INLAND WATERWAYS AUTHORITY OF INDIA

(Ministry of Shipping, Government of India), Noida

Detailed Project Report (DPR) for Construction of IWT Terminal at Sahibganj in Jharkhand on River Ganga (National Waterway–1)

DETAILED PROJECT REPORT

July 2019

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PROJECT HIGHLIGHTS

- The proposed Inland Water Transport (IWT) Terminal at Sahibganj is located in Sahibganj district which is in the state of Jharkhand and situated on the right bank of river Ganga in Rajmahal-Bhagalpur stretch of National Waterway-1.

- As per the traffic study, the major potential cargoes that are expected to be handled at Sahibganj terminal includes coal, stone chips and other cargo such as cement, food grains, fertilizers and sugar. The expected annual traffic that are likely to be handled at Sahibganj terminal is given below:

Traffic Projection likely to be handled at Sahibganj IWT Terminal (in MTPA)

SN	Commodity Name	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Stone Chips	0.85	1.19	1.67	2.29	3.14	4.12	5.41
2	Coal	0.79	1.10	1.54	2.11	2.90	3.81	5.00
3	Cement	0.04	0.05	0.07	0.10	0.14	0.18	0.24
4	Food Grains	0.03	0.05	0.07	0.09	0.13	0.17	0.22
5	Fertilizer	0.03	0.04	0.06	0.09	0.12	0.16	0.21
6	Sugar	0.03	0.04	0.05	0.07	0.10	0.13	0.17
Total (in MT)		**1.77**	**2.48**	**3.46**	**4.76**	**6.54**	**8.57**	**11.25**

- The design vessel is maximum size of vessel that would be handled at the IWT terminal at Sahibganj. The principal dimension of the design vessel are as under:

Design Vessel Size

Design Vessel Size (DWT)	Overall Length (m)	Beam (m)	Loaded Draft (m)
3,000	95	15	2.50

- Based on the projected traffic, the terminal at Sahibganj is proposed to be developed in three phases and the phase-wise handling capacity of the Sahibganj terminal is given below.

  - Phase-1 : 3.03 MTPA
  - Phase-2 : 5.48 MTPA
  - Phase-3 : 9.50 MTPA

- The number of berths required in different phases are as under:

Berth Required in different Phases of Terminal

S.No.	Commodity	Number of Berths		
		Phase-1	Phase-2	Phase-3
1	Coal	1	1	2
2	Stone Chips		1	2
3	Other cargo	1	1	1

- The handling arrangements for various commodities in different phases of the terminal at Sahibganj are as below:

S. No.	Commodity	Cargo Handling Arrangement		
		Phase-1	Phase-2	Phase-3
1	Coal	Coal shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	The mechanised coal handling system is proposed for handling coal	The mechanised coal handling system is proposed for handling coal
2	Stone chips	Stone chips shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	Stone chips shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	The mechanised handling system is proposed for handling Stone chips. The stone chips shall also be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader
3	Other cargo	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks

- The length of berths for the development of terminal in different phases is presented below:

Berth Length in Different Phases of Terminal

Berth Type	Berth Length (m)		
	Phase-1	Phase-2	Phase-3
Coal	270*	130	270
Stone Chips		140	270
Other Cargo		130**	130

* Phase-1 shall have common berth for Coal, Stone Chips and Other Cargo

** Phase-2: Other cargo & Stone chips shall be handled on existing berth of phase-1 using Mobile Harbor Crane (MHC).

- The details of berthing facilities are given below:

S. No.	Parameters	Details
1	High Flood Level	30.91 m
2	Low Water Level	21.06 m
3	Deck Elevation	33.50 m
4	Width of Jetty	25 m
5	Type of Foundation	Pile Foundation
6	Length of Approach Trestle	50 m
7	Width of Approach Trestle	10 m

- The capital cost for Phase-1 development of terminal at Sahibganj is worked out to be **Rs. 345 crores**. During Phase-2 and Phase-3 development, an additional investment of **Rs. 633 crores** and **Rs 325 crores** would be required respectively.

- Based on the capital cost and operating expenditure, the financial and economic analysis has been carried out. The financial IRR is worked out to be **14.77%** and the Economic IRR is worked out as **32.05%** for Phase-1 development of terminal at Sahibganj which indicates that the project is economically viable.

EXECUTIVE SUMMARY

INTRODUCTION

The Ganga-Bhagirathi-Hooghly river system from Haldia to Allahabad has been declared as National Waterway-1 (NW-1) having length of 1,620 km and passes through the States of West Bengal, Jharkhand, Bihar and Uttar Pradesh. It links the ocean gateway ports of Haldia and Kolkata to Bhagalpur, Patna, Ghazipur, Varanasi and Allahabad, their industrial hinterlands, and several industries located along the Ganga basin.

Inland Water Transport (IWT) on NW-1 has the potential to form the most economic, reliable, safe and environmentally friendly form of transport. Inland Waterways Authority of India (IWAI) intends to develop an IWT terminal on National Waterway-1 at Sahibganj. Government of Jharkhand has also supported development of such a terminal at Sahibganj with proper road and rail linkage.

TRAFFIC POTENTIAL

Owing to the inherent advantages IWT offers as a preferred mode of transport, the study was done to estimate the cargo potential that can be handled at proposed terminal at Sahibganj. The focus of the study was to estimate the likely potential of coal that can be handled at the proposed IWT terminal at Sahibganj to various existing and proposed thermal power plants along the NW-1. Another major commodity targeted in the study is stone chips as the entire area is known for its stone chips mining industries. Additionally, other commodities were also estimated that are likely to be handled at proposed IWT terminal at Sahibganj. The methodology adopted included detailed study of all thermal power plants (existing and proposed) for their coal requirement, respective coal linkages, distance analysis, primary survey approach (for stone chips and other commodities) etc. Based on the cargo potential, future potential traffic for time frame of 2015, 2020, 2025 till 2045 are forecasted as given below:

Potential Traffic Projections for Sahibganj (in MTPA)

SN	Commodity	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Stone Chips	3.41	4.55	6.06	8.03	10.48	13.36	16.64
2	Coal	3.15	4.20	5.59	7.42	9.68	12.34	15.37
3	Cement	0.15	0.20	0.27	0.35	0.46	0.59	0.73
4	Food Grains	0.14	0.19	0.25	0.33	0.43	0.55	0.68
5	Fertilizer	0.13	0.17	0.23	0.31	0.40	0.51	0.63
6	Sugar	0.11	0.15	0.20	0.26	0.34	0.43	0.54
Total (in MT)		**7.09**	**9.46**	**12.59**	**16.69**	**21.79**	**27.77**	**34.60**

Taking into account the Sahibganj terminal being a new startup facility in the region, operating policy of carriers and associated agencies, handling last mile connectivity, development of navigation facility in entire stretch of National Waterway 1 in the coming years, continued thrust of government towards developing waterways in coming years and other factors, it is assumed 25% of potential traffic tabulated above for base year is likely to get handled at proposed IWT terminal at Sahibganj.

With assumption of 25% of potential traffic for base year that is likely to get handled at proposed IWT terminal at Sahibganj as discussed above, it is further assumed that the traffic shall grow to 2.5 % for every ten years starting from base year i.e. 2014-2015 to 2044-45 as NW 1 gains recognition and grows as potential mode of transport in due course of time.

Consequently, the traffic likely to be handled at proposed IWT terminal at Sahibganj is projected and tabulated below:

Traffic Projection likely to be handled at Sahibganj IWT Terminal (in MTPA)

SN	Commodity Name	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Stone Chips	0.85	1.19	1.67	2.29	3.14	4.12	5.41
2	Coal	0.79	1.10	1.54	2.11	2.90	3.81	5.00
3	Cement	0.04	0.05	0.07	0.10	0.14	0.18	0.24
4	Food Grains	0.03	0.05	0.07	0.09	0.13	0.17	0.22
5	Fertilizer	0.03	0.04	0.06	0.09	0.12	0.16	0.21
6	Sugar	0.03	0.04	0.05	0.07	0.10	0.13	0.17
Total (in MT)		**1.77**	**2.48**	**3.46**	**4.76**	**6.54**	**8.57**	**11.25**

DESIGN VESSEL SIZE

Based on various parameters influencing the call of vessel at any terminal, the design vessel is maximum size of vessel that would be handled at the IWT terminal at Sahibganj.

The principal dimension of the design vessel are as under:

Design Vessel Size (DWT)	Overall Length (m)	Beam (m)	Loaded Draft (m)
3,000	95	15	2.50

DEVELOPMENT OF TERMINAL IN PHASES

Based on the future traffic likely to be handled at IWT Sahibganj, the terminal for Sahibganj is proposed to be developed in three phases, starting with Phase-1 , Phase-2 and extending to Phase 3. The terminal capacity in each phase shall be designed to cater the traffic of subsequent years till commencement of the next phase and provided below:

Phasing & Capacity of Terminal based on Traffic Potential

S. No.	Cargo	Import (I)/ Export (E)	Phase-1	Phase-2	Phase-3
			Phase Commencement year		
			2019-20	2024-25	2032-33
1.	Coal	E	1.35	2.40	4.80
2.	Stone Chips	E	1.46	2.68	3.95
3.	Other Cargo	I/E	0.22	0.40	0.75
	Total Capacity (MTPA)		**3.03**	**5.48**	**9.50**

The layout of the terminal in different phases is based on the facility requirements in terms of number and length of berths, navigational requirements, material handling equipment, storage area required for each type of cargo, road and rail access for the receipt and evacuation of cargo, and other utilities and service facilities.

