GHAGARA REPORT

RITES

EXECUTIVE SUMMARY

1.0 Introduction

Ghagra River one of the main tributary of Ganga river has the potential to serve as an important means of transport in eastern part of Utter Pradesh. Growing agricultural production and idustrialisation have resulted in substantial increase of traffic and rail / road net work is not adequate to cater to this traffic demand. It is an established fact that inland water transport (IWT) is the cheapest mode of transport for certain kind of traffic both over long and short distances specially between places located on the water front. Inland water transport being more cost effective than other modes of surface transport can help in reducing the transport cost and stabilising the prices of commodities at a reasonable level.

In order to develop Inland Water Transport as a supplementary mode of surface transport in Uttar-Pradesh State, the State Govt has initiated development of water transport on river Ghagra between Faizabad and Manjhighat (Ballia). As a first step, hydrographic survey was carried out from Faizabad to Manjhighat by Inland Waterways Authority of India (IWAI) in the year 1991. Based on the results of the survey, Techno-economic study was conducted by M/s WIZMIN in the year 1996. This study established the techno-economic feasibility of this IWT project. Against this background, the office of the Transport Commissioner, U.P. commissioned RITES Ltd, a Govt. of India Enterprise, to prepare the Detailed Project Report for above mentioned corridor of Ghagra river in order to take an investment decision for the implementation of the project.

The objective of the study is to prepare a Detailed Project Report for development of IWT for transportation of cargo on a 345 km stretch of Ghagra river, between Faizabad and Manjhighat (Ballia), covering the required facilities to be developed along the waterway. The objectives of the present study are to:

- *Design technically best suitable and optimal system of waterways, vessel and terminals on the projected traffic volume.*
- *Fix competitive tariff for IWT and other services providing motivation to adopt this mode of transport by users.*
- *Make Environment impact assessment due to development of IWT on river Ghagra*
- *Work out cost benefit analysis and establish economic viability.*

The DPR study has been conducted for river Ghagra from Faizabad to Manjhighat (354km.), considering the prospect of linkage with National Waterways No.1.

2.0 Traffic estimation and projection

Traffic estimates based on detailed surveys conducted by M/s WIZMIN Consultants at the stage of techno economic feasibility study of the project in the

year 1996-1997 have been critically reviewed . Fresh origin and destination (OD) surveys were conducted and traffic potential updated in the present study. Discussions were also held with a number of Private agencies in the hinterland having potential cargo with a view to attract the traffic in IWT mode and the information used in working out traffic projection. The estimated cargo traffic projections are as under:

Cargo traffic projections

Year	2000-01	2004-05	2009-10	2014-15	2019-20
Cargo in tonnes	735310	897393	1331296	1878144	1878144

Based on the investigations, it was felt that no significant passenger traffic would materialise for IWT despite the absence of a road or a pontoon bridge across the river.

3.0 Hydrographic Survey

Water level gauges were fixed at proposed terminal sites and water level observations were recorded during survey period. Current observations were also recorded at each terminal site. Hydrological data for past 10 year i.e. maximum and minimum Water levels ,Silt data, discharge and velocity were collected from Central Water Commission for Ayodhya and Turtipar . Chart datum was fixed at CWC gauge stations(Ayodhya, Turtipar and Darauli) based on minimum water observed during past 15 years and chart datum for intermediate stations were determined by interpolation from the chart datum value fixed at CWC gauge sites . All recorded depths were reduced to the chart datum.

Hydrographic survey of study area i.e from Ayodhya to Manjhighat was conducted with the help of Differential Global Positioning System in Real-time mode (RTDGPS), and single frequency echo sounder fitted in a mechanized boat. Depths were also recorded by running boat on preplanned X-Section lines at an interval of 1000m approx. and data(position of depth and depths) were logged in computer. The NAVPACK software was used to real time boat tracking on planned lines, data logging of DGPS and Echo-sounder data into the computer . Continuous monitoring was done in respect of boat speed, direction, display of recorded depths and position on screen, bearing, and real time display of boat position on screen (updated every second) . A single Thalweg/longitudinal profile of river bed along the deeper course of the channel was recorded with the help of RTDGPS and Echo-sounder by running vessel along the deep channel of the river.

Topographic details of river bank and other silent features in the vicinity were taken from IWAI survey charts . All hydrographic maps were prepared on computer on scale of 1 : 12,500 and placed at **Volume –II of this report**

4.0 Waterway

Keeping in view the physical constraints of the Ghagra river and the size of deign vessel and NW-1, the channel has been designed with dimensions of 45 m width, 2m depth below chart datum, side slopes of 1:3 .

A total dredging quantity of about 95,63,200 cum is estimated for development of the design channel and at proposed terminals .The river bed material can be dredged using cutter suction dredgers. Dredging can be performed through a competent Agency. ***For the purpose of cost estimates, the annual maintenance dredging quantity has been taken as 10% of the capital dredging quantities based on past experience on similar projects*** *In order to determine the quantity of maintenance dredging as a result of the effect of such re-siltation with a fair degree of accuracy, hydrographic survey should be conducted at regular intervals for few years after the completion of the capital-dredging. The above dredging quantities are based on cross section taken at an interval of 1000m approximately and thalweg survey. For getting more realistic quantity of dredging it is advisable to carry out detailed hydrographic survey of study reach just before implementation of project.*

The banks are required to be protected at selected critical places i.e. existing cutting /eroded bank and other vulnerable points. In locations where availability of land is not a problem, sloped bank with stone pitching is proposed. The design provides for a side slope of 1:2.5 over which geo-fabric filter will be provided to prevent fine particles from flowing out. Over this geo-fabric filter, stone pitching of about 40 to 50 kg. size is proposed.

Suitable navigation aids to demarcate the channel for safe navigation are also proposed. Certain safety measures have been proposed to the bridge reach with inadequate clearances.

Total capital cost for developing 354 kms. long waterways from Ayodhya to Manjhighat for 33m wide, 2m deep channel for IWT initially plying 160 tonne vessels work out to Rs7245lakh and operating and maintenance to Rs.647 Lakhs

Total capital cost for developing 354 kms. long waterways from Ayodhya to Manjhighat for 45m wide, 2m deep channel for IWT for plying ultimate designed vessel for 600tonnes work out to Rs.8253 lakh and operating and maintenance to Rs.915.86 Lakhs

5.0 Terminals

The traffic forecasts in respect of cargo traffic have been used as the basis for the functional planning of the terminals in an optimal way. The proposed terminals are:

1. Ayodhya
2. Mahir pur (Tanda)
3. Dohrighat
4. Turtipar
5. Manjhighat

A table showing the important features of the terminals is given below:

Table for important features of terminals

S. No.	Name of Terminal	Chainage In Km	Type of Terminal	HFL(m)* In m amsl	SLWL** (m) in m amsl
1.	Ayodhya	2.000	Fixed Jetty(RCC)	93.643	87.220
2.	Mahirpur(Tanda)	70.100	-do-	89.760	83.337
3.	Dohrighat	189.800	-do-	73.920	68.000
4.	Turtipar	246.500	-do-	64.800	58.410
5.	Manjhighat	340.000	-do-	53.820	47.900

*** HFL = High Flood Level ** SLWL = Standard Low Water Level**

Note:- Zero chainage taken as center line of Ayodhya road bridge.

Considering the various governing factors open type berthing structure i.e. RCC piled berth and approach(es) is the most appropriate type of berthing structure for the terminals and aveadopted for this project. All terminals are proposed to be equipped with mechanised handling system as per the latest technology. The berths are planned in units of 70m length with an apron width of 15m with a service duct through out the length.

Each berth is provided with an approach connecting the berth to land. Wherever possible approaches are planned in a way to have unidirectional flow of vehicles on berths and approaches. Approach jetty is having a carriage way width of 7.5m, foot path of 1.5m width on one side and service duct.

The standardised designs are adopted in the proposed terminals depending on the number of berths required which are summarised below:

Terminal	Phase - I		Phase- III	
	Berths	Approaches	Berths	Approaches
Ayodhya	2No.(70mx15m)	2No.(50mx9.5m)	1No.(70mx15m)	1No (50mx9.5m)
Mahirpur	1No.(70mx15m)	1No.(30mx9.5m)	-	-
Dohrighat	2No.(70mx15m)	2No.(30mx9.5m)	1No.(70mx15m)	1No (30mx9.5m)
Turtipar	2No.(70mx15m)	2No.(30mx9.5m)	-	-
Manjhighat	2No.(70mx15m)	1No.(30mx9.5m) 1No.(50mx9.5m)	-	-

The total capital cost of these terminal is Rs. 12471 lakhs. The summary of capital cost and annual operating and maintenance of these terminals are given below:

Summary of Capital Cost

(In Rs. Lakhs)

Terminal	Capital cost				
	Phase - I	Phase - II	Phase - III	Phase - IV	Total
Ayodhya	2366	-	1153	-	**3519**
Mahirpur	1222	-	-	-	**1222**
Dohrighat	2210	-	1093	-	**3303**
Turtipar	2111	-	214	-	**2325**
Manjhighat	1998	-	104	-	**2102**
Total	9907	-	2564	-	**12471**

Summary of Annual Operating Cost

(In Rs. Lakhs)

Terminal	Annual Operating cost				Remarks
	Phase - I	Phase - II	Phase - III	Phase - IV	
Ayodhya	146	154	280	326	
Mahirpur	75	79	98	116	
Dohrighat	150	159	292	336	
Turtipar	134	142	208	241	
Manjhighat	113	117	167	187	
Total	618	651	1045	1206	

6.0 Vessel Design

Keeping in view the channel parameters and propulsion systems as discussed Vessel Design chapter, the following two types of self propelled vessel having cargo capacity of 160 tonne and 600 tonne are proposed.

***160 tonne vessel* is recommended initially to start the IWT and attract private Enterpenures to divert the traffic load from rail/road sector and these vessel would be replaced suitably by 600 tonnes vessel when the required traffic will be available for IWT sector. The actual nos. of the 160 tonnes to start the IWT operation will depend on the availability of fund.**

Principal particulars of these self propelled vessel for operation on the Ghagra river are: -

160 tonne vessel (Fig. 6.1):

Length	*:28.5 meters*
Breadth	*:5.5 meters*
Maximum Draft	*:1.8meters*
Cargo capacity	*:120 tonnes at 1.3 meter draft*
	:160 tonnes at 1.8 meter draft
Propulsion System	*: Marine Diesel Engines with propeller =2, 100HP each*

600 tonne vessel (Fig. 6.2):

Length	*:56.06 meters*
Breadth	*:10.40 meters*
Maximum Draft	*:1.85meters*
Cargo capacity	*: 500 tonnes at 1.5 meter draft*
	600 tonnes at 1.85 meter draft
Propulsion System	*: Marine Engines=2, output =240kw MCR(each) with speed of 1350-1500*

Self-propelled vessels are proposed to be deployed for services between two fixed stations as in the instant case under study, namely between Calcutta and Ayodhya. In consideration of the foregoing it is recommended that self propelled barges of shallow draft suggested above need be specially designed for this waterway so that these may carry optimum payloads and ply without interruptions.

The basic assumption for calculating the number of vessels for normal traffic is as under:

Vessel speed in D/S: 15.5 km/hr. Vessel speed in U/S: 12.8 km/hr.
Average speed of Vessel: 13.75 km/hr.
No. of days in year = 330 days vessel will be available
Detention time at each terminal for
Loading and unloading =24hrs(12hours per day).

The number of vessels required for the projected traffic are as follows:

For 160 tonne vessel

Year	2001-02	2004-05	2009-10	2014-15	2019-20
No. of cargo vessels	100	125	191	276	276

For 600 tonnes vessel

Year	2001-02	2004-05	2009-10	2014-15	2019-20
No. of cargo vessels	27	33	51	74	74

The optimum vessel designed carries a 240kw propulsion engine, giving a speed of 8.5knots. The vessel can cater to the current, which is high during flood season. The vessel can accommodate a maximum 600 tonnes of cargo. It is considered that the vessel will be available for a period of 330 days in a year. Cost of the proposed vessels are given below:

160 T Vessel

Cost of vessel : Rs. 63.00 lakh per vessel
Operating and Maintenance cost :Rs. 17.37 lakh per vessel per year
(Fuel, Maintenance, Crew) per year

600T Vessel

Cost of vessel : Rs. 675.00 lakh per vessel
Operating and Maintenance cost :Rs. 74.25 lakh per vessel per year
(Fuel, Maintenance, Crew) per year

With provision of night navigation aids enabling 'round the clock' navigation, operational cost would be reduced by nearly one third.

7.0 Organization set up

An organization set up has been worked out considering the total requirement of operation and maintenance. This organization named as ***U.P. Inland Water Transport Development Authority***, will handle all matters relating to operation and maintenance of navigational waterway and will have jurisdiction and control over all government, public and private vessel operators.

8.0 Environment impact assessment

Initial Environmental Examination (IEE) of navigation of River is undertaken as per Environmental Protection Act (1986). The river Ghagra passes through 11 districts for which its forms the main channel of drainage. The main tributaries of the Ghaghra are Rapti, Budi Gandhak, Bahroi on the left bank. The geology of the districts shows only *gangetic alluvium*. The soil in the area is light sandy/dense

clay of yellowish brown colour. Some of the towns located on the bank of the river are Ayodhya, Tanda, Golaghat, Bahalganj, Dohrighat, , Turtipur, Darauli and Manjhighat. Waste Water drains meet with Ghaghra river at many places. Some of these drains discharge polluted water. to discharge it into the river. Tanda Thermal Power Plant is discharging effluent of the plant and its colony into the river. Dhobi Ghat, Cremation Ghat , Bathing ghat and Cattle washing hutments are other sources of pollution. The ambient air quality monitored in February, 2001 indicates that the SPM concentration ranged from 126 to 178 $\mu g/m^3$ which is well within the permissible limits. The average sound levels at the three monitored sites ranged between 67–70 dB(A), equal to or below the prescribed limits of 70 dB(A) for industrial areas. No endangered /rare species of flora and fauna have been observed in the study area.

The project will not pose any displacement to people, loss to cultural monuments and religious structures. In all ,about 5.90 ha of land is likely to be utilised to accommodate terminal buildings and other infrastructure. There will be no change in the drainage pattern of the area. The total refuse generated at all the terminals from all the sources will be about 150 tonnes per year. The main issues which need attention is soil erosion, pollution and health risk.

The oil spills from vessels and its spread on water may cause odour problems, and killing of aquatic life even in a short duration. The maximum noise level would be about 46 dB(A) at 50m distance from vessel which is slightly higher than the limits for sensitive zone. The dredging of 9.6 million cubic meter of sand with silt will uproot the habitat and breeding places of aquatic flora and fauna along the route and add to the already existing water pollution problems. There might be rise in SPM, NO_x and SO_2 levels during operation phase. However, with the implementation of the project, the ambient air quality is likely to be improved as peak hour peak direction trips will be shifting to this mode of transport. No loss of forest/trees is anticipated.

Positive impacts due to this project will be: employment opportunities, safety; traffic congestion reduction, less fuel consumption, reduction in noise levels, and air pollution reduction.

Compensation has to be paid to people for loss of their land. The oil and grease spill should be minimized by regular service and proper maintenance of engines, prohibition of their discharge into the surface water, installation of oil and grease removal traps. The vessel must be provided with storage bins on board for storing solid waste. The dredged material is proposed to be deposited on the banks of river to strengthen the banks. The problem of increased short term turbidity at dredging site can be tackled by efficient use of less intrusive dredging equipment, by providing silt curtains and dredging during low flow periods. It is proposed to use engine which produces less noise, muffler at engine exhaust, non-horn zone in the core area. To protect the ecological habitat, new habitat needs to be developed. In the immediate vicinity of existing habitat, plans need to be initiated

to develop aquatic farms for development of species in the area, new habitat should be protected from soil erosion, floods. Water sources should be treated before use upto WHO drinking water standards. On board, sewage/excreta disposal facility needs to be provided.

The environmental monitoring will be required during construction and operational phases for Water quality and public health, soil conservation measures, soil disposal, habitat management, and air and noise pollution.

Project will ease out the traffic situation in the hinterland. The navigation and terminal facilities will cost about Rs 1243 million. There will not be much change in the landuse due to the construction of five terminals on the way. The water quality is suitable for drinking with treatment . Drain carrying waste water should not be allowed to discharge without treatment to permissible limits. With the implementation of IWT through River Ghaghra there will be improvement in ambient air quality of the area. However, air quality will deteriorate over Ghaghra River. No loss of tree/vegetation is anticipated due to the project. A detailed investigation about the fish fauna is essential. The project will have beneficial impacts such as more employment opportunity, safety, traffic congestion reduction, less fuel consumption, reduction in noise level, air pollution reduction and less carriages in number.

9.0 Implementation Schedule

The project is proposed to be executed in three phases commencing from the year 2004-2005 and the implementation schedule worked out accordingly. The implementation period of project is four years.

10.0 Project Appraisal

The cost benefit analysis for waterway would necessitate finding out total capital and operating cost for next best alternative so it can be taken as benefit in case of foregoing IWT mode. In the command area for IWT on river Ghagra , the only alternative available is road. A comparative evaluation of total cost based on NPVs drawn for a period of 33 years has been done for Transportation by road and rail which indicates it would be cheaper to move cargo by IWT. The road mode has been chosen for cost benefit analysis w.r.t. IWT.

The details of capital costs and O&M cost are furnished bellow:

Capital Cost

(In Rs. Lakhs)

Year	Waterways Improvements	Terminal Cost	Vessels
2002-03	-	3240	-
2003-04	6143.25	6667	-
2004-05	-	-	7875
2008 –09	2109.75	-	-
2009-10	-	-	12150
2013-14	-	2564	-
2014-15	-	-	15525

O & M Cost : IWT Cost

(Rs. lakhs)

Year	Waterways	Ghagra Terml.	NW1 Terminals	Vessels
2004-05	647	651	153	2171
2009-10	915.86	1045	218	3503
2014-15	915.86	120	296	5205

The evaluation of alternatives for this project has been done on the basis of internal rate of return (IRR). IWAI and National economy.. The charges assured for used off assets to be provided by concerned authority on cost pulse system providing 12% return investment. The chargers proposed are ground rent, cargo handling charges and transit dues.

Financial IRR for the entire project life of 30 years works out to 7.7%. In case 30% subsidy on purchase price of vessels is offered as per the announced policy Govt. of India (Ministry of Shipping)in Jan. 2001,The FIRR works out to 10%.

In a possible private/public partnership scenario with the state Govt. bearing the capital cost of development of waterways and not levying charges on the uses of the waterway along with the subsidy on the flotilla as per the Govt. of India announced policy, the financial return of the private operators is estimated to be 13.8%

In request economic benefit of the project this was considered in the context of the next best alternative i.e. road transport which does not require additional expenditure towards widening of road stretch under reference. Due consideration has, however, been made in Economic analysis by proportionately accounting for annual repair and maintenance cost of the road sections. The EIRR worked out to about 1%.

11.0 Conclusion and recommendation

The study for detailed project report for development of Inland Water Transport in river Ghagra from Faizabad to Manjhighat and connecting of this waterway to national waterways No. 1 has been carried out as per the terms of reference contained in the agreement for this work. The details of the study are given in the preceding chapters.

A summary of the conclusion and recommendations as a result of the above study is as follows:-

Conclusion

Project appraisal indicates that a financial IRR of the project is 10%. Though the ideal IRR to go ahead with the project as per standard norms will be 12 or more, it is, advisable to go ahead with the project due to the following reasons:-

- The project is self sustaining and hence no funds are required from the State Government to operate the project

- A new environment friendly and fuel-efficient mode of transport will be commissioned in the State. This is expected to improve general environment and the general river regime. Beside, this establishes river connectivity with the other states of Bihar, West Bengal etc. through NW-I and subsequently to other neighboring countries like Bangladesh, Myanmar etc. in the long run.

- The economic IRR of the project is only 10%. This is mainly because of the existence of national highway on both sides of ghagra river besides railway route which carry bulk of the cargo. However, inview of the cheaper freight rates of the cargo which will be transported by IWT, there is a possibility of diversion of considerable quantum of cargo getting diverted from road/railway to IWT in course of time. Moreover development of IWT ghagra river will also generate a lot of employment and attract the industrial entrepreneurs to set up their industries along the river. This will lead to further economic development and prosperity the villages/town situated alongwith the river.

- Private participation in operating the IWT services may be considered in detail after investment decision is taken by the Govt. of UP to implement the project.

Recommendations

Before taking up detailed engineering and execution of the project, the following points will have to be addressed.

- Since the hydrographic survey of the study reach was done by IWAI in 1991-92 i.e. 10 years back, and no topographic survey alongwith the river banks has been done so far, it is necessary to carry out detailed hydrographic survey to

update the survey charts and detailed topographic survey to firm up the correct data of the bank lines of both the banks of the river and to facilitate model studies for location of the terminals and planning/design of river training works.

- Necessary geotechnical investigations should be conducted in the final terminal locations to determine the soil/rock properties and design of foundation of the jetties and other infrastructure works.

- Model study should be carried out to firm up the terminal locations at Ayodhya and Turtipar and facilitate planning/design of river training works.

CHAPTER – 1

INTRODUCTION

1.0 Preamble

Ghagra River an important tributary of Ganga, has the potential to serve as an important means of transport in eastern part of Utter Pradesh. Growing agricultural production and industrialisation have resulted in substantial increase of traffic and rail / road net work is not adequate to cater to this traffic demand. It is an established fact that inland water transport (IWT) is the cheapest mode of transport for certain kind of traffic both over long and short distances specially between places located on the water front. Inland water transport being more cost effective than other modes of surface transport can help in reducing the transport cost and stabilising the prices of commodities at a reasonable level. The following table illustrates the distinct advantage of IWT over the other modes of transport:

Inter-modal Comparison			
	Road	**Rail**	**IWT**
Energy consumption (Lts. Of HSD per 1000Tkm)	40	11	5.5
One Horse Power can move in kg.	150	500	4000
*Operator Costs **	312	138	100
** Based on 500 T vessel travelling over 300km.*			

1.1 In order to develop Inland Water Transport as a supplementary mode of surface transport in Uttar-Pradesh State, the State Govt has initiated development of water transport on river Ghagra between Faizabad and Manjhighat (Ballia). As a first step, hydrographic survey was carried out from Faizabad to Manjhighat by Inland Waterways Authority of India (IWAI) in the year 1991. Based on the results of the survey, an Techno-economic study was conducted by M/s WIZMIN in the year 1996. This study established the techno-economic feasibility of this IWT project. Against this background, the office of the Transport Commissioner, U.P. approached RITES Ltd. (A Govt. of India Enterprise), New Delhi to submit an offer for conducting the Detailed Project Report study for above mentioned corridor of Ghagra river in order to take an investment decision for the implementation of the project.

Based on RITES' offer, State Transport Commissioner awarded the work of preparing the detailed project report for development of inland water transport on river Ghagra between Faizabad and Manjhighat (Ballia) to RITES Ltd. vide their letter no.552/30-1-2000/J.P./86 dated 15th March 2000. An index map to the study reach is enclosed at **Annexure: 1.1.**

1.2 Objectives

The objective of the study is to prepare a detailed project report for development of IWT for transportation of cargo on a 345 km stretch of Ghagra river, between Faizabad and Manjhighat (Ballia), covering the required facilities to be developed along the waterway. The objectives of the present study are to:

- *Design technically best suitable and optimal system of waterways, vessel and terminals on the projected traffic volume.*
- *Fix competitive tariff for IWT and other services providing motivation to adopt this mode of transport by users.*
- *Make Environment impact assessment due to development of IWT on river Ghagra*
- *Work out cost benefit analysis and establish economic viability.*

The DPR study has been conducted for river Ghagra from Faizabad to Manjhighat (345km.), considering the prospect of linkage with National Waterway No.1.

1.3 The Ghagra river

River Ghagra is a major tributary of river Ganga. Ghagra is a snow fed river and has plenty of water throughout the year. In its 1080km long course it flows through the eastern districts of U.P. viz. Faizabad, Bahraich, Gonda, Basti, Deoria,Gorakhpur, Ballia, Azamgarh and Chhapra in Bihar (catchment area of 1,27,500sq.kms). Nearly 8% of the river length flows in Nepal and the rest in India. Its origin is near lake Mansarovar (Chuiaghat hills), from where it flows in the south eastern direction to enter Nepal . It is known as Manchu and Karnali in Nepal. As the river enters Nepal it breaks into several channels. River Karnali comes out from Nepal at Cheesapani and the total catchment area of the river up to Cheesapani is 42,457 sq.km. River Ghagra joins river Ganga at Chhapra in Bihar State.

Tributaries of Ghagra river in the up stream of study area are Saryu, Sarda and Tiralicho. Sarda is the major tributary of Ghagra river; it joins Kauriala river , after which the river is called as Ghagra. Saryu river(tributary) Joins Ghagra down stream of Sarda confluence.

Tributaries of Ghagra river within the study area are Rapti, Kuwana and little Gandak.

Close to Indo- Nepal border across river Ghagra **Girija barrage** has been constructed. Two irrigation canals namely Sarda Sahayak and Saryu main canal with capacity of 650 cumecs and 360 cumecs respectively take off from this barrage.

1.4 Past studies on river Ghagra for development of IWT

The following studies for development of IWT in river Ghagra have been carried out in the past:

1.4.1 To assess navigability in river Ghagra, IWAI conducted a 'hydrographic survey in River Ghagra from Faizabad to Manjhighat (345kms.)' at the instance of the Transport Commissioner Govt. of UP during the period Feb. to June 1991. The salient features of this survey are:

- Hydrographic charts on the scale of 1: 12,500
- Water level observations(daily day time readings at 10km intervals)
- Wet cross sectional soundings at an interval of 300m
- Thalweg Survey during the month of Feb. and another thalweg survey towards the end of detailed survey.

The report covering the above aspects was submitted in 1992 to the Transport Commissioner, Govt. of U.P.

IWAI report recommended a master plan study as a follow up to establish the Techno- economic feasibility of IWT. Important aspects to be covered in the study are:-

- Pilot study at selected shoal zones of 4 to 5 kms to ascertain the sustainable depth by regulation technique.
- Assessment of scour and selection of river training works.
- Identification of fairway development techniques and cost benefit analysis with reference to sustainable LAD, fleet size and achievable IWT cost(user cost).
- Full level traffic study including comparison of IWT mode with other modes of transportation.
- Identification of cargo potential present and future.

1.4.2 For exploring the possibility of developing inland water transport on river Ghagra , **M/s WIZMIN, Kanpur** was entrusted with the work of carrying out a **Techno – Economic Feasibility study for development of IWT on river Ghagra from Faizabad to Manjhighat (345kms)** by the office of the Transport commissioner, Govt. of U.P. in 1995-96. Based on the hydrographic survey conducted by IWAI in 1991 and traffic study, M/s WIZMIN submitted the report in 1997 to the State Transport Commissioner Govt. of U.P. The findings of this study is placed at **Annexure : 1.2.**

1.5 Scope of Present study

1.5.1 Review the Traffic projections for this waterway including divertable cargo and passenger traffic along and across the river indicated in earlier studies conducted by WIZMIN.

1.5.2 Review earlier Hydrographic survey conducted by IWAI and study the river Morphology, Hydrological, geo-technical and hydrographic condition,

operation and maintenance requirements in this stretch to identify works in sufficient detail that are required in respect of:

a) Hydrographic Survey

(i) Collection and study of available data regarding water level, depth, velocity, discharge, cross-section, bed and bank material, hydrographic, topographic data etc of rive Ghagra from various sources like Central Water Commission(CWC), concerned State Development, National Remote Sensing Agency, Survey of India, Central Water & Power Research Station(CWPRS), National Hydrographic Office(NHO) etc. and also identify the missing data to be collected in the field.

(ii) Carry out necessary thalweg survey of river Ghagra and study/ identify necessary bed regulation and / or water level/ discharge regulation for at least 2 m depth throughout the year.

(iii) Assess the depth of the flow in the river in the leanest period, the depth requirements for design vessel and minimum flow required to ensure this depth in the entire stretch proposed for navigation.

b) To select tentative location and carry out preliminary topographic surveys for river training works in different stretches of the river.

