadavole	West Godavari
5	Tadepalligudam	West Godavari
6	Unguturu	West Godavari
7	Bhimadole	West Godavari
8	Denduluru	West Godavari
9	Eluru	West Godavari
10	Pentapadu	West Godavari
11	Vijayawada (R)	Krishna
12	Vijayawada (U)	Krishna
13	Gannavaram	Krishna
14	Bapulapadu	Krishna

2.1.2.3 Commamur canal

The following districts are located in Commamur canal as given below:

S. No.	District
1	Krishna
2	Guntur
3	Prakasam
4	Nellore

2.1.2.4 North Buckingham canal

The following districts are located in North Buckingham canal as given below:

S. No.	District
1	Nellore
2	Tiruvallur

2.1.2.5 South Buckingham canal and Kaluvelly tank

The following districts are located in South Buckingham canal and Kaluvelly tank as given below:

S. No.	District
1	Tiruvallur
2	Kanchipuram
3	Viluppuram
4	Cuddalore
5	Puducherry

The details of the river system and canal system are provided in **Exhibit 2.2** and **Exhibit 2.3**. The connectivity in the hinterland is shown in **Exhibit 2.4**

Exhibit 2.2
River Systems

River	Study Points	Length (Km)
GODAVARI RIVER	BHADRACHALAM-RAJAHMUNDRY	171
KRISHNA RIVER	WAZIRABAD-PRAKASAM BARRAGE	157

Exhibit 2.3
Canal Systems

Canal	Originating-Terminating Points	Length (Km)
KAKINADA CANAL	RAJAHUMUNDRY-KAKINADA	50
ELURU CANAL	VIJAYWADA-RAJAHMUNDRY	139
COMMANURU CANAL	PEDDAGANJAM-VIJAYWADA	113
NORTH BUCKINGHAM CANAL	PEDDAGANJAM – COOUM RIVER, CHENNAI	340
SOUTH BUCKINGHAM CANAL	COOUM RIVER-MERCAUNUM-KALLUVELLY TANK	125

Exhibit 2.4

CONNECTIVITY IN THE HINTERLAND

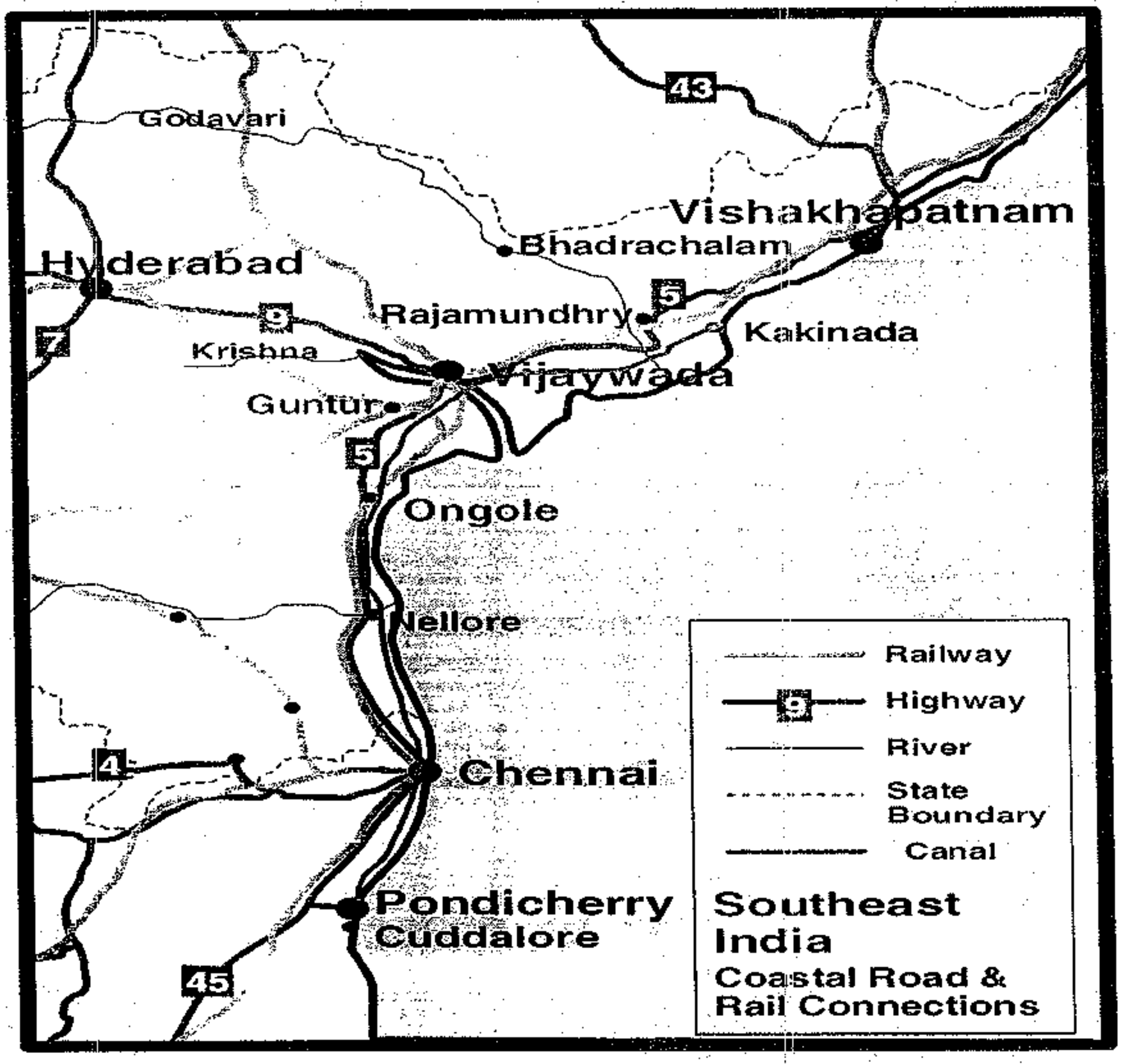
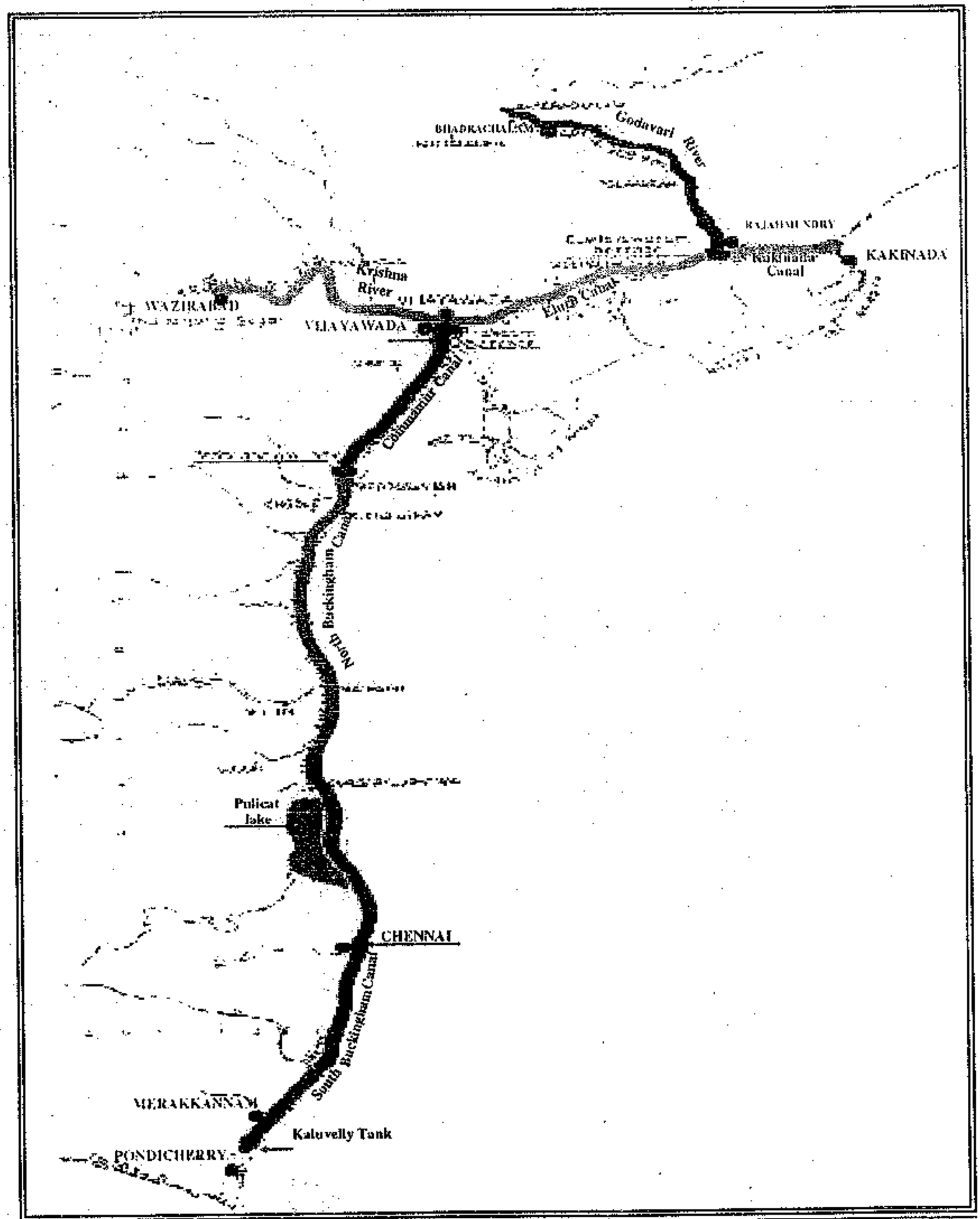


Exhibit 2.5 indicates the canal system and the river inter linkages of the proposed study.

Exhibit 2.5

Integrated Canal System



The road and rail connectivity in the hinterland of Kakinada – Puducherry hinterland is shown in **Exhibit 2.6** and **Exhibit 2.7**

Exhibit 2.6

Distances Chart in Hinterland – Road

Particulars	Distance (Km)
Kakinada - Vijaywada	223
Kakinada - Guntur	255
Kakinada - Nellore	479
Kakinada - Chennai	684
Kakinada - Puducherry	849
Puducherry - Chennai	165
Puducherry - Nellore	337
Puducherry - Guntur	561
Puducherry - Vijaywada	593
Bhadrachalam – Rajahmundry	200

Exhibit 2.7

DISTANCES CHART IN HINTERLAND – RAIL

Particulars	Distance (Km)
Kakinada - Vijaywada	245
Kakinada - Rajahmundry	95
Kakinada - Nellore	500
Kakinada - Chennai	675
Kakinada - Villupuram	835
Villupuram - Chennai	160
Villupuram - Nellore	660

Based on the initial survey, the influence zone of the proposed waterway was studied and the cargo belts were identified, which could help in understanding the movement of goods. Major commodities which would form part of the cargo in the inland waterway were also identified. Discussions were carried out with various shippers on their concerns and suggestions for Inland Water Transportation.

The districts which form part of the influence zones are East Godavari District, West Godavari, Krishna, Guntur, Nellore, Prakasam, Khammam and Nalgonda in Andhra Pradesh and Villupuram, Kanchipuram, Tiruvallur, Puducherry and areas of Cuddalore district.

2.2 TRAFFIC FORECAST

The methodology adopted for cargo traffic forecast, major assumptions for realisation of the cargo traffic, total potential for the proposed inland waterway, likely traffic, key issues and concerns, critical success factors and tariff related aspects have been discussed in the following paragraphs.

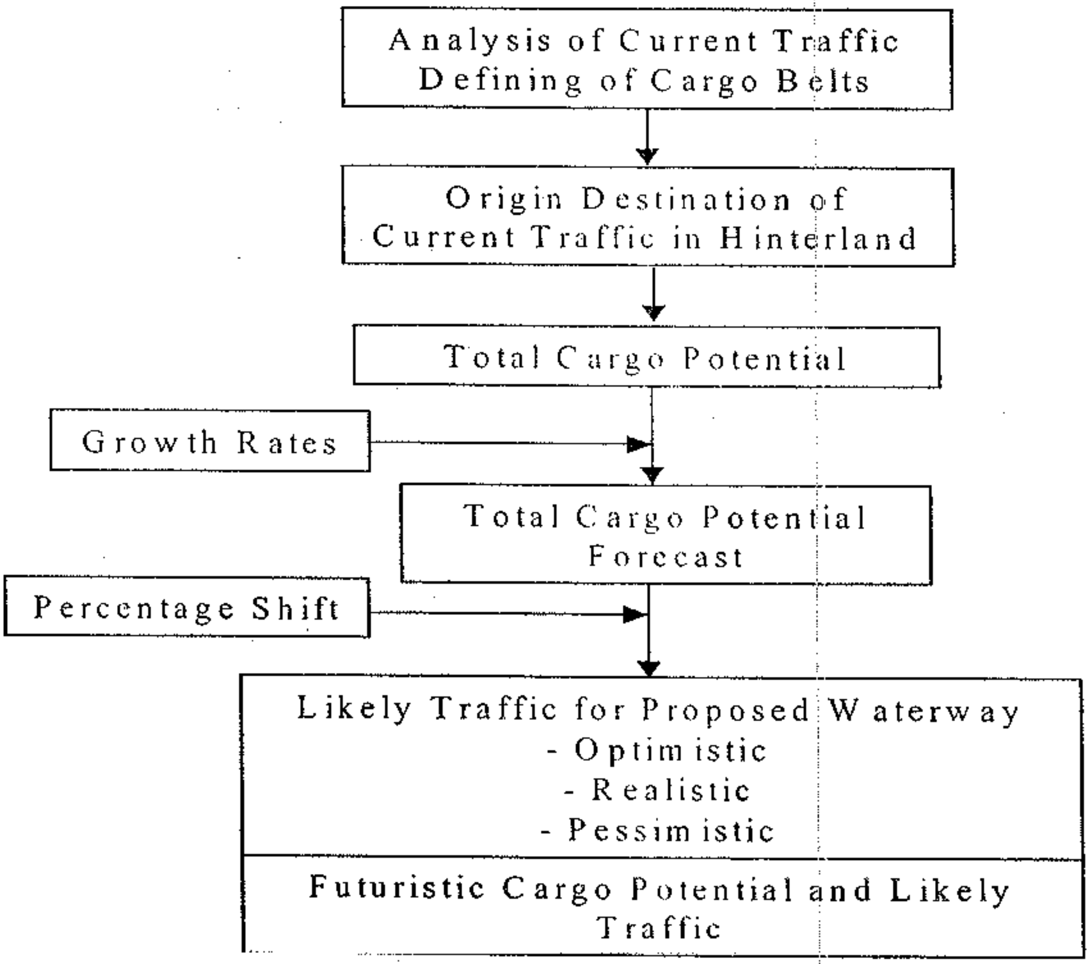
2.2.1 Demand forecasting methodology

Exhibit 2.8 indicates the methodology adopted to arrive at the future cargo potential and likely traffic. The first stage involved analysis of the current traffic in the hinterland of proposed waterway. Given the large capital investment required in the project the focus was on voluminous bulk cargo such as coal. Thus cargo traffic from large users in this hinterland was analysed. Next stage involved carrying out the origin destination analysis of cargo handled in this hinterland. All the cargo that is likely to offer distance / time / service advantage to the users was analysed and the same formed the total cargo potential. The forecast for the next fifty years was arrived at by applying a growth rate to the total cargo potential based on the future industry outlook for each commodity. However, this total cargo potential is not likely to be realised in the first year of operation because of set up linkages of shippers, cost economics (competition from other transport mode rail and road), shippers inertia etc. Hence a percentage shift was applied to the total cargo potential to arrive at the likely traffic for the proposed waterway based on feedback from the shippers and broad level cost economics.

Apart from studying the existing cargo movement, an assessment was made for cargo potential that would be triggered on account of coming up of the proposed waterway. Such cargo was identified and potential from the same was termed as futuristic cargo potential and its realisation as futuristic likely cargo traffic.

Exhibit 2.8

Demand Forecasting Methodology



2.2.2 Assumptions for cargo traffic study

Following assumptions were made while arriving at the cargo traffic forecast:

- The Stage I of the proposed waterway is assumed to commence operations from 2014-15 and Stage II from 2017-18.
- Proposed waterway will offer cost economic services to the users to facilitate shift from current transport mode to the waterway.
- Total cargo potential forecast assumes direct linkages from the hinterland to Kakinada Anchorage Port which facilitate connection of the hinterland to the sea and this would give substantial distance advantage to importers / exporters and also avoid multiple handling.
- Realisation of coal traffic (especially pertaining to cement plants and other industries) is linked to navigability on river Krishna, Godavari integrated with Kakinada - Puducherry canal system and availability of barges capable of handling large quantities of cargo such as coal.
- Continuous availability of barges for navigation is to be ensured.
- Perennial availability of water to meet adequate draft throughout the stretch of river/ canal under consideration.

2.2.3 Modal Split

The modal split is studied in this paragraph. In the major cargo belt along the Kakinada – Krishna - Godavari belt, there are many places not connected by Railway line. Particularly in the Godavari region from Rajahmundry to Bhadrachalam, the railway line is non-existent. The existing roadways for certain areas, in view of circuitous routes are not only inadequate but cumbersome too. For instance, while the distance between Devipatnam and Purushottampatnam is 10 Km by river, by road it is 74 Km. Similarly, the distance between Kunnavaram and Devipatnam is 43 Km by river as against 137 Km by road. In view of this, alternative mode of transport i.e. waterways is not only economical but also noise free and pollution free and therefore traders will definitely switch over to this mode of transport if fully developed.

For illustration purposes, O-D Pairwise Road/IWT distance is indicated in the table below:

Sr. No.	O-D Pair	Distance Road	IWT (Kms.)	Possible Share of IWT (%)	Commodities
1.	Kudunuru – Bhadrachalam	55	37	45	Paddy, Chillies, Tobacco, Pulses, Fruits
2.	Pochavaram – Rajahmundry	188	85	90	Paddy, Chillies, Tobacco, Pulses, Fruits, Bomboo, Timber, Firewood etc.
3.	Devipatnam – Rajahmundry	79	44	90	Paddy, Chillies, Tobacco, Pulses, Fruits etc.

2.3 ANALYSIS OF CARGO BELTS

Analysis of these cargo belts indicates that coal, cement, food grains and fertilisers account for majority of the total traffic in the hinterland. It is also observed that Krishna Belt and Kakinada Belt are the major zones in terms of cargo volume.

The main cargo in Krishna Belt consists of coal from SCCL. Kakinada Belt constitutes of rice and food grains owing to it being a major rice growing area. Kakinada and Chennai cargo belts also indicate a significant level of Fertiliser traffic owing to the presence of plants of Godavari Fertiliser and Nagarjuna Fertilisers in Kakinada and Madras Fertilisers in Ennore. South AP Belt contributes to the forest products traffic and the majority of the cargo comes from Ongole. And this is consumed by paper Industries in and around Bhadrachalam. Chennai Belt is a major contributor towards the salt traffic which is transported to many coastal areas of Andhra Pradesh.

On the basis of survey and discussions carried out with suppliers and users, following commodities were observed under above-mentioned cargo belts as given below.

- Coal
- Rice and Food Grains
- Cement
- Fertiliser
- Forest Products
- Salt
- Others

Exhibit 2.9 indicates the total potential for the proposed waterway. It is seen that the total cargo potential for proposed waterway is estimated at about 23 Mn. T. in the year 2005-06. Coal is the largest cargo category accounting for about 60% of the total cargo potential followed by rice, cement, fertilisers, forest products and salt which together account for 30% of the total cargo potential. The remaining cargo is accounted by Other General cargo category which consists of rice bran extractions, chilies, tobacco, marine products fruits and vegetables etc.

Exhibit 2.9

Estimated Total Cargo Potential (by all modes) in year 2005-06

(000'MT)

[illegible] Cargo [illegible]	[illegible] Supply / Consumption	[illegible] Belt	Estimated [illegible]	Potential (Y/N)	Estimated Cargo Potential
Coal For Thermal Power Plants					
KTPS	SCCL	Krishna Belt	8,400,000	N	
VTPS	SCCL	Krishna Belt	6,960,000	Y	
	SCCL	South AP Belt	153,000	Y	
Captive Thermal Power Plants	SCCL	Kakinada Belt	144,000	Y	
		Sub Total	15,657,000		7,257,000
Coal For Other Industries					
	SCCL	Kakinada Belt	212,268		
		Krishna Belt	5,503,024		
		South AP Belt	162,256		
		Subtotal	5,877,548	Y	5,877,548
Total Coal					13,134,548
Boiled Rice	Chennai	Chennai Belt	3,001,250	Y	3,001,250
Other Foodgrains	Kakinada	Kakinada Belt	36750		
	Eluru	Kakinada Belt	24500		
	Vijaywada	Krishna Belt	232750		
	Kottapatnam	South AP Belt	379750		
	Maipadu	South AP Belt	122500		
	Nalgonda	Krishna Belt	294000		
	Bhadrachalam	Krishna Belt	269500		
		Subtotal	1,359,750	Y	1,359,750
Cement	Kakinada	Kakinada Belt	470,000		
	Chennai	Chennai Belt	420,000		
	Vijaywada	Krishna Belt	300,000		
		Sub Total	1,190,000	Y	1,190,000
Fertilisers	Kakinada	Kakinada Belt	149,199		
	Eluru	Kakinada Belt	171,925		
	Vijaywada	Krishna Belt	303,880		
	Kottapatnam	South AP Belt	111,179		
	Maipadu	South AP Belt	49,905		
	Bhadrachalam	Krishna Belt	127,159		
	Nalgonda	Krishna Belt	112,600		
	Tiruvallur	Chennai Belt	10,000		
	Kanchipuram	Chennai Belt	4,000		
	Pondicherry	Chennai Belt	24,000		
	Cuddalore	Chennai Belt	10,000		
	Villupuram	Chennai Belt	8,000		
		Subtotal	1,081,847	Y	1,081,847
Rice	Vijayawada	Krishna Belt	232,750		
	Kottapatnam	South AP Belt	257,250		
	Maipadu	South AP Belt	61,250		
	Nalgonda	Krishna Belt	122,500		
	Bhadrachalam	Krishna Belt	281,750		
		Subtotal	955,500	Y	955,500
Raw Materials For Paper Industry (Forest Products/Wood Pulp/Waste Paper/Timber)	Bhadrachalam	Krishna Belt	535,000	Y	535,000
Salt	Kakinada	Kakinada Belt	10140		
	Eluru	Kakinada Belt	6391		
	Vijaywada	Krishna Belt	21012		
	Maipadu	South AP Belt	13649		
	Kottapatnam	South AP Belt	20815		
	Bhadrachalam	Krishna Belt	6499		
	Nalgonda	Krishna Belt	6350		
	Villupuram	Chennai Belt	9186		
	Kanchipuram	Chennai Belt	67268		
	Pondicherry	Chennai Belt	143579		
	Thiruvallur	Chennai Belt	15447		
		Subtotal	320,336	Y	320336
Other General cargo	Kakinada/ Chennai	Kakinada- Chennai	146,480	Y	1636770
		Grand Total			23,215,001

Source : AFF Estimates

Exhibit 2.10 indicates the snapshot of total cargo potential (by all modes) over the forecast period. The total cargo potential for the hinterland is conservatively estimated to increase from 27.62 Mn. T. in 2014 – 15 when the waterway is assumed to start operations to 47.47 Mn. T. in 2039 – 40 in twenty five years and growing upto 78.09 Mn. T. in 2059 – 60. The total cargo potential is thus conservatively growing at a CAGR of 2% p.a. for the next fifty years.

Exhibit 2.11 indicates the snapshot of total cargo potential by IWT over the forecast period. The likely traffic for the proposed waterways is estimated to be 2.82 Mn. T. in 2014 – 15 to 12.39 Mn. T. in 2039 – 40 in twenty five years and growing upto 20.55 Mn. T. in 2059 – 60 under the realistic scenario.

Exhibit 2.10

Estimated Total Cargo Potential by all Modes Under Realistic Scenario

000 Tonne

Sl. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	Coal	14409	15158	15985	16898	17906	19019	24756
2	Rice	5163	5985	6939	8044	9325	10810	19524
3	Foodgrains	1774	2057	2385	2765	3205	3715	6710
4	Cement	1694	2061	2507	3050	3711	4515	9893
5	Fertilisers	1412	1637	1897	2199	2550	2956	5339
6	Forest products	761	926	1127	1371	1668	2030	4448
7	Salt	455	554	674	820	998	1214	2660
8	Other General Cargo	1956	2160	2385	2633	2907	3210	4769
	Total Cargo Potential in 000Tonne	27625	30538	33899	37781	42270	47469	78100
	Total Cargo Potential in Million Tonne	27.62	30.54	33.90	37.78	42.27	47.47	78.10

Exhibit 2.11

Estimated Total Cargo Potential by IWT Under Realistic Scenario

000 Tonne

Sl. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	Coal	1441	2274	3197	4224	4476	4755	6189
2	Rice	516	898	1388	2011	2331	2703	4881
3	Foodgrains	177	309	477	691	801	929	1678
4	Cement	-	309	501	763	928	1129	2473
5	Fertilisers	282	409	569	770	892	1035	1869
6	Forest products	114	185	282	411	501	609	1334
7	Salt	91	139	202	287	349	425	931
8	Other General Cargo	196	324	477	658	727	802	1192
	Total Cargo Potential in 000Tonne	**2818**	**4846**	**7093**	**9816**	**11006**	**12386**	**20547**
	Total Cargo Potential in Million Tonne	2.82	4.85	7.09	9.82	11.01	12.39	20.55

TABLES

2.7 CRITICAL SUCCESS FACTORS

Following will be the critical success factors for the project:

- Aggressive marketing of new facilities and its advantages to the user community including shippers, C & F agents, barge operators etc.
- Capacity and infrastructure build up in line with the market forecast.
- Competitive Tariff rates to the shippers in order to attract forecasted volumes.
- Availability of cargo consolidators for accruing smaller volumes (particularly of other general cargo) through aggregation.
- Shippers generally express their concern on contamination of cargo with that of coal. Hence, due care would be required to avoid such possible contamination.
- Availability of storage spaces and godowns near the river/ canal terminal.
- Time is of critical significance in the transport of the commodities mentioned above, especially coal and export / import cargo. Shippers have expressed their concerns over the delivery time using the proposed waterway. In order to meet the lead time currently incurred by various users all round navigation (including night navigation) along with continuous availability of barges are critical to the realisation of forecasted traffic.
- Railways offer freight subsidy to cargo such as fertilizer and salt and hence the transportation costs for the same is very low. The operators would be required to offer services competitive enough to attract such cargo volumes to the proposed waterway.

2.8 CONCLUSION

The Kakinada – Puducherry canal shows good potential for Navigation and movement of goods owing to the proximity to major cities and towns like Chennai, Puducherry, Vijaywada, Bhadrachalam and ports like Chennai, Ennore, Puducherry and Kakinada. The shippers have shown willingness to shift to this mode of transportation if the appropriate infrastructure is put in place and the IWT offers economical tariff structure.

Peddaganjam to Ennore								
South Buckingham Canal from Muthukadu to Marakanam and Marakanam to Puducherry via Kalluvelly Tank	9	13	19	27	32	38	46	55
Total traffic movement in Million tonne - km	364	1842	2714	3779	4258	4812	5459	6210

2.6 KEY ISSUES AND CONCERNS

There are a few key issues and concern that needs to be addressed which are as follows :

- Cargo navigation on Kakinada - Puducherry Canal will require linkage amongst various entities such as IWAI, barge operators, consolidators, railways, transporters, dam development authorities, etc. to ensure efficient means of cargo transportation. Shippers have expressed their concerns over the possible increased administrative workload on account of multiple party involvement.

- Cost economics will be an important feature for shifting the cargo from present transport mode to the proposed waterway. However, due to expected involvement of multiple agencies in proposed transportation of cargo ensuring a competitive rate from all the agencies remains an area of concern amongst various shippers until an integrated waterway service provider takes responsibility of transporting the cargo from origin to destination at a competitive price.

- Large shippers of coal have already invested capital in infrastructure for handling such high volume of coal at the plant. Switching to the proposed route is likely to abandon the existing infrastructure (such as tippling facilities, rake loading / unloading sites etc.) at plant. Thus such shippers have expressed need for substantial benefits (in terms of savings in operational cost) to abandon the current infrastructure.

- Almost all the shippers have expressed concerns over the multiple handling of cargo and losses likely to occur on account of the same. A planning system would thus be required to work out a mechanism to reduce multiple handling losses.

Vijayawada								
Commamur Canal from Vijayawada to Peddaganjam	-	1.833	2.769	3.953	4.574	5.300	6.148	7.141
North Buckingham Canal from Peddaganjam to Ennore	1.119	1.833	2.769	3.953	4.574	5.300	6.148	7.141
South Buckingham Canal from Muthukadu to Marakanam and Marakanam to Puducherry via Kalluvelly Tank	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Total traffic potential in Million tonne	2.818*	4.647*	6.793*	9.387*	10.509*	11.809*	13.318*	15.072*

* **These values are the projected traffic potential consisting of all cargo commodities for the proposed waterway and therefore would not be equal to algebraic addition of above values in all stretches as above values are simply movement of projected traffic potential in all the stretches of waterway**

In Million Tonne Km

Name of Stretches	Year							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Krishna River from Wazirabad to Vijayawada	-	330	483	666	739	824	922	1037
Godawari River from Bhadrachalam to Rajahmundry	-	484	693	935	1017	1110	1216	1338
Kakinada Canal from Kakinada to Rajahmundry	22	40	58	82	96	111	130	151
Eluru Canal from Rajahmundry to Vijayawada	-	222	323	444	494	551	618	694
Commamur Canal from Vijayawada to Peddaganjam	-	207	313	447	517	599	695	807
North Buckingham Canal from	333	546	825	1178	1363	1579	1832	2128

South Buckingham canal from Chennai to Marakanam and Puducherry is summarized as under .

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Chennai and destinating to Markanam and Puducherry	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Upstream Traffic originating at Marakanam and Puducherry and destinating to Chennai	0	0	0	0	0	0	0	0
Total traffic movement in Million tonne	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Total traffic movement in Million tonne - km	9	13	19	27	32	38	46	55

2.5.2.6 Summary of Traffic Movement in Different Stretches

On the basis of traffic movement explained in Para 2.5, a summary of total traffic movement in Million Tonne and Million Tonne Km projected in different stretches for different years is reproduced below :

In Million Tonne

Name of Stretches	Year							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Krishna River from Wazirabad to Vijayawada	-	2.105	3.077	4.240	4.707	5.248	5.876	6.604
Godawari River from Bhadrachalam to Rajahmundry	-	2.834	4.055	5.469	5.946	6.490	7.112	7.824
Kakinada Canal from Kakinada to Rajahmundry	0.437	0.794	1.169	1.645	1.912	2.226	2.594	3.026
Eluru Canal from Rajahmundry to	-	1.596	2.323	3.195	3.554	3.967	4.444	4.994

Chennai to Ongole, the main traffic consists of Fertilisers from Ennore and Salt from Chennai for local consumption.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of North Buckingham canal from Peddaganjam to Chennai is summarized as under.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Peddaganjam and destinating to Chennai	0.790	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Chennai and destinating to Peddaganjam	0.329	0.490	0.727	1.033	1.221	1.444	1.711	2.030
Total traffic movement in Million tonne	**1.119**	**1.833**	**2.769**	**3.953**	**4.574**	**5.300**	**6.148**	**7.141**
Total traffic movement in Million tonne - km	**333**	**546**	**825**	**1178**	**1363**	**1579**	**1832**	**2128**

2.5.2.5 South Buckingham Canal and Kaluvelly Tank

The canal stretch of South Buckingham Canal for a length of 110 km starts from Central Station of Chennai and runs upto Marakanam and is joined by Kaluvelly tank, a huge open tank 22 km long upto sea. It has mainly traffic of salt and Fish & Marine Products because of salt pans and aquaculture shrimp farms all along the stretch. The major districts in the influence area are Chennai, Kalpakkam, Cuddalore, Villipuram, Kanchipuram, Thiruvallur, Marakanam and Puducherry. If developed in isolation, it has traffic potential of Iron scrap in the downstream direction from Chennai to Marakanam. In the upstream direction from Puducherry, Marakanam to Chennai, the main traffic consists of Salt, Fertilisers and Timber from Marakanam, Thiruvallur, Kanchipuram, Villipuram & Puducherry for local consumption.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of

2.5.2.3 Commamur Canal

This stretch from Vijayawada to Peddaganjam in Ongole of a length of 113 km is an important trade link linking Kakinada belt with south A.P. and Tamil Nadu. The major towns in the influence area are Vijayawada,and Ongole. It connects Prakasam Barrage to Peddaganjam Lock. If developed in isolation, it will not yield any substantial traffic. The main traffic to move consists of Rice & Food grains in downstream direction and Forest products in upstream direction.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Commamur canal from Vijaywada to Peddaganjam is summarized as under.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Vijayawada, and destinating to Peddaganjam	-	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Peddaganjam and destinating to Vijayawada	-	0.490	0.727	1.033	1.221	1.444	1.711	2.030
Total traffic movement in Million tonne	-	**1.833**	**2.769**	**3.953**	**4.574**	**5.300**	**6.148**	**7.141**
Total traffic movement in Million tonne - km	-	**207**	**313**	**447**	**517**	**599**	**695**	**807**

2.5.2.4 North Buckingham Canal

The canal stretch is almost dry and has mainly salt traffic because of salt pans all along the canal. The total length of the canal is 316 km between Peddaganjam lock in Ongole to Central Station of Chennai. The major districts in the influence area are Nellore, Gudur, Ennore and Chennai. If developed in isolation, it has traffic potential of Rice & food grains, Fertilisers, Chillies, Tobacco Fish & Marine Products, Granite and Fruits & vegetables in the downstream direction from Ongole to Chennai. In the upstream direction from

2.5.2.2 Eluru Canal

The Eluru canal consists of stretch of 139 km length running between Rajahmundry and Vijayawada. The important commodities forming potential for traffic are : Rice and food grains ,Rice bran extractions , Coal ,Fertilizers and Other Cargo.

Of these, rice bran extractions form the major part for IWT movement followed by other food grains, coal, fertilizers and other cargo. The rice bran extractions are sent from Tadepalligudem by road running alongside Eluru canal and are exported through Kakinada Port. It is also distributed locally. Defatted rice bran is used for pet food industry. Rice hulls are used as pressing aid in fruit juice extractions and as bedding in poultry houses. These are also exported through the port of Kakinada. Other extractions include oil seed extractions.

At present, a small quantity of movement also exists along Eluru Canal in Godavari Eluru canal between Tadepalligudam and Rajahmundry and also in Krishna Eluru Canal between Vijayawada and Eluru through country crafts, the effect of which in working out the traffic potential is considered negligible.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Eluru canal from Vijaywada to Rajahmundry is summarized as under.

		Traffic						
Year	**2014-15**	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Vijayawada and destinating to Rajahmundry	-	0.451	0.694	1.002	1.159	1.343	1.556	1.805
Upstream Traffic originating at Rajahmundry and destinating to Vijayawada	-	1.145	1.629	2.193	2.395	2.625	2.888	3.189
Total traffic movement in Million tonne	-	**1.596**	**2.323**	**3.195**	**3.554**	**3.967**	**4.444**	**4.994**
Total traffic movement in Million tonne - km	-	**222**	**323**	**444**	**494**	**551**	**618**	**694**

2.5.2 Canal Stretches

2.5.2.1 Kakinada Canal

This canal stretch is a very crucial and important link between Sea port and rivers Godavari and Krishna. On one side there is a lighterage port of Kakinada established a century ago. On the other side there is a very important trade center of Rajahmundry, an ancient town famous for its trade. Kakinada Port is handling about 2 MTPA of cargo mainly comprising of oil extractions, rice bran extractions, fertilizers, foodgrains and containerized cargo through lighterage operations. A berth has been developed by a private operator for deep drafted vessels. This cargo is expected to continue to be handled through the lighterage port. The important commodities for IWT traffic movement are : Rice and Food grains, Coal, Bulk goods, Fertilizers, Project cargo and Drilling Equipment, Wood pulp and Other Cargo. The main cargo to be transported by IWT in downstream direction from Kakinada to Rajahmundry consists of coal and fertilizer and a small quantity of Industrial salt, Rock Phosphate and drilling equipments. In the upstream direction, the main cargo to be transported by IWT from Rajahmundry to Kakinada even connecting upto Vijayawada will comprise of Rice Bran extractions, Cement clinkers and Fertilisers.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Kakinada canal from Kakinada to Rajahmundry is summarized as under.

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Kakinada and destinating to Rajahmundry	0.367	0.530	0.760	1.047	1.207	1.391	1.604	1.851
Upstream Traffic originating at Rajahmundry and destinating to Kakinada	0.070	0.264	0.409	0.598	0.706	0.835	0.989	1.175
Total traffic movement in Million tonne	**0.437**	**0.794**	**1.169**	**1.645**	**1.912**	**2.226**	**2.594**	**3.026**
Total traffic movement in Million tonne - km	**22**	**40**	**58**	**82**	**96**	**111**	**130**	**151**

traffic owing to the expansion is also taken into consideration while calculating potential traffic. A new thermal power plant is planned at Krishnapatnam near Nellore developed by APGENCO with a capacity of 1600 MW and it is expected to use a blend of imported coal and domestic coal from SCCL. It is expected to be operational by May 2010, the coal cargo meant for the power plant is also taken into consideration for the traffic potential. The coal requirement for these power plants is likely to saturate as soon as these power plants reach full capacity utilisation and hence is considered to be constant for the future years in absence of capacity expansions.

The stretch between Devipatnam and Pollavaram is dense forest. Bhadrachalam, a temple town is also famous for ITC Bhadrachalam Paper Mills. In the Godavari region from Rajahmundry to Bhadrachalam, the railway line is non-existent. The existing roadways for certain areas, in view of circuitous routes are not only inadequate but cumbersome too.

Coal in the downstream direction in Godavari river from Bhadrachalam can be very easily shifted in IWT mode of transportation as the distances through it get reduced by 70 to 100 km as compared to the road route. Rice has a traffic potential in this downstream route upto Rajahmundry. While in the upstream direction while coming back the vessels can bring forest products, wood pulp etc. and can unload it in Bhadrachalam.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Godavari river from Bhadrachalam to Rajahmundry is summarized as under.

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Bhadrachalam and destinating to Rajahmundry	-	2.557	3.639	4.869	5.229	5.633	6.086	6.595
Upstream Traffic originating at Rajahmundry and destinating to Bhadrachalam	-	0.277	0.416	0.599	0.717	0.857	1.026	1.228
Total traffic movement in Million tonne	-	**2.834**	**4.055**	**5.469**	**5.946**	**6.490**	**7.112**	**7.824**
Total traffic movement in Million tonne - km	-	**484**	**693**	**935**	**1017**	**1110**	**1216**	**1338**

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Krishna river from Wazirabad to Vijawada is summarized as under :

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Wazirabad and destinating to Vijayawada	-	0.619	0.973	1.434	1.692	1.998	2.360	2.789
Upstream Traffic originating at Vijayawada and destinating to Wazirabad	-	1.486	2.104	2.806	3.016	3.251	3.516	3.814
Total traffic movement in Million tonne	-	2.105	**3.077**	4.240	4.707	5.248	**5.876**	6.604
Total traffic movement in Million tonne - km	-	330	**483**	666	739	824	**922**	1037

2.5.1.2 Godavari River (Bhadrachalam - Rajahmundry) stretch

The coal is abundantly available commodity in this stretch owing to its proximity to SCCL mines. This is a major wealth of the region. There are existing coal fields in Kothagudam region comprising Manuguru, Kothagudem and Yellandu areas. The earlier plans of mining from Cherla coal fields, which is exactly in the project influence area, have since been postponed. The coal supplies from Manuguru to Vijayawada Super Thermal Power Station would not be possible, because KTPS (Kothagudem Thermal Power Station) is also drawing coal. But VTPS is under expansion. No other expansion plans except a thermal plant at Krishnapatnam is envisaged as revealed from the discussions with State Govt. authorities. So the growth rate of coal traffic is taken as low. Lower growth rate of coal potential especially for power plants results in reducing its share in total cargo potential over the forecast period. Coal for power plants which constitutes about 30% of total potential in 2005-06 constitutes 15% of the total potential in 2059-60.The Coal usage is seen to increase at a modest rate owing to increasing consumption by Cement plants and other industries. This is coupled with the fact that there are no plans apart from a Thermal power plant at Krishnapatnam and expansion of VTPS in Andhra Pradesh and Tamilnadu which use coal. The Vijaywada Thermal power station is planning an expansion of 500 MW as part of stage IV of its activity, this is projected to complete by May 2008 and the increase in coal

2.4 TRAFFIC PROJECTIONS

The likely traffic projections consisting of potential for various commodities of cargo in the hinterland and for the proposed waterway have been furnished in Appendix 1 to 3 under optimistic, realistic and pessimistic scenario respectively. The commodity-wise traffic movement including origin-destination by IWT under realistic scenario has been provided in Appendix 4.

2.5 TRAFFIC MOVEMENT IN DIFFERENT STRETCHES

The stretch wise cargo movement in canal and river sections of the waterway are given below :

2.5.1 River Stretches

2.5.1.1 Krishna River (Wazirabad - Vijayawada)

The existing traffic moving along this stretch comprises agricultural produce, limestone, other minerals, cement, fertilizer, building materials, iron and steel and vegetable oils etc. In this stretch, Guntur is endowed with substantial resources of limestone, which are of use in cement blast furnace, steel melting and chemical grades which are mainly consumed by M/s ACC, Andhra Cement, Parthasarathy and Gauthami Cements as well as Vishakhapatnam Steel Plant. The Krishna district is also endowed with limestones and lime Kankar. Limestone occurs in Jaggayayapet mandal in Krishna district and it contributes 6% of total production from the state of Andhra Pradesh. Cement grade limestone of Jaggayapeta mandal are being consumed by 2 major and 3 mini cement plants producing around 11 lakh tonnes of cement. Blast furnace grade limestones bearing areas near Jaggyyapeta are leased out to M/s Vishakhapatnam Steel Plant. Nalgonda district has vast deposits of limestones suitable for building and flooring purposes. The limestones in Wazirabad, Damercherla, Irkinguda, Kottapalli, Veerapaguda, Virlapalur and Mukimanikayam are of silicons, cement grade and flaggy varieties. In Wazirabad near Janapahad, Ravipahad, Mahanaligudem and in Metpally, low grade limestones occur. These deposits are consumed by 3 major and mini cement plants in the districts producing 21.45 lakh tonnes cement per annum. The various cement plants have come up around river Krishna due to availability of limestones/lime Kankar locally involving least transportation. They are producing bulk cement and are required to transport it by road through a lengthy and cumbersome route. The Inland Water Transport can definitely share the transport of a sizeable quantity of cement.

2.3.5 Forest Products

The movement of forest products, wood pulp, timber etc. is contributed by the large number of paper industries in the Krishna belt which consists of major players such as ITC and AP Paper Mills located at Bhadrachalam and large number of small paper mills in the vicinity. The growth in the forest products traffic in the hinterland under realistic scenario is estimated to increase from 0.76 Mn. T. in 2014 – 15 to 2.03 Mn. T. in 2039 – 40 in twenty five years and growing upto 4.44 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 4% p.a. for the next fifty years. The likely forest products traffic for the proposed waterway is estimated to be the 0.11 Mn. T. in 2014 – 15 and growing upto 0.61 Mn. T. in 2039 – 40 in twenty five years and further growing upto 1.33 Mn. T. in 2059 – 60 under the realistic scenario.

2.3.6 Salt

The salt traffic which is originating from Chennai Belt is linked to human consumption and hence growth in population in the region.. The growth in the Salt traffic in the hinterland under realistic scenario is estimated to increase from 0.45 Mn. T. in 2014 – 15 to 1.21 Mn. T. in 2039 – 40 in twenty five years and growing upto 2.66 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 4% p.a. for the next fifty years. The likely salt traffic for the proposed waterways is estimated to be 0.09 Mn. T. in 2014 – 15 and growing upto 0.42 Mn. T. in 2039 – 40 in twenty five years and further growing upto 0.93 Mn. T. in 2059 – 60 under the realistic scenario.

2.3.7 Other cargo

Other cargo consists of chillies, tobacco, iron scrap, rice bran extractions, industrial salt etc The Other General Cargo traffic in the hinterland under realistic scenario is estimated to increase from 1.95 Mn. T. in 2014 – 15 to 3.21 Mn. T. in 2039 – 40 in twenty five years and growing upto 4.76 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 5% p.a. for the next fifty years. The likely other cargo traffic for the proposed waterways is estimated to be the 0.19 Mn. T. in 2014 – 15 and growing upto 0.80 Mn. T. in 2039 – 40 in twenty five years and further growing upto 1.19 Mn. T. in 2059 – 60 under the realistic scenario.

S. No.	Name of Unit	Location (Distt.)	Distance from river bank	Mode of Transportation
16	Nagarjuna Cement	Sinhapuri (Nalgonda)	10	Road
17	Rassi Cements Ltd.	Vishnupuram (Nalgonda)	3	Rail/Road
18	Sagar Cements Ltd.	Mattampalli (Nalgonda)	7	Road
19	Suvarna Cements Ltd.	Medlacheruru	10	Road
20	Shri Vishnu Cements	Sitapuram	10	Rail/Road
21	Viswan Cements	Kodal	18	Road

A new cement plant at M/s Sanghi Cement is coming up near Wazirabad.

Andhra Pradesh shows presence of several Cement industries and these contribute substantially to the IWT traffic. The total potential of cement for hinterland under realistic scenario is estimated to increase from 1.69 Mn. T. in 2014 – 15 to 4.51 Mn. T. in 2039 – 40 in twenty five years and growing upto 9.89 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 4% p.a. for the next fifty years. The likely cement traffic for the proposed waterways is estimated to be growing upto 1.13 Mn. T. in 2039 – 40 in twenty five years and further growing upto 2.47 Mn. T. in 2059 – 60 under the realistic scenario.

2.3.4 Fertilisers

Fertiliser cargo is driven by major fertiliser industries present in the hinterland of IWT such as Nagarjuna Fertilisers, Godavari Fertilisers and Madras Fertilisers. The growth in the fertiliser traffic is linked to the agricultural activities in the region. The total fertiliser cargo potential for hinterland under realistic scenario is estimated to increase from 1.41 Mn. T. in 2014 – 15 to 2.95 Mn. T. in 2039 – 40 in twenty five years and growing upto 5.33 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 3% p.a. for the next fifty years. The likely fertiliser traffic for the proposed waterways is estimated to be the 0.28 Mn. T. in 2014 – 15 and growing upto 1.03 Mn. T. in 2039 – 40 in twenty five years and further growing upto 1.87 Mn. T. in 2059 – 60 under the realistic scenario.

waterways is estimated to be 0.18 Mn. T. in 2014 – 15 growing upto 0.93 Mn. T. in 2039 – 40 in twenty five years and further growing upto 1.68 Mn. T. in 2059 – 60 under the realistic scenario.

2.3.3 Cement

The following are the cement plants located in the stretch of river Krishna as given below:

S. No.	Name of Unit	Location (Distt.)	Distance from river bank	Mode of Transportation
1	Associated Cement Co.	Tadepally (Guntur)	20	Rail/Road
2	Durga Cement Works	Dachepally (Guntur)	8	Rail/Road
3	Rama Krishna (KCP) Cement Ltd.	Mancherla (Guntur)	16	Rail/Road
4	Parthasarathy Cement	Karempudi (Guntur)	25	Road
5	Hemadari Cements	Vedadri (Krishna)	12	Road
6	Andhra Cement Co.	Vijayawada (Krishna)	35	Rail
7	Madras Cement	Jaggayyapeta (Krishna)	7	Rail/Road
8	Krishnavardana Cement	Jaggayyapeta (Krishna)	10	Road
9	Vijaya Krishna Cements	Jaggayyapeta (Krishna)	12	Road
10	Amareshwari Cements	Peddaveedu (Nalgonda)	17	Road
11	Coromondal Cement	Raghunathpur (Nalgonda)	12	Road
12	Kohinoor Cement	Raghunathpur (Nalgonda)	4	Road
13	Priyadarshini Cements	Ravoor (Nalgonda)	40	Rail/Road
14	Kakatiya Cements	Srinivaspuram (Nalgonda)	25	Road
15	Deccan Cements Ltd.	Bhavanipuram (Nalgonda)	4	Rail/Road

utilisation and hence is considered to be constant for the future years in absence of capacity expansions.

The total coal cargo potential for the hinterland under realistic scenario is conservatively estimated to increase from 14.41 Mn. T. in 2014 – 15 when the waterways is assumed to start operations to 19.02 Mn. T. in 2039 – 40 in twenty five years and growing upto 24.75 Mn. T. in 2059 – 60. The total cargo potential is thus conservatively growing at a CAGR of 1% p.a. for the next fifty years. The likely coal traffic for the proposed waterways is estimated to be 1.44 Mn. T. in 2014 – 15 and growing upto 4.76 Mn. T. in 2039 – 40 in twenty five years and further growing upto 6.19 Mn. T. in 2059 – 60 under the realistic scenario.

2.3.2 Rice and Food grains

Rice is a major agricultural produce in Andhra Pradesh, It is the second largest producer of rice and is also called as the rice bowl of India, it accounts for approximately 10% of the rice production in the country. The Godavari region is the major rice producing area in AP, rice from this region is consumed by regions of Andhra Pradesh as well as it is sent to the southern markets of Tamilnadu and Kerala. Since the region of AP is deficient of other food grains such as wheat, cereals etc., these are procured from the northern parts for distribution in the region.

Rice is another commodity offering significant potential for the proposed waterway. This is owing to major rice producing districts of East and West Godavari and owing to high rice consumption in states of Andhra Pradesh and Tamilnadu.

The total rice potential for the hinterland under realistic scenario is estimated to increase from 5.16 Mn. T. in 2014 – 15 to 10.81 Mn. T. in 2039 – 40 in twenty five years and growing upto 19.52Mn. T. in 2059 – 60. The total cargo potential is thus conservatively growing at a CAGR of 3% p.a. for the next fifty years. The likely rice traffic for the proposed waterways is estimated to be 0.52 Mn. T. in 2014 – 15 and growing upto 2.70 Mn. T. in 2039 – 40 in twenty five years and further growing upto 4.88 Mn. T. in 2059 – 60 under the realistic scenario.

Similarly Food grains other than rice are brought from other states for distribution in the various districts and the total potential of Food grains for the hinterland under realistic scenario is estimated to increase from 1.77Mn. T. in 2014 – 15 to 3.71 Mn. T. in 2039 – 40 in twenty five years and growing upto 6.71 Mn. T. in 2059 – 60. The total cargo potential is thus growing at a CAGR of 3% p.a. for the next fifty years. The likely food grains traffic for the proposed

2.3.1 Coal

Coal being abundantly available in the country, is extensively used in various industrial sectors. Singareni Collieries Company Ltd. (SCCL) is the only coal company in Southern India and caters to the needs of power, cement and all other coal based Industries spread over the Southern States. **Exhibit 2.12** gives the industry wise percentage share of coal sales by SCCL.

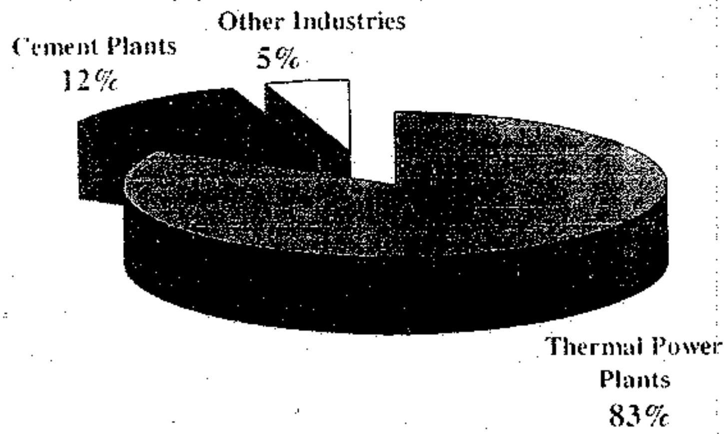


Exhibit 2.12

End Use Industry wise Sales of SCCL (2005-06)

Source: SCCL

The list of Coal users in and around Rajahmundry in Krishna & Kakinada belt along the river Godavari are as under:

Sr. No.	Name of the Industry	Location	Mode of coal transport
1.	A.P. Paper mills	Rajahmundry	Rail
2.	Hindustan Milk Food Mfg. Co.	Rajahmundry	Rail
3.	Crucible Industries	Rajahmundry	Rail
4.	Coastal Paper Mills	Kadium	Rail/Road
5.	Surya Chandra Paper Mills	Tapeswaram	Rail/Road
6.	Andhra Sugar Ltd.	Kovvur	Rail

7.	Andhra Sugar Ltd.	Tanuku	Rail
8.	West Godavari Co-op. Sugar Factory	Bhimadole	Rail
9.	Foods, Fats and Fertilizers	Tadepalligudam	Rail
10.	Foods, Fats and Fertilizers	Tanuku	Rail
11.	Sugar Factory	Changallu	Rail
12.	Khandsari Sugar Factory	Nidadavolu	Rail
13.	Nagarjuna Fertilizers	Kakinada	Rail
14.	Miscellaneous Industries Such as Tobacco, Brick & Tile kilns, cement factories, straw boards etc.		Road

Lower growth rate of coal potential especially for power plants results in reducing its share in total cargo potential over the forecast period. Coal for power plants which constitutes about 30% of total potential in 05-06 constitutes 15% of the total potential in 2055-56.The Coal usage is seen to increase at a modest rate owing to increasing consumption by Cement plants and other industries.

This is coupled with the fact that there are no plans apart from a Thermal power plant at Krishnapatnam and expansion of VTPS in Andhra Pradesh and Tamilnadu which use coal. The Vijaywada Thermal power station is planning an expansion of 500 MW as part of stage IV of its activity, this is projected to complete by May 2008 and the increase in coal traffic owing to the expansion is also taken into consideration while calculating potential traffic. A new thermal power plant is planned at Krishnapatnam near Nellore developed by APGENCO with a capacity of 1600 MW and it is expected to use a blend of imported coal and domestic coal from SCCL. It is expected to be operational by May 2010, the coal cargo meant for the power plant is also taken into consideration for the traffic potential. The coal requirement for these power plants is likely to saturate as soon as these power plants reach full capacity

TABLES

Appendix 1
000 Tonnes

Likely Traffic Under Optimistic Scenario

Sl. No.		Type of Cargo	Total Potential for 2005-06 (in 000 Tonne)	Growth Rate	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1		Coal															
	a	For KTPS	6960	-	6960	6960	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	1059	1412	1412	1412	1412
	b	For NTPS	153	-	153	153	153	153	153	153	153	153	153	153	153	153	153
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	23	31	31	31	31
	c	For Other TPS	144	2%	147	150	153	156	159	162	165	169	172	176	179	183	186
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	26	35	36	37	37
	d	For Cement	1763	2%	1798	1834	1871	1908	1946	1985	2025	2066	2107	2149	2192	2236	2281
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	316	430	438	447	456
	e	For Other Industries	4114	2%	4197	4281	4366	4453	4543	4633	4726	4821	4917	5015	5116	5218	5322
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	738	1003	1023	1044	1064
2		Rice	3957	3%	4076	4198	4324	4454	4587	4725	4867	5013	5163	5318	5477	5642	5811
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	774	1064	1095	1128	1162
3		Foodgrains	1360	3%	1401	1443	1486	1531	1577	1624	1673	1723	1774	1828	1883	1939	1997
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	266	366	377	388	399
4		Cement	1190	4%	1238	1287	1339	1392	1448	1506	1566	1629	1694	1761	1832	1905	1981
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	0	352	366	381	396
5		Fertiliser	1082	3%	1114	1148	1182	1218	1254	1292	1331	1371	1412	1454	1498	1543	1589
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	25%	30%	30%	30%	30%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	353	436	449	463	477
6		Forest Products	535	4%	556	579	602	626	651	677	704	732	761	792	824	857	891
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	20%	25%	25%	25%	25%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	152	198	206	214	223
7		Salt	320	4%	333	346	360	374	389	405	421	438	455	474	493	512	533
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	25%	30%	30%	30%	30%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	114	142	148	154	160
8		Other General Cargo	1637	2%	1670	1703	1737	1772	1807	1844	1880	1918	1956	1995	2035	2076	2118
		% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
		Likely Traffic for IWAI			0	0	0	0	0	0	0	0	293	399	407	415	424
		Total Cargo Potential in hinterland	23215		23642	24081	24633	25097	25575	26066	26571	27091	27625	28175	28741	29323	29922
		Total likely Traffic for IWAI			0	0	0	0	0	0	0	0	4115	5867	5988	6113	6241

Appendix 1
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Likely Traffic Under Optimistic Scenario

Sl. No.		Type of Cargo	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34
1		Coal															
	a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1412	1765	1765	1765	1765	1765	2118	2118	2118	2118	2118	2118	2118	2118	2118
	b	For NTPS	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	31	38	38	38	38	38	46	46	46	46	46	46	46	46	46
	c	For Other TPS	190	194	198	202	206	210	214	218	223	227	232	236	241	246	251
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	38	48	49	50	51	52	64	65	67	68	69	71	72	74	75
	d	For Cement	2326	2373	2420	2469	2518	2568	2620	2672	2726	2780	2836	2892	2950	3009	3069
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	465	593	605	617	629	642	786	802	818	834	851	868	885	903	921
	e	For Other Industries	5429	5537	5648	5761	5876	5994	6114	6236	6361	6488	6618	6750	6885	7023	7163
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1086	1384	1412	1440	1469	1498	1834	1871	1908	1946	1985	2025	2065	2107	2149
2		Rice	5985	6165	6350	6540	6737	6939	7147	7361	7582	7809	8044	8285	8534	8790	9053
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1197	1541	1587	1635	1684	1735	2144	2208	2275	2343	2413	2486	2560	2637	2716
3		Foodgrains	2057	2119	2182	2248	2315	2385	2456	2530	2606	2684	2765	2848	2933	3021	3112
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	411	530	546	562	579	596	737	759	782	805	829	854	880	906	933
4		Cement	2061	2143	2229	2318	2411	2507	2607	2712	2820	2933	3050	3172	3299	3431	3568
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	412	536	557	580	603	627	782	814	846	880	915	952	990	1029	1071
5		Fertiliser	1637	1686	1736	1788	1842	1897	1954	2013	2073	2135	2199	2265	2333	2403	2476
		% Shift to IWAI	30%	35%	35%	35%	35%	35%	40%	40%	40%	40%	40%	40%	40%	40%	40%
		Likely Traffic for IWAI	491	590	608	626	645	664	782	805	829	854	880	906	933	961	990
6		Forest Products	926	964	1002	1042	1084	1127	1172	1219	1268	1319	1371	1426	1483	1543	1604
		% Shift to IWAI	25%	30%	30%	30%	30%	30%	35%	35%	35%	35%	35%	35%	35%	35%	35%
		Likely Traffic for IWAI	232	289	301	313	325	338	410	427	444	462	480	499	519	540	562
7		Salt	554	576	599	623	648	674	701	729	758	789	820	853	887	923	960
		% Shift to IWAI	30%	35%	35%	35%	35%	35%	40%	40%	40%	40%	40%	40%	40%	40%	40%
		Likely Traffic for IWAI	166	202	210	218	227	236	280	292	303	315	328	341	355	369	384
8		Other General Cargo	2160	2203	2247	2292	2338	2385	2432	2481	2531	2581	2633	2686	2739	2794	2850
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	432	551	562	573	585	596	730	744	759	774	790	806	822	838	855
		Total Cargo Potential in hinterland	30538	31172	31825	32496	33188	33899	34631	35385	36160	36959	37781	38627	39498	40395	41319
		Total likely Traffic for IWAI	6373	8067	8240	8417	8600	8788	10713	10951	11195	11446	11705	11971	12246	12528	12819

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Likely Traffic Under Optimistic Scenario

Sl. No.	Type of Cargo	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41
1	Coal							
a	For KTPS	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	2118	2118	2118	2118	2118	2118	2118
b	For NTPS	153	153	153	153	153	153	153
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	46	46	46	46	46	46	46
c	For Other TPS	256	261	266	271	277	282	288
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	77	78	80	81	83	85	86
d	For Cement	3131	3193	3257	3322	3389	3457	3526
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	939	958	977	997	1017	1057	1058
e	For Other Industries	7306	7452	7602	7754	7909	8067	8228
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	2192	2236	2280	2326	2373	2420	2468
2	Rice	9325	9605	9893	10190	10495	10810	11134
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	2797	2881	2968	3057	3149	3243	3340
3	Foodgrains	3205	3301	3400	3502	3607	3715	3827
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	961	990	1020	1051	1082	1115	1148
4	Cement	3711	3860	4014	4175	4342	4515	4696
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	1113	1158	1204	1252	1302	1355	1409
5	Fertiliser	2550	2626	2705	2786	2870	2956	3045
	% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%
	Likely Traffic for IWAI	1020	1051	1082	1114	1148	1182	1218
6	Forest Products	1668	1735	1805	1877	1952	2030	2111
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	584	607	632	657	683	710	739
7	Salt	998	1038	1079	1123	1167	1214	1263
	% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%
	Likely Traffic for IWAI	399	415	432	449	467	486	505
8	Other General Cargo	2907	2965	3025	3085	3147	3210	3274
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	872	890	907	925	944	963	982
	Total Cargo Potential in hinterland	42270	43250	44258	45297	46367	47469	48684
	Total likely Traffic for IWAI	13119	13428	13746	14074	14411	14759	15118

Sl. No.	Type of Cargo	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
1	Coal								
a	For KTPS	7060	7063	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	2118	2118	2118	2118	2118	2118	2118	2118
b	For NTPS	153	153	153	153	153	153	153	153
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	46	46	46	46	46	46	46	46
c	For Other TPS	294	300	306	312	318	324	331	337
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	88	90	92	94	95	97	99	101
d	For Cement	3596	3668	3742	3816	3893	3971	4050	4131
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	1079	1100	1122	1145	1168	1191	1215	1239
e	For Other Industries	8393	8561	8732	8906	9085	9266	9452	9641
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	2518	2568	2620	2672	2725	2780	2835	2892
2	Rice	11468	11813	12167	12532	12908	13295	13694	14105
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	3441	3544	3650	3760	3872	3989	4108	4231
3	Foodgrains	3942	4060	4182	4307	4436	4569	4707	4848
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	1182	1218	1255	1292	1331	1371	1412	1454
4	Cement	4884	5079	5282	5493	5713	5942	6179	6427
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	1465	1524	1585	1648	1714	1783	1854	1928
5	Fertiliser	3136	3230	3327	3427	3530	3635	3744	3857
	% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%	40%
	Likely Traffic for IWAI	1254	1292	1331	1371	1412	1454	1498	1543
6	Forest Products	2196	2283	2375	2470	2569	2671	2778	2889
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	768	799	831	864	899	935	972	1011
7	Salt	1313	1366	1420	1477	1536	1598	1662	1728
	% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%	40%
	Likely Traffic for IWAI	525	546	568	591	615	639	665	691
8	Other General Cargo	3339	3406	3474	3544	3615	3687	3761	3836
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	1002	1022	1042	1063	1084	1106	1128	1151
	Total Cargo Potential in hinterland	49774	50973	52219	53498	54815	56172	57573	59011
	Total likely Traffic for IWAI	15487	15867	16259	16663	17079	17508	17953	18406

Likely Traffic Under Optimistic Scenario

Sl. No.		Type of Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
1		Coal											
	a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	2118	2118	2118	2118	2118	2118	2118	2118	2118	2118	2118
	b	For NTPS	153	153	153	153	153	153	153	153	153	153	153
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	46	46	46	46	46	46	46	46	46	46	46
	c	For Other TPS	344	351	358	365	373	380	388	395	403	411	420
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	103	105	107	110	112	114	116	119	121	123	126
	d	For Cement	4214	4298	4384	4472	4561	4652	4745	4840	4937	5036	5136
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1264	1289	1315	1341	1368	1396	1424	1452	1481	1511	1541
	e	For Other Industries	9833	10030	10231	10435	10644	10857	11074	11295	11521	11752	11987
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	2950	3009	3069	3131	3193	3257	3322	3389	3456	3526	3596
2		Rice	14528	14964	15413	15875	16351	16842	17347	17868	18404	18956	19524
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	4358	4489	4624	4763	4905	5053	5204	5360	5521	5687	5857
3		Foodgrains	4993	5143	5297	5456	5620	5788	5962	6141	6325	6515	6710
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1498	1543	1589	1637	1686	1737	1789	1842	1898	1954	2013
4		Cement	6684	6951	7229	7518	7819	8132	8457	8795	9147	9513	9893
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	2005	2085	2169	2255	2346	2440	2537	2639	2744	2854	2968
5		Fertiliser	3973	4092	4214	4341	4471	4605	4743	4886	5032	5183	5339
		% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
		Likely Traffic for IWAI	1589	1637	1686	1736	1788	1842	1897	1954	2013	2073	2135
6		Forest Products	3005	3125	3250	3380	3515	3656	3802	3954	4112	4277	4448
		% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
		Likely Traffic for IWAI	1052	1094	1138	1183	1230	1280	1331	1384	1439	1497	1557
7		Salt	1797	1869	1944	2022	2103	2187	2274	2365	2460	2558	2660
		% Shift to IWAI	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
		Likely Traffic for IWAI	719	748	778	809	841	875	910	946	984	1023	1064
8		Other General Cargo	3913	3991	4071	4152	4235	4320	4406	4494	4584	4676	4769
		% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	1174	1197	1221	1246	1271	1296	1322	1348	1375	1403	1431
		Total Cargo Potential in hinterland	60496	62026	63604	65229	66905	68632	70412	72247	74139	76089	78100
		Total likely Traffic for IWAI	18876	19360	19859	20374	20904	21451	22015	22597	23196	23815	24452

Appendix 2
000 Tonnes

Likely Traffic Under Realistic Scenario

Sl. No.	Type of Cargo	Total Potential for 2005-06 (in 000 Tonne)	Growth Rate	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1	Coal for															
a	For KTPS	6960	-	6960	6960	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	706	1059	1059	1059	1059
b	For NTPS	153	-	153	153	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	15	23	23	23	23
c	For Other TPS	144	2%	147	150	153	156	159	162	165	169	172	176	179	183	186
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	17	26	27	27	28
d	For Cement	1763	2%	1798	1834	1871	1908	1946	1985	2025	2066	2107	2149	2192	2236	2281
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	211	322	329	335	342
e	For Other Industries	4114	2%	4197	4281	4366	4453	4543	4633	4726	4821	4917	5015	5116	5218	5322
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	492	752	767	783	798
2	Rice	3957	3%	4076	4198	4324	4454	4587	4725	4867	5013	5163	5318	5477	5642	5811
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	516	798	822	846	872
3	Foodgrains	1360	3%	1401	1443	1486	1531	1577	1624	1673	1723	1774	1828	1883	1939	1997
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	177	274	282	291	300
4	Cement	1190	4%	1238	1287	1339	1392	1448	1506	1566	1629	1694	1761	1832	1905	1981
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	0	176	275	286	297
5	Fertiliser	1082	3%	1114	1148	1182	1218	1254	1292	1331	1371	1412	1454	1498	1543	1589
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	20%	25%	25%	25%	25%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	282	364	374	386	397
6	Forest Products	535	4%	556	579	602	626	651	677	704	732	761	792	824	857	891
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	114	158	165	171	178
7	Salt	320	4%	333	346	360	374	389	405	421	438	455	474	493	512	533
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	20%	25%	25%	25%	25%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	91	118	123	128	133
8	Other General Cargo	1637	2%	1670	1703	1737	1772	1807	1844	1880	1918	1956	1995	2035	2076	2118
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	196	299	305	311	318
	Total Cargo Potential in hinterland	23215		23642	24081	24633	25097	25575	26066	26571	27091	27625	28175	28741	29323	29922
	Total likely Traffic for IWAI			0	0	0	0	0	0	0	0	2818	4371	4551	4647	4745

000 Tonnes

Likely Traffic Under Realistic Scenario

Sl. No.		Type of Cargo	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34
1		Coal for															
	a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	1059	1412	1412	1412	1412	1412	1765	1765	1765	1765	1765	1765	1765	1765	1765
	b	For NTPS	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	23	31	31	31	31	31	38	38	38	38	38	38	38	38	38
	c	For Other TPS	190	194	198	202	206	210	214	218	223	227	232	236	241	246	251
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	29	39	40	40	41	42	53	55	56	57	58	59	60	61	63
	d	For Cement	2326	2373	2420	2469	2518	2568	2620	2672	2726	2780	2836	2892	2950	3009	3069
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	349	475	484	494	504	514	655	668	681	695	709	723	738	752	767
	e	For Other Industries	5429	5537	5648	5761	5876	5994	6114	6236	6361	6488	6618	6750	6885	7023	7163
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	814	1107	1130	1152	1175	1199	1528	1559	1590	1622	1654	1687	1721	1756	1791
2		Rice	5985	6165	6350	6540	6737	6939	7147	7361	7582	7809	8044	8285	8534	8790	9053
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	898	1233	1270	1308	1347	1388	1787	1840	1896	1952	2011	2071	2133	2197	2263
3		Foodgrains	2057	2119	2182	2248	2315	2385	2456	2530	2606	2684	2765	2848	2933	3021	3112
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	309	424	436	450	463	477	614	633	651	671	691	712	733	755	778
4		Cement	2061	2143	2229	2318	2411	2507	2607	2712	2820	2933	3050	3172	3299	3431	3568
		% Shift to IWAI	15%	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	309	321	446	464	482	501	521	678	705	733	763	793	825	858	892
5		Fertiliser	1637	1686	1736	1788	1842	1897	1954	2013	2073	2135	2199	2265	2333	2403	2476
		% Shift to IWAI	25%	30%	30%	30%	30%	30%	35%	35%	35%	35%	35%	35%	35%	35%	35%
		Likely Traffic for IWAI	409	506	521	537	553	569	684	704	726	747	770	793	817	841	866
6		Forest Products	926	964	1002	1042	1084	1127	1172	1219	1268	1319	1371	1426	1483	1543	1604
		% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		Likely Traffic for IWAI	185	241	251	261	271	282	352	366	380	396	411	428	445	463	481
7		Salt	554	576	599	623	648	674	701	729	758	789	820	853	887	923	960
		% Shift to IWAI	25%	30%	30%	30%	30%	30%	35%	35%	35%	35%	35%	35%	35%	35%	35%
		Likely Traffic for IWAI	139	173	180	187	194	202	245	255	265	276	287	299	311	323	336
8		Other General Cargo	2160	2203	2247	2292	2338	2385	2432	2483	2531	2581	2633	2686	2739	2794	2850
		% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
		Likely Traffic for IWAI	324	441	449	458	468	477	608	620	633	645	658	671	685	699	713
		Total Cargo Potential in hinterland	30538	31172	31825	32496	33188	33899	34631	35385	36160	36959	37781	38627	39498	40395	41319
		Total likely Traffic for IWAI	4846	6402	6649	6793	6941	7093	8852	9181	9387	9598	9816	10040	10271	10509	10753

Appendix 2
000 Tonnes

Likely Traffic Under Realistic Scenario

Sl. No.	Type of Cargo	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
1	Coal for															
a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
b	For NTPS	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
c	For Other TPS	256	261	266	271	277	282	288	294	300	306	312	318	324	331	337
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	64	65	67	68	69	71	72	73	75	76	78	79	81	83	84
d	For Cement	3131	3193	3257	3322	3389	3457	3526	3596	3668	3742	3816	3893	3971	4050	4131
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	783	798	814	831	847	864	881	899	917	935	954	973	993	1013	1033
e	For Other Industries	7306	7452	7602	7754	7909	8067	8228	8393	8561	8732	8906	9085	9266	9452	9641
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1827	1863	1900	1938	1977	2017	2057	2098	2140	2183	2227	2271	2317	2363	2410
2	Rice	9325	9605	9893	10190	10495	10810	11134	11468	11813	12167	12532	12908	13295	13694	14105
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	2331	2401	2473	2547	2624	2703	2784	2867	2953	3042	3133	3227	3324	3423	3526
3	Foodgrains	3205	3301	3400	3502	3607	3715	3827	3942	4060	4182	4307	4436	4569	4707	4848
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	801	825	850	876	902	929	957	985	1015	1045	1077	1109	1142	1177	1212
4	Cement	3711	3860	4014	4175	4342	4515	4696	4884	5079	5282	5493	5713	5942	6179	6427
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	928	965	1004	1044	1085	1129	1174	1221	1270	1321	1373	1428	1485	1545	1607
5	Fertiliser	2550	2626	2705	2786	2870	2956	3045	3136	3230	3327	3427	3530	3635	3744	3857
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	892	919	947	975	1004	1035	1066	1098	1131	1164	1199	1235	1272	1311	1350
6	Forest Products	1668	1735	1805	1877	1952	2030	2111	2196	2283	2375	2470	2569	2671	2778	2889
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	501	521	541	563	586	609	633	659	685	712	741	771	801	833	867
7	Salt	998	1038	1079	1123	1167	1214	1263	1313	1366	1420	1477	1536	1598	1662	1728
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	349	363	378	393	409	425	442	460	478	497	517	538	559	582	605
8	Other General Cargo	2907	2965	3025	3085	3147	3210	3274	3339	3406	3474	3544	3615	3687	3761	3836
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	727	741	756	771	787	802	818	835	852	869	886	904	922	940	959
	Total Cargo Potential in hinterland	42270	43250	44258	45297	46367	47469	48604	49774	50978	52219	53498	54815	56172	57570	59011
	Total likely Traffic for IWAI	11006	11266	11533	11809	12093	12386	12687	12998	13318	13648	13988	14339	14700	15072	15456

Sl. No.	Type of Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
1	Coal for											
a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
b	For NTPS	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	38	38	38	38	38	38	38	38	38	38	38
c	For Other TPS	344	351	358	365	373	380	388	395	403	411	420
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	86	88	90	91	93	95	97	99	101	103	105
d	For Cement	4214	4298	4384	4472	4561	4652	4745	4840	4937	5036	5136
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1053	1074	1096	1118	1140	1163	1186	1210	1234	1259	1284
e	For Other Industries	9833	10030	10231	10435	10644	10857	11074	11295	11521	11752	11987
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	2458	2508	2558	2609	2661	2714	2768	2824	2880	2938	2997
2	Rice	14528	14964	15413	15875	16351	16842	17347	17868	18404	18956	19524
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	3632	3741	3853	3969	4088	4210	4337	4467	4601	4739	4881
3	Foodgrains	4993	5143	5297	5456	5620	5788	5962	6141	6325	6515	6710
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1248	1286	1324	1364	1405	1447	1491	1535	1581	1629	1678
4	Cement	6684	6951	7229	7518	7819	8132	8457	8795	9147	9513	9893
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	1671	1738	1807	1880	1955	2033	2114	2199	2287	2378	2473
5	Fertiliser	3973	4092	4214	4341	4471	4605	4743	4886	5032	5183	5339
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	1390	1432	1475	1519	1565	1612	1660	1710	1761	1814	1869
6	Forest Products	3005	3125	3250	3380	3515	3656	3802	3954	4112	4277	4448
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	901	938	975	1014	1055	1097	1141	1186	1234	1283	1334
7	Salt	1797	1869	1944	2022	2103	2187	2274	2365	2460	2558	2660
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	629	654	680	708	736	765	796	828	861	895	931
8	Other General Cargo	3913	3991	4071	4152	4235	4320	4406	4494	4584	4676	4769
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	978	998	1018	1038	1059	1080	1102	1124	1146	1169	1192
	Total Cargo Potential in hinterland	60496	62026	63604	65229	66905	68632	70412	72247	74139	76089	78100
	Total likely Traffic for IWAI	15851	16259	16679	17113	17559	18026	18495	18985	19496	20010	20547

Appendix 3
000 Tonnes

Likely Traffic Under Pessimistic Scenario

Sl. No.	Type of Cargo	Total Potential for 2005-06 (in 000 Tonne)	Growth Rate	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
1	Coal for															
a	For KTPS	6960	-	5960	6960	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	353	706	706	706	706
b	For NTPS	153	-	153	153	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	8	15	15	15	15
c	For Other TPS	144	2%	147	150	153	156	159	162	165	169	172	176	179	183	186
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	9	18	18	18	19
d	For Cement	1763	2%	1798	1834	1871	1908	1946	1985	2025	2066	2107	2149	2192	2236	2281
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	105	215	219	224	228
e	For Other Industries	4114	2%	4197	4281	4366	4453	4543	4633	4726	4821	4917	5015	5116	5218	5322
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	246	502	512	522	532
2	Rice	3957	3%	4076	4198	4324	4454	4587	4725	4867	5013	5163	5318	5477	5642	5811
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	258	532	548	564	581
3	Foodgrains	1360	3%	1401	1443	1486	1531	1577	1624	1673	1723	1774	1828	1883	1939	1997
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	89	183	188	194	200
4	Cement	1190	4%	1238	1287	1339	1392	1448	1506	1566	1629	1694	1761	1832	1905	1981
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	0	88	183	191	198
5	Fertiliser	1082	3%	1114	1148	1182	1218	1254	1292	1331	1371	1412	1454	1498	1543	1589
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	20%	25%	25%	25%	25%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	282	364	374	386	397
6	Forest Products	535	4%	556	579	602	626	651	677	704	732	761	792	824	857	891
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	10%	15%	15%	15%	15%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	76	119	124	128	134
7	Salt	320	4%	333	346	360	374	389	405	421	438	455	474	493	512	533
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	15%	20%	20%	20%	20%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	68	95	99	102	107
8	Other General Cargo	1637	2%	1670	1703	1737	1772	1807	1844	1880	1918	1956	1995	2035	2076	2118
	% Shift to IWAI			0%	0%	0%	0%	0%	0%	0%	0%	5%	10%	10%	10%	10%
	Likely Traffic for IWAI			0	0	0	0	0	0	0	0	98	200	204	208	212
	Total Cargo Potential in hinterland	23215		23642	24081	24633	25097	25575	26066	26571	27091	27625	28175	28741	29323	29922
	Total likely Traffic for IWAI			0	0	0	0	0	0	0	0	1592	3035	3189	3258	3328

Likely Traffic Under Pessimistic Scenario

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Sl. No.	Type of Cargo	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34
1	Coal for															
a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	706	1059	1059	1059	1059	1059	1412	1412	1412	1412	1412	1412	1412	1412	1412
b	For NTPS	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	15	23	23	23	23	23	31	31	31	31	31	31	31	31	31
c	For Other TPS	190	194	198	202	206	210	214	218	223	227	232	236	241	246	251
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	19	29	30	30	31	31	43	44	45	45	46	47	48	49	50
d	For Cement	2326	2373	2420	2469	2518	2568	2620	2672	2726	2780	2836	2892	2950	3009	3069
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	233	356	363	370	378	385	524	534	545	556	567	578	590	602	614
e	For Other Industries	5429	5537	5648	5761	5876	5994	6114	6236	6361	6488	6618	6750	6885	7023	7163
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	543	831	847	864	881	899	1223	1247	1272	1298	1324	1350	1377	1405	1433
2	Rice	5985	6165	6350	6540	6737	6939	7147	7361	7582	7809	8044	8285	8534	8790	9053
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	599	925	952	981	1010	1041	1429	1472	1516	1562	1609	1657	1707	1758	1811
3	Foodgrains	2057	2119	2182	2248	2315	2385	2456	2530	2606	2684	2765	2848	2933	3021	3112
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	206	318	327	337	347	358	491	506	521	537	553	570	587	604	622
4	Cement	2061	2143	2229	2318	2411	2507	2607	2712	2820	2933	3050	3172	3299	3431	3568
	% Shift to IWAI	10%	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	206	214	334	348	362	376	391	542	564	587	610	634	660	686	714
5	Fertiliser	1637	1686	1736	1788	1842	1897	1954	2013	2073	2135	2199	2265	2333	2403	2476
	% Shift to IWAI	25%	30%	30%	30%	30%	30%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	409	506	521	537	553	569	684	704	726	747	770	793	817	841	866
6	Forest Products	926	964	1002	1042	1084	1127	1172	1219	1268	1319	1371	1426	1483	1543	1604
	% Shift to IWAI	15%	20%	20%	20%	20%	20%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	139	193	200	208	217	225	293	305	317	330	343	357	371	386	401
7	Salt	554	576	599	623	648	674	701	729	758	789	820	853	887	923	960
	% Shift to IWAI	20%	25%	25%	25%	25%	25%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	111	144	150	156	162	169	210	219	228	237	246	256	266	277	288
8	Other General Cargo	2160	2203	2247	2292	2338	2385	2432	2481	2531	2581	2633	2686	2739	2794	2850
	% Shift to IWAI	10%	15%	15%	15%	15%	15%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	216	330	337	344	351	358	486	496	506	516	527	537	548	559	570
	Total Cargo Potential in hinterland	30538	31172	31825	32496	33188	33899	34631	35385	36160	36959	37781	38627	39498	40395	41319
	Total likely Traffic for IWAI	3401	4927	5144	5257	5373	5493	7218	7513	7682	7857	8037	8222	8413	8609	8811

Appendix 3
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Likely Traffic Under Pessimistic Scenario

Sl. No.	Type of Cargo	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
1	Coal for															
a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412
b	For NTPS	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
c	For Other TPS	256	261	266	271	277	282	288	294	300	306	312	318	324	331	337
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	51	52	53	54	55	56	58	59	60	61	62	64	65	66	67
d	For Cement	3131	3193	3257	3322	3389	3457	3526	3596	3668	3742	3816	3893	3971	4050	4131
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	626	639	651	664	678	691	705	719	734	748	763	779	794	810	826
e	For Other Industries	7306	7452	7602	7754	7909	8067	8228	8393	8561	8732	8906	9085	9266	9452	9641
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1461	1490	1520	1551	1582	1613	1646	1679	1712	1746	1781	1817	1853	1890	1928
2	Rice	9325	9605	9893	10190	10495	10810	11134	11468	11813	12167	12532	12908	13295	13694	14105
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1865	1921	1979	2038	2099	2162	2227	2294	2363	2433	2506	2582	2659	2739	2821
3	Foodgrains	3205	3301	3400	3502	3607	3715	3827	3942	4060	4182	4307	4436	4569	4707	4848
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	641	660	680	700	721	743	765	788	812	836	861	887	914	941	970
4	Cement	3711	3860	4014	4175	4342	4515	4696	4884	5079	5282	5493	5713	5942	6179	6427
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	742	772	803	835	868	903	939	977	1016	1056	1099	1143	1188	1236	1285
5	Fertiliser	2550	2626	2705	2786	2870	2956	3045	3136	3230	3327	3427	3530	3635	3744	3857
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	892	919	947	975	1004	1035	1066	1098	1131	1164	1199	1235	1272	1311	1350
6	Forest Products	1668	1735	1805	1877	1952	2030	2111	2196	2283	2375	2470	2569	2671	2778	2889
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	417	434	451	469	488	507	528	549	571	594	617	642	668	695	722
7	Salt	998	1038	1079	1123	1167	1214	1263	1313	1366	1420	1477	1536	1598	1662	1728
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	299	311	324	337	350	364	379	394	410	426	443	461	479	499	518
8	Other General Cargo	2907	2965	3025	3085	3147	3210	3274	3339	3406	3474	3544	3615	3687	3761	3836
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	581	593	605	617	629	642	655	668	681	695	709	723	737	752	767
	Total Cargo Potential in hinterland	42270	43250	44258	45297	46367	47469	48604	49774	50978	52219	53498	54815	56172	57570	59011
	Total likely Traffic for IWAI	9020	9234	9456	9683	9918	10160	10409	10666	10931	11204	11485	11774	12073	12381	12698