BERTH REQUIREMENT

Based on the cargo volumes, handling rates and other factors, the number of berths required in different phases are as follows:

Berth Required in Different Phases of Terminal

S.No.	Commodity	Number of Berths		
		Phase-1	Phase-2	Phase-3
1	Coal	1	1	2
2	Stone Chips		1	2
3	Other cargo	1	1	1

CARGO HANDLING ARRANGEMENTS

The handling arrangements for various commodities in different phases of the terminal at Sahibganj are described below:

S. No.	Commodity	Cargo Handling Arrangement		
		Phase-1	**Phase-2**	**Phase-3**
1	Coal	Coal shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	The mechanised coal handling system is proposed for handling coal	The mechanised coal handling system is proposed for handling coal
2	Stone chips	Stone chips shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	Stone chips shall be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader	The mechanised handling system is proposed for handling Stone chips. The stone chips shall also be handled at the terminal using pay loaders, excavators, dumpers, belt conveyor system with fixed hopper and barge loader
3	Other cargo	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks	Other cargo shall be handled at the terminal using Mobile harbour crane with lifting spreader and trucks

LENGTH OF THE BERTHS

Based on the design vessel size, the length of berths for the development of terminal in different phases is presented below:

Berth Length in Different Phases of Terminal

Berth Type	Berth Length (m)		
	Phase-1	Phase-2	Phase-3
Coal	270*	130	270
Stone Chips		140	270
Other Cargo		130**	130

* Phase-1 shall have common berth for Coal, Stone Chips and Other Cargo

** Phase-2: Other cargo & Stone chips shall be handled on existing berth of phase-1 using Mobile Harbor Crane (MHC).

LAYOUT OF IWT TERMINAL

Based on design criteria followed for development of terminal layout, the detailed layout for Sahibganj Terminal in Phase-1, Phase-2 and Phase-3 are shown in Drawing I-521/ST/209 to 211 respectively.

ENGINEERING OF CIVIL WORKS

- Berthing Facilities

The details of berthing facilities are given below:

Sl. No.	Parameters	Details
1	High Flood Level	30.91 m
2	Low Water Level	21.06 m
3	Deck Elevation	33.50 m
4	Width of Jetty	25 m
5	Type of Foundation	Pile Foundation
6	Length of Approach Trestle	50 m
7	Width of Approach Trestle	10 m

-Site Grading & Dredging

The terminal is proposed to be graded to a level of 37 m and the volume of cutting and filling required to achieve the level of 37 m is worked out as given below:

S.No.	Item Description	Unit	Phases of the Terminal	
			Phase-1	Phase-2
1	Earthwork in Excavation/Cutting	Cum	14,25,000	21,50,000
2	Earthwork in Filling	Cum	215,000	7,00,000

As there are some pockets in approach channel, turning circle and manoeuvring area where water available is less than the required draft of design vessel, dredging is required to be carried out. The volume of dredging is worked out to be 1,50,000 cum.

- Storage Areas

The storage area for commoditites worked out in different phases for the Sahibganj terminal is given below:

Storage Area Requirement in Different Phases for Sahibganj Terminal

S. No.	Commodity	Storage Area (in m^2)		
		Phase-1	Phase-2	Phase-3
Open Storage Area				
1	Coal	11200	29000	58000
2	Stone Chips	8750	53000	38000
	Sub-total 1+2	**19950**	**38150**	**76300**
Covered Storage Area				
3	Other Cargo	4160	8320	16640
	Sub-total 3	**4160**	**8320**	**16640**

The above storage areas duly account for the circulation space within the storage area for effective stacking/removal of cargo.

- Terminal Buildings

The following terminal buildings are proposed for the Sahibganj terminal:

S. No.	Building	Type	Total Built up Area (m^2)
1	Terminal Administration building	Two storey building	520
2	Worker's Amenity building	Single storey building	108
3	Security Office	Single storey building	25
4	Electrical Substation	Single storey building	900
5	Weigh Bridge building	Single storey building	25

ENGINEERING OF MATERIAL HANDLING SYSTEM / EQUIPMENTS

The commodities like coal and stone chips in Phase-1 would be handled at the terminal by using pay loaders, excavators, dumpers, belt conveyor with fixed hopper and barge loader. The other cargo shall be handled at jetty with the help of Mobile Harbour Crane, trucks and barge loader.

The mechanical equipments proposed in Phase-1 of the terminal is given below:

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	1
2.	Mobile Harbour Crane	1
3.	Pay Loader / Front End Loader	8
4.	Fixed Hopper	4
5.	Conveying System	Lot

The mechanical equipments proposed in Phase-2 and Phase-3 of the terminal is given below:

Summary of Phase-2 Mechanical Equipments

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	1
2.	Stacker cum Reclaimer for Coal	2
3.	Fixed hoppers for Stone chips	4
4.	Pay Loader / Front End Loader for Stone chips	8
5.	Excavator for Stone chips	4
6.	Trucks	5
7.	Conveying System	Lot
8.	Wagon Tippler with side arm charger	1
9.	Wagon shifter with pusher car	1
10.	Track Hopper	1

Summary of Phase-3 Mechanical Equipments

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	2
2.	Trucks	5
3.	Conveying System	Lot
4.	Stacker cum Reclaimer for Coal	2
5.	Reclaimer for Stone chips	1

RAIL AND ROAD CONNECTIVITY FOR TERMINAL

Based on the topography of the region, presence of existing rail line near the terminal location, site visit and discussions with Railway authorities, the railway track is proposed to take-off from Ch. 1053.5 km of loop line no. 5, which is between between Gate no. 54 and Sakrigali Railway Station and making a Y connection with the entrance of the terminal as shown in **Figure 8.4**.

The details of proposed rail connectivity are given below:

Details of Proposed Rail Connectivity

Description	Detail
Length of Track	3.6 km
ROW	30 m
Tunnel Length	Nil
Radius of curve	440 m
Gradient	1 in 600

The summary of capital cost estimate for rail connectivity is given below:

Cost Estimate for Rail Connectivity

SL No	Description	Capital Cost (Rupees in Crores)
External Rail Connectivity		
1	Ground Improvement work	26.00
2	Earthwork in Cutting & Embankment	23.50
3	Permanent way work	25.00
4	Workshop, Inspection pit, Foot Over Bridges, Service Building and S&T Buildings	13.00
5	Signalling & Telecommunication work (Supply)	16.50
6	Signalling & Telecommunication work (Execution)	3.00
7	Electrical Works	3.00
8	Miscellaneous works	4.00
	Sub-Total	**114**
Internal Rail Connectivity		
9	Internal Rail Network (for 5150 m length)	34.00
	Grand Total (Rupees in Crores)	**148**

Based on the topography, availability of existing National Highway-80 (NH-80), site visit and discussions with NHAI, the road alignment is proposed to take-off from Gate No. 54 along existing road leading to the entrance of the terminal as shown in **Figure 8.6.** The details of proposed road alignment is given below:

Details of Proposed Road Connectivity

Description	Detail
Length of Road	902 m
Number of Lanes	4
ROW	40 m
Gradient	1 in 200

The capital cost estimates for widening of existing road to four lane road is worked out to **Rs. 14 crores**.

- Road Over Bridge

The IWT terminal at Sahibganj shall be connected to National Highway 80 through proposed road alignment along existing road, passing through Gate No. 54 where railway level crossing exists as of now.

There shall be substantial movement of dumpers and other vehicles to the terminal location, necessiating the requirement of road over bridge at Gate No. 54 so as to achieve uninterrupted flow of said traffic.

Based on the site conditions, Railways & National Highway Authroity of India (NHAI) guidelines, the capital cost estimates for road over bridge is worked out to be **38 crores**.

IN-PRINCIPLE APPROVAL FOR RAIL CONNECTIVITY & CONSTRUCTION OF ROAD OVER BRIDGE

Based on discussions and submission of layout drawings, GAD and other documents with NHAI and railway authorities, the in-principle approval for rail connectivity and road over bridge is obtained.

IMPLEMENTATION SCHEDULE

- General

It is proposed to develop IWT terminal at Sahibganj for Phase-1 initially. As the traffic gets build up and IWT sector gets momentum over the coming years, the terminal shall be developed for Phase-2 and further for phase-3 with all the required infrastructure and support system as discussed in the previous sections.

The main components for the terminal development in Phase-1 comprise of 270 m long jetty construction with approach trestle, road connectivity, Procurement of Mobile harbour cranes, Barge loaders, Levelling of the backup area for open storage, storage shed, operation buildings and other onshore infrastructure and marine support systems. The terminal construction shall be completed within a time frame of 30 months. The project implementation schedule is provided in **Table 18.1.**

COST ESTIMATES

- Capital Cost Estimates

The Capital Cost Estimates have been worked out for different Phases of IWT Terminal at Sahibganj as per Layout provided in **Section-19 of DPR**. The drawings were prepared after carrying out preliminary design of various components of the project. The quantities have been calculated from the drawings for cost estimation purpose. These will need to be developed, revised, and refined during the detailed design phase.

The following is to be noted with respect to the cost estimates:

- The cost estimates of civil works have been prepared on the basis of CPWD Schedule of Rates 2014 and Market Rates for various items of work prevailing in the region.
- The costs of equipment is based on the quotations received from manufacturers, wherever applicable and also in-house data, and include manufacture, supply, installation and commissioning.
- All costs towards overheads, labour, tools, materials, etc. are covered in the rates for individual items.
- The price level used for the estimates is as of the second quarter of 2019.