(i) 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 of 2 m depth and 45 m width in the river

c) IWT terminals on the River

(i) Conduct necessary bore hole drilling and preliminary geo- technical investigations at terminals

(ii) 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.

(iii) Plan and design of terminals taking into consideration the environmental condition 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 distance for ship to ship and ship to shore operations.

(iv) Study the draft requirements 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 dredged material for back-filling of proposed terminal. Indicate the inter-model cargo transfer facilities that are required at proposed terminals.

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

e) Avoiding adverse interference of shipping and navigation on other users of water (like irrigation / drinking water, fisheries etc.)

1.5.3 Identity suitable location and work out details for terminals including waiting berths, cargo handling facilities, cargo storage facilities, bunkering and repair facilities, passenger embarkation and disembarkation facilities at ferry ghat and also at other terminals road and rail transport linkage facilities etc.

1.5.4 Outline infrastructural facilities including communication facilities, channel patrol, security enforcement of rules and regulations, pilotage, issue of river notices, river charts, river warnings, rescue and salvage etc. to be provided during 2000,2005,2010 and upto 2025.

1.5.5 Work out the details of the type of the vessels and the number and cost for the passenger and cargo traffic projected phase-wise for 2000, 2005 and upto 2025 and the details of the proposed repair facilities for maintaining these crafts.

1.5.6 Prepare cost estimates for various possible alternatives for all 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.

1.5.7 Prepare detailed time schedule for the whole project indicating the time requirement of various components of the project from inception till commissioning of the same. Suggestions shall also be given for executing the project in different phases with split up details of the works and cost thereof.

1.5.8 Assess the environmental impact of these development works, the environmental/ pollution control measures to be adopted, and data of cost towards this be spelt out in the estimate.

1.5.9 Work out the organisational set up required for managing waterway including offices, residential accommodation for management duties providing for future expansion.

1.5.10 Work out the organisational set up and supporting facilities that are required for enforcement of rules and regulations related to shipping

and navigation, logistic support like communication network, patrolling and policing, registration and survey of vessels, rescue management, salvaging works insurance/ damage claims etc.

1.5.11 Indicate inter-modal cargo transfer facilities that are required at these terminals.

1.5.12 Workout transport cost of cargo, commodity wise per tonne-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 water 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.

1.5.13 Suggest the 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.

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

1.5.15 Identify and recommend the vessel suitable to ply both in the Ghagra waterway as well as in the National Waterway No. 1 (Ganga).

1.5.16 Make a study of the economical sizes and type of cargo vessels to be employed keeping in view the present and future traffic projections and plan the infrastructural development suitably to meet these phased requirements including possible introduction of inland vessels in future.

1.5.17 Work out the expected financial and economic returns

A) Economic Analysis

Economic analysis shall be carried out for the following three assumptions.

- Investing in the development of inland water transport services in the IWT routes under this project.
- Investing in improved rail/road connections to cater to the same volume of traffic according to available data.
- 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 2000 AD the year in which the first major infrastructural investments may be made. Costs shall be exclusive of all duties, taxes, levies and charge and shall be discounted from data of expenditure. Benefits shall include lower transport cost as

well as benefits to the national economy and related developments in the river Ghagra.
Risk 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 the consideration of State Govt.

B) Financial Analysis

In the financial analysis economic cost and benefits shall be replaced by constructions purchases, operation and maintenance cost subject to market forces and by equivalent freight rates and charges and other benefits, in so as they can be reasonably established.

A table showing annual expenditure and benefits shall be prepared and the net present value of 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 be used to work out the financial internal rate of return (FIRR) for the investment. Vessel operation will be considered as expected to be provided through participation. The activity will consider aspects of revenue mobilisation and reforms in tax structure and to work out the FIRR.

1.5.18 Workout the time schedule and phasing of expenditure for implementation of the proposed scheme for the 1st phase upto A.D. 2010.

1.6 Report Preparation

The Detailed Project Report covering all the above aspects have been prepared as per the established guidelines and practices.

CHAPTER - 2

TRAFFIC POTENTIAL

2.0. Introduction

In view of the increasing congestion and related problems on rail and road corridors and the advantages which the inland water transport (IWT) mode enjoys over other modes of transport i.e. rail and road, the Government is very keen to develop IWT as an alternative mode of transport. Allahabad-Haldia stretch of river Ganga has already been declared as National Waterway No.1 (NW-1). Efforts are also underway to make NW-1 operational over its entire stretch, as early as possible, for relieving the congestion on rail and road transport on this corridor.

2.1 Scope of Work

2.1.1 The scope of work under the present study comprises inter-alia of a review of the traffic projections (including assessment of divertible traffic - both goods and passenger, along and across the Ghagra river) projected by the WIZMIN in their report.

2.2 Methodology

2.1.2 While considering inter-modal allocation of traffic, the broad criteria for assigning traffic to IWT will be such that the haulage over the river is over reasonably long distances and where the origins or the destinations of traffic are located relatively closer to the river bank. Besides, the commodities for movement by river transport should be low-rated bulk commodities that would sustain a comparatively longer transit time. In other words, traffic diversion to IWT would take place only if the over-all haulage cost to the users turns out to be the lowest by IWT as compared to the over-all cost of available alternative modes.

2.2.2 For reviewing the traffic estimated in the earlier study by WIZMIN, terminals already proposed in their report were considered. Since the entire area along the north and the south banks of river Ghagra is likely to be served by five IWT terminals, the Catchment area of each terminal was demarcated separately as part of our work for assessing the relevant traffic volumes.

2.2.3 In order to estimate the base year traffic, relevant information was collected for the existing modes of transport, i.e. road and rail. In the case of base year passenger traffic flows, relevant streams were identified based on sample passenger interviews separately for rail and road. For the Railways, requisite information was collected from the railway station

records; for estimating the number of road passengers, bus flow pattern had been generated by using bus schedules operated from various bus stands and the average number of passengers travelled on relevant routes. Since a large number of jeeps / tempos were also observed to be plying on regular basis, on the relevant parallel routes to IWT, requisite information was collected through personal interviews and en-route surveys on selected corridors.

2.2.4 For ascertaining the existing railway goods traffic flows between different pairs of points, the required information was collected from railway station records as well as selected railway users. ***For road freight flows, since no recorded information was available from any secondary source, relevant information had been collected through(Primary surveys the only authentic source of such information) the Origin-Destination (O-D) surveys at five locations covering all important routes in the Catchment area.*** At each survey point, sample goods vehicles were intercepted and information regarding their origin, destination, type of commodity carried and its weight were elicited. Traffic count surveys were conducted round-the-clock for three days at all the locations.

2.2.5 In order to overcome the discrepancy arising on account of sample vehicle data as well as the impact of seasonality aspect of traffic flows, selected traders in respect of each important commodity were contacted and the feed back results were superimposed on the O-D flows arrived at through the survey data.

2.2.6 To consider total divertable traffic for each proposed terminal, comparative modal costs were considered. As road mode would be the other competing mode for IWT, total costs of transport for either of the modes had been worked for each O-D pair. The O-D pairs, where IWT would be able to offer comparatively cheaper services were identified. In addition, in order to ascertain the level of diversion on such O-D pairs, comparative advantage of IWT vis-à-vis overall road haulage costs had been calculated. In this exercise, the level of transport margin offered by IWT over road haulage costs was used to decide base year level of diversion. Maximum and minimum levels of diversion ranged between 30 and 10 per cent.

2.2.6 Some of the commodities, such as POL and ISO containers that require specialised facilities at terminals for their handling had not been considered, owing to the low volumes of traffic of the commodities and also higher costs. For the horizon years, as the level of diversion was also expected to improve, the same had been incorporated in the traffic projections.

2.2.7 While the ***base year traffic pertains to the year 2000-01(the goods OD surveys were conducted in March,2001),*** the traffic for the horizon

periods viz. 2004-05, 2009-10 and 2014-15 have been projected by working out and using the commodity-wise raising factors. Different proportions / levels had been used to arrive at the divertable traffic related to primary, secondary and tertiary hinterlands of each terminal.

2.3 Project Influence Area (PIA)

2.3.1 The proposed IWT stretch would not only benefit the areas / districts on either bank of river Ghagra but a large area in other states might also be benefited because of the overall length of IWT stretch between Ayodhya and Haldia. In this exercise, IWT terminals proposed in the Ghagra River in the earlier study had been reviewed in detail. The expenditure required for the development of IWT terminals on NW-1 as well as its waterways, required to attract the potential traffic to Ghagra River, had been kept outside the purview of this study.

2.3.2 For estimating the divertable traffic to IWT, the Catchment area of each terminal was divided into primary, secondary and tertiary hinterlands, based on proximity to the proposed terminal location. Broadly, the primary area was conceived as representing the district in which the proposed terminal would fall. Since Ghagra River also acts as a dividing line between many districts, the districts on the other bank of river directly connected with the road-bridge could also be considered under the primary hinterland area. The secondary hinterland would represent the districts adjoining the primary hinterland that may also be benefited by the proposed terminals. As the proposed IWT stretch would form part of Haldia–Manjhighat stretch of NW-I, long distance IWT services would benefit a much larger area. Keeping in view the cost advantages of IWT, the Catchment area was thus further extended and included under the tertiary hinterland. Terminal-wise area of influence / hinterland is described below.

2.3.3 Ayodhya

Ayodhya is located in District Faizabad, on the south bank of river Ghagra. The IWT terminal is proposed near the rail bridge presently under construction near the road bridge on NH-28. Its primary hinterland would cover districts of Faizabad, Gonda and Basti, as the north end of the bridge opens into District Gonda, near Gonda-Basti dividing line. Owing to their close proximity, districts of Sultanpur, Bara Banki, Bahraich and Sidharthnagar would fall under the secondary Catchment area of Ayodhya terminal. As Ayodhya would be the farthest end of Haldia-Ayodhya IWT stretch and keeping in view the cost advantages of IWT system, its tertiary catchment area was extended up to the entire western Uttar Pradesh which could more economically be served by the proposed IWT services.

Ayodhya town is presently well connected by rail and road. On the road sector, the area is served by National Highway No.28, a number of State Highways, Major District Roads and Other District Roads. On the rail sector it has a broad gauge (BG) connection. For goods traffic on rail sector, Ayodhya railway siding is presently used only for handling coal whereas Faizabad goods siding is used for handling commodities like, cement, fertilisers, foodgrains, etc.

2.3.4 Tanda

Tanda also is located on the south bank of river Ghagra in District Faizabad. The IWT terminal is proposed near village Tanda, about 74-km down-stream of Ayodhya. Tanda is presently connected both by road and rail. Rail services are open only for handling coal for the Thermal Power Plant located about 4 km away from Tanda village on the south bank. On the road sector, a single-lane road connects Tanda to State Highway (Faizabad–Akbarpur section), starting from Maya Bazar. Distance from Tanda to Faizabad is 62 km (Faizabad–Akbarpur 30 km and Maya Bazar-Tanda 32 km). District Basti is on the north bank of the river. Presently, Tanda is connected to Basti by a pontoon bridge which allows only light vehicles to cross the river.

Both Ayodhya and Tanda terminals fall in the same civil district and thus have an overlapping Catchment area. However since Catchment area of each terminal would be differentiated based on its nearness to the respective terminals, the primary hinterland of the Tanda terminal would cover a part of Faizabad District. Sultanpur district, running parallel to Faizabad district could also be partially served through Tanda terminal. As such, it could be considered on the same lines in the secondary Catchment area of the terminal. No tertiary hinterland was considered for Tanda terminal.

2.3.5 Dohrighat

Dohrighat is located in district Maunath Bhanjan, on the south bank of the river Ghagra. The place is presently served both by rail and road networks. On the road sector, Dohrighat is connected by NH-28 and a number of MDRs, ODRs and village roads. While Dohrighat has a meter gauge (MG) railhead, the nearest broad gauge (BG) railheads are Indara (30 km from Dohrighat) and Mau (about 40 km from Dohrighat). For goods handling by rail, Indara is mainly used for coal and Mau for other commodities like cement, fertilisers, foodgrains, etc.

The districts of Maunath Bhanjan, Azamgarh and Gorakhpur could be considered as the primary hinterland of Dohrighat and the secondary Catchment area as extended up to Maharajganj district. Since the entire Nepal bound coal traffic entering from Bhairahwa (indo-Nepal Border)

passes through this route, the same could be considered under the tertiary hinterland of the terminal.

2.3.6 Turtipar

Turtipar terminal is located on the south bank of river Ghagra in Ballia district. Presently the north and the south banks of the river are connected by a pontoon bridge. The IWT terminal is proposed near the road-bridge (under construction) which would connect Ballia District with Deoria. On the road sector, Turtipar is connected through a single-lane road. Once the road-bridge is complete the road network serving this location would also improve. Presently, the north and the south banks of the river are connected a by pontoon bridge. On the rail sector, the nearest railhead is at Turtipar that lies on the north bank of the river, whereas Turtipar village is located along the south bank. Another railhead Balthara Road is about 10 km away from the proposed terminal.

Due to the fact that the road-bridge is nearing completion, districts of Ballia and Deoria could be considered in the primary hinterland of the terminal. No secondary and tertiary hinterlands were considered for this terminal.

2.3.7 Manjhighat

While all the other terminals proposed on this stretch fall in Uttar Pradesh, Manjhighat lies in Bihar. The terminal is proposed on the north bank of the river. Manjhighat terminal is connected by a State Highway with Chapra town in Bihar. The primary Hinterland of Manjhighat would include districts Chapra and Siwan of Bihar lying along the river; Gopalganj district was been taken as the secondary hinterland for Manjhighat.

2.3.8 Primary, Secondary and Tertiary Hinterland of each terminal is summarised in **Table 2.1**.

Table 2.1 : Terminal-wise Primary, Secondary & Tertiary Hinterland (Districts)

S.#	Terminal	Primary Hinterland	Secondary Hinterland	Tertiary Hinterland
1.	Ayodhya	Faizabad, Gonda & Basti	Sultanpur, Bara Banki, Bahraich & Sidharathnagar	Entire Western Uttar Pradesh
2.	Tanda	Faizabad	Sultanpur	-
3.	Dohrighat	Maunath Bhanjan, Azamgarh & Gorakhpur	Sultanpur	-
4.	Turtipur	Ballia & Deoria	-	-
5.	Manjhighat	Chapra & Deoria	Gopalganj	-

2.3.9 Inter-Terminal Distances

Inter-terminal distances for all the terminals on NW-I and the proposed stretch of Ghagra River are presented in **Annexure : 2.1**.

2.4 Commodity Composition

2.4.1 Originating Commodities

Major originating commodities likely to be handled at various IWT terminals are discussed below:

1. **Ayodhya**: Rice, wheat, pulses, sugar, paper & paper products, livestock leather and general goods.

2. **Tanda**: No originating traffic is assigned as the entire trading of the region is controlled at Faizabad and Ayodhya.

3. **Dohrighat:** It would serve the districts of Maunath Bhanjan, Gorakhpur, Maharajganj and Azamgarh; the major originating commodities identified were rice, wheat and sugar. It was also observed that a sizeable quantity of wheat and rice was exported to Bangladesh from this area, which could more economically be transported through the proposed IWT services.

4. **Turtipar**: Would cover two districts of UP viz. Deoria and Ballia and would mainly handle rice, wheat and sugar. Our field investigations had revealed that there were 17 sugar mills in Deoria district of which presently only eight were working. A major portion of sugar was despatched to Calcutta for trading.

5. **Manjhighat**: A sizeable quantity of coarse sand (Baloo) was observed to be received from Koil Work (Son River) by motor boats at Dohriganj and was transported by trucks to various districts in U.P. and Bihar. Dohriganj is about 30 km away from the proposed terminal at Manjhighat. The traders were of the opinion that this traffic could come to Manjhighat by the country boats for onward transportation to relevant regions either by using IWT services on River Ghagra and NW -1 or by trucks.

2.4.2 Terminating Commodities

On the terminating side, coal was reckoned as the only major commodity proposed to be handled at various IWT terminals. Although presently there are no major industries in the primary or secondary hinterland, coal is required for thermal power stations and brick kilns.

2.4.3 Thermal Power Plants

The only thermal Power Station on this stretch that could be served by the proposed river services is NTPC's Thermal Power Plant at Tanda which is about four kms from the proposed IWT terminal location. The annual requirement of coal of this plant would be about 2 million tonnes.

2.4.4 Brick Kilns in the Hinterland

During the field surveys, the Consultants discussed with the brick kiln owners and associations and were informed that each district in the primary and secondary hinterlands of the proposed terminals had a large number of brick kilns, with capacities ranging between 2 lakh to 11 lakh bricks per round. (On an average a brick kiln generally has 7 to 8 rounds per year.)

It was noted that presently coal was coming from Bihar collieries through Railways. However, if IWT ensure economical services (from coal pithead to the plant site), the Thermal Power Plant authorities would be inclined to use the proposed IWT services. Further, the Plant authorities are consider further expansion of the plant capacity as a result of which coal demand would further improve. Since coal was being received from different collieries from Bihar, the entire coal requirement could not be assessed through sample road O-D surveys. However, the Consultants had carried out detailed market surveys using the 'knowledgeable persons approach' to arrive at the broad demand of coal in the region for each terminal.

Coal for brick kilns was received both by rail and road. As informed by the trade, about one third of the total requirement of coal was met through rail and the remaining two-third by road. The coal received by road, its main source being Barakar area in Bihar, is generally of inferior quality. The trade further informed that source for supply of similar quality of coal were also available mines In-and-around Bhagalpur and Munger Distrcits of Bihar. Once the IWT services were operative on this corridor, the trade may opt for Munger and Bhagalpur IWT terminals for coal traffic, keeping in view the overall cost advantages. In the current exercise the same was taken into account and the coal traffic estimated to move from Barakar area was partly diverted to Munger.

Coal traffic related to NTPC Tanda could not be considered at present since as per linkages, determined already, a particular coal mining area gets allocated to the thermal plant. The Consultants are of the view, that once IWT services are commenced on this corridor, NTPC Tanda could be approached at a later date, for re-allocation of mining area near Ganga terminal in district Munger or Bhagalpur. As coal requirement for NTPC Tanda would be more than 2 million tonnes per annum, it may require an

independent terminal facility at either end. In the current exercise this traffic was not considered.

2.5 Traffic Assessment

2.5.1 Presently, the IWT stretch between Ayodhya and Manjhighat is not used for navigation. Whatever small portion of goods and passenger traffic is handled through the river involves crossing of river by mechanised or non-mechanised country boats. Such services are commonly used in the area where road-bridge was not available for crossing. Since, no traffic appeared to be using this waterway stretch for handling goods from one terminal to another, no base year traffic was considered on this stretch.

2.5.2 Assumptions For Traffic Estimation

The essential pre-requisites for traffic materialisation over the IWT would be:

i) The proposed stretch would form a part of NW-1 (Haldia-Allahabad).

ii) Requisite facilities, to attract goods and passenger traffic on this stretch, would be available all along NW-1 route.

iii) No expenditure towards development of waterways or terminals existing or proposed on NW-1 would be considered in this exercise.

iv) Least Available Depth (LAD) would be maintained at about 2.0 metres throughout the year.

v) The width of the channel at the narrowest approach would not be less than 45 metres.

vi) The clearance under the bridges en-route would be 12 metres above High Flood Level (HFL).

vii) River bed regulation, river training and conservancy works including dredging and removal of snags wherever necessary would be taken up on regular basis to facilitate smooth and efficient movement of vessels. Adequate navigational aids would be provided over the entire length of the pathway to guide the course of the vessels during the run. The navigational facilities would be upgraded in due course to enable 24- hour navigation becoming a reality in the long run.

viii) ***Keeping in view the nature of the commodities loaded/unloaded, suitable handling & storage facilities would be provided at the terminals.***

ix) ***The approach roads at the terminals up to the main road network would be suitably upgraded.***

x) ***Adequate mooring facilities for the vessels at selected terminals would be suitably augmented.***

xi) ***The vessels would ply to a certain pre-determined schedule which will be given due publicity.***

2.6 Base Year And Projected Traffic

2.6.1 Goods Traffic

IWT provides a cost effective, fuel efficient and environment friendly mode of transport on terminal to terminal haulage basis. While road has the advantage of extending door-to-door service to the users, rail & IWT involve multiple handling at the terminals, thus pushing up the user cost of transportation. In the case of IWT, while the proximity of the origin / destination to the river terminal station would be an important factor in attracting traffic, it may be noted that there was susceptibility of the commodity concerned to longer transit delay as also the terminal hold-ups in the normal course.

Keeping all the foregoing factors, the base year traffic for various terminals were estimated. While the major commodities originating from immediate / primary Catchment area would be rice, wheat & wheat products, sugar and pulses, on the terminating side major incoming commodity was reckoned as coal. Although there were no major industries along the river, coal would be required for brick kilns in the hinterland in huge quantity.

Based on the three-day origin-destination survey carried out at five locations as well as the data collected in respect of major commodities, the average annual potential traffic from the hinterland worked out to 9.98 million tonnes. Total potential traffic in the hinterland of the proposed IWT stretch is set out in **Annexure : 2.2.**

IWT terminal wise originating and terminating traffic for the base year as well as the projected traffic for the horizon years is given in **Table 2**.

It may be seen from Table 2 that the total traffic originating and terminating in the base year from the Ghagra River Hinterland worked out to 14.71 lakh tonnes. On the originating side, Munger had the maximum traffic (3.04 lakh tonnes) followed by Turtipar, Dohrighat and Ayodhya. The level of traffic

TABLE 2.2 – SUMMARY OF TERMINAL – WISE TRAFFIC

TERMINAL	ORIGINATING TRAFFIC (t)				TERMINATING TRAFFIC (t)			
	2000-01 (Base year)	2004-05	2009-10	2014-15	2000-01 (Base year)	2004-05	2009-10	2014-15
Ayodhya	97870	116166	166797	228426	114685	145403	225428	331059
Tanda	0	0	0	0	30819	38908	59877	87097
Dohrighat	108107	125042	173447	228986	139788	176369	271894	397214
Turtipar	108262	124734	172015	225518	56701	70808	107659	154948
Manjhighat	60485	79211	127817	195251	70699	89532	138393	202312
Patna	40519	48920	71561	99490	98331	117843	171177	236981
Semaria	2312	2602	3469	4371	6629	8379	12997	19178
Munger	303776	382927	588377	854768	3992	4493	5989	7547
Farraka	1137	1519	2507	3913	2105	2369	3158	3979
Pakur	1827	2306	3549	5163	2121	2387	3182	4009
Calcutta	10358	13227	20772	31016	186745	215359	297485	390906
Haldia/B'Desh	657	739	986	1242	22697	25545	34056	42913
Grand Total	**735310**	**897393**	**1331296**	**1878144**	**735310**	**897393**	**1331296**	**1878144**

Table 2 (Contd.) – SUMMARY OF TERMINAL-WISE TRAFFIC

TERMINAL	TOTAL TRAFFIC (t)			
	2000-01 (Base year)	2004-05	2009-10	2014-15
Ayodhya	212555	261569	392225	559486
Tanda	30819	38908	59877	87097
Dohrighat	247895	301411	445341	626200
Turtipar	164963	195541	279674	380465
Manjhighat	131183	168743	266210	397563
Patna	138850	166763	242738	336470
Semaria	8941	10981	16466	23549
TERMINAL	**TOTAL TRAFFIC (t)**			
	2000-01 (Base year)	**2004-05**	**2009-10**	**2014-15**
Farraka	3242	3888	5666	7892
Pakur	3948	4693	6731	9172
Calcutta	197104	228587	318257	421922
Haldia/B'Desh	23354	26285	35042	44155
Grand Total	**1470620**	**1794786**	**2662592**	**3756287**

originating from Tanda was reckoned as nil, since the entire traffic from Tanda was routed/traded through Ayodhya or Faizabad.

On the Terminating side, Dohrighat topped the list with 1.40 lakh tonnes of traffic for the base year 2000-01, followed by Ayodhya, Manjhighat, Turtipar and Tanda within U.P.

While the origin-wise diverted traffic to various IWT terminals is set out in **Annexure :2.3**, destination-wise diverted flows are presented in **Annexure: 2.4**. Commodity-wise traffic flows diverted to IWT are summarised in **Annexure :2. 5**.

2.6.2 Passenger Traffic

For estimating the passenger traffic, relevant information was collected from selected bus terminals and railway stations. During the course of passenger interviews at bus terminals and railway stations, it was established that the passengers were not ready to opt for the proposed river services due to the slow speed inherent in IWT operations and also since only a few IWT terminals were envisaged. The Consultants are therefore of the opinion that passenger services on the proposed stretch of IWT from one terminal to the other would not be relevant. Even the passengers who wished to cross from one bank to the other would have convenient road or pontoon bridges as easy options (except in the case of Manjhighat terminal). Even at Manjhighat, ***based on the investigations, it was felt that no significant passenger traffic would materialise for IWT despite the absence of a road or a pontoon bridge across the river.***

CHAPTER - 3

HYDROGRAPHIC SURVEY

3.0 General

The purpose of Thalweg survey was to determine the hydraulic features and existing condition of river Ghagra from Ayodhya to Manjhighat from navigational point of view. To assess navigability in river Ghagra, IWAI conducted a 'hydrographic survey in River Ghagra from Ayodhya to Manjhighat (345kms) during the period from Feb. 1991 to June, 1991 at the instance of the Transport Commissioner Govt. of UP, It was necessary to carry out accurate and comprehensive thalweg survey with the help of modern survey equipments to determine the present condition of the river bed. The survey was carried out as per the methodology described below: -

3.1 Methodology

- Water level gauges were established at suitable locations along the river stretch. Water levels were observed simultaneously at all the gauges during the survey period from, 3rd March, 2001 to 26th March, 2001 in day time only.
- Levelling work was done with the help of Auto level with known Bench Mark value for fixing the temporary Bench mark on the river bank, for connecting zero of the water level gauges.
- A single longitudinal profile of river bed along the deeper course of the channel was recorded by using using Real Time Differential Global Positioning System (RTDGPS) and depths were recorded by recording type Echo-sounder.
- Current observation at each terminal location was observed by using current meter to assess the flow regime of the channel.
- To assess the dredging quantities for design channel, cross section of flow channel at intervals of 1000 m apart along the river were recorded. Position of the depths was fixed by RTDGPS and depths were recorded by recording type Echo-sounder
- Local topographic survey was conducted for each terminal with the help of DGPS/Total station. Topographic survey was also conducted at the places where major change in comparison with earlier survey was noticed in river profile during present survey.

3.2 Topographic Survey

3.2.1 Fixing of Horizontal Control Points

Horizontal control points were accurately fixed near the survey area on permanent structure/pillars with the help of DGPS. The survey was

conducted at the time of good satellite visibility, keeping the DOP (Dilution of Precision) at the minimum.

A reference point (Horizontal control point) on a culvert 100m away from south rail bridge abutment was fixed with the help of DGPS by recording continuos observations for 10hrs. After post processing of collected data, co-ordinates of this point was fixed in WGS-84 system as given below:

UTM	
Easting:	**Lat. :** 26^0 48' 23.66"
Northing:	**Long.:** 82^0 12' 56.09"

Reference points (Horizontal control points) were fixed within project area along the river on available permanent structures in Real time mode and the details are placed at **Annexure: 3.1.**

3.2.2 Fixing of Vertical Control Points

vertical control points were fixed near the river bank on available structures by connecting with known Survey of India/CWC/IWAI benchmark. The error on closure for measurements on vertical distance to establish benchmark was checked to be not more than $12\sqrt{K}$ millimeters, (where K is the linear distance in km). Benchmarks used in present survey and temporary Benchmarks fixed on river bank are placed at **Annexure:3.2.**

3.2.3 Mapping

Topographic survey maps were prepared by IWAI in 1991-92 based on satellite imaginary and survey of India topo-sheets on a scale of 1: 12,500 delineating the high bank line, existing river channels, X-sec. depths etc. For present survey, topographic details have been taken from the above survey.