Likely Traffic Under Pessimistic Scenario

Sl. No.	Type of Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
1	Coal for											
a	For KTPS	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060	7060
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412	1412
b	For NTPS	153	153	153	153	153	153	153	153	153	153	153
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	31	31	31	31	31	31	31	31	31	31	31
c	For Other TPS	344	351	358	365	373	380	388	395	403	411	420
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	69	70	72	73	75	76	78	79	81	82	84
d	For Cement	4214	4298	4384	4472	4561	4652	4745	4840	4937	5036	5136
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	843	860	877	894	912	930	949	968	987	1007	1027
e	For Other Industries	9833	10030	10231	10435	10644	10857	11074	11295	11521	11752	11987
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1967	2006	2046	2087	2129	2171	2215	2259	2304	2350	2397
2	Rice	14528	14964	15413	15875	16351	16842	17347	17868	18404	18956	19524
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	2906	2993	3083	3175	3270	3368	3469	3574	3681	3791	3905
3	Foodgrains	4993	5143	5297	5456	5620	5788	5962	6141	6325	6515	6710
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	999	1029	1059	1091	1124	1158	1192	1228	1265	1303	1342
4	Cement	6684	6951	7229	7518	7819	8132	8457	8795	9147	9513	9893
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	1337	1390	1446	1504	1564	1626	1691	1759	1829	1903	1979
5	Fertiliser	3973	4092	4214	4341	4471	4605	4743	4886	5032	5183	5339
	% Shift to IWAI	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Likely Traffic for IWAI	1390	1432	1475	1519	1565	1612	1660	1710	1761	1814	1869
6	Forest Products	3005	3125	3250	3380	3515	3656	3802	3954	4112	4277	4448
	% Shift to IWAI	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
	Likely Traffic for IWAI	751	781	813	845	879	914	951	989	1028	1069	1112
7	Salt	1797	1869	1944	2022	2103	2187	2274	2365	2460	2558	2660
	% Shift to IWAI	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
	Likely Traffic for IWAI	539	561	583	607	631	656	682	710	738	767	798
8	Other General Cargo	3913	3991	4071	4152	4235	4320	4406	4494	4584	4676	4769
	% Shift to IWAI	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Likely Traffic for IWAI	783	798	814	830	847	864	881	899	917	935	954
	Total Cargo Potential in hinterland	60496	62026	63604	65229	66905	68632	70412	72247	74139	76089	78100
	Total likely Traffic for IWAI	13025	13362	13710	14068	14438	14819	15211	15616	16034	16465	16909

Appendix 4

Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Coal	Refer Appendix 2	1441	2183	2205	2227	2250	2274	3063	3096	3129	3163
[illegible]											
Vijayawada		492	745	753	760	768	776	1046	1057	1068	1080
Kakinada		19	28	29	29	29	30	40	40	41	41
Muktiyala		374	567	572	578	584	590	795	804	812	821
Rajahmundry		39	59	59	60	60	61	82	83	84	85
Maipadu		18	28	28	28	29	29	39	39	40	40
Eluru		3	5	5	5	5	5	7	7	7	7
Durgarajupatnam		18	28	28	28	29	29	39	39	40	40
Wazirabad		461	699	706	713	720	728	960	991	1001	1012
Kottapatnam		17	25	26	26	26	26	36	36	36	37
[illegible]											
Bhadrachalam		1441	2183	2205	2227	2250	2274	3063	3096	3129	3163
[illegible]	Refer Appendix 2	694	1072	1104	1137	1171	1206	1657	1706	1758	1810
[illegible]											
Kakinada		2	4	4	4	4	4	6	6	6	6
Eluru		4	5	6	6	6	6	8	9	9	9
Vijayawada		60	92	95	98	101	104	142	147	151	156
Muktiyala		4	6	7	7	7	7	10	10	11	11
Kottapatnam		87	135	139	143	148	152	209	215	221	228
Maipadu		12	19	20	20	21	22	30	31	31	32
Rajahmundry		2	4	4	4	4	4	6	6	6	6
Durgarajupatnam		12	19	20	20	21	22	30	31	31	32
Wazirabad		55	86	88	91	94	97	133	137	141	145
Bhadrachalam		37	57	58	60	62	64	87	90	93	96
Chennai		411	635	654	674	694	715	981	1011	1041	1072
Chennai		1	1	1	1	1	1	1	2	2	2
Chennai		6	9	9	10	10	10	14	15	15	15
[illegible]											
Kakinada		48	75	77	79	82	84	115	119	123	126
Eluru		47	73	75	77	80	82	113	116	120	123
Rajahmundry		48	75	77	79	82	84	115	119	123	126
Vijayawada		61	95	98	101	104	107	146	151	155	160
Muktiyala		44	68	70	73	75	77	106	109	112	116
Kottapatnam		17	26	26	27	28	29	39	41	42	43
Maipadu		8	12	12	13	13	13	18	19	20	20
Durgarajupatnam		8	12	12	13	13	13	18	19	20	20
Wazirabad		205	316	326	336	346	356	489	504	519	534
Bhadrachalam		201	311	320	330	340	350	480	495	510	525
Vijayawada		0	0	0	1	1	1	1	1	1	1
Muktiyala		0	0	0	1	1	1	1	1	1	1
Maipadu		3	5	5	5	5	5	7	7	7	8
Durgarajupatnam		3	5	5	5	5	5	7	7	7	8

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Fertilisers	Refer Appendix 2	282	364	374	386	397	409	506	521	537	553
Loading Points											
Ennore		39	50	52	53	55	57	70	72	74	76
Kakinada		243	313	323	332	342	353	436	449	462	476
Unloading Points											
Kakinada		20	25	26	27	28	28	35	36	37	38
Eluru		45	58	60	62	64	65	81	83	86	88
Rajahmundry		20	25	26	27	28	28	35	36	37	38
Vijayawada		56	73	75	77	79	82	101	104	107	111
Muktiyala		26	33	34	35	36	37	46	47	49	50
Kottapatnam		29	38	39	40	41	43	53	54	56	57
Maipadu		6	8	8	8	8	9	11	11	11	12
Durgarajupatnam		6	8	8	8	8	9	11	11	11	12
Bhadrachalam		34	44	45	46	48	49	61	63	64	66
Wazirabad		29	38	39	40	41	43	53	54	56	57
Muthukadu		5	7	7	7	7	8	9	10	10	10
Puducherry		6	8	8	8	8	9	11	11	11	12
Salt	Refer Appendix 2	91	118	123	128	133	139	173	180	187	194
Unloading Points											
Kakinada		2	2	2	2	2	2	3	3	3	3
Eluru		2	2	2	2	2	2	3	3	3	3
Rajahmundry		2	2	2	2	2	2	3	3	3	3
Vijayawada		5	6	6	7	7	7	9	9	10	10
Muktiyala		2	2	2	2	2	2	3	3	3	3
Maipadu		2	2	2	2	2	2	3	3	3	3
Durgarajupatnam		2	2	2	2	2	2	3	3	3	3
Kottapatnam		6	8	8	9	9	10	12	12	13	13
Bhadrachalam		2	2	2	2	2	2	3	3	3	3
Wazirabad		2	2	2	2	2	2	3	3	3	3
Muthukadu		27	35	36	38	39	41	51	53	55	57
Marakanam		41	53	55	57	60	62	78	81	84	87
Loading Point											
Chennai		91	118	123	128	133	139	173	180	187	194
Forest products	Refer Appendix 2	114	158	165	171	178	185	241	251	261	271
Unloading Points											
Bhadrachalam		112	155	162	168	175	182	236	246	256	266
Marakanam		2	2	2	2	2	3	3	3	3	4

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
[redacted]											
[redacted]		64	88	92	96	99	103	134	140	145	151
[redacted]		16	22	23	24	25	26	34	35	37	38
[redacted]		34	48	50	51	54	56	72	75	78	81
[redacted]	Refer Appendix 2	0	176	275	286	297	309	321	446	464	482
Kakinada		0	98	152	159	165	171	178	247	257	267
Chennai		0	46	71	74	77	80	83	116	120	125
Vijayawada		0	22	34	36	37	39	40	56	58	60
Muktiyala		0	11	17	17	18	19	20	27	28	29
[redacted]											
[redacted]		0	106	165	172	178	186	193	268	278	290
[redacted]		0	24	37	39	40	42	43	60	63	65
[redacted]		0	47	73	76	79	82	85	118	123	128
[redacted]	Refer Appendix 2	196	299	305	311	318	324	441	449	458	468
Kakinada		28	43	43	44	45	46	63	64	65	66
Chennai		156	239	244	249	254	259	352	359	366	374
Marakanam		12	18	18	18	19	19	26	27	27	28
[redacted]											
[redacted]		26	39	40	41	42	42	58	59	60	61
[redacted]		59	90	92	94	96	98	133	136	138	141
[redacted]		49	74	76	77	79	81	109	112	114	116
[redacted]		51	78	79	81	83	84	115	117	119	122
[redacted]		12	18	18	18	19	19	26	27	27	28
[redacted]											
Unloading		70	199	256	264	273	282	324	396	409	423
[redacted]		367	501	515	530	545	561	718	739	760	782
Total		437	700	771	794	818	842	1043	1135	1169	1204
[redacted]											
Unloading		62	89	91	92	94	96	126	128	130	133
[redacted]		48	75	77	79	82	84	115	119	123	126
Total		110	164	168	172	176	130	241	247	253	259

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Bhadrachalam											
Unloading		184	258	267	277	287	297	388	402	416	431
loading		1642	2494	2525	2557	2590	2624	3544	3591	3639	3688
Total		1826	2751	2792	2834	2877	2921	3931	3992	4055	4119
[illegible]											
Unloading		0	0	0	0	0	0	0	0	0	0
loading		26	39	40	41	42	42	58	59	60	61
Total		26	39	40	41	42	42	58	59	60	61
Eluru											
Unloading		53	70	73	75	77	79	99	102	105	108
loading		47	73	75	77	80	82	113	116	120	123
Total		101	143	148	152	156	161	212	218	224	231
Vijayawada											
Unloading		613	938	963	978	992	1008	1338	1373	1394	1416
loading		110	216	246	254	261	269	341	380	392	404
Total		723	1154	1209	1231	1253	1276	1679	1753	1786	1820
[illegible]											
Unloading		38	57	58	59	60	62	82	84	86	88
loading		11	16	17	17	18	19	25	26	27	28
Total		49	73	75	77	78	80	108	110	113	115
[illegible]											
Unloading		548	824	835	846	857	869	1168	1184	1201	1218
loading		205	422	491	507	524	542	682	771	797	824
Total		752	1246	1326	1353	1382	1411	1850	1956	1998	2041
Kothapatnam											
Unloading		140	206	212	218	224	230	309	318	326	336
loading		131	192	198	204	210	216	289	297	307	316
Total		271	398	410	422	434	447	597	615	633	652
[illegible]											
Unloading		38	57	58	59	60	62	82	84	86	88
loading		11	16	17	17	18	19	25	26	27	28
Total		49	73	75	77	78	80	108	110	113	115

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
[illegible]											
Unloading		405	619	632	640	648	656	674	891	903	915
loading		45	93	108	112	115	119	150	170	175	181
Total		450	712	740	751	763	775	1023	1061	1078	1096
[illegible]											
Unloading		0	0	0	0	0	0	0	0	0	0
loading		39	50	52	53	55	57	70	72	74	76
Total		39	50	52	53	55	57	70	72	74	76
[illegible]											
Unloading		574	930	979	1007	1036	1065	1432	1501	1544	1588
loading		137	184	191	198	206	213	271	282	292	304
Total		711	1113	1170	1205	1241	1278	1704	1783	1837	1892
[illegible]											
Unloading		32	42	43	45	46	48	60	62	65	67
loading		0	0	0	0	0	0	0	0	0	0
Total		32	42	43	45	46	48	60	62	65	67
[illegible]											
Unloading		54	73	76	78	81	84	107	111	114	118
loading		0	0	0	0	0	0	0	0	0	0
Total		54	73	76	78	81	84	107	111	114	118
[illegible]											
Unloading		6	8	8	8	8	9	11	11	11	12
loading		0	0	0	0	0	0	0	0	0	0
Total		6	8	8	8	8	9	11	11	11	12

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	Reference	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Terminals		2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Kakinada		437	700	771	794	818	842	1043	1135	1169	1204
Rajahmundry		110	164	168	172	176	180	241	247	253	259
Tadepalligudem		26	39	40	41	42	42	58	59	60	61
Eluru		101	143	148	152	156	161	212	218	224	231
Kottapatnam		271	398	410	422	434	447	597	615	633	652
Maipadu		49	73	75	77	78	80	108	110	113	115
Durgarajupatnam		49	73	75	77	78	80	108	110	113	115
Ennore		750	1164	1222	1258	1296	1335	1774	1855	1911	1968
Muthukadu		32	42	43	45	46	48	60	62	65	67
Marakanam		54	73	76	78	81	84	107	111	114	118
Puducherry		6	8	8	8	8	9	11	11	11	12
Bhadrachalam		1826	2751	2792	2834	2877	2921	3931	3992	4055	4119
Wazirabad		752	1246	1326	1353	1382	1411	1850	1956	1998	2041
Muktiyala		450	712	740	751	763	775	1023	1061	1078	1096
Vijayawada		723	1154	1209	1231	1253	1276	1679	1753	1786	1820
Total Traffic in 000 Tonne		5635	8740	9102	9293	9489	9691	12802	13296	13584	13880
Total Traffic in Million Tonne		5.64	8.74	9.10	9.29	9.49	9.69	12.80	13.30	13.58	13.88

Stretches of Waterway		2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Krishna river		1202	1958	2066	2105	2145	2186	2874	3017	3076	3138
Godavari river		1826	2751	2792	2834	2877	2921	3931	3992	4055	4119
Kakinada canal		437	700	771	794	818	842	1043	1135	1169	1204
Eluru canal		959	1501	1565	1596	1627	1660	2190	2277	2323	2371
Commamur canal		1119	1708	1781	1833	1887	1942	2586	2691	2769	2851
North Buckingham canal		1119	1708	1781	1833	1887	1942	2586	2691	2769	2851
South Buckingham canal & Kaluvelly tank		92	122	127	131	136	141	178	184	191	198
Total Traffic Movement in 000 Tonne		6754	10449	10883	11126	11376	11633	15388	15986	16353	16731
Total Traffic Movement in Million Tonne		6.75	10.45	10.88	11.13	11.38	11.63	15.39	15.99	16.35	16.73

Stretches of Waterway		2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Krishna river		188748	307361	324306	330410	336690	343153	451185	473653	482987	492594
Godavari river		312295	470506	477457	484590	491910	499422	672270	682676	693354	704314
Kakinada canal		21840	35004	38561	39711	40897	42121	52127	56753	58460	60222
Eluru canal		133352	208574	217501	221779	226178	230700	304417	316480	322921	329544
Commamur canal		126406	193032	201302	207167	213215	219451	292272	304046	312948	322127
North Buckingham canal		333354	509059	530868	546334	562283	578730	770771	801822	825296	849504
South Buckingham canal & Kaluvelly tank		9209	12224	12663	13118	13590	14081	17768	18406	19068	19755
Total Traffic Movement in 000 Tonne-km		1125203	1735759	1802658	1843108	1884762	1927656	2560811	2653835	2715034	2778059
Total Traffic Movement in Million Tonne-km		1125	1736	1803	1843	1885	1928	2561	2654	2715	2778

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Coal	3197	4040	4085	4130	4177	4224	4273	4322	4373	4424	4476	4530	4584
[illegible]													
Vijayawada	1091	1379	1395	1410	1426	1442	1459	1476	1493	1510	1528	1547	1565
Kakinada	42	53	53	54	54	55	56	56	57	58	58	59	60
Muktiyala	830	1049	1060	1072	1084	1097	1109	1122	1135	1148	1162	1176	1190
Rajahmundry	86	108	109	111	112	113	115	116	117	119	120	121	123
Maipadu	41	51	52	52	53	54	54	55	56	56	57	58	58
Eluru	7	9	9	9	9	9	9	10	10	10	10	10	10
Durgarajupatnam	41	51	52	52	53	54	54	55	56	56	57	58	58
Wazirabad	1023	1293	1307	1322	1337	1352	1367	1383	1399	1416	1432	1450	1467
Kottapatnam	37	47	47	48	48	49	50	50	51	51	52	53	53
[illegible]													
Bhadrachalam	3197	4040	4085	4130	4177	4224	4273	4322	4373	4424	4476	4530	4584
Rice & Foodgrains	1865	2401	2473	2547	2623	2702	2783	2867	2953	3041	3132	3226	3323
[illegible]													
Kakinada	6	8	8	9	9	9	9	10	10	10	11	11	11
Eluru	10	12	13	13	13	14	14	15	15	16	16	16	17
Vijayawada	160	206	213	219	226	232	239	247	254	262	269	277	286
Muktiyala	11	14	15	15	16	16	17	17	18	18	19	19	20
Kottapatnam	235	302	312	321	331	340	351	361	372	383	395	407	419
Maipadu	33	43	44	46	47	48	50	51	53	54	56	58	59
Rajahmundry	6	8	8	9	9	9	9	10	10	10	11	11	11
Durgarajupatnam	33	43	44	46	47	48	50	51	53	54	56	58	59
Wazirabad	149	192	198	204	210	216	223	229	236	243	251	258	266
Bhadrachalam	98	127	131	134	139	143	147	151	156	161	165	170	175
Chennai	1104	1422	1465	1509	1554	1600	1648	1698	1749	1801	1855	1911	1968
Chennai	2	2	2	2	2	2	3	3	3	3	3	3	3
Chennai	16	20	21	22	22	23	24	24	25	26	27	27	28
[illegible]													
Kakinada	130	167	172	178	183	188	194	200	206	212	218	225	232
Eluru	127	163	168	173	178	184	189	195	201	207	213	219	226
Rajahmundry	130	167	172	178	183	188	194	200	206	212	218	225	232
Vijayawada	165	212	219	225	232	239	246	253	261	269	277	285	294
Muktiyala	119	153	158	162	167	172	178	183	188	194	200	206	212
Kottapatnam	44	57	59	61	62	64	66	68	70	72	75	77	79
Maipadu	21	27	27	28	29	30	31	32	33	34	35	36	37
Durgarajupatnam	21	27	27	28	29	30	31	32	33	34	35	36	37
Wazirabad	550	708	730	752	774	797	821	846	871	897	924	952	981
Bhadrachalam	541	696	717	739	761	784	807	831	856	882	908	936	964
Vijayawada	1	1	1	1	1	1	1	1	1	1	1	1	1
Muktiyala	1	1	1	1	1	1	1	1	1	1	1	1	1
Maipadu	8	10	11	11	11	11	12	12	13	13	13	14	14
Durgarajupatnam	8	10	11	11	11	11	12	12	13	13	13	14	14

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Commodity-wise Traffic Movement by IWT Under Realistic Scenario

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Fertilisers	569	684	704	726	747	770	793	817	841	866	892	919	947
Loading Points													
Ennore	79	95	97	100	103	106	110	113	116	120	123	127	131
Kakinada	490	589	607	625	644	663	683	704	725	747	769	792	816
Unloading Points													
Kakinada	39	47	49	50	52	53	55	57	58	60	62	64	66
Eluru	91	109	113	116	120	123	127	131	135	139	143	147	151
Rajahmundry	39	47	49	50	52	53	55	57	58	60	62	64	66
Vijayawada	114	137	141	145	149	154	159	163	168	173	178	184	189
Muktiyala	52	62	64	66	68	70	72	74	76	79	81	83	86
Kottapatnam	59	71	73	75	78	80	82	85	87	90	93	96	98
Maipadu	12	15	15	15	16	16	17	17	18	18	19	20	20
Durgarajupatnam	12	15	15	15	16	16	17	17	18	18	19	20	20
Bhadrachalam	68	82	85	87	90	92	95	98	101	104	107	110	114
Wazirabad	59	71	73	75	78	80	82	85	87	90	93	96	98
Muthukadu	11	13	13	14	14	14	15	15	16	16	17	17	18
Puducherry	12	15	15	15	16	16	17	17	18	18	19	20	20
Salt	202	245	255	265	276	287	299	311	323	336	349	363	378
Unloading Points													
Kakinada	3	4	4	5	5	5	5	5	6	6	6	6	6
Eluru	3	4	4	5	5	5	5	5	6	6	6	6	6
Rajahmundry	3	4	4	5	5	5	5	5	6	6	6	6	6
Vijayawada	10	13	13	14	14	15	15	16	17	17	18	19	20
Muktiyala	3	4	4	5	5	5	5	5	5	[illegible]	6	6	6
Maipadu	3	4	4	5	5	5	5	5	5	6	6	6	6
Durgarajupatnam	3	4	4	5	5	5	5	5	5	6	6	6	6
Kottapatnam	14	17	18	18	19	20	21	21	22	23	24	25	26
Bhadrachalam	3	4	4	5	5	5	5	5	6	6	6	6	6
Wazirabad	3	4	4	5	5	5	5	5	6	6	6	6	6
Muthukadu	59	72	75	78	81	84	88	91	95	98	102	106	111
Marakanam	91	110	114	119	124	129	134	139	145	151	157	163	169
Loading Points													
Chennai	202	245	255	265	276	287	299	311	323	336	349	363	378
Forest products	282	352	366	380	396	411	428	445	463	481	501	521	541
Unloading Points													
Bhadrachalam	277	345	359	373	388	404	420	437	454	472	491	511	531
Marakanam	4	5	5	5	5	5	5	6	6	6	6	7	7

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Loading Points													
Kottapatnam	157	196	204	212	221	230	239	248	258	269	279	291	302
Kakinada	40	50	52	54	56	58	60	63	65	68	71	73	76
Chennai	85	106	110	114	119	124	129	134	139	145	150	156	163
cement	501	521	678	705	733	763	793	825	858	892	928	965	1004
Unloading Points													
Kakinada	278	289	376	391	407	423	440	458	476	495	515	535	557
Chennai	130	135	176	183	190	198	206	214	223	232	241	250	260
Vijayawada	63	65	85	88	91	95	99	103	107	111	116	120	125
Muktiyala	31	32	41	43	45	47	48	50	52	54	57	59	61
Loading Points													
Wazirabad	301	313	407	423	440	458	476	495	515	536	557	579	603
Muktiyala	68	70	91	95	99	103	107	111	116	120	125	130	135
Vijayawada	133	138	179	187	194	202	210	218	227	236	245	255	266
Other General Cargo	477	608	620	633	645	658	671	685	699	713	727	741	756
Unloading Points													
Kakinada	68	86	88	90	92	93	95	97	99	101	103	105	107
Chennai	381	486	495	505	516	526	536	547	558	569	581	592	604
Marakanam	28	36	37	37	38	39	40	41	41	42	43	44	45
Loading Points													
Tadepaligudam	62	79	81	83	84	86	88	90	91	93	95	97	99
Kakinada	144	183	187	191	195	199	203	207	211	215	219	224	228
Vijayawada	119	151	154	157	160	164	167	170	174	177	181	184	188
Kottapatnam	124	158	161	165	168	171	175	178	182	185	189	193	197
Chennai	28	36	37	37	38	39	40	41	41	42	43	44	45
Kakinada													
Unloading	437	488	579	598	618	639	660	683	706	730	755	780	807
loading	804	990	1018	1047	1077	1108	1140	1173	1207	1241	1277	1314	1352
Total	1241	1478	1597	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159
Rajahmundry													
Unloading	135	168	171	174	177	181	184	188	191	195	198	202	206
loading	130	167	172	178	183	188	194	200	206	212	218	225	232
Total	265	335	343	352	360	369	378	387	397	407	417	427	438

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Bhadrachalam													
Unloading	447	558	579	599	621	644	667	691	717	743	770	798	827
loading	3738	4736	4802	4869	4938	5008	5080	5154	5229	5306	5385	5466	5548
Total	4185	5295	5380	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375
Tadepaligudam													
Unloading	0	0	0	0	0	0	0	0	0	0	0	0	0
loading	62	79	81	83	84	86	88	90	91	93	95	97	99
Total	62	79	81	83	84	86	88	90	91	93	95	97	99
Eluru													
Unloading	111	135	139	143	147	151	156	160	165	170	175	180	185
loading	127	163	168	173	178	184	189	195	201	207	213	219	226
Total	238	298	307	316	325	335	345	355	366	376	388	399	411
Vijayawada													
Unloading	1439	1800	1846	1876	1907	1939	1971	2004	2039	2074	2110	2147	2185
loading	416	501	552	569	586	604	623	642	662	682	703	725	747
Total	1855	2302	2398	2445	2493	2543	2594	2646	2700	2756	2813	2872	2932
Maipadu													
Unloading	90	113	116	118	121	123	126	129	132	135	138	141	144
loading	29	37	38	39	40	41	43	44	45	47	48	50	51
Total	118	150	153	157	161	165	169	173	177	182	186	191	195
Wazirabad													
Unloading	1235	1560	1583	1606	1629	1653	1678	1703	1729	1755	1782	1810	1838
loading	851	1022	1137	1175	1214	1255	1298	1341	1386	1433	1482	1532	1583
Total	2086	2582	2719	2781	2843	2908	2975	3044	3115	3188	3263	3341	3421
Kottapatnam													
Unloading	345	437	450	463	476	489	503	518	533	548	564	580	596
loading	326	412	425	438	451	465	480	495	510	527	543	560	578
Total	671	849	874	900	927	955	983	1013	1043	1074	1107	1140	1175
Durgarajupatnam													
Unloading	90	113	116	118	121	123	126	129	132	135	138	141	144
loading	29	37	38	39	40	41	43	44	45	47	48	50	51
Total	118	150	153	157	161	165	169	173	177	182	186	191	195

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Muktiyala													
Unloading	927	1161	1185	1201	1217	1234	1251	1269	1287	1306	1324	1344	1364
loading	187	225	250	259	267	276	286	295	305	316	326	337	349
Total	1114	1386	1435	1460	1485	1511	1537	1564	1592	1621	1651	1681	1713
Ennore													
Unloading	0	0	0	0	0	0	0	0	0	0	0	0	0
loading	79	95	97	100	103	106	110	113	116	120	123	127	131
Total	79	95	97	100	103	106	110	113	116	120	123	127	131
Chennai													
Unloading	1633	2066	2159	2221	2284	2350	2417	2486	2557	2631	2706	2784	2864
loading	315	387	402	417	433	450	467	485	503	523	543	564	585
Total	1948	2453	2561	2638	2717	2799	2884	2971	3061	3153	3249	3348	3449
Muthukadu													
Unloading	70	85	88	91	95	99	102	106	110	115	119	124	128
loading	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	70	85	88	91	95	99	102	106	110	115	119	124	128
Marakanam													
Unloading	123	151	156	161	167	173	179	185	192	199	206	213	221
loading	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	123	151	156	161	167	173	179	185	192	199	206	213	221
Puducherry													
Unloading	12	15	15	15	16	16	17	17	18	18	19	20	20
loading	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	12	15	15	15	16	16	17	17	18	18	19	20	20

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Terminals	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Kakinada	1241	1478	1597	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159
Rajahmundry	265	335	343	352	360	369	378	387	397	407	417	427	438
Tadepalligudem	62	79	81	83	84	86	88	90	91	93	95	97	99
Eluru	238	298	307	316	325	335	345	355	366	376	388	399	411
Kottapatnam	671	849	874	900	927	955	983	1013	1043	1074	1107	1140	1175
Maipadu	118	150	153	157	161	165	169	173	177	182	186	191	195
Durgarajupatnam	118	150	153	157	161	165	169	173	177	182	186	191	195
Ennore	2027	2547	2659	2738	2821	2906	2993	3084	3177	3273	3372	3475	3580
Muthukadu	70	85	88	91	95	99	102	106	110	115	119	124	128
Marakanam	123	151	156	161	167	173	179	185	192	199	206	213	221
Puducherry	12	15	15	15	16	16	17	17	18	18	19	20	20
Bhadrachalam	4185	5295	5380	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375
Wazirabad	2086	2582	2719	2781	2843	2908	2975	3044	3115	3188	3263	3341	3421
Muktiyala	1114	1386	1435	1460	1485	1511	1537	1564	1592	1621	1651	1681	1713
Vijayawada	1855	2302	2398	2445	2493	2543	2594	2646	2700	2756	2813	2872	2932
Total Traffic in 000 Tonne	14185	17701	18360	18771	19193	19629	20077	20539	21014	21504	22008	22528	23063
Total Traffic in Million Tonne	14.18	17.70	18.36	18.77	19.19	19.63	20.08	20.54	21.01	21.50	22.01	22.53	23.06

Stretches of Waterway	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Krishna river	3201	3968	4155	4240	4328	4419	4512	4608	4707	4809	4914	5022	5134
Godavari river	4185	5295	5380	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375
Kakinada canal	1241	1478	1597	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159
Eluru canal	2420	3015	3129	3195	3263	3333	3404	3478	3554	3632	3712	3795	3880
Commamur canal	2934	3696	3840	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146
North Buckingham canal	2934	3696	3840	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146
South Buckingham canal & Kalu	205	250	259	268	278	288	298	309	320	332	344	357	370
Total Traffic Movement in 000	17119	21397	22200	22724	23263	23819	24391	24981	25588	26214	26859	27524	28209
Total Traffic Movement in Mill	17.12	21.40	22.20	22.72	23.26	23.82	24.39	24.98	25.59	26.21	26.86	27.52	28.21

Stretches of Waterway	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Krishna river	502481	622935	652283	665714	679541	693776	708433	723523	739062	755063	771541	788511	805988
Godavari river	715562	905371	920054	935125	950594	966475	982777	999513	1016697	1034339	1052455	1071057	1090160
Kakinada canal	62040	73887	79851	82275	84777	87360	90027	92780	95623	98558	101589	104719	107950
Eluru canal	336354	419017	434978	444138	453559	463248	473213	483464	494008	504855	516013	527493	539304
Commamur canal	331594	417694	433913	446696	459881	473480	487506	501973	516896	532290	548170	564553	581453
North Buckingham canal	874470	1101529	1144300	1178014	1212784	1248646	1285635	1323788	1363143	1403739	1445618	1488820	1533390
South Buckingham canal & Kalu	20468	24982	25882	26815	27784	28789	29832	30914	32037	33202	34411	35666	36968
Total Traffic Movement in 000	2842969	3565413	3691260	3778777	3868920	3961774	4057423	4155956	4257466	4362048	4469798	4580818	4695214
Total Traffic Movement in Mill	2843	3565	3691	3779	3869	3962	4057	4156	4257	4362	4470	4581	4695

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Coal	4640	4697	4755	4814	4874	4935	4998	5062	5127	5194	5261	5331
Unloading Points	•											
Vijayawada	1584	1603	1623	1643	1664	1685	1706	1728	1750	1773	1796	1820
Kakinada	60	61	62	63	63	64	65	66	67	68	68	69
Muktiyala	1205	1219	1234	1250	1265	1281	1297	1314	1331	1348	1366	1384
Rajahmundry	124	126	127	129	131	132	134	136	137	139	141	143
Maipadu	59	60	60	61	62	63	63	64	65	66	67	68
Eluru	10	10	10	11	11	11	11	11	11	11	12	12
Durgarajupatnam	59	60	60	61	62	63	63	64	65	66	67	68
Wazirabad	1485	1503	1522	1540	1560	1579	1599	1620	1641	1662	1684	1706
Kottapatnam	54	54	55	56	57	57	58	59	59	60	61	62
Loading Point												
Bhadrachalam	4640	4697	4755	4814	4874	4935	4998	5062	5127	5194	5261	5331
Rice & Foodgrains	3423	3526	3631	3740	3853	3968	4087	4210	4336	4466	4600	4738
Unloading Points												
Kakinada	12	12	12	13	13	13	14	14	15	15	16	16
Eluru	17	18	19	19	20	20	21	21	22	23	23	24
Vijayawada	294	303	312	322	331	341	351	362	373	384	396	407
Muktiyala	21	21	22	22	23	24	25	25	26	27	28	28
Kottapatnam	431	444	458	471	485	500	515	530	546	563	580	597
Maipadu	61	63	65	67	69	71	73	75	78	80	82	85
Rajahmundry	12	12	12	13	13	13	14	14	15	15	16	16
Durgarajupatnam	61	63	65	67	69	71	73	75	78	80	82	85
Wazirabad	274	282	291	299	308	317	327	337	347	357	368	379
Bhadrachalam	181	186	192	197	203	210	216	222	229	236	243	250
Chennai	2027	2088	2151	2215	2282	2350	2421	2493	2568	2645	2725	2806
Chennai	3	3	3	3	3	4	4	4	4	4	4	4
Chennai	29	30	31	32	33	34	35	36	37	38	39	40
Loading Points												
Kakinada	239	246	253	261	269	277	285	293	302	311	321	330
Eluru	233	240	247	254	262	270	278	286	295	304	313	322
Rajahmundry	239	246	253	261	269	277	285	293	302	311	321	330
Vijayawada	303	312	321	331	341	351	361	372	383	395	407	419
Muktiyala	218	225	232	239	246	253	261	269	277	285	293	302
Kottapatnam	81	84	86	89	92	94	97	100	103	106	109	113
Maipadu	38	39	40	42	43	44	45	47	48	50	51	53
Durgarajupatnam	38	39	40	42	43	44	45	47	48	50	51	53
Wazirabad	1010	1040	1072	1104	1137	1171	1206	1242	1280	1318	1357	1398
Bhadrachalam	993	1022	1053	1085	1117	1151	1185	1221	1257	1295	1334	1374
Vijayawada	2	2	2	2	2	2	2	2	2	2	2	2
Muktiyala	2	2	2	2	2	2	2	2	2	2	2	2
Maipadu	15	15	15	16	16	17	17	18	18	19	20	20
Durgarajupatnam	15	15	15	16	16	17	17	18	18	19	20	20

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Fertilisers	975	1004	1035	1066	1098	1131	1164	1199	1235	1272	1311	1350
Loading Points												
Ennore	135	139	143	147	152	156	161	166	171	176	181	187
Kakinada	840	866	891	918	946	974	1003	1033	1064	1096	1129	1163
Unloading Points												
Kakinada	68	70	72	74	76	78	81	83	86	88	91	94
Eluru	156	161	166	170	176	181	186	192	198	204	210	216
Rajahmundry	68	70	72	74	76	78	81	83	86	88	91	94
Vijayawada	195	201	207	213	220	226	233	240	247	254	262	270
Muktiyala	88	91	94	97	100	103	106	109	112	115	119	122
Kottapatnam	101	104	108	111	114	118	121	125	128	132	136	140
Maipadu	21	21	22	23	23	24	25	26	26	27	28	29
Durgarajupatnam	21	21	22	23	23	24	25	26	26	27	28	29
Bhadrachalam	117	121	124	128	132	136	140	144	148	153	157	162
Wazirabad	101	104	108	111	114	118	121	125	128	132	136	140
Muthukadu	18	19	19	20	21	21	22	22	23	24	25	25
Puducherry	21	21	22	23	23	24	25	26	26	27	28	29
Salt	393	409	425	442	460	478	497	517	538	559	582	605
Unloading Points												
Kakinada	7	7	7	8	8	8	9	9	9	10	10	10
Eluru	7	7	7	8	8	8	9	9	9	10	10	10
Rajahmundry	7	7	7	8	8	8	9	9	9	10	10	10
Vijayawada	20	21	22	23	24	25	26	27	28	29	30	31
Muktiyala	7	7	7	8	8	8	9	9	9	10	10	10
Maipadu	7	7	7	8	8	8	9	9	9	10	10	10
Durgarajupatnam	7	7	7	8	8	8	9	9	9	10	10	10
Kottapatnam	27	28	29	30	32	33	34	36	37	39	40	42
Bhadrachalam	7	7	7	8	8	8	9	9	9	10	10	10
Wazirabad	7	7	7	8	8	8	9	9	9	10	10	10
Muthukadu	115	120	125	130	135	140	146	152	158	164	170	177
Marakanam	176	183	191	198	206	214	223	232	241	251	261	271
Loading Point												
Chennai	393	409	425	442	460	478	497	517	538	559	582	605
Forest products	563	586	609	633	659	685	712	741	771	801	833	867
Unloading Points												
Bhadrachalam	553	575	598	622	647	672	699	727	756	787	818	851
Marakanam	7	8	8	8	8	9	9	10	10	10	11	11

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Loading Points												
Kottapatnam	314	327	340	354	368	382	398	414	430	447	465	484
Kakinada	79	83	86	89	93	97	101	105	109	113	118	122
Chennai	169	176	183	190	198	206	214	223	232	241	251	261
cement	1044	1085	1129	1174	1221	1270	1321	1373	1428	1485	1545	1607
Unloading Points												
Kakinada	579	602	626	651	677	704	733	762	792	824	857	891
Chennai	271	282	293	305	317	330	343	356	371	385	401	417
Vijayawada	130	135	141	146	152	158	165	171	178	185	193	200
Muktiyala	64	66	69	72	74	77	81	84	87	91	94	98
Loading Points												
Wazirabad	627	652	678	705	733	762	793	825	858	892	928	965
Muktiyala	141	146	152	158	165	171	178	185	193	200	208	217
Vijayawada	276	287	299	311	323	336	349	363	378	393	409	425
Other General Cargo	771	787	802	818	835	852	869	886	904	922	940	959
Unloading Points												
Kakinada	110	112	114	116	119	121	123	126	128	131	134	136
Chennai	616	628	641	654	667	680	694	708	722	736	751	766
Marakanam	46	47	48	48	49	50	51	52	53	55	56	57
Loading Points												
Tadepaligudam	101	103	105	107	109	111	114	116	118	120	123	125
Kakinada	233	237	242	247	252	257	262	267	273	278	284	289
Vijayawada	192	195	199	203	207	212	216	220	225	229	234	238
Kottapatnam	201	205	209	213	217	222	226	231	235	240	245	250
Chennai	46	47	48	48	49	50	51	52	53	55	56	57
Kakinada												
Unloading	835	863	893	924	956	989	1024	1060	1097	1135	1175	1217
loading	1391	1431	1473	1515	1559	1604	1651	1699	1748	1799	1851	1905
Total	2226	2295	2366	2439	2515	2594	2675	2758	2845	2934	3026	3122
Rajahmundry												
Unloading	210	214	219	223	228	232	237	242	247	252	257	263
loading	239	246	253	261	269	277	285	293	535	549	563	578
Total	449	460	472	484	496	509	522	535	549	563	578	593

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Bhadrachalam												
Unloading	857	889	921	955	990	1026	1063	1102	1143	1185	1228	1273
loading	5633	5719	5808	5898	5991	6086	6183	6283	6385	6489	6595	6705
Total	6490	6608	6729	6853	6981	7112	7247	7385	7527	7673	7824	7978
Tadepalligudam												
Unloading	0	0	0	0	0	0	0	0	0	0	0	0
loading	101	103	105	107	109	111	114	116	118	120	123	125
Total	101	103	105	107	109	111	114	116	118	120	123	125
Eluru												
Unloading	190	196	202	208	214	220	227	233	240	247	255	262
loading	233	240	247	254	262	270	278	286	295	304	313	322
Total	423	436	449	462	476	490	505	520	535	551	568	584
Vijayawada												
Unloading	2224	2264	2305	2347	2391	2435	2481	2528	2576	2626	2677	2729
loading	770	794	819	845	871	898	927	956	986	1017	1049	1082
Total	2994	3058	3124	3192	3262	3334	3408	3484	3562	3643	3726	3811
Malpadu												
Unloading	148	151	155	158	162	166	170	174	178	183	187	192
loading	53	54	56	57	59	61	63	65	67	69	71	73
Total	200	205	210	216	221	227	233	239	245	251	258	264
Wazirabad												
Unloading	1867	1897	1927	1958	1990	2023	2056	2090	2125	2161	2198	2236
loading	1637	1692	1749	1809	1870	1933	1999	2067	2137	2210	2285	2363
Total	3504	3589	3676	3767	3860	3956	4055	4157	4263	4371	4483	4599
Kottapatnam												
Unloading	614	631	650	668	688	708	728	750	771	794	817	841
loading	597	616	635	656	677	699	721	744	769	794	820	846
Total	1210	1247	1285	1324	1365	1406	1449	1494	1540	1588	1637	1687
Durgarajupatnam												
Unloading	148	151	155	158	162	166	170	174	178	183	187	192
loading	53	54	56	57	59	61	63	65	67	69	71	73
Total	200	205	210	216	221	227	233	239	245	251	258	264

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Muktiyala												
Unloading	1384	1405	1426	1448	1470	1493	1517	1541	1565	1591	1617	1643
loading	361	373	386	399	412	426	441	456	471	487	504	521
Total	1745	1778	1812	1847	1883	1919	1957	1997	2037	2078	2121	2164
Ennore												
Unloading	0	0	0	0	0	0	0	0	0	0	0	0
loading	135	139	143	147	152	156	161	166	171	176	181	187
Total	135	139	143	147	152	156	161	166	171	176	181	187
Chennai												
Unloading	2946	3031	3119	3209	3302	3397	3496	3597	3701	3809	3920	4034
loading	608	631	656	681	707	734	763	792	823	855	888	922
Total	3554	3663	3774	3890	4009	4132	4258	4389	4524	4664	4808	4956
Muthukadu												
Unloading	133	139	144	149	155	161	167	174	181	188	195	203
loading	0	0	0	0	0	0	0	0	0	0	0	0
Total	133	139	144	149	155	161	167	174	181	188	195	203
Marakanam												
Unloading	229	237	246	255	264	274	283	294	304	316	327	339
loading	0	0	0	0	0	0	0	0	0	0	0	0
Total	229	237	246	255	264	274	283	294	304	316	327	339
Puducherry												
Unloading	21	21	22	23	23	24	25	26	26	27	28	29
loading	0	0	0	0	0	0	0	0	0	0	0	0
Total	21	21	22	23	23	24	25	26	26	27	28	29

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Terminals	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Kakinada	2226	2295	2366	2439	2515	2594	2675	2758	2845	2934	3026	3122
Rajahmundry	449	460	472	484	496	509	522	535	549	563	578	593
Tadepalligudem	101	103	105	107	109	111	114	116	118	120	123	125
Eluru	423	436	449	462	476	490	505	520	535	551	568	584
Kottapatnam	1210	1247	1285	1324	1365	1406	1449	1494	1540	1588	1637	1687
Maipadu	200	205	210	216	221	227	233	239	245	251	258	264
Durgarajupatnam	200	205	210	216	221	227	233	239	245	251	258	264
Ennore	3689	3802	3918	4037	4161	4288	4419	4555	4695	4840	4989	5143
Muthukadu	133	139	144	149	155	161	167	174	181	188	195	203
Marakanam	229	237	246	255	264	274	283	294	304	316	327	339
Puducherry	21	21	22	23	23	24	25	26	26	27	28	29
Bhadrachalam	6490	6608	6729	6853	6981	7112	7247	7385	7527	7673	7824	7978
Wazirabad	3504	3589	3676	3767	3860	3956	4055	4157	4263	4371	4483	4599
Muktiyala	1745	1778	1812	1847	1883	1919	1957	1997	2037	2078	2121	2164
Vijayawada	2994	3058	3124	3192	3262	3334	3408	3484	3562	3643	3726	3811
Total Traffic in 000 Tonne	23614	24182	24768	25371	25992	26632	27292	27972	28672	29394	30139	30906
Total Traffic in Million Tonne	23.61	24.18	24.77	25.37	25.99	26.63	27.29	27.97	28.67	29.39	30.14	30.91

Stretches of Waterway	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Krishna river	5248	5366	5488	5613	5743	5876	6013	6154	6299	6449	6604	6763
Godavari river	6490	6608	6729	6853	6981	7112	7247	7385	7527	7673	7824	7978
Kakinada canal	2226	2295	2366	2439	2515	2594	2675	2758	2845	2934	3026	3122
Eluru canal	3967	4057	4150	4245	4343	4444	4548	4655	4765	4878	4994	5114
Commamur canal	5300	5459	5623	5793	5968	6148	6334	6527	6725	6930	7141	7359
North Buckingham canal	5300	5459	5623	5793	5968	6148	6334	6527	6725	6930	7141	7359
South Buckingham canal & Kalu	383	397	412	427	443	459	476	493	511	530	550	570
Total Traffic Movement in 000	28914	29642	30391	31164	31960	32780	33626	34498	35397	36324	37280	38265
Total Traffic Movement in Mill	28.91	29.64	30.39	31.16	31.96	32.78	33.63	34.50	35.40	36.32	37.28	38.26

Stretches of Waterway	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	2046-47	2047-48	2048-49
Krishna river	823990	842531	861631	881305	901574	922456	943970	966137	988979	1012516	1036771	1061767
Godavari river	1109778	1129927	1150621	1171876	1193710	1216139	1239181	1262853	1287174	1312164	1337843	1364230
Kakinada canal	111288	114734	118293	121970	125766	129688	133739	137923	142246	146711	151324	156090
Eluru canal	551455	563958	576824	590062	603686	617706	632135	646985	662270	678002	694196	710867
Commamur canal	598890	616879	635441	654592	674354	694745	715788	737502	759912	783039	806909	831544
North Buckingham canal	1579373	1626815	1675764	1726270	1778384	1832160	1887652	1944918	2004016	2065007	2127954	2192922
South Buckingham canal & Kalu	38319	39722	41177	42688	44256	45883	47573	49326	51146	53036	54997	57033
Total Traffic Movement in 000	4813093	4934566	5059750	5188763	5321730	5458777	5600037	5745645	5895742	6050475	6209993	6374453
Total Traffic Movement in Mill	4813	4935	5060	5189	5322	5459	5600	5746	5896	6050	6210	6374

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Coal	5401	5473	5546	5621	5698	5776	5855	5936	6019	6103	6189
Unloading Points											
Vijayawada	1844	1868	1894	1919	1945	1972	1999	2027	2055	2084	2113
Kakinada	70	71	72	73	74	75	76	77	78	79	80
Muktiyala	1402	1421	1440	1459	1479	1499	1520	1541	1562	1584	1607
Rajahmundry	145	147	149	151	153	155	157	159	161	164	166
Maipadu	69	70	70	71	72	73	74	75	76	78	79
Eluru	12	12	12	12	13	13	13	13	13	13	14
Durgarajupatnam	69	70	70	71	72	73	74	75	76	78	79
Wazirabad	1728	1751	1775	1799	1823	1848	1874	1900	1926	1953	1980
Kottapatnam	63	63	64	65	66	67	68	69	70	71	72
Loading Point											
Bhadrachalam	5401	5473	5546	5621	5698	5776	5855	5936	6019	6103	6189
Rice & Foodgrains	4880	5027	5177	5333	5493	5658	5827	6002	6182	6368	6559
Unloading Points											
Kakinada	17	17	18	18	19	19	20	20	21	22	22
Eluru	25	26	26	27	28	29	30	31	32	32	33
Vijayawada	420	432	445	459	472	487	501	516	532	548	564
Muktiyala	29	30	31	32	33	34	35	36	37	38	39
Kottapatnam	615	633	652	672	692	713	734	756	779	802	826
Maipadu	87	90	93	95	98	101	104	107	111	114	117
Rajahmundry	17	17	18	18	19	19	20	20	21	22	22
Durgarajupatnam	87	90	93	95	98	101	104	107	111	114	117
Wazirabad	390	402	414	427	439	453	466	480	495	509	525
Bhadrachalam	258	265	273	282	290	299	308	317	326	336	346
Chennai	2891	2977	3067	3159	3253	3351	3452	3555	3662	3772	3885
Chennai	4	5	5	5	5	5	5	5	6	6	6
Chennai	41	43	44	45	47	48	50	51	53	54	56
Loading Points											
Kakinada	340	350	361	372	383	394	406	418	431	444	457
Eluru	332	342	352	363	374	385	396	408	420	433	446
Rajahmundry	340	350	361	372	383	394	406	418	431	444	457
Vijayawada	431	444	458	471	486	500	515	531	547	563	580
Muktiyala	311	321	330	340	350	361	372	383	394	406	418
Kottapatnam	116	120	123	127	131	135	139	143	147	152	156
Malpadu	54	56	57	59	61	63	65	67	69	71	73
Durgarajupatnam	54	56	57	59	61	63	65	67	69	71	73
Wazirabad	1440	1483	1528	1574	1621	1670	1720	1771	1824	1879	1935
Bhadrachalam	1415	1458	1501	1547	1593	1641	1690	1741	1793	1847	1902
Vijayawada	2	2	2	2	2	3	3	3	3	3	3
Muktiyala	2	2	2	2	2	3	3	3	3	3	3
Maipadu	21	21	22	23	23	24	25	26	26	27	28
Durgarajupatnam	21	21	22	23	23	24	25	26	26	27	28

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Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Fertilisers	1390	1432	1475	1519	1565	1612	1660	1710	1761	1814	1869
Loading Point											
Ennore	192	198	204	210	216	223	230	236	244	251	258
Kakinada	1198	1234	1271	1309	1348	1389	1431	1473	1518	1563	1610
Unloading Points											
Kakinada	96	99	102	105	108	112	115	119	122	126	129
Eluru	222	229	236	243	250	258	266	274	282	290	299
Rajahmundry	96	99	102	105	108	112	115	119	122	126	129
Vijayawada	278	286	295	304	313	322	332	342	352	363	374
Muktiyala	126	130	134	138	142	146	151	155	160	165	169
Kottapatnam	145	149	153	158	163	168	173	178	183	189	194
Maipadu	30	31	31	32	33	34	35	36	38	39	40
Durgarajupatnam	30	31	31	32	33	34	35	36	38	39	40
Bhadrachalam	167	172	177	182	188	193	199	205	211	218	224
Wazirabad	145	149	153	158	163	168	173	178	183	189	194
Muthukadu	26	27	28	28	29	30	31	32	33	34	35
Puducherry	30	31	31	32	33	34	35	36	38	39	40
Salt	629	654	680	708	736	765	796	828	861	895	931
Unloading Points											
Kakinada	11	11	12	12	13	13	14	14	15	15	16
Eluru	11	11	12	12	13	13	14	14	15	15	16
Rajahmundry	11	11	12	12	13	13	14	14	15	15	16
Vijayawada	33	34	35	37	38	40	41	43	45	46	48
Muktiyala	11	11	12	12	13	13	14	14	15	15	16
Maipadu	11	11	12	12	13	13	14	14	15	15	16
Durgarajupatnam	11	11	12	12	13	13	14	14	15	15	16
Kottapatnam	43	45	47	49	51	53	55	57	59	62	64
Bhadrachalam	11	11	12	12	13	13	14	14	15	15	16
Wazirabad	11	11	12	12	13	13	14	14	15	15	16
Muthukadu	184	192	199	207	216	224	233	243	252	262	273
Marakanam	262	293	305	317	330	343	357	371	386	401	417
Loading Point											
Chennai	629	654	680	708	736	765	796	828	861	895	931
Forest products	901	938	975	1014	1055	1097	1141	1186	1234	1283	1334
Unloading Points											
Bhadrachalam	885	920	957	995	1035	1077	1120	1164	1211	1259	1310
Marakanam	12	12	13	13	14	14	15	15	16	16	17

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Loading Point											
Kottapatnam	503	523	544	566	589	612	637	662	689	716	745
Kakinada	127	132	138	143	149	155	161	167	174	181	188
Chennai	271	282	293	305	317	330	343	357	371	386	401
cement	1671	1738	1807	1880	1955	2033	2114	2199	2287	2378	2473
Unloading Points											
Kakinada	927	964	1002	1043	1084	1128	1173	1220	1268	1319	1372
Chennai	434	451	469	488	507	528	549	571	593	617	642
Vijayawada	208	217	225	234	244	254	264	274	285	297	308
Muktiyala	102	106	110	115	119	124	129	134	139	145	151
Loading Point											
Wazirabad	1003	1044	1085	1129	1174	1221	1270	1320	1373	1428	1485
Muktiyala	225	234	244	254	264	274	285	297	308	321	334
Vijayawada	442	460	478	497	517	538	559	582	605	629	654
Other General Cargo	978	998	1018	1038	1059	1080	1102	1124	1146	1169	1192
Unloading Point											
Kakinada	139	142	145	147	150	153	156	160	163	166	169
Chennai	781	797	813	829	846	863	880	898	915	934	952
Marakanam	58	59	60	61	63	64	65	67	68	69	71
Loading Points											
Tadepaligudam	128	130	133	136	138	141	144	147	150	153	156
Kakinada	295	301	307	313	319	326	332	339	346	353	360
Vijayawada	243	248	253	258	263	268	274	279	285	290	296
Kottapatnam	255	260	265	270	276	281	287	292	298	304	310
Chennai	58	59	60	61	63	64	65	67	68	69	71
Kakinada											
Unloading	1260	1304	1351	1399	1448	1500	1554	1610	1667	1727	1790
loading	1961	2018	2077	2137	2200	2264	2330	2398	2468	2541	2615
Total	3220	3322	3427	3536	3648	3764	3884	4008	4136	4268	4405
Rajahmundry											
Unloading	269	274	280	286	292	299	305	312	319	326	334
loading	340	350	361	372	383	394	406	418	431	444	457
Total	609	625	641	658	675	693	712	731	750	770	791

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Bhadrachalam											
Unloading	1320	1369	1419	1471	1526	1582	1640	1701	1764	1829	1896
loading	6816	6931	7048	7168	7291	7416	7545	7677	7811	7950	8091
Total	8137	8300	8467	8639	8816	8998	9185	9377	9575	9778	9987
Tadepaligudam											
Unloading	0	0	0	0	0	0	0	0	0	0	0
loading	128	130	133	136	138	141	144	147	150	153	156
Total	128	130	133	136	138	141	144	147	150	153	156
Eluru											
Unloading	270	278	286	295	304	313	322	332	341	352	362
loading	332	342	352	363	374	385	396	408	420	433	446
Total	602	620	638	657	677	697	718	740	762	785	808
Vijayawada											
Unloading	2783	2838	2894	2953	3012	3074	3137	3202	3268	3337	3407
loading	1117	1152	1189	1227	1266	1306	1348	1392	1436	1483	1531
Total	3899	3990	4083	4179	4278	4380	4485	4593	4705	4820	4938
Malpadu											
Unloading	196	201	206	211	217	222	228	233	239	246	252
loading	75	77	79	82	84	87	89	92	95	98	101
Total	271	278	286	293	301	309	317	326	334	343	352
Wazirabad											
Unloading	2274	2314	2354	2396	2438	2482	2526	2572	2619	2666	2716
loading	2444	2527	2613	2702	2795	2890	2989	3092	3198	3307	3421
Total	4718	4841	4967	5098	5233	5372	5515	5663	5816	5974	6136
Kottapatnam											
Unloading	866	891	917	944	972	1000	1030	1060	1091	1124	1157
loading	874	903	932	963	995	1028	1062	1098	1134	1172	1211
Total	1740	1794	1850	1907	1967	2028	2092	2158	2226	2296	2368
Durgarajupatnam											
Unloading	196	201	206	211	217	222	228	233	239	246	252
loading	75	77	79	82	84	87	89	92	95	96	101
Total	271	278	286	293	301	309	317	326	334	343	352

Appendix 4

Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Muktiyala											
Unloading	1670	1698	1727	1756	1786	1817	1848	1880	1914	1948	1982
loading	539	557	576	596	617	638	660	682	706	730	755
Total	2209	2255	2303	2352	2402	2454	2508	2563	2619	2677	2737
Ennore											
Unloading	0	0	0	0	0	0	0	0	0	0	0
loading	192	198	204	210	216	223	230	236	244	251	258
Total	192	198	204	210	216	223	230	236	244	251	258
Chennai											
Unloading	4151	4272	4397	4526	4658	4794	4935	5080	5229	5382	5541
loading	958	995	1034	1074	1116	1159	1204	1251	1300	1350	1403
Total	5109	5268	5431	5600	5774	5953	6139	6330	6528	6733	6943
Muthukadu											
Unloading	210	219	227	236	245	254	264	275	285	296	308
loading	0	0	0	0	0	0	0	0	0	0	0
Total	210	219	227	236	245	254	264	275	285	296	308
Marakanam											
Unloading	351	364	378	392	406	421	437	453	470	487	505
loading	0	0	0	0	0	0	0	0	0	0	0
Total	351	364	378	392	406	421	437	453	470	487	505
Puducherry											
Unloading	30	31	31	32	33	34	35	36	38	39	40
loading	0	0	0	0	0	0	0	0	0	0	0
Total	30	31	31	32	33	34	35	36	38	39	40

Appendix 4
Commodity-wise Traffic Movement by IWT Under Realistic Scenrio

Cargo	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Terminals	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Kakinada	3220	3322	3427	3536	3648	3764	3884	4008	4136	4268	4405
Rajahmundry	609	625	641	658	675	693	712	731	750	770	791
Tadepalligudem	128	130	133	136	138	141	144	147	150	153	156
Eluru	602	620	638	657	677	697	718	740	762	785	808
Kottapatnam	1740	1794	1850	1907	1967	2028	2092	2158	2226	2296	2368
Maipadu	271	278	286	293	301	309	317	326	334	343	352
Durgarajupatnam	271	278	286	293	301	309	317	326	334	343	352
Ennore	5302	5466	5635	5810	5990	6176	6368	6567	6772	6983	7202
Muthukadu	210	219	227	236	245	254	264	275	285	296	308
Marakanam	351	364	378	392	406	421	437	453	470	487	505
Puducherry	30	31	31	32	33	34	35	36	38	39	40
Bhadrachalam	8137	8300	8467	8639	8816	8998	9185	9377	9575	9778	9987
Wazirabad	4718	4841	4967	5098	5233	5372	5515	5663	5816	5974	6136
Muktiyala	2209	2255	2303	2352	2402	2454	2508	2563	2619	2677	2737
Vijayawada	3899	3990	4083	4179	4278	4380	4485	4593	4705	4820	4938
Total Traffic in 000 Tonne	31697	32512	33352	34218	35112	36033	36982	37961	38971	40012	41086
Total Traffic in Million Tonne	31.70	32.51	33.35	34.22	35.11	36.03	36.98	37.96	38.97	40.01	41.09

Stretches of Waterway	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Krishna river	6927	7096	7270	7450	7635	7826	8023	8226	8435	8651	8874
Godavari river	8137	8300	8467	8639	8816	8998	9185	9377	9575	9778	9987
Kakinada canal	3220	3322	3427	3536	3648	3764	3884	4008	4136	4268	4405
Eluru canal	5238	5365	5496	5630	5769	5912	6059	6210	6366	6527	6692
Commamur canal	7584	7816	8056	8303	8559	8823	9095	9376	9666	9966	10275
North Buckingham canal	7584	7816	8056	8303	8559	8823	9095	9376	9666	9966	10275
South Buckingham canal & Kalu	591	613	636	660	684	710	736	764	792	822	853
Total Traffic Movement in 000	39280	40328	41408	42522	43670	44855	46077	47337	48637	49978	51361
Total Traffic Movement in Mill	39.28	40.33	41.41	42.52	43.67	44.86	46.08	47.34	48.64	49.98	51.36

Stretches of Waterway	2049-50	2050-51	2051-52	2052-53	2053-54	2054-55	2055-56	2056-57	2057-58	2058-59	2059-2060
Krishna river	1087530	1114082	1141451	1169662	1198743	1228722	1259630	1291496	1324351	1358229	1393162
Godavari river	1391348	1419217	1447860	1477301	1507563	1538672	1570653	1603531	1637335	1672092	1707832
Kakinada canal	161014	166101	171357	176789	182401	188200	194194	200387	206788	213404	220241
Eluru canal	728028	745695	763884	782611	801893	821747	842192	863245	884926	907254	930251
Commamur canal	856971	883217	910308	938274	967142	996944	1027710	1059473	1092266	1126125	1161085
North Buckingham canal	2259978	2329192	2400637	2474385	2550516	2629108	2710243	2794008	2880490	2969781	3061976
South Buckingham canal & Kalu	59147	61342	63620	65985	68441	70991	73638	76387	79241	82204	85281
Total Traffic Movement in 000	6544015	6718845	6899117	7085006	7276699	7474384	7678259	7888526	8105397	8329090	8559828
Total Traffic Movement in Mill	6544	6719	6899	7085	7277	7474	7678	7889	8105	8329	8560

CHAPTER 3
WATERWAY

CHAPTER – 3

WATERWAY

3.0 INTRODUCTION

The waterway under consideration comprises the canal section and the river section. The "river section" consists of two rivers namely, Godavari and Krishna. The Godavari river portion is from Bhadrachalam to Dowleiswaram at Rajahmundry. The Krishna river portion is from Wazirabad to Prakasam Barrage at Vijayawada. The "canal section" consists of Kakinada Canal, Eluru Canal, Commamur Canal and Buckingham Canal. The Kakinada canal runs from Dowleiswaram in Rajahmundry on the left bank of the river Godavari through a head sluice and lock to Kakinada (approx. 5 km downstream from Kakinada Port). The canal gets water from the river Godavari in Dowleiswaram barrage and thereafter connects Kakinada anchorage port. It connects the `River section' of Godavari from Bhadrachalam to Rajahmundry. The Eluru canal comprises two distinct irrigation-cum – navigation canals namely, Krishna Eluru Canal of Krishna Eastern Delta and Godavari Eluru Canal of Godavari western delta. The Krishna Eluru canal takes off from the 'River section' on the left bank of Krishna river on the upstream of Prakasam barrage through a head sluice at Vijayawada and meets Godavari Eluru Canal Canal at east Tammileru lock at Eluru. The Godavari Eluru Canal takes off from the 'River section' of river Godavari at Vijjeswaram in Rajahmundry on the upstream of Dowleiswaram anicut through a head sluice and joins Krishna Eluru canal at East Tammileru lock. The Commamur canal takes off from 'River section' in river Krishna in Vijayawada on the right side upstream off Prakasam Barrage through a head sluice at Seethanagaram and joins Buckingham Canal at Peddaganjam Lock near Ongole. The Buckingham Canal is a tidal canal taking off from Peddaganjam lock and connecting to Chennai and further down South upto Marakanam. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The Kaluvelly Tank is an open swamp/tank connecting Marakanam to the Sea at Puducherry near Kalapet.

3.1 PRESENT STATUS OF THE WHOLE WATERWAY

It is observed that the Kakinada canal and Eluru Canal have adequate flow for navigation purposes excepting in some tail reaches. The river stretches of Godavari and Krishna have adequate flows for navigation. Commamur canal can provide adequate depth for navigation only for six months in a year mainly during Monsoon season. The Buckingham Canal is a tidal canal with 13 locks provided on the canal. The depth in this canal varies from 0.2m to 1.0 m and bank-to-bank width from 15m to 35 m. All the lands along the banks of Buckingham canal has been given by revenue department of Govt. of A.P. and T.N. on lease to private land owners for cultivation/aquaculture. The banks have been eroded at many places. No work for maintaining the depth and width in the canal has however been carried out for a long time, resulting in making it non-navigable. No terminal or jetty exists in Buckingham canal although as per local information the navigation existed till the year 1967. Several bridges and causeways have been constructed across the Buckingham Canal. Especially in Chennai City, the Buckingham canal is in a very bad shape due to encroachments and the construction of Mass Rapid Transport System (MRTS) Railway stations constructed right over the canal. The foundations of pier/abutments of MRTS stations have been constructed inside the canal. Even rerouting of canal has been done to accommodate the piers of MRTS stations. The huts and houses have come up thereby reducing the width of the canal in the range of 10 m to 15 m. The open reaches of the canal have no bank protection in the whole stretch of Buckingham canal. The structural parts of the gates are heavily damaged/corroded and need replacement.

The various stretches of waterway and their status have been discussed in following paragraphs.

3.2 RIVER GODAVARI

The river Godavari rises in the Western Ghats and joins the Bay of Bengal after flowing for a distance of 1465 Km. The basin area of river Godavari is 312812 Sq. km. The important tributaries of Godavari are Manjira (30,844 Sq.km.), Penganga (23,895 Sq.km.), Wainganga (61,093 Sq.km), Wardha (24,087 Sq.km.), Indravati (41,665 Sq.Km.), Maner (13,106 sq.km.) and Sabari (24,500 Sq. km.). The tributaries indicated above in Godavari river course are alluvial in nature. There are erratic changes in the river course and shoal formations. The morphological process of the river Godavari is very complicated by the vast upland discharge, heavy rainfall, rock out crops and existence of three major dams at Paithan – Jaikwadi

(Maharashtra) and Pochampad (A.P) alongwith one dam at Pollavaram under construction. These factors restrict the river flow during lean season. The stretch of Godavari river from Bhadrachalam to Rajahmundry measuring a total length of 171 km has been identified for Inland Water Transport as per feasibility report and the terms of reference. The Godavari river stretch with connected canals is shown in **Fig. 3.1**.

The study of river Godavari for navigation has been carried out from Bhadrachalam at Ch. 0 km. up to a length of 171 km. at Dowleiswaram barrage (Ch.171 km.), which is situated at Rajahmundry. The navigation is proposed to continue from Dowleiswaram barrage further up to Kakinada Sea mouth, which will be dealt with in Kakinada Canal system. The proposed integrated system of river Godavari encompasses the area from Bhadrachalam to Rajahmundry and ultimately meeting at Kakinada – Puducherry Canal.

3.2.1 Morphological Condition of River Godavari

The morphological condition of river Godavari for a distance of 171 km has been described in following three stretches as given below.

a) Bhadrachalam to Kunnavaram (Ch 0 km to Ch. 72 km)

Bhadrachalam is a temple town of A.P. The portion of river Godavari flowing through Bhadrachalam is full of rocks and boulders A Central Water Commission site station is established, from where WAPCOS established the gauge in the river. The 3 km stretch of river having sandy bed is very shallow at present. Only fishing boats can ply at the moment. The water depths available are less than 1 m. Visible rock out crops is found with water line far away from banks. The flow is diverted to concave banks wherever the river meanders. From Ch.3.0 to Ch 52.0 km, the portion of river is sandy. The left bank in this stretch is made of huge sand dunes of medium to course sand. The flow is towards right bank up to a village Rudramukta. The main flow from Rudramukta gets gradually directed towards the left bank. From Ch 52.0 Km, the tributary Sabari, which is coming from Chhatisgarh, joins Godavari, near the village Kunnavaram. Both banks of the river are hilly. The predominant flow is to the left bank. At the confluence (Ch 52.5 Km) the low water line is close to the stable bank. Although the river is not very wide, but sufficient depth of water is available throughout the year. Hence the portion is navigable from Ch.52 to Ch 72 Km. for large boats and crafts.

b) Kunnavaram to Devipatanam (Ch.72 km to Ch. 127 Km):

The next portion of river is passing through hills and is very narrow. The banks are very steep. The riverbed is sandy with rock outcrops and boulders. The river passes through spurs of Eastern Ghats after Pochavaram. The width gradually decreases until the river forces its way through a gorge into width of 180 m to 275m. The riverbed material consists of coarse sand. The river then enters wider portion having sufficient water near plains at Devipatnam. Town Polavaram is on right bank. The dam at Polavaram is under construction by Govt. of Andhra Pradesh and this portion is navigable.

c) Devipatnam to Rajahmundry (Ch 127.0 Km to Ch 170.0 Km)

The river as stated widens at Devipatanam with high sand dunes and number of channels forming the river. These channels are mostly dry except the main water channel. A temple of Virabhadraswami at Ch 131.5 Km. on hilly island was seen along side the river at Gutala. The predominant flow is towards the right bank where ONGC pipeline and a bridge are crossing over the river. The river has meandering and braiding behaviours. A number of islands and a railway bridge at Ch.160.5 km. cross the river. This portion is very wide. Dowleiswaram barrage has been constructed at Ch.170 Km by Government of A.P. Rajahmundry and Dowleiswaram towns are on left bank and Kovvuru village is at right bank. This is navigable for large boats and crafts. The river stretch ends at Godavari Barrage or Sir Arthur Cotton Barrage (as called usually). The salient features of the Godavari Barrage are given as under:

GODAVARI BARRAGE

General

Location	-	Dowleiswaram, Andhra Pradesh.
Purpose	-	Irrigation with facility for Navigation in canal
River / Tributary	-	Godavari
Area of catchment	-	3,13,649 km^2.
Mean annual rainfall in the catchment	-	114.3 cm
Total Annual Yield of Catchment	-	154,400 M m^3
Design Flood Discharge	-	91,475 m^3/s.

Year of Commencement of Construction works	-	1970

Hydraulic Particulars

Width of River	-	5.86 km
Length of Barrage / Anicut	-	3599 m
No. of Under sluice Bays	-	3
No. of Barrage / Weir Bays	-	175
Width of Under sluice Bays	-	(i) 12.19 m for 8 vents (ii) 15.24 m for 2 vents
Width of Barrage / Weir Bays	-	18.29 m
Thickness of Intermediate Piers	-	2.13m single pier 4.26m double pier

Gates :

(a) Number	-	175
(b) Size	-	18.29 m x 3.35 m lift gates
Pond Level	-	13.64 m
Means for Dissipating Energy	-	6 rows of C.C. blocks.

Canal Head Regulator	**Eastern Delta H.R.**	**Central Delta H.R.**	**Western Delta H.R.**
Width of Head Regulator	55.15m	42.83 m 69.47m	
No. of Bays and their Width	4 (Each 12.19m width)	3	5
Thickness of Piers	2.13 m	2.13 m	2.13 m
Orientation with respect of Barrage Axis	Easter Delta H.R. at 670 50'40". The other two are located away to the barrage		
Location of Head Regulator from Barrage Axis	Left side of downstream branch	Right side of Rail branch	Right side of Vizzeswaram branch
Means for Dissipating Energy below Head Regulator	Water cushion and staggered blocks		
Maximum Discharge of Canal	170 m^3/s.	121 m^3/s.	281 m^3/s.

3.2.2 Hydrological Condition of River Godavari

The hydrological features of the river Godavari have been obtained and described below.

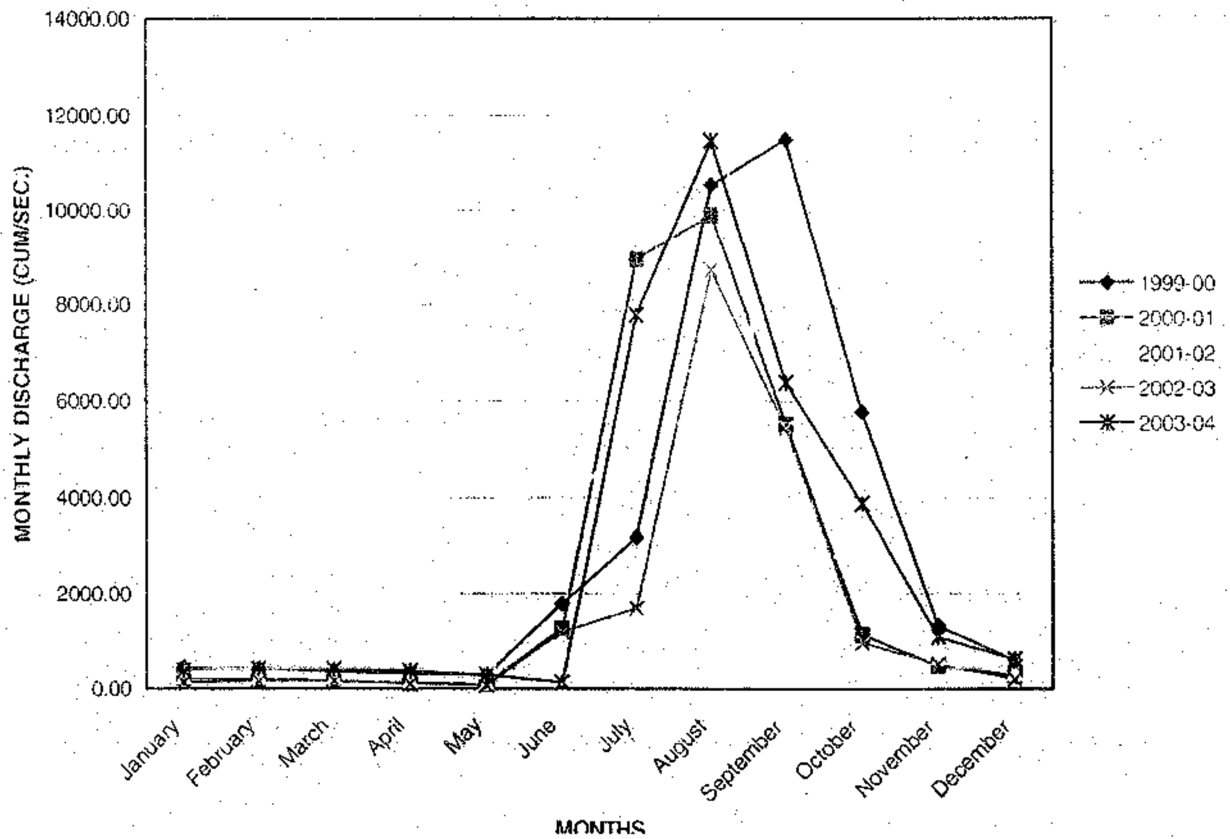
Discharge

The discharge data has been collected from CWC between the years 1999 and 2004 for different months of the years. The data in respect of Polavaram is tabulated as **Table 3.1**.The graphical representation of discharges during different months of the years for the site is shown as **Figure** 3.2. Considering that lean month discharges are critical for Inland Water Transport, the data shows that at Polavaram the maximum and minimum discharges are 13293 cum/sec and 74.42 cum/sec respectively.

Table 3.1 DETAILS OF DISCHARGE AT POLAVARAM IN GODAVARI RIVER
(IN CUMEC)
(SOURCE : CWC, HYDERABAD)

SL. NO.	MONTH	YEAR						
		1999-00	2000-01	2001-02	2002-03	2003-04	Min.	Max.
1	January	452.90	230.50	263.40	137.20	403.10	137.20	452.90
2	February	431.40	209.60	250.20	164.50	438.40	164.50	438.40
3	March	362.50	164.30	257.10	174.20	421.10	164.30	421.10
4	April	308.90	110.10	182.60	106.80	374.30	106.80	374.30
5	May	295.40	103.50	127.90	74.42	290.90	74.42	295.40
6	June	1794.00	1267.00	3505.00	1195.00	131.00	131.00	3505.00
7	July	3175.00	8946.00	5771.00	1702.00	7784.00	1702.00	8946.00
8	August	10538.00	9900.00	13293.00	8733.00	11469.00	8733.00	13293.00
9	September	11486.00	5524.00	2719.00	5450.00	6391.00	2719.00	11486.00
10	October	5780.00	1141.00	2794.00	975.20	3886.00	975.20	5780.00
11	November	1332.00	482.50	663.10	516.90	1090.00	482.50	1332.00
12	December	602.60	282.20	334.50	197.30	619.30	197.30	619.30

FIG. 3.2 MONTHLY MEAN DISCHARGE (CUM/SEC) AT POLAVARAM IN GODAVARI RIVER



3.2.3 Metrological Condition of the River Godavari

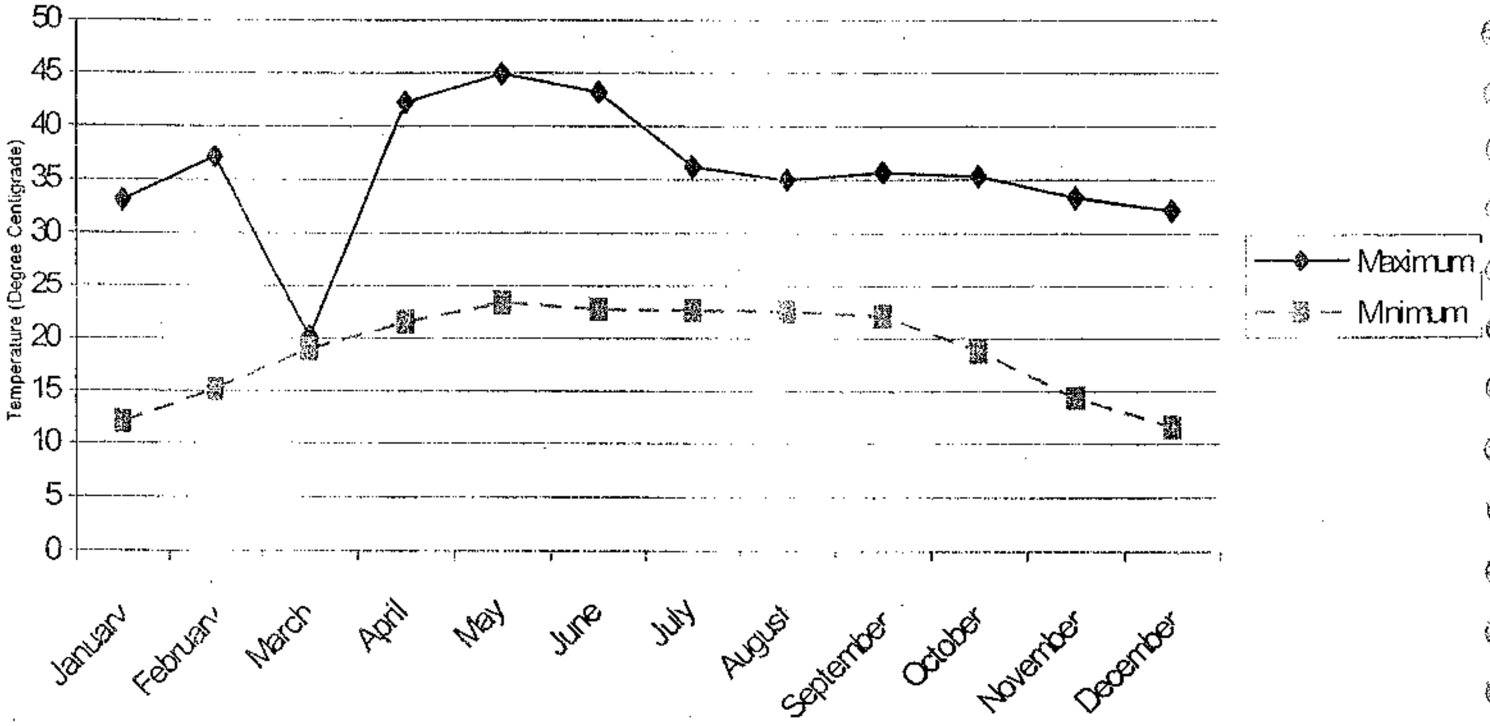
a) Temperature

The temperature data of Kothagudem (Bhadrachalam) from Indian Meteorological Department has been tabulated in **Table 3.2.** Based on observations from 1952 to 1980, the maximum temperature is observed generally in the month of May and minimum temperature in the month of December. The highest recorded temperature is 44.9^{0}C in May while minimum observed temperature is 11.6^{0}C in December. The graphical representation is shown in **Figure 3.3.**

Table 3.2 Temperature data for Kothagudem (Bhadrachalam)
(Source: IMD, 1952 to 1980)

Month	Maximum	Minimum
January	33.1	12.1
February	37.1	15.2
March	20.2	19
April	42.2	21.6
May	44.9	23.4
June	43.2	22.8
July	36.2	22.7
August	35	22.6
September	35.7	22.2
October	35.3	18.8
November	33.3	14.4
December	32.1	11.6

Figure 3.3 Monthly variation of Temperature



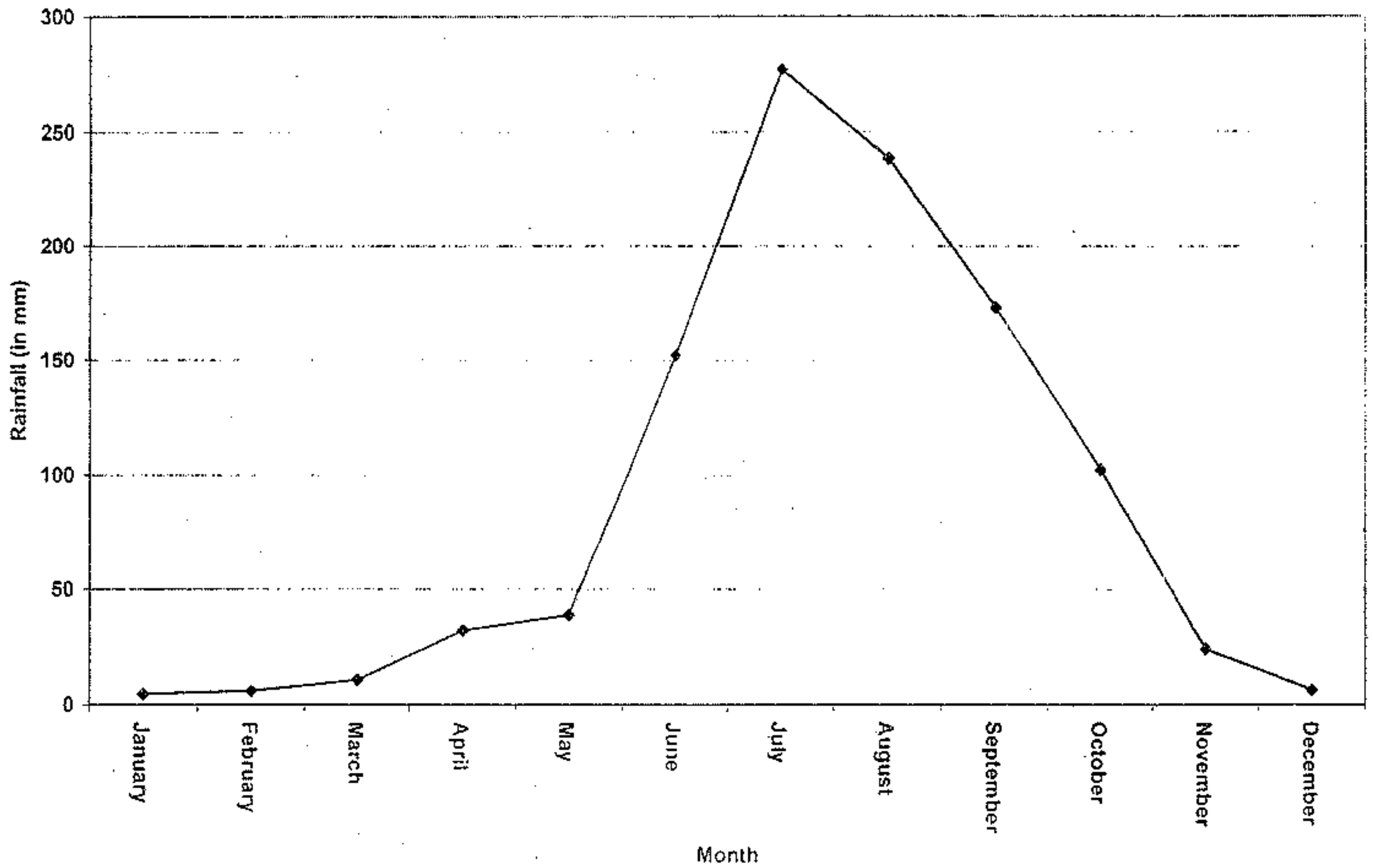
b) Rainfall

The maximum rainfall in river Godavari has the value of ranging between 152.1mm and 277.0mm from June to September. The heaviest rainfall recorded so far is on 14th July 1965 with 113.8 mm rainfall. The monthly total values of rainfall in mm has been tabulated in **Table 3.3** and graphically represented as **Figure 3.4**

Table 3.3 Rainfall in Kothagudem (Bhadrachalam) in Godavari River
(Source: IMD, 1952 - 1980)

Month	Rainfall (monthly total in mm)	No. of rainy days
January	4.5	0.3
February	5.9	0.5
March	10.7	0.8
April	31.9	2.2
May	38.6	2.8
June	152.1	8.8
July	277	14.3
August	238.3	13.8
September	172.6	10.8
October	102.7	6.2
November	24	1.4
December	6.1	0.4

Fig. 3.4: Monthly Rainfall in Kothagudem(Bhadrachalam)



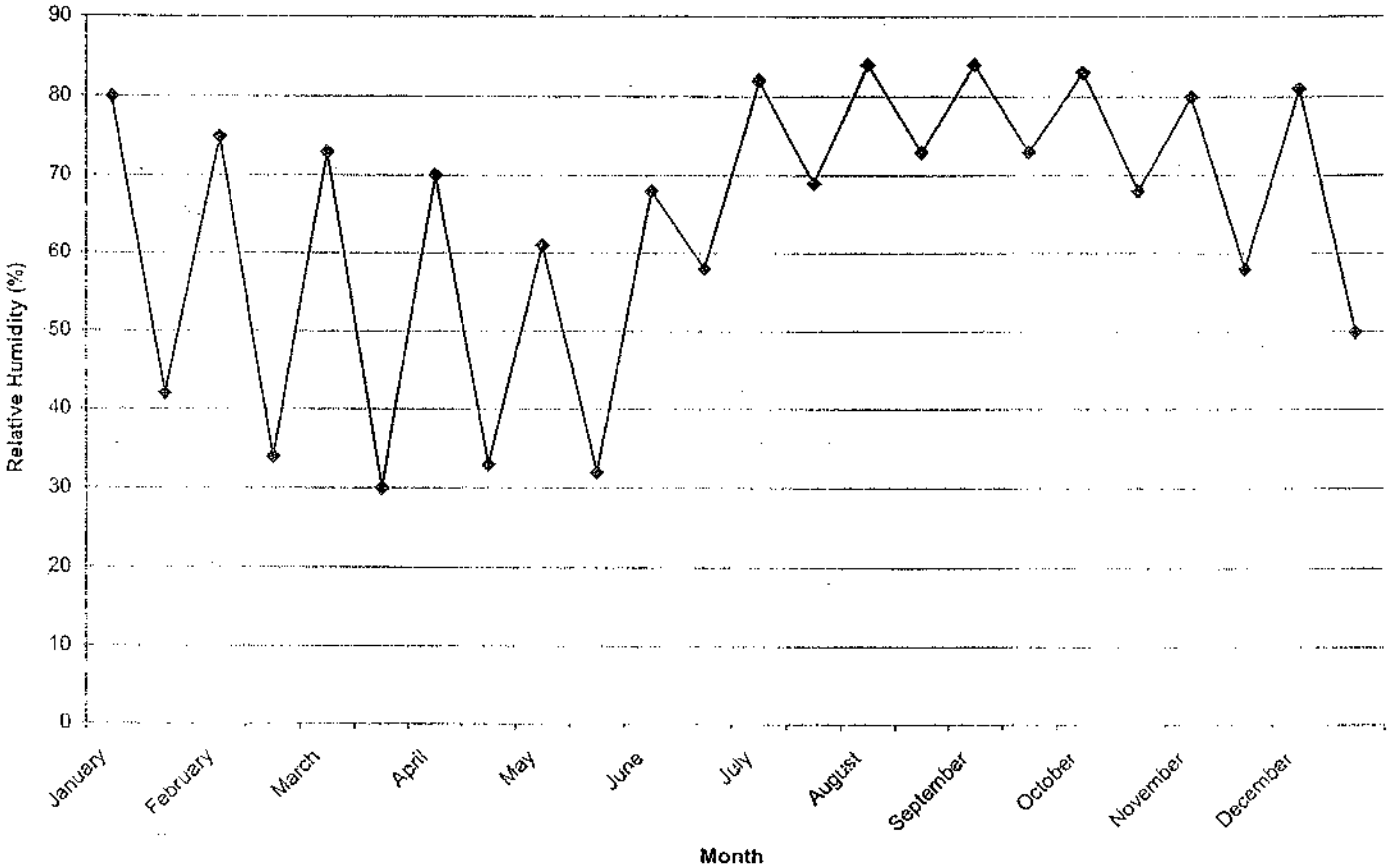
c) Humidity

The relative humidity values of Bhadrachalam representing river Godavari are tabulated in **Table 3.4** and represented graphically in **Figure 3.5**. The relative humidity of 29 years from 1952 to 1980 have been considered. The most humid months are August and September.