The estimates given here do not include the following items:

- Financing costs including IDC and other reserves

The capital cost estimates for Phase-1 of the Terminal is worked out to be **Rs.345 crores** and summary is presented below:

Summary of the Capital Cost Estimates for Phase-1 of the Terminal

S. No.	Item	Capital Cost (Rs. In Crores)
1	Site Grading and Dredging	56.38
2	Shore Protection Works	9.65
3	Berths including Approach Trestles	101.43
4	Buildings	2.56
5	Storage Areas	8.69
6	Internal Roads including Ramp	24.54
7	External / Approach Roads	14.00
8	Road Over Bridge	38.00
9	Equipments	33.40
10	Belt Conveyor System	28.00
11	Utilities and Others, Navigational Aids	18.27
Sub-total		**334.92**
Contingency @ 3% as per CPWD norms		**10.05**
Total		**344.97**
Say		**345 Crores**

The capital cost estimates for Phase-2 and Phase-3 is worked out to be **Rs. 633 crores and Rs. 325 crores** respectively.

- Operation and Maintenance Costs

Operation and Maintenance costs have been calculated under various heads as below:

- 1% of Civil Works
- 3% of Utilities
- 3% of Mechanical and Electrical Works

The annual operation and maintenance costs of the facilities for Phase-1 of the terminal is worked out to be **Rs. 20.00 crores**.

FINANCIAL AND ECONOMIC ANALYSIS

- Financial Analysis

Based on the capital costs and operating expenditure as mentioned above, the financial analysis has been carried out considering 30 years of operation and the the financial IRR is worked out to be **14.77%** for **Phase-1** development of terminal.

- Economic Analysis

The Economic Analysis for Sahibganj project is carried out considering various economic factors as given below:

- Energy Consumption
- Air Pollution
- Noise Pollution
- Soil and Water Pollution
- Accidents

Taking into consideration of the economic benefits from the projects, the economic IRR is worked out to be **32.05%** for **Phase-1** development which indicates that the project is economically viable.

1.0 INTRODUCTION

1.1 Project Background

India has large number of inland waterways consisting of rivers, canals, backwaters, creeks, and lakes etc. which have the potential for development of efficient waterways transport network.

Before 2016, five waterways namely (i) the Ganga-Bhagirathi-Hooghly river system from Haldia to Allahabad (1620 km), (ii) the Brahmaputra from Dhubri to Sadiya (891 km), (iii) West Coast canal from Kottapuram to Kollam along with Champakara and Udyogmandal canals (205 km), (iv) Kakinada-Pondicherry canals integrated with rivers Godavari and Krishna (1095 km) and (v) East Coast canals along with river Brahmani and Mahanadi (621 km), were declared as National Waterway No. 1,2,3,4 & 5 respectively. Recently, 106 new National Waterways (NW) are also notified vide National Waterways Bill-2016.

IWAI intends to develop an IWT terminal on National Waterway-1 at Sahibganj.

Govt. of Jharkhand has also supported development of such a Terminal at Sahibganj with proper road and rail linkage.

In this connection, IWAI has appointed M/s Howe Engineering Projects (India) Pvt. Ltd. (HOWE) as Consultant for Preparation of Detail Project Report (DPR) for construction of IWT terminal at Sahibganj in Jharkhand on river Ganga (National Waterway–1) in India.

1.2 Scope of Consultancy Assignment

The scope of work to be carried out by HOWE is enumerated below:

1. Review of traffic projections, study and data collection from earlier reports, all relevant authorities, updating the same and provide future potential traffic (type & quantity both) for time-frame of 2025, 2035 & 2045 with specific reference to anchor commodities of domestic coal and stone chips.
2. Fixing the location of berthing jetty so as to ensure safe berthing of loaded barges up to 3.00m draft during leanest period.
3. Collection & analysis of water level data for ascertaining the appropriate level of the jetty, current data both in magnitude and in direction as required for designing the berthing face of the jetty for safe berthing, morphological data requirement for the purpose of river bank protection works etc. Some of these data if and as available will be provided by IWAI.
4. Geo-technical investigation at berthing jetty location (minimum two locations) and on the terminal land (minimum two locations) for the purpose of design of structures.
5. Site selection of terminal along with all details for acquisition of land including ownership and estimated cost of land acquisition. This will include all details to be collected from the State Revenue Departments with adequate background papers for indicating Government or private land. This will include land not only for main terminal but also for rail connectivity as well as road connectivity.
6. Preparation of detailed terminal layout plan, land development plan, along with preliminary design and drawings, specifications for all structures like berthing jetty, approach jetty, covered and open storage along with all allied structures / buildings

/ facilities like, security office, bunkering of fuel, water supply, fire-fighting and electrical facilities including compound lighting, requirement of power, transformer / generator etc. complete. Layout plan include with preliminary design and cost estimate for track hopper and wagon tripplers (with or without wagon shifter) required to handle coal at the terminal along with coal stock yard, stacker cum reclaimers and reclaimers, conveyor belt system all complete.

7. Preparation of detailed feasibility report for railway connectivity from nearest railhead to the terminal site. The feasibility report should contain the possibility of providing railway connectivity to the terminal site, the approximate cost of providing railway connectivity and various activities involved in getting railway connectivity. However, final consideration for railway layout based on Railway DPR shall be considered by IWAI.

8. Preparation of preliminary design, drawings, technical specifications, bill of quantities and cost estimates for the shore protection works required to prevent any erosion.

9. Preparation of detailed layout plan along with preliminary design, drawings, specifications for internal road, rail connectivity, traffic circulation plan, drainage, boundary wall gate and other utilities.

10. Examine the adequacy of the existing road linkages between the terminal and nearest main road (i.e. National Highway -80), proposed improvements required, to facilitate smooth two way flow of trucks and trailers from / to the terminal and hinterland. Requirement of land acquisition (if any) for widening of road /improvement of bends & rail connectivity. Preliminary design, specifications and cost estimates for improvement of road and providing rail connectivity to the terminal shall be worked out along with drawings as a separate sub-item.

11. Every cost estimate made shall be duly supported by the justifications for the rates adopted / basis of rates like Jharkhand/Bihar PWD/CPWD schedule of rates /market rates / lowest budgetary offers received etc.

12. Recommend cargo handling equipment required at the terminal, considering the prevailing norms for operation along with inter modal compatibility and their merits/demerits. The DPR will also include facilities required for both ways transfer of cargo between the shores based facilities and the permanent berths by both mechanical and manual methods for bulk/break bulk goods and packaged goods of approx. lot size up to 1 tonne weight .

13. Preparation of EPC mode contract documents both Request for Qualification (RFQ) & Request for Proposal (RFP) for execution of all the works and provide all necessary technical details etc. which will be needed to float and accept the tender on EPC contract basis. Accordingly the preliminary designs and cost estimates of every component and sub-component of the DPR will have all such details, authenticity and back up documents which are required for preparing and processing RFQ & RFP for EPC contracts as per prevailing norms and practice.

14. Preparation of realistic construction schedule for the terminal indicating the sequence of activities duly considering the river characteristics in different seasons and priority of works. The phasing of expenditure is also to be worked out.

15. Examine and bring out in sufficient details and back up papers detailing the need of obtaining environmental clearances for construction of the terminal based on

prevailing rules and regulations of Central and State Governments. If environmental clearance is required the DPR will have a separate chapter on it with detailed action plan and procedure for getting a separate EIA/EMP/SIA study to be taken up by IWAI.

16. Suggest institutional mechanism for project preparation, approval and execution of this project without time and cost overrun. The advantages of Project Management Consultancy (PMC) method for undertaking this project are also duly analysed and well considered and recommendation for the same is include in the DPR with sufficient details.

17. Work out cost benefit analysis. Financial Internal Rate of Return (FIRR), Economic Internal Rate of Return (EIRR) based on current norms, with sufficient backup Calculations, basis, assumptions their source, justification etc.

18. Detailed presentation of DPR at IWAI head office Noida as well as to Ministry of Shipping, State Govt. of Jharkhand & Bihar and other Central / State Government Authorities which become necessary for acceptance and processing of DPR from time to time.

19. State of Art IT based system for operation, management and maintenance of the entire terminal complex.

20. Any other contingent details required for preparation of quality DPR in the given timeframe mutually acceptable to IWAI and the selected consultant.

21. Submission of all above details to IWAI in the form of a Detailed Project Report (10 hard copies & two soft copies) along with complete tender documents/RFQ/RFP as specified for undertaking the work.

1.3 Present Submission

Howe submitted Detailed Project Report during January,2016 which was approved by IWAI in February,2016. Subsequently, during phase-1 execution due to R&R and land acquisition issues, the main electrical sub-station, control room and switch yard were erected in the area where coal yard conveyors and coal stockpiles were envisaged for phase-2 in the approved DPR dated February 2, 2016.

The present submission is the revised Detailed Project Report taking into account above mentioned facilities erected at site. It spells out the project requirement, traffic projection, assessment of project facilities, development of facilities in phases, engineering of civil works and material handling system, onshore infrastructure, cost estimates and financial analysis etc.

2.0 COMPILATION OF PROJECT DATA

2.1 Project Site Location

The site for proposed terminal is located in Sahibganj district which is in the state of Jharkhand. It is situated on the right bank of river Ganga in Rajmahal-Bhagalpur stretch of National Waterway-1 and is about 74 km upstream of Farakka.