Local topographic survey was conducted for each proposed terminal site delineating ground features such as water line, high bank, house, road etc. with help of Total Station/RTDGPS. Localized topographic survey was also conducted wherever major changes were observed in the river profile during present survey .

3.3 Hydrographic Survey

3.3.1 Water level Observations

Temporary water level gauges were fixed in the study area in river and water level observations were observed at an interval of 4hrs. (during day time only) during survey period. Zero of the gauge was connected with the known benchmarks. Water level observations recorded during Thalweg/hydrographic survey have been placed at **Annexure :3.3**

3.3.2 Thalweg/Hydrographic survey

Hydrographic survey of study area i.e from Ayodhya to Manjhighat was conducted with the help of DGPS in Real-time mode, and single frequency echo sounder fitted in a mechanized boat. Depths were also recorded by running boat on preplanned X-Section lines at an interval of 1000m approx. and data(position of depth and depths) were logged in computer. The NAVPACK software was used to real time boat tracking on planned lines, data logging of DGPS and Echo-sounder data into the computer , and continuous monitoring of boat speed, direction, display of recorded depths and position on screen, bearing, and real time display of boat position on screen (updated every second) .

A single Thaweg/longitudinal profile of river bed along the deeper course of the channel was recorded with the help of RTDGPS and Echo-sounder by running vessel along the deep channel of the river.

The details and brief specifications of the survey instruments used are given at **Appendix 3.1.**

3.4 Hydrological observations

Long period hydrological observations such as water levels, discharges, flow velocities are very essential to study hydrology and availability of water for introduction of navigation and to fix the chart datum for reduction of hydrographic survey soundings.

The data regarding maximum & minimum water levels, discharges ,flow velocities and sediment data were collected for Ayodhya, Turtipar, gauge sites from Jan.1996 to Feb. 2001, from Central Water Commission and have been placed at **Annexure:3.4** .

Current observations have also been observed at all proposed Terminal locations during survey period and details placed at **Annexure: 3.5.**

3.5 Choice of Chart Datum

For easier appreciation of river bed changes, depths have to be referred to a selected Datum, which must be indicated on the hydrographic survey map. Chart datum (Standard low water level) is a reference level close to the lowest low water level and selected in such a way that the water level will seldom fall below it. Therefore, the depth shown on the chart shall be available normally throughout the year for navigation. The basic principle behind the adoption of a chart datum/standard low water level is to have a realistic picture of river bed with known base in order to facilitate comparison of the past with present surveys and assess change in the river regime.

In the case of Ghagra river, low water line and longitudinal bed profile along the river length are not parallel to each other and varied widely due to

several factors like changes in discharge, soil properties of bed & bank, river width etc. **Thus lowest low water level/chart datum can not be horizontal but will be sloped, having different gradients in different stretches.** For this study, sloped chart datum has been selected having different gradient in different stretches matching with low water line and bed profile, to get realistic picture of depths.

CWC gauge data at Ayodhya, Turtipar and Derouli for the past 10 year were analysed . From this March, 1998 was found to be the leanest month and was taken as datum for these respective reference stations as shown in table 3.1 :

Table :3.1

Sl. no.	CWC gauge site	Lowest low water
1.	Ayodhya	**87.220m** above MSL. In March,1988
2.	Turtipar	**58.410m** above MSL. In March,1988
3.	Derouli	**54.705m** above MSL. In March,1988

For calculation of chart datum value, total stretch was divided into three sub stretches:

1. Ayodhya to Mahirpur
2. Mahirpur to Choraghat
3. Choraghat to Barahalganj
4. Barahalganj to Turtipar
5. Turtipar to Derouli
6. Derouli to Manjhighat.
7. Manjhighat to confluence with Ganga.

Values of Chart datum for intermediate stations were determined by interpolation ***from the chart datum value fixed at CWC gauge sites as mentioned in the above table, and placed at Annexure :3.6. All recorded depths were reduced to the chart datum.***

3.6 Mapping and Charts

Topographic details such as high bank, villages, roads ,railway line ect. have taken from IWAI' surveyed charts. Detailed survey maps in scale of 1:12,500 delineating river bank, sounding depth below chart datum, rocky outcrops, permanent structures, , island, sand dunes have been prepared and placed at Drawing No. RITES/WW149A/HSM/1-30 (30 no. sheets). Longitudinal profile of river bed along the deeper course of river channel has been recorded and longitudinal section has been prepared on the scale of 1:12,500 horizontal, 1:500 Ver. and placed at drawing No. RITES/WW/149A/LS /1-10(10 no. sheets). Water slopes and standard low water level determined at different places along the river course have been placed at Annexure 3.6. All drawing were prepared on computer using Autocad and other softwares.

Drawings related, to topographic survey for proposed terminals site, Index map (one sheet) detailed hydrographic/thalweg survey maps (30sheets), and longitudinal section(10 sheets) have been placed **in volume – II of this report.**

3.7 Description of waterway

In addition to the depths at cross-sections and thalweg survey, vertical and horizontal clearances of the bridges, details of power lines crossings, waterway ferry crossing points etc. have been collected during field survey. Center line of Ayodhya road bridge has been taken as 0/0 chainage of navigational route alignment. Description of the proposed IWT route from Ayodhya to Confluence with Ganga river has been described in the following para:

3.7.1 Ayodhya Road Bridge to Arjunpur (0.0 – 18.0 km)

This stretch has been covered in hydrographic charts No. 1 to 2 . Reduced depth varies from 0.0 m to 6.7m and width of waterways varies from 110m to 600m . Single lane Rail bridge is under construction across the river at Ch.1.05 Km in Ayodhya having 64m horizontal clearance and 8.74m vertical clearance above high flood level(HFL). High tension(H.T.) line crosses the river just d/s of the road bridge and up stream of proposed Ayodhya Terminal.

3.7.2 Arjunpur to Tanda(Duhia) (18.0 km– 76.0 km)

This stretch has been covered in hydrographic charts No. 2 to 7.The reduced depth in this waterway stretch varies between 0.0m to 10.0m width of water various from 100.0m to 600.0m. Intake for irrigation canal is existing at Mahripur village at Chainage 69.0km. At 2km U/S of Mahripur Intake point, one major change in river course has been observed. According to IWAI survey charts main channel was flowing close to Intake point (towards right bank). But now It is 0.5 Km away from the Intake point towards left bank, Thereafter main channel is bifurcating into two channels at 1 Km D/S of Intake point; after this it is flowing near the right bank. A temporary Pontoon bridge has been erected by PWD near Tanda city at Chainage 73.850km for non monsoon period. River bed comprises mainly of loose sand.

3.7.3 Tanda (Duhia) to Kamharia Ghat (76.0Km – 134.0 kms)

This stretch has been covered in hydrographic chart no. 7 to 13. Reduced depth water varies between 0.0m to 6.0m and width of existing waterway varies 100m to 500m. One major change in river course was observed near Duhia village where two channels meet. Bed comprises of loose sand. One H.T. Line crosses the river at Naurani Rampur village, at chainage 91.850 kms. It has enough vertical clearance 12m over HFL. After Mehdighat (Ch. 97.00 km) river flows through left bank up to Chowraghat. Signs of bank erosion were observed during the survey period in Chowraghat.

3.7.4 Kamharia Ghat to Dohrigaht road bridge (134.0 km – 189.10 kms)

This zone has been covered in hydrographic chart No. 13 to 17. The reduced depth of water varies between 0.0m to 9.0m and waterway width varies between 100m to 1.02 kms. Left bank channel is observed to be navigable. At Arazi Gangapur river flows in sharp S bends. At Sohrabir river flows through south bank. Near Gola Bazar river flows through north bank . Heavy erosion has been observed at 4 km U/S of Dohrighat Road Bridge . River bed comprises of medium sand. `

3.7.5 Dohrighat road bridge to Turtipar Rail Bridge.(189.10km – 242.50 kms)

This stretch has been covered in hydrographic chart no. 21 to 24. The reduced depth of water varies between 0.0m to 25m width of existing waterway varies from 100m to 800 m. Double lane RCC road bridge exists at ch.189.1km having 51.9m horizontal clearance and 7.45m vertical clearance above HFL. A power line and Telephone line cross the river through the Road Bridge. Two nos. H.T. Lines cross the river at chainage189.3Km and189.7Km respectively. The vertical clearance is 12.0m above the HFL for H T Lines. Intake for irrigation canal is existing D/S of Dohrighat road bridge at right bank at chainage192.0Km. River Rapti meets at Chainage 212.500km of U/s of Barhaj. A double lane road bridge is under construction at 242.5 km near Turtipar having 65.5m horizontal clearance and 8.82m vertical clearance above HFL . Pontoon bridge is also functioning during the months of Nov. to May at ch, 239.08 km. A steel Rail Bridge crosses the river at Chainage 242.70 km connecting railway traffic network between Bhatni and Varanasi having 61m horizontal clearance and 8.50m vertical clearance above HFL. A power line and telephone line cross the river along the rail bridge. River bed comprises of loose sand.

3.7.6 Turtipar Rail Bridge to Derouli (242.5 km – 275.0 km)

This stretch has been covered in hydrographic chat No. 21 to 24. The reduced depths of water varies from 0.0m to 9.0m. The width of existing waterway varies from 100.0m to 800m. Two major morphological changes were observed during the survey near Duha village and near the Dumrahkhurd .Thereafter main channel bifurcate in two channels again near Dumrahkhurd .

3.7.6 Derouli to Manjhighat Rail Bridge (275.0 km – 337.4 km)

This zone has been covered in hydrographic chart No. 24 to 29. The reduced depths of water varies from 0.0 m to 9.0m and width of waterway varies form 100 m to 900.0m. River bed comprises of loose sand. A single line steel rail bridge crosses at Manjighat at ch. 337.40 km having 60.96m horizontal clearance and 5.7m vertical clearance above HFL. A power line and telephone line cross the river through the rail bridge. In this stretch river change its course from left bank to right bank and again left bank.

3.7.8 Manjhighat to Confluence (337.4 km. – 354.0 km)

This stretch has been covered in hydrographic chart No. 29 to 30 . The reduced depth of water varies from 0.0 m to 5.50m and width of waterway varies form 100 m to 300m. Two lane road bridge is under construction at ch. 337.945km having 32.25m horizontal clearance and 6.75m vertical clearance above HFL . A pontoon bridge has been erected at ch. 338.08 km for crossing the road traffic during the months from Nov. to May.

The previous surveys conducted during the year 1964 and 1974 by IWT directorate show that the meeting point with Ganga was near Doriganj approx. 36 kms d/s of Manjhighat. From the present survey, it is observed that the meeting point has shifted to Bororia tola, approx. 15km d/s of Manhighat due to varying morphological conditions of the river . Comparison of satellite imageries of March 1989 for Patna - Ballia stretch and 1973/74 S.O.I. maps and MPSO detailed survey chars (1984) reveal that the confluence of Ghagra and Ganga oscillates by about 20 kms depending of the hydrodynamic conditions of the two rivers, Ghagra and Ganga.

3.8 Ferry crossing Stations

There are 42 nos. of ferry crossing temporary ghats existing on this stretch of river, country boats are used for carrying men and material from one bank to other. At Manghighat, mechanised ferry boat is in operation in the flood period only. Cross ferry points are given **in Annexure 3.7**

3.9 Restriction on Waterway due to Bridges

2nos. road bridges and 2nos.rail bridges have already been constructed across the river Ghagra , One rail bridge and 2no.road bridges are under construction within study area . The horizontal and vertical clearances available above H.F.L. at these bridge located indicated in **Annexure 3.8**. 3nos temporary pontoon bridges have been erected across the river at Asopur, Turtipar and Manjhighat by PWD department for crossing the river in lean season. The double lane RCC road Bridge at Manjhighat which is presently under construction at ch.337.945 km will take care of the traffic when completed, and the seasonal pontoon bridge at ch.338.080 km may no longer be required. The seasonal pontoon bridge at ch.239.45 km may not be required when the double lane bridge at ch.240.70 km is completed in the immediate future.

For the design vessels the vertical clearance required as per IWAI norms, is about 5 m. From annexure 3.8 it may seen the vertical clearance available at the bridge locations vary from 5.7 m to 8.82 m. Ayodhya bridge at chainage 0.00 km with vertical clearance of 4.35 m is above study area and do not pose any problem for IWT operation. Therefore the bridges do not impose any restrictions for the inland vessel movement.

The only restriction is due to the presence of seasonal pontoon bridge with vertical clearance of 1.8 m and horizontal clearance of 2.0 m at ch. 73.850 km (Asopur – Tanda). Either total elimination or partial modification with the desired horizontal and vertical clearance may be resorted to at the time of implementation of the scheme.

3.10 Power Lines crossing the waterway

3nos. high tension power lines (HT), cross the proposed waterway. Vertical clearance between ground level/ HFL and lowest conductor of HT power line for each HT power line were taken during survey and are placed **at Annexure : 3.9.**

3.11 Water Intake Structures

There are three pumping stations for lift irrigation and two for water supply mains within the study area. These stations are located at Mahirpur , Dohrighat, Turtipar, Baranagar and Haldirampur. Details of these pumping stations have been placed at **Annexure : 3.10**

ANNEXURE : 3.5

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

Current Observation during survey

Sl.no.	Location	Date of observation	Current In m/sec.
1	Ayodhya	04-03-2001	0.31
2	Mahripur	06-03-2001	0.55
3.	Tanda	11-03-2001	0.46
4.	Dohrighat	15-03-2001	0.40
5.	Turtipar	18-03-2001	0.37
6.	Manjhighat	26-03-2001	0.74

ANNEXURE : 3.6

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

Chart Datum

Sl. no.	Chainage (in km.)	Name of Station	Chart Datum Above MSL (in m)	Water slope during survey period
1.	0.0	***Ayodhya***	***87.220***	***Observed at CWC Gauge site in March 1988***
2.	14	Belharghat	86.400	0.0575m/km
3.	36	Dilasiganj	85.200	0.0575m/km
4.	44	Sherwaghat	84.700	0.0575m/km
5.	60	Iltifatganj	83.800	0.0575m/km
6.	68	Mahripur	83.300	0.0575m/km
7.	79	Mubrakapur	81.500	0.159m/km
8.	91	Rampurghat	79.600	0.159m/km
9.	107	Chowraghat	77.200	0.159m/km
10.	136	Kamhariaghat	74.100	0.110m/km
11.	149	Shahebpur	72.700	0.110m/km
12.	166	Golabazar	70.800	0.110m/km
13.	179	Nawada	69.300	0.110m/km
14.	189	**Dohrighat**	68.200	0.180m/km
15.	202	Rasulpur	65.900	0.180m/km
16.	218	Berhalganj	63.000	0.180m/km
17.	238	Mahuatar	59.400	0.180m/km
18.	244	***Turtipar***	***58.410***	***Observed at CWC Gauge site in March 1988***
19.	256	Dheuabehra	57.455	0.110m/km
20.	269	Kewatala	55.600	0.110m/km
21.	274	***Derouli***	***54.705***	***Observed at CWC Gauge site in March 1988***
22.	293	Narhan	53.000	0.099m/km
23	299	Rajagaon	52.300	0.099m/km
24	310	Dhira Chappra	51.400	0.099m/km
25	340	Manjhighat	48.150	0.237m/km
26	348	Godna	46.000	0.237m/km

ANNEXURE : 3.7

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

List of Ferry Crossing Stations

Sl. no.	Name of Place	Chainage (in km.)	Type of vessel Used in Ferry	Remarks.
1	**Lakhri**	17.000	Country boat	Passengers
2.	Arjunpur	19.200	Country boat	Passengers
3	Bainpur	26.700	Country boat	Passengers
4.	Dhuswa	29.750	Country boat	Passengers
5	Dhuswa	31.300	Country boat	Passengers
6	Dilasiganj	35.500	Country boat	Passengers
7	Dilasiganj	36.300	Country boat	Passengers
8	Godiana	38.800	Country boat	Passengers
9	Godiana	40.000	Country boat	Passengers
10	Bhairipur	41.400	Country boat	Passengers
11	Sherwaghat	44.250	Country boat	Passengers
12	Naipura	57.700	Country boat	Passengers
13	Makum	58.200	Country boat	Passengers
14	Duhia	81.300	Country boat	Passengers
15	Duhia	83.450	Country boat	Passengers
16	Sharfuddinpur	106.100	Country boat	Passengers
17	Chouraghat	107.000	Country boat	Passengers
18	Khamaira Mahajen	132.000	Country boat	Passengers
19	Arazi Duwara	135.250	Country boat	Passengers
20	Arazi Duwara Zadia	137.600	Country boat	Passengers
21	Arazi Gangapur	142.450	Country boat	Passengers
22	Padwapur	147.800	Country boat	Passengers
23	Shahebpur	148.200	Country boat	Passengers
24	Baranagar	155.900	Country boat	Passengers
25	Bisra	164.300	Country boat	Passengers
26	Golabazar	166.700	Country boat	Passengers
27	Rasulpur	202.000	Country boat	Passengers
28	Mahuatar	238.750	Country boat	Passengers
29	Kusumganj Ghat	260.700	Country boat	Passengers
30	D/s of Kusumganj Ghat	266.250	Country boat	Passengers
31	Kewtala	269.00	Country boat	Passengers
32	Darauli	274.600	Country boat	Passengers
33	Harnatanr	276.200	Country boat	Passengers
34	Janjern	287.400	Country boat	Passengers
35	Kakarghatta Ghat	288.750	Country boat	Passengers
36	Narhan Ghat	293.500	Country boat	Passengers
37	Rajagam	299.200	Country boat	Passengers
38	Gobhiratola	305.500	Country boat	Passengers
39	D/s of Siswan Ghat	309.200	Country boat	Passengers
40	Dhira Chappra	310.250	Country boat	Passengers
41	Naukatola	316.500	Country boat	Passengers
42	Manjhighat	338.000	Country boat	Passengers/cargo

ANNEXURE : 3.8

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

List of Structures Across River Ghagra

Sl. no.	Chainage (in km)	Location	No. of Span	Type of Construction And Loading Class	Horizontal Clearance (in m)	Vertical Clearance (in m) above HFL
1.	0.000	Ayodhya	19+2	Double lane RCC Road bridge-IRC Class AA	47.7	4.35
2.	1.050	Ayodhya	18+2	Single line steel **Rail** bridge **Under construction**	64.0	8.47
3.	189.100	Dohrighat	12+2 End span	Double lane RCC Road bridge-IRC Class AA	51.9	7.45
4.	242.500	Turtipar	18	Single line steel **Rail** bridge	61.0	8.50
5.	240.700	Turtipar	17+2 End span	Double lane RCC Road bridge-IRC Class AA **Under construction**	65.5	8.82
6.	337.400	Manjhighat	18	Single line steel **Rail** bridge	60.96	**5.7**
7.	337.945	Manjhighat	34	Double lane RCC Road bridge-IRC Class AA **Under construction**	32.25	6.75
Pontoon Bridges						
1.	73.850	Asopur (Tanda)	Pontoon Bridge(Seasonal)		2.00	1.8
2.	239.450	Turtipar	Pontoon Bridge(Seasonal)		2.00	1.8
3.	338.080	Manjhighat	Pontoon Bridge(Seasonal)		2.00	1.4

Source: State PWD office of Govt. of UP and concerned Railway authority.

ANNEXURE : 3.9

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

List of High Tension Lines crossing waterways

Sl. no.	*Chainage* In km	*Location*	*Vertical clearance between lowest conductor and HFL*
1.		D/s of Ayodhya road bridge	**12m**
2.	91.700	Nooranirampur	**12.0**
3.	189.300	D/s of Dohrighat road bridge	**12.0**
4.	189.700	D/s of Dohrighat road bridge	**12.0**

ANNEXURE : 3.10

DPR for Development of IWT on River Ghagra From Ayodhya to Manjhighat

List of Water Intake Structures on River Ghagra

Sl. no.	Name of canal/Pumping Station	Chainage(in km) and Location	No. of Pumps & Capacity (in cusec.)	Design Capacity of Canal (in cusec.)
1	Mahirpur pump canal	Ch. 69.00km Mahirpur	6-60 4-50	450
2.	Bara Nagar Pump House	Ch. 155.80km Bara Nagar	2-10	------
3.	Dohrighat pump canal	Ch. 192.00 km Dohrighat	4-75 8-60	600---
4.	Turtipar pump canal	Ch. 243.5 km Turtipar	10-75	675
5.	Haldirampur pumping station	Ch. 250.45 km Haldirampur	2-10	-----

Source: ***Irrigation Department of Govt. of UP.***

CHAPTER – 4

WATERWAY DESIGN

4.0 Waterway

4.1 Channel Dimensions

In Chapter – 3 hydraulic features of the Ghagra waterway from Ayodhya to Manjhighat have been described as they exist. Various restrictions for navigation caused by existing permanent structures have also been explained. Chapter – 6 contained the details of the 'Design Vessel' for the proposed waterway. It is necessary to design a suitable waterway for uninterrupted two-way navigation for transporting the projected cargo traffic taking into account the hydraulic features of the river and dimensions of the design vessel.

4.1.1 Waterway Design

The basic parameters considered for the waterway design is:

- Depth
- Width
- Side slopes

4.1.2 Depth of a channel

The waterway depth should be good enough to ensure smooth steerability of the vessel and to prevent bottom keel from touching the bed. To meet this requirement, the minimum depth that is needed in a channel will commonly be the sum of the draught (draft) of the vessel and other tolerance factors. The tolerance factors to be considered are listed as:

- Factor of keel clearance to protect the vessel from touching the ground and minimum free water below the keel for maintaining manoeuvering control.
- Wave tolerance for the heaving and pitching of the vessel due to wave motion.
- Squat, increase of draft due to vessel motion.
- Tolerance for siltation and dredging.
- Increase of draught due to trim and heaving as a result of unequal loading and steering manoeuverability .In NW-1 and other waterways keel clearance has been considered as 20cm below draught of the vessel for safe navigation and total depth of 2.0m is being adopted. As per this practice, it is proposed to adopt the same fairway parameters i.e. 45m wide and 2.0m deep (below chart datum) channel for proposed waterway in Ghagra river also. This implies that the draught of the design vessel is 1.8m in Ghagra river.

4.1.3 Width of a channel

The total width of a navigation waterway (W) in general is expressed in terms of beam width of a vessel (B). The design width for the proposed two-way navigation can be obtained as:

W = BM+BM1 + C+2C1

Where,

W = *Navigation channel width for two way navigation*

BM = *Manoeuvering zone for the design vessel which takes into account the directional stability of vessel.*

BM1 = *Maneuvering zone for the upcoming vessel which takes into account the directional stability of vessel.*

C = *Width of separating zone.*

C1 = *Width of the security area, between the manoeuvering zone and the channel side accounts for environmental and human factors including bank section.*

Values recommended by various authorities for the above equation vary within wide limits. Some of the recommended values are presented here:

BM = 1.3 B to 3.0B

BM = BM1

C = 0.5 B to 1.0B

C1 = 0.3 B to 1.5 B

Where,

B = Beam of a design vessel. Based on the experience and judgement of the consultants, the factors considered for the present design are:

BM = 1.3 B

BM = BM1

C = 0.5 B

C1 = 0.50 B

Beam width of the design vessel (B) =10.4m

The designed channel width for Two-way navigation at draft level. = 1.3B+1.3B+0.5B+2x0.5B = 4.1B

The channel width at bed level for two way navigation = 4.1x10.4 =42.64m Say 45.0 m ***(Fig. No. : 4.1)***

4.1.4 Slopes

The selection of slopes is in accordance with the soil characteristics of the bed and banks, width of the waterway etc. The bed material of Ghagra river between Ayodhya and Manjhighat is mainly composed of sand and silt/ clay. Hence, the recommended **channel slope is 1:3.**

The designed channel dimensions with recommended slope are:

Bed width = 45.0 m
Depth below SLWL = 2.0 m
Side slope = 1:3
The channel width at draft level thus becomes 57.0 m.

The guidelines proposed by Delft Hydraulics for fairway design in normal and narrow reaches and for the present waterway design criteria are given in the following Table 4.1.

Table 4.1
Fairway Design Criteria

Criterion	Delft Hydraulics Guidelines for Normal cross section	Design cross section adopted for Ghagra Waterway
h/T_s	1.4	2/1.8=1.11
b_T/B_s	4.0	57/10.4=5.48
V_{max} (km/h)	10.0	15.0

Where
- h - Water depth
- T_s - Draft
- b_T - Width of waterway at draft level (or keel level)
- B_s - Width of vessel
- V_{max} - Maximum speed of the vessel.

From the above table it is evident that the design criteria adopted for the fairway of Ghagra river generally exceeds the minimum prescribed by Delft Hydraulics. As such the channel will be suitable for the vessel speed of the order of 12 to 15 km/h.

4.1.5 Block Ratio or 'N' Ratio

In narrow channel the 'N' ratio is the controlling factor of the vessel speed. Hence the quality of the design cross-section depends on this ratio. This ratio can be defined as the ratio between the wetted cross-sectional area of the design waterway (AC) and wetted mid ship cross-sectional area of the loaded vessel (AM). Various authorities recommend that the value of 'N' should normally be more than 7 even for a minimum speed of vessel 8.5 km/h. The block ratio 'N' increases with increase of vessel speed. The guidelines of Delft Hydraulics indicate that the 'N' ratio (AC/AM) for normal cross-sections should be minimum 7. The 'N' ratio for the present design cross section is 9.3. Therefore, the cross- sectional area of the fairway is best suited for the design vessel for an average speed of 13.75 km/h.

4.1.6 Width allowance at bends

In bends, the width of the fairway should be more than the width of the channel that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift

of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The impact of the water flow on manoeuvering vessel in drifting its position is not significant in Ghagra river. The drift angle is larger for vessels travelling in the down stream than the upstream direction. The drift angle is inversely proportional to the bend radius 'R', i.e., the larger the radius the smaller the value of drift angle. Unloaded vessel is normally subjected to more drift and consequently take up a greater width in bends than loaded vessel and therefore the proposed allowance at the keel level of the unloaded vessel is larger than the loaded vessel. The guidelines for width allowance in bends proposed by Delft Hydraulics are as follows:

Quality of the cross- section	Minimum radius permitted	At keel level of up-going loaded vessel	At keel level of down coming unloaded vessel
Normal cross section	R/L=6	$0.5\ L^2/R$	L^2/R
Narrow cross section	R/L = 4	$0.5\ L^2/R$	L^2/R

Where L = length of design vessel (56.04m)
R = radius of bend

The Ghagra Waterway is not straight and has many sharp bends. The minimum radius of the adopted bend is 1000 m. Wherever the radius of the bend is less than 6 times of the length of the designed vessel i.e. 6x56.04=336.24m or say 350m (on conservative side), additional widths are considered for free manoeuverability of the vessel. The additional width considered in the present fairway system for a designed vessel is:

$b = L^2/R = 56.04*56.04/1000$
=3.14m

4.2 Dredging

4.2.1 Capital Dredging

The existing features of the waterway from Ayodhya to Manjhighat have been described in Chapter-3. Table 4.2 gives details of the dredging quantities stretch-wise from Ayodhya to Manjhighat and at the locations of proposed terminals. The dredged spoil in this stretch can be disposed off near the bank for filling the low lying area along side the bank. The dredged spoils being mostly sand can also be transported by trucks to the interior places where reclamation of low lying areas are planned. The total quantity of capital dredging that will be required to carried out in study reach is estimated as 95,63,200 cum.

4.2.2 Maintenance Dredging

Even after completion of the capital dredging, the navigational channel will be subject to siltation due to several factors, some of which are highlighted below:

The rivers from the mountainous region carry silt/sand and when they reach the plain it deposits the sediment in the plains wherever there is a reduction in the velocity.

- Erosion of banks takes place in narrow stretches due to action of wind, rain and waves caused by movement of powered boats and crafts and eroded material gets deposited in the down stream reaches.
- Dumping of wastes, spillages of cargo etc.