Table 3.4 Relative Humidity at Kothagudem (Bhadrachalam)
(Source: IMD, 1952 - 1980)

Month	Relative Humidity (%)
January	80
	42
February	75
	34
March	73
	30
April	70
	33
May	61
	32
June	68
	58
July	82
	69
August	84
	73
September	84
	73
October	83
	68
November	80
	58
December	81
	50

Figure 3.5 Relative Humidity of Kothagudem (Bhadrachalam)
(Source: IMD, 1952 - 1980)



d) **Wind**

The no of days of the month with wind speed 1 to 19 Kmph has been tabulated in **Table 3.5**, it can be seen that the maximum wind speed (1 to 19 kmph) occurs in the most part of the year when the wind direction is Northeast and Southwest.

Table 3.5 Wind data for Kothagudem (Bhadrachalam)
(Source: IMD, 1952 - 1980)

Month	No. of days with wind speed 1 to 19 kmph	No. of days with wind speed as 0 kmph
January	27	4
	30	1
February	25	2
	27	1
March	30	1
	31	0
April	28	1
	28	1
May	31	0
	30	1
June	29	1
	29	1
July	30	1
	31	0
August	30	1
	30	1
September	28	2
	29	1
October	29	2
	30	1
November	27	3
	29	1
December	28	3
	30	1

3.2.4 Bridge across river Godavari

There are three bridges existing in the stretch of river Godavari. The first bridge is at Bhadrachalam. The details of these bridges are given in **Table 3.6**

Table. 3.6: Details of Bridges along the Stretch of River Godavari

S.No.	Distance from 0 K.M.	Name of Bridge	Length (m)	Width (m)	No of Piers	Dist. between Piers (m)	Water Level (WL) w.r.to (MSL)*	Vertical Clearance w.r.to WL (m)	Vertical Clearance w.r.to HFL (m)	Whether Bridges require modification
1	0.3	Bhadrachalam Road Bridge	1199	8	37	32.61	32.7	8	4	NO**
2	161	Rajahmundry Railway Bridge	2800	5.2	35	82.35	13.3	8	4.2	NO**
3	162.5	Rail & Road Bridge at Rajahmundry	2800	8	29	100	12.9	10	4	NO**
						Total number of bridges requiring modification				Nil

* On the day of observation

** Refer Para 6.3.7.2

3.2.5 Fairway Development:

a) Standard Low Water Level:

CWC discharge data at Koida and Pollavaram was obtained and analysed for the purpose as shown in **Table 3.7**. The discharge data at Koida shows that the water level at Koida has not fallen below +14.2 m over the last 10 years. Whereas in Pollavaram, the data indicates that the probability of water level falling below +13.2 m would be within the limits of 18 days in a year. Since most part of the fairway is non-tidal, the flow conditions are dependent on the discharge released from the Polavaram dam. The Standard Low Water Level (SLWL) has therefore been fixed as +13.2 m. At present the river remains dry during lean season. In non-lean season during monsoon, the area around the river gets flooded. The level so fixed is such that even if water level falls below SLWL, which is a rare possibility, it is contemplated that navigation would still be possible with vessels partly loaded and the reduction in draft would not exceed 20 cm. Such part loading will be for a very short period during the months of April to June, which is an acceptable practice in many inland waterways of the world.

b) Polavaram Dam:

The layout plan of Polavaram dam in river Godavari is shown in **Fig. 3.6**.The salient features of Polavaram Dam are given below:

SALIENT FEATURES OF POLAVARAM DAM

Name of the project	:	Indira Sagar Polavaram Project		
Location	:	Ramayyapeta Village, Polavaram		
		Longitude	:	81^0 – 39'-46" E
		Latitude	:	17^0 - 16'-53" N

River Basin

Name	:	Godavari
Located in	:	
i. State	:	Andhra Pradesh
ii. States (If inter-state rivers)	:	Andhra Pradesh, Chattisgarh (Madhya Pradesh), Maharastra, Orissa and Karnataka

iii. Countries if international river	:	NA

Name of River	:	Godavari
Tributary	:	-
State (s)	:	Andhra Pradesh
District (s)	:	
Reservoir	:	East Godavari, West Godavari, Khammam Districts in AP Dantewada District in Chattisgarh State Malkangari District in Orissa State
Head works	:	East and West Godavari Districts
Command Area		
Left Canal	:	East Godavari and Visakhapatnam District
Right Canal	:	West Godvari and Krishna Districts
Power House 960 MW		East Godavari District
Type of Project (Irrigation/Multipurpose)	:	Multipurpose

Power

a. Installed capacity : 960 MW (12x80 MW)

b. Firm Power : 80 MW

Navigation : River Navigation

Reservoir

Water Levels

a. Maximum water level (To be maintained during peak flood)	:	+42.67 m (140')
b. Full reservoir level	:	+45.72 m (150')
c. Low water level	:	+41.15 m (135')
d. Dead Storage level	:	+41.15 m (135')
Free Board		For earth dam 7.60 m (25')
Live Storage		2,129 M.cum (75.20 TMC)
Capacity at		
a. FRL (45.72)		5.511 T M.cum (194.60 TMC)
b. Low water levels (41.15)		3.381 T M.cum (119.43 TMC)

TABLE 3.7

VARIATION OF WATER LEVEL WITH RESPECT TO S.L.W.L. OVER THE YEARS (1978 TO 1987)

SL.	Station with S.L.W.L above M.S.L.	Level below	Months	No. of Day									
				1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	Koida SLWL +14.2M	+14.2M	April	0	0	0	0	0	0	0	0	0	0
			May	0	0	1	0	1	0	0	0	0	0
			June	3	0	0	0	3	0	0	0	0	0
		+14.2M	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3	Pollavaram SLWL + 13.2M	+13.2m	March	0	0	0	0	0	2	0	0	0	0
			Aprl	0	0	20	0	20	30	0	0	0	0
			May	0	0	31	0	22	31	0	0	0	0
			June	1	0	3	0	16	25	0	0	0	8
		+13.0M	March	0	0	0	0	0	0	0	0	0	0
			Aprl	0	0	0	0	0	0	0	0	0	0
			May	0	0	0	0	0	2	0	0	0	0
			June	0	0	0	0	0	0	0	0	0	8
		+12.8M	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Note: The no. of days in the above table have been taken after rounding off the water levels to the first decimal.

From the construction details of Polavaram Dam, it is inferred that the backwater effect of Polavaram dam will be up to Bhadrachalam and all the rock out crops in the river bed in all stretches upstream will come under submergence, once dam is constructed. The authorities of Polavaram dam are required to be associated by IWAI for planning of Waterway for navigation. It was seen that Deptt. Of Irrigation & CAD, Govt. of A.P. have already envisaged for provision of a tunnel and four nos. of locks for navigation suitable for existing navigation purposes. The consultants met Superintending Engineer for navigation and confirmed the provision of navigational locks and a tunnel for navigation on left bank of Polavaram Dam.

The Polavaram Dam will submerge the areas upstream of river in Kunavaram and Bhadrachalam. Water released from the Polavaram Dam downstream will flow in to the right canal and left canal. The design discharge capacities of these canals are 2670 million cum. (RBC) and 3090 cum (LBC) respectively. Accordingly the calculated lean season water availability at all points of the river was found to be 129.72 cumecs at the minimum while the loss of evaporation and seepage is more than compensated by the ground water recharges. However, with the commencement of irrigation this flow would be marginally affected but the same will be get supplemented with yield for uncontrolled catchments downstream as well as regenerated flow from the irrigation command. In the DPR for Polavaram Dam, uninterrupted navigation from Rajahmundry to Bhadrachalam has been envisaged. The scheme provides for separate lock channel (navigational canal) on the left bank linking up the reservoir with the main reservoir on the downstream side of the Dam through three high lift locks to negotiate the level differences from +41.0 m to +13.5 m. Since the DPR covers the required navigational aspects, no separate study on the effect of Polavaram dam is considered necessary. But Dam authorities should ensure 130 Cumec of discharge of water regularly. Then only, navigation is possible. If Dam authorities release less than this amount of water, then secondary channels downstream have to be closed. This will involve heavy expenditure every year. In addition to it, heavy maintenance dredging will be required to make the waterway navigable.

The Dam is under construction but with many obstructions. For rehabilitation and environmental problems, the project is getting delayed. Once the construction of superstructure comes up, as stated earlier, the Dam construction authorities will have to abide by the standards laid down by IWAI for uninterrupted continuation of navigation as stated above.

At Pollavaram site I&CAD is already constructing navigational lock through diversion channel (as per the drawing enclosed in Volume III). The navigational lock has been provided in the original scheme of Pollavaram dam by I&CAD. This scheme was cleared by CWC (MoWR). The following are the features observed (Reference enclosed drawing of I&CAD).

(i)	Bed width of channel	=	20.00m
(ii)	Length of navigational canal	=	4.475 km
(iii)	Full supply depth	=	3.50m
(iv)	Velocity	=	0.509 m/sec.
(v)	Godavari Max. water level	=	28.750m
(vi)	Godavari Min. water level	=	13.420m
(vii)	Tunnel length	=	Approx. 1 km
(viii)	Bed width of Tunnel	=	12m
(ix)	F.S.D of Tunnel	=	3.81m
(x)	Velocity in Tunnel	=	0.971 m/sc.

Navigational locks at Polavaram Dam

The terms of reference of IWAI stipulates development of 32m bed width and 2.0m depth of waterway for 500 ton vessels in the final phase for river Godavari.

For a 500 ton vessel, vessel dimensions proposed are LOA = 50m, Beam = 11m and Draft = 1.8m. For enabling these vessel sizes to navigate at Polavaram dam the following navigational lock dimensions are required:

(a)	Length of lock chamber (two vessel locking simultaneous)	:	105m
(b)	Width of lock chamber	:	12m
(c)	Depth of water in lock chambers	:	3.0m
(d)	Number of Chambers	:	2 (Two)
(e)	Number of gates	:	8 (Eight)
(f)	Type of gates	:	Mitre (4 twin gates)
(g)	Size of gates	:	6.4 x 3.0m

(h)	Control of lock gates operated.	:	Electrically
(i)	U/s water level at start of navigational lock	:	37.19m
(j)	D/s water level at end of navigational lock	:	9.92m
(k)	Difference in level	:	27.27 m
		Say	27.00m

WAPCOS suggested that there can be a single tunnel instead of two, if it is possible, against as planned i.e. one for navigational tunnel (12m) and other for irrigation tunnel (18m). The tunnel can be with a regulator at a certain distance adjoining the exit of this proposed new single tunnel. This can save water and probably provide for a bigger channel / tunnel with higher dimensions. This aspect can be examined by I&CAD through studies, in consultation with IWAI/ WAPCOS.

3.3 RIVER KRISHNA

The study of river Krishna for navigation has been carried out from Wazirabad near Pondugala Road Bridge to Vijaywada for a total length of 157.0 km. The Krishna river stretch with connected canals is shown in **Fig. 3.7.**

3.3.1 Morphological Condition of River Krishna

The morphological condition of river Krishna for a distance of 157 km has been described in following three stretches as given below.

a) Pondugala to Pulichintala (Ch 0 km to Ch 86 km)

Pondugala is situated on right bank of river Krishna and Wazirabad (as called Huzzurnagar or Wadapalli in local language) is at left bank of the river. They are situated at 64 km away from Nagarjuna Sagar dam towards Vijayawada. They are accessible through roads via Jaggayyapet in the route-A. CWC station is set up at Pondugala, wherefrom records of discharge data were obtained. Krishna river from Pondugala runs along rocky and boulder banks. The banks slopes vary from 1:6 to 1:8. The riverbed is rocky. There are rocky spurs on the right bank upto chainage 9 km the left bank being rocky. The rapids after rapids have been noticed at Chainage 63.0 km. This portion of the river is full of rocks and having steep gradient. The steep gradient may be due to the existence of natural rock hills across the width of the river. The rapids and steep gradient of bed are navigational hazards. They will have to be brought to the uniform grade. The tributary Musi River joins Krishna at Ch. 3.750 km. The depths of water in the stretch vary between 1m and 6.4m. The widths vary between 100m and 400m. Predominant depth of water within the stretch in the range of Ch. 63 km and Ch. 86 km is found navigable. A Dam is being constructed in Pulinchintala by the Govt. of Andhra Pradesh exclusively for irrigation purposes and for generating power of 60MW.

The Pulinchintala dam does not have a provision of navigational lock in the original scheme and the construction of dam is in full swing. However, I&CAD are contemplating a navigational lock at this site on the request of IWAI. A lock can be provided either on earthen dam section in the left bank or through a diversion / by-pass channel from upstream of dam to the downstream of dam by a twin lock to negotiate the required level difference.

There is a hill on right bank and provision of lock may be difficult. The power house is on the left bank. The Earthen dam section may be an ideal location for navigational lock. The salient features of Pulinchintala Dam are given below:

SALIENT FEATURES OF PULICHINTALA DAM

NAME OF THE PROJECT Pulichintala Project

General Particulars

Location :	Village	Pulichinta
	Mandal	Bellamkonda, Guntur District
		Longitude 80° - 03' - 33" E
		Latitude 16° - 46' - 14" E

RIVER BASIN

a.	Name	Krishna
i.	State	Andhra Pradesh
ii.	States (If inter state river)	Maharashtra, Karnataka & Andhra Pradesh
iii.	Countries	NIL

(If international River)

Name Of

a.	River	Krishna
b.	Tributary	NIL
c.	States (S)	Andhra Pradesh
d.	District (s)	Guntur & Nalgonda
e.	Reservoir	Guntur & Nalgonda

Reservoir:

Water levels (EL – m)

a)	Maximum water level:	+53.34 (+175.00 Ft.)
b)	Full Reservoir Level	+53.34 (+175.00 Ft.)
c)	Minimum Draw Down Level (MDDL)	+42.672 (+140.00 Ft.)
d)	Gross storage capacity	1296 M Cum
e)	Live storage capacity	1026 M.Cum

The layout plan of Pulichintala dam in river Krishna is shown in **Fig.3.8.** With the construction of Dam with FRL/MWL + 53.34 m and MDDL +42.672 the existing Standard Low Water Level (SLWL) of 24.8 m, which is expected to be maintained for more than 90% of the period, will automatically lift to a minimum of 42.672 m and a maximum of 53.34 m. This in turn will lift the SLWL at 8 Km. above 54 m depending upon the backwater effect due to impoundment in the Pulinchintala Dam. Hence the construction of the Dam will improve the water depth available and submerge the rock out crops and sills. This will also result into ensuring the navigability for 330 days in a year. There is no provision of navigational locks in this dam as seen in the salient features depicted above. Presently, navigation is not possible for more than six months in a year without Pulinchintala Dam. If the navigation has to be continued for 330 days in a year from Wazirabad (Pondugala Bridge) to Vijayawada, then the Dam should have provision for a series of navigational locks. The navigational locks will facilitate negotiation of the water level between 24 m to 42.67 m/53.34 m. The effective lift of the locks will be 18.67 m to 29.34 m. A series of two to three locks of effective lift of about 10m are recommended to be incorporated in the axis of the Dam while constructing the Dam. The releases downstream of Pulinchintala Dam is being used for 60 MW power generation and these releases are greater than the normal discharge during summer season in a non dam scenario. This in turn will improve the navigability in the stretch downstream of Pulinchintala Dam.

As discussed with the officials of Irrigation & CAD Deptt. In the meeting held with Superintendent Engineer, Godavari Krishna basin, Vijayawada on 25.07.2006 with WAPCOS officials and the Environment consultants M/S. CES (I) Pvt. Ltd., it was confirmed that there was no provision of locks in the Pulinchintala Dam. State government authorities should ensure construction of locks. Unless dam comes, navigation upstream for six months in a year will not be possible. The detailing of locks is itself a separate study. It is learnt that Govt. of A.P. has now decided to get the DPR prepared for the navigational locks in Pulinchintala Dam.

Navigational locks at Pullichintala Dam

The terms of reference of IWAI for this stipulates development of 32m bed width and 2.0m depth of waterway for 500 ton vessels in the final phase for river Krishna.

For a 500 ton vessel, a vessel dimensions proposed are of LOA = 50m, Beam = 11m and Draft = 1.80m. For enabling these vessel sizes to navigate at Pulinchintala dam the following navigational lock dimensions are required:

(a)	Length of lock chamber (two vessel locking simultaneous)	:	105m
(b)	Width of lock chamber	:	12m
(c)	Depth of water in lock chambers	:	3.0m
(d)	Number of Chambers	:	2 (Two)
(e)	Number of gates	:	8 (Eight)
(f)	Type of gates	:	Mitre (4 twin gates)
(g)	Size of gates	:	6.4 x 3.0m
(h)	Control of lock gates	:	Electrically operated.

The above dimensions were forwarded to I&CAD for incorporation in navigational locks being constructed, under intimation to IWAI.

b) Pulinchintala to Kasarabad (Ch 86 km to Ch. 122 km).

In the reach of Ch. 86 km to Ch. 95 km, the river is narrow with high banks. It runs between firm sandy banks. River width increases suddenly from Ch. 95 km upto Ch. 122 km. The river width is upto 1000m and depths vary between 0.5m and 16m. Predominant depth of water in this stretch is about 2m. Hydraulic gradient is flatter and flow conditions are favourable for navigation. There are wide sand areas and islands. The riverbed is predominantly sandy with intermittent submerged rocks. This stretch is morphologically ideal for development of inland water transport. A number of ferries have been seen in this stretch.

c) Kasarabad to Vijayawada (Ch. 122.0 km to Ch. 157.0 km)

The river downstream of Kasarabad is braided in nature. It comprises of a number of shallow channels due to formation of central islands. These channels fluctuate over wide width at Khadir. The depths vary between 0.5 m and 15 m and the widths vary between 1500 m and 3800 m. The deeper channel is along left bank. At Ch. 126 Km., the river crosses over to the right bank. The tributary Munneru joins the river Krishna at Ch. 144 km from left bank and forms a shallow channel. The deeper channels which flows along right bank gets braided at Amravati at Ch. 150 km. The river flows with considerable depths due to discharge of Munneru tributary. The stretch is navigable from this reach downstream, the canals drain out the water of Krishna to agricultural lands on both sides of the river, at Ch. 130 to Ch. 157 km. The navigational channel along the right bank crosses over to the left bank and hugs left bank in this stretch. The river reaches practically the backwater zone of Praksam barrage (Ch. 157 km) near Vijayawada. The town of Vijayawada is on left bank. The river stretch is navigable and a ferry ghat to ferry passengers exists near Ibrahimpatnam. The river stretch ends at Prakasam Barrage, the salient features of which are as under:

PRAKASAM BARRAGE

General:

Location	-	Near Vijayawada Town, Andhra Pradesh.
Purpose	-	Irrigation
River / Tributary	-	Krishna
Area of catchment	-	251,358 m^3/s.
Mean annual rainfall in the catchment	-	89 cm
Total Annual Yield of catchment	-	48,810 M m^3 (75% dependable yield)
Design Flood Discharge	-	33,984 m^3/s.
Year of Commencement of construction works	-	1954

Year of Completion - 1957

Hydraulic Parameters:

Length of Barrage / Anicut	-	1138.73 m
No. of Undersluice Bays	-	14
No. of Barrage/Weir Bays	-	70
Width of Undersluice Bays	-	5.18 m
Width of Barrage/Weir Bays	-	12.19 m
Thickness of Intermediate Piers	-	2.44 m

Gates:

(a) Number	-	70
(b) Size	-	12.19 m x 3.66m
Pond Level	-	17.38 m
Means for Dissipating Energy	-	Cistern

3.3.2 Hydrological Condition of River Krishna

a) Discharge

The available data on monthly mean discharge in river Krishna is collected from Central Water Commission. The following are CWC sites at river Krishna where the discharge is being monitored.

- Pondugala at Distt. Guntur
- Vijayawada
- Wadenapally

The discharge data between the years 1999 and 2004 for different months for the two sites viz. Pondugala and Vijayawada are shown in **Table – 3.8** and **Table 3.9** respectively.

Considering that lean month discharges are critical for Inland Water Transport, the data shows that at Pondugla and Vijayawada, the maximum discharges occur between months of July and October. The discharge is dependent on rainfall. There was less rainfall in the year 2003-04 in this area, hence there was less discharge in the year 2003-04. The major portion of rainfall in river Krishna is received from the southwest monsoon from June to September. However, during months of October and November cyclonic storms from the Bay of Bengal bring heavy rains to river Krishna. The discharges are very low during the dry weather season. The development of navigation in river Krishna is dependent upon the release from NS Dam that in fact is the chief source of water supply to the downstream stretches. From the discharge data it is seen

that the river Krishna has discharges more than 100 cumecs during the whole year except for a few months. The minimum discharge in the June 2003 in Pondugala was 11.07 cum/sec while maximum discharge was 1927.0 cum/sec in August 1999. Similarly the minimum discharge at Vijayawada was 0.953 cum in May 2004, while the maximum discharge was 1503 cum/sec in August 1999.

The graphical representation of the above data is also shown in **Figure 3.9** & **Figure 3.10** respectively

TABLE – 3.8
DETAILS OF DISCHARGE AT PONDUGALA IN KRISHNA RIVER
(IN CUM/SEC)

SL. NO.	MONTH	YEAR				
		1999-00	2000-01	2001-02	2002-03	2003-04
1	January	251.7	216.5	154.2	59.9	73.8
2	February	255.2	321.6	137.0	47.8	66.7
3	March	623.0	508.2	374.8	30.9	68.8
4	April	705.8	307.2	437.3	64.3	33.1
5	May	214.8	154.6	98.9	55.6	19.5
6	June	233.4	274.8	198.7	114.2	21.2
7	July	494.4	491.0	346.6	438.5	11.1
8	August	1927.0	679.2	353.6	398.1	20.3
9	September	785.7	506.1	712.4	462.4	100.4
10	October	401.0	445.2	309.0	528.3	127.3
11	November	379.0	335.2	308.4	387.5	133.2
12	December	249.0	193.4	155.3	121.8	80.7

(SOURCE: CWC, HYDERABAD)

TABLE – 3.9
DETAILS OF DISCHARGE AT VIJAYWADA IN KRISHNA RIVER
(IN CUM/SEC)

SL. NO.	MONTH	YEAR						
		1999-00	2000-01	2001-02	2002-03	2003-04	Min.	Max.
1	January	34.28	21.19	30.20	3.82	1.57	**1.57**	**34.28**
2	February	61.97	36.08	8.84	4.02	1.16	**1.16**	**61.97**
3	March	143.40	106.80	47.10	3.31	1.31	**1.31**	**143.40**
4	April	279.60	148.60	188.60	3.96	1.31	**1.31**	**279.60**
5	May	121.60	96.94	79.37	4.09	0.95	**0.95**	**121.60**
6	June	158.60	218.90	133.40	61.86	12.18	**12.18**	**218.90**
7	July	400.80	259.10	14.57	5.41	10.40	**5.41**	**400.80**
8	August	1503.00	1430.00	21.09	6.91	36.17	**6.91**	**1503.00**
9	September	707.20	116.30	34.82	9.15	14.94	**9.15**	**707.20**
10	October	324.10	103.60	470.50	23.28	19.08	**19.08**	**470.50**
11	November	76.80	75.34	100.70	12.91	1.53	**1.53**	**100.70**
12	December	89.08	68.13	62.57	3.81	27.29	**3.81**	**89.08**

(SOURCE: CWC, HYDERABAD)

. Figure – 3.9

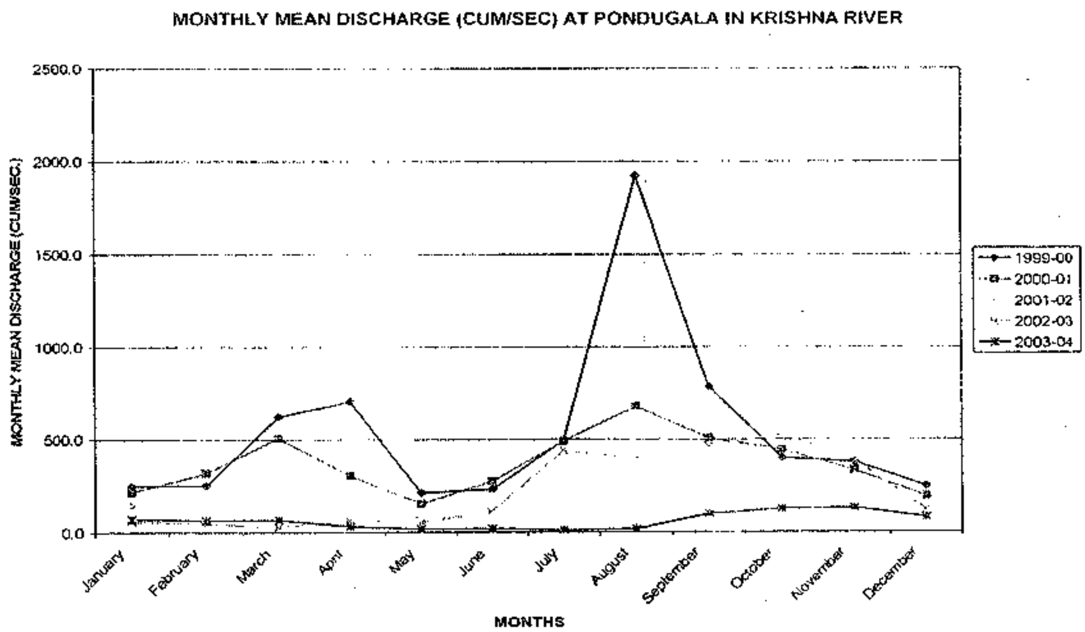
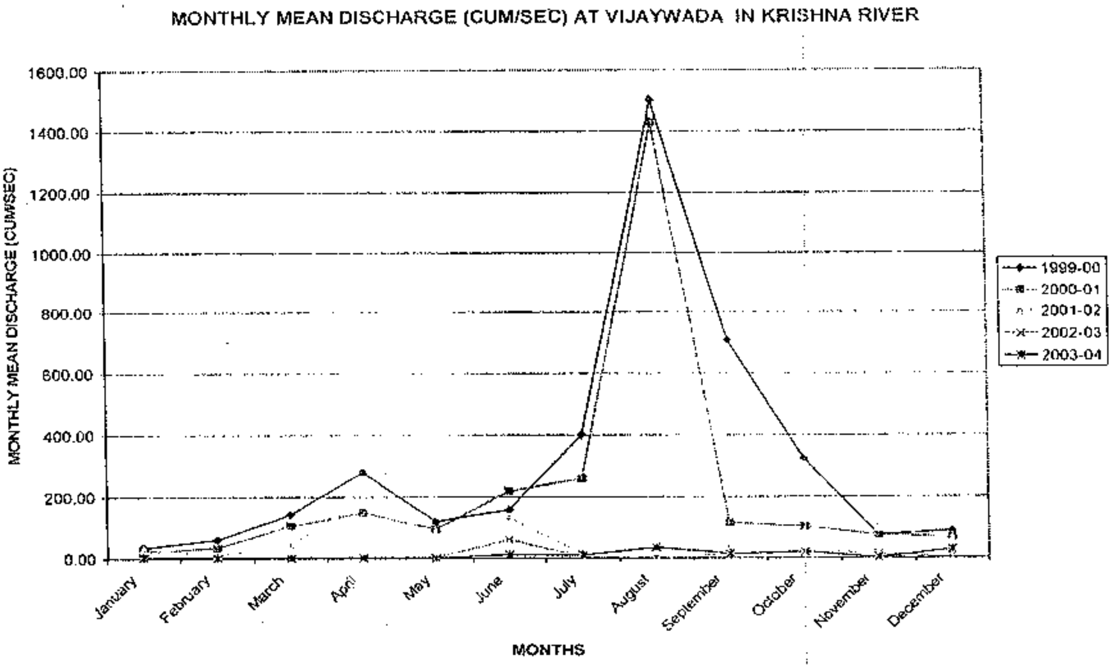


Figure – 3.10



b) Current Velocities

Maximum current velocities at bank full stage during flood period for stations Pondugala and Wadenapalli are found as 1.76 m/sec and 1.46 m/sec.

3.3.3 Meteorological Condition of river Krishna

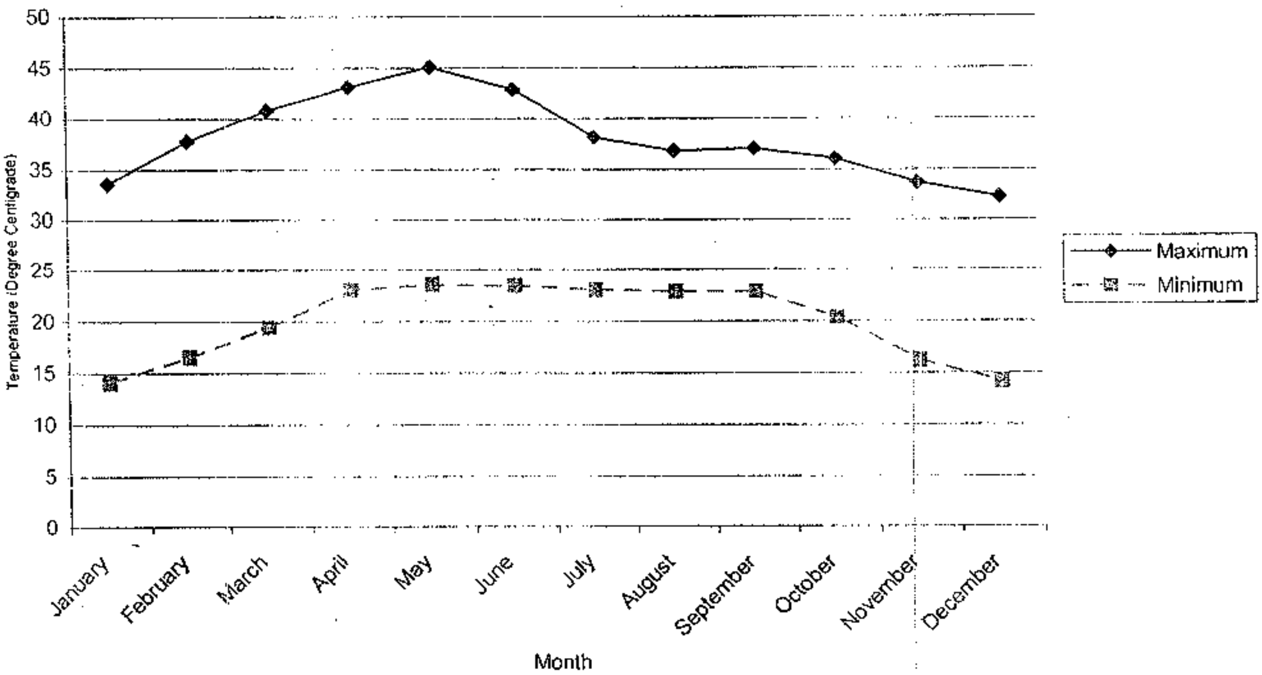
a) Temperature

The temperature variation as seen from the **Table 3.10** and **Fig. 3.11**, is between 32.1°C to 45.1°C (Maximum) and 14.1°C to 23.6°C (Minimum). The data has been obtained from IMD (1952 – 1980) for Rentachintala.

Table 3.10 Temperature data for Krishna River
(Rentachintala)
(Source: IMD, 1952 to 1980)

Month	Maximum	Minimum
January	33.6	14.1
February	37.8	16.5
March	40.8	19.4
April	43.1	23.1
May	45.1	23.6
June	42.9	23.5
July	38.2	23.1
August	36.9	22.9
September	37.1	22.9
October	36.1	20.4
November	33.7	16.2
December	32.3	14.2

Figure 3.11 Monthly variation of Temperature



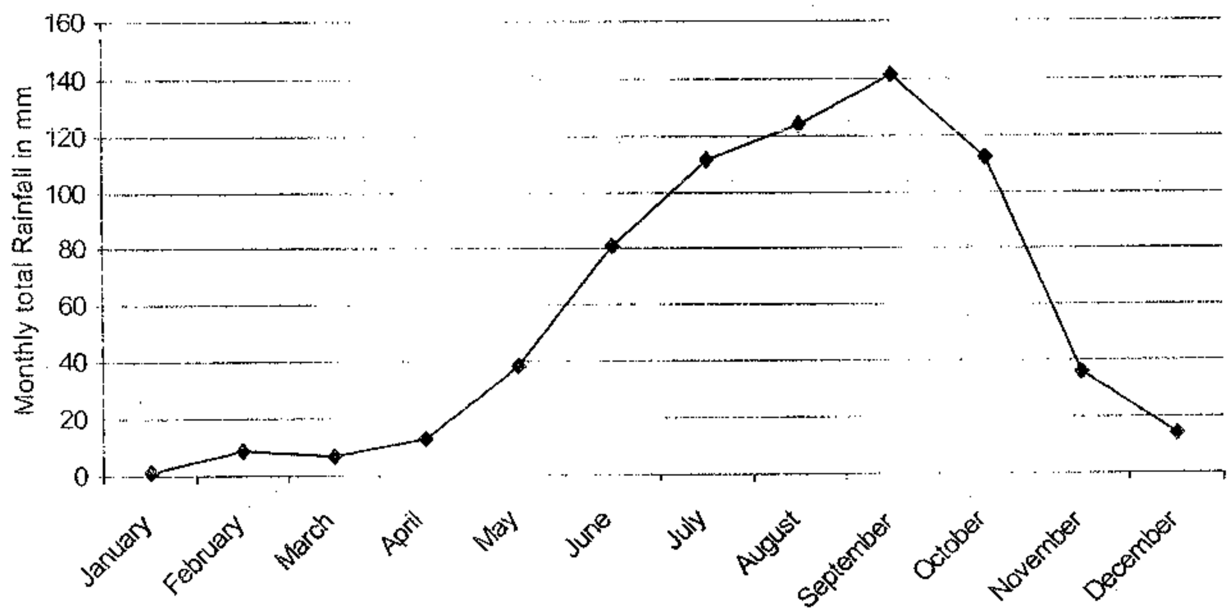
b) **Rainfall**

The maximum rainfall in river Krishna has the value of ranging between 80.9mm and 141.5mm from June to September. The heaviest rainfall recorded so far is on 29th September 1964 with 227 mm rainfall. The monthly total values of rainfall in mm has been tabulated in **Table 3.11** and graphically represented as **Figure 3.12**

Table 3.11 Rainfall near Rentachintala (Krishna River)
(Source: IMD, 1952 - 1980)

Month	Rainfall (monthly total in mm)	No. of rainy days
January	1.2	0.1
February	8.7	0.4
March	6.7	0.4
April	12.7	0.9
May	38.4	2.2
June	80.9	5.5
July	111.8	7.2
August	124.1	7.2
September	141.5	6.6
October	112.5	6.3
November	35.9	2.4
December	14	0.7

Figure 3.12 Rainfall near Rentachintala (Krishna River)
(Source: IMD, 1952 - 1980)



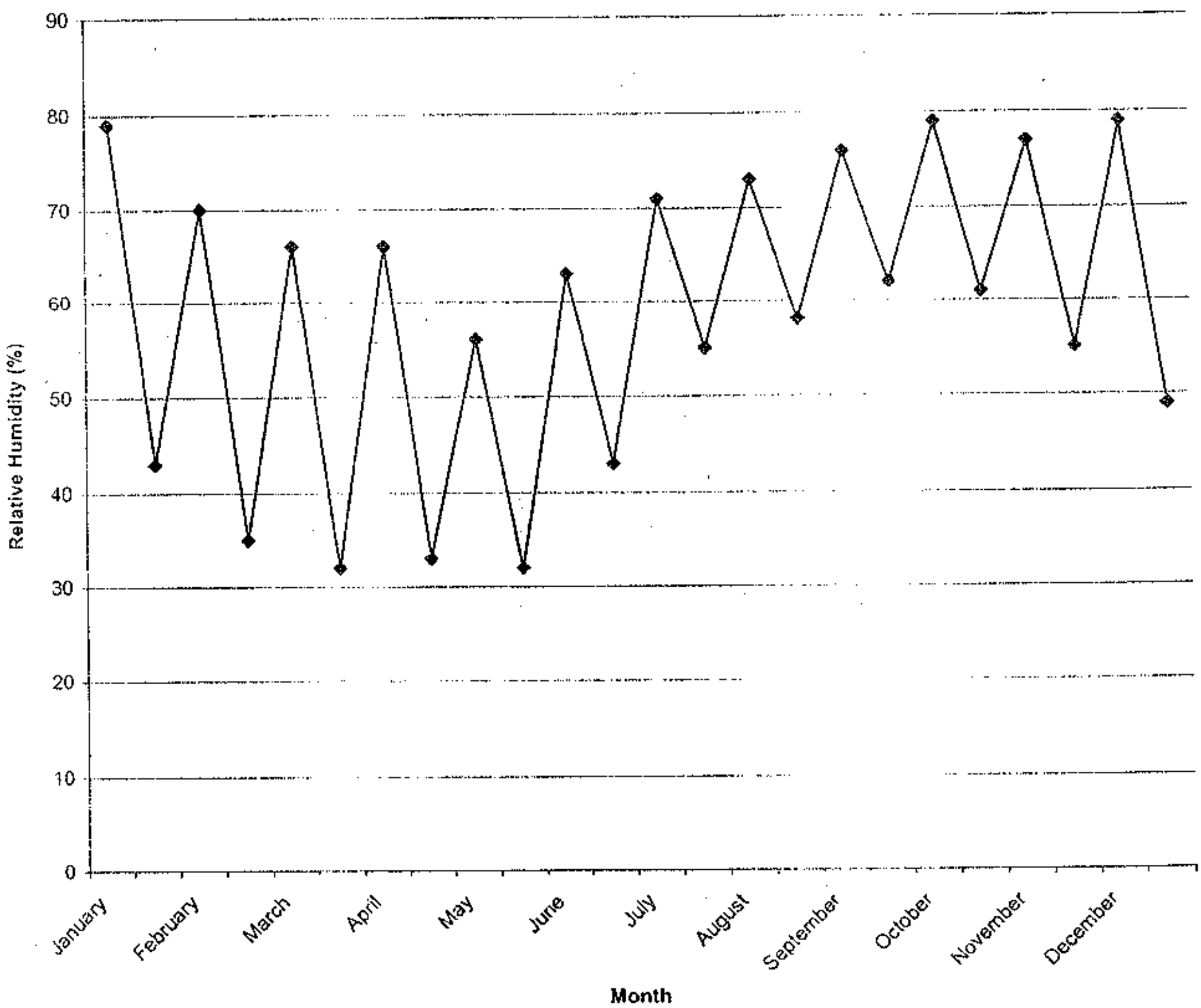
c) Humidity

The relative humidity values of Rentachintala representing river Krishna are tabulated in **Table 3.12** and represented graphically in **Figure 3.13.** The relative humidity of 29 years from 1952 to 1980 have been considered. The most humid months are July to December and January.

Table 3.12 Relative Humidity at Rentachintala (Krishna River)
(Source: IMD, 1952 - 1980)

Month	Relative Humidity (%)
January	79
	43
February	70
	35
March	66
	32
April	66
	33
May	56
	32
June	63
	43
July	71
	55
August	73
	58
September	76
	62
October	79
	61
November	77
	55
December	79
	49

Figure 3.13 Relative Humidity at Rentachintala (Krishna River)
(Source: IMD, 1952 - 1980)



d) Wind

The no of days of the month with wind speed 1 to 19 Kmph has been tabulated in **Table 3.13**, it can be seen that the maximum wind speed (1 to 19 kmph) occurs in the most part of the year when the wind direction is east and west.

Table 3.13 Wind data for Rentachintala (Krishna River)
(Source: IMD, 1952 - 1980)

Month	No. of days with wind speed 1 to 19 kmph	No. of days with wind speed as 0 kmph
January	14	17
	22	9
February	19	9
	24	4
March	23	8
	28	3
April	26	4
	27	3
May	27	4
	26	5
June	29	1
	28	2
July	30	1
	30	1
August	28	3
	28	3
September	23	7
	23	7
October	14	17
	19	12
November	9	21
	15	15
December	10	21
	15	16

3.3.4 Lock

There is one lock existing in the stretch of river Krishna. The details of lock are given in **Table 3.14.**

3.3.5 Bridge across river Krishna

There is only one bridge existing in the stretch of river Krishna. The bridge is at Pondugula. The details of bridge are given in **Table 3.15.**

Table. 3.14 Details of Lock along the Stretch of River Krishna

SL. NO.	Chainage at	Name of Lock Entrance	Details of Lock	In Mtrs.	Minimum width
1.	157.00 km	Vijayawada lock	1. Size of chamber 2. FSL 3. Sill Level	42.6 x 4.83 Sill Level - 12.36 Front FSL - 16.93 Clearance = 1.8 (From W.L.)	4.83 m
				Head = 0.46	

Table. 3.15 Details of Bridge along the Stretch of River Krishna

S.No.	Distance from 0 K.M.	Type of Bridge	Length (m)	width (m)	No of Piers	Dist.between Piers	Water Level(WL) w.r.to (MSL)*	Vertical Clearance w.r.to WL (m)	Vertical Clearance w.r.to HFL (m)	Remarks	Whether Bridges require modification
1	0.25	RCC Road Bridge	520.26	8	14	40	43.4	10	3.2	Road Bridge at Pondugula	No**
2	157	Barrage	550	10	71	7.3	15.2	8	3.5	Prakasam Barrage	No**
										Total number of bridges requiring modification	Nil

* On the observed day
** Refer Para 6.3.8.2

3.4 CANAL SECTION

The canal section of proposed waterway consists of following stretches of canals and discussed in subsequent paragraphs.

- Kakinada canal(Kakinada to Rajahmundry)
- Eluru Canal (Rajahmundry to Vijayawada)
- Commamur Canal (Vijayawada to Peddaganjam)
- North Buckingham Canal (Peddaganjam to Basin Bridge at Chennai)
- South Buckingham canal (Basin Bridge to Marakanam)

3.4.1 Eluru Canal

The Eluru Canal runs for a total distance of 139 Kms from Vijayawada to Vijjeswaram lock at Sir Arthur Cotton Barrage or Godavari Canal. The canal comprises of two distinct irrigation cum navigation canals viz :

- Krishna Eluru Eastern Delta Main Canal
- Godavari Eluru Western Delta Main Canal

The Krishna Eluru Eastern Delta Main Canal takes off on the left bank of Krishna River on the upstream of Prakasam barrage through a head sluice. A navigational lock of length 45.7 m x 4.6 m width is provided adjacent to the head sluice near Prakasam Barrage. The lock is in working condition as seen by the consultants. The vessel can move from this lock. The main canal is designed to carry 300 cumecs of water with a bed width of 61 m and Full Supply depth of 4.57 m. After traversing to a length of 1 Km., the main canal gets trifurcated into Eluru canal, Rhyves canal and Machilipatnam canal. A regulation cum navigation lock has been provided at a distance of 1 Km. from the point of trifurcation in the Eluru Krishna Canal. The Krishna Eluru canal of a total length of 63.7 Km. meets the Godavari Eluru canal at east Tammileru lock. The difference between the Full Supply levels of the two canals is 3.67 m. The Godavari Eluru Western Delta Main canal takes off from river Godavari at Vijjeswaram on the upstream of Dowleiswaram anicut through a head sluice. There are four locks in Krishna & one lock in Godavari Eluru Canal and a total of 95 structures including bridges (railway, foot, road bridges, aqueducts) along the whole Eluru canal stretch of 139 km length including Krishna Eluru & Godavari Eluru Canals.

3.4.1.1 Morphological condition of Eluru canal

The morphological condition of Eluru canal for a distance of 139 km has been described reachwise as given below.

Reachwise Status

In a stretch of 10km for Godavari Western Delta main canal from Ch.0 at Vijjeswaram lock to Ch. 10 Km. it is observed that sufficient water is available in the canal. The width of canal is near about 60 to 70 m as found in the ground which is well and good for navigation. There are Bridges including footbridges and Railway Bridges existing for communication with connected roads & path along both sides of canal. The canal gets bifurcated at 3.5 km. and rejoins at 6.5 km. Next reach from Ch. 10 Km. to Ch. 28 Km., depth of water and width of canal may be considered good for navigation. No ferry services are found as there are connected roads for transportation in this area. There are Bridges, Footbridges & Railway bridges existing over this canal. An aqueduct over Errakunda River at Km 13.0 is also found. The reach from Ch. 28 km. to Ch. 68.3 km has depth of water 1.5 m to 2.5 m. Small boats only can ply in this portion of canal. There are bridges & footbridges linked with road & footpaths for communication existing. There are six numbers of aqueducts falling in this portion of canal. In the portion from Ch. 68.3 km. to 96.7 Km., canal water is having about 2 m depth and width of canal about 25 m to 30 m This portion of area is also navigable for boats only. There are roads & footpaths for transportation with bridges including footbridges. There are five numbers of aqueducts at Km 79.6, 81.3, 85.9, 95.4, and 96.7 respectively. There is a bridge over lock at Km.74.5. Godavari water is flowing upto this lock which remains closed and thereafter Krishna feeds the canal upto Eluru Town. From Ch. 96.7 Km. to 134.7 Km., the canal is bearing depth of water 2 m to 3 m and width of this canal is 30 m to 35 m where navigation of boats is possible but due to locks no large boat can enter the canal. There are roads & footpaths well connected by bridges and foot bridges over the portion of this canal. There are two numbers of aqueducts at Km. 122.5 & 127.5, which fall in this area. The canal passes through almost the centre of Vijayawada City from Km.135-140.The portion is navigable. In the last stretch from Ch. 134.7 Km. to Ch. 139 Km, the portion of canal is navigable. This area is also comfortable for communication and transportation as there are Railway. Bridges, RCC Bridges including foot bridges over this canal and are linked with roads & paths. There are two locks. There is a bridge over lock at Km.138.0 and another lock at Km.139.7, where boat cannot enter into the canal. This portion is not navigable.

3.4.1.2 Fairway Development:

The required water depth of minimum 1.6 m will be available for a period of about 310 days in a year. The canal will be closed for maintenance works for about 55 days in a year. The tail reach of the canal needs some manual excavation/dredging.

3.4.1.3 Bridges

The details of bridges existing in the stretch of Eluru canal are given in Table 3.16.

3.4.1.4 Locks

There are five locks in the stretch of Eluru canal and details are tabulated in **Table 3.17**.

3.4.1.5 Aqueducts

Aqueducts are basically cross drainage works constructed to dispose off drainage discharge so that the canal water supply continues uninterrupted. The details of existing aqueducts are tabulated in **Table 3.18.**

TABLE – 3.16
DETAILS OF EXISTING BRIDGES IN ELURU CANAL

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
GODAVARI ELURU CANAL						
1	0.4	Vijjeswaram	RCC	40	7.7	20
2	0.6	Vijjeswaram	Foot Bridge	45	7	20
3	3.7	Kotta Gopavaram	RCC	84	6	7.5
4	6.4	Satnvatsaragudem	RCC	60	5.1	35
5	10	Chettipetta	Railway	42	5.2	12.2
6	10.2	Chettipetta	RCC	75	5.2	15
7	13.75	Foot bridge	RCC	34.5	11	8.5
8	15.4	Arulle	RCC	55.5	4.9	15.5
9	19.8	Nawabpalem	RCC	27	4	22.5
10	22.1	Kagnlamapadu	RCC	26.5	5.1	13.2
11	22.6	Prattipadu	RCC	116	10.5	40.0
12	24.3	Juwalapalem	RCC	38	4.5	10
13	25.3	Juwalapalem foot bridge	RCC	28.5	4.7	13.5
14	27.3	Tadepalligudam	RCC	30.0	4.7	10
15	27.5	Tadepalligudam	Flyover	30	6	15
16	27.6	Tadepalligudam (old)	RCC	30.6	5.4	30
17	28	Foot bridge	RCC	25.5	4.5	12

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
18	29.4	Yagarlapalle bridge	RCC	30.5	4.5	10
19	33.6	Badampudi bridge	RCC	25	5.8	12.5
20	36	Ellamilli bridge	RCC	47.5	5	8
21	38	Ungturu bridge	RCC	36.2	4.4	10
22	39.2	Ungturu bridge	RCC	21.5	4.3	9.5
23	40.6	Turingupeta bridge	RCC	21.5	4.5	10
24	42.4	Narayanpuram bridge	RCC	21.4	5	10.2
25	45.6	Kalkaram bridge	RCC	28	2.5	14
26	50.1	Pulla bridge	RCC	30.5	2.5	15
27	52.5	Kurrellagudem bridge	RCC	26	5	13
28	56.6	Bhimadolu	RCC	39	5.5	19.5
29	59	Paturu	RCC	26.5	5.1	13.2
30	62	Gundugolanu	RCC	23	5.5	18
31	64	Komirepalli bridge	RCC	30	5	10
32	67.8	Denduluru bridge	RCC	14.2	5.2	14.2
33	69	Kovvallli bridge	RCC	15	5	15
34	70.5	Kovvalli bridge	RCC	22.8	4.5	14.5

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
KRISHNA ELURU CANAL						
35	140	Bhaskararaopeta	RCC	59	13	25
36	139.5	Bhaskararaopeta	RCC	63	5.3	21.5
37	139.3	Bhaskararaopeta	RCC foot bridge	83	5	14.5
38	139.1	Railway Bridge at Kaleswaram	Iron girder bridge	85	5	30
39	138.9	Kaleswaram bridge	Railway bridge	35	5	25
40	138.2	Gandhinagar	RCC	40	4	20
41	138	Eluru canal lock bridge at Gandhinagar	Girder bridge	45	5	15
42	137.7	Gandhinagar bridge	RCC	44	5.4	11
43	137.5	Sattanarayanapuram	RCC	26	3.7	13
44	137.5	Sattanarayanapuram	Steel	26	3.7	13
45	137.1	Kedareshwarapeta	RCC	30.5	4.8	30
46	136.1	Ayodhyanagar bridge	RCC	28.5	4.9	14
47	135.5	Ajit Nagar Bridge	RCC	39	4	13
48	134.9	Madhurnagar Bridge	RCC foot bridge	42	3.8	10
49	135.5	Vijayanagar	RCC foot bridge	30.5	4.3	10

1	0	Vijjeswaram lock	9.70	12.9	2x45.72x6.1	6.1
	KRISHNA ELURU CANAL					
1	139.7	Vijayawada lock at Bhaskararaopeta	12.33	16.01	31.09 x 4.8	4.8
2	138	Eluru canal lock at Vijaywada	12.33	15.8	45 x 4.88	4.88
3	79.6	West Tammileru lock	11.40	13.16	73.15 x 7.62	7.62
4	74.5	East Tammileru lock	10.86	12.84	44.81 x 6.55	6.17

64	96.5	Perikiduvantena	RCC arched	34	4.5	19
65	93.8	Perikidu	Foot bridge	36	4	18
66	92	Totagudem	RCC	60	5	20

Table 3.18 DETAILS OF AQUEDUCTS ALONG ELURU CANAL

Sl. No.	Location of Aqueduct	Chainage	Bed level	FSL	Length	Width	Height
		Km	m	m	m	m	m
1.	Navigation Aqueduct over Errakunda River	13.000	8.85	11.00	112.80	14.00	3.3
2.	Unguturu Aqueduct Over Nala	38.300	10.70	11.50	30.00	20.40	3.5
3.	Aqueduct over Kaikaram Drain	47.500	7.90	11.70	30.00	20.00	3.4
4.	Aqueduct over No.3 EscapeDrain UT/7	54.500	8.50	11.70	30.50	16.50	3.0
5.	Aqueduct over Gandevangudem UT/8	60.000	8.00	11.90	35.00	20.00	3.0
6.	Aqueduct over Potunurs Chanel	65.300	7.70	12.00	40.00	14.02	3.0
7.	Aqueduct over Kovvali Drain	68.300	8.00	12.50	25.00	14.00	3.3
8.	Aqueduct over Tamileru River	79.600	8.40	12.80	80.00	16.00	3.4
9.	Satrampadu Aqueduct	81.300	8.50	13.20	30.00	15.00	3.9
10.	Vatluru U.T.	85.900	9.00	13.20	25.00	20.00	4.0
11.	Pedapadu Aqueduct	95.400	9.10	13.40	15.00	12.00	4.5
12.	Perikeedu U.T.	96.700	9.30	13.80	25.00	15.00	5.0
13.	Kesarapalli Aqueduct U.T.	122.500	12.00	15.20	60.00	15.00	3.2
14.	Enkapadu Aqueducts U.T.	127.500	12.09	5.20	65.00	15.0	3.5

3.4.2 Kakinada Canal

3.4.2.1 Morphological condition of Kakinada canal

The morphological condition of Kakinada canal has been described reachwise as given below.

Reachwise Status

The Kakinada Canal takes off from Dowleiswaram Barrage as a Godavari Eastern Main Canal on the left bank of river Godavari. From chainage 0 to 1.5 Km., the canal width is near about 100 m and bearing enough water liable for Navigation and both the banks of canal are lined. It starts through a head sluice and lock. The lock is exclusively provided for navigation. At present the lock is manned by Lock supervisor under Deptt. of Irrigation and CAD, GoAP. The lock is with two chambers of size 45.72 m x 6.10 m each. Water from the river Godavari passes through a lock gate and canal named as Samalkot canal starts its journey. In the Chainage 1.5 to 7.25 Km., Samalkot canal gets bifurcated at Kadiyam Lock and Kakinada Canal flows from here. The size of the lock is 45.72 m x 6.1 m. This portion of canal is having sufficient water and width is about 50m. Road approaches also are in good condition. There are two bridges and one is under construction. One-foot Bridge also exists over Kadiyam Lock & weir. This portion is not navigable at present. From Ch 7.25 Km. to Ch 21.4 Km., the portion of canal is not navigable due to locks. No ferry services are there. Bridges & Foot bridges exist for transportation and communication. Next reach observed is from Ch. 21.4 Km. to Ch 48 Km. This portion of canal is not navigable because of presence of heavily silted locks. These locks are:

Medapadu Lock
Tossipudi Lock
Chintapalli Lock of the dimensions 45.72 m x 6.1 m. each.

Width of canal is about 25 to 30 m. No ferry services are seen as there are bridges including Footbridges, which are linked with roads. Un-metaled roads are found which are connected to NH & SH. From Ch. 48 Km. to Ch. 50 Km. in Kakinada, the portion of canal is also having sufficient water and width of canal is also near about 25 to 30 m. Here a navigational lock at Kovvuru exists which is heavily corroded and silted up. The lock is manned by a lock supervisor under an Assistant Engineer, Irrgn. and CAD Deptt., GoAP. At Km 48,just after Kovvuru Lock, a big drain called

Bikkavolu drain starts from Km. 50 is passing through. A sluice gate to connect the water with this canal and Bikkavolu drain with small channel

starts from Km.47.9. A metalled road is passing through the right bank for communication. The New Flyover Bridge & Old Jagannathpuram Bridge falls in this area. The Kakinada Port area with small berths for ferryboats starts after Jagannathpuram Bridge.

3.4.2.2 Meteorological condition of Kakinada Canal

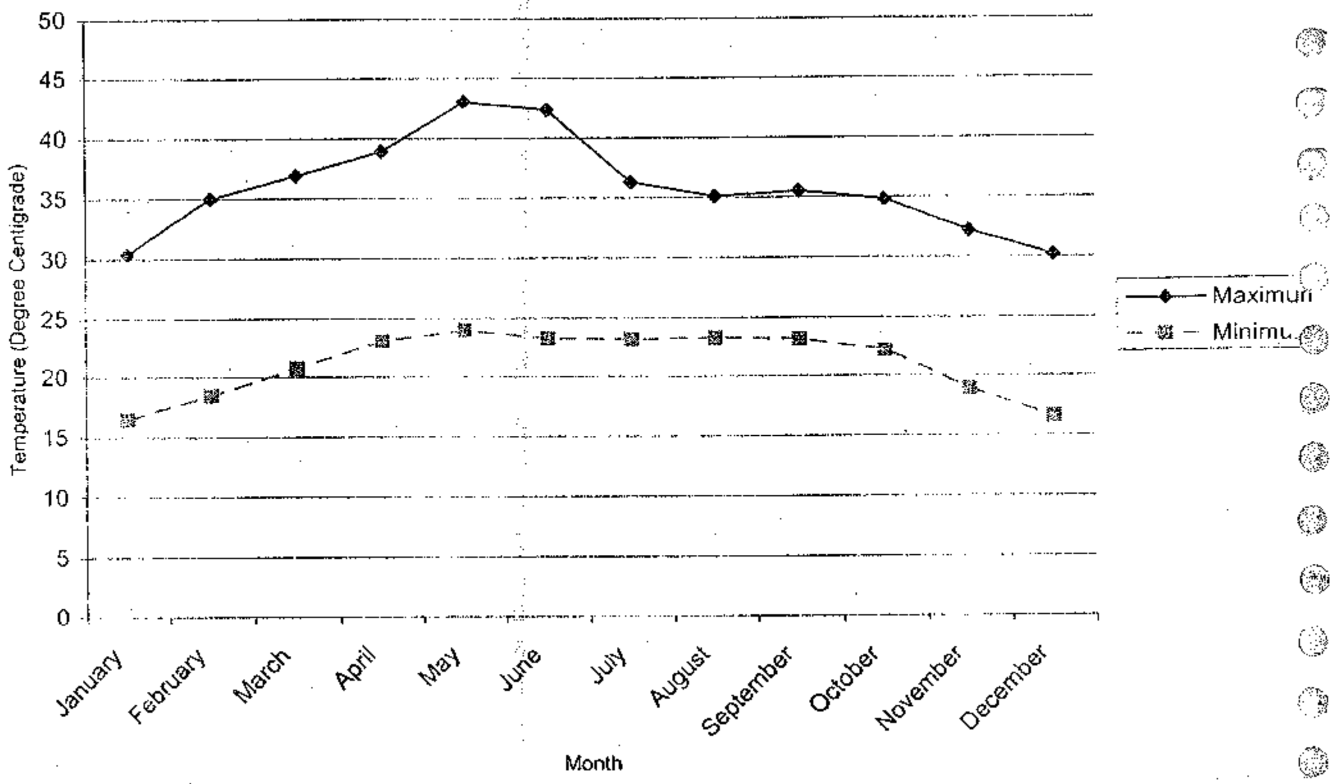
a) Temperature

The temperature variation as seen from the **Table 3.19** and **Figure 3.14**, is between 30.2°C to 42.3°C (Maximum) and 16.5°C to 23.3°C (Minimum). The data has been obtained from IMD (1952 – 1980) for Kakinada.

Table 3.19 Temperature data for Kakinada (Source: IMD, 1952 to 1980)

Month	Maximum	Minimum
January	30.4	16.5
February	35	18.5
March	36.9	20.7
April	38.9	23.1
May	43	24
June	42.3	23.3
July	36.3	23.2
August	35.1	23.3
September	35.5	23.2
October	34.8	22.2
November	32.2	18.9
December	30.2	16.6

Figure 3.14 Monthly variation of Temperature



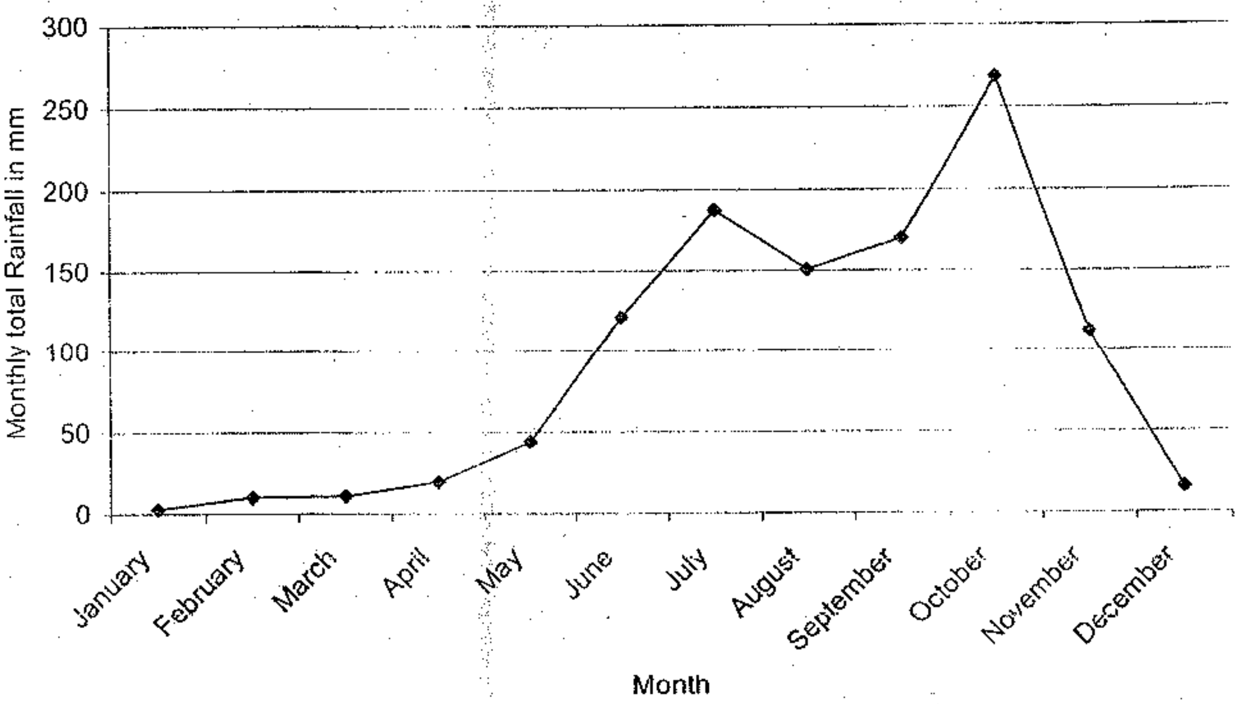
b) **Rainfall**

The maximum rainfall near Kakinada has the value of ranging between 121.2mm and 268.4mm from June to October. The heaviest rainfall recorded so far is on 29th September 1964 with 227 mm rainfall. The monthly total values of rainfall in mm has been tabulated in **Table 3.20** and graphically represented as **Figure 3.15.**

Table 3.20 Rainfall near Kakinada
(Source: IMD, 1952 - 1980)

Month	Rainfall (monthly total in mm)	No. of rainy days
January	2.9	0.2
February	10.4	0.5
March	11	0.4
April	19.7	1.1
May	44	2.2
June	121.2	7.1
July	187.3	11.2
August	150.7	10.8
September	170	8.5
October	268.4	8.8
November	112	4
December	15.6	1

Figure 3.15 Rainfall near Kakinada
(Source: IMD, 1952 - 1980)



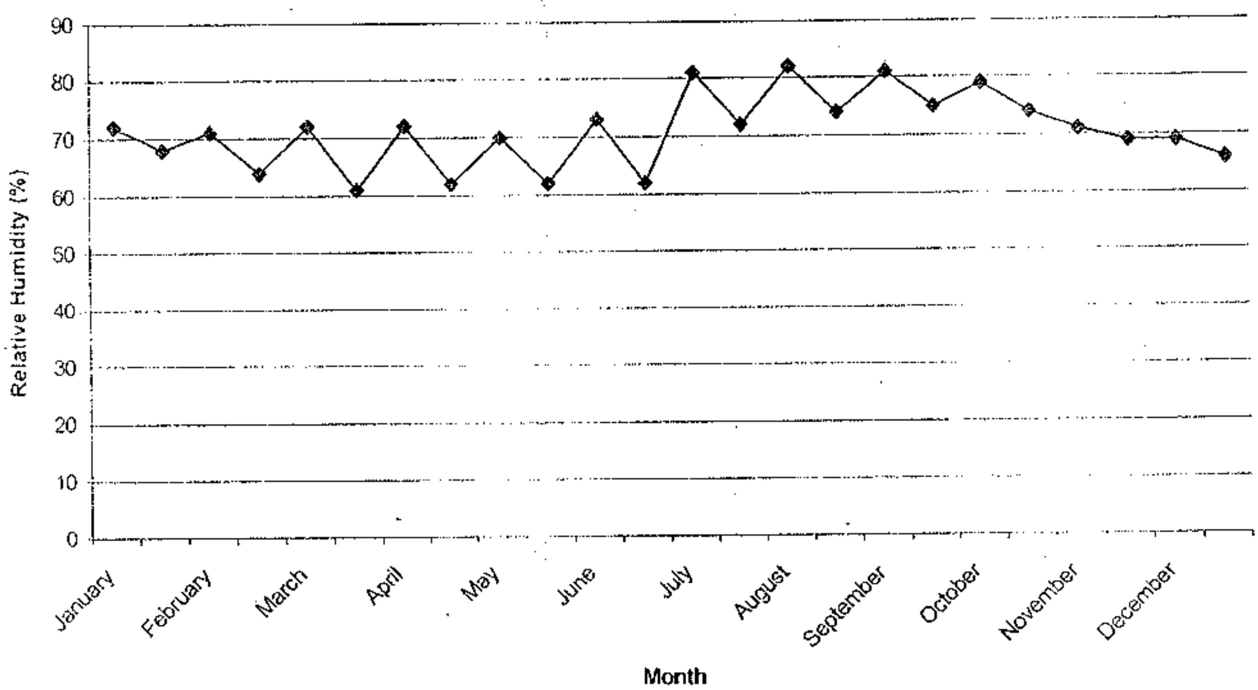
c) **Humidity**

The relative humidity values of Kakinada representing canal are tabulated in **Table 3.21** and represented graphically in **Figure 3.16.** The relative humidity of 29 years from 1952 to 1980 have been considered. The most humid months are July to October.

Table 3.21 Relative Humidity at Kakinada
(Source: IMD, 1952 - 1980)

Month	Relative Humidity (%)
January	72
	68
February	71
	64
March	72
	61
April	72
	62
May	70
	62
June	73
	62
July	81
	72
August	82
	74
September	81
	75
October	79
	74
November	71
	69
December	69
	66

Figure 3.16 Relative Humidity at Kakinada
(Source: IMD, 1952 - 1980)



d) **Wind**

The no of days of the month with wind speed 1 to 19 Kmph has been tabulated in **Table 3.22**, it can be seen that the maximum wind speed (1 to 19 kmph) occurs in the most part of the year when the wind direction is east and west.

Table 3.22 Wind data for Kakinada
(Source: IMD, 1952 - 1980)

Month	No. of days with wind speed 1 to 19 kmph	No. of days with wind speed as 0 kmph
January	28	2
	30	0
February	24	3
	27	0
March	28	3
	30	1
April	29	1
	29	0
May	30	0
	28	0
June	27	1
	28	1
July	28	1
	28	0
August	29	1
	29	1
September	27	2
	28	2
October	26	3
	27	1
November	26	1
	25	1
December	27	1
	27	0

3.4.2.3 Fairway Development:

The depth required to be maintained is 1.6 m in Phase I and 2.0 m in Phase II. The 50 km stretch from Dowleiswaram to Kakinada is a mixed zone influenced both by river discharge of river Godavari and the tide of the sea mouth at Kakinada Port. The required depth would be achieved by carrying out dredging work in the canal as discussed in Chapter – 6.

3.4.2.4 Bridges

The details of bridges existing in the stretch of Kakinada canal are given in **Table 3.23**.

3.4.2.5 Locks

There are six locks in the stretch of Kakinada canal and details are tabulated in **Table 3.24**.

TABLE 3.23
DETAILS OF EXISTING BRIDGES ACROSS KAKINADA CANAL

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
1	1.5	Vemagiri Bridge	RCC	60	3.1	30
2	7.25	Kadium Foot Bridge	RCC Foot Bridge	26.7	3.5	3
3	11.0	Jegarpadu Bridge	RCC	21	5.5	8.5
4	16.3	Medapadu bridge	RCC	54	4.8	9.5
5	20.5	Anarpatti Bridge	RCC Foot Bridge	21	4.7	9
6	21.4	Anarpatti Foot Bridge	RCC	25	4.5	7.7
7	23.6	Kuppervaram	RCC	21.5	5.5	10.5
8	25.2	Kumaripalem	RCC Foot Bridge	26	5.2	13.0
9	26.4	Tossipudi	RCC Bridge	13.5	5	6.0
10	26.5	Kumaripalem	RCC	30.5	5	15.5
11	29.2	Pandalapakka	RCC	19.5	5.3	10
12	35.5	Chintapalli	RCC	27	5	13.2
13	37.5	Puttakonda	RCC	10	5.3	10
14	41.2	Adoclanirevu Bridge	RCC	17	5.7	8.5
15	44.4	Aratlakatta	RCC	12.1	4.4	12.1
16	47	Railway bridge no. - 21	Girder	30	4	20.0

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
17	47.8	Kavvuru	Foot Bridge	15.5	2	1.5
18	51.8	Kakinada New Bridge	RCC	108	2.7	25.0
19	52	Old Bridge Jagannathpuram	RCC	104	4.5	40.0

TABLE 3.24

DETAILS OF EXISTING LOCKS AT KAKINADA CANAL

S. No.	Chainage (in km) (From Dowleiswaram Barrage)	Name of Lock	Sill Level (in m)	FSL (in m) U/S / D/S	Size of Lock Chamber L/B (in m)
1	0.2	Dowleiswaram	9.765	20.48	2 x 45.72 x 6.1
2	7.25	Kadium Lock	9.699	12.078 / 11.926	45.72 x 6.10
3	16	Medapadu Lock	6.988	11.407 / 8.683	45.72 x 6.1
4	26.4	Tossipudi Lock	5.923	8.058 / 5.995	45.72 x 6.7
5	33.6	Chintapalli Lock	3.445	5.577 / 2.987	45.72 x 6.7
6	48	Kovvuru Lock	0.732	2.774 / 0.904	45.72 x 6.7

3.4.3 Commamur canal

The Commamur Canal runs for a distance of 113km from Seethanagram lock, Vijayawada to Peddaganjam lock and is totally dependant upon the release of water from Prakasam Barrage. The present practice to release water is from 15th June to 31st January i.e. for a period of around seven and a half months.

3.4.3.1 Morphological condition of Commamur canal

The morphological condition of Commamur canal has been described reachwise as given below.

Reachwise Status

The Chainage 0 is taken as starting from Western Delta Main Krishna Canal at Vijayawada near Seethanagram. There is a navigation lock existing on west side of sluice gate connecting Krishna River to Commamur Canal. Both banks of the Canal are having Roads and track linked up with Bridges over the canal for communication & Transportation. New localities are being built up along both sides of canal. Commamur Canal starts its journey from Commamur Lock from Ch.11.2 Km., where western Krishna canal is bifurcated. This portion is not navigable up to km 21.7. But another water channel meet at km 21.7 through a sluice over western Krishna canal. From km 22.0 downstream the canal becomes navigable. There are bridges and Railway bridges over this canal. Communication/Transportation condition is mostly satisfactory. No ferry service found in this area. There are two aqueducts at km. 32.2 & 49.8 and another lock at km 33.4.However the portion between Ch. 11.2 Km. to Ch. 49.8 Km is navigable. Further next in the potion between Ch. 49.8 Km and 114 Km., the canal is not navigable. Due to fewer localities the road conditions along canal banks are being deteriorated. There are bridges, footbridges, and Railway bridges existing on the ground. There are no ferry services in this area. There are six numbers of aqueducts at km. 65.6,73.3, 82.2, 89.1,105.6 and 107.6, Three locks are found at Km. 69.2,95.5,112.9.The portion is non navigable.

3.4.3.2 Fairway Development

The Canal is navigable at a depth of 1.6 m for a period of 7.5 months. To make the whole canal navigable for 330 days in a year, the State Government of A.P. should release the water from Nagarjuna Sagar Dam (about 190 Km. upstream of Prakasam Barrage) during the remaining period. Alternatively, the depth of 1.6 m can be maintained by releasing the water from Pulinchintala Dam under Construction (85 Km. upstream of Prakasam Barrage). The Prakasam Barrage has four number of sluices to meet the lean season requirements. This provision of sluices with a total discharge of 567 cumecs, if operated during lean season, will be sufficient to maintain the required depth of 1.6 m in the remaining period in Commamur Canal. However, it is revealed from the discussions with State Govt. authorities that their top priority is to meet irrigation requirements. The navigation has to be prioritized if continuous navigation for 330 days in a year is to be ensured.

3.4.3.3 Bridges

The details of bridges existing in the stretch of Commamur canal are given in **Table 3.25**.

3.4.3.4 Locks

There are seven locks in the stretch of Commamur canal and details are tabulated **in Table 3.26**.

3.4.3.5 Aqueducts

Aqueducts are basically cross drainage works constructed to dispose off drainage discharge so that the canal water supply continues uninterrupted. The details of existing aqueducts are tabulated in **Table 3.27**.

TABLE – 3.25
DETAILS OF EXISTING BRIDGES ACROSS COMMAMUR CANAL

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
1	2	3	4	6	7	8
1	0.05	Seethanagram lock bridge	RCC	10	2.7	10
2	1.00	Seethanagram new bridge	RCC skew	77	4.1	38.5
3	1.00	Seethanagram old bridge	RCC	77	4.1	15
4	1.60	Railway Bridge	RCC	100	5.8	17
5.	2.4	Tadepalli	RCC	94	6.7	13.5
6	5.00	Kanchanpalle	RCC double	128	6.2	32
7	6.40	Vaddeswaram	RCC	87	6.8	12.5
8	11.20	Peddavaddapudi	RCC	99	5.0	11.6
9	19.60	Commamur Lock bridge	RCC	27	5.9	25
10	19.65	Bridge	RCC	50	4.8	13.5
11	20.40	Duggirala (old)	RCC	38	4.2	15.5
12	20.45	Duggirala (new)	RCC	26.6	5.2	8.6
13	21.70	Duggirala Railway Bridge	Girder Bridge	55	4.8	13.5
14	24.20	Kolakarulu (new)	RCC	66.5	5.1	8.5
15	24.25	Kolakarulu (old)	RCC	66	5	7.0
16	31.70	Angalakudure	Railway Bridge	41.6	4.2	10
17	33.45	Jagarlamudi bridge	RCC Arch bridge	59	5.5	10

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
1	2	3	4	6	7	8
18	35.60	Vadlamudi bridge	RCC	57	4.5	10
20	41.60	Chebrolu bridge	RCC	45.5	4.3	11.5
21	53.60	Lakshmipuram bridge	RCC	29.5	4.3	13.5
22	56.70	Garikipadu	RCC	39	4.1	13.2
23	63.20	Appapuram	RCC	27.5	4.1	8.5
24	77.80	Kunkelamarru	RCC	22.5	3.0	7.5
25	83.10	Karamchedu (new)	RCC	37.5	4.9	13
26	83.15	Karamchedu (old)	Girders	30.0	4.9	13
27	87.40	Swarna	RCC	27	5	12
28	88.50	Swarna	RCC Foot bridge	37.0	4.0	6
28	90.90	Rangapandapalen	RCC	12.0	4	12
29	94.10	Santarur	RCC bridge	39.0	-	2.5
30	94.40	Santarur (Santharavuru)	RCC bridge	29.0	3.2	12.2
31	95.50	Santarur	Foot bridge	9.0	3.6	9
32	96.50	Thimmasumudram	Foot bridge	24.0	4.5	9
33	100.00	Ganasapudi (old)	RCC	16.5	2.9	16
34	100.10	Ganasapudi (new)	RCC	34.0	5.5	25
35	103.80	Chintagumpalle	RCC	8.8	4	8.8
36	109.30	Faranguladinne	RCC	30	4.4	15

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
1	2	3	4	6	7	8
37	111.20	Rajubangarupalem	Rly. Bridge	35	3.2	17
38	113.95	Peddaganjam	Arches	28	5.3	12.8

TABLE – 3.26
DETAILS OF EXISTING LOCKS AT COMMAMUR CANAL

S.NO.	Chainage (in km) From Western Krishna canal	Name of Lock	Sill Level (in m)	F.S.L. (in m)	Size of Lock Chamber L/B (in m)
1	0	Seethanagram head lock	12.207	16.51	45.7 x 4.6
2	19.5	Commamur lock	11.278	14.420	45.7 x 6.7
3	33.4	Jagarlamudi lock	8.372	10.72	45.70 x 6.40
4	50.1	Kollimaria lock	6.491	8.534	47.7 x 6.70
5	69.2	Nallamada lock (kottapalem)	3.635	5.615	45.70 x 6.70
6	95.5	Santharavuru lock	1.938	4.040	47.2 x 6.70
7	112.9	Peddaganjam lock	-0.091	2.958	47.20 x 6.7

Table 3.27 Details of Aqueducts along Commamur Canal

Sl. No. Location of Aqueduct	Chainage Km	Bed level m	FSL m	Length m	Width m	Height m
1.Guntur-Nallah Aqueduct (Tungubhadra)	32.2	8.40	10.80	20.00	40.00	4.0
2.Killimerla Aqueducts	49.8	6.50	8.50	77.00	20.00	2.3
3.Nallamada Aqueduct	65.6	3.40	6.00	83.00	15.00	2.8
4.Saki Aqueduct	73.3	2.60	5.20	10.00	15.00	2.8
5.Karamchedu Aqueduct	82.2	2.30	4.80	62.00	15.00	2.9
6.Swarna Aqueduct	89.1	2.10	4.40	20.00	14.00	2.3
7.Aqueduct over drain	105.6	1.80	4.00	50.00	14.00	2.5
8.Aqueduct over drain	107.6	1.50	3.50	25.00	14.00	2.6

3.4.4 Buckingham Canal

The Buckingham canal is a tidal canal. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused by daily variation of tides. Locks serve another purpose of creation of impounding facility to retain high water level in the canal between low tides and also during the periods when sea bars are closed. After various stages of improvements and construction of lock chambers, and surplus escapes for drainage, the canal carries only Salt Water. The canal has been divided into two parts:

- North Buckingham Canal
- South Buckingham Canal

The Canal has been re- classified by W.R.O., P.W.D., Govt. of TamilNadu as North, Central and South Buckingham Canal for administrative convenience. The figure is enclosed herewith as **Figure-3.17, 3.18 & 3.19**.

The North Buckingham Canal runs for a distance of 316 km starting from Ramperu Lock and ends at Central Station of Chennai, from where the South Buckingham canal starts .The South Buckingham Canal runs for a distance of 110km and ends at Kovalam lock.

North Buckingham canal has a bed width ranging from 15 m to 30 m. Sea water being the main source of water for the entire Buckingham canal, the North Buckingham Canal has sea connections at several places and sea water enters into the canal during high tides. At present the condition of North Buckingham Canal is such that it remains almost dry. The banks have been eroded. There are many saltpans all along the canal. During March to July every year, the canal remains totally dry as revealed from the discussions with A.P. Govt. and T.N Govt. authorities. There are following confluences of rivers along the North Buckingham Canal:

1. River Paleru Confluence
2. River Manneru confluence
3. River Musi confluence
4. River Pennar confluence.

The range of the tide is about 0.7 to 1.0 m.

The South Buckingham Canal is also a tidal canal which takes off from Cooum river at Chennai and runs along the Eastern coast upto Kovalam North lock near Marakanam for a total length of 110 km. It has sea openings at seven places viz.:

- Marina beach
- Adyar
- Muthukadu
- Kalpakkam
- Palar
- Paramankani Kuppam
- Marakanam

Locks are provided in the canal near sea openings to control the tidal flow and retain the desired water level in the canal. Sand bars have been provided at these openings due to which it remains closed for about seven months in a year.

The canal in Chennai City is totally in abandoned condition. It has silted up heavily. Its banks have been heavily encroached where huts and houses have come up. The width of the canal is in the range of 10 to 15m. To add to it, Govt. of T.N. has allowed Mass Rapid Transport System (MRTS) to construct Elevated Railway Stations right over the canal as per the recommendations of the Working Group appointed by the Planning Commission in 1976-77 for better connectivity between North South Eastern (NSE) Corridors. The PWD officials and Railway M.T.P. officials did not have any other corridor available economically than to follow the Buckingham Canal Stretches. As MRTS had to follow curves in certain stretches, it has been taken sometimes crossing the canal. In many places, the columns of MRTS flyover bridges are within the canal bed itself and in certain places; the pedestal foundation of column is exposed above the canal bed. As revealed from WRO, there is no navigation possible in the Chennai stretch. Alternative suggested by earlier consultants of constructing a Bye-pass canal in Chennai City is also ruled out because of non-availability of adequate water coupled with high density of population and space crunch in Chennai City. It is therefore recommended that the Stretch inside Chennai City should not be taken for IWT development. From Chennai southwards, the canal is heavily silted up upto Marakanam. The banks have been eroded. The

East Coast Road runs parallel to the canal. The canal enters from Muthukadu Boat House Lock in backwater zone. It gets spread and is mixed with sea and other water bodies. The depth remains at 0.3 m to 1.3 m and width is about 25 m. The Muthukadu Sea opening remains closed approximately for a period of seven months in a year. The tidal effect is approx. 20 cm to 40 cm which has influence upto 10 Km. south. The canal bank remains unprotected upto Mahabalipuram Road Bridge. At around 5 km. south of Mahabalipuram, kalapakkam Atomic Power Plant is situated. Sea opening also exists there. Water is taken from the sea for cooling purposes and part of it is discharged into the canal on North side. This raises the level of water upto 20 cm for 20 km. length. The next portion is river Palaru confluence south of Kalpakkam. Sea opening exists at Pudupattinam and at the mouth of Paleru River. The canal was found dry at this portion during survey period. The south bank of canal is almost non-existant here. Further south of Kalapakkam near Alambarai Bridge the canal is curved and is widened. The depth is about 0.7 m and width is around 90 m. Canal gets obstructed by sand heaps for a km. long portion further. It meets Marakanam backwater where a sea opening exists. The sea opening remains closed for about 7 months in a year. The South Buckingham Canal ends here.