Location plan of the project site is shown in **Figure 2.1** below:

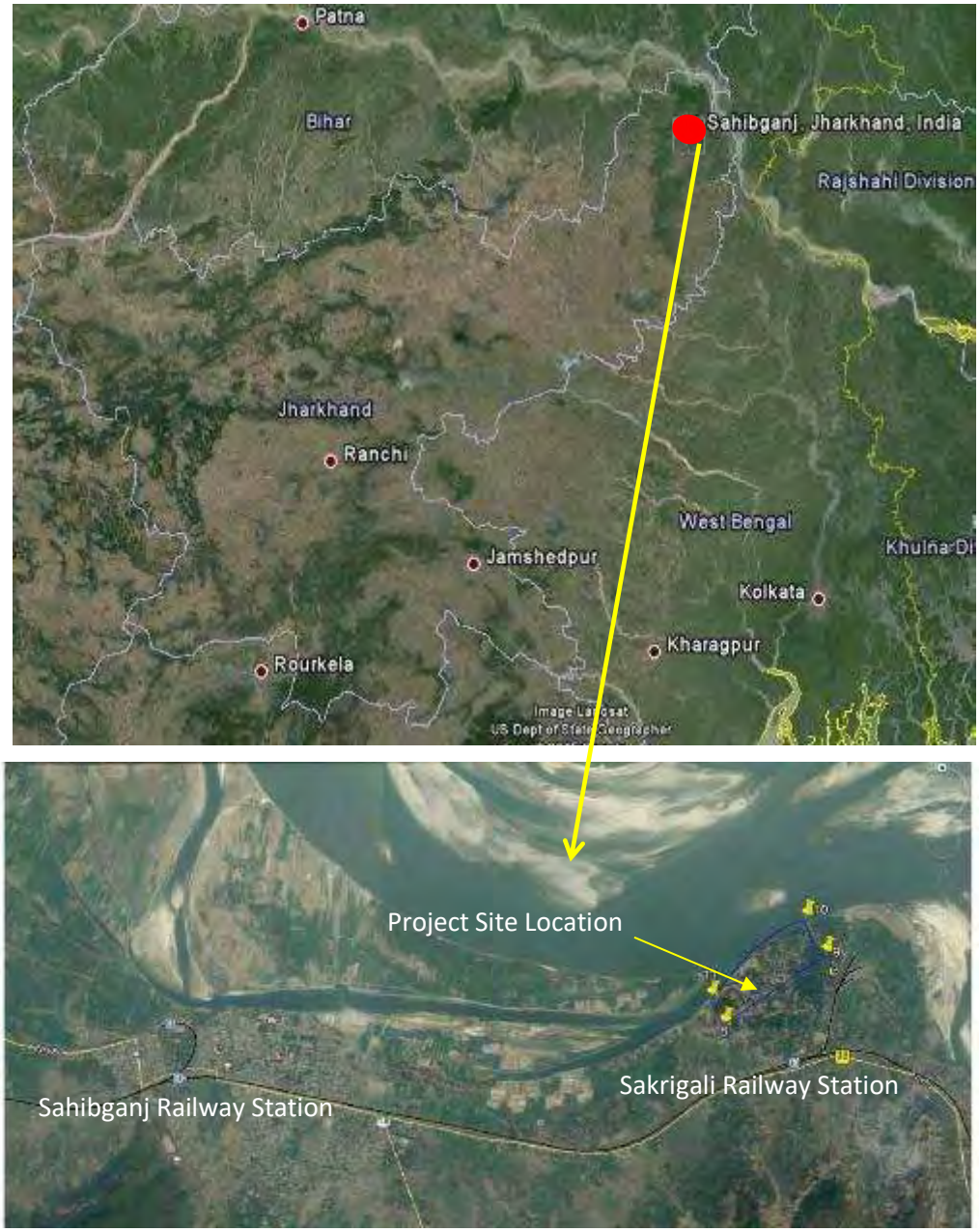


Figure 2.1: Location Plan of Project Site

2.2 Compilation of Site Data

2.2.1 Rainfall

The rainfall data for Bhagalpur, which is close to Sahibganj, is given in Table 2.1 below:

Table 2.1 : Rainfall Data for the Project Site

Month	Monthly Total (mm)	Number of Rainy Days	Heaviest Fall in 24 Hours (mm)	Year
January	13.7	1.0	91.2	1957
February	13.5	1.5	26.7	1972
March	10.9	1.1	27.9	1998
April	20.8	1.8	172	1971
May	68.7	4.8	70.3	1960
June	211.9	9.5	181.5	1984
July	315.4	14.5	147.8	1969
August	272.1	12.4	237.2	1987
September	211.3	10.1	352.8	1965
October	90.4	3.7	196.0	1987
November	6.8	0.7	37.1	1956
December	9.5	0.8	32.8	1981

As inferred from above Table, the number of rainy days varies from 4 to 13 in a month and heaviest rainfall varies in a range of 200-350 mm in a day.

2.2.2 Wind

The mean wind speed at the project site is found to be in the range of 3 to 6 km/h. The details of wind data are provided in Table 2.2 below:

Table 2.2 : Wind Data for the Project Site

Month		Percentage No. of Days Wind From									Mean Wind Speed (Km/h)
		N	NE	E	SE	S	SW	W	NW	Calm	
January	I	2	2	3	2	11	20	14	4	42	3.1
	II	3	2	3	1	0	11	23	13	44	
February	I	2	3	4	3	12	26	18	4	28	4.1
	II	4	3	3	1	2	9	33	14	31	
March	I	2	7	10	2	9	25	18	5	22	4.7
	II	6	5	6	1	2	7	29	19	25	
April	I	2	13	30	10	8	10	10	3	14	5.6
	II	9	13	23	5	1	3	16	18	12	
May	I	2	18	42	13	6	3	3	2	11	6.0
	II	6	20	39	10	3	2	4	6	10	
June	I	2	10	40	18	8	4	3	1	14	5.2
	II	4	14	40	14	5	2	2	2	17	
July	I	1	4	26	18	10	5	5	1	30	4.2
	II	1	7	33	14	7	4	3	2	29	
August	I	2	5	33	19	9	6	3	2	21	4.4
	II	2	7	35	15	6	3	6	3	23	
September	I	3	7	27	14	8	9	5	2	25	3.8
	II	3	7	26	12	6	6	7	4	29	
October	I	2	6	15	6	10	10	7	3	41	2.8
	II	4	6	12	4	3	5	8	8	50	
November	I	3	4	7	3	7	11	8	6	51	2.4
	II	3	3	6	0	1	6	9	7	65	
December	I	3	1	2	1	8	20	12	4	49	2.8
	II	2	2	2	1	1	12	18	8	54	

2.2.3 Temperature

The highest and lowest temperature recorded at the Project Site are furnished in Table 2.3 below:

Table 2.3: Highest and Lowest Temperature at the Project Site

Month	Highest (Deg. Centigrade)	Lowest (Deg. Centigrade)
January	28.2	9.0
February	32.4	10.4
March	39.1	14.9
April	42.1	19.7
May	42.6	20.5
June	41.9	23.2
July	37.3	24.0
August	36.8	23.9
September	36.7	23.5
October	35.6	19.8
November	33.2	14.4
December	29.2	10.2

2.2.4 Water Level

The maximum and minimum water levels observed at Sahibganj over a period of 2000-2014, as received from IWAI, are tabulated in Table 2.4 below. The high flood level and low water level at Sahibganj is 30.91 m and 21.06 m respectively with reference to the mean sea level.

Table 2.4: Maximum and Minimum Water Levels at Sahibganj during period 2000-2014

Year	Water Levels with reference to MSL (in meter)	
	Maximum	Minimum
2000	29.97	24.77
2001	29.56	24.30
2002	28.96	24.21
2003	30.78	24.80
2004	28.40	24.40
2005	-	-
2006	-	-
2007	26.43	23.30
2008	23.14	22.51

Year	Water Levels with reference to MSL (in meter)	
	Maximum	Minimum
2009	-	-
2010	-	-
2011	28.63	22.50
2012	28.21	21.67
2013	29.08	22.26
2014	-	-

2.2.5 Discharge and Currents

As no discharge and current site is maintained by CWC at Sahibganj or Bhagalpur, the discharge data for Farakka, which is 74 km downstream of project site, is used for planning and design of terminal facilities. The discharge data considered for the project site is furnished in Table 2.5 below

Table 2.5: Discharge Data at the Project Site

Year of Observation	Minimum Discharge (in cum/s)	Maximum Discharge (in cum/s)
1949	2105	43997
1950	1977	51340
1951	1850	31333
1952	1294	40802
1953	1228	49411
1954	1937	62694
1955	1499	61363
1956	1937	47602
1957	1922	39765
1958	1652	53410
1959	1864	43717
1960	1535	40943
1961	--	--
1962	--	--
1963	--	--
1964	--	--
1965	2122	27810

Year of Observation	Minimum Discharge (in cum/s)	Maximum Discharge (in cum/s)
1966	1403	35570
1967	1494	45930
1968	1576	27104
1969	1472	46262
1970	1754	38992
1971	1181	65072
1972	2032	24693
1973	1594	44573

During the survey work, the current was measured at the project site location and it was found to vary from 0.8 to 1.0 m/sec.

For the proposed IWT terminal at Sahibganj, the mean discharge of 40,000 cum/s is taken for design of jetty and shore protection works. Based on in-house data available for other rivers in India, the mean current velocity is taken as 4 m/s for discharge of 40,000 cum/s and the same is used for design of terminal facilities.

2.2.6 Topographic Information

The topographic survey of the proposed IWT terminal at Sahibganj was carried out by M/s Fargo Consultants Pvt. Ltd., Kolkata in May, 2015. The area behind the river bank is undulating with hillocks and levels are found to vary from 22.0 m to 64.0 m with respect to mean sea level. The topographic details are shown in **Drawing I-521/ST/201**.