In order to determine the quantity of maintenance dredging as a result of the effect of such re-siltation with a fair degree of accuracy, hydrographic survey should be conducted at regular intervals for a few a years after the completion of the capital-dredging.. ***However, for the purpose of cost estimates, the quantity has been taken as 10% of the capital dredging as per normal practice***

4.2.3 Characteristics of material to be dredged

In order to assess the type of bed material to be dredged, limited soil investigations were carried out for bed samples collected during field survey at each terminal location viz. Ayodhya, Tanda, Dohrighat, Turtipar and Manjhighat in river Ghagra .

The analysis of samples showed that the material is mostly medium sand /fine sand except in some cases where it is sand with silt .The suspended silt load in water is negligible. The mean grain size of the bed material is 0.03 to0.30 mm. Results of sediment samples are presented at **Annexure: 4.1.**

4.2.4 Agency for Dredging

Table 4.2 shows that the total quantum of capital dredging from Ayodhya to Manjhighat stretches is of the order of 95,63,200cum. **The capital dredging of study stretch has to be completed within one year as resilting of the dredged areas will occur if this work extends beyond one year.** The annual maintenance dredging of study reach is 9,56,320 cum. *This effort can be accomplished by engaging a competent agency.*

Table no. 4.2
Details of Dredging quantities in the study reach

Sl. no.	Chainage (in km.)		Dredging quantity In cum.	Remarks
	from	To		
1.	0.000	100.000	26,16,000	
2.	100.000	200.000	27,59,200	
3.	200.000	300.000	21,58,000	
4.	300.000	354.000 Up-to confluence	16,36,000	
	Terminals (5nos.)		3,94,000	

Total 95,63,200 cum.

The above dredging quantities are based on the thalweg survey and the cross sections taken at an interval of 1000m approximatly. For getting more accurate quantity of dredging it is advisable to carry out detailed hydrographic survey of study reach before implementation of project.

4.2.4.1 Selection of a Dredger

The quantity of the material required to be dredged for the project is 95,63,200cum. The type of the soil and the material to be dredged is as follows:

S. No.	Location	Grain size	Type of the material
i)	Ayodhya	0.02m to 0.425mm	Fine sand with silt
ii)	Tanda(Mahirpur)	0.04mm to 4.75mm	Coarse sand with silt
iii)	Dohrighat	0.02mm to 1.0mm	Medium sand with silt
Iv)	Turtipar	0.02mm to 4.75mm	Coarse sand with silt
v)	Manjhighat	0.02mm to 1.0mm	Medium sand with silt

As per the section of the waterway where the dredging is proposed the depth of dredging is 2.0 m, the depth within the river Ghagra as per the survey carried out is varying from 0.1 m to 25 m below chart datum.

The dredging work can be got done through a suitable agency. Accordingly the cost assessment has been made for dredging and indicated in the waterway development works.

Based on bed material of Ghagra river, the cutter suction type dredger is proposed for dredging which is the best suitable dredger for dredging sandy- silt, and clay of medium to high plasticity. The cutter suction system consists of scoop for funneling sand/silt/clay or loose deposit into suction inlet, thereby enhancing the solid/ water ratio. The system uses pumps for transporting the spoil through a discharge pipeline to dumping site situated at a considerable distance.. It has a special pump with an impeller to handle relatively large pieces of debris etc.

4.3 Protection of River Banks

4.3.1 General considerations

Current measurements during the survey period reveal that the velocities in the channel are considerably less with an average current of the order of 0.31 m/sec to0.74m/sec. Geo-technical characteristics of the river bed show that the soil is composed of mostly medium sand with traces of silty clay. The average grain size of the material is about 0.03 to 0.30mm. Therefore, it appears that the banks are not much susceptible to erosion by natural surface current. It may also be mentioned here that while carrying out the thalweg survey along river reach under consideration, the banks seen to be fairly stable free of erosion or rain cut gullies.

However, once navigation by mechanised vessels are introduced, bank erosion is likely to occur due to the fast movement of mechanised vessels

in the narrow stretches/navigation channel flows near the bank. Moving vessels generate waves and turbulence of different magnitude depending upon the speed of the vessel, its hull form, type and spacing of propellers, draft and river bed form. The effect of these waves and turbulence on the channel cross-section including the stability of the sides depends upon the width of the channel and the relative cross- section of the vessel and the channel. Further when a vessel moves in a confined channel, the return flow of water is caused by the water displaced along the vessel side. The extent of the return flow depends upon the velocity of the craft and can cause intensive suction effect on the banks eroding the side slopes of the soil. The channel bed gets disturbed by the impact of propeller jet.

4.3.1.1 Bank Protection

The erosion of channel bed and bank material is not only due to the natural currents but also due to the impact of hydraulic load produced by the vessel induced water motion. The vessel induced water motion in turn depends upon the vessel type, channel geometry and sailing course in the fairway. The vessel induced water motion can be divided into **(Fig. : 4.2):**

- Screw race
- Primary wave
- Secondary wave

4.3.1.2 Screw race

The turbulence in water and the consequent generation of currents due to propeller rotation of the vessel is known as screw race. The level of damage is proportional to both the screw race velocity and the duration over which the channel bed is exposed to the screw race. Therefore the areas susceptible to screw race damage are the places where the vessel manoeuvering is at slow speed. As per the studies conducted by Delft Hydraulics, the screw race velocities (U_b) corresponding to the vessel speed (V_s) are as follows:

V_s (m/sec)	0	1	2
U_b (m/sec)	2.5	2.0	1.5

The design vessel speed for proposed study reach is 14 km/h. The screw race velocity for a design vessel with 14 km/h speed will be of about 1.0 to 1.2 m/sec. The impact of screw race on the channel bed is likely to be more in the approaches of terminals, locks, bends etc. where the speed of the vessel will be reduced.

4.3.1.3 Primary wave

The primary waves produced by the moving vessel can be divided into the following 3 types.

- return current
- water level depression
- transversal stern wave

Computation methods based on conservation of energy as proposed by Delft Hydraulics are used for calculation of above vessel induced wave parameters. Applicability of the method for push tow units of various combinations and motor barges has extensively been tested in the laboratories of Delft Hydraulics. The basic relation for vessel speed and the average return current velocity is as follows.

$$A_c \; V_s \; = \; A_w \, (V_s \; + \; U_r)$$

The relation for water level depression is

$$h_1 \; = Vs^2 / \, 2g \; [\; (A_c/A_w)^2 - 1]$$

In which

$$A_w = b_b \; (h - \; h_1) \; + m \; (h - \; h_1) - A_m$$

$$A_c = b_b \; h \; + \; mh^2$$

The nomenclature used in the above equations is as follows:

A_c = Wetted cross-sectional area of a waterway
A_m = Wetted cross-sectional area of a vessel at mid-ship
A_w = effective wetted cross-sectional area of a waterway during the passage of a vessel.
V_s = Ship speed
U_r = Average return current velocity
h = water depth in a fairway
h_1 = average water level depression
g = acceleration due to gravity
b_b = bottom width of waterway
m = bank slope

Based on the solutions suggested by Delft Hydraulics, the return current velocity and the water level depression for a design vessel and design waterway are:

Ur (average return current velocity) = 0.51 m/sec.
h_1 (average water level depression) = 0.11 m

If the vessel moves near the bank, the return current velocities and the water level depression along the bank are more than the above average values. In this condition the maximum return current velocity (U_r') and water level depression (h_2) are calculated using the following relations:

$$h_2/h_1 = 2.0 - 2.0 \; A_c'/A_c$$

$U_r'/U_r = 1.5 - 1.0\ A_c'/A_c$

Where A_c' = Wetted cross sectional area of the channel between the centre line of the vessel and the bank.

The calculated values for the design waterway are given below.
h_2 (Max. water level depression near the bank) = 0.15 m
U_r' (Max. return current velocity near the bank) = 0.6 m/sec.

4.3.1.4 Transversal stern wave

The transversal stern wave is one of the main hydraulic loads on the bank of a navigation fairway. The wave height and current velocity characterise the main design parameters.
The transversal stern wave for loaded self propelled vessel can be worked out using

$$Z_{max} = 2.17(A_c'/A_c)^{-0.7} x\ (A_m/A_c)^2 x\ (B_s/h)^{0.5} x\ (V_s/\sqrt{gh})^4 x\ hxm^{0.4}$$

Z_{max} = stern wave height near the bank
B_s = width of the push tow unit of self propelled vessel
For a designed fairway the stern wave height
Z_{max} = 0.12m

The maximum current velocities in the transversal stern wave near the bank can be estimated for self propelled vessel with the following equations:

U_{max} = [1- K_s/Z_{max}] V_s if $Z_{max}/K_s>1$
U_{max} = [0.1 or 0.2] V_s if $Z_{max}/K_s<1$

U_{max} = Max. Current velocity in the transversal stern wave near the bank
K_s = roughness of bank material K_s = D50
ρ' = relative density = $(\rho_s-\rho)/\rho$
ρ_s = density of bank material
ρ = Density of water
V_s = velocity of the vessel

The maximum current velocity of the stern wave with a vessel speed of 10 km/h is calculated as 0.56m/sec.

4.3.1.5 Secondary waves

Secondary vessel waves are composed of transverse and diverging waves, which together produce interference peaks. The interference peaks are generally occurring due to small and fast sailing vessel and cause considerable damage to the banks. The secondary waves generated by the self propelled vessels are not significant and hence no attention has been paid.
All the above dynamic variables produced by the ship induced water motion act on different sections of the waterway cross section as detailed below:

Hydraulic load	Estimated value	Section of the waterway affected
Return current	0.6m/sec	Toe and lower section of bank
Screw Race velocity	1-1.2m/sec.	-do-
Transversal stern wave height	0.12m	Upper section of the bank
Current velocity in the transversal stern wave	0.56m/sec.	-do-
Water level depression near the bank	0.15m	-do-

The design of the bank protection works has been based on the impact of various vessel induced hydraulic loads as stated above in combination with the natural flow phenomena in the waterway.

4.3.1.6 Bank Protection Works - Design Guidelines

The design of bank protection works needs information on the soil characteristics of the bed and banks. A practical approach for determining the erosion resistance and strength aspects of the bed and banks against the natural currents and waves caused by navigation, as suggested by Delft Hydraulics, is as follows:

- If the natural currents and the vessel induced return currents exceed the critical current velocity (U_{cr}) of the quality of the bed and bank material , the banks are susceptible for erosion.

- If the natural waves and ship induced waves exceed the critical wave parameter of the bank material the banks are subjected to erosion.

The bank material of waterway is composed of fine sand with D50 ranging between 0.03 to 0.30mm.

The material is non-cohesive. The bed slope is gentle. The critical mean velocity for the quality of the present channel is considered as 0.5m/sec. The hydraulic load computations reveal that the velocity of the vessel induced return current is 0.6m/sec. The velocity of natural current during lean period is 0.5m/sec. and the maximum current during flood period is assumed as 1.0m/sec. Since the total strength of the current (1.6m/sec.) exceeds the critical current velocity, the toe and the lower sections of the banks are susceptible to erosion and hence require protection. The influence of waves on the banks of inland waterway has not been studied thoroughly. The research of Delft Hydraulics is that the channel bank will erode over a distance equal to 50 times the wave height. Hence in the case of this waterway, the upper limit of the banks to be protected is 6m (50x0.12m) from the water line.

4.3.2 Identification of Stretches requiring protection

Two different types of bank protections are envisaged. Wherever the waterway is wide and movement of vessels will not affect the bank, no protection is proposed. Where the waterway is very narrow and width is just enough for two-way navigation, and flowing near the river bank stone pitching is proposed. The exact requirement, however, should be established at the time of construction. *The banks in vulnerable regions should be watched after introduction of mechanised vessels and any damaged section should immediately be protected as part of regular maintenance.*

4.3.3 Existing Protection Work

The study reach is already provided with some bank protection in patches by Govt. of U.P. by stone boulder pitching and flood bunds.

4.3.4 Proposed bank protection

It is clear from the foregoing discussion that the banks are required to be protected at predefined places i.e. short bank and other vulnerable points. In locations where availability of land is not a problem, sloped bank with stone pitching is proposed. A typical detail is **shown in Fig.4.3.** The design provides for a side slope of 1:2.5 over which geo-fabric filter will be spread to prevent fine particles from flowing out. Over this geo-fabric filter, stone pitching of about 40 to 50 kg. size is laid.

4.4 Waterway Improvement Works

From the study of the available data it is evident that there is a wide fluctuation in water level (Maximum about 6 m) between lean season and flood season. In order to obtain sufficient water depth in the navigable channel for the designed vessel during lean period, river improvement works are necessary. This can be achieved by following:

- *River training works*
- *Dredging*
- *Combination of river training works and dredging*

This waterway improvement is proposed to be done by combination of river training and dredging. The proposal for dredging have already been discussed in earlier paragraphs. A brief description of the suggested river training works is as follow:

4.4.1 River Training Measures

There are two basic methods for river training works:

1. *Water restriction method*
2. *Water guide method*

The first method consists of restriction, compression of the channel and an increase in average flow velocity in order to achieve necessary scour of the river bed. The second method provides for increased flow in the predetermined alignment to obtain the designed depth.

Both the methods involve an interference with the morphological and hydraulic aspects of the river. ***It is an established fact that the river reacts violently to any human interference.***

M/s WIZMIN Consultant who had carried out Techno - Economic feasibility study for this project, have conducted a detailed model study in IIT Kanpur for river training and suggested provision of elliptical bamboo groynes at 300m spacing based on hydrographic survey conducted by IWAI in 1991-92 (*Fig. 4.3A and 4.3B show the geometry and alignment of proposed groynes in the model study)* . The groynes length will depend on the width channel, its course and distance from firm bank. *It is very important that a pilot project study should be carried out to test the result in the field conditions. Lump sum cost has been taken for providing* elliptical bamboo groynes for river training work where fair way is meandering too much .

As Ghagra river changes its course after flood by forming sand dunes and cutting the existing shoals a comprehensive model study of the river including the hydraulic and morphological process has to be undertaken by the client before arriving at any permanent solution for the river improvement works.

4.5 Aids to Navigation

Aids to navigation are required to be provided to identify the fairway for safe navigation. The study reach of Ghagra river is planned to be provided with necessary aids to navigation to facilitate day navigation. These are various types of marks fixed on banks and moored into the channel bed on both sides of the fairway to guide the master. Navigational marks are to be selected in such a way as to suit the morphological features of the waterway system. The following three types of aids to navigation are considered for this study reach.

1. Permanent Concrete Posts (Shore marks)
2. Floating Buoys (unlighted)
3. Temporary Stakes (Wooden/Concrete)
4. Local arrangement under bridge (erection of danger mark)

Depending upon the shape of the river and depths available in the waterway the above navigational marks are to be fixed at appropriate places.

Permanent concrete posts with navigational marks covered with sheets of adhesive scotchlite or luminous paint shall be provided on the banks along the waterway at bridges, bends, confluence of tributaries points etc. These fixed shore structures should carry the signs and signals as per the

recommendations of SIGNI published by the Economic Commission for Europe. These shore marks shall be provided where the waterway is deep and narrow. In this type of stretches, identification of the banks by shore marks is more important for manoeuvering the vessel. Shore based transit marks are required to be provided at bends so as to align the craft in a straight line along the fairway.

In wider channels the navigational marks by buoys are most ideal. Buoys are to be moored to the river bed by means of anchor and chains. The anchor-chains need to have sufficient length to facilitate their shortening/lengthening as required during lean/flood season to suit the water levels prevailing. The buoys and fixed shore structures will be provided at appropriate places as per the requirement of the waterway.

Apart from the above permanent aids to navigation, other semi-permanent and temporary channel marks are also required to be provided to facilitate navigation along the fairway more precisely in shallow reaches. For this purpose small wooden stakes/concrete poles of about 5-m length with graduation and signals at top shall be placed alternatively at an interval of 250 m. The concrete posts will be of 23 cm. square cross- section, pre-cast reinforced concrete, whereas the wooden marks could be of local tree trunks. Such marks shall project approximately 2 m above the water surface for easy visibility. With the spacing of 250 m interval the master can easily see the level of the water as well as the limits of the navigable channel. The stakes are to be driven into the sand bed and can be used as channel marks for almost round the year. The depth of penetration of stakes into the channel bed should not be less than 0.50 m. Therefore, except in the river- stretches, approximately 75% of the wooden/concrete marks will serve navigation round the year. For estimation purposes, it is assumed that 50% of the total number of such marks would be wooden and other 50% are of R.C.C.

Typical sketches of conventional aids to navigation are **provided in Fig. 4.4** in the study reach the navigational marks are selected in such a way as to provide the following necessary information or instructions to the navigator:

- Location identification of the fairway with left and right signals.
- Approaching reaches of limited water depths.
- Approaching reaches of limited channel widths.
- Location identification of spans of bridges /locks.
- Junctions or turning areas.
- Zones where pleasure crafts and pleasure boats are permitted.
- Sectors in which anchoring is not permitted (or permitted).
- Cross ferry navigation.
- Indications of Confluence Points etc.

The density of the marks depends upon the number of changes in the waterway route. Placement of the appropriate marks at right place helps the master to decide in advance of the new course to be steered. The

hydrographic survey charts prepared by RITES for DPR assessment study of the Project are the basis for determination of the number of marks.

However at very important locations a few illuminated aids to navigation following the conventions of SIGNI can be provided. Initially these can be provided at bridge piers. The colour codes for the proposed navigational marks are in line with the SIGNI, which is adopted and followed by International Inland Waterways. Table 4.3 illustrates these colour codes.

Table 4.3
Details of Colour Codes of Various Navigational Marks

Proposed Navigational Mark	Colour code (SIGNI) Description
1. **Bifurcation mark on Broad waterways where the Waterway is necessary to Indicate the designed Priority Channel.**	**Night** : the buoys shall be lighted with red rhythmic light with a cylindrical top mark or a green rhythmic light with a conical top mark **Day:** shore mark with horizontal Red and green bands or buoys with Horizontal red and green bands.
2. **Fairway channel indicator**	**Right Bank** **Day**: Shore marks red and white Horizontal bands and a cylindrical red top. **Night:** Rhythmic red lights of any type. **Left Bank** **Day:** Shore marks with green and White horizontal bands and a green conical top mark pointed upward. **Night::** Rhythmic green lights of any type.
3. **Marks on land indicating the Position of the navigable Channel in relation to the Banks at cross over**.	**Right Bank**. **Day:** Square yellow boards (Sides horizontal and vertical) with a Central vertical black stripe. **Night:** Yellow sheets of Scotchlite or luminous paint on boards. **Left Bank:** **Day:** Square yellow boards (diagonals, horizontal and vertical), With a central black stripe. Night: Yellow sheets of adhesive Scotchlite or luminous paint on the boards.

Proposed Navigational Mark	Colour code (SIGNI)	Description
4. Alignment of a cross over		**Day:** To indicate the axis of a cross-over, an alignment may be Used. It can be achieved by fixing two identical marks confirming to the above (item 3) rules and placed one behind the other, the foremost mark being lower than the rear most mark, the line joining these marks indicates the axis of the cross over. **Night::** Sheets of adhesive scotchlite or luminous paint will guide in fixation of the axis of the channel.
5. **Fixed Bridges**		
i) To mark the width of the channel by showing the site of the piers, to show the boundaries between which the channel is normally usable.		Square boards(diagonals, horizontal and vertical) with one half uminous painting with green colour, positioned on either side of the navigable channel or Buoys with luminous paint (green colour).
ii) to show where the depth of water or headroom near the piers is insufficient		Square board (diagonals, horizontal and vertical) with one half luminous painting with red colour, positioned on either side of the prohibited channel.
6. Mandatory signs:		
i) Reduce speed the figure on the board indicates the maximum speed in km/h.		Square board with number (sides horizontal and vertical) with white colour in the center and with red boarder.
ii) Pleasure crafts permitted		Square board with sign (sides horizontal and vertical) with black colour in the center and with blue colour boarder.
iii) Turning area		Square board with sign (sides horizontal and vertical) with black colour in the center and with blue colour boarder.
iv) Free cross ferry Navigation.		Rectangle board with sign (sides horizontal and vertical) with black colour in the centre and with blue colour boarder.

4.6 Power Line/Telephone line crossing the waterway

Annexure 3.7 shows the location of power lines (HT), crossing the proposed waterway with the vertical clearance between lowest conductor and HFL. These HT power lines do not impose the restriction to the movement of vessel. These lines will be required to provide the safe vertical clearance for the movement of vessel. The available clearance is 6.1m, which is more than 5m required . However, vessel operator will take all precaution (lowering the mast) while crossing these H.T. lines during flood season.

4.7 Restriction of Bridges Imposed on Waterway

2nos. road and 2nos.rail bridges have already been constructed across the river Ghagra and one rail and 2no.road bridges are under construction within study area. Turtipar rail bridge is having 5.7m vertical clearance above HFL, this will impose restriction for safe navigation for above H.F.L. indicated in **Annexure 3.8** for proposed vessel(air draft is 5.7 m). As such navigation is not advised during high flood conditions.

From annexure 3.8 , it is seen that horizontal clearance between piers under bridges is varying from 32.25m to 65.50m . Though the minimum horizontal clearance of 32.25m is just adequate for simultaneous passing of two vessel under the bridge, it is advisable by way of abundant caution that only one way navigation is allowed under the bridge. For this suitable sign boards/ waterway signals have been considered in the estimates for the guidance of the navigator.

As per practice and existing norms in NW-1, 10m-12m vertical clearance above HFL is recommended for future bridge construction for safe navigation. However, vessel operator will take all precaution while crossing these bridges during flood season by lowering the telescopic/adjustable mast as per the available clearance.

3nos. temporary poontoon bridges have been erected across the river at Asopur, Turtipar and Manjhighat by PWD department for crossing the river in lean season. For safe navigation these poontoon bridge have to be dismantled and cross ferry is proposed to facilitate the passengers to cross the river in non-monsoon period.

4.8 Cost Estimate

Cost estimate for dredging, bank protection, aids to has been worked out based on prevailing rates in the adjoining area and consultant' data bank and placed at **Annexure 4.2.**

4.9 Operating cost

The total operating cost for development of waterway from Ayodhya to Manjhighat has been worked out based on best judgement (prevailing rates in the state/country). The total operating cost includes maintenance of dredging, bank protection, aids to navigation, manning, operation and management of waterway. The operating cost of the waterway as estimated is given in **Annexure 4.3.**

Annexure :4.2/1

Cost Estimates for Dredging

Sl. no.	Description	Quantity In cum.	Rate In Rs./cum.	Amount In Rs.
1.	Dredging of waterway for creation of channel 45m wide and 2m deep (below chart datum in sandy reach and dumping of the dredged spoil with in a lead of 2km from Ayodhya to confluence with Ganga river (354 kms Route length approximate)			
	Chainage 0/0 to 100kms	26,16,000	90	23,54,40,000
	Chainage 100 to 200kms	27,59,200	90	24,83,28,000
	Chainage 200 to 300kms	21,58,000	90	19,42,20,000
	Chainage 300 to 354kms	16,36,000	90	14,72,40,000
2.	Dredging at terminal for approach channel and for movement of vessels at terminals.			
	a) Excavation of soil from river bed and dumping the excavated material with in a lead of 2kms. Ayodhya	1,68,000	60	10,08,0000
	b) Dredging for creation of approach channel and moving area and dumping dredged materials with in a lead of 2kms at terminals.			
	i) Ayodhya	1,12,000	90	10,08,00,00
	ii) Tanda	62,000	90	55,80,000
	iii) Turtipar	36,000	90	32,40,000
	iv) Manjhighat	16,000	90	14,40,000
			Total	64,37,48,000
			Contingencies @ 3%	1,93,12,440
			Engineering charges @ 3%	1,93,12,440
			Supervision Charges @ 7%	4,50,62,360

Total Rs.72,74,35,240

Say Rs. 7,275 Lakh

Annexure :4.2/2

Cost Estimates for Aids to Navigation

Sl. no.	Description	Quantity	Rate In Rs.	Amount In Rs.
1.	Hydrographic survey vessel equipped with lifting gear, work boat etc.	3 no.	25,00,000	75,00,000
2.	Survey equipment (DGPS, Echo-sounder, computer, plotter, Soft-wares etc.)	3 sets	43,50,000	1,30,50,000
3.	Communication equipment for vessel and terminals	L.S.		16,00,000
4.	Fixed permanent shore structure with navigational mark covered with sheets adhesive scotchlite.	100 no.	60,000	60,00,000
5.	Supply and fixing of RCC and wooden channel marker with sheets adhesive scotchlite.	1450 no.	1,000	14,50,000
6.	Providing wooden fenders or other means to protect bridge piers from impact of the vessel.	1450 no.	550	7,97,500
7.	Providing lightening/ danger marking on each bridge.	L.S.		6,00,000
			Total	30997500
			Contingencies @ 3%	929925
			Engineering charges @ 3%	929925
			Supervision Charges @ 12%	3719700

Total Rs.3,65,77,050

Say Rs.366 Lakh

Annexure :4.2/3

Cost Estimates for Bank protection works

Sl. no.	Description	Quantity	Rate	Amount In Rs.
1.	Provision of bank protection work on side slope with stone pitching and inverted stone filter as per design	L.S.		2,00,00,000
2.	Provision of bamboo groynes in shallow area after dredging to maintain the flow and depth in the channel	975	35000	3,41,25,000
			Total	5,41,25,000
			Contingencies @ 3%	16,23,750
			Engineering charges @ 3%	16,23,750
			Supervision Charges @ 7%	37,88,750

Total Rs.6,11,61,250

Say Rs.612 Lakh

Annexure : 4.3

Operating Cost For Waterways

Sl. no.	Description	Amount (in Rs. Lakhs)
1.	Operating cost of dredging @ 10% of capital cost (Rs. 7,275 lakhs)	727.50
2.	Maintenance and repair to aids to navigation @ 5% of capital cost (Rs. 366 lakhs)	18.30
3.	Maintenance and repair to bank protection and river training works @ 5% of capital cost (Rs. 612 lakhs)	30.06
4.	Fuel consumption of 3nos. survey vessels L.S.	15.00
5.	Man power cost	125.00

Total Rs.915.86 lakh

Total operating cost for 354 kms. long waterways for IWT from Ayodhya to Manjhighat = Rs.915.86 Lakhs

Cost for 33m wide channel

- *Cost for developing 33m wide 2m deep channel for initially plying 160T vessel is estimated Rs. 6240 lakhs. Cost for aids to navigation and bank protection work will remain same as indicated in 45m wide, 2m deep channel (Rs. 366lakh and Rs.612 lakh respectively) .*

- *Total operating and maintenance cost for 354 kms. long waterways for IWT from Ayodhya to Manjhighat = Rs.812.36 Lakhs*

CHAPTER - 5

TERMINAL AND INFRASTRUCTURE FACILITIES

5.1 Introduction

The terminal planning covers selection of suitable sites in the vicinity of the cargo concentrations considering all the relevant technical factors, choosing the type of berthing facility, and provision of covered/open storages, cargo handling systems and other ancillary facilities for efficient terminal operation. On the basis of anticipated traffic volumes and the type of cargo, selection of the requisite facilities will be made. Estimates of capital and operating costs will be made for each of the proposed system at the respective terminals.

5.2 Terminal Site Selection

Site selection is the most important factor as it dictates the investment for establishing the terminal facilities. Therefore, utmost care is taken to select most reliable locations to minimise the capital and the recurring cost for the terminals.

5.2.1 Criteria for Selection of Site

(i) River morphology and behavior

(ii) Stable river channel with natural depths so as to avoid problems of scouring or accretion at the terminal locations. This also reduces the capital cost as well as annual recurring cost on maintenance dredging and training works.

(iii) Hydraulic conditions to be favourable for berthing of barges and cargo handling operations during most part of the year.

(iv) As far as possible low water line shall be close to the high bank. This would avoid undue interference in the river hydraulic conditions and also avoid jetties with long approaches.

(v) Adequate backup space to be available for cargo handling operations and for providing ancillary facilities.

(vi) Location should not involve large investment on road communication and other infrastructure.

(vii) Location should not be far away from traffic centres leading to logistic problems.

(viii) Site so selected on the above considerations shall not only be favourable for creating facilities for the projected cargo traffic but shall allow for future development.