3.4.4.1 Meterological Conditions

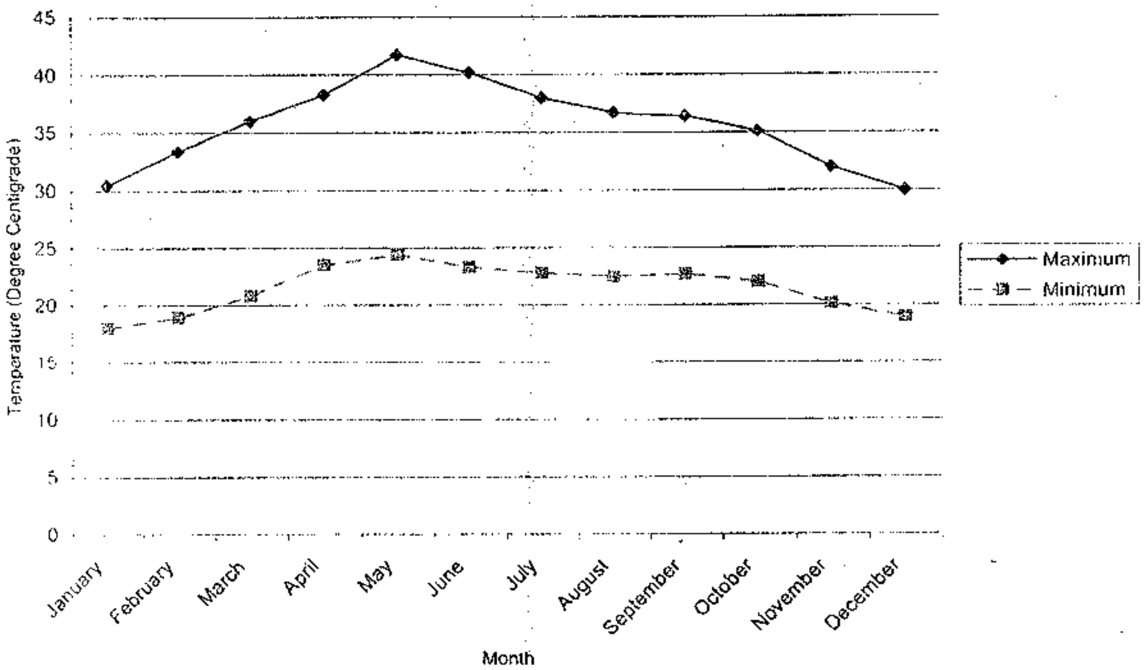
a) Temperature

The temperature variation as seen from the **Table 3.28** and **Figure 3.20** is between 30°C to 41.7°C (Maximum) and 18°C to 24.4°C (Minimum). The data has been obtained from IMD (1952 – 1980) for Chennai.

Table 3.28 Temperature data for Chennai
(Source: IMD, 1952 to 1980)

Month	Maximum	Minimum
January	30.5	18
February	33.4	18.9
March	36	20.8
April	38.3	23.5
May	41.7	24.4
June	40.2	23.3
July	38	22.8
August	36.7	22.5
September	36.4	22.7
October	35.1	22
November	32	20.1
December	30	18.9

Figure 3.20 Monthly variation of Temperature



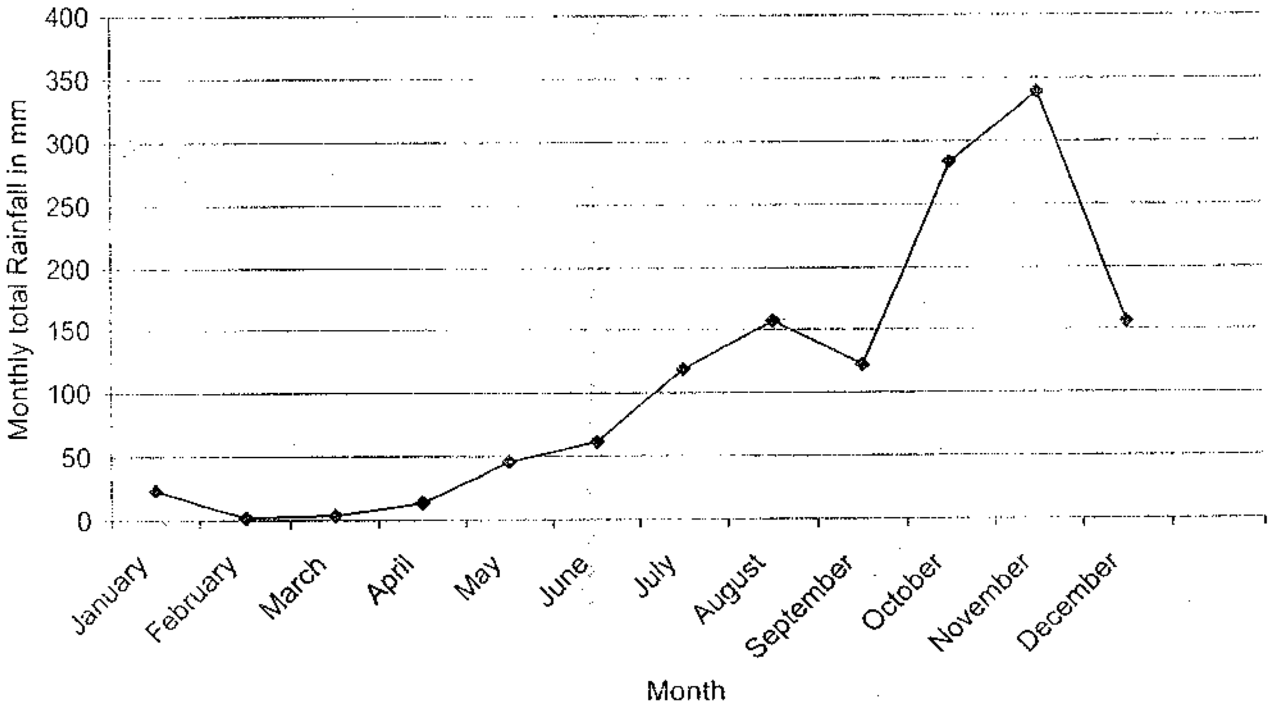
b) Rainfall

The maximum rainfall near Chennai has the value ranging between 118.5 mm and 339.2 mm from July to November. The monthly total values of rainfall in mm has been tabulated in **Table 3.29** and graphically represented as **Figure 3.21.**

Table 3.29 Rainfall near Chennai
(Source: IMD, 1952 - 1980)

Month	Rainfall (monthly total in mm)	No. of rainy days
January	23.5	1.6
February	2.1	0.3
March	3.7	0.3
April	13.5	0.9
May	45.7	1.7
June	61.5	4.6
July	118.5	7.4
August	157	9
September	121.8	7.1
October	283.2	10.2
November	339.2	10.4
December	156.2	5.6

Figure 3.21 Rainfall near Chennai
(Source: IMD, 1952 - 1980)



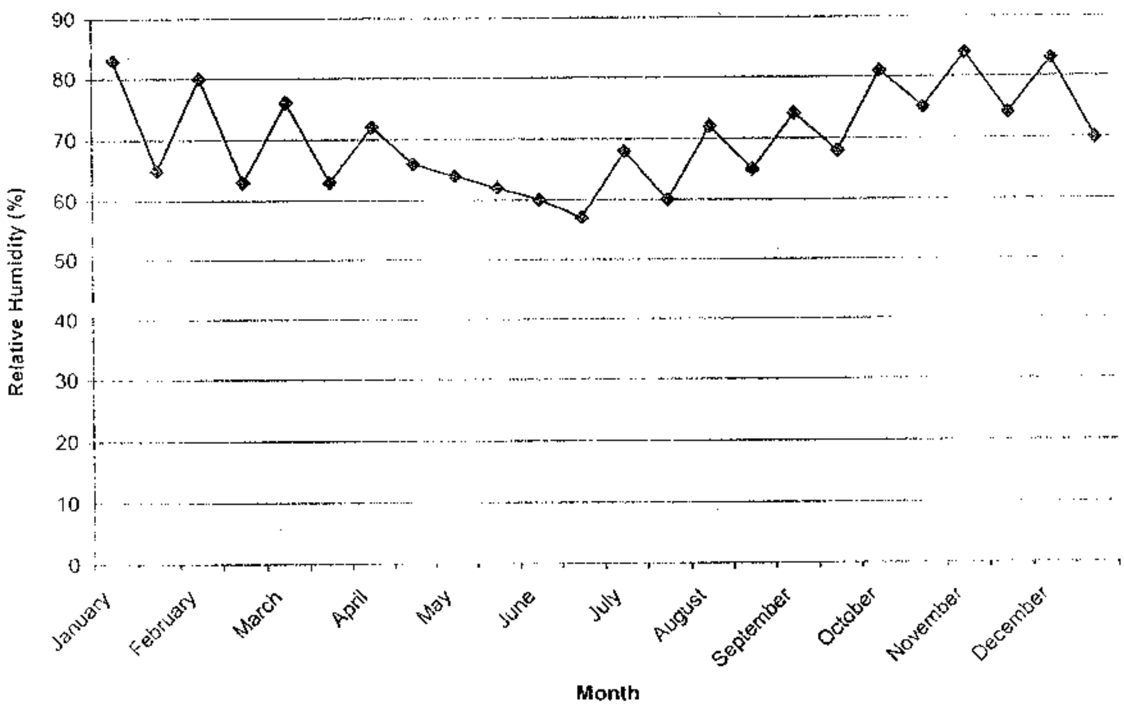
c) **Humidity**

The relative humidity values of Chennai representing canal are tabulated in **Table 3.30** and represented graphically in **Figure 3.22.** The relative humidity of 29 years from 1952 to 1980 has been considered. The most humid months are July to October.

Table 3.30 Relative Humidity at Chennai
(Source: IMD, 1952 - 1980)

Month	Relative Humidity (%)
January	83
	65
February	80
	63
March	76
	63
April	72
	66
May	64
	62
June	60
	57
July	68
	60
August	72
	65
September	74
	68
October	81
	75
November	84
	74
December	83
	70

Figure 3.22 Relative Humidity at Chennai
(Source: IMD, 1952 - 1980)



d) Wind

The no of days of the month with wind speed 1 to 19 Kmph has been tabulated in **Table 3.31**, it can be seen that the maximum wind speed (1 to 19 kmph) occurs in the most part of the year when the wind direction is east and west.

Table 3.31 Wind data for Chennai
(Source: IMD, 1952 - 1980)

Month	No. of days with wind speed 1 to 19 kmph	No. of days with wind speed as 0 kmph
January	27	4
	29	0
February	24	4
	25	0
March	27	4
	26	0
April	27	2
	22	0
May	26	1
	23	0
June	22	1
	23	0
July	26	1
	25	1
August	26	1
	27	1
September	26	2
	27	1
October	26	4
	27	3
November	26	3
	27	1
December	27	3
	28	0

3.4.4.2 Bridges

The details of bridges existing in the stretch of Buckingham canal are given in **Table 3.32.**

3.4.4.3 Locks

The details of existing locks in the stretch of Buckingham canal are tabulated in **Table 3.33.**

TABLE – 3.32
DETAILS OF BRIDGES ACROSS BUCKINGHAM CANAL

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
1	17.800	Pallepalem	RCC	30.0	4.4	10
2	25.600	Kottapatnam	RCC	25	5.2	13.2
3	33.600	Itanukkala	RCC	30.0	5.0	10
4	35.900	Gavandlapalem	Bamboo Bridge	20.0	5.0	10
5	42.700	Palleru	Wooden Bridge	25.0	5.0	12
6	44.000	Kesavapalem	RCC Bridge	54.0	4.0	17.5
7	46.400	Pallepalem	RCC	30.0	3.5	20
8	55.700	Pallepalem	Broken RCC	38.0	3.4	5
9	73.000	Ramayapatnam	RCC	37.5	6.5	11
11	76.050	Arularadipalem	RCC	42.0	4.4	11
12	77.200	Mundevadipalem	RCC Foot Bridge	42.0	(Broken and Not in use)	
13	84.200	Kotachattnam	RCC	45.0	6.2	11
17	108.500	Iskapalle	RCC	28.5	5.6	10
18	119.600	Ramachandrapuram	RCC	26.0	4.4	10
19	137.000	Maipadu	Foot Bridge	29.5	4.4	12.1
20	137.200	Maipadu	RCC Bridge	28.2	4.4	12.5
21	144.200	Venkannapalem	RCC Jetty	47.0	6.0	12
22	145.600	Patavenkatapalem	RCC Jetty	47.0	3.0	7.5
23	146.000	Mutiayalalapu	RCC Jetty	47.0	6.0	12

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
24	149.600	Yenatipalem	RCC Bridge (Broken)	23.7	1.5	8
25	150.500	Papattapalem	RCC Foot Bridge	35.0	6.0	10
26	150.800	Nadiamapattapalem	RCC	28.0	6.5	25
27	155.600	Anantapuram	RCC	25.0	5.0	15
28	158.400	Nalatur	RCC	25.5	4.5	16
29	166.800	Mathukuru	RCC	26.0	3.7	10
30	189.200	Siddhavaram	RCC	22.5	4.8	12
31	195.200	Majarapatireddipalem	RCC Jetty Bridge	45.0	6.0	12.5
32	196.800	Tupidipalem	RCC Bridge	24.0	6.1	16
33	212.800	Monapalem	RCC	27.5	5.7	11.5
34	235.300	Sriharikota	RCC	39.5	3.2	12.4
35	292.000	Kupam Railway Bridge	Iron Girder Railway	25.0	5	20
36	292.800	Kupam Road Bridge	RCC	25.0	5	20
37	293.600	Ennore Bridge	RCC	25.0	5	20
38	296.500	Ennore Bridge (new)	RCC	45.0	4.8	11
39	296.700	Ennore Railway Bridge	Iron Girder Bridge	45.0	5.1	11
40	298.900	Kattivakkam Foot Bridge	RCC Foot Bridge	35.0	3.9	15
41	299.000	Kattivakkam Bridge	RCC	35.0	3.9	15
42	301.700	Eranavur	RCC Foot Bridge	29.0	3.5	10

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
43	303.000	Wimtanagar Pipeline Bridge	Iron	29.0	5.1	25
44	304.600	Fire Station Bridge	Iron Girder Railway Bridge	25.0	4.7	25
45	305.400	Bridge near Rly Colony	RCC	25.0	4.7	25
46	307.000	Tonderpet Terminal Bridge	RCC Foot Bridge	27.5	3.2	12
47	308.800	Korukkupet Railway Bridge	Iron Girder Bridge	35.0	2.9	20.5
48	308.850	Korukkupet Bridge	RCC	35.0	4.4	20.5
49	310.200	Perambur Railway Bridge	Iron Girder Bridge (Double Bridge)	45.0	5.0	26
50	310.600	Perambur Four Lane bridge	Iron Girder Railway Bridge	45.0	5.6	10
51	310.800	Perambur Bridge	RCC	55.0	3.0	14
52	312.400	Georgetown Bridge	RCC	41.0	3.7	10
53	312.600	Pursavakam Rly bridge	Iron Girder Railway Bridge	40.0	1.5	5
54	314.000	Bridge near Central Rly Station	Iron Girder Railway Bridge	35.0	2.5	7
55	314.100	Bridge near St. George	RCC	41.0	3.0	20
56	314.200	Bridge near St. Mary's Church	RCC	Under Construction		
57	315.300	Bridge at Napier Town (Chepauk)	RCC	21.0	6.0	11
58	315.450	Napier Town Bridge	RCC	20.0	2.5	6.1

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
59	315.800	Wallajab Road Double Bridge	RCC Double Bridge	34.0	3.0	18
60	316.300	Pycrofts Road Bridge	RCC	35.0	5.0	10
61	316.600	Amirmahal	RCC Foot Bridge	10.0	3.0	8.5
62	317.000	Sunguvar Station	RCC	10.5	3.0	8.5
63	317.300	Icehouse Road Bridge	RCC	29.0	4.5	8.5
64	317.800	Lloyd's Road Bridge	RCC	20.0	2.5	6.1
65	317.850	Foot Bridge	RCC	20.0	3.5	10
66	318.500	Dr. Radhakrishnan Road Bridge	RCC	24.0	4.5	20
67	318.550	Dr. Radhakrishnan Road Bridge	RCC	26.0	1.8	15
68	318.750	Dr. Ambedkar Road Bridge	RCC	32.0	1.5	16
69	319.100	Mundakkani Street Bridge	RCC	32.0	1.5	6.5
70	319.500	Triumali Rly Bridge	Iron Girder Bridge	28.0	2.0	20
71	319.800	South of Triumalli Rly Bridge	RCC	28.0	2.0	18
72	320.200	Rangachery Road Bridge	RCC	28.0	2.0	20
73	320.600	Bridge at Chennai	RCC	28.0	2.0	20
74	320.900	St. Marry's Road Bridge	RCC	40.0	3.5	20
75	321.000	Venkatakrishna Road Bridge	RCC	40.0	3.5	20
76	321.200	Mundayem Pakkar Bridge	RCC	40.0	3.5	20
77	321.900	Greenways Road	RCC	45.0	3.5	20
78	322.800	Adyar River Bridge	RCC	45.0	3.5	20

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
79	323.000	Gandhinagar	RCC Foot Bridge	25.0	4.4	16
80	323.400	Sardar Patel Road Bridge	RCC Road Bridge	35.0	3.5	20
81	323.800	Kasturi Bai Bridge	RCC	40.0	2.5	20
82		Indira Nagar Bridge	RCC			15
83	325.500	Thiruvanmiyur Road	RCC	40.0	2.0	20
84	326.400	Thiruvanmiyur (S)	RCC	30.0		20
85	327.200	YMCA	RCC	15.0	1.3	5
86	327.700	Nehru Nagar	RCC Foot Bridge	27.0	1.3	15
87	328.600	Palavakkam (Lakshmi Nagar)	RCC Foot Bridge	15.0	2.0	3.5
88	330.00	Suvaram (U/C)	RCC Foot Bridge		Under Construction	
89	331.150	Mettakuppam (U/C)	RCC Foot Bridge		Under Construction	
90	335.00	Sholinganallur Road Bridge	Double RCC	21.6	4.6	21
91	348.800	Kolambakkam Road Bridge	RCC	25.0	2.5	16
92	367.500	Mamallapuram New Bridge	RCC	40.0	4.0	26
93	367.900	Mamallapuram Old Bridge	RCC	23.0	5.1	12
94	377.900	Sadras New	RCC	23.0	3.4	16
95	378.200	Sadras Old	RCC	23.0	4.5	15
96	381.700	Kalpakkam New Bridge along Pipeline	RCC	30.0	3.4	15
97	387.85	Kalpakkam Old Bridge	RCC	30.0	4.5	15

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)
98	388.900	Ahkuppam bridge	RCC	30.0	2.5	16.5
99	392.000	Koovathur	RCC	17.0	3.1	16
100	395.500	Mugayur	RCC Foot Bridge	40.0	2.5	16
101	399.500	Sikhankuppam	RCC	26.0	4.5	17.5
102	413.200	Ambaraikuppam	RCC	49.0	4.9	14
103	424.50	Marakanam Bridge	RCC	29.0	4	9

TABLE – 3.33
DETAILS OF LOCKS ALONG BUCKINGHAM CANAL

S.NO.	Chainage (km)	Name of Lock	Sill Level (in m)	FSL (in m)	Size of Lock Chamber (in m)	Width at entrance (in m)
1	0	Ramperu Lock	-1.665	2.385	38.1 x 6.1	6.1
2	12	Gundlakamma Lock	-2.155	2.205	38.1 x 6.1	6.1
3	18	Mudigondi Lock	-2.135	2.685	38.1 x 6.1	6.1
4	39.6	Tatepuram Lock (Musi)	-1.557	2.805	38.1 x 6.1	6.1
5	42.6	Palleru Lock	-1.945	2.175	38.1 x 6.1	6.1
6	55.1	Pallepalem lock (N)	-2.250	3.605	38.1 x 6.1	6.1
7	57.5	Manneru lock (S)	-2.250	2.905	41.175 x 6.1	6.1
8	70.6	Elikeru Lock (N)			Destroyed/Missing	
9	70.7	Elikeru lock (S)			Destroyed/Missing	
10	100	Chippaleru Lock (N)	-1.828	1.985	38.1 x 6.1	6.1
11	100.5	Chippaleru Lock (S)	-1.828	1.985	38.1 x 6.1	6.1
12	114.8	Pyderu Lock (N)	-1.615	2.555	38.1 x 6.1	6.1
13	115.2	Pyderu Lock (S)	-1.828	2.625	38.1 x 6.1	6.1
14	128.4	Pennar Lock (N)			38.1 x 6.1	6.1
15	130.2	Pennar Lock (S)			38.1 x 6.1	6.1
16	164.7	Kandaleru Lock (N)			38.1 x 6.1	6.1
17	168.5	Kandaleru Lock (S)			38.1 x 6.1	6.1
18	191.8	Swarnamukhi Lock			38.1 x 6.1	6.1
19	208.4	Pumbli Lock			38.1 x 6.1	6.1

S.NO.	Chainage (km)	Name of Lock	Sill Level (in m)	FSL (in m)	Size of Lock Chamber (in m)	Width at entrance (in m)
20	270.5	Coromandal Lock	-2.13		39.0 x 5.5 (abandoned)	5.50
21	282.6	Chintamani Lock	-2.13		39.0 x 5.50 (abandoned)	5.50
22	295.8	Ennore Lock (N)	-2.14		39.0 x 5.50	6.1
23	297.8	Ennore Lock (S)	-2.14		39.0 x 5.50	6.1
24	315.4	Cooum Lock	-1.59		33.56 x 6.1	6.1
25	322.4	Adayar Lock (N)	-1.62		33.56 x 6.1	6.1
26	322.6	Adayar Lock (S)	-1.59		33.56 x 6.1	6.1
27	346.1	Kovalam Lock (N)	-1.65		52.0 x 6.1	6.1
28	346.2	Kovalam Lock (S)	-1.50			
29	372.2	Edaiyur Lock	-1.53		Destroyed	
30	373	Edaiyur Lock	-1.53		Destroyed	
31	380.5	Pudupattinam Lock (N)	-1.56		15.0 x 6.1	6.1
32	380.8	Pudupattinam Lock (S)	-1.56		15.0 x 6.1	6.1
33	384.5	Vayalur	-1.56		52.0 x 6.1	6.1
34	387.6	Kadalur	-1.58		52.0 x 6.1	6.1

3.5. Marakanam to Puducherry through Kaluvelly Tank

The waterway from Marakanam to Puducherry runs for a distance of 22km through Kaluvelly tank.

Kaluvelly Tank is a vast lagoon situated near the eastern coast of the Tindivanam Taluk of south Arcot District at 12^0 8' latitude ad 79^0 51' in longitude. It is about 10.5 km in width and about 12.80 km in length. It covers as area of 70 Sq. km in extent and connects itself with Yeday Aanthittu swamp, through a tidal creak about 8 km in length, which in turn links itself to the sea at about 10 km. north of Marakanam. This swamp is full of water during rainy season and dry for the remaining part of the year. There are a number of fisheries, shrimp and aquaculture shrimp farms near Kaluvelly Tank. The hydraulic particulars are given in **Table 3.34.** The width is around 100 m. There were many improvements carried out to check saline water coming into the agricultural fields. However, all these improvements could not give full relief from submersion and salinity. At present the surplus arrangement is provided with 50 pen vents of size 1.22 m, 6 vents of S. G. Shutters of size 1.35 m-and 21 vents of Screw Gearing (S.G.) Shutters of size 1.83m. Now the brick masonry of superstructure are in damaged condition and Screw Gearing shutters are fully damaged and not in serviceable condition. During the study period it was found totally in abandoned condition. The weir is not maintained since years. There are no defined banks and sea water is filled up in the swamp. A further portion near sea for around 2.5 Km. is almost dry with high grasses and a causeway connecting villages of both banks. It ultimately ends at sea near "All India Institute of Medical Sciences" in Puducherry.

Table 3.34 Hydraulic Particulars of Kaluvelly Swamp

1.	Free catchment	-	116.40 sq. km.
2.	Combined catchment	-	754.69 sq. km.
3.	Integrated catchment	-	638.28 sq. km.
4.	Equivalent catchment	-	224.07 sq. km.
5.	Marakanam Rainfall station dependable yield	-	1.14 M. Cum/ sq. km.
6.	Total yield	-	34.32 M. Cum
7.	Storage of swamp	-	33.82 M. Cum
8.	Area of swamp	-	70.47 sq. km (or) 17,600 acre
9.	Maximum flood discharge	-	19,000 Cusecs

Existing Surplus Arrangement of Kaluvelly Tank

1.	First six vents of 1.35 x 1.22 m	-	S. G. Shutters have already been provided for these 27 vents. (Damaged condition)
2.	21 vents of 1.83 m x 1.22m		
3.	50 vents of 1.22m x 1.22m	-	S. G. Shutters not provided.
4.	Length of by-wash on left side Top level	-	88.50 M (+) 1.78 M (above MSL)
5.	Length of by-wash on right side Top level	-	37.60 M (+) 1.485 M (above MSL)
6.	Tide level varies from	-	(+) 0.30 M to (+) 1.35 M (above MSL).
7.	M.F.L. observed	-	(+) 2.10 M (above MSL)
8.	Top of shutter	-	(+) 1.52 M(above MSL)
9.	Length of creak from regulator to Yeday Anthittu Swamp	-	2325 M
10.	Distance from tail end of creak to sea	-	10 km
11.	Sill level of regulator	-	(+) 0.30 M (above MSL)

3.5.1 Meterological Conditions

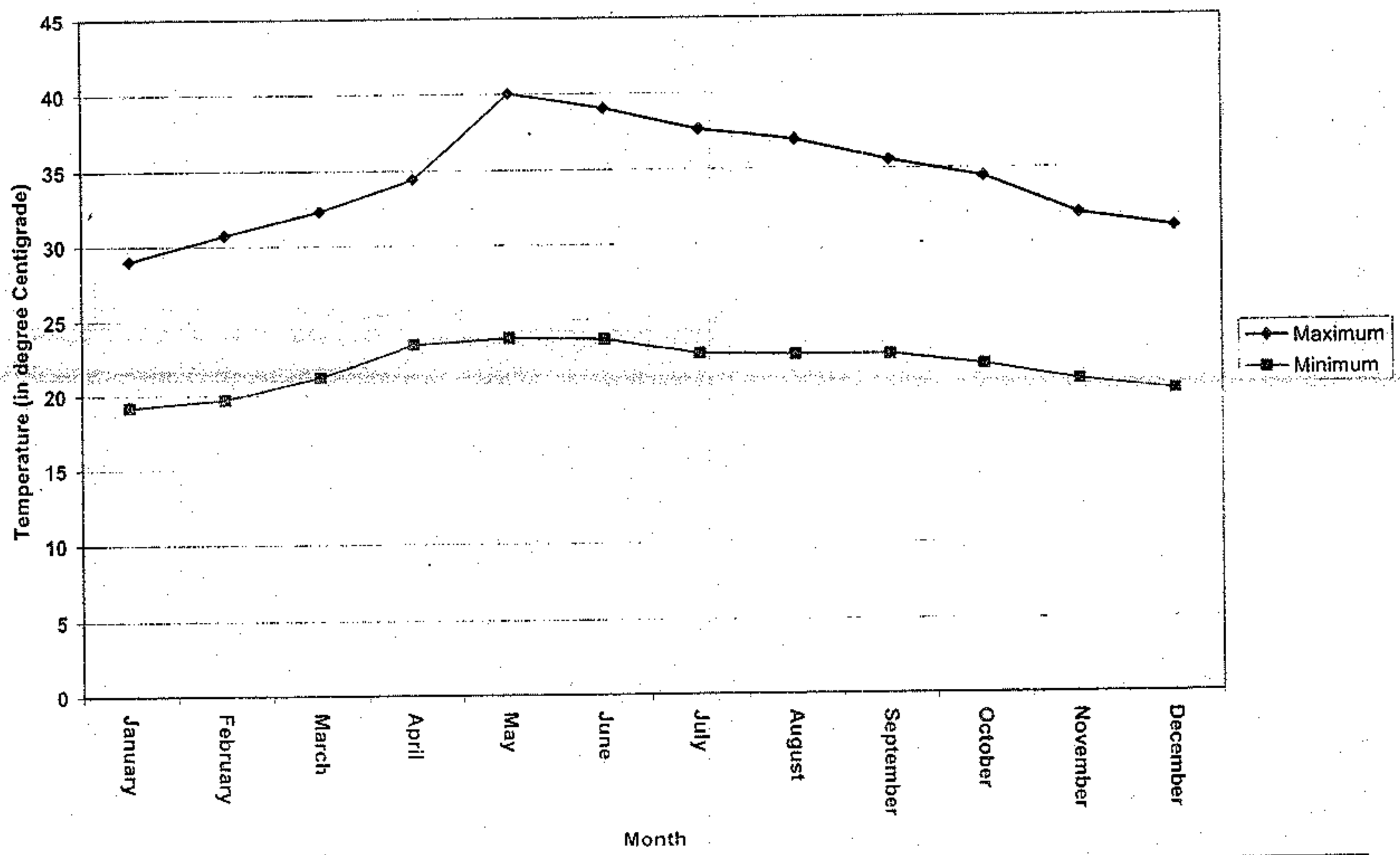
a) Temperature

The temperature variation as seen from the **Table 3.35** and **Figure 3.23** is between 39°C to 40°C (Maximum) and 19.2°C to 23.8°C (Minimum). The data has been obtained from IMD (1952 – 1980) for Puducherry.

Table 3.35 Temperature data for Puducherry
(Source: IMD, 1952 to 1980)

Month	Maximum	Minimum
January	29	19.2
February	30.7	19.7
March	32.3	21.2
April	34.4	23.4
May	40	23.8
June	39	23.7
July	37.6	22.7
August	36.9	22.6
September	35.5	22.6
October	34.4	21.9
November	31.9	20.8
December	31	20.1

Fig. 3.23 : Monthly Temperature at Puducherry



b) **Rainfall**

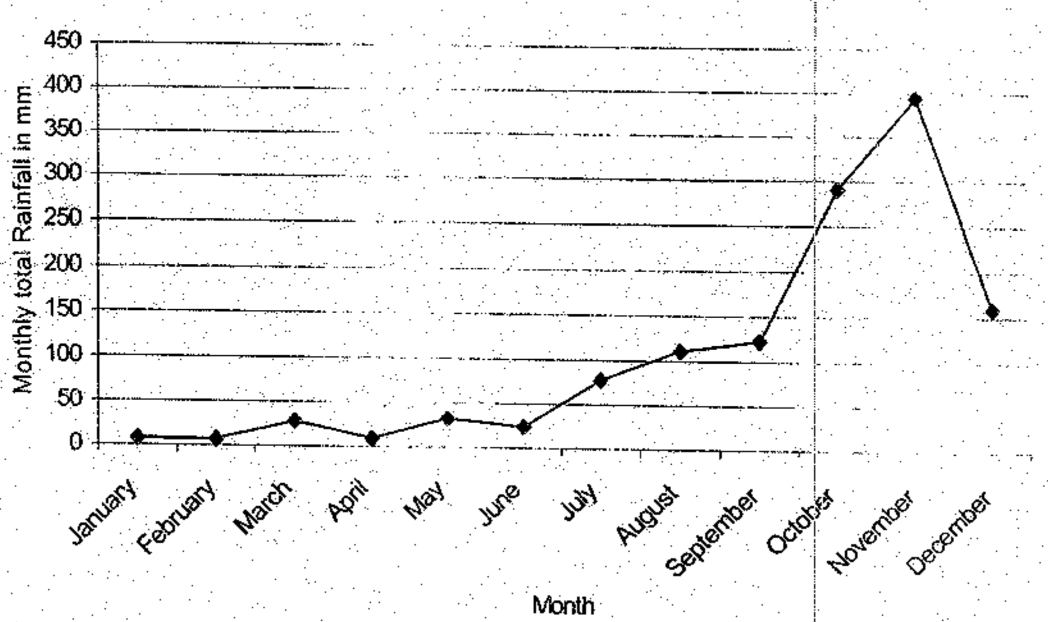
The maximum rainfall near Puducherry has the value ranging between 111.1 mm and 394.4 mm from August to November. The monthly total values of rainfall in mm has been tabulated in **Table 3.36** and graphically represented as **Figure 3.24.**

Table 3.36 : Monthly Rainfall near Puducherry

Month	Rainfall (monthly total in mm)	No. of rainy days
January	7.4	0.8
February	7	0.5
March	27.8	0.7
April	8.9	0.6
May	32.7	2.3
June	23.9	2.5
July	77.8	5.1
August	111.1	6.3
September	122.2	5.9
October	290.9	10.2
November	394.4	11.7
December	159.4	6.5

Figure 3.24 :Rainfall near Pondicherry

(Source: IMD, 1952 - 1980)



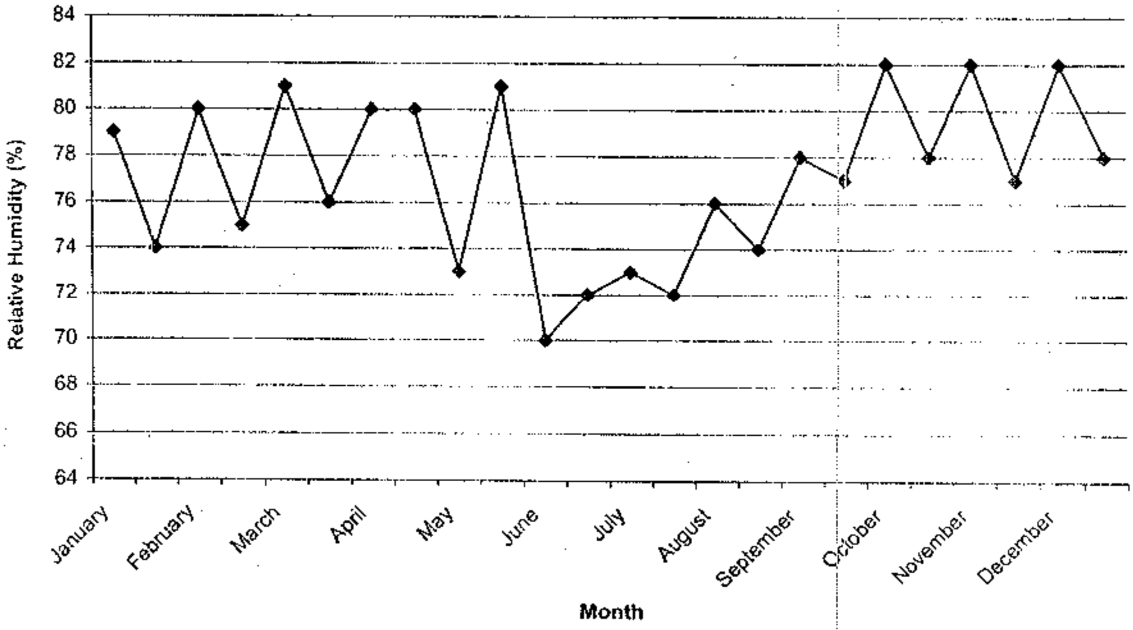
c) Humidity

The relative humidity values of Puducherry representing canal are tabulated in **Table 3.37** and represented graphically in **Figure 3.25.** The relative humidity of 29 years from 1952 to 1980 has been considered. The most humid months are July to October.

Table 3.37 Relative Humidity at Puducherry
(Source: IMD, 1952 - 1980)

Month	Relative Humidity (%)
January	79
	74
February	80
	75
March	81
	76
April	80
	80
May	73
	81
June	70
	72
July	73
	72
August	76
	74
September	78
	77
October	82
	78
November	82
	77
December	82
	78

Figure 3.25: Relative Humidity at Pondicherry
(Source: IMD, 1952 - 1980)



d) Wind

The no of days of the month with wind speed 1 to 19 Kmph has been tabulated in **Table 3.38**, it can be seen that the maximum wind speed (1 to 19 kmph) occurs in the most part of the year when the wind direction is Southeast and Southwest.

Table 3.38 Wind data for Puducherry
(Source: IMD, 1952 - 1980)

Month	No. of days with wind speed 1 to 19 kmph	No. of days with wind speed as 0 kmph
January	30	0
	17	0
February	27	0
	17	0
March	29	1
	17	0
April	27	0
	11	1
May	28	0
	14	0
June	30	0
	20	0
July	29	1
	20	1
August	30	0
	21	0
September	29	0
	21	0
October	30	0
	22	1
November	27	1
	18	0
December	27	0
	14	0

CHAPTER 4
VESSEL SIZE

CHAPTER – 4

VESSEL SIZE

4.1 INTRODUCTION

As per the Terms of Reference, it may be seen that the primary task under this study is to provide suitable infrastructure in Kakinada - Puducherry canal alongwith river Krishna & Godavari for development of Inland Water Transport to carry out transport activities for Cargo traffic and development of the surroundings. The task assigned involves considering two phases for development,

Phase I : Fairway with 1.6 m depth and 14 m wide in Kakinada , Eluru & Commamur canals and fairway with 1.8m depth and 32 m width in Rivers Godavari & Krishna, Buckingham Canal including Kaluvelly tank.

Phase II : Fairway with 2 m depth and 32 m wide for the entire waterway of 1027 km length along Kakinada Puducherry canal alongwith Rivers Godavari & Krishna.

Accordingly, the design vessel to be used in the waterway has been analysed and discussed in the following paragraphs.

4.2 SIZE OF DESIGN VESSEL

The largest sized vessel that can ply on the river/canal would depend on whether 1-way or 2-way navigation is to be catered to, the river/canal bed width, depth and lock dimensions. There are several guidelines which have been evolved by various authorities about the relationship between the dimensions of any restricted waterway and the vessels that may ply in it. However, the recommendations may vary widely from waterway to waterway. The dimension of design vessel has been analysed separately for river and canal portion as discussed below :

a. **River Portion**

According to PIANC guidelines the normal width of waterway required for two way navigation of barge with beam size of B in river are shown below

It is therefore clear that the maximum designed vessel that can ply in canal portion for 32m bed width would be 300t.

4.3 DIMENSIONS OF DESIGN VESSEL

It has been discussed that 100t, 300t and 500t barges can ply in the proposed waterway. The salient dimensions of these barges are given below

	Phase-I 14m wide & 1.6m deep canal	**Phase-I 32 m wide & 1.8 m deep canal/river**	**Phase-II 32m wide & 2.0m deep river/canals**
Length	30m	40m	50m
B	4.25m	9.0m	11.0m
D	1.20m	1.6m	1.8m
DWT	100t	300t	500t

* **<u>It is established that from above analysis that 500t barge cannot ply in river as well as canal portion for two way navigation.</u>**

CHAPTER 5
LOCATION & PLANNING OF TERMINALS

CHAPTER – 5

LOCATION AND PLANNING OF TERMINALS

5.0 GENERAL

Terminals are the centers of receipt, export, storage, distribution of cargo and embarkation of passengers. Terminals form the hub of connection at transit through various means and modes of transportation. They are the shelters where vessels can berth and load or unload cargo and get its supplies. With development of waterway transport many small and big cities at the same time have grown into political, cultural, economic and trade centres. Many such important towns have developed on the Kakinada-Puducherry Canal route.

In order to meet the need of rapid economic development in the country and also in view of congestion faced in other modes of transport like road and railway, the capacity of inland water transportation has to be increased / created and many terminals along the route have to be built. At present ferry services are operated at many places, for which ghats alongwith temples have been constructed along the banks of canals and rivers. Existing wharves are of marginal type and are mainly for convenience crossing the rivers or canals from one town on one bank to other town opposite the bank of rivers and canals.

Lack of terminal and handling facilities and infrastructure has limited the expansion of inland water transportation rate and full utilization of canals along the waterways and fleets operating thereat. Construction of terminals requires a substantial amount of revenue, either of government or of private companies through BOOT route. Huge investments involved in development of terminals reinforce the need of proper selection of location of terminals.

Inland terminals should be strategically placed in such a way that it serves dual purpose. Enough traffic passes through the terminals and associated hinterland also develops side by side.

The facilities provided at the terminals should meet the traffic demand and should be utilized to the maximum extent possible. As the resources are scarce, the investment made should be economically viable.

Planning for inland terminals and other associated development works should take into account changes in pattern of trade, future expansions, increase in size of vessels etc. Terminals development works while being implemented should ensure proper rehabilitation (R & R) of people displaced by the project.

5.1 INFLUENCING FACTORS FOR SELECTION OF TERMINAL LOCATIONS

Basic Conditions

This para deals with the various aspects of the cargo transfer, handling and storage and in consequence planning of terminals in the waterway.

The terminals when judiciously located would go a long way in making the waterway operation a success. Thus terminals are to be located near high traffic concentration points which will enable cargo owners to use IWT in preference to rail/road modes. Terminals are the hubs for inter-modal transfer of cargo and act as interface between the waterway and the hinterland. Accordingly, the main aspects requiring careful consideration for efficient traffic management and thereby effecting in the increased traffic capacity of the entire system are,

- Site condition
- Water area planning
- Navigational aids
- Berths
- Cargo handling systems
- Sufficiency of land provision

5.2 SITE CONDITIONS

The location of the inland terminal in general depends on many factors, of which the basic criteria are :

Terminal to be hub in cargo generation and consumption hinterland.
River front characteristics to be conducive
Land area availability behind waterfront at terminal

For planning an IWT terminal, inputs on following aspects are needed and the same have been obtained as available.

1. Meteorological conditions
2. Canal/river characteristics
3. Geomorphology of the site
4. Geo-technical conditions
5. Land area requirement and availability
6. Availability of construction material

5.3 METEOROLOGICAL CONDITIONS

Inland waterways are land locked and therefore are generally unaffected by extreme meteorological conditions except for floods during monsoon. The floods in rivers generally bring in high discharges and associated currents. Therefore, although water depth may not be a constraint but navigability under extreme current conditions would be difficult. In addition, the rise in water levels during the flood also would not be conducive to navigation due to unavailability of headroom for barge passage under the bridges. Accordingly, data with regard to river discharge, rainfall and maximum flood would be of vital importance. In addition, such data would also prompt suitable planning and orientation of the terminals. The extreme environmental parameters are therefore not listed here since their influences are insignificant.

5.4 DATA ON CANAL/RIVER

In addition to the depth, the other factors, which controls and determines the navigability of a waterway is,

1. Width of the waterway
2. Location and nature of shoals
3. Nature of bends and radii for barge traverse
4. Nature of river training works
5. Nature of cross-drainage works, bridges, lock gates, culverts, overhead transmission lines etc.

For the purpose, a detailed topographic and hydrographic survey was conducted and data was collected. These data along with the discharge data assessed would decide and determine the channel for navigation in the waterway. This would, in addition, help finalise the location of the terminals. Influencing factors are discussed below.

5.5 DATA ON GEOMORPHOLOGY OF THE SITE

The stability of the banks and the shoreline would be a pre-requisite for any shore based structures, like terminal. The discharge and flow conditions in the river changes seasonally and often on daily depending upon the rain and catchment conditions. Accordingly, the shoreline stability influenced by morphological changes is of paramount importance for the location of the terminal. In so far as the canal portion is concerned, the major problem is that of siltation. Cross drains and rivers joining the canal add to the problem of siltation to a great extent. In addition, the tidal ingress through lock gates provided at the confluence of the canal and the river also deposits considerable amount of silt into the canal. Most of the bunds built by the local beneficiaries have since collapsed and the canals are mostly filled up causing reduction in water depth. Therefore, in order to avoid such problems from recurrence, the cross-drains as well as the lock gates are to be suitably designed/modified.

5.6 DATA ON GEO-TECHNICAL CONDITIONS

Terminal structures, i.e. barge berths, storage buildings, open stockyards, transport equipment movement areas do require good founding soil. Accordingly, in order to reduce overall cost with regard to foundations, it is essential to select suitable location with good soil bearing capacity to put up the terminals.

WAPCOS was to undertake geotechnical investigations at the proposed terminal locations. Pending IWAI's and concerned State Governments approval, these geotechnical investigations could not be undertaken. In view of the above situation and based on visual inspection and our understanding of the soil condition, it is preferable to adopt a safe bearing capacity of 8 ton/m^2 to 12 ton/m^2 for different terminal locations. In any case detailed geotechnical investigations are to be undertaken as per IS Code provision during detailed engineering stage, which can be taken up after finalization of terminal locations.

5.7 LAND AREA

For a terminal/location to be firmed up, besides other things leveled land area in the close proximity of the river/canal is necessary. The area surrounding the canals is government land and barren. Either kutcha road or a highway is running along the routes of Commamur, Kakinada and Buckingham canals. Some portion of banks of Eluru Canal (around 20 km) is inhabited by encroachments which need to be cleared. Along the banks of river Godavari and Krishna, ample land is available for terminals. The information on land ownership is based on local enquiries. However, the ownership details has to be obtained from A.P. State Government. Most of the land along the canals are given on long term lease to farmers by the Revenue Department, Govt. of Andhra Pradesh and Tamilnadu. These lands are called as Patta land in local language. The land for the terminals would have to be acquired by the A.P. State Government authorities as the acquisition is to be planned in such a manner that, future expansion of the terminal would be easy, contiguous and unimpaired. In addition the connectivity to the terminals have to be planned and if necessary, the land for the same would have to be acquired. The land envisaged for developments of terminals are selected in such a manner, that it has easy connectivity to all the infrastructure requirements such as water supply, electricity and road/rail. The selection of the area has been undertaken considering these additional aspects also.

5.8 CONSTRUCTION MATERIAL AVAILABILITY

Construction of terminal structures are required to be carried out using the locally available materials only. Transportation of these materials would not pose any difficulty. Lack of road infrastructure at certain locations may exist, but waterways can be used to carry these material, in smaller crafts. Therefore, no problem on this account is foreseen. The construction material is available in abundance in the close environs of the waterway.

5.9 PROPOSED TERMINALS

Based on the traffic survey, navigational safety, and least interference with natural water and sediment flow phenomenon, the following terminal locations have been suggested for the integrated waterway:

- Kakinada
- Rajahmundry
- Tadepalligudem
- Eluru
- Kottapatnam
- Maipadu
- Durgarajupatnam
- Ennore
- Muthukadu
- Marakanam
- Puducherry
- Bhadrachalam
- Wazirabad
- Muktiyala
- Vijayawada

5.10 CARGO TRAFFIC AT PROPOSED TERMINALS

The cargo movement features and traffic at the terminals are given below:

1. **Kakinada** : Kakinada can become loading point for downstream cargo viz. fertilizers as many fertilizer plants are located in the vicinity. Rice and food grains can also be loaded to be sent downstream. The unloading of this cargo can be at Eluru, Vijayawada, Rajahmundry, Muktiyala, Kottapatnam, Maipadu, Durgarajupatanam, Bhadrachalam, Wazirabad and Chennai. Besides the upstream cargo of salt, forest products, rice bran extractions can be unloaded at Kakinada. The following are traffic projections at Kakinada.

(in Million Tonne)

	Traffic							
Year	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Kakinada	-	0.530	0.760	1.047	1.207	1.391	1.604	1.851
Unloading at Kakinada	-	0.264	0.409	0.598	0.706	0.835	0.989	1.175
Total traffic in Million tonne	-	**0.794**	**1.169**	**1.645**	**1.912**	**2.226**	**2.594**	**3.026**

Besides above, an SEZ promoted by MRPL, IL&FS and Kakinada Sea Ports Ltd. is coming up in Kakinada which will have an export oriented oil refinery besides bio diesel manufacturing plants, ceramics & related industries and marine products industry which will give boost to IWT traffic terminal.

2. **Rajahmundry** : Rajahmundry is chosen as a terminal location because it is a major trade centre in the east bank for both originating and terminating traffic. The downstream cargo of rice, food grains and some quantity of coal can be loaded at Rajahmundry which is a major producer of rice in Godavari Delta. There is major production of rice in Godavari delta. The rice, food grains, coal etc. can be unloaded at different downstream points viz. Kottapatnam, Maipadu, Wazirabad, Durgarajupatnam, Chennai etc. whereas the same fleet of vessels unloading at downstream points can pick up salt, fertilizers, cement, fruits and vegetables, waste paper etc. from Ennore-Chennai belt and unload it in Rajahmundry, so that the industries nearby are benefited. The following are traffic projections at Rajahmundry.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Rajahmundry	-	0.079	0.123	0.178	0.206	0.239	0.277	0.321
Unloading at Rajahmundry	-	0.092	0.130	0.174	0.191	0.210	0.232	0.257
Total traffic in Million tonne	-	**0.172**	**0.253**	**0.352**	**0.397**	**0.449**	**0.509**	**0.578**

The city of Rajahmundry is heavily inhabited along the bank of river Godavari. Sir Arthur Cotton barrage have been constructed at confluence of river Godavari and Kakinada. The Vijjeswaram side of barrage control the flow in Eluru Canal. The Dowleiswaram side of barrage controls the flow in river Godavari. There are many permanent structures along the bank of river Godavari. Two permanent big bridges are existing to connect the two banks of river through the city. There is a new Railway bridge near bathing ghat. An intake near Aryapuram for paper mill is already constructed, around which there is enough space available for constructing terminal. But there are timber depots along the bank, which need to be shifted.

3. **Tadepalligudem** : Tadepalligudem is a major business hub along the Eluru Canal. It being nearer to rice producing area, there is a significant potential of transport of rice bran extractions which are mainly exported and some part of it being consumed locally. De-oiled rice bran is in great demand for use in poultry as well as in cattle feed. Defatted rice bran is used for pet food industry. Rice hulls are used as a pressing aid in fruit juices and as bedding in poultry houses. The rice bran extractions can be loaded at Tadepalligudam and can be unloaded in Kakinada in upstream direction. There is no traffic seen as terminating in Tadepalligudam, as it is only a producing centre not a major consumption centre.

The following are traffic projections at Tadepalligudam.

(in Million Tonne)

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Loading at Tadepalligudam	-	0.041	0.060	0.083	0.091	0.101	0.111	0.123
Unloading at Tadepalligudam	-	0	0	0	0	0	0	0
Total traffic in Million tonne	-	**0.041**	**0.060**	**0.083**	**0.091**	**0.101**	**0.111**	**0.123**

An existing ghat terminal along Eluru canal near temple has been chosen as the location of terminal. There is not a problem for land acquisition as the residential structures near the proposed terminal are temporary. People residing there were excited and anxious to see IWT terminal and navigation possible in Eluru canal, when asked by the consultants.

4. **Eluru** : Eluru can be considered as a major loading point for rice and food grains along the Eluru Canal, as it is in the rice producing belt. The major cargo to be unloaded at Eluru will be coal from Bhadrachalam, Kakinada and Muktyala, rice from Rajahmundry and fertilizers from Kakinada and Ennore and salt from Chennai. The following are traffic projections at Eluru.

(in Million Tonne)

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Loading at Eluru	-	0.077	0.120	0.173	0.201	0.233	0.270	0.313
Unloading at Eluru	-	0.075	0.105	0.143	0.165	0.190	0.220	0.255
Total traffic in Million tonne	-	**0.152**	**0.224**	**0.316**	**0.366**	**0.423**	**0.490**	**0.568**

5. **Kottapatnam** : Kottapatnam is a small town situated along Commamur Canal, and is chosen as a terminal from the abundance of forests and the likely traffic of forest products to be moved from Kottapatnam and to be destined to Bhadrachalam upstream. Besides it, rice and food grains, as well as granite can be major cargo to be loaded form this terminal, and can be unloaded at Maipadu, Durgarajapatnam and Chennai downstream.

The following are traffic projections at Kottapatnam.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Kottapatnam	0.131	0.204	0.307	0.438	0.510	0.597	0.699	0.820
Unloading at Kottapatnam	0.140	0.218	0.326	0.463	0.533	0.614	0.708	0.817
Total traffic in Million tonne	0.271	0.422	**0.633**	**0.901**	**1.043**	**1.210**	**1.406**	**1.637**

6. **Maipadu** : Maipadu at the South Andhra Pradesh along Commamur Canal is another terminal location suggested, because of its proximity to heavily industrialized cities of Nellore and Ongole. The traffic to be handled originating from Maipadu is less than the traffic terminating thereat. Fish and marine products are the major products to have potential of IWT traffic. Besides, rice and food grains are other major cargo to be transported downstream. These can be unloaded at Chennai, a metropolitan city for local assumption and for export purposes. The upstream cargo of salt and fertilizers can move from Chennai and can be unloaded at Maipadu. The following are traffic projections at Maipadu.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Maipadu	0.011	0.017	0.027	0.039	0.039	0.046	0.053	0.061
Unloading at Maipadu	0.038	0.059	0.086	0.118	0.132	0.148	0.166	0.187
Total traffic in Million tonne	**0.049**	**0.077**	**0.113**	**0.157**	**0.177**	**0.200**	**0.227**	**0.258**

7. **Durgarajupatnam** : Durgarajupatnam has been selected for locating the IWT terminal, owing to its vicinity to Krishnapattnam near Nellore. A new port at Krishnapattnam is under consideration. A new Captive Thermal Power Station is coming up in Krishnapattnam. Coal is a major cargo identified to be moved from Bhadrachalam and to be unloaded at Durgarajupatnam besides other location en-route. Rice is

another major commodity identified to be moved from Vijayawada and surroundings to Durgarajupattnam besides other locations en-route. Rice is another major commodity identified to be moved form Vijayawada and surroundings to Durgarajupattnam. Fertilisers can also be unloaded at Durgarajupatnam from Kakinada. Upstream cargo of salt can be unloaded at this terminal coming from Chennai. The following are traffic projections at Durgarajupatnam.

(in Million Tonne)

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Loading at Durgarajupatnam	0.011	0.017	0.027	0.039	0.045	0.053	0.061	0.071
Unloading at Durgarajupatnam	0.038	0.059	0.086	0.118	0.132	0.148	0.166	0.187
Total traffic in Million tonne	**0.049**	**0.076**	**0.113**	**0.157**	**0.177**	0.201	0.227	0.258

8. **Ennore** : Ennore is a big sea port and shippers have shown willingness to shift to IWT mode of transportation owing to it being near sea if a terminal is proposed here.Hence the IWT terminal at Ennore. Fertilisers are identified as major cargo to be loaded from this terminal because of Manali fertilizers located at Ennore and to be unloaded at Kottapatnam, Maipadu, Durgarajupatnam, Vijayawada, Muktiyala, Eluru, Rajahmundry and Kakinada. The following are traffic projections at Ennore.

(in Million Tonne)

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Loading at Ennore	0.176	0.251	0.367	0.518	0.620	0.743	0.891	1.069
Unloading at Ennore	0.574	1.007	1.544	2.221	2.557	2.946	3.397	3.920
Total traffic in Million tonne	**0.750**	**1.258**	**1.911**	**2.739**	**3.177**	**3.689**	**4.288**	**4.989**

9. **Muthukadu :** The main commodity that can be unloaded at Muthukadu would be fertilizers coming from Ennore, Kakinada and salt originating from Chennai.

The following are traffic projections at Muthukadu.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Muthukadu	0	0	0	0	0	0	0	0
Unloading at Muthukadu	0.032	0.045	0.065	0.091	0.110	0.133	0.161	0.195
Total traffic in Million tonne	**0.032**	**0.045**	**0.065**	**0.091**	**0.110**	**0.133**	**0.161**	**0.195**

10. **Marakanam** : Iron scrap originating from Chennai can be unloaded at Marakanam for use in industries of Puducherry. Another major commodity to be unloaded at Marakanam is Timber as upstream cargo; originating from Chennai. The following are traffic projections at Marakanam.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Marakanam	0	0	0	0	0	0	0	0
Unloading at Marakanam	0.054	0.078	0.114	0.161	0.192	0.229	0.274	0.327
Total traffic in Million tonne	**0.054**	**0.078**	**0.114**	**0.161**	**0.192**	**0.229**	**0.274**	**0.327**

11. **Puducherry** : The Puducherry being terminating terminal for Kakinada Puducherry canal. The following are traffic projections at Puducherry.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Puducherry	0	0	0	0	0	0	0	0
Unloading at Puducherry	0.006	0.008	0.011	0.015	0.018	0.021	0.024	0.028
Total traffic in Million tonne	**0.006**	**0.008**	**0.011**	**0.015**	**0.018**	**0.021**	**0.024**	**0.028**

12. **Bhadrachalam** : Bhadrachalam can handle mainly coal for thermal power plants and other industries. Coal can be loaded from Bhadrachalam and can be unloaded at various unloading points along the route viz. Vijayawada, Kakinada, Muktiyala, Rajahmundry, Maipadu, Eluru, Durgarajupatnam and Wazirabad. These points can become loading points for fertilizers, salt, fruits and vegetable, wood pulp, waste paper, timber, rice bran extractions and cement clinkers etc. The wood pulp, waste paper and other forest products can be unloaded at Bhadrachalam terminal.

The famous Bhadrachalam temple is located along the bank of river Godavari. An old big bridge constructed across the river Godavari connects ITC paper mill to the temple. The terminal can be located near the temple on downstream side of river after the bridge.

The projected originating and terminating traffic at Bhadrachalam will be the highest owing to it being nearer the thermal power plants, paper industries and having abundant forest. Bhadrachalam terminal will handle more than 50% coal traffic, so separate coal berths off the town will be constructed. The following are traffic projections at Bhadrachalam.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Bhadrachalam	-	2.557	3.639	4.869	5.229	5.633	6.086	6.595
Unloading at Bhadrachalam	-	0.277	0.416	0.599	0.717	0.857	1.026	1.228
Total traffic in Million tonne	-	**2.834**	**4.055**	**5.468**	**5.946**	**6.490**	**7.112**	**7.824**

13. **Wazirabad** : As called Hoozurrabad or Huzzur Nagar in local language, is another potential location for terminal along the river Krishna. Being situated in rice belt, and near Nagarjuna Sagar Dam, there is a significant traffic potential of rice and food grains. There are many cement industries viz. KCP Cement, Andhra Cement etc. Cement has got great potential of traffic from Wazirabad. These cargoes have been projected to be unloaded at Muktyala, Vijayawada and Chennai. The upstream cargo of cement to be loaded at this terminal can be unloaded at Kakinada for export purposes.

The following are traffic projections at Wazirabad.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Wazirabad	-	0.507	0.797	1.175	1.386	1.637	1.933	2.285
Unloading at Wazirabad	-	0.846	1.201	1.606	1.729	1.867	2.023	2.198
Total traffic in Million tonne	-	**1.353**	**1.998**	**2.781**	**3.115**	**3.504**	**3.956**	**4.483**

Along the river Krishna downstream from Wazirabad to Muktiyala, Pulinchintala dam is under construction by A.P. Govt. Irrigation Department. Primarily for irrigation and small hydro power generation, A.P. Government Irrigation Department has not planned any provision for navigation, viz. construction of lock, barrage etc. It was confirmed from the concerned Superintending Engineer, Irrigation and CAD Deptt. Vijayawada. It is necessary to use backwater effect of dam to increase the level of water at Wazirabad for smooth navigation to be made possible.

14. **Muktiyala** : Muktiyala is a small town located along the banks of river Krishna. The river connects Muktiyala on left bank to Guntur in right bank. The cargo envisaged for downstream loading are rice and food grains, chillies and tobacco, and for upstream loading are cement clinkers, because of its vicinity to many cement plants. The coal cargo from Bhadrachalam can be unloaded at Muktiyala. The other potential cargoes of rice, fertilizer and cement can be unloaded at the terminal as downstream cargo and salt, fruits and vegetable from Chennai belt can be unloaded at the terminal as upstream cargo. The following are traffic projections at Muktiyala.

(in Million Tonne)

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Loading at Muktiyala	-	0.112	0.175	0.259	0.305	0.361	0.426	0.504
Unloading at Muktiyala	-	0.640	0.903	1.201	1.287	1.384	1.493	1.617
Total traffic in Million tonne	-	**0.752**	**1.078**	**1.460**	**1.592**	**1.745**	**1.919**	**2.121**

There is a ferry terminal existing at Muktiyala to ferry passengers from Muktiyala to Guntur over river Krishna. The terminal is proposed to be located at the very same location. The land behind the terminal is owned by erstwhile king of Muktiyala who also own KCP Cements. Although, king has a palace at the location, he and his family members have been very co-operative with the government, and we don't see any problem IWAI or implementing agency having a dialogue with the king of Muktiyala.

15. **Vijayawada** : Vijayawada is having significant potential of coal traffic from SCCL mines, as Vijayawada Thermal Power Station (VTPS) of capacity 1260 MW is situated here. Besides it being a confluence of Eluru canal, Commamur Canal, Ryne canal and Krishna river, it has many captive thermal power plants and cement industries in the vicinity. Cement manufacturing industries sign a Memorandum of Understanding with the thermal power plants for the distribution of the fly ash generated by thermal power plants. The major position of coal from SCCL mines is consumed by VTPS. Besides it, rice, a major agricultural produce of A.P. moves to southern markets of Tamil Nadu and Kerala through Vijayawada. It is a big division of South Central Railway. Cement can move through 22 large and 16 mini cement industrial units of A.P. through Vijayawada to Kakinada for export to Tamilnadu, Kerala and Andaman and Nicobar Island. The major suppliers of cement near Vijaywada are KCP cement, India cements, Penna cements, Andhra cement and Parashakti cements. Fruits and vegetable also move from Chennai to Vijayawada and surroundings. The following are traffic projections at Vijayawada.

(in Million Tonne)

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Loading at Vijayawada	-	0.254	0.392	0.569	0.662	0.770	0.898	1.049
Unloading at Vijayawada	-	0.978	1.394	1.876	2.039	2.224	2.435	2.677
Total traffic in Million tonne	-	**1.232**	**1.786**	**2.445**	**2.701**	**2.994**	**3.333**	**3.726**

Vijayawada is well connected by roads and railways in Kakinada-Puducherry route. The whole city is developed along the four canals and a barrage names as Prakasam Barrage. The temples are around the river Krishna and people worship the water of sacred river Krishna.

A.P. Govt. Irrigation Department has three divisions – East Godavari, West Godavari and Krishna Divisions. The city is highly industrialized.

5.11 SUGGESTED LOCATIONS OF TERMINALS

1. **Kakinada** : Kakinada has been chosen as a terminal because of its being originating station of Kakinada-Puducherry canal. The sea mouth is located at 82°15'E and 16°58'N from where Kakinada canal starts its way. The water depth available is of the order of 1.3 m. The canal is wide enough near the sea mouth, but heavily inhabited. The terminal will be located towards Aratlakatta after Jagannathpuram bridge and new bridge. The bank protection will be provided 250 m on either side of terminal. An RCC diaphragm wall along the left bank will be provided with a provision of two berths. The terminal is well connected to the road network. 30000 Sq.m land will be required to be acquired. The consultants visited the site alongwith Environmental Consultants M/S. CES (I) Pvt. Ltd. and Irrgn & CAD officials of GoAP to find out the most suitable site for locating the terminal. Two alternatives have been selected and are shown in the figure enclosed. The following are the findings:

Alternative I – 300 m downstream of Jagannathpuram road bridge on left bank in Salt Creek

Advantages :

- Adequate water front available
- Densely populated port area
- Well connected to road network
- In the heart of city
- Area of land required 30000 m^2

Problems :

- The offices of Shipping agents/transporters existing since seventeenth century – viz. Kakinada chamber of commerce, DGM - BSNL's office, Big Shipping Lines, Film Theatre etc.
- Not easy to relocate them
- Environmental problem of R&R

Alternative II – At Kovvuru road towards Atlakatta village

Advantages

- Adequate waterfront available
- Well connected to road as well as railway meter gauge nearby
- Barren land available which is on lease by AP Govt.
- Housing Board has also proposed development nearby
- No problem in R&R
- Environmentally O.K.

Selected Alternative – Alternative II

2. **Vijayawada** : Vijayawada is a big city along the river Krishna where three canals, Eluru, Commamur and Rhyve canals run across the city. The site for terminal is selected near Ibrahimpatnam where there is a river ghat. The city of Vijayawada is located at longitude 80°37'E and latitude 16°31'N. The terminal will be very near to Prakasam Barrage which has a famous regulator cum round bridge of 1223.5 m length constructed in 1855 and named after Sri Tanguturi Prakasam, the first Chief Minister of Andhra Pradesh. The banks are quite stable and properly maintained by irrigation and CAD Department of A.P. The stretch of river adjacent to proposed location is reasonably straight which will enable smooth manoeuvring of vessels coming over the terminal. The terminal jetty head is oriented in such a way that currents at proposed berthing head are parallel facilitating smooth operation of terminal. The existing ground conditions appear, prima facie, stable and suitable owing to its nearness to Prakasam barrage and Sitanagram lock. The land along the suggested location can be acquired as the land is given on lease to Private people on Patta basis. The consultants identified the location of terminal alongwith the Environmental consultants M/S. CES (I) Pvt. Ltd. and the officials of Irrgn. and CAD Deptt, GoAP.The location recommended is shown in the plan enclosed. Four alternatives were seen alongwith officials of Irrgn. & CAD, GoAP and Environmental Consultants M/S. CES (I) Pvt. Ltd.The following are the findings:
   - ➢ Site selection done with CES(P) Ltd. and Irrgn. & CAD Deptt., Govt. of A.P. Officials on 26.07.06
   - ➢ Four sites seen – One on right bank and three on left bank
   - ➢ Land to be acquired 30000 Sq.m

Alternative I – On Left Bank

- Site located near proposed ring road and flyover of NHAI at km 3.0 from Seethanagram

Advantages
- Hydraulically most suitable river regime conditions
- No wave currents even during flood season
- Tranquil conditions available
- Stable banks
- Land available but at very high cost due to heavy industries of aquaculture, commercial crop farming, proposed shopping malls, religions trusts etc.
- Land owned by private people

Disadvantages
- Major problem envisaged in land acquisition due to

    a. High cost
    b. Owned by private people called Patta land /may not permit
    c. Major development connecting Chennai-Hyderabad going on in right bank

- Many religious sentiments involved of the people
- If sluices are opened in Prakasam barrage which is a rare occasion, then the land of terminal may be affected for certain period.

Alternative II - On Left Bank
- Site located near Vijayawada Thermal Power Station (VTPS) Intake at Bhavanipuram

Advantages
- Stable Flood Bank
- No disturbance in waves due to Prakasam Barrage
- Pucca road constructed for intake is available
- Land area required is under private hands but can be purchased as no major commercial farming is carried out

Disadvantages/Problems
- The water released from cooling water canal having high temperature will affect the working of terminal
- APGENCO will not allow construction of terminal as confirmed from A.P. Govt. officials, otherwise newly constructed cooling water intake for VTPS will have to be shifted, the possibility of which is remote.

Alternative III :

- Site located near proposed bridge near Suryapalem 5 km away from VTPS intake site.

Advantages

- Near to the main highway NH-9
- Hydraulically suitable
- Land available but owned in patta
- Near hydro power station

Disadvantages

- Hydro power station of 1.5 MW is constructed 4 to 5 years back by private party. They will not allow construction of terminal as it will affect the power generation.
- Land cost by Pvt. Owners is higher, as road by NHAI is coming up nearby.

Alternative IV

- Site located near Ibrahimpatnam ferry terminal to Rayapudi

Advantages

- Most suitable site hydraulically
- Stable and firm flood banks available
- A 10 m long breakwater existing which will help locating packing bags/waiting berth
- Existing ferry terminal in the vicinity constructed 50 years back is functioning very well
- Very near to NH-5
- Land through owned by Pvt. People (Patta) is the cheapest i.e. Rs. 15 to 20 lakhs/acre
- Environmentally suitable
- Pure water available –No turbidity observed

Disadvantages

- The site will be around 8 km away from Vijayawada town.

Selected site for river terminal: Alternative IV near Ibrahimpatnam

3. **Rajahmundry** : Rajahmundry, an ancient town in East Godavari is situated at latitude 17°01'N and longitude 81°41'E. It is on the left bank of river Godavari just above the head of Delta. The average rainfall is about 1057.2 mm. A water depth of 4 m is available at the fag end of Kakinada

canal. The terminal is proposed to be located near paper mill at Aryapuram. On the right bank, Kovvur is connected by Asia's second largest road-cum-rail bridge. The famous Sir Arthur Cotton barrage of total length 5.837 km constructed in 4 arms across Godavari replacing original anicut for surpassing the maximum discharge of 98917 cumecs with 175 nos. of vents and 3 head sluices for irrigation supplies, is situated in Rajahmundry . Alternative locations were also identified and are given in the following para and shown in figure enclosed. A piled RCC jetty is proposed to handle the cargo throughput. The provision for coal berth is made for terminating coal traffic coming from Bhadrachalam. The back up facilities for terminal will be provided by reclaiming the area behind the berth. The alternative sites were seen by the consultants alongwith Irrgn. & CAD officials of GoAP and Environmental Consultants M/S. CES (I) Pvt. Ltd. The following are the findings:

- Site selection done with Environmental Consultants - CES (P) Ltd. and Irrgn. & CAD Deptt., Govt. of A.P. officials on 27.7.06.
- Land to be acquired : 30000 Sq.m.

Alternative I – At Godavari Bund Road near AP Tourism Div. Corporate Office

Advantages

1. Hydraulically stable water banks
2. Suitable site as Sand barges/boats seen plying from small wharf
3. Nearness to city road
4. Railway line running parallel
5. Pucca bund constructed along the flood bank
6. Major activities of construction viz. Hare Rama Hare Krishna Temple, hotels, function halls going on.

Disadvantages

1. It is in the near heart of the city of Rajahmundry which may lead to traffic congestion if terminal comes up.
2. Land area restricted for expansion only 75m x 38.5 m land available with Irrigation and CAD Deptt. whereas we need a min. of 300 m x 120 m on land and 180m x 90m in river

Findings: Not suitable

Alternative II – In Aryapuram near A.P. Paper Mills after burning ghat.

Advantages:

1. Stable water banks – hydraulically perfect site for terminal
2. Tranquil conditions available
3. Suitable site as many boats ply from wharf
4. A puccaghat Kotillingalareru exists
5. Ample land available
6. Land ownership is with Irrgn. & CAD Dept. but given on lease (Patta Land), where only farming is being carried out. So Govt. of A.P. acquiring 300 m x 100 m land is not a problem.
7. Near to famous road-cum-rail bridge of Rajahmundry
8. Environmentally ideal site

Disadvantages/Problems

1. Land is at present on lease with farmers. They have fenced their farms. Total 3 plots required, so land is required to be acquired from farmers.
2. Small hutments have come up in the approach road which are very small in numbers- can be evacuated by A.P. Govt.

Findings : Suitable.

Alternative III

- At Babbarlanka island near Dowleiswaram lock

Advantages

1. A land of 200 acres as island in the river near Dowleiswaram barrage is lying barren.
2. Owned by Irrigation & CAD Deptt. A.P.
3. Hydraulically adequate site, barges are kept on both sides of island
4. Water available throughout the year
5. Ghat is in existence
6. Environmentally safe

Disadvantage

1. No major access road – Only a small cycle track available from barrage
2. A bridge needs to be constructed over river to access the site, which may change the cause of river and hydraulic stability may be affected.

Chosen site - Alternative II at Aryapuram

4. **Eluru** : Eluru town is in latitude 81°08'N and longitude 16°43'E at 75.00 km from Vijjeswaram lock. The Eluru Canal runs inside the city parallel to the road. The water depth available is upto 2.0 m maximum and the width of canal is 25 m to 30 m. The river Godavari from Vijjeswaram lock terminates at a lock at 74.5 km and thereafter Krishna River feeds the canal from Vijayawada to Eluru canal upto the closed lock. There are 5 foot bridges and one double aqueduct in the city. The terminal is proposed to be located parallel to the canal. The land surrounding the proposed terminal is full of inhabitants. Alternative locations were also identified and are given in the Terminal report as follows. They are also shown in figure enclosed.

At Chainage 74 km approx
Land area required 300m x 100 m on left bank

Alternative I – **North of Eastern Lock**

Advantage

- Sufficient water available due to vicinity of lock

Disadvantage/Problem –

- A state highway road runs parallel on left bank, which is maintained since 50 years. No possibility of shifting the road.
- At 100 m away, Tammileru River meets the Eluru Canal, so no possibility of shifting the river.
- Required backup area cannot be acquired

Alternative II – On Right Bank

Advantage

- Adequate waterfront available
- Well connected to state highway by road bridge
- Adequate land available with A.P. Govt.
- Sufficient back up area available for reclamation
- Advantage of Tamileru river can be taken in the vicinity

Problems envisaged

- There is one generator room of approx. size 2 m x 2 m with A.P. State Govt. Irrigation and CAD Deptt. which needs to be relocated while acquiring land.

Selected Alternative : Alternative II

5. WAZIRABAD :

This site is located near Pondugala Bridge. This will be a Primary Terminal because of abundant traffic of cement.

Site selection for fixing the location of terminal was carried out with Environmental Consultants on 25.07.2006.The consultants have chosen two locations:

1) On left bank near Wadepalli (Wazirabad)
2) On right bank near Pondugala village

These are shown in the plan enclosed.

Selected alternative (1) because of following reasons :

Advantages of Alternative (1) :

- Adequate water front is available
- Area required 200 m x 200 m
- Ample area is vacant and is under government control
- Quality of surrounding water seemed good for aquatic life as confirmed from the Environmental Consultants.
- Well connected by road and rail

Disadvantages of alternative (1):

- Only one problem of pipeline discharging into river Krishna to be relocated
- Nearness to KCP cement factory

Advantages of alternative (2):

- Adequate waterfront available
- Area required 300 m x 100 m available to be acquired

Disadvantages/Problems in choosing site (2) :

- There are the following obstructions:
  - One Mosque
  - One Temple

➢ One mausoleum

Which are Historical Structures and need to be relocated.

- Rivers tends to shift towards left bank, so availability of water round the year is not ensured in this location.

6. **MUKTIYALA :** The site is located near Jaggayyapet and Pulinchintala. The consultants visited the site alongwith Environmental consultants on 25.07.2006. The locations identified are near existing river ferry ghat .The consultants met the Sarpanch of the village who co operated with the team of consultants in identifying the land for terminal. The following are the findings :

- Site Selection with Environmental Consultants done on 25.07.06
- Two sites selected in left bank of river Krishna as follows :

A. North of existing ghat
B. South of existing ghat

Finally recommended **A** based on following reasons :

A. North of existing ghat

Advantages

- Ample space for future expansion available
- Adequate water front available
- Used at present for mooring of ferry boats stable banks
- Land to be required 300 m x 100 m available
- Possibility of less siltation
- Well connected by road from Jaggayyapetta

Disadvantages/problems

- Away from village, hence approach needs to be established.
- Enquired from Ex-sarpanch Mr. Venkaiyer.
- At present land is with queen of Muktiyala Mrs. Reddy w/o Mr. Prasad and some portion with private household.
- The villagers were co operative.

B. South of existing ghat

Advantages

- Water depth of around 2 m available
- Land to be acquired 300 m x 100 m just available near palace of Queen Mrs. Reddy

- Well connected by road to Jaggayyapetta
- Inside Village, which may disrupt village traffic.

Disadvantage

- Both sides landlocked
- No possibility of future expansion
- Land ownership with queen of Muktayala and private household
- Whole village to be relocated
- Many houses (around 100 to be removed and relocated which is a problem.

7. TADEPALLIGUDEM

The terminal is situated near the bridge at Eluru Road . The terminal site was located alongwith representative of Environmental Consultants M/s Consulting Engg. Services (Pvt.) Ltd on 30.07.06 at Chainage 22 km approx.

Land Area required : 30000 m^2

Two alternatives were identified and are shown in the figure enclosed. The following is the justification in choosing the alternative:

Alternative I – On right bank

Advantage

- Adequate water available
- Environmentally OK

Problems

- A state highway runs parallel to the Eluru Canal – If we construct terminal, the highway should be diverted and a new highway is required to be constructed.

Alternative II – On left bank, near Shivalayam

Advantage

- Adequate water front available
- A permanent canal ghat is existing since 100 years and navigation of ferry is being carried out regularly along the ghat
- Well connected to NH-5 and railway line – No problem in locating railway siding for coal transfer
- Adequate land available with A.P. Govt.
- Easy reclamation due to barren land available
- Near Tadepalligudam railway station and market

Problems envisaged

- A permanent pond and some pucca/Kutcha houses are coming under the area to be acquired, which is a very small problem for A.P. Govt..

Selected Alternative – Alternative II

8. BHADRACHALAM :

The site is having the maximum potential of coal traffic. The temple town of A.P. is in remote tribal and forest area. The road & rail connectivity is there but is very poor. The consultants alongwith Environmental consultants met the Sub- Collector and discussed with her regarding the development of river terminal. She opined that if the river terminal comes up, the development of the area will get momentum. Many industries will come up with the development. She extended co operation by sending MRO alongwith the consultants and helped identifying the locations of terminals. Two alternatives were seen and are shown in the figure enclosed. The following are the findings:.

Alternatives seen :

Alternative I : Near road bridge at Bhadrachalam city downstream side.

Advantages

- Nearest place to existing road to Rajahmundry
- A small plot of Govt. land available
- River ghat existing

Disadvantage

- Water currents are high during floods
- Ships cannot be moored
- No tranquility
- Hence hydraulically rejected
- Possibility of traffic congestion and pollution near famous Bhadrachalam Temple, once coal terminal comes up
- No place for future expansion, if required.

Alternative II

Near road to Pollavaram (km 3.5 from Bhadrachalam)

Advantages

- Long water front available
- Water depth of around 4.5 m available in most of the time
- Stable waterfront
- High flood line at 15.0 m
- Terminal planned at +17.0 m
- Hydraulically most suitable
- An approach trestle 450 m long is to be constructed
- Back up land area 250 m x 190 m available
- Land owned partly by Govt. of A.P. for development purpose (220m x 100 m) and rest of land is given on lease i.e. patta to farmers. Patta land can be acquired at market rate of Rs. 22000/- per acre, as confirmed from revenue.

Disadvantage/problems envisaged

- The acquisition of land is prohibited by revenue Deptt., as it is tribal area (or agency area as they call it). IWAI should intimate Govt. of A.P. that Govt. of A.P. should initiate/make provision for acquisition of tribal land.

Selected Terminal – Alternative II

- Confirmed with sub-collector, Bhadrachalam

9. KOTTAPATNAM :

The terminal is located at Chainage 85 km. The site is near Ongole. The consultants alongwith Environmental Consultants met the Collector and Mandal Revenue Officer to decide upon the location of the terminal. The site identified was near Kottapatnam Bridge. An alternative site was also identified. The site identified and the alternative is shown in the figure enclosed. The following are the findings of the visit:

Alternative I : At Chainage 284 km (Approx.)and in left bank between 178 km and 179 as per state Govt. records.

- The site is in Southern side of Kottapatnam Bridge
- Land required approx. 300 m x 100 m

Met Mandal Revenue officer's revenue inspector Sh. Venkat and Sh. Prasad on 31.7.06, who accompanied the consultants to show the suitable site.

Advantages

- High water line available on bank
- Connected to Ongole Kottapatnam Beach road
- Only 50 m away from existing bridge
- Some part of land i.e. survey nos. 1217 and 1913 is already in possession of A.P. Govt., whereas adjacent portion i.e. survey no. 1958 is given on lease for 30 years called DK Temporary Patta land
- Environmentally OK.

Problems Envisaged

- Salt water farming using underground bore wells is being carried out all along Buckingham canal and required to be relocated, if the terminal comes up in the land.
- Salt Commissioner's permission is required to acquire the land.

Alternative II – In right bank of Canal on Chainage 284 km

Advantages

- High water line available on bank
- Barren land of Govt. available
- Environmentally OK

Problems Envisaged

- Salt water farming from underground borewells is being carried out all along Buckingham canal and required to be relocated
- Salt Commissioner's permission is required to acquire land.

Disadvantages/Problems

- No accessibility by road
- A new road is required to be constructed
- Ships coming from Commamur Canal will face difficulty in manoeuvering if situated on right bank as other terminals selected are mainly on left bank.

Selected Alternative – A

10. MAIPADU TERMINAL

The site is located near the bridge abutting the Maipadu Beach. The Buckingham Canal runs along the sea at this location. The consultants visited the site alongwith Project Manager, CES (P) Ltd. on 01/08/06. They met Sh. B. Ramaiah, IAS, Joint Collector, Nellore and discussed about the availability of land for developing terminal along the canal. Two alternatives were seen alongwith M.R.O. and Revenue Inspector. The sites chosen are shown in the figure enclosed.

Area of land required – 30000 m^2

Alternative I – Near the bridge abutting the beach on right bank 2 km from Maipadu village

Advantages

- Adequate waterfront available
- Nearness to road. A pucca road of 3 m wide exists near the selected site.

Disadvantage/Problem

- Land occupied by aqua-farm hatcheries on patta land (Govt. of A.P. has given to private people on lease)
- Cost of land – Too high, because of aqua-farms and structures thereof.
- Falling in CRZ

Alternative II : Near village road survey no. 220

Advantages

- Adequate waterfront available
- Near to Kutcha road survey no. 220
- Barren land available, but on Patta land

Disadvantages/Problems

- Land occupied by aqua-farm hatcheries on patta land

Suggested Alternative – Alternative II

11. DURGARAJUPATNAM :

This site falls under Wakadu Mandal in Nellore District. The consultants have seen the site alongwith Project Manager, CES (I) Pvt. Ltd. on 02/08/06.They met Mandal Revenue Officer, Wakadu. The terminal was sited at ½ km from Durgarajupatnam on left bank of Buckingham canal.
Two alternatives were seen and are shown in the figure enclosed. The following are the findings:

Land area required – 300 m x 100 m

Alternative I – Near Marine Police Station and Tsunami rehabilitation colony by ACT, Geneva on left side of R&B riad

Advantage

- Adequate and stable water front available
- Well connected with road
- Two plots (Patta lands) no. 676 and 678 can be acquired as these are vacant
- Can be expanded as there are vacant lands available
- Environmentally OK

Disadvantage/problem

- A temple temporarily constructed on plot 676 needs to be demolished.

Alternative II – On right side of R&B road ending at Buckingham canal near Marine Police Station

Advantage

- Adequate and stable waterfront available
- Well connected with road
- Three plots (Patta lands) no. 210,211 and 606 need to be acquired, but they are vacant.
- Environmentally OK

Disadvantage

- Cannot be expanded in future, as Tsunami rehabilitation colony constructed by ATC, Geneva is existing beyond these plots.

Suggested alternative – Alternative I

12. ENNORE :

The terminal is selected because of its proximity to the industrial city of Chennai. Ennore is having many industrial units including a Thermal Power Station. It has a very big port called "Ennore Port Ltd." Two alternative locations were identified alongwith Environmental consultants M/S. CES (I) Pvt. Ltd. and the officials of Water Resources Organisation (WRO), Public Works Department, Govt. of Tamil Nadu. The locations identified are shown in the figure enclosed.The following are the findings:

- Seen two alternative sites alongwith Project Manager of Environmental Consultants M/s CES (P) Ltd.

Land area required 300 m x 125 m

Alternative I – South of Ennore South Lock near Kattukuppam village

Advantages

- Adequate waterfront available (water depth 0.65 to 1.0 m)
- Stable bank available
- No obstruction viz. power line, electric line etc. at the site in heavy industrial area
- Well connected to road (KH Road) and rail
- Electricity can be bought from T.N.E.B.

Disadvantages

- The site is at present occupied totally by fishermen – There are pucca/permanent houses in Kattukuppam village.
- The fishermen colony needs to be rehabilitated which is a complex issue.
- The effluent from nearby industries of Ennore is released into the canal, hence fishermen have kept sand bags at Ennore South Lock to control effluents and survive the fish.

Alternative II :Next to Ennore creek bridge no. 44 around 200 m away from bridge on K.H. Road.

Advantage

- Adequate water front available, water depth =1.0 m
- Stable bank available
- No obstruction of power line, electric line at the site
- Situated on K.H. Road in the vicinity of Ennore Creek Rail Bridge
- Adequate barren land available with salt office

- Problem of effluent release into creek is minimal at the site.

Disadvantage/Problem

- Land to be acquired from Salt Deptt.
- Barren land is at present available of size 300 m x 100 m

Recommended Alternative – Alternative II

13. MUTHUKADU

This is the only location available for Muthukadu Terminal.

Size of land required – 300 m x 100 m

Advantage

- Adequate water front available
- Stable water banks in canal
- Accessibility to road and rail
- Width of canal available is 25 m
- Land available with WRO, PWD, Chennai – Some part (25m stretch) needs to be acquired – To be confirmed from Revenue Deptt.