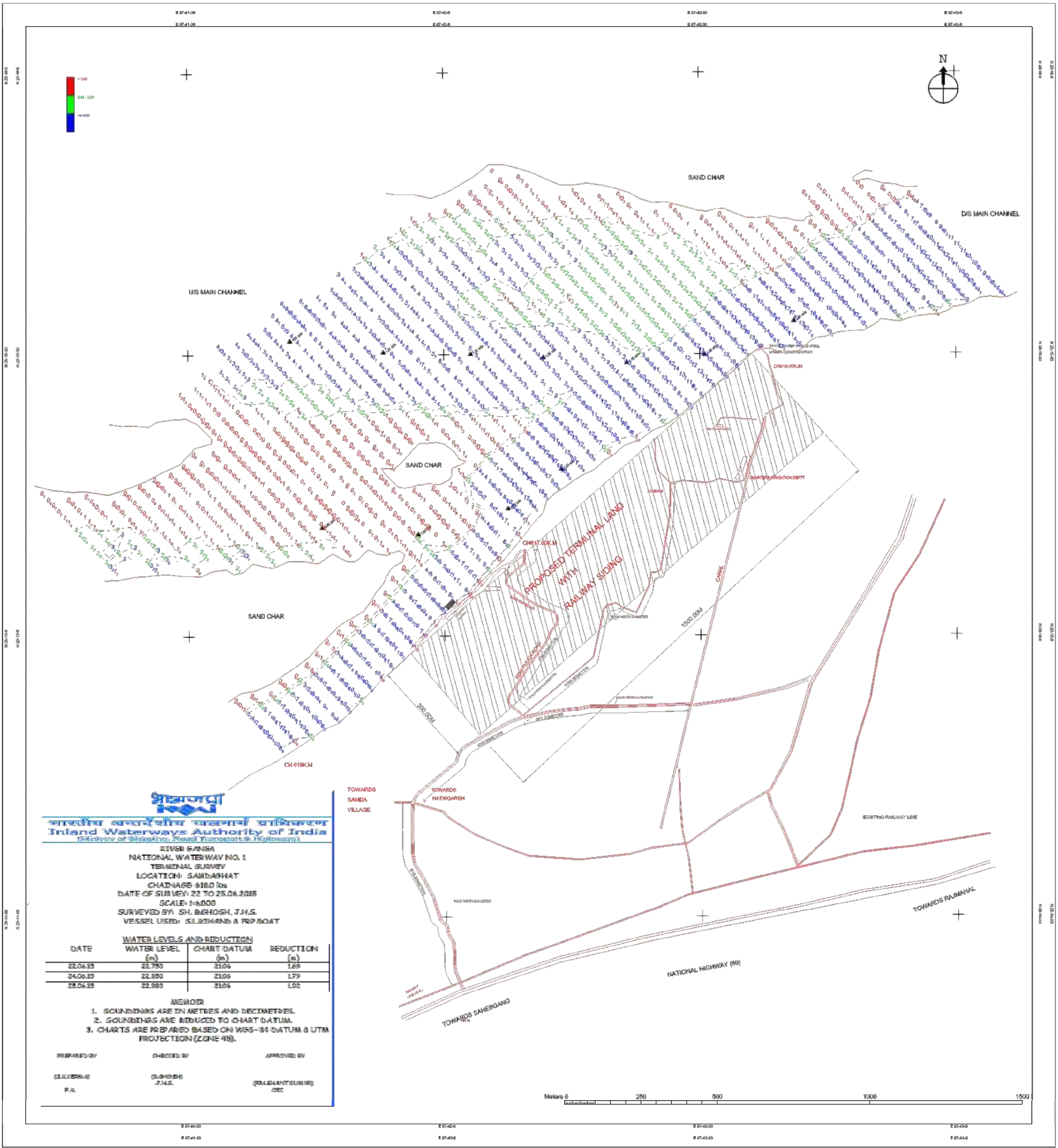
2.2.7 Hydrographic Information

The hydrographic survey of river Ganga near the proposed terminal at Sahibganj is shown in **Figure 2.2** below.

An area of 130 Hectare was surveyed and the soundings were taken with respect to chart datum. The chart datum is taken as 21.06 m with respect to mean sea level (MSL).

2.2.8 Geotechnical Data

The geotechnical investigations at the proposed terminal location were carried out by M/s Fargo Consultants Pvt. Ltd. Kolkata during July-August, 2015. The investigations included carrying out two number of boreholes (RBH-1 & RBH-2) in river and five number of boreholes (LBH-1 to LBH-5) on land. The details of these boreholes are given in Table 2.6 below:



भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण
Inland Waterways Authority of India
(Ministry of Shipping, Road Transport & Highways)

RIVER GANGA
NATIONAL WATERWAY NO. 1
TERMINAL SURVEY
LOCATION: SAHIBGANJ
CHAINAGE: 618.0 Km
DATE OF SURVEY: 22 TO 25.06.2015
SCALE: 1:4000
SURVEYED BY: SH. BGHOSH, J.H.S.
VESSEL USED: SURVEY LAUNCH & FRP BOAT

WATER LEVELS AND REDUCTION

DATE	WATER LEVEL (m)	CHART DATUM (m)	REDUCTION (m)
22.06.15	22.790	21.06	1.69
24.06.15	22.850	21.06	1.79
25.06.15	22.980	21.06	1.92

MEMOIR
1. SOUNDINGS ARE IN METRES AND DECIMETRES.
2. SOUNDINGS ARE REDUCED TO CHART DATUM.
3. CHARTS ARE PREPARED BASED ON WGS-84 DATUM & UTM PROJECTION (ZONE 45).

PREPARED BY	CHECKED BY	APPROVED BY
(S.K.VERMA) F.A.	(S.GHOSH) J.H.S.	(PRASHANT KUMAR) CEC

Figure 2.2: Details of Hydrographic Survey in river Ganga at Proposed Terminal at Sahibganj

Table 2.6: Details of Boreholes for Proposed IWT Terminal at Sahibganj

Borehole No.	Location (co-ordinate)		RL at Borehole top (m)	Depth of Borehole (m)
	Northing	Easting		
LBH-1	2792953	570640	30.55	41
LBH-2	2793079	570775	28.47	45
LBH-3	2793687	571498	26.37	18
LBH-4	2793532	571555	45.78	23
LBH-5	2793059	570884	37.75	40
RBH-1	2793713	571361	7.66	13
RBH-2	2793069	570574	13.46	30

Moreover, two additional borehoels in river viz. RBH 3 & 4 were also carried out in February 2016 and the details are given in Table 2.7 below:

Table 2.7: Details of Additional Boreholes in River

Borehole No.	Location (co-ordinate)		RL at Borehole top (m)	Depth of Borehole (m)
	Northing	Easting		
RBH-3	2793290	570845	17.06	13
RBH-4	2793510	571118	11.06	9

The borehole location plan is shown in **Drawing I-521/ST/202.**

Based on the geotechnical investigation results, the different layers encountered in these boreholes are furnished in Table 2.8 below:

Table 2.8: Details of Layers Encountered in Boreholes for IWT Terminal at Sahibganj

Layer No.	Description	Layer Thickness (m)								
		LBH-1	LBH-2	LBH-3	LBH-4	LBH-5	RBH-1	RBH-2	RBH-3	RBH-4
1	Stiff Silty Clay / Clayey Silt	13	7	-	6	17	-	-	-	-
2	Hard Silty Clay / Clayey Silt	3	15.5	-	11.8	23.4	-	-	1.5	-
3	Highly decomposed product of rock	1.5	-	-	-	-	-	-	-	-
4	Hard Silty Clay with traces of calcarious nodules	7.5	22.57	-	-	-	-	-	-	-
5	Hard Silty Clay with gravel	16.12	-	-	-	-	-	-	-	-
6	Soft Silty Clay	-	-	1	-	-	1.3	1.5	-	-
7	Loose Silty Sand / Sandy Silt	-	-	12	-	-	6.75	24	-	-
8	Weathered Sandstone	-	-	5	5.2	-	4.95	5	11.5	9

The location of sub-soil profiles along LBH 1, 2 & 3, LBH 4 & 5 and RBH 1, 4,3 & 2 for terminal facilities are shown in **Drawing I-521/ST/203.**

The sub-soil profiles along LBH 1, 2 & 3, LBH 4 & 5 and RBH 1,4,3 & 2 indicating type of soil strata available for design of terminal facilities are shown in **Drawing I-521/ST/204 to I-521/ST/206.**

The geotechnical investigation report for the said boreholes is furnished in **Appendix-A**:

3.0 INITIAL MARKET ASSESSMENT

3.1 Introduction

An efficient transport sector is vital for development of the economy of any country. In a large country like India, efficient transportation becomes pivotal to stimulate competitive business environment. Indian transport system comprises various modes, viz; Railways, Roadways, Inland Waterways, Coastal Shipping and Airways. Inland Water Transport (IWT) is a fuel efficient, environment friendly and cost effective mode of transport having potential to supplement the overburdened rail and congested roads. For this, however, it is necessary that IWT mode is developed with public funding at least to a threshold level at which private sector would get attracted to the mode.

Post-independence, the rapid growth of railways as well as ever expanding road sector network made a dent in share of water transport in India. Moreover inadequate development of IWT sector over the years gave a decisive set back to IWT in the later years of 20th century. The setback to IWT as a viable mode of transport are also due to various obvious factors like slow transportation, inability to maintain navigable draft, inadequate "last mile connectivity" etc. However, considering its inherent advantages, the need for systematic development of IWT as a transportation mode is important which duly recognized post-independence was.