The above factors as applicable to individual sites have been considered in recommending the proposed location of the five terminal sites. The specific considerations for each place forming the basis for the selection of recommended site are discussed location wise.

5.2.2 Description of Selected Sites

5.2.2.1 Ayodhya

The proposed site for terminal development is down stream of the new railway bridge under construction on the right bank of river Ghagra. Location plan of this terminal is shown in Drg.No.RITES/WW/149-A/TP-01.

The possibility of locating this terminal upstream of the new railway bridge is ruled out as the land is not available due to existence of Ghats and Bus Terminal.

5.2.2.2 Mahirpur (Tanda)

The terminal is proposed down stream of thermal power plant on the right bank of the river as shown in Drg. No. RITES/WW/149-A/TP-02. This proposed location is about 1400 m from Faizabad Tanda Road. This terminal location will facilitate coal movement from river terminal to most of the kilns by road without entering into the Tanda town. Being near to thermal plant, this terminal can be used for bringing coal for thermal plant.

5.2.2.3 Dohrighat

The river terminal is proposed down stream of the existing road bridge on the left bank of the river Ghagra as shown in Drg. No. RITES/WW/149-A /TP-03. The terminal location on the right bank of river down stream of the road bridge is not proposed as the channel in the lean season is far away from the high bank.

5.2.2.4 Turtipar

The proposed river terminal is located on the right bank of river Ghagra as shown in Drg. No. RITES/WW/149-A/TP-04. This terminal is about 350 m from Hansawar road.

5.2.2.5 Manjhighat

The river terminal proposed is located down stream of rail bridge on the left bank of the river as shown in the Drg. No. RITES/WW/149-A/TP-05. The main Ballia-Chappra road is passing adjacent to the proposed terminal.

5.3 Terminal Facilities

5.3.1 General

The type of cargo handling system required at the terminals is generally dependant on the type of cargo, the annual volumes required to be handled and the size of the vessels deployed in the system. The various cargoes foreseen to be handled at the terminals have been classified primarily into two groups:

(i) Incoming cargoes, and

(ii) Outgoing cargoes

These two groups have been further sub-divided into bulk, bagged and other miscellaneous general cargo for the purpose of planning the cargo handling system requirements.

Hence the anticipated traffic can be broadly grouped into the following categories:

- Ψ Bulk cargo (coal)
- Ψ Bagged cargo (fertiliser, food grains, provisions, fodder)
- Ψ Miscellaneous general cargo (general goods, house hold goods, fruits & vegetables, leather, live stock, machinery & parts, iron & steel, paper & paper products, tobacco, timber & wood, sand & building materials)

5.3.2 Basic Assumption for the Planning of Facilities

For the purposes of planning the terminal facilities and the infrastructure, the following assumptions have been made:

- Ψ Terminal facilities would be planned for the initial traffic projected for the period 2000-01 and would be expanded in the subsequent development phase of 2004-05, 2009-10 and 2014-15. System will be planned in such a manner that any additions to the facilities will

be possible for handling future traffic. Terminal layouts prepared will ensure that entire facilities can be expanded to meet the ultimate traffic projected for the year 2014-15.

- Ψ Number of days the berths are considered available for operation is 330 days per year.

- Ψ Navigation of vessels in the Ghagra River includes night navigation except during flood season when operation would be suspended.

- Ψ Number of shifts for barge loading/unloading operations and onshore facilities is considered as 3 per day.

- Ψ Average time required for to and fro movement from anchorage to berth, berthing time, other formalities, etc. is considered as 1 hour per barge.

- Ψ All hinterland transportation of material out of the facilities or into the facility is assumed to be by trucks.

- Ψ Since the distance between the loading and the unloading terminal is relatively large, the arrival pattern of the barges at the terminals is expected to be random.

- Ψ Ratings of equipment as well as the storage facility requirements etc. have been planned considering the inter-arrival rate of barges.

- Ψ Storage capacities provided at the facility will be adequate to guarantee loading or unloading of barges even during disruption of road transportation of 5 to 7 days.

- Ψ Maximum truck size assumed is 10 Tonne payload.

- Ψ Average barge size is assumed as 600 DWT with a full loaded draft of 1.8m. One barge load will contain material for one destination only.

- Ψ All bulk cargoes, which are not affected by weather, will be stored in open stockpile. All bagged cargo will be stored in covered sheds.

- Ψ The storm water drainage provided at the terminals will discharge into the river.

- Ψ It is assumed that captive barge fleet will be used for transportation of bulk, bagged and miscellaneous general cargo. This

arrangement will help to reduce the turn-around time of barges and also increase the handling efficiency of the on-shore equipment. In the case of bulk cargo such as coal, the last few layers of material in the barge bottom, will require manual assistance to unload and thus will take considerable time for unloading in comparison to quantum of material to be unloaded in this manner.

Ψ No custom clearance or any kind of security check is foreseen for the materials/cargo to be handled at these facilities.

5.3.3 Terminal Planning

A summary of the commodity wise traffic projections for the periods 2000-01, 2004-05, 2009-10 and 2014-15 for Ayodhya, Tanda, Dohrighat, Turtipar and Manjhighat Terminals, is given in **tables 5.1 to 5.5** respectively.

Based on the above assumption and the traffic projections the terminal planning requirements have been evaluated for handling the various bagged, bulk and miscellaneous general cargoes and are summarised in **Table 5.6. .**

For the foreseen volumes of cargo required to be handled at the five inland terminals at the various throughput development stages, the phase wise terminal requirements have been worked out. The detailed description of each of the proposed terminals is as given below:

5.3.3.1 Ayodhya Terminal Facilities

Layout of Ayodhya Terminal is given in Drg.No.RITES/WW/149-A/TP-06. At this terminal, it is proposed to have 3 berths to meet the projected traffic level in the period 2014-15, with the development of two berths in phase – 1 and one additional berth in Phase – 3.

In the proposed terminal site low water line is 700m away from the high bank. Berths have been proposed 50m from the high bank to reduce the approach length. For this a turning circle of 250m diameter and approach channel of length 1200m have been proposed for access of the IWT vessels to the berth.

Considering the design vessel of 600 DWT, the total berth length required is 210m with an apron width of 15m. Also, three approaches each of 50m in length and 9.5m width, suitable for two lane carriage-way with a width of 7.5m is required to be provided for movement of material to & from the berth(s).

It is proposed to provide on these berths for loading/unloading operation to and from the barges, three mobile crawler mounted cranes each of 5 tonne capacity, each with hook and grab options suitable for handling bagged and bulk cargo. The maximum outreach required for these cranes is 15m.

The facilities proposed at the terminal back-up area is the following:

- Ψ Covered storage area of (60mx30m) for fertiliser and food grains, paper and paper products, machinery parts, provisions & general goods, in Phase -1.
- Ψ Covered storage area of (60mx30m) for cement, fertiliser and food grains in Phase - 3.
- Ψ Open storage area of (30mx60m) for coal in Phase – I and an area of (30mx60m) in phase – 3.
- Ψ Open storage area of (20mx25m) for timber & wood, in Phase – 1
- Ψ Open storage area of (20x25m) for sand and building material, in Phase - 1
- Ψ Open storage area of (20mx50m) for iron & steel, in Phase– 1
- Ψ Two lane access road of length 175m to connect the terminal with National Highway.

In addition to the above, the terminal facilities cover, the present & future requirements of truck parking area, office building, electrical room and watch & ward office. Also, the terminal requirements include, lighting, drainage and compound wall.

The total area requirement for Ayodhya terminal is 210mx140m.

The capital cost estimates and annual operating cost estimates for the proposed terminal development are given in **Table No. 5.7 & 5.17** respectively. Man power requirements for the proposed terminal are given in **Table 5.12.**

5.3.3.2 Mahirpur (Tanda) Terminal Facilities

The layout of Terminal is given in Drg. No. RITES/WW/149-A/TP-07. At this terminal, it is proposed to have one berth to meet the projected traffic level up to the period 2014-15,

Considering the design vessel of 600 DWT, the total berth length required is 70m with an apron width of 15m. Also, one approach of 30m in length and 9.5m width, suitable for two lane carriage way with a width of 7.5m is required to be provided for movement of material to & from the berth.

It is proposed to provide one mobile crawler mounted crane for loading/unloading operation to and from the barges, of 5 tonne capacity, with grab option suitable for handling bulk cargo. The maximum outreach required for the crane is 15m.

The facilities proposed at the terminal back-up area is the following:

- Open storage area of (30mx50m) for coal in Phase – I
- Truck parking area of (40mx17.5m)
- Office building of (12x10m)
- Electrical Substation of (20mx50m)
- Two lane access road of length 1400m to connect the terminal with Faizabad – Tanda Road.

Also, the terminal requirements include lighting, drainage and compound wall.

The total area requirement for Tanda terminal is 85mx70m.

The capital cost estimates and annual operating cost estimates for the proposed terminal development are given in Table No. 5.8 & 5.18 respectively. Man power requirements for the proposed terminal are given in Table 5.13.

5.3.3.3 Dohrighat Terminal Facilities

The layout of the proposed Dohrighat Terminal facilities is given in Drg. No. RITES/WW/149-A/TP-08. At this terminal it is proposed to have three berths to meet the projected throughput upto 2014-15, with 2 berths in Phase – I and (I) additional berth in Phase – 3 of development. Considering the design vessel of 600 DWT, the total berth length required is 210m with an apron width of 15m, also three approaches each of 30m length and 9.5m width suitable for two lane carriage way for movement of material to & from the berth(s) are proposed.

It is proposed to have on these 3 berths three mobile crawler mounted cranes of 5 tonne capacity each with hook & grab attachment suitable for

handling both bagged & bulk cargo. The maximum outreach of the required crane is 15m.

The following facilities are proposed to be located in the terminal back-up area of the terminal.

- Ψ Covered storage area of (60mx40m) with suitable partition walls for segregating commodities such as fertiliser and food grains in Phase – 1
- Ψ Covered storage area of (60mx40m) for fertiliser and food grains in phase – 3
- Ψ Open storage area of (45mx50m) for iron & steel, commodities such as machinery & other miscellaneous general cargo in Phase – 1 and an additional area of (45mx50m) in Phase – 3.
- Ψ Open storage area of (25mx25m) for sand and building materials, in phase-I
- Ψ Open storage area of (25mx35m) for sand and building materials, in Phase – 3
- Ψ Provision of two weigh-bridges, one in Phase-1 & one in Phase – 3
- Ψ Truck parking area of 50mx30m
- Ψ Two lane access road of length 850m to connect the terminal with State Highway leading to Gorakhpur.

In addition to the above, the facilities include office space, electrical room, as well as watch & ward office.

The terminal back-up area requirements include provision of general area lighting, and compound wall and gate complex.

The total area requirement for Dohrighat Terminal is 210mx120m.

The capital cost estimates and annual operating cost estimates for the proposed terminal development are given in **Table No. 5.9 & 5.19** respectively. Man power requirements for the proposed terminal are given **in Table 5.14.**

5.3.3.4 Turtipar Terminal Facilities

The layout of the proposed terminal facilities is given in Drg. No. RITES/WW/149-A/TP-09. At this terminal it is proposed to have two berths to meet the projected traffic levels upto 2014-15.

In the proposed terminal site low water line is 120m away from the high bank. Berths have been proposed 30m from the high bank to reduce the approach length. For this river training has been proposed to divert the flow of the river towards the berths.

The total length of berths is 140m with 15m-apron width. Two approaches each of 30m length and 9.5m width suitable for two lane carriage-way for access to berths are proposed.

For meeting the handling requirements at these berths, it is proposed to have 2 crawler mounted mobile cranes each of 5 tonne capacity with hook and grab attachments suitable for handling both bagged and bulk cargoes, the maximum outreach of the proposed crane is 15m.

The following facilities are proposed to be developed in the backup area of the terminal.

- Ψ Covered storage area of (40mx50m) in Phase – I with suitable partitions for segregation of commodities such as food grains, facilities and cement
- Ψ Covered storage area of (40mx50m) in phase – 3
- Ψ Open storage area of (30mx40m) in Phase – 1, for coal.
- Ψ Open storage area of (30mx40m) in, Phase – 3, for coal.
- Ψ Open storage area of (20mx10m) in Phase – 1, for building materials.
- Ψ Provision of two weigh-bridges, one in Phase-1and one in Phase-3.
- Ψ Provision of Electrical Sub-Station of (10mx8m)
- Ψ Two-lane access road of length 400m to connect the terminal with State Highway (Tanda – Ballia).

In addition to the above, terminal facilities include truck parking area, office building, and watch & ward.

The total area required for Turtipar terminal is 140mx110m.

The capital cost estimates and annual operating cost estimates for the proposed terminal development are given in **Table No. 5.10 & 5.20** respectively. Man power requirements for the proposed terminal are given in **Table 5.15.**

5.3.3.5 Manjhighat Terminal Facilities

The layout of the proposed Manjhighat Terminal facilities is given in Drg. No. RITES/WW/149-A/TP-10. At this terminal it is proposed to have two berths to meet the projected throughput up to 2014-15. Considering the design vessel of 600 DWT, the total berth length required is 140m with an apron width of 15m, also two approaches each of 30m length and 9.5m width suitable for two lane carriage way for movement of material to & from the berth (s) are proposed.

It is proposed to have on these 2 berths two mobile crawler mounted cranes of 5 tonne capacity each with hook & grab attachment suitable for handling both bagged & bulk cargo. The maximum outreach of the required crane is 15m.

The following facilities are proposed to be located in the terminal back-up area of the terminal.

- Ψ Covered storage area of (25mx20m) with suitable partition walls for segregating commodities such as fodder and food grains, in Phase – 1
- Ψ Open storage area of (30mx50m) for iron & steel, commodities such as machinery & other miscellaneous general cargo in Phase – 1 and an additional area of (35mx50m) in Phase – 3.
- Ψ Open storage area of (40mx25m) for Timber
- Ψ Open storage area of (40mx25m) for sand and building materials, in Phase – 1
- Ψ Open storage area of (40mx35m) for sand and building materials, in Phase – 3
- Ψ Provision of two weigh-bridges one in Phase-1 & one in Phase – 3
- Ψ Truck parking area of 40mx10m and 40mx20m, in Phase – 1

Ψ Two-lane access road of length 25m to connect the terminal with Chapra – Gorakhpur Road.

In addition to the above, the facilities include office space, electrical room, as well as watch & ward office.

The terminal back-up area requirements include provision of general area lighting, and compound wall and gate complex.

The total area requirement for Manjhighat Terminal is 140mx130m.

The capital cost estimates and annual operating cost estimates for the proposed terminal development are given in **Table No. 5.11 & 5.21** respectively. Man power requirements for the proposed terminal are given in **Table 5.16.**

A summary of capital cost and annual operating cost for all the five terminals is given in Table 5.22.

5.4 Selection of Berthing Structure

5.4.1 General

Among the numerous structural forms and layout available for terminal planning, only few are convenient to handle the designated cargo efficiently at moderate investment levels, with distinct operational advantage.

The three possible alternative berthing structures considered in the evaluation are:

- Floating pontoon with access bridge.
- Gravity type structure.
- Open type structure (R.C.C. deck with piles for berth and approaches)

5.4.2 Floating Pontoon

This alternative is generally the most cost-effective form of berthing facility that can be provided at inland water terminals with less water level variations. However, as this arrangement at best can be operated as a semi-mechanised facility with suitable loading/unloading equipment located on the pontoon, the movement of cargo to & from the pontoon through the access bridge will necessary have to be a manual operation. The entire loading / unloading operation being semi-mechanised will

handle lower cargo volume per pontoon berth annually & consequently require larger number of pontoon berths for a given throughput.

Also, in terminal locations with large difference between the high and low water levels, the length of the access bridge becomes the limiting factor, considering the normal gradients that are necessary to be provided for manual working.

In view of the above limitations, this alternative of floating pontoon with access bridge is not considered further in planning the terminal facilities even though this arrangement does not influence the hydraulic regime in the river.

5.4.3 Gravity Type Structure

This arrangement consists of berthing structure formed with concrete block work placed geometrically. Though this type of structure requires lower level of investment in comparison to open type structures, the block work creates a complete barrier to flow lines by virtue of it being a solid construction and due to this obstruction it is expected to disturb the morphological balance in the vicinity of the terminal as well as downstream.

Also in the absence of detailed model studies, it would be difficult to predict and quantify the consequent effect on the river morphology.

In view of this, this alternative can be considered, as the least preferred one for the river terminals.

5.4.4 Open Type Structure (R.C.C. Berth & Approach Jetty on Piles)

This alternative provides many favourable features and can comply with the project requirements with minimal implications on environment and project economics.

The jetty head is located inside the river basin and is connected to the bank by approach(es). The RCC deck structure will be supported by RCC piles.

The connecting approaches are made of RCC deck supported on piles. The slender pile structure for the berth and approaches would not disturb the hydraulic regime in the proximity of the terminals because of the open type construction with a minimum blockage to the river flow.

Considering all the above factors it can be concluded that open type berthing structure i.e. RCC piled berth and approach(es) is the most

appropriate type of berthing structure for the terminals in this project. Though quantum of cargo in Tanda is less, which can be handled by a pontoon type jetty, to maintain compatibility with other terminals RCC jetty with mechanised handling is proposed.

5.5 Details Of The Proposed Berths And Approaches

The design of the open type berthing structure and approaches proposed for the river terminals have been standardised as follows:

5.5.1 Berthing Jetty

The berths are planned in units of 70m length with an apron width of 15m with a service duct through out the length. Vertical bored cast in-situ piles of 1200m dia are provided in a grid of 5mx3.9m up to low water level, tie level (to reduce the unsupported length of the piles). Above this circular columns are provided to support the RCC deck. Piles are interconnected by beams at tie level. Deck is provided with a slab supported by beams. A staircase is provided from deck level to tie level for easy access during low water. Cylindrical rubber fenders and pipe bollards are proposed for berthing and mooring of the barge. Typical plan and cross section of the berth are shown in the Drg. No. RITES/WW/149-A/TP-11&12 respectively.

5.5.2 Approach

Each berth is provided with an approach connecting the berth to land. Wherever possible approaches are planned in a way to have unidirectional flow of vehicles on berths and approaches. Approach jetty is having a carriage way width of 7.5m, foot path of 1.5m width on one side and service duct. In approach jetty also vertical bored cast in-situ piles of 1200mm dia. are provided in a grid of 6mx6m up to tie level similar to in berthing structure. Circular columns support the RCC deck, which is of beam and slab structure. Approach lengths vary for different terminals depending on distance of berth from land. Typical plan and section of the approach are shown in the Drg. No. RITES/WW/149-A/TP-11&12 respectively.

5.5.3 Design Criteria

Detailed geo-technical investigations were carried out at all the proposed terminal locations, to determine the soil parameters to be used for civil design works. Two bore holes i.e. one on the river bed and one on the bank were drilled for this purpose. Details of Geo-technical investigation of these bore-holes have been placed at **Annexure : 5.1.**

Soil parameters summarized below are as obtained from geo-technical investigations at the terminal location sites and are used in the design of the civil structures.

Terminal Location	Angle of internal friction (ϕ) in degrees	Cohesion kg/cm^2	Bulk density t/m3
Ayodhya	28	0.02	1.86
Mahirpur	30	0.0	1.86
Dohrighat	5	0.8 to 1.6	1.91
Turtipar	30	0.0	1.85
Manjhighat	5	0.8 to 1.6	1.96

The following loads and materials are considered in the design of berths and approach jetties for terminals.

Live Load	:	UDL of 3.3 T per sqm. Class AA/70R of IRC
Crane Load	:	75 T crawler mounted crane
River current Velocity	:	3.6 m/sec. (Mean)
Berthing Force	:	600 DWT barge approaching at a velocity of 0.3 m/sec at an angle of 10° to berth
Bollard Pull	:	10 T
Design concrete Mix	:	M 30
Steel reinforcement	:	HYSD bars conforming to IS Specification

Relevant Indian Standards viz. IS:4651, IS:456, IS:800, IS:875. IS:1893, IS:2911,IRC:5, IRC:6, IRC:78 etc. have been followed in the design.

Pile lengths proposed are tentative only. Pile length can be reviewed by conducting model studies and additional soil investigations at proposed terminal sites, before taking up actual construction.

Typical cross section of the access road is shown in the Drg. No. RITES/WW/149-A/TP-13.

The standardised designs are adopted in the proposed terminals depending on the number of berths required which are summarised below:

Terminal	Phase - I		Future	
	Berths	Approaches	Berths	Approaches
Ayodhya	2No.(70mx15m)	2No.(50mx9.5m)	1No.(70mx15m)	1No (50mx9.5m)
Mahirpur	1No.(70mx15m)	1No.(30mx9.5m)	-	-
Dohrighat	2No.(70mx15m)	2No.(30mx9.5m)	1No.(70mx15m)	1No (30mx9.5m)
Turtipar	2No.(70mx15m)	2No.(30mx9.5m)	-	-
Manjhighat	2No.(70mx15m)	1No.(30mx9.5m) 1No.(50mx9.5m)	-	-

CHAPTER – 6

VESSEL DESIGN

6.0 Introduction

The guiding feature of IWT fleet for operation on the Ghagra river is requirement of low draft. Reasonably high speed and efficiency in terms of cargo carrying capacity vis-a-vis power requirement is essential. The design of suitable fleet depends on:

- *waterway characteristics like river course, depth of water, radius of bends, current/ velocities of water etc.*
- *cargo characteristics like type of cargo, quantum of cargo, distance of transportation, and*
- *physical constraints like clearance under bridges, navigation locks size etc.*

6.1 Type of Craft

Self propelled barges and pusher tug-barge combinations are most commonly used in IWT services. Self propelled barges move under their own power and obtain a higher speed than dumb barges in tow. These barges are more effective against strong currents and have a low turn-around time (since no time is lost in anchoring and making up tows).

Dumb barges are used for carriage of cargo. These can be loaded partially or fully depending on cargo availability and river depth. Dumb barges are grouped together to form flotillas which are towed by river tugs. The method of towage, side towing, pull towing or push towing depends on channel depths and widths as well as the weather conditions experienced along the route. **The conventional method on the National waterway no.1/River Ganga in India has been towing abreast or side towing.** In pull towing, the propeller race of the tug impinges on the front barge thus increasing considerably the resistance of the barge fleet. Moreover, pull towing requires deployment of crew for steering the towed barges and has, in addition, the disadvantage of being less manoeuverable. In 'push towing' barges are lashed together by wire ropes to form a single unit and this, in turn, is lashed rigidly to the towing knees of the pusher tug. The tug, working at the rear can handle a fleet of barges at a greater speed and with greater control than is possible in 'pull towing' operations. The tug is equipped with a set of steering and flanking (backing) rudders which afford maximum control for forward, backward and sideward movements as are required in restricted channels. For this reason, *push towing has been recognized as the most efficient. It requires 20% less power than pull towing for comparable loads.*

Commodity-wise traffic flows indicate that fertilisers, cement, iron & steel and coal are likely to constitute the bulk of cargo for IWT. In order to

determine the type of craft most suitable for transporting such commodities at the lowest possible costs, it is necessary to have an understanding of the factors that go into costing of IWT. Modern steel vessels require considerable investment. Hence there is a need to design vessels carefully with a view to reduce the quantity of steel and ensure maximum cargo carrying capacity at minimal cost in the channel parameters (45 m width x 2 m depth) projected to be made available in the Ghagra. These channel parameters are also projected for the Ganga river from its confluence with Ghagra up-to the Port of Calcutta/Haldia. Indeed a special fleet with maximum draft not exceeding 1.7 m will need to be acquired for safe and economic operation in the shallow depth channels of the **Ganga-Ghagra** rivers.

Push tow flotilla is generally used where a multiple number of points are to be served and detention at terminals is too long. In the present case, because of the small carrying capacity of the barge, the cargo could be discharged at the terminal in one day only. For this reason *pusher tug-barge combination is not recommended* ***(Fig.6.0).***

Discussions with ship builders indicate that for dry bulk or bagged cargoes like fertilizers, cement etc., and also containerised cargo, open hold construction providing free access to the hold for faster handling would be suitable. Shallow draft barges of this type can be built and delivered in reasonable time frame of 9 to 10 months for the first vessel and two to three months thereafter for second and subsequent vessels.

6.3 Technical Considerations

The physical factors, which affect the cost of water transport, are depth and width of channel, current velocity and terminal facilities. The loading of barges is limited by the depth in the channel at its shallowest point along the route. Actually, the more the depth of waters between the barge and the river bottom (under-keel clearance), the less is the frictional resistance and cost of operation.

There is a close relationship between the dimensions of a navigable channel and the dimensions of the vessels, which may use it. Therefore, it is necessary to stipulate the length (L), breadth (B) and draft of the user vessel or combination of vessels with reference to minimum channel width and depth. Another associated factor is the *ratio of the wetted cross section of the channel to the submerged part of the vessel at its mid-ship section commonly known as 'n' ratio. To avoid excessive resistance, the value of 'n' should not be less than 6.* For vessel operating economics, minimum L : B ratio is considered to be 7. If the geography of the channel at its sharpest curve so permits, it would be desirable to have even longer vessels, as these are conducive to speed without loss of capacity or manoeuverability. Further, for two way navigation, the channel width should be 5 times the breadth of the vessel. It may, however, be stated that there are no hard and fast rules or standards in these matters and

The above mentioned problems have been confronted in several developed countries and overcome to a large extent by designing tunnels in the hull at the stern. In addition, continuing research has resulted in improvement of the state of the art of propulsion systems. Over the last two decades the **schottel propulsion system** has been developed and is widely used for service in shallow waters. It has three options, i.e., **rudder propeller, pump and jet types.**

Rudder propellers are right angle drives with propellers fitted to a 360 degrees steer-able lower gear, which replaces the standard propulsion equipment and the complete rudder system. The system has the following advantages:

- Since steerable Rudder propulsion unit has a 'built in' reduction gear and steering system, the stern tube, reduction gearbox, rudder with stock and blade, steering system etc. are not required. This results in savings both in space and cost.
- Compact construction reduces number of parts. In consequence less time is required on maintenance and repairs.
- Easy installation
- Unit incorporating reduction gear and steering system resulting in lower machinery weight compact engine room and hence nearly 10% increase in cargo hold capacity.
- Short stopping time and distance
- Full thrust available in all directions.
- Aft of vessel can be designed to achieve higher displacement.
- Reduced shipbuilding time as units can be mounted after launching.
- No need to dry-dock the vessel for maintenance/repairs as units can be removed while the vessel is afloat.

The Schottel pump and jet system is very useful for extremely shallow water application in depths of less than one metre. However, due to the working principle of these jet systems, their **efficiency is lower as compared to a propeller**. In general, for the jet system 15-20% higher power and for pump jet 30 to 40% higher power is required.

In the Ghagra River, the minimum depth after necessary improvement works is projected to be 2.0 m . Conventional marine diesel engines coupled to fixed screws and fitted in specially designed hulls with tunnel form, as also the rudder propeller system will be most effective and economical for inland water operations in such depths.

Traffic

The traffic details are discussed in **Chapter-2** of this report i.e. Traffic potential in detail. The cargo traffic projections are as under:

Cargo traffic projections are furnished below:

Year	2000-01	2004-05	2009-10	2014-15	2019-20
Cargo in tonnes	735310	897393	1331296	1878144	1878144

there can be considerable variations depending on the conditions of each waterway and its traffic.

In general, the basic parameters, which need consideration for optimisation of the design of fleet, are as follows:

- ◊ *principal particulars of vessels, i.e. length, breadth, depth, loaded and light draft, air draft, carrying capacity etc.*
- ◊ *type of cargo*
- ◊ *type of propulsion*
- ◊ *cost (capital, operation & maintenance)*

As the time spent in terminal for loading/unloading is a significant factor in determining the vessel size, the design of the vessel and terminal must be considered in conjunction for optimum output. The possibilities of improving the channel in the short and medium terms and also the economics of scale with the introduction of larger vessels to achieve lower transport costs shall also be considered.