14. MARAKANAM :

This terminal is proposed to be a terminating station of the entire waterway of Kakinada-Puducherry Canal. The town is very near to Puducherry. The Buckingham canal ends and Kaluveli tank starts from here and meets the sea. Two locations were identified alongwith WRO,PWD officials and Environmental Consultants on 02.08.2006. The locations are shown in the figure enclosed. The following are the findings:

Land Area Required : 30000 m^2

Alternative I : In Kaluvelly Tank near Kaipanikuppam village road opposite Vaisakhi Bio-Medical Pvt. Ltd. Shimp Hatchery at km 113/6 near Tahamgadu Check Post

Advantage

- Adjacent to busy East Coast Road
- Adequate land area available

  There are salt pans on shores of Kaluvelly tank and immediately after farm lands (wet lands) available

- There are catamaran services originating/terminating in the location selected, which justifies the location.

Disadvantage/Problem

- No adequate assured water depth available
- Only 0.45 m to 0.6 m depth of water is available at shore of Kaluvelly tank whereas a minimum of 1.4 m draft should be available at shore.

Hence the location is rejected.

Alternative II – Near Alambarai Fort Road Bridge
(12 km from Merakannam in south Buckingham canal)

Advantage

- Adjacent to busy East Coast Road
- Adequate land area available, can be acquired from villagers
- Met village president Sh. M.R. Kuppuraj, who has agreed to extend Co-operation while acquiring land. In fact, he is very anxious to see the project coming.
- Adequate water depth of around 1.8 m because of back water effect of sea is available.
- 50 m length of stretch of either side of canal available with WRO, PWD Chennai and a total of 300 acre of land on north side of canal is available with village Revenue Deptt. As confirmed.– can be acquired

Disadvantage- No problem anticipated in developing the terminal.

Recommended Alternative – Alternative – II

15. PUDUCHERRY :

This terminal will be identical to Marakanam terminal to be located near the Pondicherry Institute of Medical Sciences. The commodity base and hinterland are of same envelope as Marakanam. This is the only location available for Muthukadu Terminal. The terminal is located immediately south of Kalluvelly tank swamp 500 m west of Puducherry coastal highway junction point of 3 m road linking Puducherry medical institute and coastal highway. The northern and southern side of this link road is enveloped by Banana & coconut land.

As the kalluvelly tank, Pudupatti village and coastal highway are enveloping the terminal closely no alternative site for terminal location is available.

Land Area Required : 30000 m^2

5.12 ELECTRICITY AND WATER REQUIREMENT FOR ALL TERMINALS

The electricity and water requirement is described for all the terminals except Ennore and Bhadrachalm terminal as given below.

The power required for the terminal is as follows:

Sl. No.	Item Description	KW Required
1	Lighting for offices,yards/storages area(covered & open),jetty etc.	200
2	Service equipment,any supplementary cranes etc.,water supply pumps from storage	200
	Total	400

A provision for 400 kW is to be allocated. Incoming supply voltage from State Electricity Board can be 3.3 kV or 440 Volts depending on the available state supply point voltage. The power supply can be partly supplemented by 100 kW D.G. set for terminal operations in the event of stoppage of city supply. Main incoming supply of 3.3kV or 440 Volts will be reduced as required for through station.

As regards water supply, the river/canal source is to be used. The daily requirement is 10000 lt. per day with 50% to be potable water using water treatment methods. Disposal of used and drainage water is to made to the flowing river at suitable designated point. The water supply system will have an underground storage of 10000 lt. and overhead tank of 5000 lt. Water supply can be drawn from river or municipal supply as would suit conditions.

The electricity and water requirement is described for Ennore and Bhadrachalm terminal as given below.

The power required for the terminal is as follows:

Sl. No.	Item Description	KW Required
1	Lighting for offices,yards/storages area(covered & open),jetty etc.	250
2	Service equipment,any supplementary cranes etc.,water supply pumps from storage	250
	Total	**500**

A provision for 500 kW is to be allocated. Incoming supply voltage from State Electricity Board can be 3.3 kV or 440 Volts depending on the available state supply point voltage. The power supply can be partly supplemented by 100 kW D.G. set for terminal operations in the event of stoppage of city supply. Main incoming supply of 3.3kV or 440 Volts will be reduced as required for through station.

As regards water supply, the river/canal source is to be used. The daily requirement is 10000 lt. per day with 50% to be potable water using water treatment methods. Disposal of used and drainage water is to made to the flowing river at suitable designated point. The water supply system will have an underground storage of 10000 lt. and overhead tank of 5000 lt. Water supply can be drawn from river or municipal supply as would suit conditions.

CHAPTER 6
DESCRIPTION & DESIGN BASIS FOR ENGINEERING WORKS

CHAPTER – 6

DESCRIPTION AND DESIGN BASIS FOR ENGINEERING WORKS

6.1 INTRODUCTION

The waterway and structures falling in entire stretch of waterway has been discussed in Chapter 3.The engineering works required to be carried out so as to make the waterway navigable for movement of designed barges have been discussed in following paragraphs.

6.2 DESIGN BASIS

The structural design of the various components has been carried out using standard engineering practices and codal provision.

WAPCOS was to undertake geotechnical investigations at the proposed terminal locations. However due to various reasons, these geotechnical investigations could not be undertaken. In view of the above situation and based on visual inspection and our understanding of the soil condition, it is preferable to adopt a safe bearing capacity of 8 ton/m^2 to 12 ton/m^2 for different terminal locations. In any case detailed geotechnical investigations are to be undertaken as per IS Code provision during detailed engineering stage, which can be taken up after finalization of terminal locations.

6.3 ENGINEERING WORKS

The various engineering works proposed to be carried out have been dealt separately in various canals and river portion as follows.

6.3.1 Engineering Works for Kakinada canal

Following engineering works have been proposed in Kakinada canal

- Dredging
- Bridges
- Terminals
- Navigation lock
- Pipe sluices
- Navigational Aids

6.3.1.1 Dredging

The quantity of dredging required in Phase I & Phase II for Kakinada canal has been worked out as given below and details are furnished in Volume III : Annexures. The dredged quantity would be laid on both banks of canal.

Quantity of Dredging required in Phase I for 14m bed width in Kakinada canal from 0km to 50km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)
	From	To	From	To	
1	Dowleiswaram lock	Kadium Lock	0.00	7.00	72975
2	Kadium Lock	Medapadu Lock	7.00	16.00	1410
3	Medapadu Lock	Tossipudi Lock	16.00	26.00	134414
4	Tossipudi Lock	Chintapalli Lock	26.00	34.00	609
5	Chintapalli Lock	Kovvuru Lock	34.00	48.00	153524
6	Kovvuru Lock	Jagannathpuram bridge, Kakinada	48.00	50.00	0
				Total	**362932**

Quantity of Dredging required in Phase II for 32m bed width in Kakinada canal from 0km to 50km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)
	From	To	From	To	
1	Dowleiswaram lock	Kadium Lock	0.00	7.00	620062
2	Kadium Lock	Medapadu Lock	7.00	16.00	1126757
3	Medapadu Lock	Tossipudi Lock	16.00	26.00	1936630
4	Tossipudi Lock	Chintapalli Lock	26.00	34.00	787363
5	Chintapalli Lock	Kovvuru Lock	34.00	48.00	959082
6	Kovvuru Lock	Jagannathpuram bridge, Kakinada	48.00	50.00	69220
				Total	**5499114**

6.3.1.2 Bridges

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across canal is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
I*	20	4

* Class I waterway refers to navigable channel with minimum of 1.5m depth, 20m bottom width, 300m bend radius in canal portion.

The salient details of existing bridges falling in Kakinada canal are furnished in Table 3.23. In Phase I, it is proposed to provide a channel width of 14 m and 100 t barge would ply in the stretch of Kakinada canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 15 m. Following the same principle the width of waterway for one way navigation would be 6.8m. For the width of 100 t barge equal to 4.25m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges have been verified for a horizontal clearance of 6.0m for one-way navigation and a vertical clearance of 3.8m so as to pass 100 t barge through them. It is observed that 4 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase I are shown in Fig. 6.1 and 6.2 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	1.5	Vemagiri Bridge	RCC	60	3.1	30	Yes
2	7.25	Kadium Foot Bridge	Foot Bridge	26.7	3.5	3	Yes
3	11.0	Jegarpadu Bridge	RCC	21	5.5	8.5	No
4	16.3	Medapadu bridge	RCC	54	4.8	9.5	No
5	20.5	Anarpatti Bridge	Foot Bridge	21	4.7	9	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
6	21.4	Anarpatti Foot Bridge	RCC	25	4.5	7.7	No
7	23.6	Kuppervaram	RCC	21.5	5.5	10.5	No
8	25.2	Kumaripalem	Foot Bridge	26	5.2	13.0	No
9	26.4	Tossipudi	RCC	13.5	5	6.0	No
10	26.5	Kumaripalem	RCC	30.5	5	15.5	No
11	29.2	Pandalapakka	RCC	19.5	5.3	10	No
12	35.5	Chintapalli	RCC	27	5	13.2	No
13	37.5	Puttakonda	RCC	10	5.3	10	No
14	41.2	Adoclanirevu Bridge	RCC	17	5.7	8.5	No
15	44.4	Aratlakatta	RCC	12.1	4.4	12.1	No
16	47	Railway bridge no. - 21	Girder	30	4	20.0	No
17	47.8	Kavvuru	Foot Bridge	15.5	2	1.5	Yes
18	51.8	Kakinada New Bridge	RCC	108	2.7	25.0	Yes
19	52	Old Bridge Jagannathpuram	RCC	104	4.5	40.0	No
Total number of bridges requiring modification							**4**

In Phase II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of Kakinada Canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 32.4 m. Following the same principle the width of waterway for one way navigation would be 14.4 m. For the width of 300 t barge equal to 9.0 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges have been verified for a horizontal clearance of 11.0 m for one-way navigation and a vertical clearance of 4.8m so as to pass 300 t barge through them. It is observed that 16 nos. bridges as tabulated below, do not satisfy minimum clearances required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase II are shown in Fig. 6.3 and 6.4 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	1.5	Vemagiri Bridge	RCC	60	3.1	30	Yes
2	7.25	Kadium Foot Bridge	RCC Foot Bridge	26.7	3.5	3	Yes
3	11.0	Jegarpadu Bridge	RCC	21	5.5	8.5	Yes
4	16.3	Medapadu bridge	RCC	54	4.8	9.5	Yes
5	20.5	Anarpatti Bridge	RCC Foot Bridge	21	4.7	9	Yes
6	21.4	Anarpatti Foot Bridge	RCC	25	4.5	7.7	Yes
7	23.6	Kuppervaram	RCC	21.5	5.5	10.5	Yes
8	25.2	Kumaripalem	RCC Foot Bridge	26	5.2	13.0	No
9	26.4	Tossipudi	RCC Bridge	13.5	5	6.0	Yes
10	26.5	Kumaripalem	RCC	30.5	5	15.5	No
11	29.2	Pandalapakka	RCC	19.5	5.3	10	Yes
12	35.5	Chintapalli	RCC	27	5	13.2	No
13	37.5	Puttakonda	RCC	10	5.3	10	Yes
14	41.2	Adoclanirevu Bridge	RCC	17	5.7	8.5	Yes
15	44.4	Aratlakatta	RCC	12.1	4.4	12.1	Yes
16	47	Railway bridge no. - 21	Girder	30	4	20.0	Yes
17	47.8	Kavvuru	Foot Bridge	15.5	2	1.5	Yes
18	51.8	Kakinada New Bridge	RCC	108	2.7	25.0	Yes

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
19	52	Old Bridge Jagannathpuram	RCC	104	4.5	40.0	Yes
Total number of bridges requiring modifications							16

6.3.1.3 Terminals

It has been proposed to provide terminal at Kakinada in Kakinada canal. The details of terminal have been discussed in Chapter 5.

6.3.1.4 Navigation Lock

The details of existing six no. locks falling in the stretch of Kakinada canal are furnished in Table 3.24. The dimensions of these locks are predominantly suitable for safe passage of 100t barge in Phase I. It is further observed that most of these locks are in bad condition and therefore require urgent repair work in order to make them navigable for movement of 100 t barge.

As development of proposed waterway in Phase II would enable movement of 300t barge in Kakinada canal, it is found that the nominal width required at entrance of lock would be 11m and nominal length of lock chamber would be 50m so as to provide safe passage of 300t barge. It is therefore clear that the existing locks are not sufficient enough to provide safe passage of 300t barge. Hence it is proposed to provide 6 nos. new locks in place of existing ones for safe passage of 300t barge in Phase II.

The salient features for a typical new lock are as follows:

- No. of lock chamber : 2
- Length of lock chamber : 50 m
- Width of lock chamber : 15m
- Type of superstructure : RCC counterfort
- Height of wall : 7.5m
- Width of out lock walls : 1.0 m
- Width of inner lock walls : 2.0 m
- Type of foundation : Pile Foundation

- Type of Lock Gates : Mitre Gate
- No. of Gates : 8
- Size of Gates : 6m x 15 m
- Length of guide wall : 10m on both banks
- Bed protection : Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide canal is shown in Fig 6.5.

6.3.1.6 Pipe Sluices

The storm water accumulating in the catchment area from local villages along the entire length of Kakinada canal needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on both banks throughout the entire length of Kakinada canal.

The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.6.

6.3.1.7 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks of Kakinada canal. The estimated quantity of these navigational aids required in stretch of Kakinada canal are given below:

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	110
2.	Shore beacon	No.	8

6.3.2 Engineering Works for Eluru canal

Following engineering works have been proposed in Eluru canal

- Dredging
- Bridges
- Terminals
- Navigation lock
- Aqueducts
- Pipe sluices
- Navigational Aids

6.3.2.1 Dredging

The quantity of dredging required in Phase I & Phase II for Godavari Eluru and Krishna Eluru canal has been worked out as given below and details are furnished in Volume III : Annexures. The dredged quantity would be laid on both banks of canal.

Quantity of Dredging required in Phase I for 14m bed width in Godavari Eluru canal from 0km to 74km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Vijjeswaram lock	East Tammileru lock	0.00	74.00	1180391
				Total	1180391

Quantity of Dredging required in Phase II for 32m bed width in Godavari Eluru canal from 0km to 74km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Vijjeswaram lock	East Tammileru lock	0.00	74.00	10407986
				Total	10407986

Quantity of Dredging required in Phase I for 14m bed width in Krishna Eluru canal from 74km to 139km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	East Tammileru lock	West Tammileru lock	74.00	79.00	36739
2	West Tammileru lock	Eluru lock, Vijayawada	79.00	138.00	31979
3	Eluru lock, Vijayawada	Vijayawada lock	138.00	139.00	0
				Total	68718

Quantity of Dredging required in Phase II for 32m bed width in Krishna Eluru canal from 74km to 139km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	East Tammileru lock	West Tammileru lock	74.00	79.00	409408
2	West Tammileru lock	Eluru lock, Vijayawada	79.00	138.00	5804879
3	Eluru lock, Vijayawada	Vijayawada lock	138.00	139.00	113902
				Total	6328189

6.3.2.2 Bridges

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across canal is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
I*	20	4

* Class I waterway refers to navigable channel with minimum of 1.5m depth, 20m bottom width, 300m bend radius in canal portion.

The salient details of bridges are tabulated in Table 3.16. In Phase I, it is proposed to provide a channel width of 14 m and 100 t barge would ply in the stretch of Eluru Canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 15 m. Following the same principle the width of waterway for one way navigation would be 6.8m. For the width of 100 t barge equal to 4.25m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed. all the existing bridges have been verified for a horizontal clearance of 6.0m for one-way navigation and a vertical clearance of 3.8 m so as to pass 100 tonne barge through them. It is observed that 8 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase I are shown in Fig. 6.1 and 6.2 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
GODAVARI ELURU CANAL							
1	0.4	Vijjeswaram	RCC	40	7.7	20	No
2	0.6	Vijjeswaram	Foot Bridge	45	7	20	No
3	3.7	Kotta Gopavaram	RCC	84	6	7.5	No
4	6.4	Satnvatsaragude m	RCC	60	5.1	35	No
5	10	Chettipetta	Railway	42	5.2	12.2	No
6	10.2	Chettipetta	RCC	75	5.2	15	No
7	13.75	Foot bridge	RCC	34.5	11	8.5	No
8	15.4	Arulle	RCC	55.5	4.9	15.5	No
9	19.8	Nawabpalem	RCC	27	4	22.5	No
10	22.1	Kagnlamapadu	RCC	26.5	5.1	13.2	No
11	22.6	Prattipadu	RCC	116	10.5	40.0	No
12	24.3	Juwalapalem	RCC	38	4.5	10	No
13	25.3	Juwalapalem foot bridge	RCC	28.5	4.7	13.5	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
14	27.3	Tadepalligudam	RCC	30.0	4.7	10	No
15	27.5	Tadepalligudam	Flyover	30	6	15	No
16	27.6	Tadepalligudam (old)	RCC	30.6	5.4	30	No
17	28	Foot bridge	RCC	25.5	4.5	12	No
18	29.4	Yagarlapalle bridge	RCC	30.5	4.5	10	No
19	33.6	Badampudi bridge	RCC	25	5.8	12.5	No
20	36	Ellamilli bridge	RCC	47.5	5	8	No
21	38	Ungturu bridge	RCC	36.2	4.4	10	No
22	39.2	Ungturu bridge	RCC	21.5	4.3	9.5	No
23	40.6	Turingupeta bridge	RCC	21.5	4.5	10	No
24	42.4	Narayanpuram bridge	RCC	21.4	5	10.2	No
25	45.6	Kalkaram bridge	RCC	28	2.5	14	Yes
26	50.1	Pulla bridge	RCC	30.5	2.5	15	Yes
27	52.5	Kurrellagudem bridge	RCC	26	5	13	No
28	56.6	Bhimadolu	RCC	39	5.5	19.5	No
29	59	Paturu	RCC	26.5	5.1	13.2	No
30	62	Gundugolanu	RCC	23	5.5	18	No
31	64	Komirepalli bridge	RCC	30	5	10	No
32	67.8	Denduluru bridge	RCC	14.2	5.2	14.2	No
33	69	Kovvallli bridge	RCC	15	5	15	No
34	70.5	Kovvalli bridge	RCC	22.8	4.5	14.5	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
KRISHNA ELURU CANAL							
35	140	Bhaskararaopeta	RCC	59	13	25	No
36	139.5	Bhaskararaopeta	RCC	63	5.3	21.5	No
37	139.3	Bhaskararaopeta	RCC foot bridge	83	5	14.5	No
38	139.1	Railway Bridge at Kaleswaram	Iron girder bridge	85	5	30	No
39	138.9	Kaleswaram bridge	Railway bridge	35	5	25	No
40	138.2	Gandhinagar	RCC	40	4	20	No
41	138	Eluru canal lock bridge at Gandhinagar	Girder bridge	45	5	15	No
42	137.7	Gandhinagar bridge	RCC	44	5.4	11	No
43	137.5	Sattanarayanapuram	RCC	26	3.7	13	Yes
44	137.5	Sattanarayanapuram	Steel	26	3.7	13	Yes
45	137.1	Kedareshwarapeta	RCC	30.5	4.8	30	No
46	136.1	Ayodhyanagar bridge	RCC	28.5	4.9	14	No
47	135.5	Ajit Nagar Bridge	RCC	39	4	13	No
48	134.9	Madhurnagar Bridge	RCC foot bridge	42	3.8	10	No
49	135.5	Vijayanagar	RCC foot bridge	30.5	4.3	10	No
50	133	Gundala	Swing type	31	One span for	11	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
			bridge		navigation (swing type)		
51	131.5	Ramavarappadu	RCC foot bridge	28	5.2	14	No
52	121.3	Kesarapalli (New Bridge)	RCC	68	5.7	22	No
53	121.2	Kesarapalli (On high road)	RCC	68	5.7	22	No
54	121	Kesarapalli	RCC Arched	36	3.7	14.2	Yes
55	117.8	Ajjampudi	RCC	26	3.7	13	Yes
56	116.4	Budhavaram		26	5	13	No
57	114.8	Devajigudem	RCC	26	4.6	12.7	No
58	112.2	Avutupalli	Girder Bridge	44	3.7	10	Yes
59	110.4	Atkuru bridge	RCC	36	4	14.2	No
60	108.5	Pottipadu bridge	RCC	29	4	14.2	No
61	105.7	Tedaprolu bridge (old)	Girder	25	3.5	10	Yes
62	105.7	Tedaprolu bridge (new)	RCC	31	4.2	10.7	No
63	101.8	Viravalli	Girder	41	4	13	No
64	96.5	Perikiduvantena	RCC arched	34	4.5	19	No
65	93.8	Perikidu	Foot bridge	36	4	18	No
66	92	Totagudem	RCC	60	5	20	No
67	91.4	Totagudem	RCC	26.5	5.3	13	No
68	89.4	Fonukollu	RCC	27.5	6.3	18	No
69	87.7	Kalaparru	RCC	26	4.7	9	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
70	83.2	Vatluru	RCC	31	5	16	No
71	79.8	Hanumannagar	RCC	20	5.1	10	No
72	79	Eluru	RCC foot bridge	21.5	4.8	14	No
73	78	Eluru bridge	RCC	21	6.3	10.5	No
74	77.6	Old Eluru	RCC	13.2	5	13.2	No
75	77.6	New Eluru	RCC	13.2	5	13.2	No
76	77.5	Eluru	RCC foot bridge	16.5	5.2	15	No
77	77.4	Double bridge	RCC	30	5.2	10	No
78	77.2	Eluru foot bridge	RCC	14	5.4	7	No
79	77	Eluru	RCC foot bridge	15	5.4	15	No
80	76.9	Eluru bridge	RCC foot bridge	15	5.5	15	No
81	74.5	Bridge	RCC	65	5	20	No
Total number of bridges requiring modifications							**8**

In Phase II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of Eluru Canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 32.4 m. Following the same principle the width of waterway for one way navigation would be 14.4 m. For the width of 300 t barge equal to 9.0 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges would be verified for a horizontal clearance of 11 m for one-way navigation and a vertical clearance of 4.8m so as to pass 300 t barge through them. It is observed that 39 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase II are shown in Fig. 6.3 and 6.4 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
GODAVARI ELURU CANAL							
1	0.4	Vijjeswaram	RCC	40	7.7	20	No
2	0.6	Vijjeswaram	Foot Bridge	45	7	20	No
3	3.7	Kotta Gopavaram	RCC	84	6	7.5	Yes
4	6.4	Satnvatsaragudem	RCC	60	5.1	35	No
5	10	Chettipetta	Railway	42	5.2	12.2	No
6	10.2	Chettipetta	RCC	75	5.2	15	No
7	13.75	Foot bridge	RCC	34.5	11	8.5	Yes
8	15.4	Arulle	RCC	55.5	4.9	15.5	No
9	19.8	Nawabpalem	RCC	27	4	22.5	Yes
10	22.1	Kagnlamapadu	RCC	26.5	5.1	13.2	No
11	22.6	Prattipadu	(newly construc ted by NHAI)	116	11	40.0	No
12	24.3	Juwalapalem	RCC	38	4.5	10	Yes
13	25.3	Juwalapalem foot bridge	RCC	28.5	4.7	13.5	Yes
14	27.3	Tadepalligudam	RCC	30.0	4.7	10	Yes
15	27.5	Tadepalligudam	Flyover	30	6	15	No
16	27.6	Tadepalligudam (old)		30.6	5.4	30	No
17	28	Foot bridge	RCC	25.5	4.5	12	Yes
18	29.4	Yagarlapalle bridge	RCC	30.5	4.5	10	Yes
19	33.6	Badampudi bridge	RCC	25	5.8	12.5	No
20	36	Ellamilli bridge	RCC	47.5	5	8	Yes
21	38	Ungturu bridge	RCC	36.2	4.4	10	Yes

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
22	39.2	Ungturu bridge	RCC	21.5	4.3	9.5	Yes
23	40.6	Turingupeta bridge	RCC	21.5	4.5	10	Yes
24	42.4	Narayanpuram bridge	RCC	21.4	5	10.2	Yes
25	45.6	Kalkaram bridge	RCC bridge over dram	28	2.5	14	Yes
26	50.1	Pulla bridge	RCC	30.5	2.5	15	Yes
27	52.5	Kurrellagudem bridge	RCC	26	5	13	No
28	56.6	Bhimadolu	RCC	39	5.5	19.5	No
29	59	Paturu	RCC	26.5	5.1	13.2	No
30	62	Gundugolanu	RCC	23	5.5	18	No
31	64	Komirepalli bridge	RCC	30	5	10	Yes
32	67.8	Denduluru bridge	RCC	14.2	5.2	14.2	No
33	69	Kovvallli bridge	RCC	15	5	15	No
34	70.5	Kovvalli bridge	RCC	22.8	4.5	14.5	Yes
KRISHNA ELURU CANAL							
35	140	Bhaskararaopeta	RCC	59	13	25	No
36	139.5	Bhaskararaopeta Double bridge	RCC	63	5.3	21.5	No
37	139.3	Bhaskararaopeta	RCC foot bridge	83	5	14.5	No
38	139.1	Railway Bridge at Kaleswaram	Iron girder bridge	85	5	30	No
39	138.9	Kaleswaram bridge	Railway bridge	35	5	25	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
40	138.2	Gandhinagar	RCC	40	4	20	Yes
41	138	Eluru canal lock bridge at Gandhinagar	Girder bridge	45	5	15	No
42	137.7	Gandhinagar bridge	RCC	44	5.4	11	No
43	137.5	Sattanarayanapuram bridge under construction	RCC	26	3.7	13	Yes
44	137.5	Sattanarayanapuram bridge under construction	Steel	26	3.7	13	Yes
45	137.1	Kedareshwarapeta	RCC	30.5	4.8	30	No
46	136.1	Ayodhyanagar bridge	RCC	28.5	4.9	14	No
47	135.5	Ajit Nagar Bridge	RCC	39	4	13	Yes
48	134.9	Madhurnagar Bridge	RCC foot bridge	42	3.8	10	Yes
49	133.5	Vijayanagar	RCC foot bridge	30.5	4.3	10	Yes
50	133	Gundala	Swing type bridge	31	One span for navigation (swing type)	11	No
51	131.5	Ramavarappadu	RCC foot bridge	28	5.2	14	No
52	121.3	Kesarapalli (New Bridge)	RCC	68	5.7	22	No
53	121.2	Kesarapalli (On high road)	RCC	68	5.7	22	No
54	121	Kesarapalli	RCC Arched	36	3.7	14.2	Yes

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
55	117.8	Ajjampudi	RCC Bridge under construction	26	3.7	13	Yes
56	116.4	Budhavaram		26	5	13	No
57	114.8	Devajigudem	RCC	26	4.6	12.7	Yes
58	112.2	Avutupalli	Girder Bridge	44	3.7	10	Yes
59	110.4	Atkuru bridge	RCC	36	4	14.2	Yes
60	108.5	Pottipadu bridge	RCC	29	4	14.2	Yes
61	105.7	Tedaprolu bridge (old)	Girder	25	3.5	10	Yes
62	105.7	Tedaprolu bridge (new)	RCC	31	4.2	10.7	Yes
63	101.8	Viravalli	Girder	41	4	13	Yes
64	96.5	Perikiduvantena	RCC arched	34	4.5	19	Yes
65	93.8	Perikidu	Foot bridge	36	4	18	Yes
66	92	Totagudem	RCC	60	5	20	No
67	91.4	Totagudem	RCC	26.5	5.3	13	No
68	89.4	Fonukollu	RCC	27.5	6.3	18	No
69	87.7	Kalaparru	RCC	26	4.7	9	Yes
70	83.2	Vatluru	RCC	31	5	16	No
71	79.8	Hanumannagar	RCC	20	5.1	10	Yes
72	79	Eluru	RCC foot bridge	21.5	4.8	14	No
73	78	Eluru bridge	RCC	21	6.3	10.5	Yes
74	77.6	Old Eluru	RCC	13.2	5	13.2	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridge requiring modification
75	77.6	New Eluru	RCC	13.2	5	13.2	No
76	77.5	Eluru	RCC foot bridge	16.5	5.2	15	No
77	77.4	Double bridge	RCC	30	5.2	10	Yes
78	77.2	Eluru foot bridge	RCC	14	5.4	7	Yes
79	77	Eluru	RCC foot bridge	15	5.4	15	No
80	76.9	Eluru bridge	RCC foot bridge	15	5.5	15	No
81	74.5	Bridge over lock and weir	RCC	65	5	20	No
Total number of bridges requiring modifications							**39**

6.3.2.3 Terminals

It has been proposed to provide terminals at Eluru and Tadepalligudem in Eluru canal. The details of terminal have been discussed in Chapter 5.

6.3.2.4 Navigation Lock

The details of existing five no. locks falling in the stretch of Eluru canal are tabulated in Table 3.17. The dimensions of these locks are predominantly suitable for safe passage of 100t barge in Phase I. It is also observed that most of these locks are in bad condition and therefore require urgent repair work in order to make them navigable for movement of 100 t barge.

As development of proposed waterway in Phase II would enable movement of 300t barge in Eluru canal, it is found that the nominal width required at entrance of lock would be 11m and nominal length of lock chamber would be 50m so as to provide safe passage of 300t barge. It is therefore clear that the existing locks are not sufficient enough to provide safe passage of 300t barge. Hence it is proposed to provide 5 nos. new locks in place of existing ones for safe passage of 300t barge in Phase II.

The salient features for a typical new lock are as follows:

- No. of lock chamber : 2
- Length of lock chamber : 50 m
- Width of lock chamber : 15m
- Type of superstructure : RCC counterfort
- Height of wall : 7.5m
- Width of out lock walls : 1.0 m
- Width of inner lock walls : 2.0 m
- Type of foundation : Pile Foundation
- Type of Lock Gates : Mitre Gate
- No. of Gates : 8
- Size of Gates : 6m x 15 m
- Length of guide wall : 10m on both banks
- Bed protection : Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide canal is shown in Fig 6.5.

6.3.2.5 Aqueducts

The details of existing 19 no. aqueducts falling in Eluru canal are tabulated in Table 3.18. It is observed that all these aqueducts have been provided for a width ranging between 12 to 20 m which is sufficient enough for passage of 100 t barge in two way navigation. Therefore no modification is required in these aqueducts during Phase I.

In Phase II, it is proposed to provide a channel width of 32 m in Eluru canal and 300 t barge would ply in the stretch of Eluru Canal. It is observed that all aqueducts have been provided for a width ranging between 12 to 20 m which is sufficient enough for passage of 300 t barge in one way navigation. Therefore no modification is required in these aqueducts during Phase II.

6.3.2.6 Pipe Sluices

A total no. of 19 aqueducts have been existing in Eluru canal in a length of 139km, thereby making each aqueduct covering length of about 7 km and this cannot cater the discharge of such huge areas. The storm water accumulating in the catchment area from local villages along the entire length of Eluru canal needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on both banks throughout the entire length of Eluru canal. The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.6.

6.3.2.7 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks of Eluru canal. The estimated quantity of these navigational aids required in stretch of Godavari Eluru canal and Krishna Eluru canal is given below:

Quantity of Navigation Aids required in Godavari Eluru canal

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	162
2.	Shore beacon	No.	12

Quantity of Navigation Aids required in Krishna Eluru canal

Sl. No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	143
2.	Shore beacon	No.	10

6.3.3 Engineering Works for Commamur canal

Following engineering works have been proposed in Commamur canal

- Dredging
- Bridges
- Terminals
- Navigation lock
- Aqueducts
- Pipe sluices
- Navigational Aids

6.3.3.1 Dredging

The quantity of dredging required in Phase I & Phase II for Commamur canal has been worked out as given below and details are furnished in
Volume III : Annexures. The dredged quantity would be laid on both banks of canal.

Quantity of Dredging required in Phase I for 14m bed width in Commamur canal from 0km to 113km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Seethanagram lock	Commamur lock	0.00	19.00	2886
2	Commamur lock	Jagarlamudi lock	19.00	33.00	8613
3	Jagarlamudi lock	Kollimaria lock	33.00	50.00	3237
4	Kollimaria lock	Nallamada lock	50.00	69.00	0
5	Nallamada lock	Santharavuru lock	69.00	95.00	119853
6	Santharavuru lock	Peddaganjam lock	95.00	113.00	16809
				Total	**151398**

Quantity of Dredging required in Phase II for 32m bed width in Commamur canal from 0km to 113km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Seethanagram lock	Commamur lock	0.00	19.00	1558383
2	Commamur lock	Jagarlamudi lock	19.00	33.00	602837
3	Jagarlamudi lock	Kollimaria lock	33.00	50.00	735757
4	Kollimaria lock	Nallamada lock	50.00	69.00	732855
5	Nallamada lock	Santharavuru lock	69.00	95.00	1491087
6	Santharavuru lock	Peddaganjam lock	95.00	113.00	696306
				Total	5817225

6.3.3.2 **Bridges**

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across canal is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
I*	20	4

* Class I waterway refers to navigable channel with minimum of 1.5m depth, 20m bottom width, 300m bend radius in canal portion.

The salient details of bridges are tabulated in Table 3.25.In Phase I, it is proposed to provide a channel width of 14 m and 100 t barge would ply in the stretch of Commamur Canal. As discussed in Chapter - 4, the width of waterway required for two-way navigation is determined as 15 m. Following the same principle the width of waterway for one way navigation would be 6.8m. For the width of 100 t barge equal to 4.25 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges have been verified for a horizontal clearance of 6.0m for one-way navigation and a vertical clearance of 3.8m so as to pass 100 t barge through them. It is observed that 7 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase I are shown in Fig. 6.1 and 6.2 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
1	0.05	Seethanagram	RCC	10	2.7	10	Yes
2	1.00	Seethanagram new bridge	RCC skew	77	4.1	38.5	No
3	1.00	Seethanagram old bridge	RCC	77	4.1	15	No
4	1.60	Railway Bridge	RCC	100	5.8	17	No
5.	2.4	Tadepalli	RCC	94	6.7	13.5	No
6	5.00	Kanchanpalle	RCC double	128	6.2	32	No
7	6.40	Vaddeswaram	RCC	87	6.8	12.5	No
8	11.20	Peddavaddapudi	RCC	99	5.0	11.6	No
9	19.60	Commamur Lock bridge	RCC	27	5.9	25	No
10	19.65	Bridge	RCC	50	4.8	13.5	No
11	20.40	Duggirala (old)	RCC	38	4.2	15.5	No
12	20.45	Duggirala (new)	RCC	26.6	5.2	8.6	No
13	21.70	Duggirala Railway Bridge	Girder Bridge	55	4.8	13.5	No
14	24.20	Kolakarulu (new)	RCC	66.5	5.1	8.5	No
15	24.25	Kolakarulu (old)	RCC	66	5	7.0	No
16	31.70	Angalakudure	Railway Bridge	41.6	4.2	10	No
17	33.45	Jagarlamudi bridge	RCC Arch bridge	59	5.5	10	No
18	35.60	Vadlamudi bridge	RCC	57	4.5	10	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
20	41.60	Chebrolu bridge	RCC	45.5	4.3	11.5	No
21	53.60	Lakshmipuram bridge	RCC	29.5	4.3	13.5	No
22	56.70	Garikipadu	RCC	39	4.1	13.2	No
23	63.20	Appapuram	RCC	27.5	4.1	8.5	No
24	77.80	Kunkelamarru	RCC	22.5	3.0	7.5	Yes
25	83.10	Karamchedu (new)	RCC	37.5	4.9	13	No
26	83.15	Karamchedu (old)	Girders	30.0	4.9	13	No
27	87.40	Swarna	RCC	27	5	12	No
28	88.50	Swarna	RCC Foot bridge	37.0	4.0	6	No
28	90.90	Rangapandapalen	RCC	12.0	4	12	No
29	94.10	Santarur	RCC bridge	39.0	-	2.5	Yes
30	94.40	Santarur (Santharavuru)	RCC bridge	29.0	3.2	12.2	Yes
31	95.50	Santarur	Foot bridge	9.0	3.6	9	Yes
32	96.50	Thimmasumudram	Foot bridge	24.0	4.5	9	No
33	100.00	Ganasapudi (old)	RCC	16.5	2.9	16	Yes
34	100.10	Ganasapudi (new)	RCC	34.0	5.5	25	No
35	103.80	Chintagumpalle	RCC	8.8	4	8.8	No
36	109.30	Faranguladinne	RCC	30	4.4	15	No
37	111.20	Rajubangarupalem	Rly. Bridge	35	3.2	17	Yes
38	113.95	Peddaganjam	Arches	28	5.3	12.8	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
Total number of bridges requiring modifications							7

In Phase II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of Commamur Canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 32.4 m. Following the same principle the width of waterway for 1way navigation would be 14.4 m. For the width of 300 t barge equal to 9.0 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges would be verified for a horizontal clearance of 11 m for one-way navigation and a vertical clearance of 4.8 m so as to pass 300 t barge through them. It is observed that 25 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase II are shown in Fig. 6.3 and 6.4 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
1	0.05	Seethanagram	RCC	10	2.7	10	Yes
2	1.00	Seethanagram new bridge	RCC skew	77	4.1	38.5	Yes
3	1.00	Seethanagram old bridge	RCC	77	4.1	15	Yes
4	1.60	Railway Bridge	RCC	100	5.8	17	No
5.	2.4	Tadepalli	RCC	94	6.7	13.5	No
6	5.00	Kanchanpalle	RCC double	128	6.2	32	No
7	6.40	Vaddeswaram	RCC	87	6.8	12.5	No
8	11.20	Peddavaddapudi	RCC	99	5.0	11.6	No
9	19.60	Commamur Lock bridge	RCC	27	5.9	25	No
10	19.65	Bridge	RCC	50	4.8	13.5	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
11	20.40	Duggirala (old)	RCC	38	4.2	15.5	Yes
12	20.45	Duggirala (new)	RCC	26.6	5.2	8.6	Yes
13	21.70	Duggirala Railway Bridge	Girder Bridge	55	4.8	13.5	No
14	24.20	Kolakarulu (new)	RCC	66.5	5.1	8.5	Yes
15	24.25	Kolakarulu (old)	RCC	66	5	7.0	Yes
16	31.70	Angalakudure	Railwa y Bridge	41.6	4.2	10	Yes
17	33.45	Jagarlamudi bridge	RCC Arch bridge	59	5.5	10	Yes
18	35.60	Vadlamudi bridge	RCC	57	4.5	10	Yes
20	41.60	Chebrolu bridge	RCC	45.5	4.3	11.5	Yes
21	53.60	Lakshmipuram bridge	RCC	29.5	4.3	13.5	Yes
22	56.7	Garikipadu	RCC	39	4.1	13.2	Yes
23	63.20	Appapuram	RCC	27.5	4.1	8.5	Yes
24	77.80	Kunkelamarru	RCC	22.5	3.0	7.5	Yes
25	83.10	Karamchedu (new)	RCC	37.5	4.9	13	No
26	83.15	Karamchedu (old)	Girders	30.0	4.9	13	No
27	87.4	Swarna	RCC	27	5	12	No
28	88.50	Swarna	RCC Foot bridge	37.0	4.0	6	Yes
28	90.90	Rangapandapalen	RCC	12.0	4	12	Yes
29	94.10	Santarur	RCC bridge	39.0	-	2.5	Yes

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges requiring modification
1	2	3	4	6	7	8	9
30	94.40	Santarur (Santharavuru)	RCC bridge	29.0	3.2	12.2	Yes
31	95.50	Santarur	Foot bridge	9.0	3.6	9	Yes
32	96.50	Thimmasumudram	Foot bridge	24.0	4.5	9	Yes
33	100.00	Ganasapudi (old)	RCC	16.5	2.9	16	Yes
34	100.10	Ganasapudi (new)	RCC	34.0	5.5	25	No
35	103.80	Chintagumpalle	RCC	8.8	4	8.8	Yes
36	109.30	Faranguladinne	RCC	30	4.4	15	Yes
37	111.20	Rajubangarupalem	Rly. Bridge	35	3.2	17	Yes
38	113.95	Peddaganjam	Arches	28	5.3	12.8	No
Total number of bridges requiring modifications							25

6.3.3.3 Terminals

No terminal has been proposed in the Commamur canal.

6.3.3.4 Navigation Lock

The details of existing seven no. locks falling in the stretch of Commamur canal are tabulated in Table 3.26. The dimensions of these locks are predominantly suitable for safe passage of 100t barge in Phase I. It is also observed that most of these locks are in bad condition and therefore require urgent repair work in order to make them navigable for movement of 100 t barge.

As development of proposed waterway in Phase II would enable movement of 300t barge in Commamur canal, it is found that the nominal width required at entrance of lock would be 11m and nominal length of lock chamber would be 50m so as to provide safe passage of 300t barge. It is therefore clear that the existing locks are not sufficient enough to provide safe passage of 300t barge. Hence it is proposed to provide 7 nos. new locks in place of existing ones for safe passage of 300t barge in Phase II.

The salient features for a typical new lock are as follows:

- No. of lock chamber : 2
- Length of lock chamber : 50 m
- Width of lock chamber : 15m
- Type of superstructure : RCC counterfort
- Height of wall : 7.5m
- Width of out lock walls : 1.0 m
- Width of inner lock walls : 2.0 m
- Type of foundation : Pile Foundation
- Type of Lock Gates : Mitre Gate
- No. of Gates : 8
- Size of Gates : 6m x 15 m
- Length of guide wall : 10m on both banks
- Bed protection : Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide canal is shown in Fig 6.5.

6.3.3.5 Aqueducts

The details of existing 10 no. aqueducts falling in Commamur canal are tabulated in Table 3.27. It is observed that all these aqueducts have been provided for a width ranging between 14 to 40 m which is sufficient enough for passage of 100 t barge in two way navigation. Therefore no modification is required in these aqueducts during Phase I.

In Phase II, it is proposed to provide a channel width of 32 m in Commamur canal and 300 t barge would ply in the stretch of Commamur Canal. It is observed that all aqueducts have been provided for a width ranging between 14 to 40 m which is sufficient enough for passage of 300 t barge in one way navigation. Therefore no modification is required in these aqueducts during Phase II.

6.3.3.6 Pipe Sluices

A total no. of 10 aqueducts have existed in Commamur canal in a length of 114km, thereby making each aqueduct covering length of about 12 km and this cannot cater the discharge of such huge areas. The storm water accumulating in the catchment area from local villages along the entire length of Commamur canal needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on both banks throughout the entire length of Commamur canal. The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.6.

6.3.3.7 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks of Commamur canal. The estimated quantity of these navigational aids required in stretch of Commamur canal is given below:

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	250
2.	Shore beacon	No.	18

6.3.4 Engineering Works for North Buckingham canal

Following engineering works have been proposed in North Buckingham canal.

- Dredging
- Raising of Banks
- Bridges
- Terminals
- Navigation lock
- Pipe sluices
- Navigational Aids

6.3.4.1 Dredging

The quantity of dredging required in Phase I for North Buckingham canal has been worked out as given below and details are furnished in Volume III : Annexures.

Quantity of Dredging required in Phase I for 32m bed width in North Buckingham canal from 0km to 297km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)
	From	To	From	To	
1	Ramperu lock,Peddaganjam	Gundlakamma lock	0.00	12.00	704865
2	Gundlakamma lock	Mudigundi lock	12.00	18.00	367459
3	Mudigundi lock	Musi lock	18.00	40.00	1461947
4	Musi lock	Palleru lock	40.00	43.00	84714
5	Palleru lock	Manneru lock (N)	43.00	55.00	430134
6	Manneru lock (N)	Manneru lock (S)	55.00	58.00	97226
7	Manneru lock (S)	Elikeru lock (N)	58.00	71.00	474699
8	Elikeru lock (N)	Chippaleru lock (N)	71.00	100.00	1724998
9	Chippaleru lock (N)	Ryderu lock (N)	101.00	115.00	117222
10	Ryderu lock (N)	Pennar lock (N)	115.00	128.00	620179
11	Pennar lock (N)	Kandaleru lock (N)	130.00	165.00	1513181
12	Kandaleru lock (N)	Swarnamukhi lock	168.00	192.00	1444928
13	Swarnamukhi lock	Pambali Lock	192.00	208.00	496272
14	Pambali Lock	Coromandal Lock	208.00	270.00	2172057
15	Coromandal Lock	Chintamani Lock	271.00	283.00	399097
16	Chintamani Lock	Ennore Lock (N)	283.00	295.00	552429
17	Ennore Lock (N)	Ennore Lock (S)	295.00	297.00	101414
				Total	**12762821**

It is proposed not to carryout dredging work in Phase II because the section of canal maintained in Phase I would be sufficient for Phase II also.

6.3.4.2 Raising of Banks

The quantity of filling required in raising banks for North Buckingham canal in Phase I has been worked out as given below and details are furnished in Volume III : Annexures

Quantity of Filling required in Phase I for 32m bed width in North Buckingham canal from 0km to 297km

Sl. No.	Location		Chainage (in km)		Quantity of Filling (in m^3)
	From	To	From	To	
1	Ramperu lock,Peddaganjam	Gundlakamma lock	0.00	12.00	0
2	Gundlakamma lock	Mudigundi lock	12.00	18.00	0
3	Mudigundi lock	Musi lock	18.00	40.00	51800
4	Musi lock	Palleru lock	40.00	43.00	16490
5	Palleru lock	Manneru lock (N)	43.00	55.00	98195
6	Manneru lock (N)	Manneru lock (S)	55.00	58.00	34335
7	Manneru lock (S)	Elikeru lock (N)	58.00	71.00	198015
8	Elikeru lock (N)	Chippaleru lock (N)	71.00	100.00	398335
9	Chippaleru lock (N)	Ryderu lock (N)	101.00	115.00	457805
10	Ryderu lock (N)	Pennar lock (N)	115.00	128.00	12145
11	Pennar lock (N)	Kandaleru lock (N)	130.00	165.00	1002220
12	Kandaleru lock (N)	Swarnamukhi lock	168.00	192.00	325945
13	Swarnamukhi lock	Pambali Lock	192.00	208.00	655309
14	Pambali Lock	Coromandal Lock	208.00	270.00	2151186
15	Coromandal Lock	Chintamani Lock	271.00	283.00	520405
16	Chintamani Lock	Ennore Lock (N)	283.00	295.00	340235
17	Ennore Lock (N)	Ennore Lock (S)	295.00	297.00	14500
				Total	**6276920**

6.3.4.3 Bridges

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across canal is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
II*	30	5

* Class II waterway refers to navigable channel with minimum of 1.8m depth, 30m bottom width, 500m bend radius in canal portion.

The salient details of bridges are tabulated in Table 3.32.In Phase I and II , it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of North Buckingham canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 32.4 m. Following the same principle the width of waterway for 1way navigation would be 14.4 m. For the width of 300 t barge equal to 9.0 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges have been verified for a horizontal clearance of 11m for one-way navigation and a vertical clearance of 4.8 m so as to pass 300 t barge through them. It is observed that 17 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges are shown in Fig. 6.3 and 6.4 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges Requiring Modification
1	17.800	Pallepalem	RCC	30.0	4.4	10	Yes
2	25.600	Kottapatnam	RCC	25	5.2	13.2	No
3	33.600	Itanukkala	RCC	30.0	5.0	10	Yes
4	35.900	Gavandlapalem	Bamboo Bridge	20.0	5.0	10	Yes
5	42.700	Palleru	Wooden Bridge	25.0	5.0	12	No
6	44.000	Kesavapalem	RCC Foot Bridge	54.0	4.0	17.5	Yes
7	46.400	Pallepalem	RCC	30.0	3.5	20	Yes
8	55.700	Pallepalem	Broken RCC	38.0	3.4	5	Yes
9	73.000	Ramayapatnam	RCC	37.5	6.5	11	No
11	76.050	Arularadipalem	RCC	42.0	4.4	11	Yes
12	77.200	Mundevadipalem	RCC Foot Bridge	42.0	(Broken and Not in use)		No
13	84.200	Kotachattnam	RCC	45.0	6.2	11	No
17	108.500	Iskapalle	RCC	28.5	5.6	10	Yes

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges Requiring Modification
18	119.600	Ramachandrapuram	RCC	26.0	4.4	10	Yes
19	137.000	Maipadu	Foot Bridge	29.5	4.4	12.1	Yes
20	137.200	Maipadu	RCC Foot Bridge	28.2	4.4	12.5	Yes
21	144.200	Venkannapalem	RCC Jetty	47.0	6.0	12	No
22	145.600	Patavenkatapalem	RCC Jetty	47.0	3.0	7.5	Yes
23	146.000	Mutiayalalapu	RCC Jetty	47.0	6.0	12	No
24	149.600	Yenatipalem	RCC Bridge (Broken)	23.7	1.5	8	Yes
25	150.500	Papattapalem	RCC Foot Bridge	35.0	6.0	10	Yes
26	150.800	Nadiamapattapalem	RCC	28.0	6.5	25	No
27	155.600	Anantapuram	RCC	25.0	5.0	15	No
28	158.400	Nalatur	RCC	25.5	4.5	16	Yes
29	166.800	Mathukuru	RCC	26.0	3.7	10	Yes
30	189.200	Siddhavaram	RCC	22.5	4.8	12	No
31	195.200	Majarapatireddipalem	RCC Jetty Bridge	45.0	6.0	12.5	No
32	196.800	Tupidipalem	RCC Bridge	24.0	6.1	16	No
33	212.800	Monapalem	RCC	27.5	5.7	11.5	No
34	235.300	Sriharikota	RCC	39.5	3.2	12.4	Yes
35	292.000	Kupam Railway Bridge	Iron Girder Railway	25.0	5	20	No

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges Requiring Modification
36	292.800	Kupam Road Bridge	RCC	25.0	5	20	No
37	293.600	Ennore Bridge	RCC	25.0	5	20	No
38	296.500	Ennore Bridge (new)	RCC	45.0	4.8	11	No
39	296.700	Ennore Railway Bridge	Iron Girder Bridge	45.0	5.1	11	No
Total Number of bridges requiring modification							17

6.3.4.4 Terminals

It has been proposed to provide following terminals in North Buckingham canal. The details of terminal have been discussed in Chapter 5.

- Kottapatnam
- Durgarajupatnam
- Muktiyala
- Ennore(South)

6.3.4.5 Navigation Lock

The details of existing 23 no. locks falling in the stretch of North Buckingham canal are tabulated in Table 3.33. In Phase I and II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of North Buckingham Canal. The dimensions of these locks are not suitable for safe passage of 300t barge. It is therefore proposed to provide 23 nos. new locks in place of existing ones for safe passage of 300t barge.

The salient features for a typical new lock are as follows:

- No. of lock chamber : 2
- Length of lock chamber : 50 m
- Width of lock chamber : 15m
- Type of superstructure : RCC counterfort
- Height of wall : 7.5m

- Width of out lock walls : 1.0 m
- Width of inner lock walls : 2.0 m
- Type of foundation : Pile Foundation
- Type of Lock Gates : Mitre Gate
- No. of Gates : 8
- Size of Gates : 6m x 15 m
- Length of guide wall : 10m on both banks
- Bed protection : Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide canal is shown in Fig 6.5.

6.3.4.6 Pipe Sluices

The storm water accumulating in the catchment area from local villages along the entire length of North Buckingham canal needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on one bank throughout the entire length of North Buckingham canal. The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.7.

6.3.4.7 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks of North Buckingham canal. The estimated quantity of these navigational aids required in stretch of North Buckingham canal is given below:

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	655
2.	Shore beacon	No.	50

6.3.5 Engineering Works for South Buckingham canal

Following engineering works have been proposed in South Buckingham canal.

- Dredging
- Raising of Banks
- Bridges
- Terminals
- Navigation lock
- Pipe sluices
- Navigational Aids

6.3.5.1 Dredging

The quantity of dredging required in Phase I for South Buckingham canal has been worked out as given below and details are furnished in Volume III : Annexures.

Quantity of Dredging required in Phase I & Phase II for 32m bed width in South Buckingham canal from 347km to 425km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Muthukadu	Edaiyur Lock (N)	347.00	372.00	984934
2	Edaiyur Lock (S)	Puddupattinam Lock (N)	373.00	381.00	265404
3	Puddupattinam Lock (S)	Vaualur lock	381.00	385.00	91804
4	Vaualur lock	Kadalur lock	385.00	388.00	76660
5	Kadalur lock	Marakanam	388.00	425.00	1963587
				Total	3382389

It is proposed not to carryout dredging work in Phase II because the section of canal maintained in Phase I would be sufficient for Phase II also.

6.3.5.2 Raising of Banks

The quantity of filling required in raising banks for South Buckingham canal in Phase I has been worked out as given below and details are furnished in Volume III : Annexures

Quantity of Filling required in Phase I for 32m bed width in South Buckingham canal from 347km to 425km

Sl. No.	Location		Chainage (in km)		Quantity of Filling (in m3)
	From	To	From	To	
1	Muthukadu	Edaiyur Lock (N)	347.00	372.00	342219
2	Edaiyur Lock (S)	Pudupattinam Lock (N)	373.00	381.00	107760
3	Pudupattinam Lock (S)	Vayalur lock	381.00	385.00	86410
4	Vayalur lock	Kadalur lock	385.00	388.00	95000
5	Kadalur lock	Marakanam	388.00	425.00	348030
				Total	979419

6.3.5.3 Bridges

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across canal is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
II*	30	5

* Class II waterway refers to navigable channel with minimum of 1.8m depth, 30m bottom width, 500m bend radius in canal portion.

The salient details of bridges are tabulated in Table 3.32. In Phase I and II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of South Buckingham canal. As discussed in Chapter – 4, the width of waterway required for two-way navigation is determined as 32.4 m. Following the same principle the width of waterway for 1way navigation would be 14.4 m. For the width of 300 t barge equal to 9.0 m & considering the practical approach that barge can navigate through restrictions with slow/crawling speed, all the existing bridges have been verified for a horizontal clearance of 11m for one-way navigation and a vertical clearance of 4.8 m so as to pass 300 t barge through them. It is observed that 11 nos. bridges as tabulated below, do not satisfy minimum clearance required and therefore needs to be replaced with new bridges at these locations. The general layout and details for new foot & road bridges in Phase II are shown in Fig. 6.3 and 6.4 respectively.

S. No.	Chainage (in km)	Name of Bridge	Type of Bridge	Length (in m)	Vertical Clearance (in m)	Horizontal Clearance (in m)	Bridges Requiring Modification
1	348.800	Kolambakkam Road Bridge	RCC	25.0	2.5	16	Yes
2	367.500	Mamallapuram New Bridge	RCC	40.0	4.0	26	Yes
3	367.900	Mamallapuram Old Bridge	RCC	23.0	5.1	12	No
4	377.900	Sadras New	RCC	23.0	3.4	16	Yes
5	378.200	Sadras Old	RCC	23.0	4.5	15	Yes
6	381.700	Kalpakkam New Bridge	RCC	30.0	3.4	15	Yes
7	381.85	Kalpakkam Old Bridge	RCC	30.0	4.5	15	Yes
8	388.900	Ahkuppam bridge	RCC	30.0	2.5	16.5	Yes
9	392.000	Koovathur	RCC	17.0	3.1	16	Yes
10	395.500	Mugayur	RCC Foot Bridge	40.0	2.5	16	Yes
11	399.500	Sikhankuppam	RCC	26.0	4.5	17.5	Yes
12	413.200	Ambaraikuppam	RCC	49.0	4.9	14	No
13	424.50	Marakanam Bridge	RCC	29.0	4	9	Yes
Total Number of Bridges Required Modification							**11**

6.3.5.4 Terminals

It has been proposed to provide following terminals in South Buckingham canal. The details of terminal have been discussed in Chapter 5.

- Muthukadu
- Marakanam

6.3.5.5 Navigation Lock

The details of existing 6 no. locks falling in the stretch of South Buckingham canal are tabulated in Table 3.33. In Phase I and II, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of South Buckingham Canal. The dimensions of these locks are not suitable for safe passage of 300t barge. It is therefore proposed to provide 6 nos. new locks in place of existing ones for safe passage of 300t barge.

The salient features for a typical new lock are as follows:

• No. of lock chamber	:	2
• Length of lock chamber	:	50 m
• Width of lock chamber	:	15m
• Type of superstructure	:	RCC counterfort
• Height of wall	:	7.5m
• Width of out lock walls	:	1.0 m
• Width of inner lock walls	:	2.0 m
• Type of foundation	:	Pile Foundation
• Type of Lock Gates	:	Mitre Gate
• No. of Gates	:	8
• Size of Gates	:	6m x 15 m
• Length of guide wall	:	10m on both banks
• Bed protection	:	Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide canal is shown in Fig 6.5.

6.3.5.6 Pipe Sluices

The storm water accumulating in the catchment area from local villages along the entire length of South Buckingham canal needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on one bank throughout the entire length of South Buckingham canal. The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.7

6.3.5.7 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks of South Buckingham canal. The estimated quantity of these navigational aids required in stretch of South Buckingham canal is given below:

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	175
2.	Shore beacon	No.	12

6.3.6 Engineering Works in stretch of Marakanam to Puducherry

Following engineering works have been proposed in stretch of Marakanam to Puducherry

- Dredging
- Raising of Banks
- Terminals
- Navigational Aids

6.3.6.1 Dredging

The quantity of dredging required in Phase I from Marakanam to Puducherry through Kaluvally tank has been worked out and details for chainage 425km to 430km are furnished in Volume III: Annexures

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m3)
	From	To	From	To	
1	Marakanam	Kaluvelly tank	425	430	**70904**

The quantity of dredging required in Phase I for remaining stretch of 17 km out of 22km stretch of Marakanam to Puducherry is calculated as under.

Bed Width	:	32m
Side Slope in cutting	:	1.5:1
Dredging Depth	:	2m
Top width	:	32+3+3 = 38m

Area : $\frac{1}{2}$ x (32+38) x2 = 70m^2
Length : 17km
Volume : 70x17x1000 = **1190000** m^3

Therefore, the total quantity of dredging required in Phase I & Phase II is estimated as 70904+1190000 = **1260904** m^3

It is proposed not to carryout dredging work in Phase II because the section of channel maintained in Phase I would be sufficient for Phase II also.

6.3.6.2 Raising of Banks

The quantity of filling required in raising banks from Marakanam to Kaluvelly tank in Phase I has been worked out as given below and and details for chainage 425km to 430km are furnished in Volume III: Annexures

Sl. No.	Location		Chainage (in km)		Quantity of Filling (in m3)
	From	To	From	To	
1	Marakanam	Kaluvelly tank	425	430	249625

The quantity of filling required in raising banks for remaining stretch of 17 km out of 22km stretch of Marakanam to Puducherry in Phase I is calculated as under.

Height of Filling above NSL : 3m
Side Slope in Filling : 1.5:1
Top Width of Banks : 8+5=13m
Bottom Width at NSL : 17+14=31m
Area : $\frac{1}{2}$ x (13+31) x3 = 66m^2
Length : 17km
Volume : 66x17x1000 = **1122000** m^3

Therefore, the total quantity of filling required in Phase I is estimated as 249625+1122000 = **1371625** m^3

6.3.6.3 Terminals

It has been proposed to provide terminal at Puducherry in stretch of Marakanam to Puducherry. The details of terminal have been discussed in Chapter 5.

6.3.6.4 Pipe Sluices

The storm water accumulating in the catchment area from local villages along the the stretch of Marakanam to Puducherry needs to be drained suitably so as to avoid breach in the canal and also to maintain stability of banks of canal. Further, there is no provision to cater for local discharge occurring due to rainfall. As such pipe sluices in the form of non pressure NP2 RCC pipe of diameter 600mm with sump well have been proposed to cater for such local discharge, at an interval of 500m and on one bank throughout the entire length of South Buckingham canal. The details of pipe sluices carrying storm water into the canal has been shown in Fig. 6.7

6.3.6.5 Navigational Aids

It is proposed to provide lighted marks and shore beacons on banks in stretch of Marakanam to Puducherry. The estimated quantity of these navigational aids required in stretch of Marakanam to Puducherry is given below:

Sl.No.	Item Description	Unit	Quantity
1.	Lighted Marks	No.	50
2.	Shore beacon	No.	3

6.3.7 Engineering Works for river Godavari

Following engineering works have been proposed in river Godavari from Bhadrachalam to Rajahmundry.

- Dredging
- Bridges
- Terminals
- Protection Measures
- Navigational Aids

6.3.7.1 Dredging

The quantity of dredging required in Phase I for river Godavari from Bhadrachalam to Rajahmundry has been worked out as given below and details are furnished in Volume III : Annexures.

Quantity of Dredging required in Phase I for 32m bed width in river Godavari from 0km to 127km (Bhadrachalam to Polavaram)

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)	
	From	To	From	To	In Rock	In Soil
1	Bhadrachalam	Polavaram	0.00	127.00	6440	267440

Quantity of Dredging required in Phase I for 32m bed width in river Godavari from 127km to 171km (Polavaram to Rajahmundry)

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)	
	From	To	From	To	In Rock	In Soil
1	Polavaram	Rajahmundry	127.00	171.00	0	95310

It is proposed not to carryout dredging work in Phase II because the section of channel maintained in Phase I would be sufficient for Phase II also.

6.3.7.2 Bridges

The salient details of bridges existing in the stretch of river Godavari from Bhadrachalam to Rajahmundry are tabulated in Table 3.6.

As per the Classification of Inland Waterways in India, the minimum horizontal and vertical clearance required for structures across river is as given below:

Class of Waterway	Minimum Horizontal Clearance between piers	Minimum Vertical Clearance above HTL/FSL
	(in m)	(in m)
III*	50	7

* Class III waterway refers to navigable channel with minimum of 1.4m depth, 50m bottom width, 500m bend radius in river.

The first bridge is at Bhadrachalam. As the navigation has to be started from Bhadrachalam, the bridge being in upstream direction will not pose any hindrance in the navigation. For remaining two bridges, distance between two piers is more than 80m and vertical clearance with respect to HFL has been more than 4m. As HFL tends to occur for 10 to 15 days in a year, it is therefore not feasible to demolish this bridges having length more than 2.5km and require huge investment for reconstruction.

6.3.7.3 Terminals

It has been proposed to provide following terminals in river Godavari. The details of terminal have been discussed in Chapter 5.

- Rajahmundry
- Bhadrachalam

6.3.7.4 Protection Measures

On the basis of topographic and hydrographic survey, it is observed that there are various bends and curves in the river Godavari from Bhadrachalam to Rajahmundry. To prevent the banks from meandering action of river, it is therefore proposed to provide stone pitching on banks for a suitable distance in these bends and curves. The details showing the location and length of pitching have been tabulated below.

Sl. No.	Chainage (in km)	Location	Length of Pitching (in m)
a) From Bhadrachalam to Polavaram			
1	16	Right Bank	50
2	71	Right Bank	50
3	96	Left Bank	50
4	101	Left Bank	50
5	114	Right Bank	50
		Total (a)	250
b) From Polavaram to Rajahmundry			
6	134	Right Bank	75
7	170	Left Bank	60
		Total (b)	135
		Total(a+b)	385

A typical detail showing the general layout of stone pitching on bends have been shown in Fig. 6.8. The quantity of stone pitching required on slope of bank is calculated as follows:

Quantity of Stone Pitching on slope of bank

Sl. No.	Bed Level (in m)	Proposed level of Pitching (in m)	Height of Pitching above bed (in m)	Horizontal distance between bed & Pitching level (in m)	D^2	E^2	F+G	Length of slope of bank =sqrt(H) (in m)	Area of Pitching on slope of bank (in m^2) =Ix2.75	Length of pitching on banks (in m)	Quantity of pitching on slope of bank (in m^3) =JxK
A	B	C	D	E	F	G	H	I	J	K	L
a) From Bhadrachalam to Polavaram											
1	31.90	34.23	2.33	20	5	400	405	20.14	55.37	50	2769
2	24.40	27.33	2.93	20	9	400	409	20.21	55.59	50	2779
3	21.50	23.50	2.00	20	4	400	404	20.10	55.27	50	2764
4	21.10	22.81	1.71	20	3	400	403	20.07	55.20	50	2760
5	19.40	21.13	1.73	20	3	400	403	20.07	55.21	50	2760
										Total (a)	13832
b) From Polavaram to Rajahmundry											
6	17.10	18.70	1.60	20	3	400	403	20.06	55.18	75	4138
7	12.90	13.69	0.79	20	1	400	401	20.02	55.04	60	3303
										Total (b)	7441

Thickness of pitching on side slope	=	2.75 m
Length of launching apron	=	10 m
Thickness of pitching in launching apron	=	5.25 m
Length of side slope below bed in scoured depth portion	=	6 m

∴ Total quantity of stone pitching in between Bhadrachalam and Polavaram

$= 13832 + 250 \times [(10 \times 5.25) + (6 \times 3.5)]$
$= 32207\ m^3$

∴ Total quantity of stone pitching in between Polavaram and Rajahmundry

$= 7441 + 135 \times [(10 \times 5.25) + (6 \times 3.5)]$
$= 17363\ m^3$

6.3.7.5 Navigational Aids

For safe navigation of barges round the clock, it is necessary to provide navigational aids in the developed waterway. The following navigational aids have been proposed in the stretch from Bhadrachalam to Rajahmundry:

- Country boats mounted with light system
- Buoys mounted with light system
- Shore beacon mounted with light system

a. Country boats mounted with light system

The navigational lights with solar panel will be erected on the top of a medium size (15' long x 6' wide) country boats with about 2 meter elevated platform from the deck of boat. The boat will have provision for accommodation for 2 nos. labourers/manjhis. The battery will be kept under the shed. These boats would have the red or green colour day/night marks to work as channel mark round the clock. Lights shall have red/green plastic lenses with DC bulb/LED as per the standards followed for night navigational lights and will be fixed over the platform. These lights will be equipped with two number solar panels for charging a 12 volt battery. For emergency, one hurricane lamp (red/green) is also proposed in each boat. These boats will be placed within a distance of 2km along the stretch and also at sand chars, bends etc.

b. **Buoy mounted with light system**

It has been proposed to provide 1300 mm diameter FRP buoy mounted with light system and 150 kg concrete sinkers at an interval of 2 km along the stretch and also at sand chars, bends etc. As the channel changes after each flood, the buoys need to be shifted and relocated immediately before and after the flood season every year. This requires a buoy laying vessel with provision for a winch and water jet injection systems to lift the buoys and storage facility for the buoys. The buoy laying vessel is required to be available timely to ensure navigation marks at correct location without any slippage. It is therefore proposed to procure one buoy laying vessel in the stretch from Bhadrachalam to Rajahmundry.

c. **Shore Beacon mounted with light system**

Shore Beacons fitted with LED light at a 15 m height from ground are considered sufficient to have visibility about 7 km. The specifications for shore beacon LED light are as follows :

Sl. No.	Parameters	Characteristics
1.	Type	Rugged, light weight, water proof, compact, impact resistant, omni directional, marine flashing beacon of high performance moulded lens cover UV stabilized
2.	Range	>5 NM at 0.74 ATF
3.	Light Source	High Intensity LEDs with 100,000 hrs of life
4.	Uniformity of Output	Horizontal plane 360 degrees
5.	Vertical divergence	>2° at 50% of peak intensity
6.	Signal color	White/Red/Green meeting IALA Standards
7.	Autonomy	15 days
8.	Flasher	Microprocessor Controlled, Programmable
9.	Day light control	On/Off preferably photo diode control
10.	Battery Type	Maintenance free valve regulated lead Acid
11.	Battery life expectancy	More than 2000 charge-discharge cycles
12.	Solar Panel	Mono-crystaline SPV Module
13.	Protection	IP 66

The quantity of these above mentioned navigational aids required in stretch from Bhadrachalam to Rajahmundry are given below:

Quantity of Navigational Aids required in between Bhadrachalam & Polavaram

Sl.No.	Item Description	Unit	Quantity
1.	Country Boats	No.	93
2.	FRP buoys	No.	93
3.	Shore beacon	No.	22
4.	Buoy laying vessel	No.	1

Quantity of Navigational Aids required in between Polavaram & Rajahmundry

Sl.No.	Item Description	Unit	Quantity
1.	Country Boats	No.	32
2.	FRP buoys	No.	32
3.	Shore beacon	No.	8

6.3.8 Engineering Works for river Krishna

Following engineering works have been proposed in river Krishna from Wazirabad to Vijaywada.

- Dredging
- Bridges
- Terminals
- Protection Measures
- Navigational Aids

6.3.8.1 Dredging

The quantity of dredging required in Phase I for river Krishna from Wazirabad to Vijaywada has been worked out as given below and details are furnished in Volume III : Annexures.

Quantity of Dredging required in Phase I for 32m bed width in river Krishna from 0km to 100km

Sl. No.	Location		Chainage (in km)		Quantity of Dredging (in m^3)	
	From	To	From	To	In Rock	In Soil
1	Pondugula	Chintapalle	0.00	100.00	101210	205930

It is proposed not to carryout dredging work in Phase II because the section of channel maintained in Phase I would be sufficient for Phase II also.

6.3.8.2 Bridges

There is only one bridge existing in the stretch of river Krishna. The bridge is at Pondugula. As the navigation has to be started from Pondugula, the bridge being in upstream direction will not pose any hindrance in the navigation.

6.3.8.3 Terminals

It has been proposed to provide following terminals in river Krishna. The details of terminal have been discussed in Chapter 5.

- Wazirabad
- Vijayawada

6.3.8.4 Lock

The details of existing one lock falling in the stretch of river Krishna are tabulated in Table 3.14. In Phase I, it is proposed to provide a channel width of 32 m and 300 t barge would ply in the stretch of river Krishna. The dimensions of these locks are not suitable for safe passage of 300t barge. It is therefore proposed to provide one new lock in place of existing for safe passage of 300t barge.

Further it has also been proposed that the dimensions of new lock provided in Phase I would be sufficient for movement of 500t barge so that it would not require any further modification in Phase II.

The salient features for a typical new lock are as follows:

- No. of lock chamber : 2
- Length of lock chamber : 60 m
- Width of lock chamber : 15m
- Type of superstructure : RCC counterfort

- Height of wall : 7.5m
- Width of out lock walls : 1.0 m
- Width of inner lock walls : 2.0 m
- Type of foundation : Pile Foundation
- Type of Lock Gates : Mitre Gate
- No. of Gates : 8
- Size of Gates : 6m x 15 m
- Length of guide wall : 10m on both banks
- Bed protection : Stone pitching

The typical layout plan showing the details of navigation lock for 32m wide channel is shown in Fig 6.5.

6.3.8.5 Protection Measures

The waterway between Wazirabad to Vijaywada consists of bends and curves at various locations. In order to protect the banks from meandering action of river, it is therefore proposed to provide stone pitching on banks at these locations. The details showing the location and length of pitching have been tabulated below.

Sl. No.	Chainage (in km)	Location	Length of Pitching (in m)
1	20	Left Bank	100
2	61	Left Bank	75
3	70	Left Bank	75
4	75	Right Bank	75
5	92	Left Bank	75
6	96	Right Bank	75
7	100	Left Bank	90
		Total	565

A typical detail showing the general layout of stone pitching on bends have been shown in Fig. 6.9. The quantity of stone pitching required on slope of bank is calculated as follows :

Quantity of Stone Pitching on slope of bank

Sl. No.	Bed Level (in m)	Proposed level of Pitching (in m)	Height of Pitching above bed (in m)	Horizontal distance between bed & Pitching level (in m)	D^2	E^2	F+G	Length of slope of bank =sqrt(H) (in m)	Area of Pitching on slope of bank =I x 2 (in m^2)	Length of pitching on banks (in m)	Quantity of pitching on slope of bank (in m^3) = JxK
A	B	C	D	E	F	G	H	I	J	K	L
1	39.8	40.49	0.69	20	0.48	400	400.48	20.01	40.02	100	4002
2	32.4	34.01	1.61	20	2.59	400	402.59	20.06	40.13	75	3010
3	30.8	32.81	2.01	20	4.04	400	404.04	20.10	40.20	75	3015
4	29.9	32.07	2.17	20	4.71	400	404.71	20.12	40.23	75	3018
5	26.8	27.76	0.96	20	0.92	400	400.92	20.02	40.05	75	3003
6	26.1	27.06	0.96	20	0.92	400	400.92	20.02	40.05	75	3003
7	25.7	26.34	0.64	20	0.41	400	400.41	20.01	40.02	90	3602
									Total	**565**	**22654**

Thickness of pitching on side slope	=	2 m
Length of launching apron	=	10 m
Thickness of pitching in launching apron	=	4 m
Length of side slope below bed in scoured depth portion	=	6 m

The stone pitching has been proposed on curves for a length of 565m

∴ Total quantity of stone pitching

$= \quad 22654 + 565 \times [(10 \times 4) + (6 \times 2.5)]$

$= \quad 53729 \text{ m}^3$

6.3.8.6 Navigational Aids

As already discussed in Para 6.3.7.5, a combination of country boats, buoy and shore beacons has been proposed in river portion as navigational aids for movement of barges round the clock. The estimated quantity of these navigational aids required in stretch from Wazirabad to Vijaywada is given below:

Sl. No.	Item Description	Unit	Quantity
1.	Country Boats	No.	115
2.	FRP buoys	No.	115
3.	Shore beacon	No.	15
4.	Buoy laying vessel	No.	1

CHAPTER 7
LAND ACQUISITION FOR DEVELOPMENT

CHAPTER – 7

LAND ACQUISITION FOR DEVELOPMENT

7.0 INTRODUCTION

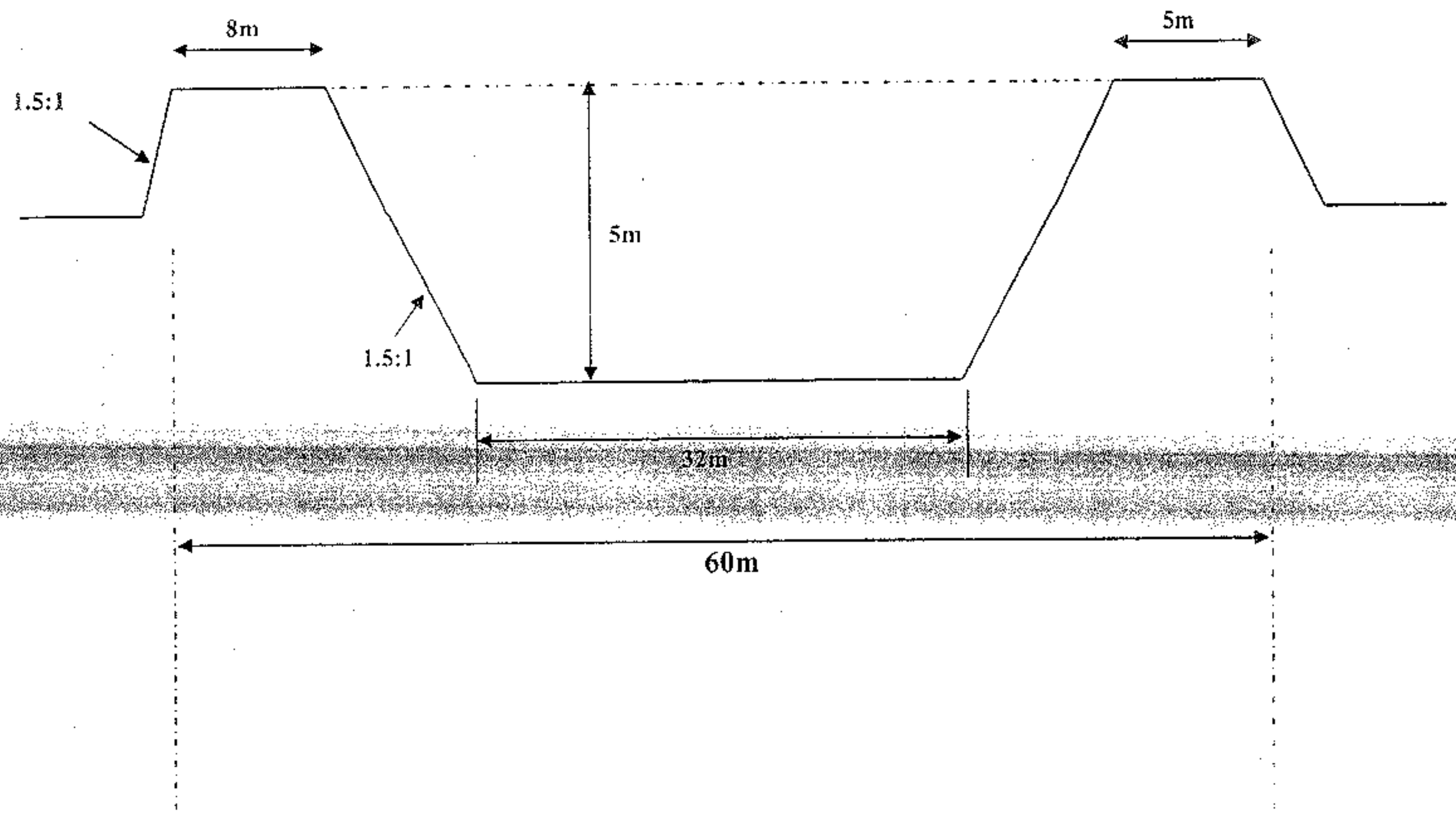
The Right of Way (RoW) details for development of navigation have been discussed in this chapter. It is very important issue. The existing river stretches of Krishna and Godavari have got more than adequate width required for navigation. The present land use pattern of the canal has already been showing that the land is under irrigation as well as cultivated wasteland. But it was seen during the surveys that the encroachments are abutting along canal sections. Kakinada Canal, Eluru Canal, Commamur Canal are surrounded mainly by irrigation lands. Buckingham Canal is mainly of tidal nature. The width of corridor required is discussed in the following paragraphs.

7.1 WIDTH OF CORRIDOR (ROW)

The width of corridor required for developing 32 m wide canal is worked out as 100 m and details are given below.

Bed Width of canal	:	32 m
Side Slope	:	1.5:1
Height of Bank above bed level	:	5.0m
Top width of bank	:	8m + 5m
Total width required to develop section for 32m wide canal as shown below	:	60m
Width for maintenance on both banks	:	20m + 20m
Therefore, Total width of land required	:	60 + 40 = **100m**

On an average therefore 50 m land on either side of centerline of the canals has to be acquired for smooth operation and future maintenance of the canal.



TYPICAL CROSS SECTION OF 32m WIDE CANAL

7.2 ADDITIONAL LAND TO BE ACQUIRED FOR WATERWAY

Governments of Andhra Pradesh and Tamilnadu have indicated that they will be able to acquire corridor of 100 m width for the proposed development. The details received from these state Governments are enclosed in Volume III - Annexure.

These areas are only indicative as seen during topographic/ Hydrographic surveys carried out by WAPCOS. These areas include the areas under occupation by the Irrigation Departments of GoAP and Govt. of Tamilnadu, waste land, encroached land etc. which were verified by the concerned state Govts after detailed surveys in coordination with their revenue departments.

7.2.1 Eluru Canal (139 km)

The land area to be acquired for 100m wide corridor of Eluru Canal is tabulated below:

Area to be acquired in Eluru Canal

S. No.	Chainage (km)	Area to be acquired (ha)	Location
	Godavari Eluru		
1	0-10 km	0 ha	Vijjeswaram
2	10-20 km	30.1 ha	
3	20-30 km	37 ha	
4	30-40 km	37 ha	
5	40-50 km	40.4 ha	
6	50-60 km	56 ha	
7	60-70 km	58 ha	
8	70-74.9 km	30.3 ha	Eluru
	Krishna Eluru		
1	0-10 km	10 ha	Vijayawada
2	10-20 km	40 ha	
3	20-30 km	32.5 ha	
4	30-40 km	27.5 ha	
5	40-50 km	38.6 ha	
6	50-60 km	54.2 ha	
7	60-65 km	32.7 ha	Eluru
	TOTAL	**524.3 ha**	

7.2.2 Kakinada Canal (50 km)

The land area to be acquired for 100m wide corridor of Kakinada Canal is tabulated below:

Area to be acquired in Kakinada Canal

S. No.	Chainage (km)	Area to be acquired (ha)	Location
1	0-5	6.35	Rajahmundry
2	5-10	14.8	
3	10-15	14.25	
4	15-20	13.25	
5	20-25	21.0	
6	25-30	22.8	
7	30-35	22	
8	35-40	26	
9	40-45	24.9	
10	45-50	16.6	
11	50-55	22.9	
12	55-60	22.7	Kakinada
	TOTAL	**227.55**	

Note:-
Length of Kakinada canal is 50 km, but the above details have been given upto fishing channel entrance which leads to sea mouth at Kakainda.

7.2.3 Commamur Canal

The land area to be acquired for 100m wide corridor of Commamur Canal is tabulated below:

Area to be acquired in Commamur Canal

S. No.	Chainage (km)	Area to be acquired (ha)	Location
1	0-5 km	3.75 ha	Seethanagram
2	5-10 km	4.75 ha	
3	10-15 km	6.25 ha	
4	15-20.8 km	13.05 ha	
5	20.8-25 km	10.50 ha	
6	25-30 km	15.50 ha	

7	30-35 km	17.00 ha	
8	35-40 km	19.50 ha	
9	40-45 km	21.75 ha	
10	45-50 km	23.75 ha	
11	50-55 km	26.25 ha	
12	55-60 km	27.75 ha	
13	60-65 km	29.00 ha	
14	65-70 km	29.00 ha	
15	70-75 km	28.75 ha	
16	75-80 km	28.50 ha	
17	80-85 km	26.75 ha	
18	85-90 km	26.75 ha	
19	90-95 km	27 ha	
20	95-100 km	28 ha	
21	100-105 km	32.5 ha	
22	105-110 km	35 ha	
23	110-112.4 km	16.8 ha	Peddaganjam
	TOTAL	**497.85**	

7.2.4 Buckingham Canal

The land area to be acquired for 100m wide corridor of Buckingham Canal is tabulated below:

Area to be acquired in North Buckingham Canal (Andhra Pradesh Stretch – 258 km)

S. No.	Chainage (km)	Area to be acquired (ha)	Location
1	0-2	5	Peddaganjam
2	2-7	12.5	
3	7-12	11	
4	12-17	12.5	
5	17-22	10	
6	22-27	10	
7	27-32	10	
8	32-37	7.5	
9	37-42	7.5	
10	42-47	10	
11	47-52	0	
12	52-57	0	
13	57-62	0	

S. No.	Chainage (km)	Area to be acquired (ha)	Location
14	62-67	0	
15	67-72	0	
16	72-77	0	
17	77-82	0	
18	82-87	0	
19	87-92	0	
20	92-97	0	
21	97-102	0	
22	102-107	0	
23	107-112	0	
24	112-117	0	
25	117-122	0	
26	122-127	0	
27	127-132	5	
28	132-137	10	
29	137-142	7.5	
30	142-147	7.5	
31	147-152	0	
32	152-157	0	
33	157-162	0	
34	162-167	0	
35	167-172	0	
36	172-177	0	
	TOTAL	126	
37	178.5-316	3.9	Tada
	TOTAL	**129.9**	

Area to be acquired in North/South Buckingham Canal (Tamilnadu Stretch)

S. No.	Chainage (km)	Area to be acquired (ha)
North Buckingham Canal		
1	Chainage 2.74-16.35	
	Patta Land	4.256
	Poramboke Land	13.264
	Encroachment Area	5.156
2	Chainage 18.4-58	
	Poramboke Land	52.95

S. No.	Chainage (km)	Area to be acquired (ha)
South Buckingham Canal		
1	Chainage 5.7-23.86	
	Patta Land	7.567
	Poramboke Land	45.936
	Encroachment Area	9.269
2	Chainage 39.7-65.23	
	Poramboke Land	32.315
3	Chainage 65.6-102.4	
	Government Land Encroached by persons having Patta	31.25
	Poramboke Land Available	97.02
	TOTAL	**298.983**

7.2.5 Kaluvelly Tank(Marakanam to Puducherry)

The land area to be acquired for 100m wide corridor of Kaluvelly Tank is 27ha.

7.3 TERMINAL AREA REQUIREMENTS

The area of land to be acquired for developing and building all the proposed terminals in the entire stretch of waterway is tabulated below:

S. No.	Name of Terminal	Area to be acquired (ha)
1	Kakinada	3
2	Rajahmundry	3
3	Eluru	3
4	Tadepalligudem	3
5	Kottapatnam	3
6	Durgarajupatnam	3
7	Maipadu	3
8	Ennore	3.75
9	Muthukadu	3
10	Marakanam	3
11	Puducherry	3
12	Bhadrachalam	4
13	Wazirabad	3
14	Muktiyala	3
15	Vijayawada	3
	Total	**46.75**

7.4 DETAILS OF REVENUE MAPS FOR AREA REQUIREMENT

The Tamilnadu Govt. has carried out delineation surveys to find out the actual width of Buckingham canal available with Water Resources Department. Similar exercise was also carried out by Govt. of A.P. The details received from Tamilnadu Govt. and Govt. of A.P are enclosed in Volume III- Annexure.