The business potential of cargo movement through waterways is still in infancy in India, which is mainly attributable to inadequate infrastructure and improper logistic management. The vast hinterland provides extensive opportunity to transport goods through the cheaper mode of transportation (IWT) which has not been exploited till date. The share of India's inland water transport (IWT) cargo traffic to the logistics market is significantly lower at less than 1% as compared to China at 8.7% and the US at 8.3%. The planned development of waterways with the ultimate aim of integrating hinterland with coastal destinations could go a long way in providing total optimal solutions for transportation of goods across the country. The imports and exports could be well integrated in a cost effective manner using efficient IWT mechanism. Towards this objective, IWAI has planned initiatives to augment the waterways sector through strategic development, complementing one activity with other to ensure efficient and effective movement of goods within the country for in-bound and out-bound destinations.

As per Indian constitutional provisions, only those waterways which are declared as National Waterways come under the purview of Central Government while rest of waterways remains in the purview of respective State Government. With the support of government, it can be easily said that Indian IWT sector holds immense potential for growth if developed due to its characteristic advantages over other modes of transportation, especially for coal and other bulk movement.

3.2 Need of the Study

India has some of the world's longest river system and most of the big cities and important cities of the country are developed around these rivers. The country has a huge network of water network consisting of rivers, canals, backwaters, creeks and lakes etc, which have the potential for development of efficient waterways transport network. It is already said earlier that Indian waterways have huge potential for goods transportation. However, Inland Water Transport (IWT) sector in India is largely underutilized and is a great opportunity loss for the country.

Considering the obvious advantages of IWT over other modes of transportation like operationally cheaper, high in fuel efficiency and environmentally friendly mode of transport, it has a vast potential to act as not only as alternate and supplementary mode of transportation for handling certain bulk commodities but can become preferred mode of transport. Not long ago, IWT was considered as important mode of transport but in the recent times, it's lost its sheen due to poor maintenance, inability to maintain minimum draft, poor rail or road connectivity, high terminal costs etc.

Inland Waterways Authority of India (IWAI) is a premium Govt. of India institution which develop and promotes Inland Waterway transportation throughout the country. In this regard, it has declared five waterways as the National Waterways. Moreover, it is developed many IWT terminals on these declared national Waterways.

Sahibganj Inland Water terminal is one of the significant IWT terminals which fall on NW-1. IWAI is planning to further develop the said terminal to cater the coal movement to existing and planned thermal plants along the national waterway-1. The availability of abundant coal reserves in the area coupled with the tremendous demand of coal in thermal plants fuels the idea of development of Sahibganj IWT terminal. Moreover, as Indian Railway is marred with various operational and financial bottle necks related to coal transportation, IWT can give a viable and cost effective alternative for coal transportation.

Coal transportation by Railway bottlenecks

- Railway Congestion
- Shortage of rakes
- Shortage of bottom opening wagons
- Port congestion

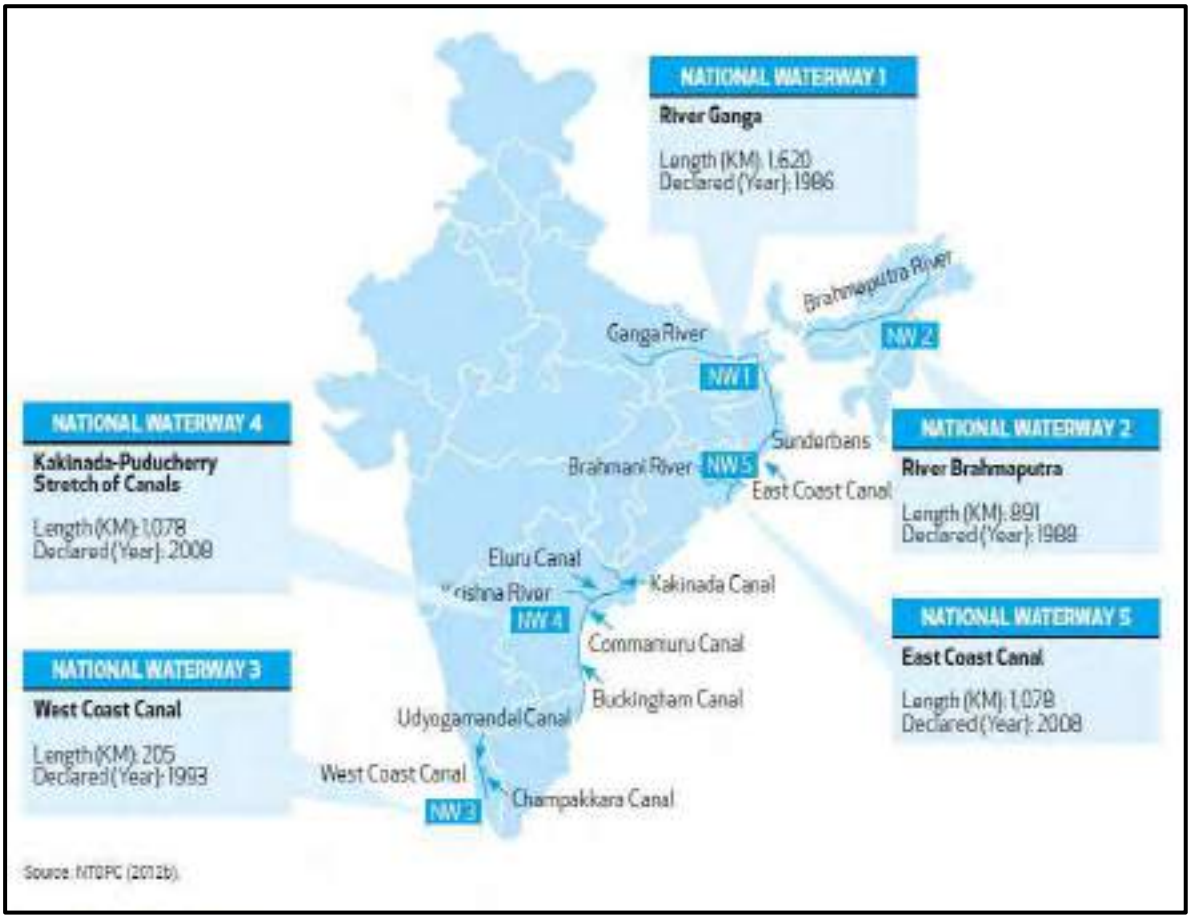
Hence, overdependence on railways needs to be reduced: road is out of question for bulk transportation: IWT a realistic supplementary option.

In this direction, Sahibganj is identified as the potential IWT terminal catering mainly to coal and stone chips movement through waterways.

3.3 Inland Waterway Transport

3.3.1 World Experience

Most of the world's major cities are located either on a navigable river or a coastal harbour at the mouth of a navigable river. The water systems like rivers, lakes, canals etc. have been used for centuries in countries including China, Egypt, the Netherlands, the United States, Germany, China, and Bangladesh. Statistically, in the Netherlands, IWT handles 46% of the nation's inland freight; 32% in Bangladesh, and 9% in China.



Today, in countries such as China, Argentina, and Brazil, inland waterways are stimulating and supporting rapid economic growth. In China, presence of effective and extensive inland waterways system are credited for the rapid economic development of Jingsu, Shanghai, Zheijiang, and Guangdong provinces. This system includes the Yangtze River, Grand Canal, and many tributaries and canals with a total length of more than 24,000 km . Improvements in the inland waterways in South America have aided the agricultural development of vast regions in Bolivia, Paraguay, and Brazil.

Hence the reliable, affordable transport networks are still a prerequisite for economic development. In many of the less developed countries, more intense use of inland waterways is moving goods in and out of regions and helping economies to grow. Expansion of highway and railroad networks often takes more time and requires much greater investments, in comparison with waterways. Therefore, greater use of inland water transport can provide a critical economic advantage.

3.3.2 Indian Scenario

India has an extensive network of inland waterways in the form of rivers, canals, backwaters and creeks. Of the total navigable length of 20,236 km, 17,980 km of the river and 2,256 km of canals can be used by mechanized crafts. Freight transportation by waterways is highly under-utilized in the country as compared to countries and regions like the United States, China and the European Union. National waterways of India are well in line to become the lifeline of the country. Not only will these serve the transportation obligations of our nation, but also will serve as recreational centers.

Ministry of Shipping, Govt. of India had directed Inland Waterways Authority of India (IWAI) to identify the viable waterways in India for their phased development. Accordingly, 106 new waterways were identified by IWAI and intimated to MoS. In this regard, National Waterways Act, 2016 was published in the Gazette of India, Extraordinary, Part II, Section I dated 26th March, 2016 as an Act No. 17 of 2016. The State-wise details of new National Waterways are furnished in Table 3.1 below:

Table 3.1: Details of New National Waterways

#	State	No. of rivers / canal	Name of the River / Canal
1	**Andhra Pradesh**	**2**	Pennar and Tungabhadra
2	**Arunachal Pradesh**	**1**	Lohit
3	**Assam**	**14**	Aai, Barak, Beki, Dhansiri / Chathe, Dehing, Dikhu, Doyans, Gangadhar, Jinjiram, Kopili, Lohit, Puthimari, Subansiri and Tlwang (Dhaleswari)
4	**Bihar**	**6**	Gandak, Ghaghra, Karamnasa, Kosi, Punpun and Sone
5	**Delhi**	**1**	Yamuna
6	**Goa**	**6**	Chapora, Cumberjua, Mandovi, Mapusa, Sal and Zuari
7	**Gujarat**	**5**	Jawai-Luni - Rann of Kutch, Mahi, Narmada, Sabarmati and Tapi
8	**Haryana**	**2**	Indira Gandhi Canal and Yamuna
9	**Himachal Pradesh**	**3**	Beas, Ravi and Sutlej
10	**Jammu & Kashmir**	**4**	Chenab, Indus, Jhelum and Ravi
11	**Jharkhand**	**2**	Kherkai and Subarnarekha
12	**Karnataka**	**11**	Bheema, Ghataprabha, Gurupur, Kabini, Kali, Malaprabha, Netravathi, Panchagangavali (Panchagangoli), Sharavati, Tungabhadra and Udayavara