6.4 Vessel Design

The IWT fleet currently deployed on the **NW no.1/Ganga** consists of self - propelled vessels and push-cum-side towing flotillas. The present river characteristics of the Ganga and the projected channel parameters 45mwide and 2m deep on the river Ghagra call for a new fleet design which will be influenced by these restrictions, speed requirement to overcome current, blockage coefficient and operational factors such as terminal infrastructure, number of operating days in a year and crew efficiency. Hence a more realistic design of fleet for the Ganga-Ghagra rivers would need to be considered as a whole.

3nos. rail and 4nos. road bridges already constructed across river Ghagra . These are having 5.7m to 8.82m vertical clearances above HFL under bridges, *which do not impose any limitations on vessel design (refer para 3.90 of this report)*. 3nos. temporary pontoon bridges constructed by PWD dept. for accessibility between north and south bank in non-monsoon season in different places have to be removed during navigation. The only point which is required to be kept in view is that if the height of flag mast is more than the least available vertical clearance , some adjustment may have to be done in the design of flag mast.

6.5 Propulsion Systems

At present the conventional screw propulsion system is *mostly used by the IWT operators*. But due to shallow water condition in the Ganga, difficulties are being faced on account of damage to propellers and rudders consequent on the vessel touching the ground. Such difficulties will also be faced in the Ghagra river. These, apart from raising the cost of operation result in inordinate delay in the delivery of cargo thus affecting the reliability of service.

Propeller : 2 no. pitch- fixed

Brief specifications of 600 tonnes vessel have been given at ***Annexure :6.1***

Self-propelled vessels are deployed for services between two fixed stations as in the instant case under study, namely between Calcutta and Ayodhya. In view of the foregoing, it is recommended that self propelled barges of shallow draft suggested above need to be specially designed for this waterway so that these may carry optimum payloads and ply without interruptions.

The basic assumption for calculating the number of vessels for normal traffic is as under:

Nos. of vessels has been calculated on the following assumptions:

Vessel speed in D/S: 15.5 km/hr.
Vessel speed in U/S: 12.8 km/hr.
Average speed of Vessel: 13.75 km/hr.
No. of days in year = 330 days vessel will be available
Detention time at each terminal for loading and unloading = 24hrs(12 hours per day).

Vessel Requirement

The number of vessels required for the projected traffic is as follows:

For 160 tonne vessel

Year	2001-02	2004-05	2009-10	2014-15	2019-20
No. of cargo vessels	100	125	191	276	276

For 600 tonnes vessel

Year	2001-02	2004-05	2009-10	2014-15	2019-20
No. of cargo vessels	27	33	51	74	74

The optimum vessel designed (600 tonne) carries a 240kw propulsion engine, giving a speed of 8.5knots. The vessel can cater to the current, which is high during flood season. The vessel can accommodate a maximum 600 tonnes of cargo. It is considered that the vessel will be available for a period of 330 days in a year.

6.8 Cost Estimates

The cost estimates for the vessels has been worked out on basis of interaction with Mazagon Dock Limited Mumbai, a Government of India Enterprise and market survey. Though the cost adopted in estimate is

6.6 Reduction in capital cost

For viability of IWT operations, it is imperative to reduce the cost of construction of vessels consistent with standards of safety as prescribed by the **Classification Societies**. For instance, vessels meant for plying in non-saline sheltered river waters could be built with lighter scantlings thereby reducing the quantity of steel used in the construction and providing increased cargo carrying capacity. The open barge hold will facilitate carriage of containers. Whenever considered necessary, the barge hold may be covered with tarpaulins, which would be just as effective as in trucks and can be replaced as required. The capital cost could be further reduced by minimising accommodation space. Building accommodation on vessels is very expensive. It should be provided for the minimum number of crew members.

6.7 Optimal Vessel Size

Keeping in view the channel parameters and propulsion systems as discussed above, the following two types of self propelled vessel having cargo capacity of 160 tonne and 600 tonne are proposed.

***160 tonne vessel* is recommended initially to start the IWT operation and attract private Enterpenures to divert the traffic-load from rail/road sector and this vessel would be replaced suitably by 600 tonnes vessel when the required traffic develops for IWT sector. The actual nos. of the 160 tonnes to start the IWT operation will depend on the availability of funds.**

Principal particulars of these self propelled vessel for operation on the Ghagra river are: -

160 tonne vessel (Fig. 6.1):

Length :*28.5 metres*
Breadth :*5.5 metres*
Maximum Draf :*1.8 metres*
Cargo capacity :*120 tonnes at 1.3 metre draft*
:*160 tonnes at 1.8 metre draft*
Propulsion System : *Marine Diesel Engines with propeller =2, 100HP each*

600 tonne vessel (Fig. 6.2):

Length :*56.06 metres*
Breadth :*10.40 metres*
Maximum Draf :*1.85 metres*
Cargo capacity : *500 tonnes at 1.5 metre draft*
600 tonnes at 1.85 metre draft
Propulsion System : *Marine Engines=2, output =240kw MCR(each) with speed of 1350-1500 rpm*

CHAPTER - 7

ORGANISATIONAL SET UP

7.1 Organisational Set Up

As Ghagra river is a major waterway (354 km long) and as there is no proper setup at present in the state government for managing IWT works the consultant proposes that an authority is required to be constituted in Govt. of U.P. under Dept. of Transport to deal with development, operation and maintenance of navigational waterways in U.P. This authority will also serve as an administrative unit and an organ of Govt. Which implements Government policies on IWT. The organisational set up should also have jurisdiction and control over all other Govt., public and private vessel operators on the developed waterway. *The conceptual set up of such organisation is given in* ***annexure: 7.1.*** *This envisages operation and setting up of Inland waterway on river Ghagra for construction of terminals, maintenance and operation of waterway etc.*

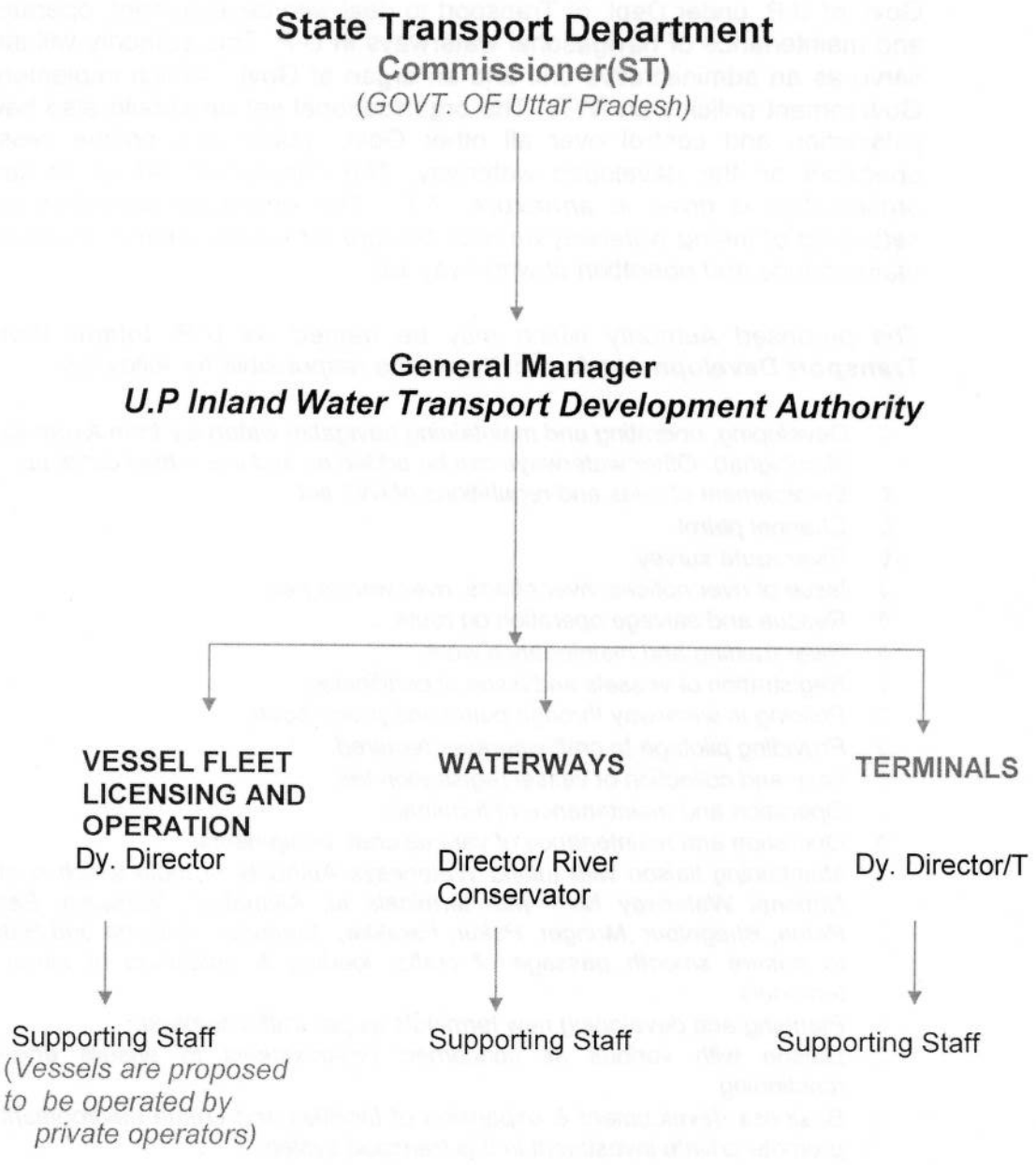
The proposed Authority which may be named ***as U.P. Inland Water Transport Development Authority****, will be responsible for following:*

- ◊ *Developing, operating and maintaining navigable waterway from Ayodhya to Manjhighat). Other waterways can be added as and when they come up.*
- ◊ *Enforcement of rules and regulations of IWT act.*
- ◊ *Channel petrol.*
- ◊ *River route survey*
- ◊ *Issue of river notices, river charts, river warning etc.*
- ◊ *Rescue and salvage operation on route.*
- ◊ *River training and maintenance work.*
- ◊ *Registration of vessels and issue of certificates*
- ◊ *Policing in waterway through petrol and police boats.*
- ◊ *Providing pilotage to craft wherever required.*
- ◊ *Levy and collection of vessel registration fee.*
- ◊ *Operation and maintenance of terminals*
- ◊ *Operation and maintenance of various craft, equipments.*
- ◊ *Maintaining liaison with Inland Waterways Authority of India which control National Waterway No.1 with terminals at, Allahabad, Varanasi, Ballia, Patna, Bhagalpur ,Munger, Pakur, Farakka, Semeria, Calcutta and Haldia to ensure smooth passage of crafts, loading & unloading of cargo at terminals..*
- ◊ *Planning and developing new terminals as per traffic demand.*
- ◊ *Liaison with various all concerned organisations to ensure efficient functioning*
- ◊ *Business development & expansion of facilities and create environment to promote private investment in this transport system.*
- ◊ *Financial/administrative/technical control of operation.*

To discharge smoothly above functions staff requirement is given in **table 7.1 to 7.3.**

Annexure:7.1

ORGANISATION SET UP FOR IWT ON RIVER GHAGRA



Note: 1. Vessel fleet operation is proposed to be left to private operators and hence manpower is not shown

2. For *support staff details please refer table 7.1 to 7.3.*

Table 7.1

Manpower for IWT on River Ghagra Waterway Maintenance and Management

A.	Sl. No.	Manpower	No. proposed
	1	Director/ River Conservator	1
	2	Dy.Durector - Dredging and river conservancy work	1
	3	Dredging Superintendent	1
	4	Steno-cum-clerk	1
	5	Peon	1
		(A) Total	**5**
B.	(I)	Dy. Director -Hydrographic survey	1
	(ii)	Asstt. Hydrographic Surveyor	3
	(iii)	Jr. Hydrographic surveyor	6
	(iv)	Draftsman/Tracer	3
	(v)	Computer Operator	3
	(vi)	Master, Driver, Lasker, Greaser, cook, each one	15
	(vii)	Steno-cum-clerk	3
	(viii)	Peon	3
		(B) Total	**37**
C		Dy. Director - Aid to navigation channel patrolling and communication	1
		Jr. Hydrographic surveyor for fast sounding boat	2
	-	Channel marking personnel	8
	-	Channel mark maintenance staff	8
	-	Store maintenance staff	8
	-	Radio officer	4
	-	Communication equipment technician	4
	-	Master for fast sounding boat & patrolling boat	8
	-	Driver	4
	-	Greaser	4
	-	Lasker	4
	-	Steno-cum-clerk	2
	-	Peon	2
		(C) Total	**58**
		Total Manpower = 5 + 37 +58 = 100 Nos.	***100***

Note:-

1. The study reach has been divided into three sectors for conducting regular hydrographic survey, maintenance and repair of aids to navigation.
2. Licensing of vessels will be done at one place (Dohrighat).

TABLE 7.2

Terminal Man Power Requirement

Sl. No.	Description	Man Power (No.)				
		Ayodhya Terminal	Tanda Terminal	Doharihgat Terminal	Turtipar Terminal	Manjhighat Terminal
1.	Crane Operators	8	3	9	6	6
2.	Fork Lift Truck Operators	54	-	60	48	60
3.	Pay load Operators	6	6	6	6	6
4.	Dumper Truck operator	36	6	45	12	36
5.	Weigh bridge operator	6	3	6	6	6
6.	Office Staff -Manager/Supervisor -Clerical	 3 9	 3 9	 3 9	 3 9	 3 9
7.	Maintenance Staff - Mechanical - Electrical - Civil - Skilled Labour - Unskilled Labour	 5 5 3 25 25	 3 3 1 12 12	 5 5 3 25 25	 4 4 3 23 23	 4 4 3 23 23
8.	Electrical sub station supervisor	3	3	3	3	3
9.	Security Staff	18	12	18	18	18
Total		**206**	**76**	**222**	**168**	**204**

Table 7.3

Man Power For Fleet Licensing And Operation

Sl. No.	Description	Man Power (in No.)	Remarks
1.	Dy. Director	1	
2.	Inspector of Crafts	1	
3.	Tech. Asstt.	1	
4.	Steno-cum- clerk	1	
5.	Peon	1	
Total		5	

7.2 Communication

For the operation of IWT terminals and the waterway it is proposed that dedicated communication system should be provided. The system of communication proposed is as follows:

1. Communication between each terminal including the Central office.
2. Communication among the terminals.
3. Communication between the navigating barges and the terminals nearby.
4. Communication among navigating barges.

The establishment of the above communication net work system will help co-ordinate and control the waterway transport operations effectively and contribute to optimising terminal loading pattern, cargo dispersal, functional deployment and use of barges, the use of service facilities.

For barge to terminal and barge to barge communication a short distance range radio frequency system is to be provided. A lump sum cost provision for the Communication system is provided in the project estimates to cover the requirements.

7.3 Hydrographic services

Hydrographic service is an integral part of aids to navigation. In view of proposed aids to navigation the hydrographic service has been integrated therein for an efficient round the year navigation on the waterway.

The total hydrographic service for the waterway comprises of the following activities:

- Carrying out hydrographic survey and publishing river charts,
- Issue of notices,
- Marking of channel,
- Instructions/warning to navigators,
- Waterway patrol,
- Efficient bank to vessel communication system,
- Monitoring of dredging work,
- Laying and retrieval of flood season and lean season channel marks,
- Data collection pertaining to river hydrology and morphology,
- Checking the levels of gauge stations and fixed shore marks etc.

A hydrographic survey, cum buoy laying vessel fitted with lifting gear, work boat etc. is recommended to carryout both periodic hydrographic survey and channel marking.

One channel patrol boat for every 175 Km is proposed to assist laying and removal of flood season channel marking buoys and leans season staff gauges. In addition, they will perform the channel patrolling for efficient operation of the waterway. The crafts will also be utilised in event of an emergency for search and rescue operation.

Two speedboats are recommended for the thalweg survey to facilitate issuing of notices to the navigators regarding danger areas, shallow patch, temporary new channel etc.

7.4 Hydrographic Survey, aids to navigation, channel patrol

Hydrographic survey plays the most vital role in the proper planning, execution and maintenance of waterways by keeping a continuous track of changes in the river regime. Like any other river, the Ghagra is likely to be subjected to rapid morphological changes. It is therefore necessary to provide aids to navigation and to maintain the waterway in good condition by dredging or by river training works, by carrying out regular hydrographic survey. In view of the importance of the activity, U.P. Inland Water Transport Development Authority shall acquire and maintain a captive survey unit duly manned, operated and maintained. The authority would be responsible for publishing river charts, notices, warnings, laying and maintenance of navigational marks, channel patrol, rescue operation, communication facilities to transiting vessels, supervision of dredging work, collection of basic data for the river conservancy works, proper alignment for economic dredging, utilisation of dredge spoil etc. The cost of crew, fuel, repair maintenance cost of crafts and equipment including cost of maintaining fixed, floating and semi permanent aids to navigation etc. have been accounted for in the operating cost.

CHAPTER- 8

ENVIRONMENTAL IMPACT ASSESSMENT

8.0 Environmental Regulation

In pursuance of global goals of nature conservation and protection to which India is committed, since our participation in Stockholm conference, State Government has initiated plans, schemes and actions to implement various legislation's and regulations. In Uttar Pradesh, there is an increasing pressure on country's resources. This has resulted in depletion and degradation of natural resources owning to rapidly growing population. However, there is growing awareness among policy maker and the public about effects of environmental degradation. Following Acts, Regulation and Documents were consulted for the preparation of this chapter:

- Water (Prevention and control of pollution) Act 1974. Amended in 1978 and 1988
- Air (Prevention and control of pollution) Act 1981 Amended 1988.
- Forest (conservation) .Act ,1980, Amended in 1988
- Environment Protection Act , and Rules.1986
- Environmental Guidelines for Transportation projects, Ministry of Environment and Forest MOEF, Govt. of India (1989)

On May 1994, MOEF had issued a notification of Environmental Impact Assessment (EIA) of development projects. The schedule – I, lists 29 types of projects which need environmental clearance from MOEF; Waterways projects are included in this list. The main aim of the study is:

- Environmental Conservation,
- Pollution Control,
- Compliance to Environmental Standards,
- Environmental Impact Assessment,
- Preparation of Environmental Management Plans, and
- Post project Monitoring.

With rapid strides in economic development the need for rationalising the transport system is imperative. In the process of development, there has been intensive use of natural resources. Very often the process of development has adversely affected the environment, leading to ecological imbalances. The importance of conserving and enhancing the environmental assets has assumed urgency. Apart from navigation, water resources, land use, conservation of flora and fauna and planning transportation is an important aspects of eco-development. It is in this context that Initial Environmental Examination (IEE) of navigation of River is planned as per Environmental Protection Act (1986). The chapter has following sections:

- Environmental baseline data,

- Environmental Impacts,
- Environmental Management Plans,
- Environmental Monitoring Program, and
- Conclusions and Recommendations

8.1 Baseline Environmental Data

Baseline environmental data plays a key role in the Environmental Assessment process as it provides the vital / necessary information on the environmental parameters which are likely to be affected due to the proposed development. The data also facilitates the decision-maker in identification of the type of impact (short/ long term; permanent / temporary) due to the proposed development on environmental parameters. These impacts are mitigated / reduced with the help of environmental management & enhancement measures incorporated during design, construction and implementation stages. In Waterway projects like this involving continuous movement activities, conservation of flora, fauna and the ecosystem forms important aspect of overall sustainable development process. The baseline data documented hereunder have been collected through field visits, interaction with local population and desk research. This section deals with the existing baseline conditions of the project in general. The data have been collected for the following:

- Land Environment,
- Water Environment,
- Air Environment,
- Ecological Environment.

The information available has been quantified wherever possible. An attempt has been made to assess the negative impacts.

8.1.1 Land Environment

In land environment, the parameters involved are physiography, soil, and geology and land use. These are discussed in the following paragraphs.

8.1.1.1Physiography

The river between Ayodhya and Manjhighat is flowing from west to east direction and meets river Ganga at Chapra in Bihar. The river passes through 11 districts (6 on left bank and 5 on Right Bank). It is almost a level plain with few distinguished features. The districts are completely devoid of any relief of appreciable size, and the monotony of the level plain is broken only in the vicinity of the rivers where the land is cut up by deep ravines, as the districts are crossed by a number of rivers and nalas, among which the Ghaghra is the principal one. The Ghaghra forms the main channel of drainage for all the 11 districts situated on the bank. The main tributaries of the Ghaghra are Rapti, Budi Gandhak, Bahroi on the left bank. There is no evidence that the river has ever been extensively used for navigation, except country crafts for transport of straw, fuel-woods, passenger's etc.

8.1.1.2 Geology & Soils

The area forms part of the great Indo-Gangetic plain formed by the deposits laid down by the rivers in the post tertiary period. The geology of the districts shows only gangetic alluvium. The nature and the depth of this alluvium show only coarse sand and sandy silt with occasional beds of clay and Kankar. Alluvium can be classified into two group's i.e. older and newer alluvium. Older alluvium is of middle Pleistocene age and generally occupies high ground, which is not effected by floods during the rainy season. Kankar occurrences associated with this alluvium is common. The ground water also generally lies within 15 metres of land surface. Most productive aquifers of the area are found in these sediments. Newer alluvium covers the lower height and is mainly confined to the flood plains along the river channels and belongs to the recent age. Small to moderate quantities of water is found in this aquifer. The ground water is of excellent quality for irrigation and public water supply.

The minerals of commercial value are the nodular limestone conglomerate known as Kankar, brick earth, saltpetre, reh, sand and clay. Lime is obtained by burning Kankar. Brick clay is abundant everywhere and bricks are being made all over the area. The soil in the area is light sandy or dense clay of yellowish brown colour. The sand found in the river is medium to coarse grained, greyish, white to brownish in color and is suitable for construction purposes.

8.1.1.3 Land-use Pattern

The data on land-use pattern has been collected from various secondary sources like district census Handbook, Revenue Records, State and Central Government Offices. The records have been verified with present land-use. Broadly speaking, river is used for drainage of the area, irrigation, ferry service, fishing etc. There are two road bridges and two rail bridges across the river under operation. Two road bridges and one rail bridge are under construction. Some of the towns located on the bank of the river are Ayodhya, Tanda, Golaghat, Bahalganj, Dohrighat, Bhagalpur, Turtipur, Darauli. In the river bed itself, there is cultivation of 2m high grass in some patches. Scrub may also be seen in some areas. Sand dunes may be seen in the river bed for whole of the year except monsoon season. In monsoon season, sand dunes are submerged. The sand available in the river bed is frequently used in building construction and clay brick. River being the perennial source, water is used for irrigation and other uses. At Mahrighat, there is pumping station supplying the water to Tanda power plant and for irrigation. Pumping station at Dohrighat supplies water to irrigation canal.

8.1.2 Water Environment

Water availability and its quality play a significant role. Water quality parameters of water resources available in the have been studied for assessing the water environment, to evaluate the suitability of water for drinking purpose and to anticipate impact of the proposed project. Understanding the water quality is as essential environmental issue to

identify critical issues with a view to suggests appropriate mitigation measures for implementation.

8.1.2.1 Water Availability

Long period hydrological data such as water levels, discharge, and flow velocity are very essential to study the water availability for introduction of navigation and fix the chart datum for reduction in soundings. To know the water level fluctuations within project area, monthly maximum and minimum water levels for the last 10 years have been collected from Central Water Commission and available in Project report. Data has indicted that sufficient depth is available. Discharge and water level of CWC gauge site fixed at Aydhya and Turtipar have been given in **Table 8.1.**

TABLE 8.1
DISCHARGE AND WATER LEVEL

Station	Date	Maximum values		Date	Minimum Values	
		Discharge (m3/s)	Water Level (m)		Discharge (m3/s)	Water Level (m)
Ayodhya	23.8.88	20,005.27	93.531	16.4.85	41.18	87.19
Turtipar	10.8.74	29,686.8	64.800	07.3.88	127.22	58.47
Source : Central Water Commission						

8.1.2.2 Water Quality

To assess the status of water quality of the project area, RITES made a reconnaissance survey and got the water quality sample analysed. The data was also collected from U.P. Pollution Control Board. During survey of the project area it was observed that number of water drains flow into river Ghaghra. Some of the drains carry polluted water to discharges it into the river. River Tapti, Bawana, Budhi Gandhak and Barhi river are tributaries of this river. On the bank of river, Tanda Thermal Power Plant is in operation and is discharging waste water from plant and colony into the river. At some location, Dhobi Ghat, Cremation Ghat and Bathing ghat are also located which also causes pollution. Cattle washing, hutments and villages at a number of places is also adding the pollution to the river .During survey in February, 2001, the water was found to be almost clear and the samples were collected at Ayodhya, Dohrighat and Manjhighat . The results of water analysis are depicted in **Table 8.2.**

Table 8.2
Water Quality Analysis Results at Aydhya and Manjhighat

S.No	Parameters	Unit	Ayodhya	Dohrighat	Manjhighat
1.	PH	-	8.14	8.14	8.13
2.	Total Suspended Solid	mg/l	47.50	62.4	75.00
3.	Total Dissolved Solid	mg/l	250.00	252.00	254.00
4.	Total Hardness	mg/l	184.00	184.00	184.00
5.	Calcium as Ca	mg/l	44.89	44.89	44.89
6.	Chloride as Cl	mg/l	10.00	9.5	8.00

S.No	Parameters	Unit	Ayodhya	Dohrighat	Manjhighat
7	Nitrate as NO3	mg/l	0.42	0.29	0.09
8	Sulphate as SO4	mg/l	16.57	24.00	23.71
9.	Phosphate as PO4	mg/l	ND	ND	ND
10.	Total Iron as Fe	mg/l	1.44	1.60	1.89
11.	Fluoride as F	mg/l	0.14	0.13	0.12
12.	BOD 3 days at 27 deg. C	mg/l	0.92	1.05	1.07

The above table indicates that the water is fit for navigation purposes.

Central Pollution Control Board has one monitoring station in river Ghaghra at 25°47 ′ latitude and 84° 32′ longitude near Chapra. Monitoring station at this has not been classified. Parameter with values for the year 1986, 1987 and 1988 at this monitoring locations are depicted in **Table 8.3.**

Table 8.3
WATER QUALITY REPORT IN TERMS OF ANNUAL MEAN VALUES

S.No	Parameters	Unit	1986	1987	1988
1.	Temperature	Deg. C	25.3	27.2	27.3
2.	PH	-	7.8	8.1	8.4
3.	Total Alkalinity	mg/l	117	96	116
4.	Dissolved Oxygen	mg/l	7.8	8.0	7.9
5.	B. O. D	mg/l	1.6	1.4	1.5
6.	C. O. D	mg/l	19.5	17.3	20.7
7	Nitrites Nitrates	mg/l	N. A	N. A.	1.197
8	Total Nitrogen	mg/l	0.568	0.408	0.620
9.	Chlorides	mg/l	9	8	8
10.	Sulphates	mg/l	11	11	10
11.	Sodium	mg/l	9	15	11
12.	Hardness as CaCO3	mg/l	127	131	124
13.	Fecal Coliform	MPN/100ml	3149	547	351
14.	Total Coliform	MPN/100ml	14313	2497	2875

8.1.3 Air Environment

The air environment is responsible for the health of human beings, animals, wildlife and vegetation. Air pollutants emitted by point and non-point sources are transported, and dispersed by meteorological and topographical conditions. In order to assess the impact on existing air environment due to the project it is necessary to have baseline air status of pollutants. The base line status of the ambient air quality has been assessed by monitoring suspended particulate matter, Sulphur di-oxide and nitrogen oxide at terminal location of Ayodhya, Dohrighat and Manjhighat.

8.1.3.1 Meteorology

The micro meteorological parameters regulate the transport and diffusion of pollutants released into the atmosphere. Meteorological data collected from secondary sources provides long term data that is good for averaging purposes. The meteorological data has been found from the relevant district Gazettier.