7.5 ADDITIONAL REQUIREMENT AND ASSUMPTIONS

Based on the request of IWAI, GoAP have also given the total land requirement details at Kakinada Canal, Eluru Canal, Commamur Canal, Buckingham Canal vide their letter dated 17.7.2007 for 100 m RoW. (Volume III- Annexure).

However we had requested for the details regarding, type of land, cost of land vide IWAI's letter dated 31st August 2007. The details of the same are yet to be received.

In the absence of details of type of land, cost of land etc., the following costs have been assumed, which are based on the experience of the consultant and local enquiries.

1. Cost of Barren land : Rs. 5 lakhs/Ha
2. Cost of agricultural land : Rs. 10 lakhs/Ha
3. Cost of built up land : Rs. 20 lakhs/Ha

With regard to type of land, we have used satellite imageries for assessing the type of land i.e. barren/cultivated etc. for estimation purpose (as these details are yet to be received from GoAP). Sample sheets of the satellite imageries are enclosed in Volume – III for reference.

CHAPTER 8
COST ESTIMATES

CHAPTER - 8

COST ESTIMATES

8.1 INTRODUCTION

The present chapter deals with the cost estimates for development of navigable waterway for Kakinada-Puducherry canals along with river Krishna & Godavari.

The Delhi Schedule of Rate, 2007 published by CPWD has been followed and escalated by 7% per annum for year 2009 to arrive at the cost of the project. For other items like dredging, navigational aids etc. (not available in DSR) have been taken as per local market rates.

In order to carry out economically sustainable navigation, the waterway is proposed to be developed in two Phases as per the TOR of IWAI. Accordingly, the cost estimate for these two phases has been evaluated separately in the following paragraphs.

8.2 COST ESTIMATE FOR PHASE-I DEVELOPMENT

It has already been discussed that Phase I development is proposed to be carried out in two stages i.e. Stage I & Stage II as given below

Stage I

Sl. No.	Stretches of waterway	Distance (km)
1.	Kakinada canal between Rajahmundry & Kakinada	50
2.	Godavari Eluru canal between Rajahmundry & Eluru	74
3.	Godavari river between Polavaram and Rajahmundry	44
4.	North & South Buckingham canal	425
5.	Marakanam to Puducherry through Kaluvelly tank	22
	Total	**615**

Stage II

Sl. No.	Stretches of waterway	Distance (km)
1.	Godavari river between Bhadrachalam & Polavaram	127
2.	Krishna Eluru canal between Vijayawada & Eluru	65
3.	Krishna river between Wazirabad and Vijayawada	157
4.	Commamur Canal between Peddaganjam & Vijayawada	113
	Total	**462**

8.2.1 Cost Estimate for Stage I

The cost estimate for different items involved in developing Stage I waterway are furnished below :

i) Cost for land Acquisition

As already discussed in previous chapters, it is required to acquire 100m width of corridor to develop 32m width canal portion and further Govt. of A.P. & Tamilnadu have confirmed the type and area of land to be acquired with respect to existing canal section.

The cost involved in acquiring land for Stage I is given below :

Sl. No.	Stretches of waterway	Area of Land required (In Hectare)	Rate (in Rs)	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	228	2000000	4560
2	Godavari Eluru canal between Rajahmundry & Eluru	289	2000000	5780
3	North & South Buckingham canal	429	2000000	8580
4	Marakanam to Puducherry through Kaluvelly tank	27	2000000	540
			Total	**19460**

The cost for land acquisition for terminals has been included under "cost for terminals" as discussed in respective paragraphs.

ii) Cost for Dredging

The details of quantity of dredging required in various stretches of Stage I development have been furnished in Volume III : Annexures and the cost for dredging is tabulated below:

Sl. No.	Stretches of waterway	Quantity (in m^3)	Rate (in Rs)	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	362932	200*	726
2	Godavari Eluru canal between Rajahmundry & Eluru	1180391	160*	1889
3	Godavari river between Polavaram and Rajahmundry	95310	200*	191
4	North & South Buckingham canal	16145210	140*	22603
5	Marakanam to Puducherry through Kaluvelly tank	1260904	140*	1765
			Total	**27174**

* Refer Code No. 2.6, 2.24 and 2.26 of CPWD, DSR, 2007

iii) Cost for Pipe Sluices

The cost for pipe sluices required in various stretches of Stage I has been calculated as given below. The cost for a typical pipe sluice has been worked out Rs. 1 Lakh and details are furnished in Table 8.1.

Sl. No.	Stretches of waterway	No. of Pipe Sluices	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	200	200
2	Godavari Eluru canal between Rajahmundry & Eluru	296	296
3	Godavari river between Polavaram and Rajahmundry	-	-
4	North & South Buckingham canal	750	750
5	Marakanam to Puducherry through Kaluvelly tank	44	44
	Total	1290	**1290**

iv) **Cost for Locks**

There are six no. locks falling in Kakinada canal and one lock in the Godavari Eluru canal. The dimensions of these locks are sufficient for safe passage of 100t barge in Phase I but most of these locks are in bad condition and therefore require urgent repair work in order to make them navigable for movement of 100 t barge. It is proposed to have a provision of Rs. 100 Lakhs per lock for repair and modification.

In the North and South Buckingham canal, there are 29 nos.(23+6) locks and not suitable for safe passage of 300t barge. It is therefore proposed to provide 29 nos. new locks in place of existing ones for safe passage of 300t barge. The cost for a typical new lock has been worked out as Rs.1390 Lakhs and details are furnished in Table 8.2(a).

The cost for locks required in various stretches of Stage I is calculated as given below.

Sl. No.	Stretches of waterway	No. of Lock	Rate (Rs. in Lakhs)	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	6	100	600
2	Godavari Eluru canal between Rajahmundry & Eluru	1	100	100
3	Godavari river between Polavaram and Rajahmundry	-	-	-
4	North & South Buckingham canal	29	1390	40310
5	Marakanam to Puducherry through Kaluvelly tank	-	-	-
	Total	36		**41010**

v) **Cost for Bridges**

The following no. of new foot bridges and road bridges have been proposed (Refer Chapter 6) in Stage I of waterway as given below:

Sl. No.	Stretches of waterway	No. of foot bridges	Length of foot bridges (in m)	No. of road bridges		Length of Road bridge (in m)	
				SLB*	DLB*	SLB*	DLB*
1	Kakinada canal between Rajahmundry & Kakinada	2	47	-	2	-	168
2	Godavari Eluru canal between Rajahmundry & Eluru	-	-	2	-	58	-
3	North Buckingham canal	4	146	7	6	262	200
4	South Buckingham canal	1	40	2	8	64	264
	Total	**7**	**233**	**11**	**16**	**384**	**632**

*SLB stands for Single Lane Bridge
*DLB stands for Two Lane Bridge

The cost for foot bridges and road bridges has been determined for Stage I development as given below.

Sl. No.	Stretches of waterway	Cost of foot bridge (in Rs. Lakhs/m)	Reference	Cost of road bridges (in Rs. Lakhs/m)		Reference	
			(in m)	SLB*	DLB*	SLB*	DLB*
1	Kakinada canal between Rajahmundry & Kakinada	1.35	Table 8.3(a)	3.5	4.85	Table 8.4(a)	Table 8.4(c)
2	Godavari Eluru canal between Rajahmundry & Eluru	1.35	Table 8.3(a)	3.5	4.85	Table 8.4(a)	Table 8.4(c)
3	North Buckingham canal	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)
4	South Buckingham canal	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)

*SLB stands for Single Lane Bridge
*DLB stands for Two Lane Bridge

Accordingly, the cost for constructing all these new bridges has been worked out as given below.

Sl. No.	Stretches of waterway	Cost foot bridges (in Rs. Lakhs)	Cost of road bridges (in Rs. Lakhs)		Total Cost (in Rs. Lakhs)
			SLB*	DLB*	
1	Kakinada canal between Rajahmundry & Kakinada	63	-	815	878
2	Godavari Eluru canal between Rajahmundry & Eluru	-	203	-	203
3	North Buckingham canal	202	975	1032	2209
4	South Buckingham canal	56	238	1362	1656
				Total	**4946**

Total cost for providing new bridges = Rs. 4946 Lakhs

vi) Cost for Terminals

The summary of cost estimate for terminals falling in the stretch of Stage I development is tabulated below:

S. No.	Stretches of waterway	Name of Terminal	Cost of Terminal (Rs. in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	Kakinada	834
2	Godavari river between Polavaram and Rajahmundry	Rajahmundry	834
3	Godavari Eluru canal between Rajahmundry & Eluru	Tadepalligudam	834
		Eluru	834
4	North Buckingham canal	Kottapatnam	834
		Maipadu	834
		Durgarajupatnam	834
		Ennore (South)	834
5	South Buckingham canal	Muthukadu	853
		Marakanam	834
6	Marakanam to Puducherry through Kaluvelly tank	Puducherry	834
		Total	**9193**

The detailed cost estimate for all these terminals have been furnished in Table No. 8.5 to 8.15.

vii) Cost for Navigational Aids

The navigational aids required in stretches of Stage I development have been discussed in Chapter 6.The cost for these navigational aids has been worked out as given below :

S. No.	Item Description	Unit	Quantity	Rate (In Rs.)	Amount (Rs. in lakhs)
1	FRP Buoys	No.	32	70000	22
2	Country Boats	No.	32	100000	32
3	Shore Beacons	No.	92	265000	244
4	Lighted Marks	No.	1153	15000	173
5	Buoy laying Vessel	No.	1	50000000	500
				Total	**971**

viii) Cost for Protection Measures

The cost for providing stone pitching on the banks of river Godavari from Bhadrachalam to Rajahmundry is worked out as given below

Cost of providing stone pitching in between Bhadrachalam & Polavaram

Item Description	Quantity (in m^3)	Rate (in Rs/m^3)	Amount (Rs. in Lakhs)	Remarks
Stone pitching	32207	450	**145**	Refer Para 6.3.7.4

Cost of providing stone pitching in between Polavaram & Rajahmundry

Item Description	Quantity (in m^3)	Rate (in Rs/m^3)	Amount (Rs. in Lakhs)	Remarks
Stone pitching	17363	450	**78**	Refer Para 6.3.7.4

Abstract of Cost Estimate for Stage I

Further as informed by IWAI, when this project was submitted to the IWAI Board in its 126th meeting held on 27.11.08, the Board directed that a provision of Rs 25 cr may be further added to this cost for providing small facilities for local people (such as ferry ghats etc) so that the local people got involved in the project. Therefore a provision of Rs 15 cr in Stage I and Rs 10 cr for Stage II has been added for the purpose.

To arrive at the total cost for Stage I development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various above mentioned items for development of Stage I waterway for the year 2007 and 2009 is given below:

Cost Estimate for Stage I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	19460	22280
2	Dredging	27174	31112
3	Cross Drainage Works	1290	1477
4	Locks	41010	46952
5	Bridges	4946	5663
6	Terminals	9193	10525
7	Navigational Aids	971	1112
8	Protection Measures	223	255
9	Facilities to local people for ferry service etc	1500	1500
	Total	**105767**	**120876**

8.2.2 Cost estimate for Stage II

The cost estimate for different items involved in developing Stage II waterway are furnished below

i) **Cost for land Acquisition**

As already discussed in previous chapters, it is required to acquire 100m width of corridor to develop 32m width canal portion and further Govt. of A.P. & Tamilnadu have confirmed the type and quantity of land to be acquired with respect to existing canal section.

The cost involved in acquiring land for Stage II is given below :

Sl. No.	Stretches of waterway	Area of Land required (in Hectare)	Rate (in Rs)	Amount (Rs in Lakhs)
1	Krishna Eluru canal between Vijayawada & Eluru	236	2000000	4720
2	Commamur canal between Peddaganjam & Vijayawada	498	2000000	9960
			Total	**14680**

The cost for land acquisition for terminals has been included under "cost for terminals" as discussed in following paragraphs.

ii) **Cost for Dredging**

The details of quantity of dredging required in various stretches of Stage II development have been furnished in Volume III : Annexure and the cost for dredging is tabulated below:

Sl. No.	**Item Description**	**Quantity (in m^3)**	**Rate (in Rs)**	**Amount (Rs in Lakhs)**
1	Godavari river between Bhadrachalam and Polavaram			
	i. Sand	267440	200	535
	ii. Rock	6440	550	35

2	Krishna river between Wazirabad and Vijayawada i. Sand ii. Rock	 205930 101210	 200 550	 412 557
3	Krishna Eluru canal between Vijayawada and Eluru	68718	160	110
4	Commamur Canal between Peddaganjam & Vijaywada	151398	160	242
			Total	**1891**

iii) Cost for Pipe Sluices

The cost for pipe sluices required in various stretches of Stage II has been calculated as given below. The cost for a typical pipe sluice has been worked out Rs. 1 Lakh and details are furnished in Table 8.1.

Sl. No.	Stretches of waterway	No. of Pipe Sluices	Amount (Rs in Lakhs)
1	Krishna Eluru canal between Vijayawada and Eluru	260	260
2	Commamur Canal between Peddaganjam & Vijaywada	452	452
	Total	712	**712**

iv) Cost for Locks

There are 4 no. locks falling in Krishna Eluru canal and 7 nos. locks in the Commamur canal. The dimensions of these locks are sufficient for safe passage of 100t barge in Phase I but most of these locks are in bad condition and therefore require urgent repair work in order to make them navigable for movement of 100 t barge. It is proposed to have a provision of Rs. 100 Lakhs per lock for repair and modification.

In the river Krishna, there is one lock at Vijayawada and not suitable for safe passage of 300t barge. It is therefore proposed to provide new lock in place of existing for safe passage of 300t barge. The cost for a typical new lock has been worked out as Rs.1488 Lakhs and details are furnished in Table 8.2(b).

The cost for locks required in various stretches of Stage II is calculated as given below.

Sl. No.	Stretches of waterway	No. of Lock	Rate (Rs. in Lakhs)	Amount (Rs in Lakhs)
1	Krishna Eluru canal between Vijayawada and Eluru	4	100	400
2	Commamur Canal between Peddaganjam & Vijaywada	7	100	700
3	Krishna river between Wazirabad and Vijayawada	1	1488	1488
	Total	12		2588

v) **Cost for Bridges**

The following no. of new foot bridges and road bridges have been proposed (Refer Chapter 6) in Stage II of waterway as given below:

Sl. No.	Stretches of waterway	No. of foot bridges	Length of foot bridges (in m)	No. of road bridges		Length of Road bridge (in m)	
				SLB*	DLB*	SLB*	DLB*
1	Krishna Eluru canal between Vijayawada and Eluru	1	26	4	1	131	26
2	Commamur Canal between Peddaganjam & Vijaywada	1	20	6	-	166	-
	Total	**2**	**46**	**10**	**1**	**297**	**26**

*SLB stands for Single Lane Bridge
*DLB stands for Two Lane Bridge

The cost for foot bridges and road bridges has been determined for Stage II development as given below.

Sl. No.	Stretches of waterway	Cost of foot bridge (in Rs. Lakhs/m)	Reference	Cost of road bridges (in Rs. Lakhs/m)		Reference	
			(in m)	SLB *	DLB*	SLB*	DLB*
1	Krishna Eluru canal between Vijayawada and Eluru	1.35	Table 8.3(a)	3.5	4.85	Table 8.4(a)	Table 8.4(c)
2	Commamur Canal between Peddaganjam & Vijaywada	1.35	Table 8.3(a)	3.5	4.85	Table 8.4(a)	Table 8.4(c)

*SLB stands for Single Lane Bridge
*DLB stands for Two Lane Bridge

Accordingly, the cost for constructing all these new bridges has been worked out as given below.

Sl. No.	Stretches of waterway	Cost foot bridges (in Rs. Lakhs)	Cost of road bridges (in Rs. Lakhs)		Total Cost (in Rs. Lakhs)
			SLB*	DLB*	
1	Krishna Eluru canal between Vijayawada and Eluru	35	459	126	620
2	Commamur Canal between Peddaganjam & Vijaywada	27	581	-	608
				Total	1228

Total cost for providing new bridges = Rs. 1228 Lakhs

Cost Estimate for Phase I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	34140	39087
2	Dredging	29065	33277
3	Cross Drainage Works	2002	2292
4	Locks	43598	49915
5	Bridges	6174	7069
6	Terminals	12562	14382
7	Navigational Aids	2058	2356
8	Protection Measures	465	532
9	Facilities to local people for ferry service etc	2500	2500
	Total	**132564**	**151410**

Say **1515 Crores**

Therefore the total cost of Phase I of the project is estimated as Rs **1515 Crores.**

8.3 COST ESTIMATE FOR PHASE-II DEVELOPMENT

It has already been discussed that Phase II development would be carried out for entire stretch of waterway with channel width of 32m and depth of 2.0m in canal as well as in river portion.

The cost estimate for different items involved in developing Phase II waterway are given below.

i) Cost for land Acquisition

As already discussed in previous paragraphs, 100m width of corridor to develop 32m bed width canal portion and area of land for all the terminals would be acquired in Phase I itself, therefore there would be no cost involved in land acquisition in Phase II.

ii) Cost for Dredging

The cost for dredging in Phase II development is tabulated below:

Sl. No.	Item Description	Quantity (in m^3)	Rate (in Rs)	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	5187191	200	10374
2	Godavari Eluru canal between Rajahmundry & Eluru	10407986	160	16653
3	Krishna Eluru canal between Vijayawada and Eluru	6328189	160	10125
4	Godavari river between Bhadrachalam & Polavaram			
	i. Sand	0	200	0
	ii. Rock	0	550	0
5	Godavari river between Polavaram and Rajahmundry	0	200	0
6	Krishna river between Wazirabad and Vijayawada			
	i. Sand	0	200	0
	ii. Rock	0	550	0
7	Commamur Canal between Peddaganjam & Vijaywada	5817225	160	9308
8	North & South Buckingham canal	0	140	0
9	Marakanam to Puducherry through Kaluvelly tank	0	140	0
			Total	**46460**

*** 0 refers to No dredging**

iii) Cost for Pipe Sluices

The cost for pipe sluices required in various stretches in Phase II has been calculated as given below. The cost for a typical pipe sluice has been worked out Rs. 1 Lakh and details are furnished in Table 8.1.

Sl. No.	Stretches of waterway	No. of Pipe Sluices	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	200	200
2	Godavari Eluru canal between Rajahmundry & Eluru	296	296
3	Krishna Eluru canal between Vijayawada and Eluru	260	260
4	Commamur Canal between Peddaganjam & Vijaywada	452	452
	Total	1208	**1208**

iv) **Cost for Locks**

The existing locks falling in Kakinada, Eluru and Commamur canal are not sufficient for movement of 300t barges in Phase II. It is therefore proposed to provide new locks in place of existing ones for safe passage of 300t barge. The cost for a typical new lock has been worked out as Rs.1390 Lakhs and details are furnished in Table 8.2(a).

The cost for locks required in various stretches of waterway in Phase II is calculated as given below.

Sl. No.	Stretches of waterway	No. of Lock	Cost per Lock (Rs. in Lakhs)	Amount (Rs in Lakhs)
1	Kakinada canal between Rajahmundry & Kakinada	6	1390	8340
2	Godavari Eluru canal between Rajahmundry & Eluru	1	1390	1390
3	Krishna Eluru canal between Vijayawada and Eluru	4	1390	5560
4	Commamur Canal between Peddaganjam & Vijaywada	7	1390	9730
	Total	18		**25020**

v) **Cost for Bridges**

The following no. of new foot bridges and road bridges have been proposed (Refer Chapter 6) in Phase II of waterway as given below:

Sl. No.	Stretches of waterway	No. of foot bridges	Length of foot bridges (in m)	No. of road bridges		Length of Road bridge (in m)	
				SLB*	DLB*	SLB*	DLB*
1	Kakinada canal between Rajahmundry & Kakinada	3	96	7	6	224	390
2	Godavari Eluru canal between Rajahmundry & Eluru	5	185	7	5	276	165
3	Krishna Eluru canal between Vijayawada and Eluru	5	177	11	6	385	202
4	Commamur Canal between Peddaganjam & Vijaywada	2	69	11	12	391	603
5	North Buckingham canal	-	-	-	-	-	-
6	South Buckingham canal	-	-	-	-	-	-
	Total	**15**	**527**	**36**	**29**	**1276**	**1360**

*SLB stands for Single Lane Bridge

*DLB stands for Two Lane Bridge

The cost for foot bridges and road bridges has been determined for Stage I development as given below.

Sl. No.	Stretches of waterway	Cost of foot bridge (in Rs. Lakhs/m)	Reference	Cost of road bridges (in Rs. Lakhs/m)		Reference	
			(in m)	SLB*	DLB*	SLB*	DLB*
1	Kakinada canal between Rajahmundry & Kakinada	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)
2	Godavari Eluru canal between Rajahmundry & Eluru	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)
3	Krishna Eluru canal between Vijayawada and Eluru	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)
4	Commamur Canal between Peddaganjam & Vijaywada	1.38	Table 8.3(b)	3.72	5.16	Table 8.4(b)	Table 8.4(d)

*SLB stands for Single Lane Bridge
*DLB stands for Two Lane Bridge

Accordingly, the cost for constructing all these new bridges has been worked out as given below.

Sl. No.	Stretches of waterway	Cost foot bridges (in Rs. Lakhs)	Cost of road bridges (in Rs. Lakhs)		Total Cost (in Rs. Lakhs)
			SLB*	DLB*	
1	Kakinada canal between Rajahmundry & Kakinada	133	833	2012	2978
2	Godavari Eluru canal between Rajahmundry & Eluru	255	1027	851	2133
3	Krishna Eluru canal between Vijayawada and Eluru	244	1432	1042	2718
4	Commamur Canal between Peddaganjam & Vijaywada	95	1455	3112	4662
5	North Buckingham canal	-	-	-	-
6	South Buckingham canal	-	-	-	-
				Total	12491

Total cost for providing new bridges = Rs. 12491 Lakhs

vi) Cost for Terminals

The summary of cost for terminals in Phase II development is tabulated below:

S.No.	Name of Terminal	Cost of Terminal (Rs. In lakhs)
1	Kakinada	188
2	Rajahmundry	188
3	Tadepalligudam	188
4	Eluru	188
5	Kottapatnam	188
6	Maipadu	188
7	Durgarajupatnam	188
8	Ennore (South)	188
9	Muthukadu	188

S.No.	Name of Terminal	Cost of Terminal (Rs. In lakhs)
10	Marakanam	188
11	Puducherry	188
12	Bhadrachalam	188
13	Wazirabad	188
14	Muktiyala	188
15	Vijayawada	188
	TOTAL	**2820**

The detailed cost estimate for all these terminals have been tabulated in Table 8.5 to 8.19.

vii) **Cost for Navigational Aids**

The navigational aids provided in Phase I will suffice the purpose in Phase II as the length of the proposed waterway remains same. Hence it is not necessary to consider any cost provision for Phase II.

Abstract of Cost estimate for Phase II

To arrive at the total cost for Phase II development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various above mentioned items for development of Phase II waterway for the year 2007 and 2009 is given below:

Cost estimate for Phase II

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	0	0
2	Dredging	46460	53192
3	Cross Drainage Works	1208	1383
4	Locks	25020	28645
5	Bridges	12491	14301
6	Terminals	2820	3229
7	Navigational Aids	0	0
	TOTAL	**87999**	**100750**

Say 1008 Crores

Therefore the total cost of Phase II of the project is estimated as Rs **1008 Crores.**

TABLES

TABLE – 8.1

Cost Estimate for Pipe Sluice

Sl. No.	Item Description	Unit	Quantity	Rate (In Rs.)	Amount (Rs. In Lakhs)
1.	Earthwork in excavation	m^3	50	125	6250
2.	Providing and laying Non pressure NP.2 RCC pipe with collars jointed with stiff mixture of cement mortar in proportion of 1:2 including testing of joint etc.	m	20	895	17900
3.	Providing and laying cement concrete 1:4:8 in bed concrete	m^3	20	2450	49000
4.	Providing and laying cement concrete 1:3:6 in sump well	m^3	2	2792	5584
5.	Providing and laying 100 mm thick cement concrete lining 1:3:6 on sloping sides in a length of 3m on sloping side of canal, berm including shuttering	m^3	5	2800	14000
6.	Providing C.I grating of size 1.5mx1.5m on opening of sump well	m^2	2.25	38	85
				Total	**92819**
				Say	**Rs. 1.0 lakh**

Table 8.2 (a)

Cost Estimate for New Lock for 32m canal bed width

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means in foundation including disposal of excavated earth in all kinds of soil	m^3	2500	125	3
2	Providing and laying in position stone pitching on bed in front of guide wall	m^3	650	450	3
	FOUNDATION				
3	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in the pile cap	m	5350	6220	333
4	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	495	42700	211
5	Supplying and erecting necessary kentiledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated below :				
i.	Vertical load test	No.	3	60000	1.8
ii.	Lateral load test	No.	3	40000	1.2
	SUPERSTRUCTURE				
6	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in Lock walls etc. of M25 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	3200	5200	166
7	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	377	42700	161
8	Providing steel in lock gates of size 8.0 m x 6.0 m	tonne	200	100000	200
9	Installation and fabrication cost for steel gates @ Rs. 10 lacs per gate	No.	8	1000000	80
10	Cost for Gate Drive @ Rs. 1000000 per gate	No.	8	1000000	80
11	Providing and laying drainage system including pipe drains, valves etc. in lock chamber	Lumpsum			150
				Total (Rs. in Lakhs)	1390

Table 8.2(b)

Cost Estimate for Navigation Lock in 32m wide channel in Krishna river

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means in foundation including disposal of excavated earth in all kinds of soil	m^3	2700	125	3
2	Providing and laying in position stone pitching on bed in front of guide wall	m^3	800	450	4
	FOUNDATION				
3	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in the pile cap	m	5600	6220	348
4	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	530	42700	226
5	Supplying and erecting necessary kentiledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated below :				
i	Vertical load test	No	3	60000	1.8
ii	Lateral load test	No	3	40000	1.2
	SUPERSTRUCTURE				
6	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in Lock walls etc. of M25 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	3600	5200	187
7	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	424	42700	181
8	Providing steel in lock gates of size 8.0 m x 6.0 m	tonne	200	100000	200
9	Installation and fabrication cost for steel gates @ Rs. 10 lacs per gate	No.	8	1000000	80
10	Cost for Gate Drive @ Rs. 1000000 per gate	No	8	1000000	80
11	Providing and laying drainage system including pipe drains, valves etc. in lock chamber	Lumpsum			175
				Total (Rs. in Lakhs)	1488

Table 8.3(a)
Cost Estimate for Foot bridge across 14m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
	FOUNDATION				
1	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete.excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	55	6220	3
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning. straightening, cutting, bending, hooking, binding, welding etc.	Tonne	6	42700	3
4	Supplying and erecting necessary kentiledge, platform. etc. and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	1	60000	0.6
ii.	Lateral load test	No.	1	40000	0.4
	SUPERSTRUCTURE				
5	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	140	5500	8
6	Fabricating and placing in position M S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	8	42700	3
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	2	3300	0.1
8	Providing earthfilling in ramp on both banks	m^3	2720	190	5
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	2	200000	4
				Total (Rs. in Lakhs)	27
				Cost per m length (Rs. In Lakhs)	1.350
				Say	1.35

Table 8.3(b)

Cost Estimate for Foot bridge across 32m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
	FOUNDATION				
1	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	90	6220	6
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	10	42700	4
4	Supplying and erecting necessary kentiledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	2	60000	1.2
ii.	Lateral load test	No.	2	40000	0.8
	SUPERSTRUCTURE				
5	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	230	5500	13
6	Fabricating and placing in position M S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	15	42700	6
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	4	3300	0.1
8	Providing earthfilling in ramp on both banks	m^3	4600	190	9
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	2	200000	4
				Total (Rs. in Lakhs)	44
				Cost per m length (Rs. In Lakhs)	1.375
				Say	1.38

Table 8.4(a)

Cost Estimate for Single Lane road bridge across 14m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
	FOUNDATION				
1	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	165	6220	10
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	18	42700	8
4	Supplying and erecting necessary kentiledge, platform, etc and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	1	60000	0.6
ii.	Lateral load test	No.	1	40000	0.4
	SUPERSTRUCTURE				
5	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	375	5500	21
6	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	22	42700	9
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	5	3300	0.2
8	Providing earthfilling in ramp on both banks	m^3	6800	190	13
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	4	200000	8
				Total (Rs. in Lakhs)	70

Cost per m length (Rs. In Lakhs) **3.500**

Say **3.5**

Table 8.4(b)

Cost Estimate for Single Lane road bridge across 32m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
	FOUNDATION				
1	Boring. providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	280	6220	17
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	32	42700	14
4	Supplying and erecting necessary kentledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	2	60000	1.2
ii.	Lateral load test	No.	2	40000	0.8
	SUPERSTRUCTURE				
5	Manufacturing, , transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	635	5600	35
6	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	40	42700	17
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	10	3300	0.3
8	Providing earthfilling in ramp on both banks	m^3	11550	190	22
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	6	200000	12
				Total (Rs. in Lakhs)	**119**

Cost per m length (Rs. In Lakhs) 3.719

Say 3.72

Table 8.4(c)

Cost Estimate for Two Lane road bridge across 14m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate	Amount
				(in Rs.)	(Rs. in Lakhs)
	FOUNDATION				
1	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	220	6220	14
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	25	42700	11
4	Supplying and erecting necessary kentiledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	1	60000	0.6
ii.	Lateral load test	No.	1	40000	0.4
	SUPERSTRUCTURE				
5	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	550	5500	30
6	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	35	42700	15
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	10	3300	0.3
8	Providing earthfilling in ramp on both banks	m^3	11800	190	22
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	2	200000	4
				Total (Rs. in Lakhs)	**97**
				Cost per m length (Rs. In Lakhs)	**4.850**
				Say	**4.85**

Table 8.4(d)

Cost Estimate for Two Lane road bridge across 32m wide channel

SL. No.	Item Desription	Unit	Quantity	Rate (in Rs.)	Amount (Rs. in Lakhs)
	FOUNDATION				
1	Boring, providing and installing bored cast-in-situ reinforced cement concrete pile of 1000mm diametre and length below the pile cap M 35 in cement concrete,excluding the cost of steel reinforcement but including the cost of boring with casing and /or bentonite solution and length of pile to be embedded in	m	370	6220	23
3	Fabricating and placing in position M.S./TOR steel reinforcement in the piles including cleaning, straightening, cutting, bending, hooking, binding, welding etc.	Tonne	40	42700	17
4	Supplying and erecting necessary kentiledge, platform, etc. and conducting load tests on working piles as per IS 2911 as indicated				
i.	Vertical load test	No.	2	60000	1.2
ii.	Lateral load test	No.	2	40000	0.8
	SUPERSTRUCTURE				
5	Manufacturing, transporting, supplying and placing in position, as per relevant drawings, reinforced cement concrete in elements such as girders,slabs,abutments etc. of M30 grade with 20mm down size graded crushed stone aggregates for all leads, level	m^3	925	5500	51
6	Fabricating and placing in position M.S./HYSD reinforcement in girders, slabs, piers,abutments etc including cleaning, straightening, cutting, bending, hooking,	Tonne	60	42700	26
7	Providing and laying concrete screed 1:2:4 in wearing coat including shuttering, vibrating, tamping, curing, champhering where required, finishing the top surface as	m^3	16	3300	0.5
8	Providing earthfilling in ramp on both banks	m^3	19885	190	38
9	Providing rubber tyre fenders of external diameter 1.2m on sides of pier	No.	4	200000	8
				Total (Rs. in Lakhs)	165

Cost per m length (Rs. In Lakhs) **5.156**

Say **5.16**

Table 8.5
Cost Estimate for Kakinada Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.6

Cost estimate for Rajamundry Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.7
Cost Estimate for Tadepalligudam Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.8
Cost Estimate for Eluru Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS -	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.9
Cost Estimate for Kottapatnam Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.10
Cost Estimate for Maipadu Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.11
Cost Estimate for Durgarajupatnam Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	**834**	**188**

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.12
Cost Estimate for Ennore(South) Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	37500	-	Sq.m	200	75	-
2	Reclamation of land behind berth	45000	-	cu.m	100	45	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	**853**	**188**

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	643	120
2	Electrical and Mechanical works	211	68

Table 8.13
Cost Estimate for Muthukadu Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.14
Cost Estimate for Marakanam Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.15
Cost Estimate for Puducherry Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.16
Cost Estimate for Bhadrachalam Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	40000	-	Sq.m	200	80	-
2	Reclamation of land behind berth	54000	-	cu.m	100	54	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	**867**	**188**

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	657	120
2	Electrical and Mechanical works	211	68

Table 8.17
Cost Estimate for Wazirabad Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.18
Cost Estimate for Muktiyala Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	834	188

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

Table 8.19
Cost Estimate for Vijayawada Terminal

Sl. No.	Item	Quantitiy		Unit	Rate (in Rs)	Amount (Rs in lakhs)	
		Phase I	Phase II			Phase I	Phase II
1	Land Acquisition	30000	-	Sq.m	200	60	-
2	Reclamation of land behind berth	40500	-	cu.m	100	40.5	-
3	Gate and fencing around the terminal	-	-		LS	10	-
4	Wharf viz. cost of construction of berth	90	0	m	300000	270	0
5	Storage						
	Covered Shed	1500	500	m^2	5000	75	25
	Open storage	5000	2000	m^2	1000	50	20
	Truck Parking	1500	1000	m^2	1500	22.5	15
	Other service area	500	500	m^2	2000	10	10
	Canteen	600	-	m^2	1500	9	-
6	Roads and Pavements	1000	500	m	6000	60	30
7	Water Supply	-	-		LS	10	10
8	Fire fighting arrangement	-	-		LS	6	10
9	Electric Sub-staiton	300	-	m^2	5000	15	
10	Weigh Bridge	2	1	No.	800000	16	8
11	Equipment						
(i)	Tyre mounted mobile crane - 5 t capacity	2	1	No.	3000000	60	30
(ii)	Fork lifts - 3 t capacity	4	2	No.	500000	20	10
(iii)	Payloaders - 2 m^3 capacity	2	-	No.	2000000	40	-
(iv)	Dumper truck	4	2	No.	1000000	40	20
(v)	Trolley Train	6	-	No.	300000	18	-
(vi)	Slings	6	-	sets	30000	1.8	-
					Total	**834**	**188**

Base Year : 2007

Summary:

Sl. No.	Items	Amount (Rs in lakhs)	
		Phase I	Phase II
1	Civil Works including land acquisition.	623	120
2	Electrical and Mechanical works	211	68

CHAPTER 9
ECONOMIC & FINANCIAL EVALUATION

CHAPTER –9

ECONOMIC AND FINANCIAL EVALUATION

9.1 INTRODUCTION

Economic analysis attempts to measure the overall impact of the project on improving the economic welfare of the citizens of the country. It would assess the project in the context of the national economy rather than the project entity. Economic analysis of an investment proposed differs from its financial analysis counterpart both in terms of identification and evaluation of inputs and outputs and in measurement of cost and benefits. For instance, the program's positive and negative impacts would be measured in terms of willingness to pay or in terms of benefits foregone or in terms of disaster funds earmarked to overcome the adverse impact of competing/existing alternative.

9.2 OPTIONS/STRETCHES CONSIDERED FOR EVALUATION

Taking into account the traffic projections carried out for the entire stretch of waterway and cost of development works associated, two options have been broadly identified for economic and financial analysis as follows :

a) Option I: The option I consist of following stretches of waterway as given below:

i. Kakinada canal
ii. Eluru canal
iii. Godavari River
iv. Krishna River

b) **Option II:** The option II consists of entire stretch of waterway as given below:

i. Kakinada canal
ii. Eluru canal
iii. Godavari River
iv. Krishna River
v. Commamur Canal
vi. North Buckingham Canal
vii. South Buckingham Canal
viii. Marakanam to Puducherry by Kalluvelly Tank.

Finally, economic & financial analysis have been carried out for both the option during Phase I & Phase II developments.

9.3 ECONOMIC EVALUATION

The economic analysis of a project is carried out by determining the economic cost involved in the project and economic benefits being accrued with the development of project. The economic cost and benefits associated with a project ultimately lead to EIRR computation. For the present IWT project, economic cost and benefits have been illustrated in the following paragraphs.

9.3.1 Economic Cost

For EIRR computation, economic cost has been taken as two-third of the total costs of the project; one-third being the taxes and duties which represent transfer payments. The total cost for any infrastructure project consists of capital cost during the construction period and operational & maintenance costs over the project life. Based on the current practices being followed during major EPC contract, it is assumed that each and every option would be completed over a construction period of 5(five) years.

The capital cost for developing any option has been divided into following component cost as given below :

i. Land Acquisition

ii. Dredging

iii. Bridges

iv. Civil Works

v. E&M Works

vi. Navigation Aids

The O&M cost has been considered as % of component capital cost as tabulated below :

Component Capital Cost	O&M Cost as % of component capital cost
Dredging	10
Bridges	1
Civil works	2
E&M Works	8
Navigation Aids	2

On the basis of cost estimates carried out for both the phases of entire waterway in Chapter – 8, the total cost consisting of capital cost and operation and maintenance cost and finally economic cost have been worked out for all the options in tables referenced as given below:

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.1
2.	Option I during Phase II	Refer Table 9.7
3.	Option II during Phase I	Refer Table 9.13
4.	Option II during Phase II	Refer Table 9.19

9.3.2 Economic Benefits

The economic benefits that will accrue with the development of present waterway have been classified into following categories :

- Employment benefits
- Fuel saving
- Carbon credit earned
- Other benefits such as accidents, noise etc.

These benefits have been analysed and formulated in the following paragraphs.

9.3.2.1 Employment benefits due to development of Bhadrachalam coal fields

The development of Bhadrachalam coalfields has a multiplier effect on the output generation and consequent employment benefits within the Andhra Pradesh economy. This can be quantified using output multiplier and employment coefficient derived from the Input-Output table for Andhra Pradesh. Output multiplier for any industry is defined in terms of cumulative units of output generated within the economy due to an initial stimulus of one unit output of this particular industry. The employment coefficient for any industry is defined in terms of man-years of employment created within the economy for every Rs 1 lakh of output generated in that particular industry. For the present waterway, NCAER report entitled *Social Cost Benefit Analysis of POSCO Project* has been followed to arrive at the output Multiplier and employment coefficient for the coal commodity as given below. Employment coefficient in the present report has been indexed to 2006-07 prices using Wholesale Price Index.

Coal	
Output Multiplier	1.54
Employment Coefficient (man-years/per Rs. lakh of output)	0.43

The Factory Gate price of coal used in the calculation is given below :

Commodity	Rs per tonne	Reference
Coal	530	Refer Table 9.2

The last step in the estimation of social benefits of employment generation is the calculation of the annual social profit per man-year of employment generation. For this, one third of the difference between industrial unskilled wages and the agricultural labour wages is taken as the social profit.

	Rs
Industrial unskilled wages (daily)	106
Agricultural labour (daily)	50
Annual* Social profit	5600

Note: * 300 mandays in a year

The economic benefits on this account for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.2
2.	Option I during Phase II	Refer Table 9.8
3.	Option II during Phase I	Refer Table 9.14
4.	Option II during Phase II	Refer Table 9.20

9.3.2.2 Fuel savings due to IWT transportation of coal

IWT, being a fuel efficient mode of transportation, would generate enormous fuel savings compared to the alternative mode of road. A report done by NCAER, *Evaluation of Inland Vessel Building Subsidy Scheme*, has estimated fuel savings in the IWT mode. For the present waterway, NCAER report has been followed for fuel efficiency of IWT vis-à-vis road. For calculation of fuel savings, we have considered round trip with fully loaded cargo from the originating terminal while the return cargo is assumed to be empty. For IWT, the fuel efficiency is calculated for a 1000 t barge and barge operation taking place with infrastructural facilities of night navigation and mechanical operation. This gives fuel efficiency of 116 Tkm/litre in NW 1 and 88 Tkm/litre in NW 3 for fully loaded cargo. In the return journey, the empty barges consumes 20% less of fuel in the fully loaded operation and hence for the round trip the fuel efficiency is 97 Tkm/litre in NW 1 and 73 Tkm/litre in NW 3 respectively. In the alternative scenario of roadways, a 15 t truck goes for 3 km when fully loaded and in return trip with empty truck the mileage works out to be 4 km. The fuel efficiency in case of road is given in the Table below. The fuel efficiency considered for canal portion is an average of the NW-1 and NW-3 IWT movements.

	Fully loaded single trip TKM/litre	Round trip TKM/litre	Fuel Saving – round trip (litre/TKM)
Road	45	26	
IWT	102	85	0.027

Note: Cargo is in terms of tonne kilometres (TKM). TKM/litre for single trip IWT movement in case of NW-1 is 116 and that for NW-3 is 88. The corresponding figures for round trip is 97 and 73 respectively.

The following assumptions have been considered for calculation of fuel savings.

Crude- $ 70 per barrel	
Real price per litre - in Rs	41
Market price per litre - in Rs	35
Economic Price per litre - in Rs. (2/3rd of real price)	27

The economic benefits on this account for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.3
2.	Option I during Phase II	Refer Table 9.9
3.	Option II during Phase I	Refer Table 9.15
4.	Option II during Phase II	Refer Table 9.21

9.3.2.3 Carbon credit earned due to savings on fuel consumption in IWT movement compared to the road

Savings on fuel (diesel) consumption have a commensurate savings of CO2 emission. This CO2 equivalence savings on fuel consumption when quantified using market instruments is referred to as carbon credit earned. The following parameters have been considered for calculation of carbon credit earned.

CO2 equivalent fuel savings (in tonne)	3.2	per tonne of fuel saved
Density of diesel	0.82	kg/litre

Euro value	12	per tonne of CO_2 saved
Rs/Euro	64	

The economic benefits on this account for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.4
2.	Option I during Phase II	Refer Table 9.10
3.	Option II during Phase I	Refer Table 9.16
4.	Option II during Phase II	Refer Table 9.22

9.3.2.4 Other Benefits such as Accidents, Noise etc.

There are other benefits associated with transportation activities and these benefits have been identified in terms of average external costs due to accidents, noise pollution, infrastructure, wear and tear cost and congestion cost etc. The benefits have been quantified by inland navigation authority of Netherlands in terms of euro/1000 Tkm for road and IWT mode of transportation as given below.

Average External Cost per mode of Transport - Euro/1000 Tonne-km

Kind of Cost	Road	IWT
Accidents	5.44	0
Noise	2.14	0
Pollution	7.85	3
Infrastrcuture	2.45	1
Traffic jam	5.45	Negligible
Total	23.33	4
Difference of cost compared to road transport		19 Euro/1000 Tonne-km
External cost saved by not transporting 1000 tonne-km on the road		**19 Euro**

Source : www.binnenvaart.be

As can be seen from the above table, IWT has significant advantages over road in terms of lower average external costs which is only 4 euros per 1000 Tkm of operations in IWT mode compared to 23 euros for road. IWT mode has negligible cost associated with accidents, noise pollution and congestion. In case of road, external costs due to accidents, air pollution and congestion are quite significant. This low marginal average external costs of IWT operation is perhaps one of the strongest reason that modal shift to IWT from other modes should take place in the interests of the society. In the Indian context, this statement becomes more strong due to the larger number of road accidents.

The economic benefits on this account for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.5
2.	Option I during Phase II	Refer Table 9.11
3.	Option II during Phase I	Refer Table 9.17
4.	Option II during Phase II	Refer Table 9.23

9.3.3 Results of EIRR

The costs involved and the benefits accrued spread over different time periods, needs to be discounted to the base year. Internal rate of return (IRR) is that discount rate at which the present value (PV) of costs equals the PV of the benefits. In Economic IRR (EIRR), the economic costs and benefits are only considered.

The results of EIRR for various options are summarized as under :

S.No.	Options	EIRR	Reference
1.	Option I during Phase I	34.27%	Refer Table 9.6
2.	Option I during Phase II	25.84%	Refer Table 9.12
3.	Option II during Phase I	22.84%	Refer Table 9.18
4	Option II during Phase II	29.48%	Refer Table 9.24

9.4 FINANCIAL EVALUATION

For the development of present waterway involving heavy investments, it becomes very important to analyse the benefits of the owner i.e. IWAI/Govt. and the users i.e. barge operator who would use such IWT facility when compared to road. The FIRR has therefore been evaluated for IWAI/Government and Users/Barge operator in the following paragraphs.

9.4.1 FIRR For Government/IWAI

The Financial Analysis is carried out so as to drive possible levy charges per tonne kilometre of cargo transported through IWT mode that the IWT authority/Govt. should levy if it wants to recover the costs of the project from the users of the waterways. For calculation we have considered economic costs along with cargo projections in tonne kilometers as the IWAI/Government will be the funding authority who would make investment for development of this project. We have assumed 3 scenarios depending on the weighted cost of capital viz. 3%, 6% and 12%. The results of FIRR for all the options are summarised as follows.

a. Option I –Phase I

Weighted cost of capital	3%	6%	12%
Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital	13	19	36
Reference	Refer Table 9.25(a)	Refer Table 9.25(b)	Refer Table 9.25(c)

b. Option I –Phase II

Weighted cost of capital	3%	6%	12%
Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital	36	46	77
Reference	Refer Table 9.26(a)	Refer Table 9.26(b)	Refer Table 9.26(c)

c. Option II –Phase I

Weighted cost of capital	3%	6%	12%
Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital	31	43	81
Reference	Refer Table 9.27(a)	Refer Table 9.27(b)	Refer Table 9.27(c)

d. Option II –Phase II

Weighted cost of capital	3%	6%	12%
Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital	27	35	60
Reference	Refer Table 9.28(a)	Refer Table 9.28(b)	Refer Table 9.28(c)

9.4.2 FIRR for Users/Barge Operator

The development of the present waterway involving heavy investments is completely defined and meaningful if the user/barge operator is getting minimum financial benefits when compared to other financial instruments available in the market by using this IWT waterway and therefore attracted to invest money and time to use this waterway. It is therefore necessary to evaluate financial benefits in term of FIRR in availing present IWT facility for user/barge operator.

The total cost to be invested by the barge operator in running the barges has been classified into capital cost and operation and maintenance cost.

Further, the operation and maintenance cost has been identified into following components.

a. Fuel cost
b. Cost of insurance
c. Repair and maintenance cost
d. Manpower cost
e. Administrative expenses

The total cost has been evaluated for all the options in the following paragraphs.

9.4.2.1 Capital Cost

For barge operator, the capital cost would consist of cost incurred in owning the barges. The funding of the capital cost has been taken as 20% and 80% for equity and debt component respectively. The debt component is assumed to be taken @ 12% interest for 20 year loan period.

The no. of barges is required to be calculated for transportation of coal in all the options so as to arrive at the total capital cost for owning these barges. The total capital cost required for all the options have been calculated in the following paragraphs :

9.4.2.1.1 Option I during Phase I

The Option I during Phase I consists of 14 m wide channel in Kakinada and Eluru Canal and 32m wide channel in Godavari and Krishna River respectively. On the basis of traffic movement projected for all the stretches of waterway in Appendix 4, the quantity of various commodities to be transported for Option I during Phase I is reproduced for next 25 years in Table 9.29.

In Option I during Phase I, the transportation of various commodities would take place through 300 t barge in Godavari and Krishna river and through 100 t barge in Kakinada and Eluru Canal.

The number of barges required during 2014-2015 for transportation of commodities from Bahadrachalam to Rajahmundry and from Rajahmundry to Kakinada have been calculated and explained below :

Year	:	**2014-2015**
Capacity of barge	:	300 t
Quantity of Cargo Movement	:	1.826 million tonne/annum
Distance	:	171 km

The carrying capacity of one 300 t barge in a year from Bahadrachalam to Rajahmundry is determined as follows :

Loading/unloading time at Bhadrachalam Terminal	:	2+2=4 hrs.
Loading/Unloading time at Rajahmundry Terminal	:	2+2=4 hrs.

Speed of 300 t barge	=	12 km/hr.
Travel time from Bahadrachalam to Rajahmundry	=	171/12
	=	14.25
	Say 15 hrs.	
∴ Total travel time in a round trip	=	2x15 = 30 hrs.
Miscellaneous time for unforeseen events	=	2 hrs.

The total time for transportation of cargo from Bahadrachalam to Rajahmundry and back by one 300t barge would be algebraic sum of all these calculated time.

Total time = 4 + 4 + 30 + 2 = 40 hrs.

Available time in a year for movement of barge	=	300 days
	=	300 x 24
	=	7200 hrs.
∴ No. of trips made by one 300 t barge in a year	=	7200/40 = 180
∴ Carrying capacity of one 300 t barge in a year	=	180 x 300
	=	54000 t
Cargo to be transported during 2014–2015 per annum	=	1.826MillionTon
∴ No. of barges required	=	$\frac{1.826\times10^{6}}{54000}=34$
Cost of one 300 t barge	=	175 lakhs
∴ Capital cost for 35 nos. of 300 t barge	=	34 x 175
	=	5950 lakhs

Year : 2014 – 2015

Capacity of barge : 100 t

Quantity of Cargo Movement : 437000 tonne/annum

Distance : 50 km

The carrying capacity of one 100 t barge in a year from Rajahmundry to Kakinada is determined as follows :

Loading/unloading time at Rajahmundry Terminal : 1.5 + 1.5 = 3hrs.

Loading/Unloading time at Kakinada Terminal : 1.5 + 1.5 = 3hrs.

On the basis of locks discussed in Chapter 6, it is clear that there are 6 Nos. locks falling in the stretch between Rajahmundry and Kakinada.

Taking 0.75 hr for movement of 100 t barge through a lock,

Total lockage time through 6 locks in a round trip	=	2x6x0.75=9hrs
Speed of 100 t barge	=	15 km/hr.
Travel time from Rajahmundry to Kakinada	=	50/15
	=	3.33
	Say 4 hrs.	
∴ Total travel time in a round trip	=	2x4= 8 hrs.
Miscellaneous time for unforeseen events	=	2 hrs.

The total time for transportation of cargo from Rajahmundry to Kakinada and back by one 100t barge would be algebraic sum of all these calculated time.

Total time = 3 + 3 + 9 + 8 + 2 = 25 hrs.

Available time in a year for movement of barge	=	300 days
	=	300 x 24
	=	7200 hrs.

∴ No. of trips made by one 100 t barge in a year	=	7200/25 = 288
∴ Carrying capacity of one 100 t barge in a year	=	288 x 100
	=	28800 t
Cargo to be transported during 2014 – 2019 per annum	=	437000 Tonne
∴ No. of barges required	=	$\frac{437000}{28800}=15$
Cost of one 100 t barge	=	125 lakhs
∴ Capital cost for 1 no. of 100 t barge	=	15 x 125
	=	1875 lakhs

Following the same methodology, the no. of barges required for transportation of projected cargo traffic during remaining periods have been calculated and finally the capital cost has been determined for owning these barges. The capital cost is further divided into equity and debt component in the ratio 20:80. The capital cost for next 25 years in Option I during Phase I has been tabulated in Table 9.33.

9.4.2.1.2 Option I during Phase II

The Option I during Phase II consists of 32 m wide channel in Kakinada and Eluru Canal and 32m wide channel in Godavari and Krishna River respectively. The quantity of commodities to be transported for Option I during Phase II is reproduced for next 25 years Table 9.30.

Following the same methodology as followed for Option I during Phase I, the no. of barges required for transportation of projected cargo traffic during remaining periods have been calculated and finally the capital cost has been determined for owning these barges. The capital cost is further divided into equity and debt component in the ratio 20:80. The capital cost for next 25 years in Option I during Phase II has been tabulated in Table 9.34.

9.4.2.1.3 Option II during Phase I

The Option II during Phase I consists of 14 m wide channel in Kakinada, Eluru & Commamur Canal and 32m wide channel in Buckingham canal, Marakanam to Puducherry through Kaluvelly tank, Godavari and Krishna River respectively. The quantity of commodities to be transported for Option II during Phase I is reproduced for next 25 years Table 9.31.

Following the same methodology as followed for Option I during Phase I, the no. of barges required for transportation of projected cargo traffic during remaining periods have been calculated and finally the capital cost has been determined for owning these barges. The capital cost is further divided into equity and debt component in the ratio 20:80. The capital cost for next 25 years in Option I during Phase II has been tabulated in Table 9.35.

9.4.2.1.4 Option II during Phase II

The Option II during Phase II consists of 32 m wide channel in Kakinada, Eluru & Commamur Canal and 32m wide channel in Buckingham canal, Marakanam to Puducherry through Kaluvelly tank, Godavari and Krishna River respectively. The quantity of commodities to be transported for Option II during Phase I is reproduced for next 25 years Table 9.32.

Following the same methodology as followed for Option I during Phase I, the no. of barges required for transportation of projected cargo traffic during remaining periods have been calculated and finally the capital cost has been determined for owning these barges. The capital cost is further divided into equity and debt component in the ratio 20:80. The capital cost for next 25 years in Option II during Phase I has been tabulated in Table 9.36.

9.4.2.2 Operation & Maintenance Cost

The O&M cost consisting of various component cost as defined in Para 9.4.2 has been evaluated for all the options in the following paragraphs.

9.4.2.2.1 Fuel Cost

For calculation of cost of fuel, the round trip of a barge is considered with fully loaded cargo from originating terminal to terminating terminal and return cargo is also assumed to be fully loaded. The quantity of fuel and therefore cost in running the barges for transporting projected cargo traffic has been evaluated for all the options as given below :

Option I during Phase I : The no. of 300 t barges and trips made by one 300 t barge from Bhadrachalam to Rajahmundry and no. of 100 t barges and trips made by 100 t barge from Rajahmundry to Kakinada haven been evaluated while calculating capital cost in Option I during Phase I.

No. of trips made by one 300 t barge in one year = 180

The consumption of fuel for 300 t barge is given as,

= 0.15 x HP x 1 lt/hr

= 0.15 x 180 x 1

= 27 lt/hr for loaded barge

For year 2014 – 2015,

No. of 300 t barges = 34

Running time for motor of 300 t barge from Bhadrachalam to Rajahmundry = Total travel time + Miscellaneous time and back

= 30 + 2 = 32 hrs.

∴ Average running time for loaded barge = Average running time for empty barge

= 32/2 = 16 hrs.

Total fuel consumption per annum = 34 x 180 x 16 x (27 +27)

= 5.29 million lts.

Current price of diesel = Rs. 34

∴ Total cost of fuel per annum = $\frac{5.29 \times 10^6 \times 34}{10^5}$ = 1798 lakhs

For year 2014 – 2015,

No. of 100 t barges = 327

The consumption of fuel for 100 t barge is given as,

= 0.17 x HP x 1 lt/hr

= 0.15 x 65 x 1

= 11 lt/hr for loaded barge

Running time for 100 t barge's motor from Rajahmundry to Kakinada = Total travel time + Miscellaneous time

= 8 + 2

= 10hrs.

∴ Average running time for loaded barge = Average running time for empty barge

= 10/2 = 5 hrs.

Total fuel consumption per annum = 15 x 288 x 5 x (11 +11)

= 0.475 million lts.

Current price of diesel = Rs. 34

Total cost of fuel per annum = $\frac{0.475 \times 10^6 \times 34}{10^5}$ = 162 lakhs

Following the same methodology the cost for fuel during remaining periods for all the options has been calculated and furnished in Tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.33
2.	Option I during Phase II	Refer Table 9.34
3.	Option II during Phase I	Refer Table 9.35
4.	Option II during Phase II	Refer Table 9.36

9.4.2.2.2 Cost of Insurance

The cost of insurance is basically calculated for the useful life of barge after depreciation. For the present waterway, the useful life of barge has been taken as 30 years. The depreciated cost of barge has been calculated @ 1/30th per annum of capital cost of barge. The useful cost is finally estimated by substracting depreciated cost from capital cost of barge. The insurance cost is considered as 1.5% of useful cost of barge. The insurance cost for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.33
2.	Option I during Phase II	Refer Table 9.34
3.	Option II during Phase I	Refer Table 9.35
4.	Option II during Phase II	Refer Table 9.36

9.4.2.2.3 Repair and Maintenance Cost

For the present waterway, the repair and maintenance cost has been considered as 2% of capital cost of barges. The cost for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.33
2.	Option I during Phase II	Refer Table 9.34
3.	Option II during Phase I	Refer Table 9.35
4.	Option II during Phase II	Refer Table 9.36

9.4.2.2.4 Manpower Cost

The no. of personnel and the remuneration for 100 t and 300 t barge has been taken as given below :

S. No.	Type of Barge	No. of Personnel	Total Remuneration/ month
1.	100 t	4	60000
2.	300 t	5	75000

The manpower cost for all the options have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.33
2.	Option I during Phase II	Refer Table 9.34
3.	Option II during Phase I	Refer Table 9.35
4.	Option II during Phase II	Refer Table 9.36

9.4.2.2.5 Administrative Expenses

The administrative expenses has been taken as Rs. 50,000/barge. On the basis of no. of barge required for all the options, the total administrative expenses have been calculated for next 25 years in terms of Rs. Lakhs in tables referenced as given below :

S. No.	Options	Reference
1.	Option I during Phase I	Refer Table 9.33
2.	Option I during Phase II	Refer Table 9.34
3.	Option II during Phase I	Refer Table 9.35
4.	Option II during Phase II	Refer Table 9.36

9.4.2.3 Result of FIRR for barge operator

After carrying out the total cost for all the options as explained in the earlier paragraphs, the revenue for barge operator in terms of Rs. per Tonne - km has been assumed so as to gain an IRR of 12%. The results of FIRR for all the options are summarized as follows :

S. No.	Options	Levy Charge (Rs. per Tonne - km) to earn an IRR of 12%	Reference
1.	Option I during Phase I	1.20	Refer Table 9.33
2.	Option I during Phase II	1.07	Refer Table 9.34
3.	Option II during Phase I	1.31	Refer Table 9.35
4.	Option II during Phase II	1.14	Refer Table 9.36

TABLES

Table 9.1

Capital and O & M Cost for Option I during Phase I

Year	Capital Cost							O&M Cost	Total Cost	Economic Cost
	Land Acquisition	Dredging	Bridges	Civil works	E & M works	Nav. Aids	Total Capital Cost			
1	17243	1020	195	0	0	0	18458	0	18458	12305
2	0	1020	779	2021	0	0	3820	0	3820	2547
3	0	1020	974	4042	580	0	6616	0	6616	4411
4	0	1020	0	2021	774	957	4772	0	4772	3181
5	0	1020	0	2021	580	957	4578	0	4578	3052
6								925	925	616
7								925	925	616
8								925	925	616
9								925	925	616
10								925	925	616
11								925	925	616
12								925	925	616
13								925	925	616
14								925	925	616
15								925	925	616
16								925	925	616
17								925	925	616
18								925	925	616
19								925	925	616
20								925	925	616
21								925	925	616
22								925	925	616
23								925	925	616
24								925	925	616
25								925	925	616
26								925	925	616
27								925	925	616
28								925	925	616
29								925	925	616
30										

O & M Cost

Component	Dredging	Bridges	Civil works	E & M works	Nav. Aids	
Component Cost	5101	1947	10106	1934	1913	
O&M (% of Capital Cost)	10	1	2	8	2	
Year						Total O & M Cost
1	510	19	202	155	38	925
2	510	19	202	155	38	925
3	510	19	202	155	38	925
4	510	19	202	155	38	925
5	510	19	202	155	38	925
6	510	19	202	155	38	925
7	510	19	202	155	38	925
8	510	19	202	155	38	925
9	510	19	202	155	38	925
10	510	19	202	155	38	925
11	510	19	202	155	38	925
12	510	19	202	155	38	925
13	510	19	202	155	38	925
14	510	19	202	155	38	925
15	510	19	202	155	38	925
16	510	19	202	155	38	925
17	510	19	202	155	38	925
18	510	19	202	155	38	925
19	510	19	202	155	38	925
20	510	19	202	155	38	925
21	510	19	202	155	38	925
22	510	19	202	155	38	925
23	510	19	202	155	38	925
24	510	19	202	155	38	925
25	510	19	202	155	38	925

Table 9.2

Employment benefits due to development of Bhadrachalam Coal fields for Option I during Phase I

Year	Output		Output Stimulus	Employment generation	Employment benefits	
	lakh tonne	Rs lakh	Rs lakh	Manyears	Rs million	Rs lakhs
1	14	7354	11325	4885	27	274
2	21	11141	17158	7401	41	414
3	21	11254	17331	7476	42	419
4	21	11369	17508	7552	42	423
5	22	11485	17688	7630	43	427
6	22	11605	17871	7709	43	432
7	30	15635	24078	10386	58	582
8	30	15801	24333	10496	59	588
9	30	15969	24593	10608	59	594
10	30	16141	24858	10723	60	600
11	31	16317	25128	10839	61	607
12	39	20620	31755	13698	77	767
13	39	20848	32107	13849	78	776
14	40	21081	32465	14004	78	784
15	40	21319	32831	14162	79	793
16	41	21561	33204	14323	80	802
17	41	21808	33585	14487	81	811
18	42	22060	33973	14654	82	821
19	42	22318	34369	14825	83	830
20	43	22580	34773	14999	84	840
21	43	22847	35185	15177	85	850
22	44	23120	35605	15358	86	860
23	44	23399	36034	15543	87	870
24	45	23683	36471	15732	88	881
25	45	23972	36917	15924	89	892

Assumptions

Output Multiplier	
2003-04	1.54

Employment Multiplier		
2006-07	0.43	
2003-04	0.51	*Posco Repor*

Daily wages (Rs)
Industrial unskilled (urban)
106
Agricultural wages
50

Annual social profit per manyear (Rs)
5600

	Rs
Price per tonne	530

WPI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Non-coking coal	196.9	225.6	232.8	232.8	239.2	254.0
Coking coal	184.6	227.2	239.0	239.0	246.4	263 7

Price non-coking coal - Grade F (2400-3360 Kcal/Kg)	
Rs 351-710 per tonne	*Source: Coal Directory of India 2005-06*

Table 9.3
Fuel Saving for Option I during Phase I

Year	Total traffic movement by IWT	Fuel Saving	Fuel Saving	
	Million Tonne-km	Million litre	Rs Million	Rs lakhs
1	656	18	481	4806
2	1021	28	748	7481
3	1058	29	775	7747
4	1076	29	788	7884
5	1096	30	802	8024
6	1115	30	817	8169
7	1480	40	1084	10839
8	1530	41	1120	11202
9	1558	42	1141	11408
10	1587	43	1162	11620
11	1616	44	1184	11838
12	2021	55	1480	14802
13	2087	57	1529	15285
14	2127	58	1558	15579
15	2168	59	1588	15881
16	2211	60	1619	16191
17	2254	61	1651	16511
18	2299	62	1684	16839
19	2345	64	1718	17177
20	2393	65	1752	17524
21	2442	66	1788	17881
22	2492	68	1825	18249
23	2543	69	1863	18627
24	2597	70	1902	19016
25	2651	72	1942	19416

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

Crude- $ 70 per barrel	
Real price per litre - in Rs	41
Market price per litre - in Rs	35
Economic price per litre - in Rs (2/3rd of Real price)	27

Table 9.4
Carbon Credit Earned for Option I during Phase I

Year	Total traffic movement by IWT	Fuel Saving	Carbon Credit Earned
	Million Tonne-km	Million litre	Rs lakhs
1	656	18	359
2	1021	28	558
3	1058	29	578
4	1076	29	588
5	1096	30	599
6	1115	30	610
7	1480	40	809
8	1530	41	836
9	1558	42	851
10	1587	43	867
11	1616	44	884
12	2021	55	1105
13	2087	57	1141
14	2127	58	1163
15	2168	59	1185
16	2211	60	1208
17	2254	61	1232
18	2299	62	1257
19	2345	64	1282
20	2393	65	1308
21	2442	66	1335
22	2492	68	1362
23	2543	69	1390
24	2597	70	1419
25	2651	72	1449

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

CO_2 equivalent fuel savings (in tonne)	3.2	per tonne of fuel saved
Density of diesel	0.82	kg/litre
Euro value	12	per tonne of CO_2 saved
Rs/Euro	64	

Table 9.5

Other Benefits such as Accidents, Noise etc for Option I during Phase I

Year	Total traffic movement by IWT	Other Benefits
	Million Tonne-km	Rs lakhs
1	656	7980
2	1021	12421
3	1058	12863
4	1076	13090
5	1096	13323
6	1115	13563
7	1480	17997
8	1530	18599
9	1558	18942
10	1587	19294
11	1616	19656
12	2021	24578
13	2087	25380
14	2127	25867
15	2168	26369
16	2211	26884
17	2254	27414
18	2299	27959
19	2345	28520
20	2393	29097
21	2442	29690
22	2492	30300
23	2543	30928
24	2597	31574
25	2651	32238

Assumptions	64	
Rs/Euro	19	Euro per 1000 Tonne-km
Other Benefits		

Average External Cost per mode of Transport - Euro/1000 Tonne-km	Road	IWT
Kind of Cost	5.44	0
Accidents	2.14	0
Noise	7.85	3
Pollution	2.45	1
Infrastrcuture	5.45	Negligible
Traffic jam	23.33	4
Total		19 Euro/1000 Tonne-km
Difference of cost compared to road transport		**19 Euro**
External cost saved by not transporting 1000 tonne-km on the road		

Source : www.binnenvaart.be

Table 9.6

EIRR for Government for Option I during Phase I

	Year	Economic Costs	Economic Benefits	Net Cash Flow
		Rs lakhs	Rs lakhs	Rs lakhs
Reference		Refer Table 9.1	Refer Table 9 6	
	1	12305		-12305
	2	2547		-2547
	3	4411		-4411
	4	3181		-3181
	5	3052		-3052
	6	616	13418	12802
	7	616	20874	20258
	8	616	21607	20991
	9	616	21985	21369
	10	616	22374	21757
	11	616	22773	22157
	12	616	30226	29610
	13	616	31225	30609
	14	616	31795	31179
	15	616	32382	31765
	16	616	32984	32368
	17	616	41252	40636
	18	616	42582	41965
	19	616	43393	42777
	20	616	44228	43611
	21	616	45086	44469
	22	616	45968	45352
	23	616	46876	46259
	24	616	47809	47192
	25	616	48768	48152
	26	616	49755	49139
	27	616	50771	50154
	28	616	51815	51199
	29	616	52889	52273
	30	616	53995	53378
			IRR	34.27%

	Total Economic Benefits				
	Employment benefit due to Coal	Fuel Saving	Carbon Credit Earned	Other Benefits	Total
	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs
Reference	Refer Table 9.2	Refer Table 9.3	Refer Table 9.4	Refer Table 9.5	
	274	4806	359	7980	13418
	414	7481	558	12421	20874
	419	7747	578	12863	21607
	423	7884	588	13090	21985
	427	8024	599	13323	22374
	432	8169	610	13563	22773
	582	10839	809	17997	30226
	588	11202	836	18599	31225
	594	11408	851	18942	31795
	600	11620	867	19294	32382
	607	11838	884	19656	32984
	767	14802	1105	24578	41252
	776	15285	1141	25380	42582
	784	15579	1163	25867	43393
	793	15881	1185	26369	44228
	802	16191	1208	26884	45086
	811	16511	1232	27414	45968
	821	16839	1257	27959	46876
	830	17177	1282	28520	47809
	840	17524	1308	29097	48768
	850	17881	1335	29690	49755
	860	18249	1362	30300	50771
	870	18627	1390	30928	51815
	881	19016	1419	31574	52889
	892	19416	1449	32238	53995

Table 9.7

Capital and O & M Cost for Option I during Phase II

Year	Capital Cost: Land Acquisition	Capital Cost: Dredging	Capital Cost: Bridges	Capital Cost: Civil works	Capital Cost: E & M works	Capital Cost: Nav. Aids	Capital Cost: Total Capital Cost	O&M Cost	Total Cost	Economic Cost
1	0	8507	896	0	0	0	9403	0	9403	6269
2	0	8507	3586	3894	0	0	15986	0	15986	10658
3	0	8507	4482	7788	187	0	20964	0	20964	13976
4	0	8507	0	3894	250	0	12650	0	12650	8434
5	0	8507	0	3894	187	0	12588	0	12588	8392
6								4782	4782	3188
7								4782	4782	3188
8								4782	4782	3188
9								4782	4782	3188
10								4782	4782	3188
11								4782	4782	3188
12								4782	4782	3188
13								4782	4782	3188
14								4782	4782	3188
15								4782	4782	3188
16								4782	4782	3188
17								4782	4782	3188
18								4782	4782	3188
19								4782	4782	3188
20								4782	4782	3188
21								4782	4782	3188
22								4782	4782	3188
23								4782	4782	3188
24								4782	4782	3188
25								4782	4782	3188
26								4782	4782	3188
27								4782	4782	3188
28								4782	4782	3188
29								4782	4782	3188
30								4782	4782	3188

O & M Cost

Component	Dredging	Bridges	Civil works	E & M works	Nav. Aids	
Component Cost	42535	8964	19469	624	0	
O&M (% of Capital Cost)	10	1	2	8	2	
Year						Total O & M Cost
1	4254	90	389	50	0	4782
2	4254	90	389	50	0	4782
3	4254	90	389	50	0	4782
4	4254	90	389	50	0	4782
5	4254	90	389	50	0	4782
6	4254	90	389	50	0	4782
7	4254	90	389	50	0	4782
8	4254	90	389	50	0	4782
9	4254	90	389	50	0	4782
10	4254	90	389	50	0	4782
11	4254	90	389	50	0	4782
12	4254	90	389	50	0	4782
13	4254	90	389	50	0	4782
14	4254	90	389	50	0	4782
15	4254	90	389	50	0	4782
16	4254	90	389	50	0	4782
17	4254	90	389	50	0	4782
18	4254	90	389	50	0	4782
19	4254	90	389	50	0	4782
20	4254	90	389	50	0	4782
21	4254	90	389	50	0	4782
22	4254	90	389	50	0	4782
23	4254	90	389	50	0	4782
24	4254	90	389	50	0	4782
25	4254	90	389	50	0	4782

Table 9.8

Employment benefits due to development of Bhadrachalam Coal fields for Option I during Phase II

	Output		Output Stimulus	Employment generation	Employment benefits	
Year	lakh tonne	Rs lakh	Rs lakh	Manyears	Rs million	Rs lakhs
1	14	7354	11325	4885	27	274
2	21	11141	17158	7401	41	414
3	21	11254	17331	7476	42	419
4	21	11369	17508	7552	42	423
5	22	11485	17688	7630	43	427
6	22	11605	17871	7709	43	432
7	30	15635	24078	10386	58	582
8	30	15801	24333	10496	59	588
9	30	15969	24593	10608	59	594
10	30	16141	24858	10723	60	600
11	31	16317	25128	10839	61	607
12	39	20620	31755	13698	77	767
13	39	20848	32107	13849	78	776
14	40	21081	32465	14004	78	784
15	40	21319	32831	14162	79	793
16	41	21561	33204	14323	80	802
17	41	21808	33585	14487	81	811
18	42	22060	33973	14654	82	821
19	42	22318	34369	14825	83	830
20	43	22580	34773	14999	84	840
21	43	22847	35185	15177	85	850
22	44	23120	35605	15358	86	860
23	44	23399	36034	15543	87	870
24	45	23683	36471	15732	88	881
25	45	23972	36917	15924	89	892

Assumptions

Output Multiplier		
2003-04	1.54	
Employment Multiplier		
2006-07	0.43	
2003-04	0.51	*Posco Report*

Daily wages (Rs)	
Industrial unskilled (urban)	
106	
Agricultural wages	
50	

Annual social profit per manyear (Rs)
5600

	Rs
Price per tonne	530

WPI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Non-coking coal	196.9	225.6	232.8	232.8	239.2	254.0
Coking coal	184.6	227.2	239.0	239.0	246.4	263.7

Price non-coking coal - Grade F (2400-3360 Kcal/Kg)	
Rs 351-710 per tonne	*Source: Coal Directory of India 2005-06*

Table 9.9

Fuel Saving for Option I during Phase II

Year	Total traffic movement by IWT	Fuel Saving	Fuel Saving	
	Million Tonne-km	Million litre	Rs Million	Rs lakhs
1	656	18	481	4806
2	1021	28	748	7481
3	1058	29	775	7747
4	1076	29	788	7884
5	1096	30	802	8024
6	1115	30	817	8169
7	1480	40	1084	10839
8	1530	41	1120	11202
9	1558	42	1141	11408
10	1587	43	1162	11620
11	1616	44	1184	11838
12	2021	55	1480	14802
13	2087	57	1529	15285
14	2127	58	1558	15579
15	2168	59	1588	15881
16	2211	60	1619	16191
17	2254	61	1651	16511
18	2299	62	1684	16839
19	2345	64	1718	17177
20	2393	65	1752	17524
21	2442	66	1788	17881
22	2492	68	1825	18249
23	2543	69	1863	18627
24	2597	70	1902	19016
25	2651	72	1942	19416

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	Source
Road	26		IVBSS report
IWT	85	0.027	

Crude- $ 70 per barrel	
Real price per litre - in Rs	41
Market price per litre - in Rs	35
Economic price per litre - in Rs (2/3rd of Real price)	27

Table 9.10

Carbon Credit Earned for Option I during Phase II

Year	Total traffic movement by IWT	Fuel Saving	Carbon Credit Earned
	Million Tonne-km	Million litre	Rs lakhs
1	656	18	359
2	1021	28	558
3	1058	29	578
4	1076	29	588
5	1096	30	599
6	1115	30	610
7	1480	40	809
8	1530	41	836
9	1558	42	851
10	1587	43	867
11	1616	44	884
12	2021	55	1105
13	2087	57	1141
14	2127	58	1163
15	2168	59	1185
16	2211	60	1208
17	2254	61	1232
18	2299	62	1257
19	2345	64	1282
20	2393	65	1308
21	2442	66	1335
22	2492	68	1362
23	2543	69	1390
24	2597	70	1419
25	2651	72	1449

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

CO_2 equivalent fuel savings (in tonne)	3.2	per tonne of fuel saved
Density of diesel	0.82	kg/litre
Euro value	12	per tonne of CO_2 saved
Rs/Euro	64	

Table 9.11

Other Benefits such as Accidents, Noise etc for Option I during Phase II

Year	Total traffic movement by IWT	Other Benefits
	Million Tonne-km	Rs lakhs
1	656	7980
2	1021	12421
3	1058	12863
4	1076	13090
5	1096	13323
6	1115	13563
7	1480	17997
8	1530	18599
9	1558	18942
10	1587	19294
11	1616	19656
12	2021	24578
13	2087	25380
14	2127	25867
15	2168	26369
16	2211	26884
17	2254	27414
18	2299	27959
19	2345	28520
20	2393	29097
21	2442	29690
22	2492	30300
23	2543	30928
24	2597	31574
25	2651	32238

Assumptions	64	
Rs/Euro	19	Euro per 1000 Tonne-km
Other Benefits		

Average External Cost per mode of Transport - Euro/1000 Tonne-km	Road	IWT
Kind of Cost	5.44	0
Accidents	2.14	0
Noise	7.85	3
Pollution	2.45	1
Infrastrcuture	5.45	Negligible
Traffic jam	23.33	4
Total		19 Euro/1000 Tonne-km
Difference of cost compared to road transport		**19 Euro**
External cost saved by not transporting 1000 tonne-km on the road		

Source : www.binnenvaart.be

Table 9.12

EIRR for Government for Option I during Phase II

	Year	Economic Costs	Economic Benefits	Net Cash Flow
		Rs lakhs	Rs lakhs	Rs lakhs
Reference		Refer Table 9.7	Refer Table 9.12	
	1	6269		-6269
	2	10658		-10658
	3	13976		-13976
	4	8434		-8434
	5	8392		-8392
	6	3188	13418	10230
	7	3188	20874	17686
	8	3188	21607	18419
	9	3188	21985	18797
	10	3188	22374	19185
	11	3188	22773	19585
	12	3188	30226	27038
	13	3188	31225	28037
	14	3188	31795	28607
	15	3188	32382	29193
	16	3188	32984	29796
	17	3188	41252	38064
	18	3188	42582	39393
	19	3188	43393	40205
	20	3188	44228	41040
	21	3188	45086	41898
	22	3188	45968	42780
	23	3188	46876	43687
	24	3188	47809	44620
	25	3188	48768	45580
	26	3188	49755	46567
	27	3188	50771	47582
	28	3188	51815	48627
	29	3188	52889	49701
	30	3188	53995	50806
			IRR	25.84%

	Total Economic Benefits				
	Employment benefit due to Coal	Fuel Saving	Carbon Credit Earned	Other Benefits	Total
	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs
Reference	Refer Table 9.8	Refer Table 9.9	Refer Table 9.10	Refer Table 9.11	
	274	4806	259	7980	13418
	414	7481	558	12421	20874
	419	7747	578	12863	21607
	423	7884	588	13090	21985
	427	8024	599	13323	22374
	432	8169	610	13563	22773
	582	10839	809	17997	30226
	588	11202	836	18599	31225
	594	11408	851	18942	31795
	600	11620	867	19294	32382
	607	11838	884	19656	32984
	767	14802	1105	24578	41252
	776	15285	1141	25380	42582
	784	15579	1163	25867	43393
	793	15881	1185	26369	44228
	802	16191	1208	26884	45086
	811	16511	1232	27414	45968
	821	16839	1257	27959	46876
	830	17177	1282	28520	47809
	840	17524	1308	29097	48768
	850	17881	1335	29690	49755
	860	18249	1362	30300	50771
	870	18627	1390	30928	51815
	881	19016	1419	31574	52889
	892	19416	1449	32238	53995

Table 9.13

Capital and O & M Cost for Option II during Phase I

Year	Capital Cost							O&M Cost	Total Cost	Economic Cost
	Land Acquisition	Dredging	Bridges	Civil works	E & M works	Nav. Aids	Total Capital Cost			
1	39087	6655	707	0	0	0	46449	0	46449	30966
2	0	6655	2828	12699	0	0	22182	0	22182	14788
3	0	6655	3535	25398	1088	0	36676	0	36676	24451
4	0	6655	0	12699	1450	1178	21983	0	21983	14655
5	0	6655	0	12699	1088	1178	21620	0	21620	14413
6								5005	5005	3337
7								5005	5005	3337
8								5005	5005	3337
9								5005	5005	3337
10								5005	5005	3337
11								5005	5005	3337
12								5005	5005	3337
13								5005	5005	3337
14								5005	5005	3337
15								5005	5005	3337
16								5005	5005	3337
17								5005	5005	3337
18								5005	5005	3337
19								5005	5005	3337
20								5005	5005	3337
21								5005	5005	3337
22								5005	5005	3337
23								5005	5005	3337
24								5005	5005	3337
25								5005	5005	3337
26								5005	5005	3337
27								5005	5005	3337
28								5005	5005	3337
29								5005	5005	3337
30								5005	5005	3337

O & M Cost						
Component	Dredging	Bridges	Civil works	E & M works	Nav Aids	
Component Cost	33277	7069	63496	3625	2356	
O&M (% of Capital Cost)	10	1	2	8	2	
Year						Total O & M Cost
1	3328	71	1270	290	47	5005
2	3328	71	1270	290	47	5005
3	3328	71	1270	290	47	5005
4	3328	71	1270	290	47	5005
5	3328	71	1270	290	47	5005
6	3328	71	1270	290	47	5005
7	3328	71	1270	290	47	5005
8	3328	71	1270	290	47	5005
9	3328	71	1270	290	47	5005
10	3328	71	1270	290	47	5005
11	3328	71	1270	290	47	5005
12	3328	71	1270	290	47	5005
13	3328	71	1270	290	47	5005
14	3328	71	1270	290	47	5005
15	3328	71	1270	290	47	5005
16	3328	71	1270	290	47	5005
17	3328	71	1270	290	47	5005
18	3328	71	1270	290	47	5005
19	3328	71	1270	290	47	5005
20	3328	71	1270	290	47	5005
21	3328	71	1270	290	47	5005
22	3328	71	1270	290	47	5005
23	3328	71	1270	290	47	5005
24	3328	71	1270	290	47	5005
25	3328	71	1270	290	47	5005

Table 9.14

Employment benefits due to development of Bhadrachalam Coal fields for Option II during Phase I

	Output		Output Stimulus	Employment generation	Employment benefits	
Year	lakh tonne	Rs lakh	Rs lakh	Manyears	Rs million	Rs lakhs
1	14	7637	11761	5073	28	284
2	22	11570	17817	7685	43	430
3	22	11686	17997	7763	43	435
4	22	11805	18180	7842	44	439
5	23	11927	18367	7923	44	444
6	23	12051	18558	8005	45	448
7	31	16236	25003	10785	60	604
8	31	16408	25268	10899	61	610
9	31	16583	25538	11016	62	617
10	32	16762	25813	11134	62	624
11	32	16944	26094	11256	63	630
12	40	21412	32975	14224	80	797
13	41	21650	33340	14381	81	805
14	41	21891	33713	14542	81	814
15	42	22138	34093	14706	82	824
16	42	22390	34480	14873	83	833
17	43	22646	34875	15044	84	842
18	43	22908	35278	15217	85	852
19	44	23175	35690	15395	86	862
20	44	23447	36109	15576	87	872
21	45	23725	36537	15760	88	883
22	45	24009	36973	15949	89	893
23	46	24298	37418	16141	90	904
24	46	24592	37872	16336	91	915
25	47	24893	38335	16536	93	926

Assumptions

Output Multiplier	
2003-04	1.54

Employment Multiplier		
2006-07	0.43	
2003-04	0.51	Posco Report

Daily wages (Rs)
Industrial unskilled (urban)
106
Agricultural wages
50

Annual social profit per manyear (Rs)
5600

	Rs
Price per tonne	530

WPI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Non-coking coal	196.9	225.6	232.8	232.8	239.2	254.0
Coking coal	184.6	227.2	239.0	239.0	246.4	263.7

Price non-coking coal - Grade F (2400-3360 Kcal/Kg)	
Rs 351-710 per tonne	*Source: Coal Directory of India 2005-06*

Table 9.15
Fuel Saving for Option II during Phase I

Year	Total traffic movement by IWT	Fuel Saving	Fuel Saving	
	Million Tonne-km	Million litre	Rs Million	Rs lakhs
1	1125	31	824	8240
2	1736	47	1271	12712
3	1803	49	1320	13202
4	1843	50	1350	13498
5	1885	51	1380	13803
6	1928	52	1412	14117
7	2561	69	1875	18754
8	2654	72	1944	19435
9	2715	74	1988	19884
10	2778	75	2035	20345
11	2843	77	2082	20821
12	3565	97	2611	26111
13	3691	100	2703	27033
14	3779	102	2767	27674
15	3869	105	2833	28334
16	3962	107	2901	29014
17	4057	110	2971	29715
18	4156	113	3044	30436
19	4257	115	3118	31180
20	4362	118	3195	31946
21	4470	121	3273	32735
22	4581	124	3355	33548
23	4695	127	3439	34386
24	4813	131	3525	35249
25	4935	134	3614	36138

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

Crude- $ 70 per barrel	
Real price per litre - in Rs	41
Market price per litre - in Rs	35
Economic price per litre - in Rs (2/3rd of Real price)	27

Table 9.16

Carbon Credit Earned for Option II during Phase I

Year	Total traffic movement by IWT	Fuel Saving	Carbon Credit Earned
	Million Tonne-km	Million litre	Rs lakhs
1	1125	31	615
2	1736	47	949
3	1803	49	985
4	1843	50	1007
5	1885	51	1030
6	1928	52	1054
7	2561	69	1400
8	2654	72	1451
9	2715	74	1484
10	2778	75	1519
11	2843	77	1554
12	3565	97	1949
13	3691	100	2018
14	3779	102	2066
15	3869	105	2115
16	3962	107	2166
17	4057	110	2218
18	4156	113	2272
19	4257	115	2327
20	4362	118	2384
21	4470	121	2443
22	4581	124	2504
23	4695	127	2566
24	4813	131	2631
25	4935	134	2697

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

CO_2 equivalent fuel savings (in tonne)	3.2	per tonne of fuel saved
Density of diesel	0.82	kg/litre
Euro value	12	per tonne of CO_2 saved
Rs/Euro	64	