#	State	No. of rivers / canal	Name of the River / Canal
13	**Kerala**	**4**	AVM Canal, Alappuzha- Changanassery Canal, Alappuzha-Kottayam – Athirampuzha Canal and Kottayam-Vaikom Canal
14	**Maharashtra**	**14**	Amba, Arunawati - Aran, Dabhol Creek - Vashishti River, Kalyan-Thane-Mumbai Waterway - Vasai Creek - Ulhas River, Manjara, Nag, Narmada, Penganga - Wardha, Rajpuri Creek, Revadanda Creek - Kundalika River, Savitri (Bankot Creek), Shastri River - Jaigad Creek, Tapi and Wainganga - Pranahita
15	**Meghalaya**	**5**	Ganol, Jinjiram, Kynshi, Simsang and Umngot (Dawki)
16	**Mizoram**	**1**	Tlwang (Dhaleswari)
17	**Nagaland**	**1**	Tizu - Zungki
18	**Odisha**	**5**	Baitarni, Birupa - Badi Genguti - Brahmani, Budha Balanga, Mahanadi and Subarnarekha
19	**Punjab**	**3**	Beas, Indira Gandhi Canal and Sutlej
20	**Rajasthan**	**3**	Indira Gandhi Canal, Jawai-Luni - Rann of Kutch and Luni
21	**TamilNadu**	**9**	AVM Canal, Bhavani, Kaveri - Kollidam, Manimutharu, Palar, Pazhyar, Ponniyar, Tamaraparani and Vaigai
22	**Telangana**	**5**	Bheema, Manjara, Penganga - Wardha, Tungabhadra and Wainganga - Pranahita
23	**Uttar Pradesh**	**10**	Asi, Betwa, Chambal, Gandak, Ghaghra, Gomti, Karamnasa, Tons, Varuna and Yamuna
24	**West Bengal**	**15**	Ajoy, Bakreswar - Mayurakshi, Damodar, DVC Canal, Dwarekeswar, Dwarka, Gangadhar, Ichamati, Jalangi, Kumari, Mahananda, Rupnarayan, Silabati, Subarnarekha, Sunderbans Waterway - Bidya - Chhota Kalagachi (Chhoto Kalergachi) - Gomar - Haribhanga - Hogla (Hogal) / Pathankhali - Kalindi (Kalandi) - Katakhali - Matla - Muri Ganga (Baratala) - Raimangal - Sahibkhali (Sahebkhali) - Saptamukhi - Thakuran

Note:

1 Some of the rivers / canals (underlined) are in more than one State.
2 West Cost Canal extended in Kerala under NW-3.
3 Godavari extended in Telangana and Maharashtra under NW-4.
4 Krishna extended in Telangana, Andhra Pradesh and Karnataka under NW-4.

3.3.3 National Waterway 1

Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration and regulation.

The Ganga - Bhagirathi - Hooghly river system between Haldia (Sagar) & Allahabad (1620 km) was declared as National Waterway No.1 (NW-1) in 1986. It passes through Uttar Pradesh, Bihar, Jharkhand and West Bengal. The details of National Waterway 1 are given in Table 3.2 below:

Table 3.2: Details of National Waterway-1 (NW-1)

Opened	27th October 1986
Length	1620 km
North end	Haldia (Sagar)
South end	Allahabad
No. of Terminals	20 Floating Terminal 4 Fixed RCC Jetty
Owner	Inland Waterways Authority of India (IWAI)
Operator	Central Inland Water Transport Corporation (CIWTC)

As per the IWAI, during the year of 2013-14, it has been maintaining a Least Available Depth (LAD) of 3.0 meters between Haldia (Sagar) & Farakka (560 km), 2.5 meters in Farakka- Barh (400 km), 2.0 meters in Barh - Ghazipur (290 km) and 1.2 to 1.5 meters in Chunar - Allahabad sector (370 km).

Nowadays this waterway is being used by cargo vessels, ODC carriers, tourist vessels and IWAI vessels etc. Under the project of transportation of 3 MMTPA of imported coal from Haldia/Sand-heads to NTPC's power plant at Farakka through NW-1 by M/s Jindal ITF Ltd., about 20 barges of 2000 dwt capacity each started moving between Haldia / Sand-heads and Farakka since Oct. / Nov., 2013 and about 2.6 lakh tons coal reached Farakka up to May, 2014 under this project. The trial movements of 2600 tons fertilizer of M/s Tata Chemicals from Haldia to Fatuha (Patna) and another 2500 tons M/s IFFCO Phulpur from Fatuha (Patna) to Kolkata respectively was done successfully during 2013-14. Further, Inland tourist vessel RV Bengal Ganga of M/s Heritage River Cruise Pvt. Ltd. and ABN Sukhapha of M/s Assam Bengal Navigation Co. Pvt. Ltd. made their voyages successfully on NW-1 in Kolkata-Semaria-Kolkata and Kolkata-Patna-Kolkata respectively during 2013-14.

At present, several power companies are planning to setup Thermal Power projects and extensive movement of Over Dimensional Cargo (ODC), imported coal for NTPC projects is planned to be done on NW-1 in coming years. The IWAI is planning to augment the dredging fleet during forth coming years. After deployment of the additional dredgers along with bandalling, IWAI has planned to provide an enhanced minimum depth of 2.5 meters in

Farakka - Buxar stretch instead of Farakka - Barh i.e. about 235 km stretch with enhanced target of 2.5 meters depth against 2.0 meters. Further, IWAI has planned to develop 2.0 meters LAD up to Varanasi in place of Ghazipur i.e. about 133km stretch with enhanced target of 2.0 meters depth against 1.5 meters.

Major IWT terminals of NW-1 have comparatively good connectivity to road as well as railway network. Major high density IWT Terminals of NW-1 and their nearest existing rail and road links are given in Table 3.3 below. It is pertinent to note that in the current exercise nearest railhead suggested is because of its proximity rather than its workability to provide necessary rail connection/linkage.

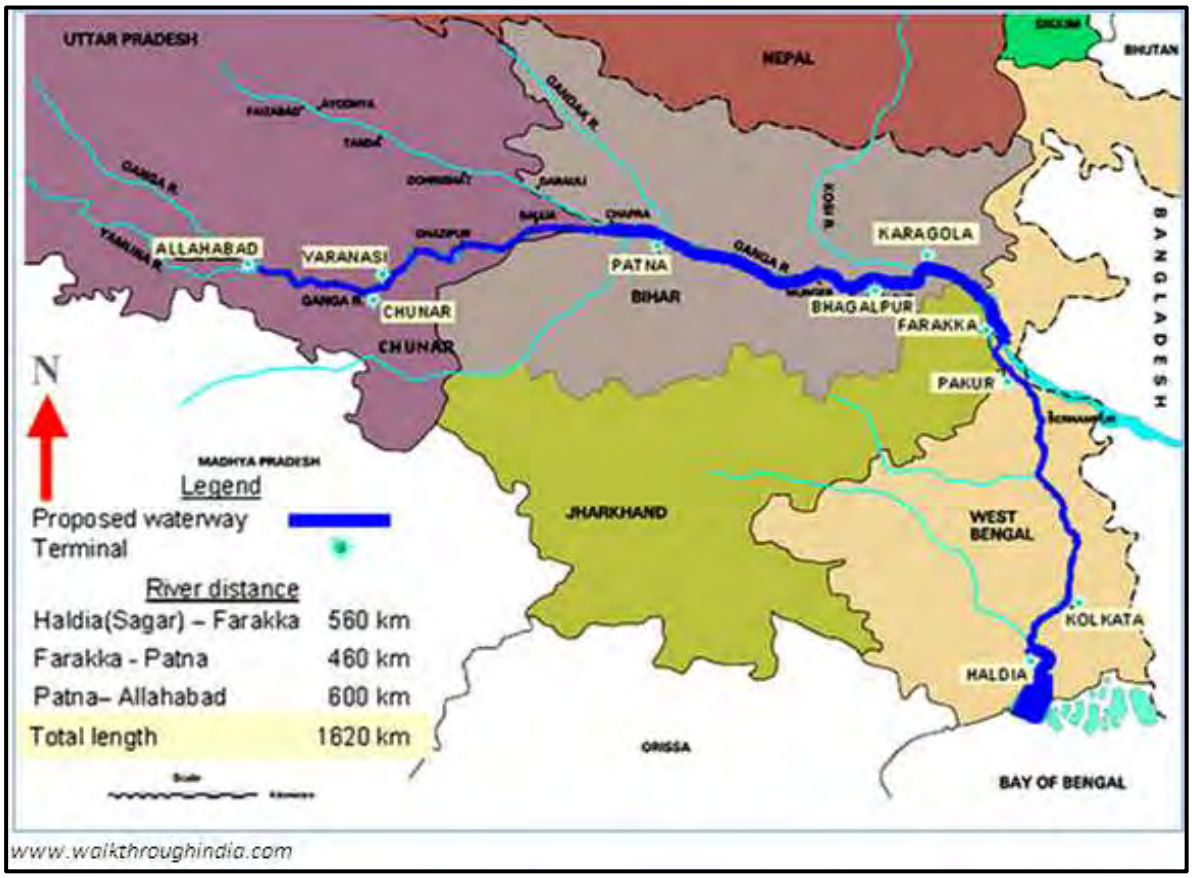


Table 3.3: Nearest Road & Rail Location of Major IWT Terminal of NW-1

SN	IWT Terminal	Nearest NH/SH	Railhead Nearest	Gauge	Land area	Berth Size	Type of Terminal
1	Haldia	NH–41	Haldia	BG	10319 Sq m	200 m	Floating Terminal
2	Katwa	NH–6	Katwa	BG	Pontoon placed on water front	30 m	
3	Hazardwari	SH	Murshidabad	BG	Pontoon placed on water front	30 m	
4	Farakka	NH-34	Farakka	BG	4800 Sq m	80 m	
5	Sahibhanj (Samdaghat)	NH–80	Sahibhanj	BG	Pontoon placed on water front	35 m	
6	Bhagalpur	NH-80	Bhagalpur	BG	1000 Sq. m	35 m	
7	Barh	NH-30A	Barh	BG	-	27 m	
8	Rajghat (Varanasi)	NH–7	Mugalsarai	BG	Pontoon placed on water front	35 m	
9	G.R.Jetty-2 (Kolkata)	SH	Kidderpore	BG	14606 Sq m	216 m	Fixed RCC Jetty
10	Patna (Gaighat)	NH–19	Gulzarbagh	BG	3.24 Acre	46.6 m	Fixed RCC Jetty
11	Allahabad	NH-35	Karchhana	BG	8.759 Hectare	35 m	Floating Terminal