Temperature : From mid November, there is a rapid fall in temperature . January is the coldest month. Day temperature begins to rise rapidly after February and May is the hottest month. Maximum and minimum temperature range in the month of May and January are as given in **Table 8.4.**

Table 8.4
Maximum and Minimum Temperature

District	Mean Daily Temperature (° C)	
	Maximum (in May)	Minimum (in January)
Gorakhpur	25.1 – 38.4	9.3 – 22.8
Deoria	25 – 38	9 – 23
Basti	25 – 38	9 - 23
Ballia	25.4 – 41.8	9.9 – 23.9
Azamgarh	26.1 – 41.4	9.7 – 23.3

Humidity: The humidity is high during monsoon and post monsoon season ranging between 70 and 85 percent after which it decreases gradually. The driest part of the year is the summer season when the relative humidity in the afternoons is less than 40 percent.

Wind: Winds are generally light with some increase in force in the late summer and monsoon months. During the non-monsoon months, predominant winds are from directions between south – west and north – west. By May, winds from directions between south – east and north east begin to blow and in the monsoon season these predominate. During the cold season, winds blow mostly from the west. Easterlies appear in the early part of the hot season but westerlies predominate later in the summer. The average annual wind speed is about 4.0 km per hour, the maximum being 7.2 km per hour in May and the minimum 1.6 per hour in November.

Rainfall: Rainy season starts at mid June and lasts up to September. Mean monthly rainfall of five districts are as given in **Table 8.5.**

Table 8.5
Mean Monthly and Annual Rainfall (in mm)

Month	Gorakhpur	Basti	Deoria	Azamgarh	Ballia
January	14.5	13.8	12.9	14.9	14.9
February	21.5	21.5	17.4	19.5	19.6
March	10.9	11.9	9.3	7.3	8.3
April	16.3	10.6	13.3	6.1	5.9
May	44.8	34.4	38.7	14.5	15.3
June	168.7	163.0	168.8	107.6	110.6
July	409.5	380.1	328.8	298.2	279.3
August	369.9	325.3	319.5	295.4	294.5
September	257.3	231.3	214.2	198.5	207.8
October	72.7	60.3	58.4	48.0	48.3
November	4.0	6.0	5.2	5.6	4.7
December	3.0	5.8	3.3	5.7	3.9
Annual	1393.1	1264.0	1189.8	1021.3	1013.1

Source: Gazettier of India

From the above table, it may be seen that there is slight variation in the mean monthly annual rainfall for all the five districts coming under the project area.

8.1.3.2 Air Quality

The AAQM stations was monitored in Feb., 2001 at Ayodhya, Dohrighat and Manjhighat by installing AAQM station there for monitoring the pollutants. List of ambient air quality stations along with the sampling criteria and frequency are given in **Table 8.6**. The results so obtained are presented in **Table 8.7.**

Table – 8.6
Ambient Air Quality Stations

Sl. No.	Location/Name	Sampling Criteria	Frequency	Parameters
1	Ayodhya	8 hourly samples for one day	1 day	SPM, SO_2, and NOx
2	Dohrighat	- do -	- do -	- d0 -
3	Manjhighat	- do -	- do -	- d0 -

Table 8.7
Ambient Air Quality

Sl No.	Parameters	Unit	Ayodhya	Dohrighat	Manjhighat
1.	Suspended Particulate Matter	ug/m3	126	178	166
2.	Sulphur dioxide	ug/m3	<5	<5	<5
3.	Oxides of nitrogen	ug/m3	<5	<5	<5

The SPM concentration from all the three AAQM stations ranged from about 126 to 178 $\mu g/m^3$ for one season, well within the permissible limit of 200 $\mu g/m^3$. Low values of SPM is mainly due to local conditions. Both SO2 and NOx were found to be below detectable limits. The results have been compared with the available standards. It has been observed that values of sulphur dioxide and nitrogen oxide are well within the permissible limits for industrial and residential areas.

8.1.4 Noise Environment

The impact of noise can lead to effects such as Noise Induced Hearing Loss (NIHL) and annoyance depending upon the loudness of noise levels. Noise level survey was conducted at the project sites. The main objective of noise monitoring in the study area is to establish the baseline noise levels, and assess the impact of the total noise expected to be generated by the proposed activities and IWT in operation. The noise monitoring has

been conducted for determination of noise levels at three terminal locations. The noise levels were recorded for 8 hours taking reading at an interval of 15 minutes. The results are presented in **Annexure: 8.1** Based on the above results, maximum, minimum and Leq. have been calculated and summarised in **Table 8.8**.

Table 8.8
Daily Average Noise Level In dB(a)

Sr. No.	Locations	Date	Noise Level dB(A)		
			Max.	Min.	Leq.(calculated)
1.	Ayodhya	20.02.2001	72.50	45.80	70.12
2.	Dohrighat	22.02.2001	68.40	42.90	66.04
3.	Manjhighat	24.02.2001	69.80	45.00	67.42

The average sound levels at the three proposed sites ranged between 67–70 dB(A). **These are equal to or below the prescribed limits of 70 dB(a) for industrial areas.**

8.1.5 Ecological Environment

An ecological study of the ecosystem is essential to understand the impact due to project development activities on the existing flora and fauna of the area. The present study was undertaken to assess the changes likely to take place as a result of project activities and to suggest measures for maintaining the conditions. This section describes the ecology of the area based on information compiled from secondary data available for the area.

8.1.5.1Flora

The variety of vegetation has been observed along the banks of river Ghaghra. There is forest in the reach. The important species found in the study area are given in **Table 8.9.** No endangered /rare species of plants have been observed in the study area as per any scheduled species of plants as per Wildlife (Protection) Act, 1972, 1980.

Table 8.9
Common Trees in Study Area

Local Name	***Botanical Name***
Mango	*Mangitera indica*
Mahua	*Madhuca indica*
Sal	*Sorea robusta*
Bamboo	*Bambusa arundinacea*
Eucalyptus	*Eucalyptus teritrornis*
Sheesham	*Dalbergia sisso*
Neem	*Azadirachta indica*
Pipal	*Ficus religiosa*
Banyan(Bargad)	*Ficus bengalensis*
Gular	*Ficus glomerata*
Jamum	*Syzygium cumini*
Kachnar	*Bauhinia variegata*

Local Name	Botanical Name
Imli	Tamarindus indica
Bel	Aegle marmelos
Bahera	Terminalia bellirica
Barhal	Artocarpus lakoocha
Aonla	Emblica officinalis
Kathal or Jackfruit	Artocarpus heterophyllus

8.1.5.2 Fauna

The chief domestic animals of the project area are oxen, cows, buffaloes, sheeps, goats, pigs and donkeys. The bird fauna encountered in the study area are *Red vented bulbul*, Jerdon's Chloropsis (maina Weaver's Bird) baya, Wax bill (red munia), Koel, Indian Parakeet, Black rock pigeon (Kabuter), Grey quail (Ghaga bater). **Table 8.10, 8.11, 8.12 and 8.13** describe the common species of animals, birds, reptiles and fishes.

Table 8.10
Common Animals in Study Area

Local Name	Zoological Name
Fox	Vulpus bengalensis
Jackal	Canis aurcus
Wild pig	Sus secrofa
Nilgai	Boselaphus tragocamelus
Antelope	Antelope cervicapra
Wolf	Canis lupus
Jackal	Conis aureus
Hare	Lepus ruficandatus
Monkey	Macaca mulatta

Table 8.11
Common Birds in Study Area

Local Name	Zoological Name
Patridge(Titar)	Francolines pondicerionus
Pigeon(Kabutar)	Columbia livia
Dove (Fakhta)	Streptopelia decaocto
Peacock	Pavo cristatus
Jal Murgi	Amaurornis phoeonicums
Snipe (Chaha)	Capella gallinago
Kite	Milvus migrans govinda
Crow	Corvus splendens splendens
Vulture	Gyps bengalensis
Mynah	Acridotheres tristis
Sparrow	Passer domesticus indicus
Bagula	Eqret alba modesta
Bulbul	Molpaster cafer

Table 8.12
Common Reptiles in Study Area

Local Name	Zoological Name
Cobra	Naja naja
Karait	Rungarus coeruleus
Rat snake	Styas mucosus
Crocodile	Crocodilus palustris
Monitar Lizard	Varanus monio
Python	Python molurus
Turtle	Chelonia Mydas

Table 8.13
Common Fishes in Study Area

Local Name	Zoological Name
Rohu	Labeo rohita
Karounch	Labeo calbasu
Bata	Labeo bata
Khursa	Labeo gonius
Bhakur	Catla catla
Nain	Crirrihina mirgala
Tengra	Mystus aor
Girai	Ophicephalus gachuwa
Chelwa	Chela bacaila
Putia	Barbus stigma
Khasua	Trigogaster

8.2 Environmental Impacts

The impacts of the project could be positive or negative. Both types of impact have been studied. The potential impacts have been assessed in this section.

- Impact due to project location,
- Impacts due to project construction and operation

For each of these heading potential impacts has been considered while management and mitigation measures have been made in section 8.4.

8.2.1 Impact due to Project Location

During this phase, those impacts, which are likely to take place due to the layout of the project have been assessed. The project will not pose any displacement to people, loss to cultural monuments and religious structures and risk due to earthquake. The anticipated impacts are:

- Change in land use
- Drainage and utilities problems,
- Jetty inlets and outlets,
- Lighting, and
- Terminal refuses.

(a) Change in Land use

The route is planned through the Ghaghra River. The traffic would consist of mainly cargo. Terminals will have landing structure, waiting berths, handling facilities, storage facilities, bunkering, repair facilities, road and rail transport linkage etc. The land required at different terminals is reported in **Table 8.14.**

Table 8.14
Land requirement at Terminals

S. No.	Terminals	Area required (In ha)
1	Ayodhya	1.76
2	Tanda	0.38
3	Dohrighat	1.64
4	Turtipar	1.07
5	Manjhighat	1.05
	Total	**5.90**

In all about 5.9 ha. of land is likely to be utilised to accommodate terminal buildings and other infrastructure. The area to be acquired will partly fall in agriculture land.

b) Drainage and Utilities Problems

The main drainage in catchment area is through rivers. Due to plying of transport vessels, neither the terminals nor vessels will change the drainage pattern of the area. It will also not create any hindrance in utilities available in the area. Moreover, existing water flow in the river will be utilised for navigation.

c) Jetty Inlets and Outlets,

In the Project two type of cargo vessels namely 160 tonnes (size 28.5X5.5m) and 600 tonnes (size56.06m X10.4m) are envisaged. The width of the Channel is proposed to be kept as 45m for cargo vessel movement.

d) Lighting

The jetty and approach areas both on ground and in water will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. Where electricity is not available, the illumination shall be by solar lights. The ferry boats could be fitted with extra lamps to light up the landing pontoon. It is proposed to adopt the norms followed at International level for illumination as reported in section 8.4.

e) Terminal Refuse

The collection and removal of refuse in a sanitary manner from jetty/terminal stations are of importance for effective vector control,

aesthetic improvement and nuisance and water pollution abatement. The refuse from terminals/jetty includes :

- Garbage
- Rubbish and
- Floor Sweepings

Due to non-availability of solid waste data for such facilities, it is assumed that about 350 gms, per person per day will be generated. About 876 people per terminal are likely to work/visit. The total refuse generated at all terminals will thus be about 112 tonnes per year.

8.2.2 Impact due to Project Construction and Operation

Although environmental hazards related to construction works are mostly of temporary nature, this does not mean that these should not be considered. The impacts due to construction will be of insignificant magnitude and temporary in nature. The main issues need attention is soil erosion, pollution and health risk. Runoff from unprotected excavated areas can result in excessive soil erosion, especially when the erodability of soil is high. Mitigation measures include careful planning, timing of cut-and fill operations and re-vegetation.

Health risks include disease hazards to people from lack of sanitation(water supply, human waste disposal) and insect vector disease hazards to the local population. Mitigation measures should include proper water supply, sanitation, drainage and health care and human waste disposal facilities. In addition to these, efforts need to avoid oil spills and adopt disease control measures.

Along with many positive impacts, the project may cause the following negative impacts due to construction and operation of vessel is proposed.

- Oil pollution,
- Noise
- Accidental hazards,
- Water Supply and Sanitation,
- Dredging,
- Water pollution,
- Air pollution,
- Terminal refuse,
- Soil erosion at construction site,
- Disposal of excavated soil,
- Health risks,
- Impact on ecological environment,

8.2.2.1 Oil Pollution

Vessels will need workshops/services for maintenance of vessels. Oil is spilled during change of lubricating oil, cleaning and repair processes. Moreover, cleaning of vessels will generate waste water and solid waste at such sites. The problem could be serious in case of accidents. The oil spills and its spread on water may lead to decrease in dissolved oxygen in water as low as 3 mg per litre. This may cause a total depletion of oxygen, which may cause odour problems, and killing of aquatic life even in a short duration. The spilled oil will need to be trapped at source. In case of spills on water, attempt need to be made to recover it from water surfaces. The arrangement for such collection system are reported in section 8.4

8.2.2.2 Noise

The main source of noise in the vessel are engine and propeller. The noise level at source is 90 dB(A) due to above sources. The consultant has made an attempt to predict the rise in ambient noise at different distances. The total number of vessels, which will run on the proposed route , comes to about 350. On an average, the speed of the vessel will be about **13.75km per hour.**

The contact surface of water vessel noise propagation to wayside is determined by the continuous point source model, using the following relationship:

$L_{max} = 30 \log_{10}(V) + 28$ dB(A)

Where :

L_{max} =sound pressure level in dB(A)

V = Vessel speed in km per hour

The level of total sound energy (Lax) for a vessel point source is :

$Lax = L_{max} + 10 \log_{10}(d/V) + 8.6$

The Lax for vessel is estimated with the following equation :

$Lax = L_{max} + 10 \log_{10}(l/V) - 10 \log_{10}(4D2 + l) + 2 \tan^{-1}(l/2D) + 10.5$

Where: l = length of vessel,

D = d / l

d = distance from the vessel

The equivalent noise level (leq) is given by :

$(Leq)1 = (Lax)1 - 10 \log_{10}(T)$

T = Time in seconds

Different structure/land use/geometry of project will attenuate the noise at receiving point. The attenuation has been estimated with the following formula :

I) Geometric attenuation : 17 log10(d-25/25)
II) Ground attenuation : 1.5 dB(A)/100m
III) Air absorption : 0.5 dB(A)/100m

The maximum noise level would be about 46 dB(a) at 50m distance from vessel which is slightly higher than the limits for sensitive zone.

However, the aesthetic appearance of vessel and even minimum noise the wildlife to migrate away from river or park areas close to navigation route. In the study route, there are no life wild sanctuary .

8.2.2.3 Accidental Hazards

In view of the hazards of potential involved due to failure and accident, it is necessary to formulate and implement an emergency action plan. Accidental Risk involved in such projects has indicated accidental hazards as 0.9 people per million per year. Hazardous materials/chemicals are planned to be transported through Waterways route are fertilizers (Ammonium Nitrate) Chemicals. The quantity of transport and storage shall meet International norms/standards.

8.2.2.4 Water supply and Sanitation

The public health facilities, such as water supply, sanitation and toilets are much needed at the terminals. Central Public Health and Environmental Engineering Organisation (CPHEEO) has recommended as 45 litres per day per person water supply demand. It is proposed to make water provisions for passengers/staffs and to provide sanitary facilities with adequate flushing water. These could be fitted with septic tank with appropriate disposal point. Terminals are generally in the rural area except one at Ayodhya. Water demand on each terminal will be catered by bore well, municipal or local water supply.

8.2.2.5 Dredging

Dredging is the principal practice used world wide to improve the navigability of Inland Waterways. The dredging requirements are reproduced in **Table 8.15.** The consultant has estimated quantity of dredging that needs to be dredged at a particular stretch en-route. As per detailed study report 9.6million cubic meter of sand with silt to be dredged for 45m wide channel in a stretch of 354km. This need to be disposed at scientifically designed site. The effects of dredged soil will be on aquatic ecology and water quality. The dredging will uproot the habitat and breeding places of aquatic flora and fauna along the route. Dredging will add to the already existing water pollution problems by facilitating the particulate matter up and down and will increase the turbidity at dredging site and thus disturbing the biological life. This is a short term impact and can be tackled by efficient use of less intrusive dredging equipment and by providing silt curtains.

Table 8.15
Dredged Soil Quantity (cum)

Sl. No.	Chainage(in km)		Dredging Qty in cum.
	From	To	
1	0.0	100	26,16,000
2	100	200	27,59,200
3	200	300	21,58,000
4	300	354	16,36,000
5	Terminals		3,94,000
Total			**95,63,200**

8.2.2.6 Water Pollution

Water pollution problems will be mainly due to dredging. About 27015 m3 per km length of waterways, the soil will be dredged. It is estimated that about 27015m3 per kg length of waterways accomplished. It is estimated that about 54029 tonnes of soil per km will be dredged. Dredging leads the water pollution. The water flow changes throughout the year, which will facilitate the particulate matter to settle down.

8.2.2.7 Air Pollution

The impacts on air environment will be during construction and operation phases. Impact on air environment during construction will be of short duration. There might be rise in SPM, NO_x and SO_2 levels during operation phase. No significant change is anticipated due to less number of vessels. However, in other areas with the implementation of the project, the air quality is likely to be improved as peak hour peak direction trips will be shifting to this mode of transport.

8.2.2.8 Terminal Refuse

The collection and removal of refuse in a sanitary manner from jetty/terminal stations are of importance for effective vector control, aesthetic improvement, nuisance and water pollution abatement. The refuse from terminals/jetty includes garbage, rubbish and floor sweepings. The vessels must be provided with proper storage capacity on board for storing waste, to be disposed off. The storage containers for this purpose need to be designed scientifically later on.

8.2.2.9 Soil erosion at construction site

The impact on soil due to this project is in terms of top soil erosion. The upper layer of soil, may be replaced with construction materials like sand, cement, concrete, bricks, aggregate etc. During construction activity, soil may erode due to cutting and embankment. Considerable care need to be taken while locating the labour camps buildings, quarries, spoil and disposal site which will minimise the soil erosion.

8.2.2.10 Disposal of excavated soil

Construction activities involve earthworks both cut and fill. The earthwork likely to be generated from cutting will be marginal and no dumping is likely to be required. No major impact on land environment is anticipated.

8.2.2.11 Health risks

These include disease hazards due to lack of sanitation (water supply, and human waste disposal), vector borne diseases and hazards to local carriers. Improvement of water quality will help to reduce the proliferation of water borne diseases. The water quality can be improved by way of: (i) not allowing the untreated sewage/solid waste to get entry into the river. (ii) stopping / reducing dhobighat activities and slums to some other suitable areas (iii) regular check up of water for tributaries.

8.2.3 Impacts on Ecological Environment

No loss of forest/trees is anticipated. Dredging/navigational activities may disturb the habitat of some aquatic fish species and force them to migrate to other areas. However, it needs further scientific study. There will be no conflict regarding the encroachment on nature reserve, as the project area and its surroundings are not declared as nature reserve. No impact on Bio-diversity is expected because of waterways project implementation.

8.2.4 Positive Impacts

Based on project particulars and the existing environmental conditions, potential positive impacts have been identified that are likely to result from the proposed project. Positive impacts have been listed below:

- Employment opportunities;
- Safety;
- Traffic congestion reduction;
- Less fuel consumption;
- Reduction in noise levels;
- Air pollution reduction; and
- Reduction in trucks/wagons;

8.3 Checklist of Impacts

Checklist is the list of environmental parameters or impact indicators, which the environmentalist is encouraged to consider when summarising the potential impacts. A typical checklist identifying the anticipated environmental impacts due to the project activities is shown in **Table 8.16.**

Table 8.16
Checklist of Impacts

Sl. No.	Parameter	Negative Impact	No Impact	Positive Impact	Short Term	Long Term
A.	**Impact on Land Environment**					
1.	Loss of land	□	--	--	--	□
2.	Terminal Refuse	□	--	--	--	□
3.	Soil erosion at construction site	□	--	--	□	--
4.	Disposal of excavated soils	--	□	--	--	--
B.	**Impact on Water Environment**					
1.	Oil pollution	□	--	--	--	□
2.	Health risks	□	--	--	--	□
3.	Water supply & sanitation	□	--	--	--	□
4.	Dredging	□	--	--	□	--
C.	**Impact on air environment**					
1.	During construction	□	--	--	□	--
2.	During operation	--	--	□	--	□
D.	**Impact on Noise environment**	--	--	--	--	--
E.	**Impact on ecological environment**	--	□	--	--	--
F.	**Positive Impacts**					
1.	Employment opportunities	--	--	□	--	--
2.	Safety	--	--	□	--	--
3.	Traffic congestion reduction	--	--	□	--	--
4.	Less fuel consumption	--	--	□	--	--
5.	Less air pollution	--	--	□	--	--
6.	Reduction in buses	--	--	□	--	--

8.4 Environmental Management Plan

The Inland Water Transport project will provide employment opportunity, enhancement in career opportunities, enhancement of mobility, easy Inter-State movement, reduced energy consumption on the one hand and will create problems of soil disposal due to dredging, problems for aquatic habitat, water pollution etc. on the other hand. The environmental issues likely to develop during project construction and operation phases could be minimised by making necessary provisions in project design and adopting Environmental Management Plan (EMP).

Based on the planned project activities, environmental baseline conditions and impacts assessed in earlier, this section enumerates the set of measures to be taken during implementation and operation, to eliminate or avoid offset adverse environmental impacts or to reduce them to

acceptable levels, together with the action which needs to be taken to implement them.

The most reliable way to ensure that the plan will be integrated into the overall project planning and implementation is to establish the plan as a component of the project. This will ensure that the plan will receive funding and supervision along with the other investment components. For optimal integration of EMP into the project, these should be linked for:

- Funding
- Management and training, and
- Monitoring

The purpose of the first is to ensure that proposed actions are adequately financed. The second link help in imparting training, technical assistance, staffing and other institutional strengthening items needed to implement the mitigation measures in the overall management plan. The third link is necessary to provide a critical patch for implementation and to enable sponsors and the funding agency to evaluate the success of mitigation as part of project supervision and as a means to improve future project.

The management plans have been developed for negative impacts:

- Change of land use,
- Spills of Oil and Grease,
- Refuse and Waste,
- Disposal of Dredged Material,
- Control of Air Pollution,
- Control of Noise Pollution,
- Protection of Aquatic Habitat and Ecology,
- Water Supply and Sanitation,
- Lighting, and
- Health facilities.

8.4.1 Change in land use

The land will be required for road, facilities and storage of cargo. Compensation has to be paid to people for loss of their land.

8.4.2 Spills of Oil and Grease

The oil and grease may spill from engines and storage, which could pollute river water. The best way is to maintain and service engines and mobile part at regular intervals. Wherever leak possibilities are there sealing must be kept in a perfect condition to prevent unnecessary spills. Discharge of lubricating oil and grease including their packages into the surface water must be prohibited. Further, the bottom of the engine room must not drain into the other part of the ship/vessel. Water entering into the bilge of the ship should not be contaminated with the oil. The oil and grease from the workshop should not join the drainage system. It is therefore proposed to

install oil and grease removal traps. After skimming the oil and grease, it needs to be burnt or disposed off in scientific manner. Studies have indicated that accident in water transport take place in connection with transport of oil and chemicals. In such cases efforts need to be made to stop the movement of oil by spreading boom in the area. Microbiological methods could also be adopted depending upon availability.

8.4.3 Refuse and Waste

The vessel must be provided with storage bins on board for storing solid waste. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the project authorities. The storage containers for this purpose need to be designed. However, it is suggested that the capacity of these containers should not exceed 120 litres and these should be equipped with side handles to facilitate handling. The cans specially for garbage storage should not exceed 50 litres and should preferably be equipped with lockable cover. To avoid odour and the accumulation of fly supporting materials, garbage container should be washed at frequent intervals.

8.4.4 Disposal of Dredged Material

It has been estimated that about 9.6Mcum of soil will be dredged. In addition annual maintenance will also be there. The dredged material is proposed to be deposited on the banks of river to strengthen the banks or suitable identified place near the river bank and also prevent any interference. Since there are no industrial units in the vicinity of the waterway route, dredged material is not expected to be toxic.

The problem of increased short term Turbidity at dredging site can be tackled by efficient use of less intrusive dredging equipment, by providing silt curtains and dredging during low flow periods. Using technologies such as temporary barriers could reduce the generation of turbidity plumes.

8.4.5 Control of Air pollution

Air quality was monitored along the IWT route. This has indicated low values for Suspended Particulate Matter (SPM). However, the values for Sulphur dioxide and nitrogen oxides were below detectable limits. There will be an increase in ambient air pollution levels. This increase will be insignificant. Good engine maintenance can prevent increase in air pollutants. In order to facilitate better diffusion the exhaust tail pipe could be elevated into the atmosphere. The exhaust mufflers, catalytic converters and exhaust gas re-circulation could be fitted in the tail piece. With these measures, it is possible to maintain the present levels of air pollutants, which are below the ambient air quality limits.

8.4.6 Control of Noise pollution

Noise from the engines of the vessels and ships plying on the IWT must be kept under acceptable level both for the safety and health point of the view

and also due to sensity of the area. During field study, the maximum noise level found is 72.50 dB(A) at the terminal of Ayodhya. After commissioning of the project, the maximum level may increase slightly at the time of horn of the vehicle. But the frequency of this level will be very less.

As a mitigation measure, it is proposed to use :

- Engine which produces less noise
- Muffler at engine exhaust,
- Non-horn zone in the core area, and
- Mobile telephone/transmitter for communication, to reduce the noise levels from vessels and other activities.

8.4.7 Protection to Aquatic Habitat and Ecology

A wide variety of aquatic habitats are found all along the IWT route, which has already been documented in , section 8.1.5. This habitat is susceptible to pollution of waters. Following recommendations need to be adopted to protect these habitat :

- In the immediate vicinity of existing habitat, new habitat needs to be developed,
- Plans need to be initiated to develop aquatic farms for development of species in the area,
- New habitat should be protected from soil erosion, floods,
- Avoiding of pollution of river stream and
- Construction of river training works.

If such precautions are taken, then danger to aquatic habitat could be reduced. However a detailed study on long term basis on ecological parameters will be essential.

8.4.8 Water Supply and Sanitation

Water sources should be treated before use upto WHO drinking water standards. Water supply could be from conventional water treatment plant used for this purpose in the area. The collection and safe disposal of human wastes are among the most important problems of environmental health. On board sewage/excreta disposal facility need to be provided. In case it not possible, the collected excreta on board could be disposed on terminal in sewage disposal systems through septic tank/sewage treatment plant. The capacities for septic tanks serving are indicated in **Table 8.17.**

Table 8.17
Capacity of Septic Tanks for Individual Dwellings

S. No.	Max. no. of persons served	Liquid capacity of tank, gallons	Recommended Dimensions (m)			
			Width	Length	Liquid depth	Total depth
1.	8	1100	1.22	2.60	1.37	1.68
2.	10	1300	1.22	3.05	1.37	1.68
3.	12	1500	1.37	3.05	1.37	1.68

8.4.9 Lighting

The jetty and approach areas, both on ground and in water will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. The illuminations at different locations is indicated in **Table 8.18.**

Table 8.18
Illumination at Different Locations

Location/Premises	Illumination (Lux)
Entrance to Jetty from road	250
Booking office/Concourse	200
Jetty platform	150
Passenger staircase	250
Toilets	100
Offices	200
Emergency lighting of Jetty, platform passage and public utilities	50

8.4.10 Health Facilities

The people will be working on terminals. They should utilise the facilities available in the area according to the criteria of Ministry of Health/WHO.

8.5 Environmental Monitoring Program

Environmental Monitoring Program is a vital process in management plan of a navigation project. This helps in signaling the potential problems to result from the proposed project and will allow for prompt implementation of effective corrective measures. The environmental monitoring will be required during construction and operational phases. The following parameters need to be monitored :

- Water Quality and Public Health,
- Soil Conservation Measures,
- Soil Disposal,
- Habitat Management, and
- Air and Noise pollution.