Table 9.17

Other Benefits such as Accidents, Noise etc for Option II during Phase I

Year	Total traffic movement by IWT	Other Benefits
	Million Tonne-km	Rs lakhs
1	1125	13682
2	1736	21107
3	1803	21920
4	1843	22412
5	1885	22919
6	1928	23440
7	2561	31139
8	2654	32271
9	2715	33015
10	2778	33781
11	2843	34571
12	3565	43355
13	3691	44886
14	3779	45950
15	3869	47046
16	3962	48175
17	4057	49338
18	4156	50536
19	4257	51771
20	4362	53042
21	4470	54353
22	4581	55703
23	4695	57094
24	4813	58527
25	4935	60004

Assumptions

Rs/Euro	64	
Other Benefits	19	Euro per 1000 Tonne-km

Average External Cost per mode of Transport - Euro/1000 Tonne-km

Kind of Cost	Road	IWT
Accidents	5.44	0
Noise	2.14	0
Pollution	7.85	3
Infrastrcuture	2.45	1
Traffic jam	5.45	Negligible
Total	23.33	4
Difference of cost compared to road transport		19 Euro/1000 Tonne-km
External cost saved by not transporting 1000 tonne-km on the road		19 Euro

Source : www.binnenvaart.be

Table 9.18

EIRR for Government for Option II during Phase I

	Year	Economic Costs	Economic Benefits	Net Cash Flow
		Rs lakhs	Rs lakhs	Rs lakhs
Reference		Refer Table 9 13	Refer Table 9.18	
	1	30966		-30966
	2	14788		-14788
	3	24451		-24451
	4	14655		-14655
	5	14413		-14413
	6	3337	22822	19485
	7	3337	35198	31861
	8	3337	36542	33205
	9	3337	37357	34020
	10	3337	38196	34859
	11	3337	39060	35723
	12	3337	51897	48560
	13	3337	53767	50430
	14	3337	54999	51662
	15	3337	56268	52932
	16	3337	57575	54238
	17	3337	72212	68875
	18	3337	74742	71405
	19	3337	76504	73167
	20	3337	78319	74982
	21	3337	80188	76851
	22	3337	82113	78776
	23	3337	84097	80760
	24	3337	86140	82803
	25	3337	88245	84908
	26	3337	90413	87076
	27	3337	92648	89311
	28	3337	94950	91613
	29	3337	97322	93985
	30	3337	99766	96429
			IRR	22.84%

	Total Economic Benefits				
	Employment benefit due to Coal	Fuel Saving	Carbon Credit Earned	Other Benefits	Total
	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs
Reference	Refer Table 9.14	Refer Table 9.15	Refer Table 9.16	Refer Table 9.17	
	284	8240	515	13682	22822
	430	12712	949	21107	35198
	435	13202	985	21920	36542
	439	13498	1007	22412	37357
	444	13803	1030	22919	38196
	448	14117	1054	23440	39060
	604	18754	1400	31139	51897
	610	19435	1451	32271	53767
	617	19884	1484	33015	54999
	624	20345	1519	33781	56268
	630	20821	1554	34571	57575
	797	26111	1949	43355	72212
	805	27033	2018	44886	74742
	814	27674	2066	45950	76504
	824	28334	2115	47046	78319
	833	29014	2166	48175	80188
	842	29715	2218	49338	82113
	852	30436	2272	50536	84097
	862	31180	2327	51771	86140
	872	31946	2384	53042	88245
	883	32735	2443	54353	90413
	893	33548	2504	55703	92648
	904	34386	2566	57094	94950
	915	35249	2631	58527	97322
	926	36138	2697	60004	99766

Table 9.19

Capital and O & M Cost for Option II during Phase II

Year	Capital Cost							O&M Cost	Total Cost	Economic Cost
	Land Acquisition	Dredging	Bridges	Civil works	E & M works	Nav. Aids	Total Capital Cost			
1	0	10638	1430	0	0	0	12069	0	12069	8046
2	0	10638	5720	6418	0	0	22776	0	22776	15184
3	0	10638	7151	12835	351	0	30975	0	30975	20650
4	0	10638	0	6418	468	0	17524	0	17524	11682
5	0	10638	0	6418	351	0	17407	0	17407	11604
6								6197	6197	4132
7								6197	6197	4132
8								6197	6197	4132
9								6197	6197	4132
10								6197	6197	4132
11								6197	6197	4132
12								6197	6197	4132
13								6197	6197	4132
14								6197	6197	4132
15								6197	6197	4132
16								6197	6197	4132
17								6197	6197	4132
18								6197	6197	4132
19								6197	6197	4132
20								6197	6197	4132
21								6197	6197	4132
22								6197	6197	4132
23								6197	6197	4132
24								6197	6197	4132
25								6197	6197	4132
26								6197	6197	4132
27								6197	6197	4132
28								6197	6197	4132
29								6197	6197	4132
30								6197	6197	4132

O & M Cost						
Component	Dredging	Bridges	Civil works	E & M works	Nav. Aids	
Component Cost	53192	14301	32088	1169	0	
O&M (% of Capital Cost)	10	1	2	8	2	
Year						Total O & M Cost
1	5319	143	642	94	0	6197
2	5319	143	642	94	0	6197
3	5319	143	642	94	0	6197
4	5319	143	642	94	0	6197
5	5319	143	642	94	0	6197
6	5319	143	642	94	0	6197
7	5319	143	642	94	0	6197
8	5319	143	642	94	0	6197
9	5319	143	642	94	0	6197
10	5319	143	642	94	0	6197
11	5319	143	642	94	0	6197
12	5319	143	642	94	0	6197
13	5319	143	642	94	0	6197
14	5319	143	642	94	0	6197
15	5319	143	642	94	0	6197
16	5319	143	642	94	0	6197
17	5319	143	642	94	0	6197
18	5319	143	642	94	0	6197
19	5319	143	642	94	0	6197
20	5319	143	642	94	0	6197
21	5319	143	642	94	0	6197
22	5319	143	642	94	0	6197
23	5319	143	642	94	0	6197
24	5319	143	642	94	0	6197
25	5319	143	642	94	0	6197

Table 9.20

Employment benefits due to development of Bhadrachalam Coal fields for Option II during Phase II

	Output		Output Stimulus	Employment generation	Employment benefits	
Year	lakh tonne	Rs lakh	Rs lakh	Manyears	Rs million	Rs lakhs
1	14	7637	11761	5073	28	284
2	22	11570	17817	7685	43	430
3	22	11686	17997	7763	43	435
4	22	11805	18180	7842	44	439
5	23	11927	18367	7923	44	444
6	23	12051	18558	8005	45	448
7	31	16236	25003	10785	60	604
8	31	16408	25268	10899	61	610
9	31	16583	25538	11016	62	617
10	32	16762	25813	11134	62	624
11	32	16944	26094	11256	63	630
12	40	21412	32975	14224	80	797
13	41	21650	33340	14381	81	805
14	41	21891	33713	14542	81	814
15	42	22138	34093	14706	82	824
16	42	22390	34480	14873	83	833
17	43	22646	34875	15044	84	842
18	43	22908	35278	15217	85	852
19	44	23175	35690	15395	86	862
20	44	23447	36109	15576	87	872
21	45	23725	36537	15760	88	883
22	45	24009	36973	15949	89	893
23	46	24298	37418	16141	90	904
24	46	24592	37872	16336	91	915
25	47	24893	38335	16536	93	926

Assumptions

Output Multiplier	
2003-04	1.54

Employment Multiplier		
2006-07	0.43	
2003-04	0.51	*Posco Report*

Daily wages (Rs)
Industrial unskilled (urban)
106
Agricultural wages
50

Annual social profit per manyear (Rs)
5600

	Rs
Price per tonne	530

WPI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Non-coking coal	196.9	225.6	232.8	232.8	239.2	254.0
Coking coal	154.6	227.2	239.0	239.0	246.4	263.7

Price non-coking coal - Grade F (2400-3360 Kcal/Kg)	
Rs 351-710 per tonne	*Source: Coal Directory of India 2005-06*

Table 9.21

Fuel Saving for Option II during Phase II

Year	Total traffic movement by IWT	Fuel Saving	Fuel Saving	
	Million Tonne-km	Million litre	Rs Million	Rs lakhs
1	1125	31	824	8240
2	1736	47	1271	12712
3	1803	49	1320	13202
4	1843	50	1350	13498
5	1885	51	1380	13803
6	1928	52	1412	14117
7	2561	69	1875	18754
8	2654	72	1944	19435
9	2715	74	1988	19884
10	2778	75	2035	20345
11	2843	77	2082	20821
12	3565	97	2611	26111
13	3691	100	2703	27033
14	3779	102	2767	27674
15	3869	105	2833	28334
16	3962	107	2901	29014
17	4057	110	2971	29715
18	4156	113	3044	30436
19	4257	115	3118	31180
20	4362	118	3195	31946
21	4470	121	3273	32735
22	4581	124	3355	33548
23	4695	127	3439	34386
24	4813	131	3525	35249
25	4935	134	3614	36138

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	Source
Road	26		IVBSS report
IWT	85	0.027	

Crude- $ 70 per barrel	
Real price per litre - in Rs	41
Market price per litre - in Rs	35
Economic price per litre - in Rs (2/3rd of Real price)	27

Table 9.22

Carbon Credit Earned for Option II during Phase II

Year	Total traffic movement by IWT	Fuel Saving	Carbon Credit Earned
	Million Tonne-km	Million litre	Rs lakhs
1	1125	31	615
2	1736	47	949
3	1803	49	985
4	1843	50	1007
5	1885	51	1030
6	1928	52	1054
7	2561	69	1400
8	2654	72	1451
9	2715	74	1484
10	2778	75	1519
11	2843	77	1554
12	3565	97	1949
13	3691	100	2018
14	3779	102	2066
15	3869	105	2115
16	3962	107	2166
17	4057	110	2218
18	4156	113	2272
19	4257	115	2327
20	4362	118	2384
21	4470	121	2443
22	4581	124	2504
23	4695	127	2566
24	4813	131	2631
25	4935	134	2697

Assumptions

Type of Mode	Round trip Tonne-km/litre	Fuel Saving (litre/Tonne-km)	*Source*
Road	26		IVBSS report
IWT	85	0.027	

CO_2 equivalent fuel savings (in tonne)	3.2	per tonne of fuel saved
Density of diesel	0.82	kg/litre
Euro value	12	per tonne of CO_2 saved
Rs/Euro	64	

Table 9.23

Other Benefits such as Accidents, Noise etc for Option II during Phase II

Year	Total traffic movement by IWT	Other Benefits
	Million Tonne-km	Rs lakhs
1	1125	13682
2	1736	21107
3	1803	21920
4	1843	22412
5	1885	22919
6	1928	23440
7	2561	31139
8	2654	32271
9	2715	33015
10	2778	33781
11	2843	34571
12	3565	43355
13	3691	44886
14	3779	45950
15	3869	47046
16	3962	48175
17	4057	49338
18	4156	50536
19	4257	51771
20	4362	53042
21	4470	54353
22	4581	55703
23	4695	57094
24	4813	58527
25	4935	60004

Assumptions		
Rs/Euro	64	
Other Benefits	19	Euro per 1000 Tonne-km

Average External Cost per mode of Transport - Euro/1000 Tonne-km

Kind of Cost	Road	IWT
Accidents	5.44	0
Noise	2.14	0
Pollution	7.85	3
Infrastrcuture	2.45	1
Traffic jam	5.45	Negligible
Total	23.33	4
Difference of cost compared to road transport		19 Euro/1000 Tonne-km
External cost saved by not transporting 1000 tonne-km on the road		19 Euro

Source : www.binnenvaart.be

Table 9.24

EIRR for Government for Option II during Phase II

Reference	Year	Economic Costs	Economic Benefits	Net Cash Flow
		Rs lakhs	Rs lakhs	Rs lakhs
		Refer Table 9.19	Refer Table 9.24	
	1	8046		-8046
	2	15184		-15184
	3	20650		-20650
	4	11682		-11682
	5	11604		-11604
	6	4132	22822	18690
	7	4132	35198	31066
	8	4132	36542	32411
	9	4132	37357	33225
	10	4132	38196	34064
	11	4132	39060	34928
	12	4132	51897	47766
	13	4132	53767	49635
	14	4132	54999	50868
	15	4132	56268	52137
	16	4132	57575	53444
	17	4132	72212	68081
	18	4132	74742	70610
	19	4132	76504	72372
	20	4132	78319	74187
	21	4132	80188	76056
	22	4132	82113	77982
	23	4132	84097	79965
	24	4132	86140	82008
	25	4132	88245	84113
	26	4132	90413	86282
	27	4132	92648	88516
	28	4132	94950	90818
	29	4132	97322	93190
	30	4132	99766	95634
			IRR	29.48%

	Total Economic Benefits				
	Employment benefit due to Coal	Fuel Saving	Carbon Credit Earned	Other Benefits	Total
	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs	Rs lakhs
Reference	Refer Table 9.20	Refer Table 9.21	Refer Table 9.22	Refer Table 9.23	
	284	8240	615	13682	22822
	430	12712	949	21107	35198
	435	13202	985	21920	36542
	439	13498	1007	22412	37357
	444	13803	1030	22919	38196
	448	14117	1054	23440	39060
	604	18754	1400	31139	51897
	610	19435	1451	32271	53767
	617	19884	1484	33015	54999
	624	20345	1519	33781	56268
	630	20821	1554	34571	57575
	797	26111	1949	43355	72212
	805	27033	2018	44886	74742
	814	27674	2066	45950	76504
	824	28334	2115	47046	78319
	833	29014	2166	48175	80188
	842	29715	2218	49338	82113
	852	30436	2272	50536	84097
	862	31180	2327	51771	86140
	872	31946	2384	53042	88245
	883	32735	2443	54353	90413
	893	33548	2504	55703	92648
	904	34386	2566	57094	94950
	915	35249	2631	58527	97322
	926	36138	2697	60004	99766

Table 9.25 (a)

FIRR for Government for Option I during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.13 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.1			
	1	12305			-12305
	2	2547			-2547
	3	4411			-4411
	4	3181			-3181
	5	3052			-3052
	6	616	656	853	237
	7	616	1021	1328	711
	8	616	1058	1375	759
	9	616	1076	1399	783
	10	616	1096	1424	808
	11	616	1115	1450	834
	12	616	1480	1924	1308
	13	616	1530	1988	1372
	14	616	1558	2025	1409
	15	616	1587	2063	1446
	16	616	1616	2101	1485
	17	616	2021	2628	2011
	18	616	2087	2713	2097
	19	616	2127	2765	2149
	20	616	2168	2819	2203
	21	616	2211	2874	2258
	22	616	2254	2931	2314
	23	616	2299	2989	2373
	24	616	2345	3049	2433
	25	616	2393	3111	2494
	26	616	2442	3174	2558
	27	616	2492	3239	2623
	28	616	2543	3306	2690
	29	616	2597	3375	2759
	30	616	2651	3446	2830
				IRR	3.18%
			Levy charge per Tonne-km (in Rs)		0.13
			Levy charge per Tonne-km (in Paise)		13

Table 9.25 (b)

FIRR for Government for Option I during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.19 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.1			
	1	12305			-12305
	2	2547			-2547
	3	4411			-4411
	4	3181			-3181
	5	3052			-3052
	6	616	656	1247	630
	7	616	1021	1941	1324
	8	616	1058	2010	1393
	9	616	1076	2045	1429
	10	616	1096	2082	1465
	11	616	1115	2119	1503
	12	616	1480	2812	2196
	13	616	1530	2906	2290
	14	616	1558	2960	2343
	15	616	1587	3015	2398
	16	616	1616	3071	2455
	17	616	2021	3840	3224
	18	616	2087	3966	3349
	19	616	2127	4042	3425
	20	616	2168	4120	3504
	21	616	2211	4201	3584
	22	616	2254	4283	3667
	23	616	2299	4369	3752
	24	616	2345	4456	3840
	25	616	2393	4546	3930
	26	616	2442	4639	4023
	27	616	2492	4734	4118
	28	616	2543	4832	4216
	29	616	2597	4933	4317
	30	616	2651	5037	4421
				IRR	6.32%
			Levy charge per Tonne-km (in Rs)		0.19
			Levy charge per Tonne-km (in Paise)		19

Table 9.25©

FIRR for Government for Option I during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.36 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.1			
	1	12305			-12305
	2	2547			-2547
	3	4411			-4411
	4	3181			-3181
	5	3052			-3052
	6	616	656	2362	1746
	7	616	1021	3677	3061
	8	616	1058	3808	3192
	9	616	1076	3875	3259
	10	616	1096	3944	3328
	11	616	1115	4015	3399
	12	616	1480	5328	4712
	13	616	1530	5506	4890
	14	616	1558	5608	4991
	15	616	1587	5712	5096
	16	616	1616	5819	5203
	17	616	2021	7276	6660
	18	616	2087	7514	6897
	19	616	2127	7658	7042
	20	616	2168	7806	7190
	21	616	2211	7959	7343
	22	616	2254	8116	7500
	23	616	2299	8277	7661
	24	616	2345	8443	7827
	25	616	2393	8614	7998
	26	616	2442	8790	8173
	27	616	2492	8970	8354
	28	616	2543	9156	8540
	29	616	2597	9347	8731
	30	616	2651	9544	8928
				IRR	12.04%
			Levy charge per Tonne-km (in Rs)		0.36
			Levy charge per Tonne-km (in Paise)		36

Table 9.26 (a)

FIRR for Government for Option I during Phase II

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.36 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.7			
	1	6269			-6269
	2	10658			-10658
	3	13976			-13976
	4	8434			-8434
	5	8392			-8392
	6	3188	656	2362	-826
	7	3188	1021	3677	489
	8	3188	1058	3808	620
	9	3188	1076	3875	687
	10	3188	1096	3944	756
	11	3188	1115	4015	827
	12	3188	1480	5328	2140
	13	3188	1530	5506	2318
	14	3188	1558	5608	2420
	15	3188	1587	5712	2524
	16	3188	1616	5819	2631
	17	3188	2021	7276	4088
	18	3188	2087	7514	4326
	19	3188	2127	7658	4470
	20	3188	2168	7806	4618
	21	3188	2211	7959	4771
	22	3188	2254	8116	4928
	23	3188	2299	8277	5089
	24	3188	2345	8443	5255
	25	3188	2393	8614	5426
	26	3188	2442	8790	5601
	27	3188	2492	8970	5782
	28	3188	2543	9156	5968
	29	3188	2597	9347	6159
	30	3188	2651	9544	6356
				IRR	3.28%
			Levy charge per Tonne-km (in Rs)		0.36
			Levy charge per Tonne-km (in Paise)		36

Table 9.26 (b)

FIRR for Government for Option I during Phase II

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.46 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.7			
	1	6269			-6269
	2	10658			-10658
	3	13976			-13976
	4	8434			-8434
	5	8392			-8392
	6	3188	656	3019	-170
	7	3188	1021	4699	1510
	8	3188	1058	4866	1678
	9	3188	1076	4952	1764
	10	3188	1096	5040	1852
	11	3188	1115	5131	1943
	12	3188	1480	6808	3620
	13	3188	1530	7036	3848
	14	3188	1558	7166	3977
	15	3188	1587	7299	4110
	16	3188	1616	7436	4247
	17	3188	2021	9298	6109
	18	3188	2087	9601	6413
	19	3188	2127	9785	6597
	20	3188	2168	9975	6787
	21	3188	2211	10170	6982
	22	3188	2254	10370	7182
	23	3188	2299	10577	7388
	24	3188	2345	10789	7601
	25	3188	2393	11007	7819
	26	3188	2442	11231	8043
	27	3188	2492	11462	8274
	28	3188	2543	11700	8511
	29	3188	2597	11944	8756
	30	3188	2651	12195	9007
				IRR	6.08%
			Levy charge per Tonne-km (in Rs)		0.46
			Levy charge per Tonne-km (in Paise)		46

Table 9.26©

FIRR for Government for Option I during Phase II

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.77 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.7			
	1	6269			-6269
	2	10658			-10658
	3	13976			-13976
	4	8434			-8434
	5	8392			-8392
	6	3188	656	5053	1865
	7	3188	1021	7865	4677
	8	3188	1058	8145	4957
	9	3188	1076	8289	5101
	10	3188	1096	8437	5248
	11	3188	1115	8589	5400
	12	3188	1480	11396	8208
	13	3188	1530	11778	8589
	14	3188	1558	11994	8806
	15	3188	1587	12217	9029
	16	3188	1616	12447	9258
	17	3188	2021	15563	12375
	18	3188	2087	16071	12883
	19	3188	2127	16380	13192
	20	3188	2168	16697	13509
	21	3188	2211	17024	13835
	22	3188	2254	17359	14171
	23	3188	2299	17704	14516
	24	3188	2345	18060	14871
	25	3188	2393	18425	15236
	26	3188	2442	18800	15612
	27	3188	2492	19187	15998
	28	3188	2543	19584	16396
	29	3188	2597	19993	16805
	30	3188	2651	20414	17226
				IRR	12.07%
				Levy charge per Tonne-km (in Rs)	0.77
				Levy charge per Tonne-km (in Paise)	77

Table 9.27 (a)

FIRR for Government for Option II during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.31 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.13			
	1	30966			-30966
	2	14788			-14788
	3	24451			-24451
	4	14655			-14655
	5	14413			-14413
	6	3337	1125	3488	151
	7	3337	1736	5381	2044
	8	3337	1803	5588	2251
	9	3337	1843	5714	2377
	10	3337	1885	5843	2506
	11	3337	1928	5976	2639
	12	3337	2561	7939	4602
	13	3337	2654	8227	4890
	14	3337	2715	8417	5080
	15	3337	2778	8612	5275
	16	3337	2843	8813	5476
	17	3337	3565	11053	7716
	18	3337	3691	11443	8106
	19	3337	3779	11714	8377
	20	3337	3869	11994	8657
	21	3337	3962	12281	8945
	22	3337	4057	12578	9241
	23	3337	4156	12883	9547
	24	3337	4257	13198	9861
	25	3337	4362	13522	10185
	26	3337	4470	13856	10519
	27	3337	4581	14201	10864
	28	3337	4695	14555	11218
	29	3337	4813	14921	11584
	30	3337	4935	15297	11960
				IRR	3.11%
			Levy charge per Tonne-km (in Rs)		0.31
			Levy charge per Tonne-km (in Paise)		31

Table 9.27 (b)

FIRR for Government for Option II during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.43 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.13			
	1	30966			-30966
	2	14788			-14788
	3	24451			-24451
	4	14655			-14655
	5	14413			-14413
	6	3337	1125	4838	1501
	7	3337	1736	7464	4127
	8	3337	1803	7751	4414
	9	3337	1843	7925	4588
	10	3337	1885	8104	4768
	11	3337	1928	8289	4952
	12	3337	2561	11011	7675
	13	3337	2654	11411	8075
	14	3337	2715	11675	8338
	15	3337	2778	11946	8609
	16	3337	2843	12225	8888
	17	3337	3565	15331	11994
	18	3337	3691	15872	12535
	19	3337	3779	16249	12912
	20	3337	3869	16636	13299
	21	3337	3962	17036	13699
	22	3337	4057	17447	14110
	23	3337	4156	17871	14534
	24	3337	4257	18307	14970
	25	3337	4362	18757	15420
	26	3337	4470	19220	15883
	27	3337	4581	19698	16361
	28	3337	4695	20189	16852
	29	3337	4813	20696	17359
	30	3337	4935	21219	17882
				IRR	6.0%
			Levy charge per Tonne-km (in Rs)		0.43
			Levy charge per Tonne-km (in Paise)		43

Table 9.27©

FIRR for Government for Option II during Phase I

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.81 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.13			
	1	30966			-30966
	2	14788			-14788
	3	24451			-24451
	4	14655			-14655
	5	14413			-14413
	6	3337	1125	9114	5777
	7	3337	1736	14060	10723
	8	3337	1803	14602	11265
	9	3337	1843	14929	11592
	10	3337	1885	15267	11930
	11	3337	1928	15614	12277
	12	3337	2561	20743	17406
	13	3337	2654	21496	18159
	14	3337	2715	21992	18655
	15	3337	2778	22502	19165
	16	3337	2843	23028	19691
	17	3337	3565	28880	25543
	18	3337	3691	29899	26562
	19	3337	3779	30608	27271
	20	3337	3869	31338	28001
	21	3337	3962	32090	28753
	22	3337	4057	32865	29528
	23	3337	4156	33663	30326
	24	3337	4257	34485	31149
	25	3337	4362	35333	31996
	26	3337	4470	36205	32868
	27	3337	4581	37105	33768
	28	3337	4695	38031	34694
	29	3337	4813	38986	35649
	30	3337	4935	39970	36633
				IRR	12.06%
			Levy charge per Tonne-km (in Rs)		0.81
			Levy charge per Tonne-km (in Paise)		81

Table 9.28 (a)

FIRR for Government for Option II during Phase II

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.27 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.19			
	1	8046			-8046
	2	15184			-15184
	3	20650			-20650
	4	11682			-11682
	5	11604			-11604
	6	4132	1125	3038	-1094
	7	4132	1736	4687	555
	8	4132	1803	4867	736
	9	4132	1843	4976	845
	10	4132	1885	5089	957
	11	4132	1928	5205	1073
	12	4132	2561	6914	2783
	13	4132	2654	7165	3034
	14	4132	2715	7331	3199
	15	4132	2778	7501	3369
	16	4132	2843	7676	3544
	17	4132	3565	9627	5495
	18	4132	3691	9966	5835
	19	4132	3779	10203	6071
	20	4132	3869	10446	6314
	21	4132	3962	10697	6565
	22	4132	4057	10955	6823
	23	4132	4156	11221	7089
	24	4132	4257	11495	7363
	25	4132	4362	11778	7646
	26	4132	4470	12068	7937
	27	4132	4581	12368	8237
	28	4132	4695	12677	8545
	29	4132	4813	12995	8864
	30	4132	4935	13323	9192
				IRR	3.2%
			Levy charge per Tonne-km (in Rs)		0.27
			Levy charge per Tonne-km (in Paise)		27

Table 9.28 (b)

FIRR for Government for Option II during Phase II

Reference	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.35 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.19			
	1	8046			-8046
	2	15184			-15184
	3	20650			-20650
	4	11682			-11682
	5	11604			-11604
	6	4132	1125	3938	-193
	7	4132	1736	6075	1943
	8	4132	1803	6309	2178
	9	4132	1843	6451	2319
	10	4132	1885	6597	2465
	11	4132	1928	6747	2615
	12	4132	2561	8963	4831
	13	4132	2654	9288	5157
	14	4132	2715	9503	5371
	15	4132	2778	9723	5592
	16	4132	2843	9950	5819
	17	4132	3565	12479	8347
	18	4132	3691	12919	8788
	19	4132	3779	13226	9094
	20	4132	3869	13541	9410
	21	4132	3962	13866	9735
	22	4132	4057	14201	10069
	23	4132	4156	14546	10414
	24	4132	4257	14901	10769
	25	4132	4362	15267	11136
	26	4132	4470	15644	11513
	27	4132	4581	16033	11901
	28	4132	4695	16433	12302
	29	4132	4813	16846	12714
	30	4132	4935	17271	13139
				IRR	6.0%
				Levy charge per Tonne-km (in Rs)	0.35
				Levy charge per Tonne-km (in Paise)	35

Table 9.28©

FIRR for Government for Option II during Phase II

	Year	Economic Cost	Total traffic movement by IWT	Revenue @ Rs. 0.60 per Tonne-km	Net Cash Flow
		Rs lakhs	Million Tonne-km	Rs lakhs	Rs lakhs
Reference		Refer Table 9.19			
	1	8046			-8046
	2	15184			-15184
	3	20650			-20650
	4	11682			-11682
	5	11604			-11604
	6	4132	1125	6751	2620
	7	4132	1736	10415	6283
	8	4132	1803	10816	6684
	9	4132	1843	11059	6927
	10	4132	1885	11309	7177
	11	4132	1928	11566	7434
	12	4132	2561	15365	11233
	13	4132	2654	15923	11791
	14	4132	2715	16290	12159
	15	4132	2778	16668	12537
	16	4132	2843	17058	12926
	17	4132	3565	21392	17261
	18	4132	3691	22148	18016
	19	4132	3779	22673	18541
	20	4132	3869	23214	19082
	21	4132	3962	23771	19639
	22	4132	4057	24345	20213
	23	4132	4156	24936	20804
	24	4132	4257	25545	21413
	25	4132	4362	26172	22041
	26	4132	4470	26819	22687
	27	4132	4581	27485	23353
	28	4132	4695	28171	24040
	29	4132	4813	28879	24747
	30	4132	4935	29607	25476
				IRR	12.01%
			Levy charge per Tonne-km (in Rs)		0.60
			Levy charge per Tonne-km (in Paise)		60

Table 9.29

Cargo Movement in Option I during Phase I

	Cargo Movement in 000 tonne												
Stretches of Waterway	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**
Krishna river	1202	1958	2066	2105	2145	2186	2874	3017	3076	3138	3201	3968	4155
Godavari river	1826	2751	2792	2834	2877	2921	3931	3992	4055	4119	4185	5295	5380
Kakinada canal	437	700	771	794	818	842	1043	1135	1169	1204	1241	1478	1597
Eluru canal	959	1501	1565	1596	1627	1660	2190	2277	2323	2371	2420	3015	3129
Total Traffic Movement in 000 Tonne	4425	6910	7194	7328	7466	7608	10038	10421	10623	10832	11046	13755	14261
Total Traffic Movement in Million Tonne	4.42	6.91	7.19	7.33	7.47	7.61	10.04	10.42	10.62	10.83	11.05	13.75	14.26

	Cargo Movement in 000 tonne-km												
Stretches of Waterway	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**
Krishna river	188748	307361	324306	330410	336690	343153	451185	473653	482987	492594	502481	622935	652283
Godavari river	312295	470506	477457	484590	491910	499422	672270	682676	693354	704314	715562	905371	920054
Kakinada canal	21840	35004	38561	39711	40897	42121	52127	56753	58460	60222	62040	73887	79851
Eluru canal	133352	208574	217501	221779	226178	230700	304417	316480	322921	329544	336354	419017	434978
Total Traffic Movement in 000 Tonne-km	656234	1021444	1057825	1076490	1095675	1115395	1480000	1529562	1557722	1586673	1616437	2021209	2087166
Total Traffic Movement in Million Tonne-km	656	1021	1058	1076	1096	1115	1480	1530	1558	1587	1616	2021	2087

Table 9.29

Cargo Movement in Option I during Phase I

	Cargo Movement in 000 tonne												
Stretches of Waterway	**2027-28**	**2028-29**	**2029-30**	**2030-31**	**2031-32**	**2032-33**	**2033-34**	**2034-35**	**2035-36**	**2036-37**	**2037-38**	**2038-39**	**2039-40**
Krishna river	4240	4328	4419	4512	4608	4707	4809	4914	5022	5134	5248	5366	5488
Godavari river	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375	6490	6608	6729
Kakinada canal	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159	2226	2295	2366
Eluru canal	3195	3263	3333	3404	3478	3554	3632	3712	3795	3880	3967	4057	4150
Total Traffic Movement in 000 Tonne	14550	14846	15151	15464	15787	16119	16461	16813	17175	17548	17931	18326	18733
Total Traffic Movement in Million Tonne	14.55	14.85	15.15	15.46	15.79	16.12	16.46	16.81	17.18	17.55	17.93	18.33	18.73

	Cargo Movement in 000 tonne-km												
Stretches of Waterway	**2027-28**	**2028-29**	**2029-30**	**2030-31**	**2031-32**	**2032-33**	**2033-34**	**2034-35**	**2035-36**	**2036-37**	**2037-38**	**2038-39**	**2039-40**
Krishna river	665714	679541	693776	708433	723523	739062	755063	771541	788511	805988	823990	842531	861631
Godavari river	935125	950594	966475	982777	999513	1016697	1034339	1052455	1071057	1090160	1109778	1129927	1150621
Kakinada canal	82275	84777	87360	90027	92780	95623	98558	101589	104719	107950	111288	114734	118293
Eluru canal	444138	453559	463248	473213	483464	494008	504855	516013	527493	539304	551455	563958	576824
Total Traffic Movement in 000 Tonne-km	2127251	2168471	2210858	2254450	2299281	2345390	2392816	2441599	2491780	2543403	2596511	2651150	2707368
Total Traffic Movement in Million Tonne-km	2127	2168	2211	2254	2299	2345	2393	2442	2492	2543	2597	2651	2707

Table 9.30

Cargo Movement in Option I during Phase II

	Cargo Movement in 000 tonne												
Stretches of Waterway	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Krishna river	1202	1958	2066	2105	2145	2186	2874	3017	3076	3138	3201	3968	4155
Godavari river	1826	2751	2792	2834	2877	2921	3931	3992	4055	4119	4185	5295	5380
Kakinada canal	437	700	771	794	818	842	1043	1135	1169	1204	1241	1478	1597
Eluru canal	959	1501	1565	1596	1627	1660	2190	2277	2323	2371	2420	3015	3129
Total Traffic Movement in 000 Tonne	4425	6910	7194	7328	7466	7608	10038	10421	10623	10832	11046	13755	14261
Total Traffic Movement in Million Tonne	4.42	6.91	7.19	7.33	7.47	7.61	10.04	10.42	10.62	10.83	11.05	13.75	14.26

	Cargo Movement in 000 tonne-km												
Stretches of Waterway	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**
Krishna river	188748	307361	324306	330410	336690	343153	451185	473653	482987	492594	502481	622935	652283
Godavari river	312295	470506	477457	484590	491910	499422	672270	682676	693354	704314	715562	905371	920054
Kakinada canal	21840	35004	38561	39711	40897	42121	52127	56753	58460	60222	62040	73887	79851
Eluru canal	133352	208574	217501	221779	226178	230700	304417	316480	322921	329544	336354	419017	434978
Total Traffic Movement in 000 Tonne-km	656234	1021444	1057825	1076490	1095675	1115395	1480000	1529562	1557722	1586673	1616437	2021209	2087166
Total Traffic Movement in Million Tonne-km	656	1021	1058	1076	1096	1115	1480	1530	1558	1587	1616	2021	2087

Table 9.30

Cargo Movement in Option I during Phase II

Stretches of Waterway	Cargo Movement in 000 tonne												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	4240	4328	4419	4512	4608	4707	4809	4914	5022	5134	5248	5366	5488
Godavari river	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375	6490	6608	6729
Kakinada canal	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159	2226	2295	2366
Eluru canal	3195	3263	3333	3404	3478	3554	3632	3712	3795	3880	3967	4057	4150
Total Traffic Movement in 000 Tonne	14550	14846	15151	15464	15787	16119	16461	16813	17175	17548	17931	18326	18733
Total Traffic Movement in Million Tonne	14.55	14.85	15.15	15.46	15.79	16.12	16.46	16.81	17.18	17.55	17.93	18.33	18.73

Stretches of Waterway	Cargo Movement in 000 tonne-km												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	665714	679541	693776	708433	723523	739062	755063	771541	788511	805988	823990	842531	861631
Godavari river	935125	950594	966475	982777	999513	1016697	1034339	1052455	1071057	1090160	1109778	1129927	1150621
Kakinada canal	82275	84777	87360	90027	92780	95623	98558	101589	104719	107950	111288	114734	118293
Eluru canal	444138	453559	463248	473213	483464	494008	504855	516013	527493	539304	551455	563958	576824
Total Traffic Movement in 000 Tonne-km	2127251	2168471	2210858	2254450	2299281	2345390	2392816	2441599	2491780	2543403	2596511	2651150	2707368
Total Traffic Movement in Million Tonne-km	2127	2168	2211	2254	2299	2345	2393	2442	2492	2543	2597	2651	2707

Table 9.31

Cargo Movement in Option II during Phase I

Stretches of Waterway	Cargo Movement in 000 tonne												
	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Krishna river	1202	1958	2066	2105	2145	2186	2874	3017	3076	3138	3201	3968	4155
Godavari river	1826	2751	2792	2834	2877	2921	3931	3992	4055	4119	4185	5295	5380
Kakinada canal	437	700	771	794	818	842	1043	1135	1169	1204	1241	1478	1597
Eluru canal	959	1501	1565	1596	1627	1660	2190	2277	2323	2371	2420	3015	3129
Commamur canal	1119	1708	1781	1833	1887	1942	2586	2691	2769	2851	2934	3696	3840
North Buckingham canal	1119	1708	1781	1833	1887	1942	2586	2691	2769	2851	2934	3696	3840
South Buckingham canal & Kaluvelly tank	92	122	127	131	136	141	178	184	191	198	205	250	259
Total Traffic Movement in 000 Tonne	6754	10449	10883	11126	11376	11633	15388	15986	16353	16731	17119	21397	22200
Total Traffic Movement in Million Tonne	6.75	10.45	10.88	11.13	11.38	11.63	15.39	15.99	16.35	16.73	17.12	21.40	22.20

Stretches of Waterway	Cargo Movement in 000 tonne-km												
	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27
Krishna river	188748	307361	324306	330410	336690	343153	451185	473653	482987	492594	502481	622935	652283
Godavari river	312295	470506	477457	484590	491910	499422	672270	682676	693354	704314	715562	905371	920054
Kakinada canal	21840	35004	38561	39711	40897	42121	52127	56753	58460	60222	62040	73887	79851
Eluru canal	133352	208574	217501	221779	226178	230700	304417	316480	322921	329544	336354	419017	434978
Commamur canal	126406	193032	201302	207167	213215	219451	292272	304046	312948	322127	331594	417694	433913
North Buckingham canal	333354	509059	530868	546334	562283	578730	770771	801822	825296	849504	874470	1101529	1144300
South Buckingham canal & Kaluvelly tank	9209	12224	12663	13118	13590	14081	17768	18406	19068	19755	20468	24982	25882
Total Traffic Movement in 000 Tonne-km	1125203	1735759	1802658	1843108	1884762	1927656	2560811	2653835	2715034	2778059	2842969	3565413	3691260
Total Traffic Movement in Million Tonne-km	1125	1736	1803	1843	1885	1928	2561	2654	2715	2778	2843	3565	3691

Table 9.31

Cargo Movement in Option II during Phase I

Stretches of Waterway	Cargo Movement in 000 tonne												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	4240	4328	4419	4512	4608	4707	4809	4914	5022	5134	5248	5366	5488
Godavari river	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375	6490	6608	6729
Kakinada canal	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159	2226	2295	2366
Eluru canal	3195	3263	3333	3404	3478	3554	3632	3712	3795	3880	3967	4057	4150
Commamur canal	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146	5300	5459	5623
North Buckingham canal	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146	5300	5459	5623
South Buckingham canal & Kaluvelly tank	268	278	288	298	309	320	332	344	357	370	383	397	412
Total Traffic Movement in 000 Tonne	22724	23263	23819	24391	24981	25588	26214	26859	27524	28209	28914	29642	30391
Total Traffic Movement in Million Tonne	22.72	23.26	23.82	24.39	24.98	25.59	26.21	26.86	27.52	28.21	28.91	29.64	30.39

Stretches of Waterway	Cargo Movement in 000 tonne-km												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	665714	679541	693776	708433	723523	739062	755063	771541	788511	805988	823990	842531	861631
Godavari river	935125	950594	966475	982777	999513	1016697	1034339	1052455	1071057	1090160	1109778	1129927	1150621
Kakinada canal	82275	84777	87360	90027	92780	95623	98558	101589	104719	107950	111288	114734	118293
Eluru canal	444138	453559	463248	473213	483464	494008	504855	516013	527493	539304	551455	563958	576824
Commamur canal	446696	459881	473480	487506	501973	516896	532290	548170	564553	581453	598890	616879	635441
North Buckingham canal	1178014	1212784	1248646	1285635	1323788	1363143	1403739	1445618	1488820	1533390	1579373	1626815	1675764
South Buckingham canal & Kaluvelly tank	26815	27784	28789	29832	30914	32037	33202	34411	35666	36968	38319	39722	41177
Total Traffic Movement in 000 Tonne-km	3778777	3868920	3961774	4057423	4155956	4257466	4362048	4469798	4580818	4695214	4813093	4934566	5059750
Total Traffic Movement in Million Tonne-km	3779	3869	3962	4057	4156	4257	4362	4470	4581	4695	4813	4935	5060

Table 9.32

Cargo Movement in Option II during Phase II

	Cargo Movement in 000 tonne												
Stretches of Waterway	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**
Krishna river	1202	1958	2066	2105	2145	2186	2874	3017	3076	3138	3201	3968	4155
Godavari river	1826	2751	2792	2834	2877	2921	3931	3992	4055	4119	4185	5295	5380
Kakinada canal	437	700	771	794	818	842	1043	1135	1169	1204	1241	1478	1597
Eluru canal	959	1501	1565	1596	1627	1660	2190	2277	2323	2371	2420	3015	3129
Commamur canal	1119	1708	1781	1833	1887	1942	2586	2691	2769	2851	2934	3696	3840
North Buckingham canal	1119	1708	1781	1833	1887	1942	2586	2691	2769	2851	2934	3696	3840
South Buckingham canal & Kaluvelly tank	92	122	127	131	136	141	178	184	191	198	205	250	259
Total Traffic Movement in 000 Tonne	6754	10449	10883	11126	11376	11633	15388	15986	16353	16731	17119	21397	22200
Total Traffic Movement in Million Tonne	6.75	10.45	10.88	11.13	11.38	11.63	15.39	15.99	16.35	16.73	17.12	21.40	22.20

	Cargo Movement in 000 tonne-km												
Stretches of Waterway	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**
Krishna river	188748	307361	324306	330410	336690	343153	451185	473653	482987	492594	502481	622935	652283
Godavari river	312295	470506	477457	484590	491910	499422	672270	682676	693354	704314	715562	905371	920054
Kakinada canal	21840	35004	38561	39711	40897	42121	52127	56753	58460	60222	62040	73887	79851
Eluru canal	133352	208574	217501	221779	226178	230700	304417	316480	322921	329544	336354	419017	434978
Commamur canal	126406	193032	201302	207167	213215	219451	292272	304046	312948	322127	331594	417694	433913
North Buckingham canal	333354	509059	530868	546334	562283	578730	770771	801822	825296	849504	874470	1101529	1144300
South Buckingham canal & Kaluvelly tank	9209	12224	12663	13118	13590	14081	17768	18406	19068	19755	20468	24982	25882
Total Traffic Movement in 000 Tonne-km	1125203	1735759	1802658	1843108	1884762	1927656	2560811	2653835	2715034	2778059	2842969	3565413	3691260
Total Traffic Movement in Million Tonne-km	1125	1736	1803	1843	1885	1928	2561	2654	2715	2778	2843	3565	3691

Table 9.32

Cargo Movement in Option II during Phase II

Stretches of Waterway	Cargo Movement in 000 tonne												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	4240	4328	4419	4512	4608	4707	4809	4914	5022	5134	5248	5366	5488
Godavari river	5469	5559	5652	5747	5845	5946	6049	6155	6263	6375	6490	6608	6729
Kakinada canal	1645	1696	1747	1801	1856	1912	1971	2032	2094	2159	2226	2295	2366
Eluru canal	3195	3263	3333	3404	3478	3554	3632	3712	3795	3880	3967	4057	4150
Commamur canal	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146	5300	5459	5623
North Buckingham canal	3953	4070	4190	4314	4442	4574	4711	4851	4996	5146	5300	5459	5623
South Buckingham canal & Kaluvelly tank	268	278	288	298	309	320	332	344	357	370	383	397	412
Total Traffic Movement in 000 Tonne	22724	23263	23819	24391	24981	25588	26214	26859	27524	28209	28914	29642	30391
Total Traffic Movement in Million Tonne	22.72	23.26	23.82	24.39	24.98	25.59	26.21	26.86	27.52	28.21	28.91	29.64	30.39

Stretches of Waterway	Cargo Movement in 000 tonne-km												
	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40
Krishna river	665714	679541	693776	708433	723523	739062	755063	771541	788511	805988	823990	842531	861631
Godavari river	935125	950594	966475	982777	999513	1016697	1034339	1052455	1071057	1090160	1109778	1129927	1150621
Kakinada canal	82275	84777	87360	90027	92780	95623	98558	101589	104719	107950	111288	114734	118293
Eluru canal	444138	453559	463248	473213	483464	494008	504855	516013	527493	539304	551455	563958	576824
Commamur canal	446696	459881	473480	487506	501973	516896	532290	548170	564553	581453	598890	616879	635441
North Buckingham canal	1178014	1212784	1248646	1285635	1323788	1363143	1403739	1445618	1488820	1533390	1579373	1626815	1675764
South Buckingham canal & Kaluvelly tank	26815	27784	28789	29832	30914	32037	33202	34411	35666	36968	38319	39722	41177
Total Traffic Movement in 000 Tonne-km	3778777	3868920	3961774	4057423	4155956	4257466	4362048	4469798	4580818	4695214	4813093	4934566	5059750
Total Traffic Movement in Million Tonne-km	3779	3869	3962	4057	4156	4257	4362	4470	4581	4695	4813	4935	5060

Table 9.33

FIRR for Barge Operator in Option I during Phase I

Year	Capital Cost	Equity @ 20% of Capital Cost	Debt @ 80% of Capital Cost	Total EMI per annum @ 12% on debt for 20 year loan period																									Total Capital Cost including EMI	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)							
		Rs lakhs		Rs lakhs																									Rs lakhs								
1	18725	3,745	14980	1979																									5724	18725							
2	10725	2,145	8580	1979	1134																								5258	18101	10725						
3	1275	255	1020	1979	1134	135																							3503	17477	10368	1275					
4	550	110	440	1979	1134	135	58																						3416	16853	10010	1233	550				
5	600	120	480	1979	1134	135	58	63																					3489	16228	9653	1190	532	600			
6	725	145	580	1979	1134	135	58	63	77																				3591	15604	9295	1148	513	580	725		
7	10350	2,070	8280	1979	1134	135	58	63	77	1094																			6610	14980	8938	1105	495	560	701	10350	
8	1700	340	1360	1979	1134	135	58	63	77	1094	180																		5060	14356	8580	1063	477	540	677	10005	1700
9	850	170	680	1979	1134	135	58	63	77	1094	180	90																	4980	13732	8223	1020	458	520	653	9660	1643
10	850	170	680	1979	1134	135	58	63	77	1094	180	90	90																5070	13108	7865	978	440	500	628	9315	1587
11	850	170	680	1979	1134	135	58	63	77	1094	180	90	90	90															5160	12483	7508	935	422	480	604	8970	1530
12	11550	2,310	9240	1979	1134	135	58	53	77	1094	180	90	90	90	1221														6521	11859	7150	893	403	460	580	8625	1473
13	2425	485	1940	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256													6952	11235	6793	850	385	440	556	8280	1417
14	1275	255	1020	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135												6857	10611	6435	808	367	420	532	7935	1360
15	1275	255	1020	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135											6992	9987	6078	765	348	400	508	7590	1303
16	1450	290	1160	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153										7180	9363	5720	723	330	380	483	7245	1247
17	1275	255	1020	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135									7280	8738	5363	680	312	360	459	6900	1190
18	1325	265	1060	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140								7430	8114	5005	638	293	340	435	6555	1133
19	1450	290	1160	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153							7608	7490	4648	595	275	320	411	6210	1077
20	1575	315	1260	1979	1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166						7799	6866	4290	553	257	300	387	5865	1020
21	1700	340	1360		1134	135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166	180					6025	6242	3933	510	238	280	363	5520	963
22	1450	290	1160			135	58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166	180	153				4994	5618	3575	468	220	260	338	5175	907
23	1575	315	1260				58	63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166	180	153	166			5050	4993	3218	425	202	240	314	4830	850
24	1575	315	1260					63	77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166	180	153	166	166		5158	4369	2860	383	183	220	290	4485	793
25	2000	400	1600						77	1094	180	90	90	90	1221	256	135	135	153	135	140	153	166	180	153	166	166	211	5391	3745	2503	340	165	200	266	4140	737

Table 9.33

FIRR for Barge Operator in Option I during Phase I

Year	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)																
	Rs lakhs																
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9	850																
10	822	850															
11	793	822	850														
12	765	793	822	11550													
13	737	765	793	11165	2425												
14	708	737	765	10780	2344	1275											
15	680	708	737	10395	2263	1233	1275										
16	652	680	708	10010	2183	1190	1233	1450									
17	623	652	680	9625	2102	1148	1190	1402	1275								
18	595	623	652	9240	2021	1105	1148	1353	1233	1325							
19	567	595	623	8855	1940	1063	1105	1305	1190	1281	1450						
20	538	567	595	8470	1859	1020	1063	1257	1148	1237	1402	1575					
21	510	538	567	8085	1778	978	1020	1208	1105	1193	1353	1523	1700				
22	482	510	538	7700	1698	935	978	1160	1063	1148	1305	1470	1643	1450			
23	453	482	510	7315	1617	893	935	1112	1020	1104	1257	1418	1587	1402	1575		
24	425	453	482	6930	1536	850	893	1063	978	1060	1208	1365	1530	1353	1523	1575	
25	397	425	453	6545	1455	808	850	1015	935	1016	1160	1313	1473	1305	1470	1523	2000

Year	Total Useful Cost	Cost of Insurance	Fuel Cost	Repair & Maintenance Cost	Manpower Cost	Administrative Expenses	Total Cost	Traffic in Million Tonne km	Revenue @ Rs. 1.20 per Tonne-km	Net Cash Flow
	Rs lakhs						Rs lakhs		Rs lakhs	Rs lakhs
1	18725	281	3771	375	1024	64	11238	656	7908	-3331
2	28826	432	5862	589	1602	100	13849	1021	12308	-1541
3	29119	437	6080	615	1672	105	12411	1058	12747	336
4	28645	430	6188	626	1704	107	12470	1076	12972	502
5	28203	423	6299	638	1737	109	12695	1096	13203	508
6	27865	418	6413	652	1772	111	12957	1115	13441	484
7	37128	557	8504	859	2332	146	19007	1480	17834	-1173
8	37397	561	8792	893	2426	152	17884	1530	18431	547
9	36758	551	8955	910	2475	155	18026	1556	18771	745
10	36092	541	9123	927	2525	158	18344	1587	19119	776
11	35397	531	9295	944	2576	161	18667	1616	19478	811
12	45373	681	11617	1175	3203	200	25397	2021	24356	-1041
13	45840	688	12000	1224	3327	208	24399	2087	25150	751
14	45076	676	12232	1249	3397	213	24624	2127	25633	1010
15	44269	664	12471	1275	3468	217	25087	2168	26130	1044
16	43595	654	12716	1304	3541	222	25617	2211	26641	1024
17	42698	640	12966	1329	3617	227	26061	2254	27156	1105
18	41808	627	13226	1356	3694	232	26566	2299	27706	1140
19	40998	615	13495	1385	3774	237	27113	2345	28262	1149
20	40266	604	13759	1416	3856	242	27687	2393	28833	1147
21	39606	594	14052	1450	3941	247	26309	2442	29421	3112
22	38639	580	14342	1479	4028	253	25676	2492	30026	4350
23	37749	566	14641	1511	4118	259	26144	2543	30648	4504
24	36807	552	14948	1542	4210	265	26675	2597	31288	4613
25	36237	544	15265	1562	4305	271	27357	2651	31946	4589
									IRR	12%
						Levy charge per Tonne-km (in Rs)				1.20
						Levy charge per Tonne-km (in paise)				120

Table 9.34

FIRR for Barge Operator in Option I during Phase II

Year	Capital Cost	Equity @ 20% of Capital Cost	Debt @ 80% of Capital Cost	Total EMI per annum @ 12% on debt for 20 year loan period																								
	Rs lakhs			Rs lakhs																								
1	15050	3,010	12040	1591																								
2	8575	1,715	6860	1591	906																							
3	1050	210	840	1591	906	111																						
4	525	105	420	1591	906	111	55																					
5	350	70	280	1591	906	111	55	37																				
6	525	0	525	1591	906	111	55	37	69																			
7	8400	1,680	6720	1591	906	111	55	37	69	888																		
8	1400	280	1120	1591	906	111	55	37	69	888	148																	
9	525	105	420	1591	906	111	55	37	69	888	148	55																
10	700	140	560	1591	906	111	55	37	69	888	148	55	74															
11	525	105	420	1591	906	111	55	37	69	888	148	55	74	55														
12	9625	1,925	7700	1591	906	111	55	37	69	888	148	55	74	55	1017													
13	1925	385	1540	1591	905	111	55	37	69	888	148	55	74	55	1017	203												
14	700	140	560	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74											
15	1050	210	840	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111										
16	1225	245	980	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129									
17	875	175	700	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92								
18	1050	210	840	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111							
19	1225	245	980	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129						
20	1225	245	980	1591	906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129					
21	1225	245	980		906	111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129	129				
22	1225	245	980			111	55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129	129	129			
23	1225	245	980				55	37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129	129	129	129		
24	1225	245	980					37	69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129	129	129	129	129	
25	1400	280	1120						69	888	148	55	74	55	1017	203	74	111	129	92	111	129	129	129	129	129	129	148

Year	Total Capital Cost including EMI	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)							
	Rs lakhs								
1	4601	15050							
2	4212	14548	8575						
3	2818	14047	8289	1050					
4	2768	13545	8003	1015	525				
5	2770	13043	7718	980	508	350			
6	2769	12542	7432	945	490	338	525		
7	5337	12040	7146	910	473	327	508	8400	
8	4085	11538	6860	875	455	315	490	8120	1400
9	3965	11037	6574	840	438	303	473	7840	1353
10	4074	10535	6288	805	420	292	455	7560	1307
11	4094	10033	6003	770	403	280	438	7280	1260
12	6931	9532	5717	735	385	268	420	7000	1213
13	5594	9030	5431	700	368	257	403	6720	1167
14	5423	8528	5145	665	350	245	385	6440	1120
15	5604	8027	4859	630	333	233	368	6160	1073
16	5768	7525	4573	595	315	222	350	5880	1027
17	5790	7023	4288	560	298	210	333	5600	980
18	5936	6522	4002	525	280	198	315	5320	933
19	6100	6020	3716	490	263	187	298	5040	887
20	6229	5518	3430	455	245	175	280	4760	840
21	4767	5017	3144	420	228	163	263	4480	793
22	3990	4515	2858	385	210	152	245	4200	747
23	4008	4013	2573	350	193	140	228	3920	700
24	4082	3512	2287	315	175	128	210	3640	653
25	4228	3010	2001	280	158	117	193	3360	607

Table 9.34

FIRR for Barge Operator in Option I during Phase II

Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year) — Rs lakhs

Year																	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9	525																
10	508	700															
11	490	677	525														
12	473	653	508	9625													
13	455	630	490	9304	1925												
14	438	607	473	8983	1861	700											
15	420	583	455	8663	1797	677	1050										
16	403	560	438	8342	1733	653	1015	1225									
17	385	537	420	8021	1668	630	980	1184	875								
18	368	513	403	7700	1604	607	945	1143	846	1050							
19	350	490	385	7379	1540	583	910	1103	817	1015	1225						
20	333	467	368	7058	1476	560	875	1062	788	980	1184	1225					
21	315	443	350	6738	1412	537	840	1021	758	945	1143	1184	1225				
22	298	420	333	6417	1348	513	805	980	729	910	1103	1143	1184	1225			
23	280	397	315	6096	1283	490	770	939	700	875	1062	1103	1143	1184	1225		
24	263	373	298	5775	1219	467	735	898	671	840	1021	1062	1103	1143	1184	1225	
25	245	350	280	5454	1155	443	700	858	642	805	980	1021	1062	1103	1143	1184	1400

Year	Total Useful Cost	Cost of Insurance	Fuel Cost	Repair & Maintenance Cost	Manpower Cost	Administrative Expenses	Total Cost	Traffic in Million Tonne km	Revenue @ Rs. 1.07 per Tonne-km	Net Cash Flow
	Rs lakhs						Rs lakhs		Rs lakhs	Rs lakhs
1	15050	226	3742	301	782	43	9695	656	7009	-2687
2	23123	347	5823	473	1222	68	12143	1021	10905	-1234
3	23386	351	6032	494	1271	71	11036	1058	11298	262
4	23088	346	6139	504	1294	72	11124	1076	11497	373
5	22598	339	6249	511	1318	73	11261	1096	11702	441
6	22272	334	6362	522	1343	75	11405	1115	11912	508
7	29803	447	8437	690	1775	99	16784	1480	15806	-977
8	30053	451	8722	718	1841	102	15919	1530	16336	417
9	29383	441	8884	728	1876	104	15998	1558	16636	638
10	28869	433	9050	742	1913	106	16318	1587	16946	628
11	28158	422	9221	753	1950	108	16548	1616	17264	715
12	36528	548	11525	945	2431	135	22515	2021	21587	-928
13	36878	553	11904	984	2519	140	21694	2087	22291	597
14	35939	539	12134	998	2569	143	21806	2127	22719	913
15	35327	530	12371	1019	2621	146	22290	2168	23159	869
16	34854	523	12614	1043	2675	149	22771	2211	23612	841
17	33991	510	12864	1051	2730	152	23105	2254	24078	972
18	33273	499	13121	1082	2786	155	23578	2299	24556	978
19	32696	490	13365	1106	2844	158	24084	2345	25049	965
20	32078	481	13657	1131	2904	161	24563	2393	25555	992
21	31418	471	13937	1155	2966	165	23461	2442	26076	2616
22	30718	461	14225	1180	3029	168	23052	2492	26612	3560
23	29978	450	14521	1204	3095	172	23449	2543	27164	3715
24	29196	438	14825	1229	3162	176	23911	2597	27731	3820
25	28548	428	15139	1257	3231	179	24462	2651	28314	3852
									IRR	12%
							Levy charge per Tonne-km (in Rs)			1.07
							Levy charge per Tonne-km (in paise)			107

Table 9.35

FIRR for Barge Operator in Option II during Phase I

Year	Capital Cost	Equity @ 20% of Capital Cost	Debt @ 80% of Capital Cost	Total EMI per annum @ 12% on debt for 20 year loan period																									Total Capital Cost including EMI	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)							
	Rs lakhs			Rs lakhs																									Rs lakhs								
1	38225	7,645	30580	4141																									11786	38225							
2	20700	4,140	16560	4141	2188																								10469	36951	20700						
3	2725	545	2180	4141	2188	288																							7162	35677	20010	2725					
4	1525	305	1220	4141	2188	288	161																						7083	34403	19320	2634	1525				
5	1450	290	1160	4141	2188	288	161	153																					7221	33128	18630	2543	1474	1450			
6	1700	340	1360	4141	2188	288	161	153	180																				7451	31854	17940	2453	1423	1402	1700		
7	21650	4,330	17320	4141	2188	288	161	153	180	2288																			13729	30580	17250	2362	1373	1353	1643	21650	
8	3400	680	2720	4141	2188	288	161	153	180	2288	359																		10438	29306	16560	2271	1322	1305	1587	20928	340[illegible]
9	2250	450	1800	4141	2188	288	161	153	180	2288	359	238																	10446	28032	15870	2180	1271	1257	1530	20207	328[illegible]
10	2250	450	1800	4141	2188	288	161	153	180	2288	359	238	238																10684	26758	15180	2089	1220	1208	1473	19485	317[illegible]
11	2250	450	1800	4141	2188	288	161	153	180	2288	359	238	238	238															10922	25483	14490	1998	1169	1160	1417	18763	306[illegible]
12	24850	4,970	19880	4141	2188	288	161	153	180	2288	359	238	238	238	2627														18069	24209	13800	1908	1118	1112	1360	18042	294[illegible]
13	4800	960	3840	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507													14566	22935	13110	1817	1068	1063	1303	17320	283[illegible]
14	2350	470	1880	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248												14324	21661	12420	1726	1017	1015	1247	16598	272[illegible]
15	3575	715	2860	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378											14947	20387	11730	1635	966	967	1190	15877	260[illegible]
16	3575	715	2860	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378										15325	19113	11040	1544	915	918	1133	15155	249[illegible]
17	3350	670	2680	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354									15634	17838	10350	1453	864	870	1077	14433	238[illegible]
18	3450	690	2760	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365								16019	16564	9660	1363	813	822	1020	13712	226[illegible]
19	3875	775	3100	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410							16514	15290	8970	1272	763	773	963	12990	215[illegible]
20	3950	790	3160	4141	2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417						16946	14016	8280	1191	712	725	907	12268	204[illegible]
21	4125	825	3300		2188	288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417	436					13276	12742	7590	1090	661	677	850	11547	192[illegible]
22	3825	765	3060			288	161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417	436	404				11432	11468	6900	999	610	628	793	10825	181[illegible]
23	4425	885	3540				161	153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417	436	404	468			11732	10193	6210	908	559	580	737	10103	170[illegible]
24	4250	850	3400					153	180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417	436	404	468	449		11985	8919	5520	818	508	532	680	9382	158[illegible]
25	4675	935	3740						180	2288	359	238	238	238	2627	507	248	378	378	354	365	410	417	436	404	468	449	494	12411	7645	4830	727	458	483	623	8660	147[illegible]

Table 9.35

FIRR for Barge Operator in Option II during Phase I

Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year), Rs lakhs

Year																	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9	2250																
10	2175	2250															
11	2100	2175	2250														
12	2025	2100	2175	24850													
13	1950	2025	2100	24022	4800												
14	1875	1950	2025	23193	4640	2350											
15	1800	1875	1950	22365	4480	2272	3575										
16	1725	1800	1875	21537	4320	2193	3456	3575									
17	1650	1725	1800	20708	4160	2115	3337	3456	3350								
18	1575	1650	1725	19880	4000	2037	3218	3337	3238	3450							
19	1500	1575	1650	19052	3840	1958	3098	3218	3127	3335	3875						
20	1425	1500	1575	18223	3680	1880	2979	3098	3015	3220	3746	3950					
21	1350	1425	1500	17395	3520	1802	2860	2979	2903	3105	3617	3818	4125				
22	1275	1350	1425	16567	3360	1723	2741	2860	2792	2990	3488	3687	3988	3825			
23	1200	1275	1350	15738	3200	1645	2622	2741	2680	2875	3358	3555	3850	3698	4425		
24	1125	1200	1275	14910	3040	1567	2503	2622	2568	2760	3229	3423	3713	3570	4278	4250	
25	1050	1125	1200	14082	2880	1488	2383	2503	2457	2645	3100	3292	3575	3443	4130	4108	4675

Year	Total Useful Cost	Cost of Insurance	Fuel Cost	Repair & Maintenance Cost	Manpower Cost	Administrative Expenses	Total Cost	Traffic in Million Tonne km	Revenue @ Rs. 1.31 per Tonne-km	Net Cash Flow
	Rs lakhs						Rs lakhs		Rs lakhs	Rs lakhs
1	38225	573	6383	765	2098	133	21738	1125	14684	-7054
2	57651	865	9576	1179	3238	205	25532	1736	22652	-2880
3	58412	876	9954	1233	3378	214	22818	1803	23525	707
4	57882	868	10180	1264	3460	220	23074	1843	24053	978
5	57226	858	10412	1293	3545	225	23554	1885	24596	1043
6	56772	852	10651	1327	3632	231	24143	1928	25156	1013
7	76211	1143	14137	1760	4808	305	35882	2561	33419	-2463
8	76678	1150	14661	1828	5002	317	33397	2654	34633	1236
9	75883	1138	15002	1873	5126	325	33911	2715	35431	1520
10	75012	1125	15353	1918	5254	334	34668	2778	36254	1586
11	74066	1111	15715	1963	5386	342	35439	2843	37101	1662
12	95645	1435	19697	2460	6741	428	48829	3565	46529	-2300
13	96346	1445	20405	2556	7003	445	46420	3691	48171	1751
14	94437	1417	20893	2603	7181	456	46873	3779	49313	2440
15	93674	1405	21395	2674	7364	468	48253	3869	50489	2236
16	92793	1392	21912	2746	7553	480	49408	3962	51701	2294
17	91567	1374	22445	2813	7748	492	50505	4057	52949	2444
18	90329	1355	22994	2882	7946	505	51703	4156	54235	2532
19	89402	1341	23560	2959	8159	518	53047	4257	55560	2513
20	88420	1326	24143	3036	8369	532	54353	4362	56925	2572
21	87482	1312	24743	3121	8588	546	51586	4470	58331	6745
22	86106	1292	25362	3197	8814	561	50657	4581	59780	9123
23	85203	1278	26000	3286	9047	575	51918	4695	61273	9354
24	83977	1260	26657	3371	9288	591	53151	4813	62811	9660
25	83034	1246	27334	3464	9536	607	54597	4935	64396	9799

IRR	12%
Levy charge per Tonne-km (in Rs)	1.31
Levy charge per Tonne-km (in paise)	131

Table 9.36

FIRR for Barge Operator in Option II during Phase II

Year	Capital Cost	Equity @ 20% of Capital Cost	Debt @ 80% of Capital Cost	Total EMI per annum @ 12% on debt for 20 year loan period																									Total Capital Cost including EMI
		Rs lakhs		Rs lakhs																									Rs lakhs
1	29925	5,985	23940	3163																									9148
2	16100	3,220	12880	3163	1702																								8085
3	2100	420	1680	3163	1702	222																							5507
4	1225	245	980	3163	1702	222	129																						5461
5	1050	210	840	3163	1702	222	129	111																					5537
6	1225	245	980	3163	1702	222	129	111	129																				5701
7	16975	3,395	13580	3163	1702	222	129	111	129	1794																			10645
8	2625	525	2100	3163	1702	222	129	111	129	1794	277																		8052
9	1575	315	1260	3163	1702	222	129	111	129	1794	277	166																	8008
10	1750	350	1400	3163	1702	222	129	111	129	1794	277	166	185																8228
11	1575	315	1260	3163	1702	222	129	111	129	1794	277	166	185	166															8359
12	19775	3,955	15820	3163	1702	222	129	111	129	1794	277	166	185	166	2090														14089
13	3675	735	2940	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388													11257
14	2100	420	1680	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222												11164
15	2800	560	2240	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296											11600
16	2975	595	2380	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314										11949
17	2275	455	1820	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240									12049
18	2800	560	2240	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296								12450
19	2975	595	2380	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314							12799
20	2975	595	2380	3163	1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314						13113
21	3150	630	2520		1702	222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314	333					10318
22	2975	595	2380			222	129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314	333	314				8895
23	3325	665	2660				129	111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314	333	314	351			9094
24	3325	665	2660					111	129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314	333	314	351	351		9316
25	3500	700	2800						129	1794	277	166	185	166	2090	388	222	296	314	240	296	314	314	333	314	351	351	370	9610

Year	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)							
1	29925							
2	28928	16100						
3	27930	15563	2100					
4	26933	15027	2030	1225				
5	25935	14490	1960	1184	1050			
6	24938	13953	1890	1143	1015	1225		
7	23940	13417	1820	1103	980	1184	16975	
8	22943	12880	1750	1062	945	1143	16409	262
9	21945	12343	1680	1021	910	1103	15843	253
10	20948	11807	1610	980	875	1062	15278	245
11	19950	11270	1540	939	840	1021	14712	236
12	18953	10733	1470	898	805	980	14146	227
13	17955	10197	1400	858	770	939	13580	218
14	16958	9660	1330	817	735	898	13014	210
15	15960	9123	1260	776	700	858	12448	201
16	14963	8587	1190	735	665	817	11883	19
17	13965	8050	1120	694	630	776	11317	183
18	12968	7513	1050	653	595	735	10751	175
19	11970	6977	980	613	560	694	10185	166
20	10973	6440	910	572	525	653	9619	157
21	9975	5903	840	531	490	613	9053	148
22	8978	5367	770	490	455	572	8488	140
23	7980	4830	700	449	420	531	7922	131
24	6983	4293	630	408	385	490	7356	122
25	5985	3757	560	368	350	449	6790	113

Table 9.36

FIRR for Barge Operator in Option II during Phase II

Year	Useful Cost after Depriciation (Depriciating @ 1/30th of Capital Cost per year)																
	Rs lakhs																
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9	1575																
10	1523	1750															
11	1470	1692	1575														
12	1418	1633	1523	19775													
13	1365	1575	1470	19116	3675												
14	1313	1517	1418	18457	3553	2100											
15	1260	1458	1365	17798	3430	2030	2800										
16	1208	1400	1313	17138	3308	1960	2707	2975									
17	1155	1342	1260	16479	3185	1890	2613	2876	2275								
18	1103	1283	1208	15820	3063	1820	2520	2777	2199	2800							
19	1050	1225	1155	15161	2940	1750	2427	2678	2123	2707	2975						
20	998	1167	1103	14502	2818	1680	2333	2578	2048	2613	2876	2975					
21	945	1108	1050	13843	2695	1610	2240	2479	1972	2520	2777	2876	3150				
22	893	1050	998	13183	2573	1540	2147	2380	1896	2427	2678	2777	3045	2975			
23	840	992	945	12524	2450	1470	2053	2281	1820	2333	2578	2678	2940	2876	3325		
24	788	933	893	11865	2328	1400	1960	2182	1744	2240	2479	2578	2835	2777	3214	3325	
25	735	875	840	11206	2205	1330	1867	2083	1668	2147	2380	2479	2730	2678	3103	3214	3500

Year	Total Useful Cost	Cost of Insurance	Fuel Cost	Repair & Maintenance Cost	Manpower Cost	Administrative Expenses	Total Cost	Traffic in Million Tonne km	Revenue @ Rs.1.14 per Tonne-km	Net Cash Flow
	Rs lakhs						Rs lakhs		Rs lakhs	Rs lakhs
1	29925	449	6331	599	1542	86	18154	1125	12771	-5383
2	45028	675	9765	921	2378	132	21957	1736	19701	-2256
3	45593	684	10143	953	2477	138	19911	1803	20460	549
4	45214	678	10371	987	2536	141	20174	1843	20919	746
5	44619	669	10605	1008	2596	144	20560	1885	21392	832
6	44164	652	10846	1033	2659	148	21048	1928	21879	830
7	59418	891	14403	1372	3525	196	31031	2561	29065	-1966
8	59757	896	14928	1425	3661	203	29165	2654	30121	956
9	58958	884	15272	1456	3750	208	29579	2715	30816	1237
10	58281	874	15626	1491	3842	213	30275	2778	31531	1256
11	57371	861	15991	1523	3936	219	30888	2843	32268	1380
12	74608	1119	20048	1918	4931	274	42379	3565	40467	-1912
13	75087	1126	20758	1992	5116	284	40533	3691	41896	1363
14	73868	1108	21250	2034	5243	291	41090	3779	42889	1799
15	73278	1099	21756	2090	5375	299	42218	3869	43912	1694
16	72771	1092	22278	2149	5510	306	43283	3962	44966	1683
17	71464	1072	22815	2195	5649	314	44094	4057	46052	1958
18	70607	1059	23369	2251	5793	322	45243	4156	47170	1927
19	69831	1047	23939	2310	5941	330	46366	4257	48322	1956
20	68956	1034	24527	2370	6093	339	47475	4362	49509	2034
21	68157	1022	25132	2433	6250	347	45502	4470	50732	5230
22	67078	1006	25756	2492	6412	356	44918	4581	51992	7075
23	66249	994	26399	2559	6579	366	45990	4695	53291	7301
24	65310	980	27061	2625	6751	375	47108	4813	54629	7521
25	64435	967	27744	2695	6929	385	48329	4935	56007	7679
									IRR	12.23%
							Levy charge per Tonne-km (in Rs)			1.14
							Levy charge per Tonne-km (in paise)			114

CHAPTER 10
PROJECT CONSTRUCTION /IMPLEMENTATION

CHAPTER – 10

PROJECT CONSTRUCTION/IMPLEMENTATION

10.1 INTRODUCTION

Based on economic and financial evaluation of the present IWT project under consideration, two options have been found viable as cited below:

1. Option I (Kakinada canal + Eluru canal + Godavari River + Krishna River)
2. Option II (Total waterway)

The construction involvement for the respective options are as follows :

- Land Acquisition
- Dredging
- Bridges
- Locks
- Civil Works (Terminals etc.)
- Navigational Aids.

The implementation of the project for the two options has been discussed in the following paragraphs.

10.2 IMPLEMENTATION OF OPTION I

The Option I involves construction of bridges, protection measures, 8 (eight) terminals, dredging work and navigational aids. In order to complete these tasks over a period of five years, it is proposed to carryout entire construction work into different packages.

Tender for each package will be called from the contractors specialized in these works. The contractor shall have an experience of construction Project worth more than Rs. 100 crores with Project Manager of having minimum 10 to 15 years experience and a team of 6 full time supervisors including Environment and Social Specialist looking after the Environmental Management Plan (EMP). The Project Manager will report to Dy. Director posted in the regional office of IWAI at Vijayawada/Chennai. The organisation setup for regional office will be as follows :

S.NO.	PERSONNEL	NO.
1	Director	1
2	Dy. Director	2
3.	Asstt. Director	3
4	Asstt. Hyd. Surveyor	2
5	Acct. Officer	1
6	Section Officer	1
7	Tech. Asstt.	4
8	Jr. Hy. Surveyor	6
9	Jr. Acct. Officer	1
10	Acct. Asstt.	2
11	EDP Asstt.	1
12	Supervisor	8
13	Data Entry Opr.	1
14	Draftsman	2
15	UDC	1
16	Steno Gr.-II	2
17	Store Keeper	1
18	Tracer	2
19	LDC	3

20	Field Asstt.	6
21	Attendant	4

The regional office of IWAI will further report to Chief Engineer, Head Office who will be assisted by following officers.

S.NO.	PERSONNEL	NO.
1	Asstt. Director	1
2	Asst. Hy. Surveyor	1
3.	Tech. Asstt.	1
4.	Data Entry Operator	1

The work will be implemented by setting up a Committee comprising the following Institutes/Government Agencies:

- IWAI as nodal agency and will play a coordinating role – A Director Level Officer can be nominated, who will report to chairman and Vice Chairman
- Chief Secretary and Engineer-in-Chief of concerned State Irrigation Departments of A.P and Tamil Nadu.
- Apex Committee at District Level comprising the collectors/Mandal Revenue Officers of the districts, representative of Zilla Panchayat and Forest Department and Gram Panchayat etc.

The contractor will report to IWAI's Project Construction Management (PCM) Unit about the progress made, who will report to the Committee on Implementation of the project.

Manpower in each package during construction :

S.NO.	ITEM	MANPOWER
1	Project Manager	1
2	Dredging Expert	1
3	Environment & Social Expert	1
4	Construction Supervisor • Land Acquisition & Waterway Improvement • Lock/Bridge • Terminal • Billing • Asstt. Environment Specialist • Asstt. Social Specialist	6
	Total	9

The detailed Time Schedule to carry out the entire construction work for Option I is indicated in Table 10.1.

10.3 IMPLEMENTATION OF OPTION II

The Option II involves construction of bridges, protection measures, 15 (Fifteen) terminals, dredging work and navigation aids in the entire stretch of waterway. In order to complete these tasks over a period of five years, it is proposed to carryout entire construction work into two packages with sub packages working simultaneously.

The detailed Time Schedule to carry out the entire construction work for Option II is indicated in Table 10.2.

TABLES

TABLE - 10.1

DETAILED TIME SCHEDULE FOR CONSTRUCTION IN OPTION I

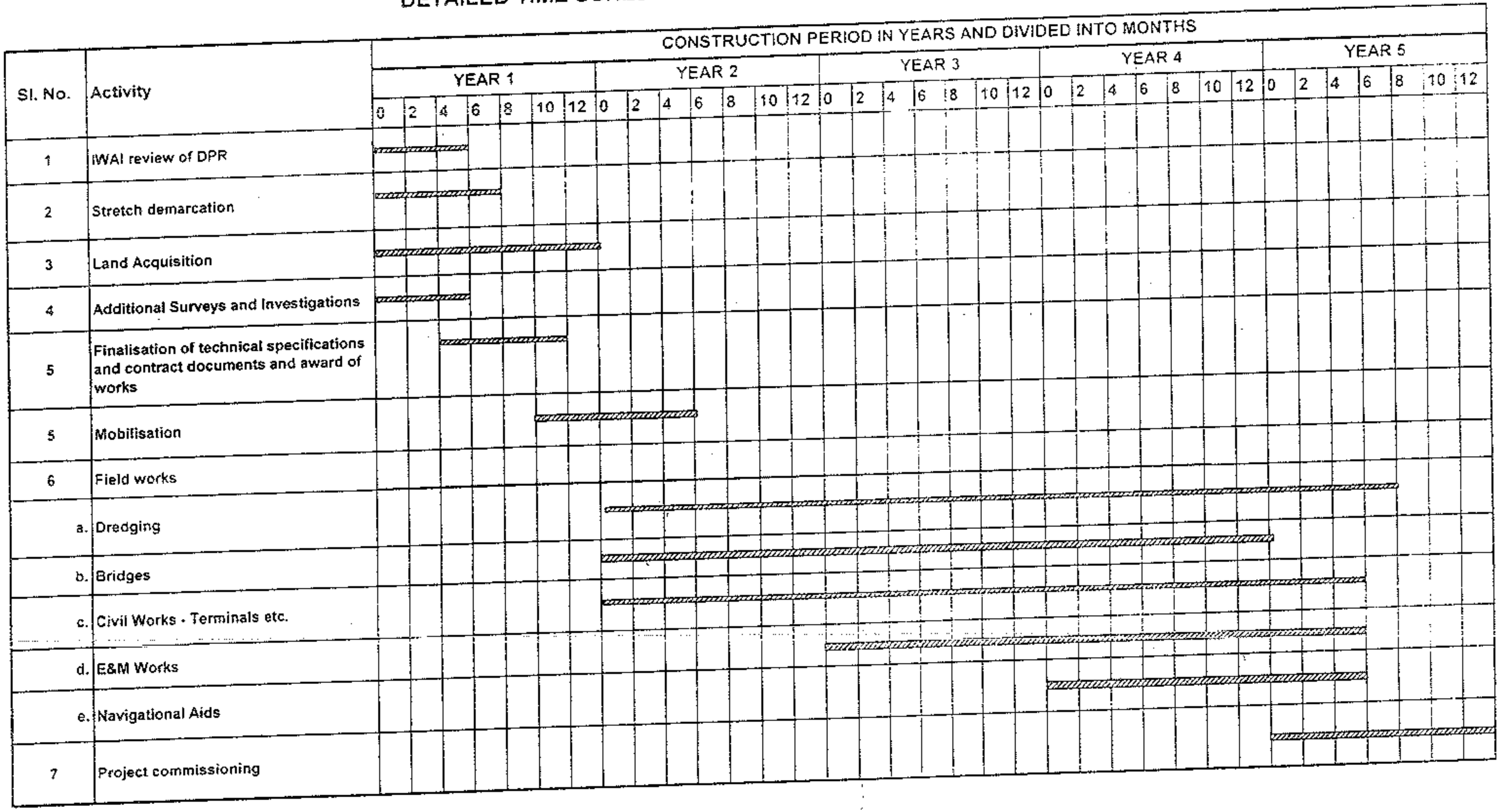


TABLE - 10.2
DETAILED TIME SCHEDULE FOR CONSTRUCTION IN OPTION II

Sl. No.	Activity	CONSTRUCTION PERIOD IN YEARS AND DIVIDED INTO MONTHS				
		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
		0 2 4 6 8 10 12	0 2 4 6 8 10 12	0 2 4 6 8 10 12	0 2 4 6 8 10 12	0 2 4 6 8 10 12
1	IWAI review of DPR					
2	Stretch demarcation					
3	Land Acquisition					
4	Additional Surveys and Investigations					
5	Finalisation of technical specifications and contract documents and award of works					
5	Mobilisation					
6	Field works for Option I					
a.	Dredging					
b.	Bridges					
c.	Civil Works - Terminals etc.					
d.	E&M Works					
e.	Navigational Aids					
7	Field works for remaining portion of Option II excluding Option I					
a.	Dredging					
b.	Bridges					
c.	Civil Works - Terminals etc.					
d.	E&M Works					
e.	Navigational Aids					
8	Project commissioning					

CHAPTER 11
CONCLUSIONS AND RECOMMENDATIONS

CHAPTER – 11

CONCLUSIONS & RECOMMENDATIONS

11.1 INTRODUCTION

With the consent of IWAI, the work of DPR study for the present waterway was undertaken by WAPCOS. After having carried out survey work and field investigations including traffic studies, engineering works required for development of waterway were analysed and proposed. Finally, the cost estimates for the present project were prepared and economic and financial evaluation of the project was carried out.

11.2 CONCLUSIONS

11.2.1 EIRR Inferences

Based on the economic and financial evaluation carried out, the computed EIRR for various options are summarized as under

S.No.	Options	EIRR	Reference
1.	Option I during Phase I	34.27%	Refer Table 9.6
2.	Option I during Phase II	25.84%	Refer Table 9.12
3.	Option II during Phase I	22.84%	Refer Table 9.18
4.	Option II during Phase II	29.48%	Refer Table 9.24

As inferred from the above table, the following conclusion are drawn as given below :

a. Among both the options considered, the Option I consisting of Kakinada canal, Eluru canal, Godavari river, Krishna river during Phase I development works out to be most attractive as it is gaining an EIRR of 34.27%.

b. The Option II consisting of entire stretch of waterway during Phase II development qualify for economic viability as it is commanding an EIRR of 29.48%.

11.2.2. FIRR Inferences

The computed FIRR for Government/IWAI for various options are summarized as under :

S.No.	Weighted cost of capital	3%	6%	12%	
	Options	Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital			Reference
1.	Option I –Phase I	13	19	36	Refer Table 9.25 (a) to (c)
2.	Option I –Phase II	36	46	77	Refer Table 9.26 (a) to (c)
3.	Option II –Phase I	31	43	81	Refer Table 9.27 (a) to (c)
4.	Option II –Phase II	27	35	60	Refer Table 9.28 (a) to (c)

The computed FIRR for user/barge operator for various options are summarized as under :

S. No.	Options	Levy Charge (Rs. per Tonne - km) to earn an IRR of 12%	Reference
1.	Option I during Phase I	1.20	Refer Table 9.33
2.	Option I during Phase II	1.07	Refer Table 9.34
3.	Option II during Phase I	1.31	Refer Table 9.35
4.	Option II during Phase II	1.14	Refer Table 9.36

The following conclusion are drawn from the above table as given below :

a. To earn FIRR of 3% by Govt./IWT, the levy charges work out to be minimum as 13 Paise per Tonne - km for Option I – Phase I and maximum as 36 Paise per Tonne - km for Option I – Phase II.

b. To earn FIRR of 6% by Govt./IWT, the levy charges work out to be minimum as 19 Paise per Tonne - km for Option I – Phase I and maximum as 46 Paise per Tonne - km for Option I – Phase II.

c. To earn FIRR of 12% by Govt./IWT, the levy charges work out to be minimum as 36 Paise per Tonne - km for Option I – Phase I and maximum as 81 Paise per Tonne - km for Option II – Phase I.

d. For user/barge operator, the cargo fare to be charged for earning 12% FIRR works out to be minimum as 107 paise per Tonne - km for Option I during Phase II development and maximum as 131 paise per Tonne - km for Option II during Phase I development.

e. Taking into view of highly favorable EIRR for Govt./IWAI and levy charges exceeding Rs. 1.00 per Tonne-km for all the Options to earn an IRR of 12% by barge operator, it is concluded that the charges for using terminal and other infrastructural facilities may be absorbed so as to attract users to avail IWT facility.

f. Taking overview of all the activities associated with the development of proposed waterway, it is understood that the barge building facility is the activity that can be taken up under private sector participation/BOT/JV basis.

11.3 RECOMMENDATIONS

On the basis of conclusions discussed in previous para, it is understood and recommended that the Option I consisting of 14 m wide channel in Kakinada & Eluru canal and 32 m wide channel in Godavari & Krishna river during Phase I development is economically viable and most attractive as it is commanding an EIRR of 34.27% thus contributing to valuable national upgradation. Moreover, the user/barge operator has sufficient scope to use the recommended option of present waterway by charging 120 paise per Tonne - km in comparison to road. Taking into account the past experience of IWAI for not taking levy charges from barge operator in NW I and NW 2, it may be proposed that IWAI may not charge or charge on a nominal basis such as 5 paise per Tonne - km so as to attract the barge operator to use the proposed IWT facility. In order to attract users and operators to IWT mode, following short term and long term measures are proposed.

Short Term and Long Term Measures for sustenance of IWT

The measures to be instituted are meant to encourage cargo owners/users use IWT mode of transport, in order to do this the following aspects require to be contemplated as short and long term measures.