8.6 Epilogue

Based on project description, environmental baseline data and impacts assessment, it could be concluded that project will not have significant impact on environment due to implementation of IWT in river Ghaghra. However, it is recommended that the client may take up detailed aquatic study to assess density and diversity of aquatic species along with detailed engineering project report. More detailed work on habitat of aquatic species, their path etc. need study on long term basis.

8.7 Conclusions & Recommendations

Based on field visits, baseline data and analysis following conclusions and recommendation could be drawn:

- The integrated Mass Transit System involving Inland Water Transport through Ghaghra will ease out the traffic situation in the hinterland.
- The width of the water channel in Ghaghra river varies 90 m to 1200 m. Appropriate water depth is available except some dredging at few points. The navigation and terminal facilities will cost about Rs.1242 million.
- The reconnaissance survey has indicated that there will not be much change in the land-use due to the construction of five terminals on the way.
- The water quality is suitable for drinking with treatment. However, It is reported that there are 4 tributaries of this river and drains at few location meet to the river. Drain carrying waste water should not be allowed to discharge without treatment to permissible limits. The movement of IWT vessels will not create any major deterioration in water quality. But clean water have to be maintained from aesthetics and hygienic point of view of waterways.
- With the implementation of IWT through River Ghaghra there will be improvement in ambient air quality of the area. However, air quality will deteriorate over Ghaghra River.
- No loss to the tree/vegetation is anticipated due to the project. However, there are number of fish species available in the River. Much impact due to IWT is not anticipated. However, a detailed investigation about the fish fauna is essential.
- During construction, the consultant should make arrangement for terminal refuse, soil erosion at construction site, and disposal of excavated soil.
- Project Authority have to make suitable measures to control oil spills and dispose dredged material at suitable sites.
- Provision of water supply and sanitation facility as per requirement of CPCB and as per guidelines of Central Public Health and Environmental Organisation (CPHEEO) need to be incorporated.
- The Project will have beneficial impacts such as more employment opportunity, safety, traffic congestion reduction, less fuel consumption, reduction in noise level, air pollution reduction and less carriages in number.

CHAPTER - 10

PROJECT APPRAISAL

10.0 Approach & Methodology

10.1 The appraisal of the proposed investment on provision of IWT services on the Ayodhya - Manjhighat stretch of Ghagra River has been carried out both in economic terms.

10.2 The economic analysis deals with the problem as one of cost minimisation by comparing the aggregated haulage cost of the projected streams of traffic by competing modes under "with" & "without" project options. The "with project" option provides for movement of the projected level of traffic by a modal mix of road-IWT-road. The traffic either originates from Calcutta/Haldia area or converges from different countries to this place from where it takes IWT route via Indian National Waterways No.1 to reach Manjhighat or Ayodhya via the River Ghagra. Thereafter it again moves on road to reach final destination points. The traffic in the return direction follows similar pattern. In case of the `without project' scenario, the projected traffic as earmarked in the earlier option by IWT will move throughout, right from its origin to the final destination, by road, of course, transshipment (road-to-road). Thus, in the economic analysis the comparison of total haulage costs has been made by considering the modal-mix option with IWT vis-a-vis the all road mode available for moving the traffic. The net present values of the cost will determine the least cost option. In case the IWT option turns out to be the cheaper one, the same will be obviously advantageous for the economy and in that case the rate of return on the investment involved in IWT will be worked out by taking the cost of the next best option foregone (which is road in the present case) as benefit/saving to the economy. In this exercise, all the costs have been converted into economic costs by using the shadow pricing technique. Project life is considered as 30 years.

10.3 In the financial analysis the commercial profitability of the IWT option is examined purely from the point of view of the implementing organisation. The revenues that would accrue to the system would obviously form the basis for working out the rate of return under this analysis.

10.4 For both the economic and financial analyses, the discounted cash flow (DCF) technique is followed.

10.5 Economic Analysis

Cost Series

The cost on the IWT alternative comprises the expenditure for the development of infrastructural facilities and their operation and

maintenance on the one hand and on acquiring self propelled vessels (SPVs), their operating cost, user and inventory cost on the other. At one end, it is assumed that cargo will be directly off loaded from the mother ship and put into the SPVs. The road haulage cost at the other end has been super-imposed on the total haulage cost by the IWT services in order to arrive at the total transportation cost in the `with project' option.

Item-wise details of cost streams under the IWT operation are given below:

(a) Capital Cost

Terminal:

- Civil works including land acquisition,
- Mechanical handling facilities,
- Miscellaneous.

Waterways:

- Dredging
- Aids to navigation
- Miscellaneous

Fleet:

- Tugs
- Barges

The technical details on the civil works, handling equipment, navigational aids, etc., as also the flotilla has already been discussed in earlier chapters. For the pupose of this analysis. A summary table on the costs is given below:

In regard to incremental traffic additional floating stock has been provided for in the year 2005-06 and 2010-11 at the cost of NRs.478 million and NRs.662 million respectively. Due consideration has been given to the replacement of machinery, equipment, etc., as per their operating life, and the terminal value of all capital assets/equipment as per their remaining functional life.

9.2.1.2 Operation and Maintenance Cost

The annual O&M costs of waterways, terminals and fleet have been brought out in the table below:

Operating & Maintenance Cost: IWT Cost

(NRs. Million)

Year	Waterways	Terminals	Fleet	Total
2001-02	13	290	8	311
2006-07	19	290	10	319
2011-12	25	290	13	328

9.2.1.3 User Cost including Inventory Cost

User cost is the extra cost incurred by the transport users in addition to the transport operator's cost. The cost includes inventory cost, local cartage, handling, packing, etc. Feeder and extra handling, if any, in the IWT option has been debited to the project cost. As for inventory cost the same is estimated on the basis of the value of the commodity held up at terminals and in transit during its movement from the consignor's godown to the consignee's place. The inventory cost is nothing but the blockage of the value of the goods over a period and this has been reckoned as interest on capital held up at the prevailing rate.

9.2 Benefit Series

9.3.1 The cost of haulage under the `road only' option will be the benefit/saving that will accrue to the economy in case the IWT services are introduced. The total road haulage cost of cargo from origin to destination has been compiled by taking suitable operating and cost norms. In the road only option, one transhipment (road to road) of cargo will take place at exit/entry point (Indo-Nepal border) which has been accounted for as such. The cost under road option has been summarised in the table that follows.

Aggregated Road Haulage Cost

(NRs.Million)

Year	Cost
2001-02	405.78
2006-07	1061.48
2011-12	1394.44

9.4 Economic Analysis

9.4.1 The cost and benefit series have been arrayed in the form of cash flows on year-to-year basis and presented in Annexure 9.1.

9.4.2 The net present values of aggregated costs under the "with" and "without" project options work out to NRs. 7424 million and NRs.6849 million respectively. Thus the option involving IWT turns out to be the costlier one. The economic internal rate of return (EIRR) on the incremental capital cost on IWT works out to 8.5 per cent which is below the cut-off criterion rate of 10 percent.

9.4.3 The project thus does not qualify to be an economically viable proposition. However, the project could be justified in view of its tremendous developmental impact. Nepal is presently totally dependent on one mode of surface transport, viz., road. Once the IWT route is also available, it would not only decongest the roads but would also give a moral boost to the transport users of the country. In the long run, the system could sustain itself. The IWT is an environment friendly mode and entails employment generation of higher magnitude as compared to the other modes. Tourism in the PIA will develop tremendously once the IWT in the Narayani Ghat - Tribeni stretch passing through the Chitwan National Park is operative. There is no doubt that the IWT would, in the ultimate stage, boost up the socio-economic development of the PIA and country as a whole.

9.4.4 In view of what has been stated above, the provision of IWT services on Narayani stretch, under reference, can be explored on socio-economic considerations.

9.5 Financial Analysis

9.5.1 As the project does not yield an EIRR equal to or higher than the minimum acceptable criterion rate of 10 per cent, the Consultants feel that the financial analysis on any preconceived freight structure is not being attempted at this stage.

Freight is dominant parameter based on which financial analysis is carried out. A major portion of the river route passes through India, a part of which is yet to be developed for navigation. The freight rates are to be fixed for the whole stretch from Calcutta/Haldia to Narayani Ghat and apportioned for the Tribeni-Narayani Ghat section within Nepal on a bilateral agreement basis which needs to be firmed up between the two countries. As the freight structure can not be developed at this stage on any wild assumptions, the financial results may not be visualised with a considerable degree of accuracy and may give misleading conclusions. As such it is considered advisable that financial analysis may be attempted only in the Detailed Project Report (DPR) stage after necessary policy guidelines on the part of Govt. of Nepal & Govt. of India and bilateral agreement are firmed up.

CHAPTER – 10

PROJECT APPRAISAL

10.0 Approach & Methodology

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10.3 In the financial analysis the commercial profitability of the IWT option has been examined purely from the point of view of the implementing organisation. The revenue that would accrue to the system has obviously formed the basis for working out the rate of return under this analysis.

10.4 For both the economic and financial analyses, the discounted cash flow (DCF) technique has been followed.

10.5 Economic Analysis

Cost Series

The cost on the IWT alternative comprises the incremental expenditure for the development of infrastructural facilities, their operation and maintenance on the one hand and on acquiring barges and tugs, their

operating cost, user and inventory cost on the other. The road haulage cost at the two ends has been super-imposed on the total haulage cost by the IWT services in order to arrive at the total transportation cost under 'with the project' option.

Item-wise details of cost streams under the IWT option are given below:

(a) Capital Cost

Terminal:

- Civil works including land acquisition
- Mechanical handling facilities,
- Miscellaneous

Waterways:

- Dredging
- Aids to navigation
- Miscellaneous

Vessel:

- Tugs
- Barges

The technical details on the civil works, handling equipment, navigational aids, etc., as also the fleet in terms of barges and tugs have already been discussed in earlier chapters. A summary table on the costs is given below:

Capital Cost

(In Rs. Lakhs)

Year	Waterways Improvements	Terminal Cost	Vessels
2002-03	-	3240	-
2003-04	6143.25	6667	-
2004-05	-	-	7875
2008 –09	2109.75	-	-
2009-10	-	-	12150
2013-14	-	2564	-
2014-15	-	-	15525

As regards the incremental traffic, additional floating stock has been provided in the years 2009-10 and 2014-15 at the cost of Rs. 12150 lakh and Rs. 15525 lakh, respectively.

Due consideration has been given to the replacement of vessels, machinery, equipment, etc. as per their operating life and the terminal value of all capital assets/ equipment as per their remaining functional life.

For IWT terminals located on NW-1 *incremental/developmental costs have not being debited to the project.* The same has already been provided in the Ganga terminal study for a traffic level, which is considerably higher. Moreover, there is always a time lag between the traffic level and facilities provided. The major traffic of Ghagra river would be fully served by the than existing terminal facilities at various terminals on NW 1.

(b) Operation and Maintenance Cost

The annual operation and maintenance (O&M) costs of waterways, terminals and fleet have been brought out in the table below:

O & M Cost : IWT Cost

(Rs. lakhs)

Year	Waterways	Ghagra Terml.	NW1 Terminals	Vessels
2004-05	647	651	153	2171
2009-10	915.86	1045	218	3503
2014-15	915.86	120	296	5205

Although entire road stretch under reference does not require further expansion/widening on account of the marginal traffic shifted from road to IWT, due consideration have been made in economic analysis by proportionately accounting for annual repair and maintenance costs of the road sections.

(c) User Cost including Inventory Cost

User cost is the extra cost incurred by the transport users in addition to the transport operator's cost. This cost includes inventory cost, local cartage, handling, packing, etc. Feeder transport services and extra handling (transshipment) cost, if any, in the IWT option has been debited to the project cost. As for inventory cost the same is estimated on the basis of the value of the commodity held up at terminals and in transit during its movement from the consignor's godown to the consignee's place. The inventory cost is nothing but the blockage of the value of the goods over a period of time and this has been reckoned as interest on capital held up at the prevailing rate. For working out the comparative costs of IWT vis-à-vis road, local cartage and handling charges at origin and destination, cost of transportation by IWT vessels, IWT terminal costs, etc. have been considered. For different commodities involving different costs on account of handling, local cartage, etc. have been worked out separately.

Similarly, cost per tonne-km has also been worked out to arrive at the total cost of transportation for various O-D pairs.

Benefit Series

The cost of haulage under the `road only' option is the benefit/saving that will accrue to the economy in case the IWT services are introduced. The total road haulage cost of cargo from origin to destination has been worked out by collecting existing operating and maintenance cost norms from the operator. The cost under road option has been summarised in the table below:

Aggregated Road Haulage Cost

(In Rs. Lakh)

Year	Cost
2004-05	5827
2009-10	8531
2014-15	11885

Cost Benefit Analysis

The economic internal rate of return (EIRR) of the project has been worked out by ***using shadow price technique***. The cost and benefit series have been arrayed in the form of cash flows on year-to-year basis. The same is presented vide **Annexure - 10.1.**

The EIRR on the incremental capital cost on IWT works out to 1 per cent.

10.6 Financial Analysis

Financial analysis looks at the project from the perspectives of the implementing agency. In this framework, the rate of return on the investment for creating the infra-structural facilities for the proposed IWT system has been worked out in relation to the net attributable earnings that would accrue to the concerned implementing agency after accounting for the costs. The earnings would accrue on account of the following services.

i) Cargo handling charges
a) Loading/unloading from/to vessel to stacking/warehouse points or vice versa
b) Storage/warehouse/stacking point to road vehicle or vice-versa

The above earnings, net of the corresponding year to year operation and maintenance costs give the net earning series. The net earnings are

matched with the investment involved to arrive at the commercial or financial rate of return.

Norms Adopted

The norms adopted for working out the earnings that would accrue to the system operators are discussed as under.

1. **Cargo Handling**

The general practice, which is followed, is that the terminal operators sublet to cargo handling works at the terminal to contractors and charge from them a certain fixed amount. The norms adopted for working out the earnings are stated as under:

A) **Non-Bulk Cargo (Rs./t)**

i) Handling of cargo from vessels to vehicles/trucks and vice-versa	50
ii) Handling of cargo from vessels to shore bank / godown and godown to vehicle and vice-versa	95

B) **Bulk Cargo (Rs/t)**

i) Handling of cargo from vessels to vehicles/trucks and vice-versa	40
ii) Handling of cargo from vessels to shore bank/godown and Godown to vehicle and vice-versa (wherever Warehousing facility is proposed to be used, due consideration in rates have been made in the terminal charges)	90

C) **Godown Charges**

Free storage period for three days is allowed from the date of landing of cargo in the Godown//Foreshore Wharf. On the expiry of the free storage period, storage charge is levied at the following rates, which are to be paid by the consignor/consignee:

(i)	All cargo	Rs. 30/t per month or part of a month

D) **Freight Charges (Rs./Tkm)**

i)	Bulk Cargo	0.90
ii)	Non-Bulk Cargo	1.00

The costs and benefits thus worked out and presented vide **Annexure - 10.2.**

For working out the gross earnings attributable to each terminal, following assumptions have been made:

i) 80% of the bulk cargo handled at each terminal will move directly from vessel to vehicle/truck and vice-versa. For non- bulk cargo, only 20% of cargo would use such services.

ii) The balance 20% of the bulk cargo will move from vehicle/truck to godown and from godown to vessel and vice-versa. Since non-bulk cargo involves consolidation of traffic, 80% of the cargo is assumed to use this service.

iii) Only 10% of the incoming cargo needing storage in the godown will not be able to clear in the free time available and will invite the godown charges.

iv) For other earnings, like from allotment of parking area, advertisement boards, etc. 5% of the earnings from freight and other terminal services have been considered.

Based on the above norms/assumption the gross earnings have been worked out and the same are presented in the following table.

Gross Earnings

(Rs. in lakh)

Year	Earnings
2004-05	5708
2009-10	8296
2014-15	11480

Financial Internal Rate of Return (FIRR)

The costs and benefits of the project are arrived at in the form of cash flow presented vide **Annexure – 10.2. The FIRR works out to 7.7%.** However, if 30% of the barge cost is subsidized as per the government's policy announce by Ministry of Shipping in Jan., 2001 to encourage **this mode is considered, the rate of return works out to 10%.**

10.7 Prospects for Privatisation

With the assumptions that the State Govt. would bear the capital cost of development of waterways & would not charge any amount on usage of waterway path from the private operator and that the subsidy on the flotilla cost to the extent of 30% would be available from the Govt. of India as per announced policy and that the private party undertakes construction of terminals, procurement of flotilla, O & M of terminal, waterways and fleet, the rate of return for the private operator would work out to 13.83% The cash flow statements are enclosed as Annexture 10.3.

The Consultants are of the view that the present trend in infrastructure sector with public-private partnerships or at least the initial investment and initiative being taken by the State sector would give the fillip to the project. Since private sector would not abinito take the initiative of provision of infrastructure and operate the services on its own. The State government should take investment decision to develop the said facility. Then private sector could be expected to take interest in the project. Once the proposed services are operated by private sector, the FIRR may further improve because they would undertake intensive marketing efforts and relate it to utilisation of vessels and terminals facilities .

10.8 Inter Modal Cost Comparison

The total estimated divertible inter-terminal traffic at all the five proposed terminals in the base year worked out to 53555 tonnes (Table No. 10.1 showing the traffic). Sand traffic for Manjhighat to Ayodhya and Dohrighat terminals is estimated on the assumption that existing Sone river sand movement services would also be extended up to Manjhighat through the services.

In case inter-terminal traffic on the proposed IWT terminals/stretch is studied in isolation, sand traffic may not materialise. Thus the net inter-terminal traffic would be only 11945 tonnes in the base year. In light of this, it may be noted that the proposed IWT services or the economics of transportation only on section of Ayodhya – Manjhighat inland water transport may not be considered. *Such movement would be viable only if it forms a part of the extended NW No. 1.*

In the present study, diversion of traffic is assumed from road sector only, since railways were not considered as an alternative mode due to absence of any divertiable traffic. **In this light the broad order of comparison can be approximately viewed as cost per TKM movement by road at Rs. 1.12 as against the cost by movement by IWT (for the entire project) at Rs. 0.82 per TKM.** This also underscores the cost advantage that IWT services would have over the alternative (road movement) when IWT costs are considered over the entire network of proposed service.

CHAPTER – 10

PROJECT APPRAISAL

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10.5 Economic Analysis

Cost Series

The cost on the IWT alternative comprises the incremental expenditure for the development of infrastructural facilities, their operation and maintenance on the one hand and on acquiring barges and tugs, their operating cost, user and inventory cost on the other. The road haulage cost at the two ends has been super-imposed on the total haulage cost by the IWT services in order to arrive at the total transportation cost under `with the project' option.

Item-wise details of cost streams under the IWT option are given below :

(a) Capital Cost

Terminal

- Civil works including land acquisition
- Mechanical handling facilities,
- Miscellaneous

Waterways

- Dredging
- Aids to navigation
- Miscellaneous

Fleet

- Tugs
- Barges

The technical details on the civil works, handling equipment, navigational aids, etc., as also the fleet in terms of barges and tugs have already been discussed in earlier chapters. A summary table on the costs is given below:

Capital Cost

(Rs. Lakhs)

Year	Waterways Improvements	Terminal Cost	Flotills
2002-03		3240	
2003-04	6240	6667	
2004-05			7875
2008 –09	2127		
2009-10			12150
2013-14		2564	
2014-15			15525

As regards the incremental traffic, additional floating stock has been provided in the years 2009-10 and 2014-15 at the cost of Rs. 12150 lakh and Rs. 15525 lakh, respectively.

Due consideration has been given to the replacement of vessels, machinery, equipment, etc. as per their operating life and the terminal value of all capital assets/ equipment as per their remaining functional life.

For IWT terminals located on NW-1 incremental/developmental costs have not being debited to the project. The same has already been provided in the Ganga terminals study for a traffic level which is considerably higher. Moreover, there is always a time lag between the traffic level and facilities provided. The major traffic of Ghagra river would be fully served by the than existing terminal facilities at various terminals on NW- 1.

(b) Operation and Maintenance Cost

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Although entire road stretch under reference does not require further expansion/widening on account of the marginal traffic shifted from road to IWT, due

consideration have been made in economic analysis by proportionately accounting for annual repair and maintenance costs of the road sections.

(c) User Cost including Inventory Cost

User cost is the extra cost incurred by the transport users in addition to the transport operator's cost. This cost includes inventory cost, local cartage, handling, packing, etc. Feeder transport services and extra handling (transshipment) cost, if any, in the IWT option has been debited to the project cost. As for inventory cost the same is estimated on the basis of the value of the commodity held up at terminals and in transit during its movement from the consignor's godown to the consignee's place. The inventory cost is nothing but the blockage of the value of the goods over a period of time and this has been reckoned as interest on capital held up at the prevailing rate. For working out the comparative costs of IWT vis-à-vis road, local cartage and handling charges at origin and destination, cost of transportation by IWT vessels, IWT terminal costs, etc. have been considered. For different commodities involving different costs on account of handling, local cartage, etc. have been worked out separately. Similarly, cost per tonne-km have also been worked out to arrive at the total cost of transportation for various O-D pairs.

Although entire road stretch under reference does not require further expansion/wideing on account of the marginal traffic shifted from road to IWT, due consideration has been made in economic analysis by proportionately accounting for annual O & M costs of the road sections.

Benefit Series

The cost of haulage under the `road only' option is the benefit/saving that will accrue to the economy in case the IWT services are introduced. The total road haulage cost of cargo from origin to destination has been worked out by collecting existing operating and maintenance cost norms from the operator. The cost under road option has been summarised in the table below :

Aggregated Road Haulage Cost

(In Rs. Lakh)

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Cost Benefit Analysis

The economic internal rate of return (EIRR) of the project has been worked out by using shadow price technique. The cost and benefit series have been arrayed in the form of cash flows on year-to-year basis. The same is presented vide **Annexure - 10.1.**

The EIRR on the incremental capital cost on IWT works out to 1 %.

10.6 Financial Analysis

Financial analysis looks at the project from the perspectives of the implementing agency. In this framework, the rate of return on the investment for creating the infra-

structural facilities for the proposed IWT system has been worked out in relation to the net attributable earnings that would accrue to the concerned implementing agency after accounting for the costs. The earnings would accrue on account of the following services.

i) Cargo handling charges
a) Loading/unloading from/to vessel to stacking/warehouse points or vice versa
b) Storage/warehouse/stacking point to road vehicle or vice-versa

The above earnings, net of the corresponding year to year operation and maintenance costs give the net earning series. The net earnings are matched with the investment involved to arrive at the commercial or financial rate of return.

Norms Adopted

The norms adopted for working out the earnings that would accrue to the system operators are discussed as under.

1. **Cargo Handling**

The general practice which is followed is that the terminal operators sublet to cargo handling works at the terminal to contractors and charge from them a certain fixed amount. The norms adopted for working out the earnings are stated as under:

A) **Non-Bulk Cargo (Rs. Per tonne)**

i) Handling of cargo from vessels to vehicles/trucks and vice-versa	50
ii) Handling of cargo from vessels to shore bank / godown and godown to vehicle and vice-versa	95

B) **Bulk Cargo (Rs. Per tonne)**

i) Handling of cargo from vessels to vehicles/trucks and vice-versa	40
ii) Handling of cargo from vessels to shore bank/godown and godown to vehicle and vice-versa (wherever warehousing facility is proposed to be used, due consideration in rates have been made in the terminal charges)	90

C) **Godown Charges**

Free storage period for three days is allowed from the date of landing of cargo in the Godown//Foreshore Wharf. On the expiry of the free storage period, storage charge is levied at the following rates which are to be paid by the consignor/consignee :

(i) All cargo	Rs. 30/t per month or part of a month

D. **Freight Charges (Rs./Tkm)**

i)	Bulk Cargo	0.90
ii)	Non-Bulk Cargo	1.00

The costs and benefits thus worked out yield a financial internal rate of return of 7.7%, which is presented vide **Annexure – 10.2**

For working out the gross earnings attributable to each terminal, following assumptions have been made:

i) 80% of the bulk cargo handled at each terminal will move directly from vessel to vehicle/truck and vice-versa. For non- bulk cargo, only 20% of cargo would use such services.

ii) The balance 20% of the bulk cargo will move from vehicle/truck to godown and from godown to vessel and vice-versa. Since non-bulk cargo involves consolidation of traffic, 80% of the cargo is assumed to use this service.

iii) Only 10% of the incoming cargo needing storage in the godown will not be able to clear in the free time available and will invite the godown charges.

iv) Apart from above additional earnings on account of allotment of parking area, advertisement boards, etc. 5% of the earnings from freight and other terminal services have been considered.

Based on the above norms/assumption the gross earnings have been worked out and the same are presented in the following table.

Gross Earnings

(Rs. in lakh)

Year	Earnings
2004-05	5708
2009-10	8296
2014-15	11480

Financial Internal Rate of Return (FIRR)

The costs and benefits of the project are arrived at in the form of cash-flow presented vide Annexure - 10.2. The FIRR works out to 7.7%. However, if 30% of the barge cost is subsidized as per the Government of India's IWT policy announce by Ministry of Shipping in Jan. 2001 to encourage this mode is considered, the rate of return works out to about 10%.

10.7 Recommendations

The consultant are of the view that once the proposed services are operated by private sector, the FIRR may further improve because they would undertake intensive marketing efforts and relate it to utilisation of vessels and terminal facilities . Private sector would however, may not abinitio take the initiative of provision of the infrastructure and operate the services on its own. The present trend in infrastructure sector envisages public – private partnerships or at least the initial investments and initiative being taken by the State sector. Once the State government takes investment decision to develop the said facility, the private participation could be expected to take interest to entire the field and operate the facilities, since the financial return is estimated to be about 10%

CHAPTER – 11

CONCLUSIONS AND RECOMMENDATIONS

11.0 General

The study for detailed project report for development of Inland Water Transport in river Ghagra from Faizabad to Manjhighat and connection of this waterway to national waterways No. 1 have been carried out as per the terms of reference contained in the agreement for this work. The details of the study are given in the preceding chapters.

A summary of the recommendations and conclusion as a result of the above study is as follows:-

11.1 Recommendations

Before taking up detailed engineering and execution of the project, the following points will have to be addressed.

- Even though a detailed hydrographic and topographic survey as well as geo-technical investigations were called for, only a limited hydrographic and geo-technical investigations have been carried out due to fund constraint. The hydrographic survey of the study reach as done by IWAI in 1991-92 along with the Thalweg Survey and C.S. Survey at 1.0 km interval as carried out by RITES during the present study have been made use of in the preparation of this DPR. Therefore, it is recommended that it is necessary to carry out detailed hydrographic survey to update the survey charts and detailed topographic survey to firm up the exact bank lines of the river..

- Additional geo-technical investigations should be conducted in the final terminal locations to firm up design parameters of foundation of the jetties and other infrastructure works.

11.2 Conclusion

Project appraisal indicates that a financial IRR of the project is 10% Though the ideal IRR to take up the project as per standard norms will be 12 or more, it is, advisable to go ahead with the project due to the following reasons:-

- The project is self sustaining and hence no funds are required from the State Government to operate the project

- A new environment friendly and fuel-efficient mode of transport will be commissioned in the State. This is expected to improve general environment and the general river regime. Beside this, this establishes river connectivity with the other states (Bihar, West Bengal etc.) through NW-I and subsequently to other neighboring countries like Bangladesh, Myanmar etc. in the long run.

- The economic IRR of the project is only 1%. This is mainly because of the existence of national highway on both sides of Ghagra river besides railway route which carry bulk of the cargo. However, in view of the cheaper freight rates of the cargo which will be transported by IWT, there is a possibility of diversion of considerable quantum of cargo getting diverted from road/railway to IWT in course of time. Moreover development of IWT Ghagra river will also generate a lot of employment and attract the industrial entrepreneurs to set up their industries along the river. This will lead to further economic development and prosperity of the villages/town situated along with the river.

- In a possible private/public partnership scenario with the state Govt. bearing the capital cost of development of waterways and not levying charges on the uses of the waterway along with the subsidy on the flotilla as per the Govt. of India announced policy, the financial return of the private operators is estimated to be 13.8%

- Private participation in operating the IWT services may be considered in detail after investment decision is taken by the Govt. of UP to implement the project.