Short term measures

- To trigger shift from road/rail modes to IWT mode, accessibility to terminals need to be improved, by way of extending road and rail access to respective terminals ensuring uninterrupted access to cargo origin/destination.
- All measures on the river routes for ensuring uninterrupted barge movement of optimum speed levels. These measures shall include river bank supervision, continuous river patrolling, advanced level of signaling and other indicators, midway fueling systems to prevent exigencies.
- Midway attendance to minor repairs, upkeep and touch-ups to barges to ensure uninterrupted operational sustenance.
- After initial IWT operation examine reasons as to any aspects that seem to retard/inconvenience users. These could be :
    - ➢ Additional cargo storage required space needed by cargo owners
    - ➢ Isolation of cargo storage of different users, which would mean additional storage space covered and open as per cargo complexion
    - ➢ Berthing and deberthing time to be reduced to minimum by standardizing the operations over a period of time
    - ➢ Provide bunkering facility at each terminal ensuring no-delay in barge movement on this account
    - ➢ Obtain views of cargo owners/barge owners on terminal provisions and study their suggestions for implementation
    - ➢ Discuss with industries towards increased use of IWT so as to elicit their contribution to fuel saving by IWT at national level and cause release of capacity on road and rail modes for more qualifying cargo
    - ➢ Provide vessel building subsidy and freight subsidy

Long Term Measures

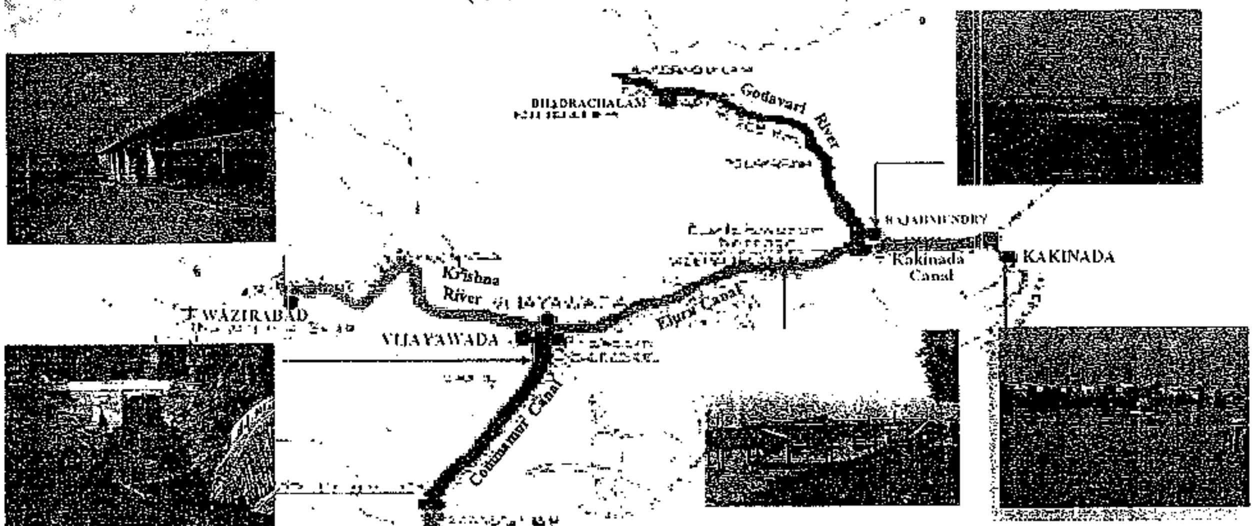
- IWAI shall have to initiate discussions with the following agencies forming a complexion of cargo senders, and users, and major level transporters for ensuring their attention on use of IWT and to show preference to it
    - TNEB
    - Mining authorities like Coalfields Co.
    - NTPC
    - Other Power Station Authorities
- It is quite possible that cargo receivers are continuing their programmes to make new investments on rail/road receiving/dispatch systems which may cause encouragement for continuance of existing modes (non-IWT) even for additional and futuristic requirements.
- In pursuance of the above towards firmly obtaining guarantee/assurance/preference for use of IWT for large volumes of their cargo on saturation of receiving and handling original capacities through rail/road and to shift to IWT, IWAI can promote discussions which can result in certain agreement to this effect among the parties.
- Discuss possibility of levying surcharge on freight by rail for movement of cargo when the IWT mode exists in a certified manner on the O-D of the cargo
- For enforcing this type of levy by railways, IWAI may bring certification procedures for the O-D of IWT the river/canal occupancy levels, terminal capacities and fitness to handle cargo etc. in the O-D of the cargo. Such certification has to be made official so that

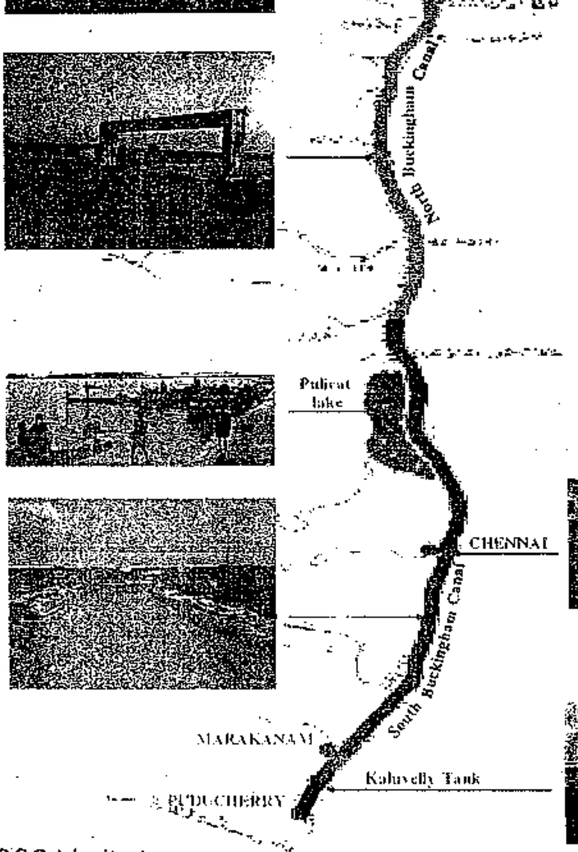
railways can consider levying surcharge with violation to the rights of the cargo own/transporter.

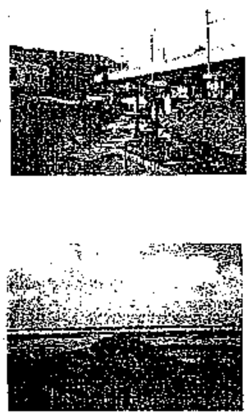
- Propose to Government of India that when clearing projects of public/private authorities, that if considerable level of material transport is involved, the project authorities shall mandatorily examine use of IWT for transport purposes in the region of their project and in the O-D of material movement while proposing for approval. Preference shall be given the involvement/use of IWT in the project objectives when proposed.

INLAND WATERWAYS AUTHORITY OF INDIA

MINISTRY OF SHIPPING, ROAD TRANSPORT & HIGHWAYS
(GOVERNMENT OF INDIA)







DETAILED PROJECT REPORT

for

DEVELOPMENT OF NAVIGATION

in

KAKINADA - PUDUCHERRY CANAL ALONGWITH RIVER GODAVARI AND KRISHNA (NATIONAL WATERWAY-4)

FINAL REPORT

VOLUME-I

EXECUTIVE SUMMARY

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ISO 9001 : 2000

March, 2010

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VOLUME – I : EXECUTIVE SUMMARY

VOLUME – II : MAIN REPORT

EXECUTIVE SUMMARY

1 INTRODUCTION

Till 1975, there had been an active navigation in the integrated canal waterway viz. Kakinada Canal, Eluru Canal, Commamur Canal, Buckingham Canal interlinking the two major rivers Krishna and Godavari in Andhra Pradesh. In 1987-89, the studies for techno-economic feasibility on rivers Godavari and Krishna were carried out for development of Inland Water Transport. The navigation in isolation was not found promising due to in adequate cargo potential. Studies also revealed that if navigation was linked with the existing irrigation cum navigation canals connecting Chennai and Kakinada, there is possibility of increasing the cargo potential through the integrated canal system. Subsequently Irrigation and Command Area Development (CAD) department of Andhra Pradesh (AP) requested Inland Waterways Authority of India (IWAI) to explore the possibilities of development of IWT on the integrated waterway system canals alongwith rivers falling in the areas of A.P. and Tamil Nadu (T.N.). IWAI got the studies for development of IWT on integrated canal linking Kakinada and Chennai done during 1993-95.

Studies conducted by IWAI through RITES have also strongly emphasized the need to develop a viable and reliable Inland Waterway compared to the available modes of transport like-rail and road, to carry the cargo from Kakinada to Markanam alongwith river Godavari and Krishna to serve the needs of Andhra Pradesh, Tamilnadu, Puducherry and hinterland and other consumer destinations as well as to support international trade with link to the seaport. The findings of the earlier studies have indicated technical viability in this stretch of Kakinada-Puducherry via Eluru Canal, Kakinada Canal, Commamur Canal, Buckingham Canal and Kalluvelly tank alongwith rivers Krishna and Godavari (Total length 1078 km). IWAI has therefore proposed that the waterway along this stretch of 1078 Km. would be declared as a National Waterway No. 4. IWAI simultaneously decided to get the DPR prepared for this National Waterway.

2 TERMS OF REFERENCE FOR DPR

IWAI has assigned the task of preparation of Detailed Project Report (DPR) to Water and Power Consultancy Services (I) Ltd. (WAPCOS) for development of navigation in Kakinada Puducherry canal alongwith river Godavari and Krishna, vide work order no. IWAI/HY/13(25)/2004 dated 26.10.2005 towards taking investment decisions and implement the project for execution.

The objective of the study are:

1. To conduct detailed investigations for the final design, to ensure a coordinated development to cover river and canal engineering works and structures, river and canal crossings, navigation structures, riverine ports and terminals, land and rail access.

2. To select and upgrade to preliminary engineering and cost standards of the structures with navigation by pass channel, locks and other structures

3. Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.

4. To suggest a phased programme of construction including river and canal terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities so that navigation shall have priority;

5. To conduct a full economic and financial analysis of the costs and benefits of the alternatives indicated, independently as also in an integrated package in one stage or in phases. This analysis shall indicate the project parameters such as economic rate of return, cost/benefit ratios, cash flows and an assessment of the sensitivity of these parameters to changed inputs.

Detailed Terms of Reference has been given in Chapter 1 of Volume II : Main Report.

In pursuance of the studies, WAPCOS Ltd. has carried out detailed Hydrographic, topographic surveys and Traffic surveys and selection of Terminals locations. WAPCOS Ltd. have been constantly interacting with IWAI and also accompanied them in meetings with concerned State Governments.

The salient features of the Final Detailed Project Report prepared are explained here under in the executive summary.

3 BACKGROUND

In order to give a boost to inter state movement of various products a canal system was planned in the late 19th century. The canal system running between Kakinada in the state of Andhra Pradesh to Markanam in the state of Tamilnadu near Puducherry was looked upon as one of the greatest link in the total area linking Kakinada Port with Chennai Port. The canals covered in the portions are Kakinada Canal, Eluru Canal, Commamur Canal and Buckingham Canal. These canals integrated with rivers Godavari and Krishna provided uninterrupted navigational link till 1975. Out of these, the Kakinada Canal, Eluru Canal and Commamur Canal are irrigation-cum-navigational canals with interlinkage with rivers Godavari and Krishna; while Buckingham Canal is a tidal canal with sea confluences at many places and was constructed during Eighteenth Century exclusively for Navigation purposes. In this canal waterway, the major commodities used to be transported were rice, salt, sand, forest products, paddy, pulse, building materials etc. by country crafts of 30 to 40 tonnes capacity. Over the years, due to simultaneous development of railways and road network the canal system could not be utilised to the extent envisaged. This has resulted into canal system losing its existence.

Moreover, the irrigation canals are still being maintained by the State Government of Andhra Pradesh but Buckingham Canal is silted up heavily without any proper maintenance and usage. It was unable to pay for its own upkeep and maintenance

and started silting up badly and slowly went out of use. Obvious reasons for this condition can be traced out to then newly created alternative mode of cheaper transport infrastructure and technology available as compared to IWT, which was basically old. Though certain stretches of this integrated system of canals and rivers are still being used by people for movement of sand ,agricultural and other cargo alongwith passengers by country boats, most part of the canal and its control structures are commonly found out of use and need repair if the system is to be put back in use.

The Godavari river system which flows along the Bhadrachalam forests and coal deposits; and Krishna river system which flows along the limestone deposits and cement industries at Jaggayyapetta, however is navigable or can be made navigable without any effort for almost 8 months of the year. However, lean season navigation would have to be carried out after adoption of certain regulatory measures.

4 PROPOSED WATERWAY AND ITS PRESENT STATUS

The waterway under consideration comprises the canal section and the river section. The "river section "is combination of two rivers namely, Godavari and Krishna. The Godavari river portion is from Bhadrachalam to Dowleiswaram at Rajahmundry. The Krishna river portion is from Wazirabad to Prakasam Barrage at Vijayawada. The "canal section" is the combination of the Kakinada Canal, Eluru Canal, Commamur Canal and Buckingham Canal. The Kakinada canal runs from Dowleiswaram in Rajahmundry on the left bank of the river Godavari through a head sluice and lock to Kakinada (approx. 5 km downstream from Kakinada Port).The canal gets water from the river Godavari in Dowleiswaram barrage and thereafter connects Kakinada anchorage port. It connects the 'River section' of Godavari from Bhadrachalam to Rajahmundry. The Eluru canal comprises two distinct irrigation-cum – navigation canals namely, Krishna Eluru Canal of Krishna Eastern Delta and Godavari Eluru Canal of Godavari western delta. The Krishna Eluru canal takes off from the 'River section' on the left bank of Krishna river on the upstream of Prakasam barrage through a head sluice at Vijayawada and meets Godavari Eluru Canal at east Tammileru lock at Eluru.The Godavari Eluru Canal takes off from the 'River section' of river Godavari at Vijjeswaram in Rajahmundry on the upstream of Dowleiswaram anicut through a head sluice and joins Krishna Eluru canal at East Tammileru lock. The Commamur canal takes off from 'River section' in river Krishna in Vijayawada on the right side upstream off Prakasam Barrage through a head sluice at Seethanagaram and joins Buckingham Canal at Peddaganjam Lock near Ongole. The Buckingham Canal is a tidal canal taking off from Peddaganjam lock and connecting to Chennai and further down South upto Markanam. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused by daily variation of tides. Locks serve another purpose of creation of impounding facility to retain high water level in the canal between low tides and also during the periods when sea bars are closed. The Buckingham canal from Peddaganjam lock to Chennai is called North Buckingham canal and from Chennai to Marakanam it is called South Buckingham canal. The

Kalluvelly Tank is an open swamp/tank connecting Markanam to the Sea at Puducherry. A key map of the waterway system is at Annexure-1.

The proposed waterway comprise of the following stretches:-

a)	Kakinada Canal(Kakinada to Rajahmundry)	50 km
b)	Eluru Canal (Rajahmundry to Vijayawada)	139 km
c)	Krishna river (Wazirabad to Vijayawada)	157 km
d)	Godavari river (Bhadrachalam to Rajahmundry)	171 km
e)	Commamur Canal (Vijayawada to Peddaganjam)	113 km
f)	North Buckingham Canal (Peddaganjam to Central Station of Chennai)	316 * km
g)	South Buckingham canal (Central Station of Chennai to Marakanam)	110 * km
h)	Marakanam to Puducherry through Kaluvelly tank	22 km
	Total length of waterway -	**1078 km**

* It may be noted in earlier draft report that the North and South Buckingham canals were indicated for a length of 340km and 103km respectively.However after carrying out detailed analysis based on Delineation survey of Buckingham canal carried out by Government of TamilNadu during 2006-07,the corresponding lengths for the North and South Buckingham canals have been changed to 316km and 110km respectively.

A stretch of 50 km from Ennore South to Muthukadu [18km of North Buckingham Canal (Ennore South to Central Station of Chennai) and 32 km of South Buckingham canal (Central Station of Chennai to Muthukadu)] in Tamilnadu is not considered for waterway development. In this stretch multi-modal cargo transfer is proposed.

A stretch of approx. 2 km falls in Puducherry, out of the total stretch of 22 km from Marakanam to Kalluvelly tank.

A stretch of 258 km falls in Andhra Pradesh out of the total stretch of 316 km of North Buckingham Canal.

A stretch of 39 km of North Buckingham canal (excluding 18 km stretch from Ennore South to Central Station of Chennai) and 78 km of South Buckingham Canal (excluding 32 km stretch from Central Station of Chennai to Muthukadu) has been considered in Tamilnadu.

Thus the length of stretches of the waterway in the two States of Andhra Pradesh and Tamil Nadu are as follows:

State	Stretches	Total length (km)	Length included in the proposal for development (km)
Andhra Pradesh	Kakinada canal, Eluru Canal, Commamur canal, Godavari river, Krishna river and North Buckingham canal (Peddaganjam to Andhra Pradesh – Tamil Nadu border at Tada)	888	888
Tamil Nadu	North Buckingham canal (AP-TN border at Tada to Basin Bridge), South Buckingham canal and Kalluvelly tank	188	138
Puducherry	Southern portion of Kalluvelly tank – Puducherry link	2	2
TOTAL		1078	1028

* Excluding 50 km stretches of North and South Buckingham canals as explained earlier.

A detailed topographic and Thalweg survey was carried out for the entire length of the canals i.e. from Kakinada to Puducherry and river systems (Refer enclosed Index Map). The survey of the canal and the river indicated that the canals have been silted at many places due to lack of maintenance. The embankments on either bank of some of the canals are also leveled in some parts. Number of low level temporary bridges have been constructed over the canal at numerous locations owing to local requirements which have made navigation in canal difficult. The control structures are seen damaged except in Eluru Canal. In some places cross-drainage works have also seen developed. All these factors are carefully considered while proposing future development of Kakinada-Puducherry canals.

In so far as the river section is concerned, depth availability in the lean season from Wazirabad to Vijayawada (Krishna river)can be achieved by constructing a water retaining structure such as barrage or dam and by putting bed regulations. There is a dam being constructed at Pulichintala near Jaggayyapeta, 85km upstream of Vijayawada. The navigational locks will be provided for continuous uninterrupted navigation by Govt. of A. P. Similarly in Godavari river from Bhadrachalam to Rajahmundry, depth availability in the lean season can be achieved from the Pollavaram Dam (44km upstream of Rajahmundry) under construction. However, the existence of rapids between Bhadrachalam and Rajahmundry in river Godavari would have to be adequately taken care of before the navigation in the lean season is taken up.

Kalluvelly Tank is a vast lagoon situated near the eastern coast of the Tindivanam taluk of south Arcot District. It is about 10.5 km in width and about 12.80 km in length. It connects itself with Yedi Anthittu swamp, through a tidal creak about 8 km in length, which it turn links itself to the sea at about 10 km. north of Markanam. This swamp is full of water during rainy season and dry for the remaining part of the year. A further portion near sea for around 2.5 Km. is almost dry with high grasses and a causeway connecting villages of both banks. It ultimately ends at sea near "All India Institute of Medical Sciences" in Puducherry.

A brief description about different stretches of the proposed waterway is given in following paragraphs.

(a) Godavari River

The least available depth in Godavari river from Bhadrachalam to Rajahmundry (171 km) is between 0.5 to 1.5 m in the leanest period, marked by narrow and meandering condition near Pollavaram and wider reaches of 100 m to 500 m wide near Rajahmundry. The river bed consists of rock out crops and braided water flow. The river portion between Bhadrachalam and Rajahmundry is navigable by country boats and motor launches of about 40 tons capacity upto Tolagudem (31 Km. u/s of Venkatapuram). These crafts require a minimum of 1.2 m depth of water. The waterway depth available in the stretch from Bhadrachalam to Kunavaram is 1 m to 10.5 m and width is from 100 m to 900m. The waterway depth from Kunavaram to Pochavaram is from 1 m to 10 m with bed width of 100 m to 500 m. It is free from rock outcrops whereas the portion from Bhadrachalam to Kunavaram is full of rock outcrops. The portion from Pochavaram to Polavaram is having depth from 1 m to 15 m and bed width from 180 m to 500 m. At Polavaram a Dam is under construction. The dam is planned to have live storage capacity of 2100 million cu.m which is provided for between FRL +45.72 m and LWL of +41.15 m . The backwater effect of the dam is upto Bhadrachalam. The depth will increase to more than 2.5 m. The rock out crops which otherwise would have required dredging in hard rocks will also pose no navigational hindrance, once the Pollavaram Dam comes up. Thus a vessel of 500 t will easily ply in this stretch. Beyond Pollavaram upto Rajahmundry, the river width increases to 250 m to 850 m. and a depth of 0.5 m to 10.0 m is available with coarse sand at its bed.

The Pollavaram Dam will submerge the areas upstream of river in Kunavaram and Bhadrachalam. Water released from the Pollavaram Dam downstream will flow in to the right canal and left canal . The design discharge capacities of these canals are 2670 million Cu. m. (RBC) and 3090 Cu. m. (LBC) respectively. In the DPR for Pollavaram Dam, uninterrupted navigation from Rajahmundry to Bhadrachalam has been envisaged. The scheme provides for separate lock channel (navigational canal) on the left bank linking up the reservoir with the downstream side of the Dam through three high lift locks to negotiate the level differences from +41.0 m to +13.5 m. Since the DPR covers the required navigational aspects, no separate study on the effect of Pollavaram dam is considered necessary. The Dam is under construction but with many obstructions. For rehabilitation and environmental problems, the project is getting delayed. Once the construction of superstructure comes up, the Dam

construction authorities have to abide by the standards laid down by IWAI for uninterrupted continuation of navigation.

(b) Krishna River

The Krishna river in the portion between Wazirabad and Vijayawada (157 km) gets water from Nagarjuna Sagar Dam. This is a prime source of water for downstream navigation. This stretch runs through rocks and steep slope upto Pulichintala (at Chainage 71.20 Km) i.e. around 85 Km. upstream of Prakasam Barrage. A Dam is being constructed in Pulichintala by the Govt. of Andhra Pradesh exclusively for irrigation purposes and for generating power of 60MW.

The river stretch can therefore be categorized into two distinct regions i.e. Wazirabad to Pulichintala (62 Km.) and Pulichintala to Vijayawada (95 Km.)

The water requirement for the design channel depth of 1.8 m is 114 cumecs. This quantity is exclusive of water losses. If losses are added, the requirement will be 125 cumecs of water. The analysis of CWC records at Pondugala indicate that adequate discharge is available. Only small waterway improvement works (dredging and rock cutting) will be required for navigation by the designed vessel. However Nagarjuna Sagar Dam authorities should ensure daily uninterrupted supply of 125 cumecs. for smooth navigation exclusively. If discharge is less, the navigation through rocky reaches would call for elaborate river training and control measures. The temporary measures are bandalling, bottom paneling and maintenance dredging. The permanent measures are construction of spurs, groynes, bank revetment, capital dredging. The river training measures need careful scientific model study to provide required depth in the designed channel. In absence of the study, the only recommendation is to restrict to dredging and rock blasting.

The next reach between Pulichintala dam and Vijayawada is through plains and a number of secondary channels. Water spread area is more with exposed shoals and islands. The calculated discharge for existing channel with 1.5 m depth is 140 cumecs. Adding the losses (evaporation, seepage, runoff etc.),the required discharge is 150 cumecs. Pulichintala Dam is under construction. The Dam authorities should ensure 150 cumecs release downstream daily for ensuring un-interrupted navigation for maintaining 1.8 m depth. Besides they will be providing a lock arrangement for the purpose. IWAI may have to pursue and coordinate the matter.

(c) Kakinada canal

This canal runs from Kakinada to Rajahmundry for a length of 50 km. The depth required to be maintained is 1.6 m in Phase I and 2.0 m in Phase II. The Kakinada canal has adequate flow for navigational purposes excepting in some tail reaches. The water depth of 1.6 m will be available for a period of around 310 days in a year. The canal would remain closed for remaining days of the year for maintenance purposes. The dredging would be carried out in order to cater to the depth required for both phases.

(d) Eluru canal

From Vijayawada to Vijjeswaram lock at Sir Arthur Cottan Barrage the Eluru Canal runs for a total distance of 139 Kms. The canal comprises of two distinct irrigation cum navigation canals viz : Krishna Eluru Eastern Delta Main Canal, and Godavari Eluru Western Delta Main Canal

The Krishna Eluru Eastern Delta Main Canal takes off on the left bank of Krishna river on the upstream of Prakasam barrage through a head sluice. The Godavari Eluru Western Delta Main canal takes off from river Godavari at Vijjeswaram on the upstream of Dowleiswaram anicut through a head sluice. There are three locks, and many bridges (railway foot, road bridges, aqueducts) along the whole Eluru canal.

The required water depth of minimum 1.6 m will be available for a period of about 75 days in a year as estimated. The canal will be closed for maintenance works for about 55 days in a year. The tail reach of the canal also needs some manual excavation/dredging.

(e) Commamur canal

The 113 km long Commamur Canal from Vijayawada Seethanagram lock to Peddaganjam lock is totally dependant upon the release of water from Prakasam Barrage. The Canal is navigable at a depth of 1.6 m for a period of seven and a half months only. To make the whole canal navigable for 330 days in a year, the State Government of A.P. should release the water from Nagarjuna Sagar Dam (about 190 Km. upstream of Prakasam Barrage) during the remaining period. Alternatively, the depth of 1.6 m can be maintained by releasing the water from Pulinchintala Dam under Construction (85 Km. upstream of Prakasam Barrage).

(f) Buckingham canal

The Buckingham canal is a tidal canal. It was constructed during 19th century along the Coromandal Coast. The main purpose of the canal was to have a lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately upto the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused by daily variation of tides. Locks serve another purpose of creation of impounding facility to retain high water level in the canal between low tides and also during the periods when sea bars are closed. After various stages of improvements and construction of lock chambers, and surplus escapes for drainage, the canal carries only Salt Water. The canal has been divided into two portions, viz North Buckingham Canal, and South Buckingham Canal.

The North Buckingham Canal of a total length of 316km starts off after Peddaganjam Lock in A.P (where Commamur Canal ends) and ends at Central Station of Chennai in Tamil Nadu, from where the South Buckingham canal starts .The South Buckingham Canal of a total length of 110 Km ends at Kovalam North River lock in Marakanam.

North Buckingham canal from Ramperu lock has a bed width ranging from 15 m to 30 m. At present the condition of North Buckingham Canal is such that it remains almost dry. The banks have eroded. There are many salt pans all along the canal. During March to July every year, the canal remains totally dry. There are several confluences of rivers i.e. Paleru, Manneru, Musi and Pennar along the North Buckingham Canal. The range of the tide is about 0.7 to 1.0m.

The South Buckingham Canal is also a tidal canal. It has sea openings at seven places viz. Marina beach, Adyar, Muthukadu, Kalpakkam (Ediyuru), Palar, Paramankani Kuppam and Markanam. Locks are provided in the canal near sea openings to control the tidal flow and retain the desired water level in the canal. Sand bars have been provided at these openings due to which it remains closed for about seven months in a year. There are confluences of rivers Cooum and Adyar in Chennai city along the South Buckingham Canal. But as these rivers are rain fed rivers, and remain dry during non-monsoon periods. Hence the canal takes water from sea only. The canal in Chennai City is totally in abandoned condition. It has silted up heavily. Its banks have been heavily encroached where huts and houses have come up. The width of the canal is in the range of 10 to 15m. To add to it, T.N. Govt. has allowed Mass Rapid Transport System (MRTS), to construct Elevated Railway Stations right over the canal as per the recommendations of the Working Group appointed by the Planning Commission in 1976-77. In many places, the columns of MRTS flyover bridges are within the canal bed itself and in certain places, the pedestal foundation of column is exposed above the canal bed. Therefore, there is no navigation possible in the Chennai stretch. Alternative suggested by earlier consultants of constructing a Bye-pass canal in Chennai City is also ruled out because of non-availability of adequate water and high density population and space crunch in Chennai City. **It is therefore recommended that the Stretch inside Chennai City of approx 50 km should not be taken for IWT** development

(g) Kalluvelly tank

Kalluvelly tank is a vast lagoon in Sourth Arkot Distt of Tamil Nadu. It is about 10.5 km wide and about 12.8 km long. It is connected with Yidi Anthittu Swamp through a tidal creek of about 8 km long which in turn is connected with sea at about 10 km North of Markanam. This swamp is full of water during rainy season and dry for the remaining part of the year. During 2005 M/s. RITES had conducted a Detailed Feasibility Study for navigability of the stretch between Markanam and Puducherry including the Kalluvelly tank. They had assessed that with dredging and some other developmental works this stretch can be made navigable.

5 PHASEWISE DEVELOPMENT FOR NAVIGATION

In order to carry out economically sustainable navigation, the waterway is proposed to be developed in two Phases as per the TOR of IWAI as given below. However in Phase I it has been proposed to develop the waterway in two stages based on the request of Government of Andhra Pradesh (GoAP). Please see Annexure 2 of Volume III.

Phase – I - Buckingham canal 32 m wide and depth of 1.8 m Godavari and Krishna River 32 m wide and depth of 1.8 m. Other Irrigation Canals (Eluru, Commamur and Kakinada Canals) 14 m wide and depth of 1.6 m

Stage I : Kakinada canal from Kakinada to Rajahmundry, Godavari river from Polavaram to Rajahmundry, Godavari Eluru canal from Rajahmundry to Eluru, North Buckingham canal from Pedaganjam (A.P) to Basin bridge, South Buckingham canal from Basin bridge to Marakanam and Kalluvelly Tank upto Puducherry

Stage II: Godavari river from Bhadrachalam to Pollavaram, Krishna Eluru canal from Eluru to Vijayawada, Krishna river from Wazirabad to Vijayawada, and Commamur canal from Vijayawada to Peddaganjam

Phase – II - Width of 32 m and depth of 2.0 m for the entire stretch of canal/river systems

6 TRAFFIC STUDIES

The earlier traffic studies conducted in the techno economic feasibility for development of navigation on South Buckingham Canal including integration from Kakinada to Marakanam integrated with Godavari – Krishna rivers during the year 1999 have been reviewed. Further, WAPCOS appointed M/s A. F. Ferguson, an experienced firm in traffic studies, to carry out traffic survey for proposed waterway in 2005-06 . It involved an in-depth desk study through Trade Journals, Annual Reports, Statistical abstracts of the states, Cement Statistics, Fertiliser Statistics and in house database to assess the profile of hinterland that could be catered to by the proposed waterway, major industries in the hinterland, raw material and products consumed and manufactured by such industries, review of various government plans, trend in traffic at major ports etc. A field survey has also been carried out which involved discussions with various Government Authorities, Association of industries such as Cement Manufacturer's Association, Fertiliser Association, Sugar Mills Association and talking to the Marketing Departments of various industries in the hinterland of the waterway. The field visits were made to Kakinada, Guntur, Vijayawada, Kothagudem, Bhadrachalam, Ennore Port and Vishakhapatnam. The consultants met potential customers primarily Cement, Fertilisers, Rice Mills, Paper Industries, Ports etc. The data so obtained has been analysed and led to the cargo traffic projections for proposed waterway.

6.1 Existing Traffic

There is no appreciable traffic in any of the waterways except for movement of country boats which carry local produce. The main reason for lack of IWT movement being the absence of other infrastructure facilities and coordinated effort for improvements.

6.2 Potential Traffic

The hinterland of Kakinada-Puducherry Inland waterway could be divided into four major cargo belts viz. Kakinada belt, Krishna belt, South AP belt, and Chennai belt. Analysis of these cargo belts indicates that coal, cement, fertilisers and food grains account for majority of the total traffic in the hinterland. Based on the secondary survey and primary survey the cargo identified as relevant to the cargo belts under consideration are: Coal, Rice, Foodgrains, Cement, Fertilisers, Forest Products, Salt and Other Bulk Cargo.

Coal being abundantly available in the country, is extensively used in various industrial sectors. Singareni Collieries Company Ltd. (SCCL) is the only coal company in Southern India and caters to the needs of power, cement and all other coal based Industries spread over the Southern States. Rice is a major agricultural produce in Andhra Pradesh, It is the second largest producer of rice, termed rice bowl of India, it accounts for nearly 10% of the rice production in the country. The Godavari region is the major rice producing area in AP. Rice from this region is consumed by regions of Andhra Pradesh and sent to the southern markets of Tamil Nadu and Kerala. Since the region of AP is deficient of other food grains such as wheat, cereals etc., these are procured from the northern parts for distribution in the region. The traffic for other foodgrains from other states has a high potential.

Andhra Pradesh shows presence of large number of cement plants, totaling installed capacity of 23.33 Mn tonnes. The consumption in Andhra Pradesh was approximately 9 Mn MT in the year 2004-05 and has shown an increase of 7 % over the last year. The consumption of cement in Tamil Nadu and Puducherry was approximately 10 Mn MT. Fertiliser Industry is another important industry, which forms part of the hinterland of the inland waterways. The major fertiliser companies in the influence zone are Nagarjuna Fertilisers (NFCL), Godavari Fertilisers (GFL), Madras Fertilisers (MFL), etc. Andhra Pradesh produced approximately 1.4 Mn MT of fertilisers in the year 2004-05 and Tamil Nadu approximately 1 Mn MT.

Andhra Pradesh has many paper mills concentrated in the northern part, the major ones being ITC Bhadrachalam and Andhra Pradesh paper mills. Besides there are many small paper mills in the districts of East and West Godavari. The raw materials for these factories are mainly forest based wood products, waste paper and chemicals. Salt is an important cargo in the hinterland and forms potential for the inland water transportation. This is due to the proximity of the coastal regions as well as the salt producing areas to the waterway. Other cargo groups consist of vegetables, raw materials for ceramic tiles, marine products, iron ore, rice bran extractions, granite which move in the hinterland and can form part of the cargo. The total cargo potential for the hinterland is conservatively estimated to increase from 27.62 Mn. T. in 2014 – 15 when the waterway is assumed to start operations to 47.47 Mn. T. in 2039 – 40 in twenty five years and growing upto 78.09 Mn. T. in 2059 – 60. The total cargo potential is thus conservatively growing at a CAGR of 2% p.a. for the next fifty years. The snapshot of total cargo potential (by all modes) for the hinterland is summarized over the forecast period as under

000 Tonne

S. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	Coal	14409	15158	15985	16898	17906	19019	24756
2	Rice	5163	5985	6939	8044	9325	10810	19524
3	Foodgrains	1774	2057	2385	2765	3205	3715	6710
4	Cement	1694	2061	2507	3050	3711	4515	9893
5	Fertilisers	1412	1637	1897	2199	2550	2956	5339
6	Forest products	761	926	1127	1371	1668	2030	4448
7	Salt	455	554	674	820	998	1214	2660
8	Other General Cargo	1956	2160	2385	2633	2907	3210	4769
	Total Cargo Potential in 000 Tonne	27625	30538	33899	37781	42270	47469	78100
	Total Cargo Potential in Million Tonne	27.62	30.54	33.90	37.78	42.27	47.47	78.10

Thus, the main cargoes identified to be moved on this waterway are coal, limestone, cement, fertilizers, iron and steel, building materials, paddy, tobacco, oil seeds, pulses and cotton, timber, bamboo, firewood, beedi leaves, chillies, general merchandise and civil supplies. The likely traffic for the proposed waterways is estimated to be 2.82 Mn. T. in 2014 – 15 to 12.39 Mn. T. in 2039 – 40 in twenty five years and growing upto 20.55 Mn. T. in 2059 – 60 under the realistic scenario. The snapshot of total cargo potential by IWT for the proposed waterway is summarized over the forecast period as under

000 Tonne

S. No.	Cargo	2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2059-60
1	Coal	1441	2274	3197	4224	4476	4755	6189
2	Rice	516	898	1388	2011	2331	2703	4881
3	Foodgrains	177	309	477	691	801	929	1678
4	Cement	-	309	501	763	928	1129	2473
5	Fertilisers	282	409	569	770	892	1035	1869
6	Forest products	114	185	282	411	501	609	1334
7	Salt	91	139	202	287	349	425	931
8	Other General Cargo	196	324	477	658	727	802	1192
	Total Cargo Potential in 000 Tonne	**2818**	4846	7093	9816	**11006**	12386	20547
	Total Cargo Potential in Million Tonne	**2.82**	4.85	7.09	9.82	**11.01**	12.39	20.55

The stretch wise cargo movements in canal and river sections of the waterway are described below:

(a) Krishna river (Wazirabad – Vijayawada)

The existing traffic moving along this stretch comprises agricultural produce, limestone, other minerals, cement, fertilizer, building materials, iron and steel and vegetable oils etc. Guntur is endowed with substantial resources of limestone, which are of use in cement blast furnace type, steel melting and chemical grades which are mainly consumed by M/s. ACC, Andhra Cement, Parthasarathy and Gauthami Cements as well as Visakhapatnam Steel Plant. The Krishna district is also endowed with limestone. Various cement plants have come up around river Krishna due to availability of limestones. They are producing bulk cement and are required to transport it by road through a lengthy and cumbersome route. The Inland Water Transport can definitely share the transport of a sizeable quantity of cement.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Krishna river from Wazirabad to Vijawada is summarized as under :

Million tonne

Year	Traffic							
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Wazirabad and destinating to Vijayawada	-	0.619	0.973	1.434	1.692	1.998	2.360	2.789

Upstream Traffic originating at Vijayawada and destinating to Wazirabad	-	1.486	2.104	2.806	3.016	3.251	3.516	3.814
Total traffic movement in Million tonne	-	**2.105**	**3.077**	**4.240**	**4.707**	**5.248**	**5.876**	**6.604**
Total traffic movement in Million tonne - km	-	**330**	**483**	**666**	**739**	**824**	**922**	**1037**

(b) **Godavari River (Bhadrachalam - Rajahmundry) stretch**

The coal is abundantly available commodity in this stretch owing to its proximity to SCCL mines. There are existing coal fields in Kothagudam region comprising Manuguru, Kothagudem and Yellandu areas.

Coal in the downstream direction in Godavari river from Bhadrachalam can be very easily shifted to IWT mode as the distances through it get reduced by 70 to 100 km as compared to the road route. Rice has a traffic potential in this downstream route upto Rajahmundry. While in the upstream direction while coming back the vessels can bring forest products, wood pulp etc. and can unload it at Bhadrachalam.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Godavari river from Bhadrachalam to Rajahmundry is summarized as under.

Million tonne

Year		Traffic						
	2014-15	**2017-18**	**2022-23**	**2027-28**	**2032-33**	**2037-38**	**2042-43**	**2047-48**
Downstream Traffic originating at Bhadrachalam and destinating to Rajahmundry	-	2.557	3.639	4.869	5.229	5.633	6.086	6.595
Upstream Traffic originating at Rajahmundry and destinating to Bhadrachalam	-	0.277	0.416	0.599	0.717	0.857	1.026	1.228
Total traffic movement in Million tonne	-	**2.834**	**4.055**	**5.469**	**5.946**	**6.490**	**7.112**	**7.824**
Total traffic movement in Million tonne - km	-	**484**	**693**	**935**	**1017**	**1110**	**1216**	**1338**

(c) **Canal Stretches**

(i) Kakinada Canal

The main cargo to be transported by IWT in downstream direction from Kakinada to Rajahmundry is coal and fertilizer, and small quantities of Industrial salt, Rock Phosphate and Project cargo and drilling equipments. In the upstream direction the main cargo comprise of Rice bran extractions, Cement clinker and Fertilisers.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Kakinada canal from Kakinada to Rajahmundry is summarized as under.

Million tonne

Year		Traffic						
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Kakinada and destinating to Rajahmundry	0.367	0.530	0.760	1.047	1.207	1.391	1.604	1.851
Upstream Traffic originating at Rajahmundry and destinating to Kakinada	0.070	0.264	0.409	0.598	0.706	0.835	0.989	1.175
Total traffic movement in Million tonne	**0.437**	**0.794**	**1.169**	**1.645**	**1.912**	**2.226**	**2.594**	**3.026**
Total traffic movement in Million tonne - km	**22**	**40**	**58**	**82**	**96**	**111**	**130**	**151**

(ii) Eluru Canal

At present, movement exists along Eluru Canal (both in Godavari Eluru canal and Krishna Eluru Canal) through country crafts, however the effect of which in working out the traffic potential is considered negligible. The important commodities forming potential for traffic on development of this waterway are Rice and other food grains, Rice bran extractions, Coal, Fertilizer and other General Cargo.

A summary of total traffic in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Eluru canal from Vijaywada to Rajahmundry is tabulated below.

Million tonne

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Vijayawada and destinating to Rajahmundry	-	0.451	0.694	1.002	1.159	1.343	1.556	1.805
Upstream Traffic originating at Rajahmundry and destinating to Vijayawada	-	1.145	1.629	2.193	2.395	2.625	2.888	3.189
Total traffic movement in Million tonne	-	1.596	2.323	3.195	3.554	3.967	4.444	4.994
Total traffic movement in Million tonne - km	-	222	323	444	494	551	618	694

(iii) Commamur Canal

This stretch from Vijayawada to Peddaganjam in Ongole (113 km) is an important trade link linking Kakinada belt with south A.P. and Tamil Nadu. The major towns in the influence area are Vijayawada, Guntur and Ongole. It connects Prakasam Barrage to Peddaganjam Lock. The main traffic to move is of Rice & Foodgrains in downstream direction and Forest products in upstream direction.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of Commamur canal from Vijaywada to Peddaganjam is summarized as under.

Million tonne

Year	Traffic							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Vijayawada, and destinating to Peddaganjam	-	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Peddaganjam and destinating to Vijayawada	-	0.490	0.727	1.033	1.221	1.444	1.711	2.030

Total traffic movement in Million tonne	-	1.833	2.769	3.953	4.574	5.300	6.148	7.141
Total traffic movement in Million tonne - km	-	207	313	447	517	599	695	807

(iv) North Buckingham Canal

The canal stretch is almost dry and has mainly salt traffic because of salt pans all along the canal. If developed in isolation, it has traffic potential of Rice & foodgrains, Fertilisers, Chillies, Tobacco Fish & Marine Products, Granile and Fruits & vegetables in the downstream direction from Peddaganjam to Chennai. In the upstream direction from Chennai to Peddaganjam, the main traffic consists of Fertilisers from Ennore, and Salt from Chennai for local consumption.

A summary of total traffic in Million tonne and Million tonne --km projected in upstream as well as downstream direction for different years in the stretch of North Buckingham canal from Peddaganjam to Chennai is tabulated below.

Million tonne

		Traffic						
Year	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Peddaganjam and destinating to Chennai	0.790	1.343	2.042	2.920	3.353	3.856	4.437	5.111
Upstream Traffic originating at Chennai and destinating to Peddaganjam	0.329	0.490	0.727	1.033	1.221	1.444	1.711	2.030
Total traffic movement in Million tonne	**1.119**	**1.833**	**2.769**	**3.953**	**4.574**	**5.300**	**6.148**	**7.141**
Total traffic movement in Million tonne - km	**333**	**546**	**825**	**1178**	**1363**	**1579**	**1832**	**2128**

(v) South Buckingham Canal and Kaluveli Tank including Puducherry

The canal stretch of South Buckingham Canal (103 km) starts from Basin bridge and runs upto Marakanam and is joined by Kalluvelly Tank, a huge open tank 22 km long, upto Puducherry. It has mainly traffic of salt and Fish & Marine Products because of salt pans and aquaculture shrimp farms all along the route. If developed in isolation, it

has traffic potential of Iron scrap in the downstream direction from Chennai to Marakanam and Puducherry. In the upstream direction from Puducherry and Markanam to Chennai, the main traffic consists of Salt, Fertilisers and Timber from Markanam, Thiruvallur, Kanchipuram, Villipuram & Puducherry for local consumption.

The total traffic movement in Million tonne and Million tonne –km projected in upstream as well as downstream direction for different years in the stretch of South Buckingham canal from Chennai to Marakanam and Puducherry is summarized as under.

Million tonne

	Traffic							
Year	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Downstream Traffic originating at Chennai and destinating to Markanam and Puducherry	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Upstream Traffic originating at Marakanam and Puducherry and destinating to Chennai	0	0	0	0	0	0	0	0
Total traffic movement in Million tonne	**0.092**	**0.131**	**0.191**	**0.268**	**0.320**	**0.383**	**0.459**	**0.550**
Total traffic movement in Million tonne - km	**9**	**13**	**19**	**27**	**32**	**38**	**46**	**55**

6.3 Summary of Traffic Movement in Different Stretches

On the basis of traffic movement explained in Para 6.2, a summary of total traffic movement in Million Tonne and Million Tonne Km projected in different stretches for different years is reproduced below :

In Million Tonne

Name of Stretches	Year							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Krishna River from Wazirabad to Vijayawada	-	2.105	3.077	4.240	4.707	5.248	5.876	6.604
Godawari River from Bhadrachalam to Rajahmundry	-	2.834	4.055	5.469	5.946	6.490	7.112	7.824
Kakinada Canal from Kakinada to Rajahmundry	0.437	0.794	1.169	1.645	1.912	2.226	2.594	3.026
Eluru Canal from Rajahmundry to Vijayawada	-	1.596	2.323	3.195	3.554	3.967	4.444	4.994
Commamur Canal from Vijayawada to Peddaganjam	-	1.833	2.769	3.953	4.574	5.300	6.148	7.141
North Buckingham Canal from Peddaganjam to Ennore	1.119	1.833	2.769	3.953	4.574	5.300	6.148	7.141
South Buckingham Canal from Muthukadu to Marakanam and Marakanam to Puducherry via Kalluvelly Tank	0.092	0.131	0.191	0.268	0.320	0.383	0.459	0.550
Total traffic potential in Million tonne	2.818*	4.647*	6.793*	9.387*	10.509*	11.809*	13.318*	15.072*

* These values are the projected traffic potential consisting of all cargo commodities for the proposed waterway and therefore would not be equal to algebraic addition of above values in all stretches as above values are simply movement of projected traffic potential in all the stretches of waterway

In Million Tonne - km

Name of Stretches	Year							
	2014-15	2017-18	2022-23	2027-28	2032-33	2037-38	2042-43	2047-48
Krishna River from Wazirabad to Vijayawada	-	330	483	666	739	824	922	1037
Godawari River from Bhadrachalam to Rajahmundry	-	484	693	935	1017	1110	1216	1338
Kakinada Canal from Kakinada to Rajahmundry	22	40	58	82	96	111	130	151
Eluru Canal from Rajahmundry to Vijayawada	-	222	323	444	494	551	618	694
Commamur Canal from Vijayawada to Peddaganjam	-	207	313	447	517	599	695	807
North Buckingham Canal from Peddaganjam to Ennore	333	546	825	1178	1363	1579	1832	2128
South Buckingham Canal from Muthukadu to Marakanam and Marakanam to Puducherry via Kalluvelly Tank	9	13	19	27	32	38	46	55
Total traffic movement in Million tonne - km	364	1842	2714	3779	4258	4812	5459	6210

7 WATERWAY DIMENSIONS PROPOSED

Considering the hydro-morpholical aspects of various stretches, the feasibility for development of Kakinada – Puducherry Canals integrated with Godavari and Krishna rivers waterway has been studied considering a channel of 14m width, and 1.6m depth (1:1 side slope) in Kakinada, Eluru and Commamur canals and 32 m width and 1.8 m depth (1:1.5 side slope) in Buckingham canal and river portions in Phase I and 32m width and 2 m depth in the entire waterway in Phase II. It may be noted that the Government of A.P. expressed that initially (till construction of Pollavaram dam and Pulichintala dams is completed) Kakinada, Eluru and Commamur Canals be developed with 14 m width and 1.6 m depth since they were of the view that if these

dimensions are increased before the construction of these dams, this will adversely affect the irrigation purposes.

Accordingly the waterway dimension proposed along with the vessel size/capacity is as follows

a) **Kakinada, Eluru and Commamur Canals**
Bed width : 14 m
Depth : 1.6 m
Side slope : 1:1
Vessel capacity & size – 100 tonnes [30 m(L) x 4.25 m(B) x 1.2 m (draft)]

b) **Rivers Godavari and Krishna, Buckingham canal and Kaluvelly tank**
Bed width : 32 m
Depth : 1.8 m
Side slope : 1:1.5
Vessel capacity & size – 300 tonnes [40 m (L) x 9 m (B) x 1.5 m (draft)]

A key map of the waterway is given at Annexure-1. Sketch of these two cross sections are given at Annexure – 2.

8 VESSEL DIMENSIONS PROPOSED

The design vessel size for canal portion and river portion during Phase I and Phase II development has been worked out and given below:

	Phase-I 14m wide & 1.6m deep canal	**Phase-I** 32 m wide & 1.8 m deep canal/river	**Phase-II** 32m wide & 2.0m deep river/canals
Length	30m	40m	50m
B	4.25m	9.0m	11.0m
D	1.20m	1.5m	1.8m
DWT	100t	300t	500t

9. DEVELOPMENT WORKS PROPOSED

The project envisages land acquisition for 100 m corridor for waterway, dredging for widening & deepening of waterway and opening of sea mouths for free tidal flow into canals, marking the waterway with navigational aids, construction of terminals for loading / unloading of cargo, modification of locks, modification of low level bridges to facilitate movement of bigger barges and construction of cross drainage works for flow of flood water into/across the canals.

Further, as informed by IWAI, the Govt of Andhra Pradesh while giving concurrence to the proposal for declaration stated that till completion of construction of Polavaram dam on Godavari and Pulichintala dam on Krishna, sufficient depth for navigation will

be available only for about 5 months in Eluru canal and Commamur canal. They suggested that the waterway be developed in two stages. Therefore, in Phase I, the waterway is proposed to be developed in following two stages.

Stage-I

(i) Polavaram-Rajahmundry Stretch of river Godavari	- 44 km
(ii) Kakinada-Rajahmundry Stretch of Kakinada Canal	- 50 km
(iii) Rajahmundry-Eluru stretch of Eluru canal	- 74 km
(iv) North and South Buckingham canal (excluding 50 km in Chennai city)	- 376 km
(v) Kalluvelly Tank including Puducherry	- 22 km
Sub total Stage I	**566 km**

Stage II

(i) Bhadrachalam - Polavaram Stretch of river Godavari	- 127 km
(ii) Wazirabad-Vijayawada Stretch of river Krishna	- 157 km
(iii) Vijayawada – Eluru stretch of Eluru Canal	- 65 km
(iv) Vijayawada-Peddaganjam Stretch of Commamur canal	- 113 km
Sub total Stage II	**462 km**

Total Stages I & II 1028 km

9.1 Land Acquisition/Right of Way

100m wide corridor (Right of Way) is required for development of waterway of 32 m bottom width in canals (Kakinada, Eluru, Commamur, North and South Buckingham canals and Kalluvelly tank) which were in the possession of State Govts earlier at the time of construction of these canals. However, certain stretches are now under occupation by public. The State Govts were requested by IWAI to collect data on Land Acquisition. Govt. of Tamil Nadu completed the same but the details are yet to be received from States Govt. of Andhra Pradesh and Puducherry. Based on the information received from the States the abstract of requirement of land acquisition is given below:

a)	Additional Area required to be acquired in Kakinada Canal -	227.55 ha
b)	Additional Area required to be acquired in Eluru Canal -	524.3 ha
c)	Additional Area required to be acquired in Commamur Canal -	497.85 ha
d)	Additional Area required to be acquired in North Buckingham Canal (Andhra Pradesh Stretch – 258 km)	- 129.90 ha
e)	Additional Area required to be acquired in North/South Buckingham Canal (Tamilnadu Stretch)	- 298.98 ha
f)	Area required to be acquired in Puducherry	- 27.00 ha

Govt of T.N has also indicated the extent of various types of land to be acquired (i.e. whether Patta land, Poramboke land or Encroachment) and the same is given below:

S. No.	Chainage (km)	Additional Area required to be acquired (ha)
North Buckingham Canal		
	Patta Land	4.256
	Poramboke Land	66.214
	Encroachment Area	5.156
	Total NBC	75.626
South Buckingham Canal		
	Patta Land	7.567
	Poramboke Land	175.271
	Encroachment Area	9.269
	Government Land Encroached by persons having Patta	31.25
	Total SBC	223.357
	Total	**298.983**

However, such details have not been received from Govts of A.P and Puducherry. Moreover, the States also could not so for provide the cost of acquisition of these land areas. Therefore the cost of land acquisition was assessed by WAPCOS based on local circle area rates collected from the Revenue Departments or estimated based on local enquiries.

The State wise land acquisition requirement is summarized below:

(Area in Hectares)

	Tamil Nadu		A.P	Puducherry
Patta land	43	300	1380	27
Poramboke land –	242			
Encroachment –	15			

9.2 Dredging

Since the canals remained disused for navigation for many decades and the rivers do not have adequate depth for navigation during non-monsoon months, substantial quantity of dredging (both sand and rock dredging) is required to develop navigational channels of design dimensions. For constructing navigational channel in river and canal portions of the waterway of dimensions mentioned in item (7) above, dredging of 19 million cubic meter in Stage I and 0.80 million cubic meter (0.69 million cub m of sand and 0.11 million cubic meter of rocks) in Stage II is required. Thus total dredging required is 19.85 million cubic meter (19.74 million cubic meter of sand and

0.11 million cubic meter of rock). Stretch wise dredging quantities are given in Annexure -3 .

9.3 Modification/Reconstruction of Bridges

Since the waterway (particularly the canals) remained disused for navigation for many decades, several bridges/cross structures have come up thereon which are required to be either modified or reconstructed to provide desired horizontal and vertical clearances to allow passage of design size of inland vessels. There are a total of 190 such bridges out of which 47 require modifications. 105 bridges fall in the stretches of Stage I (out of which 34 requires modification) and 85 bridges fall in the stretches of Stage II (out of which 13 requires modification). Canal wise details of these bridges is given at Annexure 4 .

In addition, there are three bridges on river Godavari and two on river Krishna but these do not require any modification since they already possess adequate vertical and horizontal clearances.

9.4 Modification/Reconstruction of Navigational Locks

Since the canal portions of the waterway remained disused for a long time, the navigational locks (which are necessary to control water level during different seasons of the year) have also become defunct and most of these need to be modified. In most of these locks, the gates are also totally defunct. There is total number of 48 locks in the waterway and all these locks require modification. In stretches of Stage I, all the 36 locks falling in the stretch require modification while in Stage II all the 12 locks falling in the stretch require modification. Canal wise details of these locks may be seen at Annexure 5.

Since as of now there is no dam/barrage either on Godavari or Krishna rivers, there are no locks as of now on these. However, on Godavari river, Polavaram dam is being constructed by the Govt of A.P and IWAI and the WAPCOS had suggested to the State Govt to provide navigational locks of adequate capacity and size and the channel to allow navigation across the dam. Similarly, on Krishna river also, Pulichintala dam is being constructed by the State Govt of A.P and as per information collected by WAPCOS, initially there was no provision of navigational lock in the original scheme of the State Govt which would have made navigation up stream of the dam impossible. The WAPCOS and the IWAI had however, taken up the matter with the State Govt and it is learnt that the State Govt has agreed to provide a navigational lock across Pulichintala dam as well. Accordingly, cost of construction of locks across these two dams in A.P has not been included in the cost of project for development of the instant waterway as a National Waterway.

9.5 Terminals

The terminals are the gateway for the cargo and therefore should be strategically placed near high traffic concentration points in order to allow smooth and uninterrupted traffic between canal and hinterland. A total of 15 terminals have been proposed in the project, 11 in Stage I and 4 in Stage II. These terminals are

proposed at Kakinada, Rajahmundry, Eluru, Kottapatnam, Maipadu, Durgarajupatnam, Muktiyala, Ennore(south), Muthukadu, Marakanam and Puducherry in Stage I and Bhadrachalam, Wazirabad, Vijayawada, and Tadepaligudam in Stage II. A brief description of each terminal is given below:

(i) **Kakinada** : At this terminal there would be cargo exchange from and to near the main Port to use the River Port Terminal. Therefore mechanical handling facilities for bulk and general cargo are proposed.

(ii) **Rajahmundry** : This terminal on river Godavari is to be developed for coal handling facilities primarily.

(iii) **Eluru** : Feeder cargo of Rice & foodgrains and other Bulk Cargo.

(iv) **Kottapatnam** : The terminal in canal section in Ongole to be developed for fertilizers, salt and fishery & Marine products.

(v) **Maipadu** : Feeder terminal for fishery products and finished goods .

(vi) **Durgarajupatnam**: Feeder terminal for fishery products and finished goods.

(vii) **Muktiyala** : Feeder terminal in river section for coal, cement, agro products and finished goods.

(viii) **Ennore(South)** : New fully mechanical handling facilities for handling fertilizers and industrial cargo are proposed in the terminal.

(ix) **Muthukadu:** A terminal on the Buckingham Canal proposed to be equipped with both bulk and general cargo handling facilities.

(x) **Marakanam** : The near end point in South Buckingham Canal to be developed for handling facilities for timber and industrial goods.

(xi) **Puducherry**: The final terminating point of the proposed waterway. The terminal will be planned for mainly general cargo in the hinterland of Puducherry state such as Cuddalore, Villupuram etc.

(xii) **Bhadrachalam** : This Probably is the most important terminal on the river and hence is to be equipped with both bulk and general cargo handling facilities.

(xiii) **Wazirabad:** This terminal on river Krishna is to be developed for cement and coal handling facilities primarily.

(xiv) **Vijayawada** : This terminal to be developed along Krishna river. The terminal is generally for agro products, cement, fertilizers and finished goods.

(xv) **Tadepaligudam** : Feeder terminal for rice bran extractions, agro products and finished goods.

A list of these terminals (waterway stretch wise) may be seen at Annexure –6.

The terminals are proposed to be provided with equipment and handling facilities suitable for bulk handling of coal/fertilizer and other general cargo with suitable adjustments and interchangeability. These arrangements can be carried out as per occurring cargo compositions. Along side berthing wharf on piles with pitched slopes on land side are planned. This is a flexible as well as economic system, which would allow easy future expansion. While planning the river port system, the following factors were considered:

- No. and length of berth for the throughput of cargo
- The length of the largest vessel and distance between two vessels for simultaneous berthing as would occur.
- Operation for 330 days a year
- Night navigation permitted
- Berth occupancy as permissible
- Waiting time (Tw) to Service time(Ts) not exceeding 1

9.6 Navigational Aids

Navigation in the waterway is generally associated with the risk of vessels going around. In order to prevent such incidences the channel has to be marked properly to make it navigable without risk. Since the present canal system is man made, the fairway is well defined. In order to have navigation for movement of barges round the clock, it has been proposed to provide a combination of shore beacon lights, lighted marks, FRP buoys and lights mounted on country boats in river/canal portion in Phase I.

The estimated quantity required for above mentioned navigational aids during Phase I is given below:

S.No.	Item Description	Quantity
1	FRP Buoys	240
2	Country Boats mounted with light system	240
3	Shore beacons with lights	158
4	Lighted marks on banks of canals	1545
5	Buoys laying vessel	2

As explained in para 5 and 7, the waterway is proposed in two phases.

10 ENVIRONMENTAL ASPECTS

Certain environment and environmental problems arise as a result of the development, exploitation and management of water resources projects. Due to execution of the dredging activity, certain effects may occur. However as it would be carried out at identified isolated locations, the resultant effect on river water quality would not be significant. In order to keep the environment free from pollution by dumping of dredged spoil, it is proposed that the spoil be disposed off in the low lying areas adjoining the river / canal course, without creating noticeable environmental

degradation. The terminals are expected to handle materials like chemicals, cement, tea, food grains, fertilizers, coal, paper and paper products, stone, boulder and chips etc. Necessary care would be taken to minimize the adverse effect on the environment due to spillage/ handling of materials while loading/ unloading the same at terminal points. Effects on air and noise pollution shall be negligible. Overall, any significant negative impact on environment is not expected due to the implementation of IWT development on the entire waterway system. The advantages on the other hand are:-

- Considerable reduction in vehicular traffic when major portion of road traffic is diverted to IWT.
- Savings in cost of fuel, foreign exchange and energy savings.
- More employment generation
- Development of tourism.

However a separate report on environment impact analysis is being prepared by IWAI through a separate agency which also broadly agrees with the above points.

11. COST OF DEVELOPMENT WORKS

The phasewise cost estimate has been worked out for development of Phase I and Phase II. The Delhi Schedule of Rate, 2007 published by CPWD has been followed to arrive at the cost estimate of the project. It has already been discussed that Phase I development is proposed to be carried out in two stages i.e. Stage I & Stage II. Accordingly, the cost estimate for developing stretches of proposed waterway falling in these two stages i.e. Stage I & Stage II have been worked out separately. Further as informed by IWAI, when this project was submitted to the IWAI Board in its 126th meeting held on 27.11.08, the Board directed that a lump sum provision of Rs 25 cr may be further added to this cost for providing small facilities for local people (such as ferry ghats) etc so that the local people get involved in the project. Therefore a provision of Rs 15 cr in Stage I and Rs 10 cr for Stage II has been added for the purpose.

11.1 Cost estimate for Stage I of Phase I

To arrive at the total cost for Stage I development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various items for development of Stage I waterway for the year 2007 and 2009 is given below:

Cost Estimate for Stage I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	19460	22280
2	Dredging	27174	31112
3	Cross Drainage Works	1290	1477
4	Locks	41010	46952
5	Bridges	4946	5663

6	Terminals	9193	10525
7	Navigational Aids	971	1112
8	Protection Measures	223	255
9	Facilities to local people for ferry service etc	1500	1500
	Total	**105767**	**120876**

11.2 Cost estimate for Stage II of Phase I

To arrive at the total cost for Stage II development for the year 2009, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly a summary of cost involved in various items for development of Stage II waterway for the year 2007 and 2009 is given below:

Cost Estimate for Stage II

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	14680	16807
2	Dredging	1891	2165
3	Cross Drainage Works	712	815
4	Locks	2588	2963
5	Bridges	1228	1406
6	Terminals	3369	3857
7	Navigational Aids	1087	1245
8	Protection Measures	242	277
9	Facilities to local people for ferry service etc	1000	1000
	Total	**26797**	**30535**

11.3 Cost estimate for Phase I (Stage I + Stage II)

As the Phase I would be carried out in 2 stages i.e. Stage-I and Stage-II , accordingly the cost estimate for development of Phase I would be sum of the cost involved in Stage I and II as discussed above. Therefore, the cost estimate for Phase I is tabulated below.

Cost Estimate for Phase I

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	34140	39087
2	Dredging	29065	33277
3	Cross Drainage Works	2002	2292
4	Locks	43598	49915
5	Bridges	6174	7069

6	Terminals	12562	14382
7	Navigational Aids	2058	2356
8	Protection Measures	465	532
9	Facilities to local people for ferry service etc	2500	2500
	Total	**132564**	**151410**

Say 1515Crores

Therefore the total cost of **Phase I** of the project is estimated as **Rs 1515 Crores.**

11.4 Cost estimate for Phase II

In Phase II, the development proposed are mainly with respect to increasing the width and depth of all the portions of the waterways of river as well as canals to 32 m width and 2 m depth. While the extent of land acquisition, terminals and navigational aids proposed in Phase I would be sufficient for scope of Phase II also, for increasing the width and depth of the waterway stretches the important works to be undertaken under Phase II would be: dredging, cross drainage works, modification/re-construction of bridges and locks and up gradation of some terminals. Considering that in the optimistic scenario, the Phase I will be completed by 2016-17 it is proposed that after observing the utilization of the waterway developed under Phase I for a few years, the development works under Phase II may be started in 2024-25 and completed in about five years time i.e. by 2029-30.

To arrive at the total cost for Phase II development at 2009 price, an escalation of 7% p.a. has been assumed w.r.t. base year 2007. Accordingly, a summary of cost involved in various items for development of Phase II waterway for the year 2007 and 2009 is given below.

Cost estimate for Phase II

S.No.	Item Description	Cost for year 2007 (Rs. In lakhs)	Cost for year 2009 (Rs. In lakhs)
1	Land Acquisition	0	0
2	Dredging	46460	53192
3	Cross Drainage Works	1208	1383
4	Locks	25020	28645
5	Bridges	12491	14301
6	Terminals	2820	3229
7	Navigational Aids	0	0
	Total	**87999**	**100750**

Say 1008Crores

Therefore the total cost of **Phase II** of the project is estimated as **Rs 1008Crores.**

12 ECONOMIC AND FINANCIAL EVALUATION

Economic analysis attempts to measure the overall impact of the project on improving the economic welfare of the citizens of the country. It would assess the project in the context of the national economy rather than the project entity.

Taking into account the traffic projections carried out for the entire stretch of waterway and cost of development works associated, two options have been broadly identified for economic and financial analysis as follows:

a) **Option I:** The option I consist of following stretches of waterway as given below:
Kakinada canal
Eluru canal
Godavari River
Krishna River

b) **Option II:** The option II consists of entire stretch of waterway as given below:
Kakinada canal
Eluru canal
Godavari River
Krishna River
Commamur Canal
North Buckingham Canal
South Buckingham Canal
Marakanam to Puducherry by Kalluvelly Tank

The results of EIRR for various selected options are given below :

S.No.	Options	EIRR
1.	Option I during Phase I	34.27%
2.	Option I during Phase II	25.84%
3.	Option II during Phase I	22.84%
4.	Option II during Phase II	29.48%

For the development of present waterway involving heavy investments, it becomes very important to analyse the benefits of the owner i.e. IWT/Govt. and the users i.e. barge operator who would use such IWT facility when compared to road. The FIRR has therefore been evaluated for IWT/Government and Users/Barge operator. The results of FIRR for Government/IWAI for all the options are summarised as follows.

S.No.	Weighted cost of capital	3%	6%	12%
	Options	Levy charges (paise per Tonne - km) to earn an IRR equivalent to the weighted cost of capital		
1.	Option I –Phase I	13	19	36
2.	Option I –Phase II	36	46	77
3.	Option II –Phase I	31	43	81
4.	Option II –Phase II	27	35	60

The results of FIRR for User/Barge Operator for all the options are summarized as follows :

S. No.	Options	Levy Charge (Rs. per Tonne - km) to earn an IRR of 12%
1.	Option I during Phase I	1.20
2.	Option I during Phase II	1.07
3.	Option II during Phase I	1.31
4.	Option II during Phase II	1.14

13 CONCLUSIONS AND RECOMMENDATIONS

The following conclusion are drawn from the above table as given below :

a. To earn FIRR of 3% by Govt./IWT, the levy charges work out to be minimum as 13 Paise per Tonne - km for Option I – Phase I and maximum as 36 Paise per Tonne - km for Option I – Phase II.

b. To earn FIRR of 6% by Govt./IWT, the levy charges work out to be minimum as 19 Paise per Tonne - km for Option I – Phase I and maximum as 46 Paise per Tonne - km for Option I – Phase II.

c. To earn FIRR of 12% by Govt./IWT, the levy charges work out to be minimum as 36 Paise per Tonne - km for Option I – Phase I and maximum as 81 Paise per Tonne - km for Option II – Phase I.

d. For user/barge operator, the cargo fare to be charged for earning 12% FIRR works out to be minimum as 107 paise per Tonne - km for Option I during Phase II development and maximum as 131 paise per Tonne - km for Option II during Phase I development.

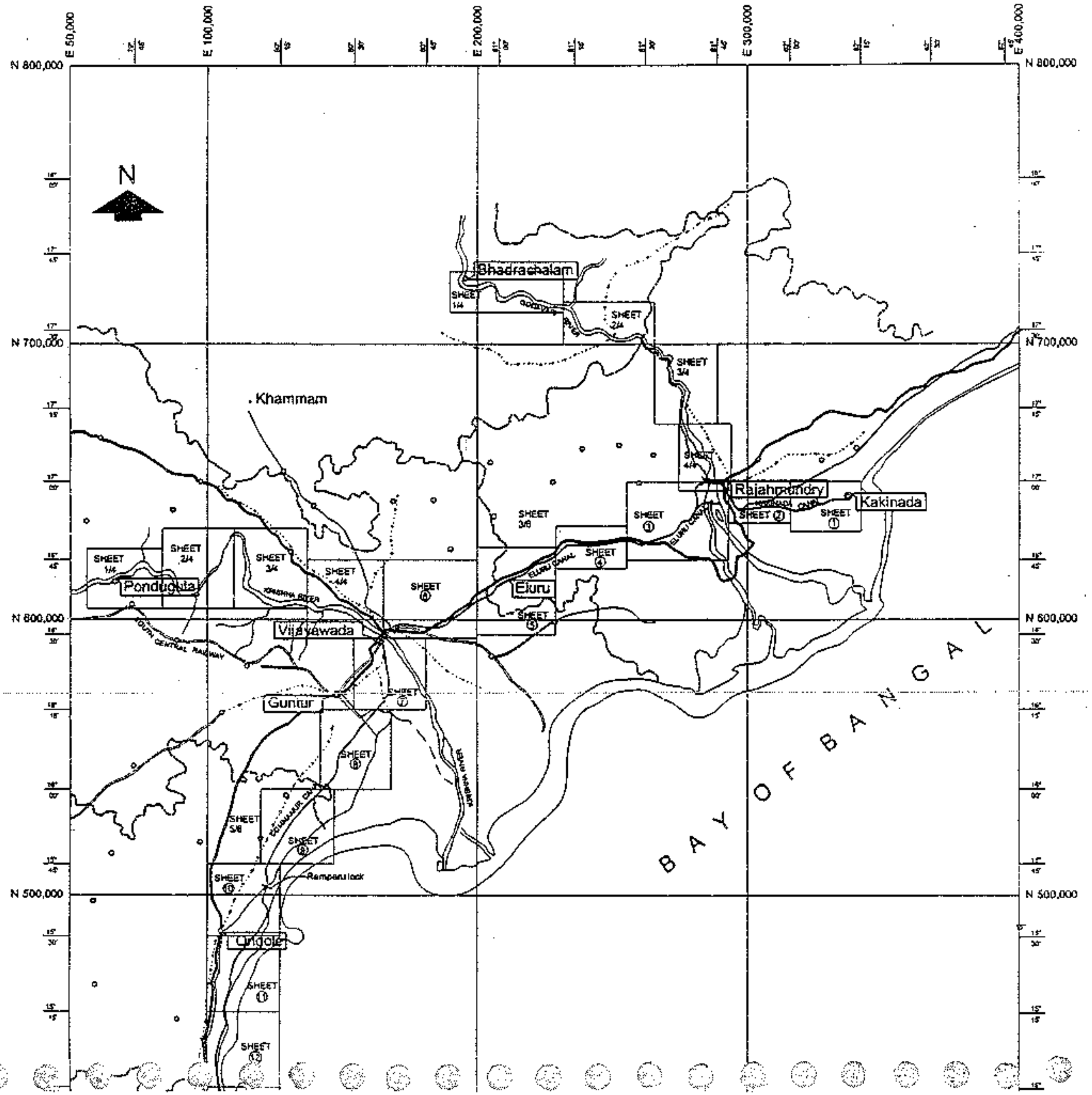
e. Taking into view of highly favorable EIRR for Govt./IWAI and levy charges exceeding Rs. 1.00 per Tonne-km for all the Options to earn an IRR of 12%

by barge operator, it is concluded that the charges for using terminal and other infrastructural facilities may be absorbed so as to attract users to avail IWT facility.

f. Taking overview of all the activities associated with the development of proposed waterway, it is understood that the barge building facility is the activity that can be taken up under private sector participation/BOT/JV basis.

On the basis of conclusions discussed in previous para, it is understood and recommended that the Option I consisting of 14 m wide channel in Kakinada & Eluru canal and 32 m wide channel in Godavari & Krishna river during Phase I development is economically viable and most attractive as it is commanding an EIRR of 34.27% thus contributing to valuable national upgradation. Moreover, the user/barge operator has sufficient scope to use the recommended option of present waterway by charging 120 paise per Tonne - km in comparison to road. Taking into account the past experience of IWAI for not taking levy charges from barge operator in NW I and NW 2, it may be proposed that IWAI may not charge or charge on a nominal basis such as 5 paise per Tonne - km so as to attract the barge operator to use the proposed IWT facility.

ANNEXURE -1
KEY MAP OF WATERWAY


N
E 50,000
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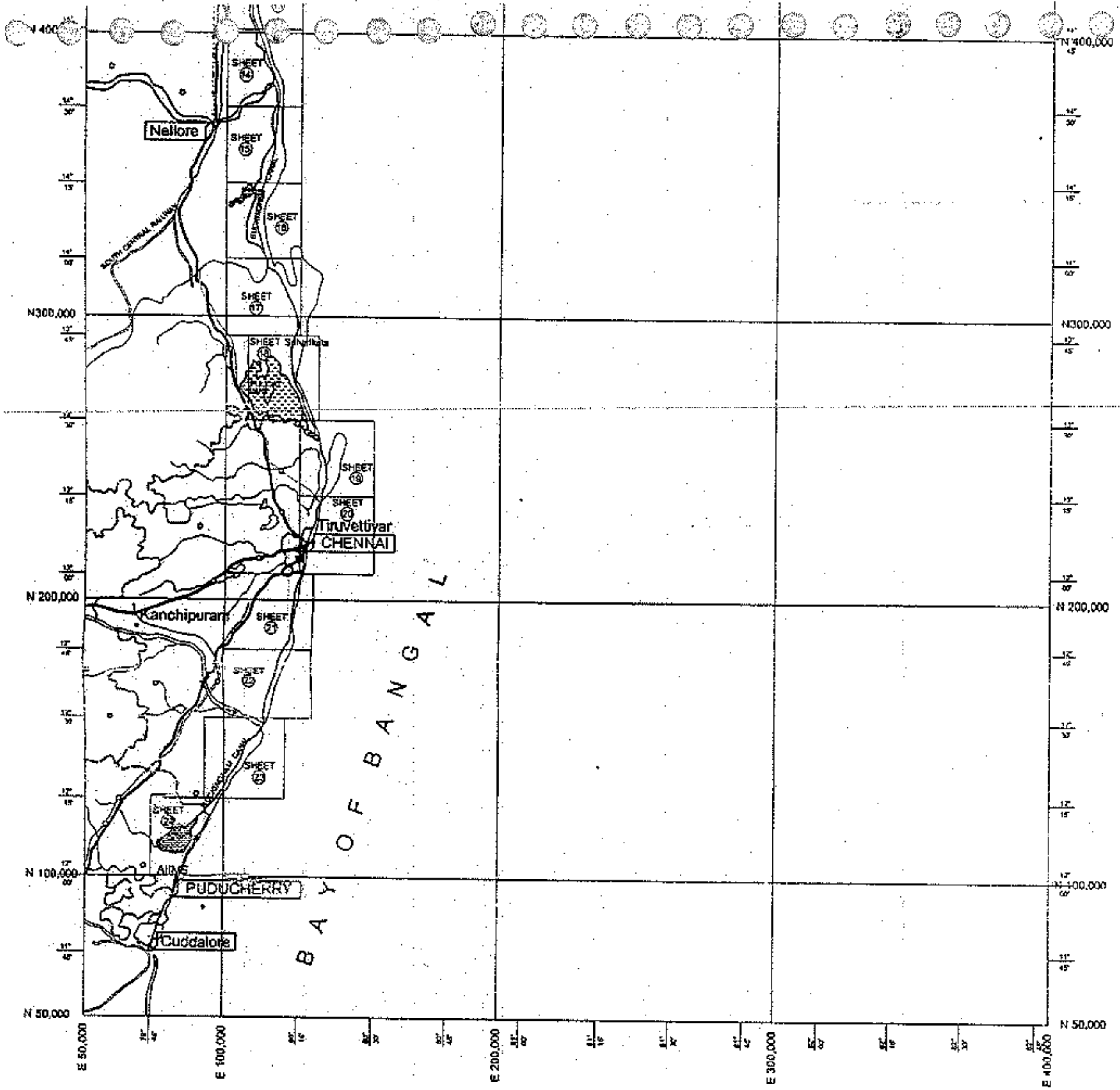
E 200,000
E 300,000
E 400,000
N 800,000
N 700,000
N 600,000
N 500,000
Khammam
Bhadrachalam
Rajahmundry
Kakinada
Pondugula
Vijayawada
Eluru
Guntur
Ongole
ELURU CANAL
KRISHNA RIVER
SOUTH CENTRAL RAILWAY
Ramperu lock
BAY OF BANGAL



WAPCOS

(A GOVERNMENT OF INDIA UNDERTAKING)

IWAI

INLAND WATERWAYS AUTHORITY OF INDIA

KEY MAP OF WATERWAY

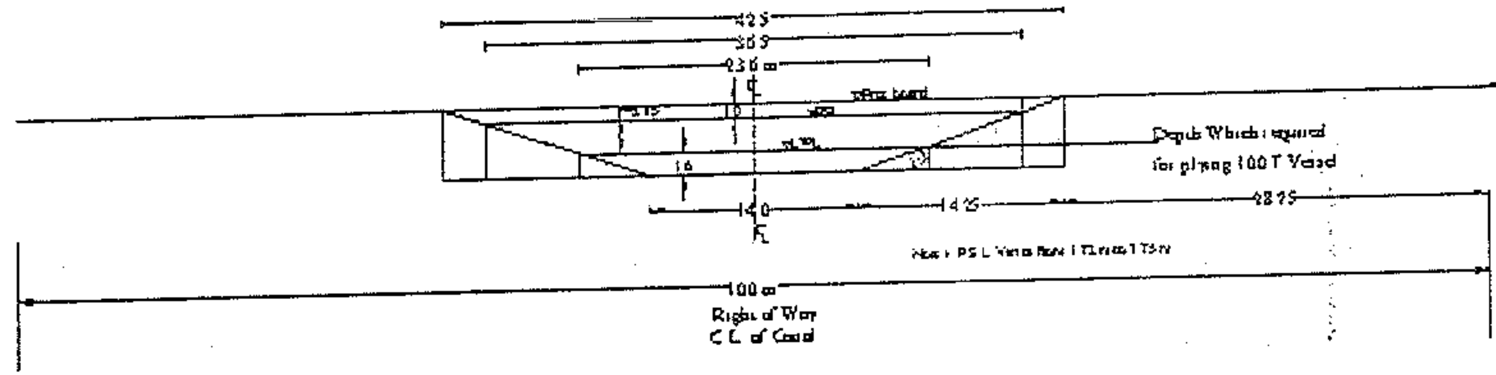
KAKINADA-PUDUCHERRY CANAL ALONG WITH RIVERS GODAVARI & KRISHNA

SCALE	DIVISION	DRG. NO.	SHEET NO.
1: 10,00,000			1

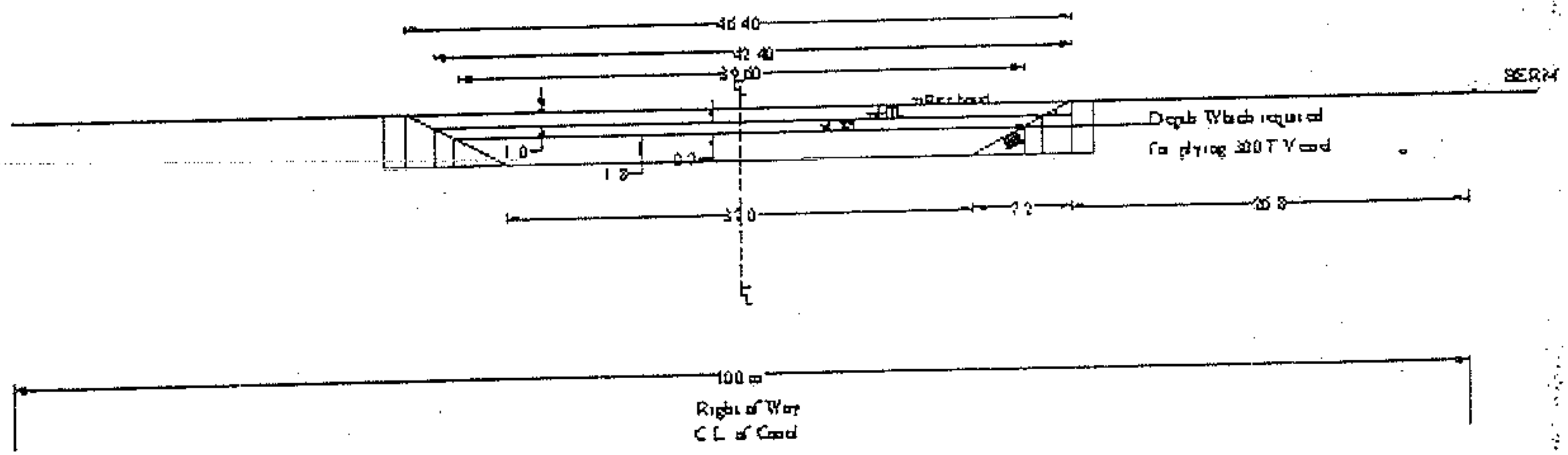
ANNEXURE-2
DETAILS OF CROSS-SECTION FOR CANALS

ANNEXURE-2

Proposed minimum Canal Section in Irrigation Canals
Kakinada Canal, Eluru Canal and Commamur Canal



Proposed minimum navigational Channel dimension in
Godavari & Krishna river and Buckingham Canal.



ANNEXURE-3
DETAILS OF DREDGING

ANNEXURE-3

DETAILS OF DREDGING

Sl No.	Canal/River	Dredging Qty.
	Stage I	
1.	Kakinada Canal between Rajhmundry & Kakinada	362932 m^3
2.	Godavari Eluru Canal between Rajahmunadry & Eluru	1180391 m^3
3.	Godavari river between Pollavaram & Rajahmundry	95310 m^3
4.	Buckingham canal from Pedaganjam to Marakanam	16145210 m^3
5.	Marakanam to Puducherry (Kalapet)	1260904m^3
	Total	19044747 m^3 Say 19 million m^3
	Stage II	
1.	Godavari river between Bhadrachalam and Pollavaram	
	(a) Sand	267440 m^3
	(b) Rock	6440 m^3
2.	Krishna river between Wazirabad and Vijayawada	
	(a) Sand	205930 m^3
	(b) Rock	101210 m^3
3.	Krishna Eluru Canal between Vijayawada & Eluru	68718 m^3
4.	Commamur Canal between Pedaganjam & Vijayawada	151398 m^3
	Total Stage II Sand	693486 m^3 Say 0.69 million m^3
	Rock	107650m^3 Say 0.11 million m^3
	Grand total (Stage I+ Stage II) (Sand)	19738233 m^3 Say 19.74 million m^3
	(Rock)	107650m^3 Say 0.11 million m^3

ANNEXURE-4
DETAILS OF BRIDGES

ANNEXURE-4

DETAILS OF BRIDGES

Sl No.	Canal/River	Total number of Bridges	Bridges requiring modification
Stage I			
1.	Kakinada Canal	19 nos	4 nos
2.	Godavari Eluru Canal	34 nos	2 nos
3.	North and South Buckingham Canal	52 nos	28 nos
Total Stage I		**105 nos**	34 nos
Stage II			
1.	Krishna Eluru Canal	47 nos	6nos
2.	Commamur Canal	38 nos	7 nos
Total Stage II		**85 nos.**	13 nos
Grand Total (Stage I + Stage II)		**190 nos**	47nos

Note: There are three and two bridges in rivers Godavari and Krishna respectively but these bridges do not require any modification.

ANNEXURE-5
DETAILS OF NEW NAVIGATIONAL LOCKS

ANNEXURE-5

DETAILS OF NAVIGATIONAL LOCKS

Sl No.	Canal/River	Total number of Locks	Locks requiring modification
	Stage I		
1.	Kakinada Canal	6 nos	6 nos
2.	Godavari Eluru Canal	1 nos	1 nos
3.	North and South Buckingham Canal	29 nos	29 nos
	Total Stage I	**36 nos**	36 nos
	Stage II		
1.	Krishna river	1 no	1 no
2.	Krishna Eluru Canal	4 nos	4 nos
3.	Commamur Canal	7 nos	7 nos
	Total Stage II	**12 nos**	12 nos
	Grand Total (Stage I + Stage II)	**48 nos**	48 nos

ANNEXURE-6
DETAILS OF TERMINALS

ANNEXURE-6

Details of Terminals			
S.No.	Canal / River Section	No. of Terminals	Places
	Stage I		
1	River Godavari	1	Rajahmundry
2	Kakinada Canal	1	Kakinada
3	Godavari Eluru Canal	2	Eluru
			Tadepaligundam
4	Buckingham Canal		
(a)	North Buckingham Canal	4	Kottapatnam
			Maipadu
			Durgarajupatnam
			Ennore (South)
(b)	South Buckingham Canal	2	Muthukadu
			Markanam
5	Marakanam to Kaluvally Tank	1	Puducherry
	Stage II		
1	Godavari River	1	Bhadrachalam
2	Krishna River	3	Wazirabad
			Muktiyala
			Vijayawada
3	Krishna - Eluru Canal	0	
	Total	15	