Considering the traffic potential of NW-1 with many thermal power plans and other big industries planned along the river Ganges, IWAI plans to develop IWT terminals along the national Waterways-1. In this direction, Sahibganj is identified as the potential IWT terminal catering mainly to coal and stone chips movement through waterways.

3.3.4 Sahibganj- District Profile

Sahibganj district falls in the Indian state of Jharkhand. The district has a predominant tribal population and is a part of Santhal Pargana division and forms the eastern most tip of the division. Sahibganj is the administrative headquarter of the district and situated on the bank of the river Ganges. The geographical area of the district is 1599.00 sq. km. It is bounded on north by the river Ganges and district of Katihar, on the south by the district Godda, on the east by Maldah and Murshidabad districts of the state of West Bengal, and on the west by Bhagalpur and Godda districts.

Agriculture is the mainstay of economy of Sahibganj. However, the area is also blessed with tremendous quantities of various minerals and other natural resources. Pakur chips are quite well known and are used extensively all over Jharkhand, Bihar and parts of West Bengal. Kaolin is found near Mangal Hat in Rajmahal subdivision.

Sahibganj city is by far the most important place for trade and commerce in the district. Wholesale trading in food grains is mostly carried on in Sahibganj. The main imports of the districts are linseed, mustard seed, tobacco, raw cotton, sugar, refined and unrefined molasses, salt, kerosene oil, coal, coke, gunny bags, gram, wheat and maize.

3.3.5 Infrastructure Scenario

a) Roads: The district has good network of roadways. No important place in the district is left unconnected by a metalled road. The Jamtara-Dumka-Sahibganj road provides a link with Assam after ferry across the Ganges. The road between Farakka and Bhagalpur has been upgraded as National Highway.

b) Railways: The district is deprived of adequate railway communication as it lies on the Howrah-Bhagalpur loop line. Both the sub-divisional headquarters have railway stations. Presently there is rail connection for Howrah, New Delhi and Patna.

c) Waterways: The only navigable waterway is the river Ganges. There are ferry services across the river Ganges between Sahibganj ghat to Manihari Ghat in Katihar district of Bihar, which is directly linked to the Guwahati highway and between Rajmahal ghat to Manikchak ghat in Maldah district of West Bengal.

Sahibganj district is bounded on north by the river Ganges and district of Katihar, on the south by the district Godda, on the east by Maldah and Murshidabad districts of the state of West Bengal, and on the west by Bhagalpur and Godda districts. Sahibganj is by far the most important place for trade and commerce in the district. Wholesale trading in food grains is mostly carried on in Sahibganj. The main imports of the districts are linseed, mustard seed, tobacco, raw cotton, sugar, refined and unrefined molasses, salt, kerosene oil, coal, coke, gunny bags, gram, wheat and maize. The main exports are paddy, jawar, sabai, grass, stone chips, hides, fibers, kaolin and bentonite. Ceramic based MSMEs have good potential at Sahibganj.

3.3.6 Mines & Minerals in Sahibganj and Adjoining Area

The Rajmahal Hills are the source of building and road stones. Most of the quarrying is done by the side of the loop line of the Eastern Railway. Pakur District is having a large number of stone mines and crushers. Approximately 500 mines & 800 crushers are in operation with the support of one lac labour force in present time. The quality of Pakur black stone chips is excellent for constructional purpose. Black stones of Pakur are also exported in the South Asian countries. Among the minerals found are coal, china clay, fireclay, quartz, and silica sand and glass sand. It is famous across the world for its Black stone. It supplies nearly 500 Truck Stone chips daily to Bangladesh. It is generating the highest revenue for Howrah railway Division by supplying Black Stone Chips across India and Coal to Punjab.

3.3.7 Defining Project Influence Zone (PIZ)

Transportation through IWT offers many advantages like cost effectiveness, safety, timely services among many. Considering all the advantages IWT as a mode of transport can offer, the proposed services are expected to attract traffic not only from immediate district i.e. Sahibganj but from immediate adjoining districts once the IWT terminal are fully developed with all the necessary handling and other facilities. However, considering that the IWT

terminal are at the southern bank of Ganges river, only those district which falls on southern end are include in the Project Influence Zone (PIZ).

The following districts are included in the PIZ which is expected to generate maximum traffic to various districts/thermal plants for the proposed services:

- Sahibganj
- Bhagalpur
- Pakur
- Godda and other nearby areas

Consequently, consultants studied traffic pattern of the above mentioned districts to work out the traffic divertiblity to proposed IWT services. However, consultants are aware that unlike road sector which provides door-to-door services, transportation by IWT involves multiple handling which adds on to the total transportation cost of the commodity.

In the current exercise, districts/areas on either side of the waterway systems which are likely to be served (primary hinterland) by the proposed IWT services are considered. Consequently, civil districts located on either banks of the river are considered as the relevant traffic regions. The list of such districts is as tabulated are furnished in Table 3.4 below:

Table 3.4: Districts Adjoining to National Waterway-1

Bihar	Jharkhand	West Bengal	Uttar Pradesh
Buxar	Sahibganj	Ingraj Bazar/Maldah	Allahabad
Bhojpur	Godda	Bahrampur/Murshidabad	Varanasi
Patna	Pakur	Krishnanagar	Ghazipur
Nalanda		Barasat	Balia
Luckeesarai		Chunchura	Mirzapur
Munger		Haora	Chandauli
Bhagalpur		Alipur	
Saran		Purba Medinipur	
Vaishali		Bardhaman	
Samstipur		Birbhum	
Begusarai			
Khagaria			
Kathiar			

3.3.8 Regionalization

Regional scheme approach is adopted wherein each traffic region is co-terminus with the civil district and each region was designated with a centroid. All the traffic originating or terminating from the region was represented by the centroid. In the case of Railways, all the stations falling in particular district were clubbed together to represent a region and the entire traffic of the region was assumed to originate/terminate from the respective centroid.

3.3.9 Base Year

Base year of the study is considered as 2014-15.

3.3.9.1 NW-1: Literature Review

The study commenced with the literature review that involved close scrutiny of secondary information available from different reports and documents. The consultants studied reports prepared by different agencies on National waterways-1. This gave an insight about the past and present traffic scenario of the national waterways, its potential, its advantages and bottlenecks.

The Dutch Mission, which has done the study for NW-1 has forecasted the traffic for the waterways. Based on traffic studies conducted by the research group, entire range of commodities are likely to be transported by WT services on the said corridor, 11 cargo groups were formed with common handling & storage requirements. As per the report prepared by the Dutch Mission, Haldia was selected as important IWT terminal. Based on the export/import traffic and the domestic traffic, the potential commodities that were recommended for proposed IWT services includes; Fertilisers, POL & Kerosene, Raw Jute, Jute textiles, Food grains, Sugar, and Salt. Originating commodities estimated for the year 1991 are summarized in Table 3.5 below:

Table 3.5: Cargo Traffic as Forecasted by Dutch Mission at Haldia for the year 1991 ('000 tones)

S. No.	Cargo	Loading/Originating	Unloading / Terminating
1.	Fertilizer	209	
2.	POL + Kerosene	395	145
3.	Raw Jute, Jute textiles, Food grains, Sugar & Salt	168	
Source: Rites Report in NW Grid 2013			

In addition, dutch Mission had estimated that considerable quantum of cargo can be handled between Bhagirathi and Hooghly Terminals via IWT terminals.

In 2013, Rites Ltd had carried out a detailed study on "Integrated National Waterways Transportation Grid Study" . In this study, Sahibganj was identified as IWT terminal which can be further developed

3.3.10 Potential Traffic Estimation

In previous times when the road and rail network were not so developed, location of industrial activity has been influenced by logistical convenience of riverine transport possibilities. However, this may not be true to the same extent today, although access to water for processing and in some cases effluent treatment is still a consideration in location like in the case of major industries like thermal power plants.

Consequently, while estimating potential traffic for proposed IWT services, the viability of goods movement using IWT were analyzed from the perspectives of technological and

physical viability, commercial potential and operating policy of carriers and associated agencies. As in any mode of transport, factors that may affect the economics and operation of a transport are the availability of the channel or right-of-way, handling and ancillary facilities at both end of the trip and the carriers or vessels, and other supporting services like administrative services, services to manage day-to-day operations etc. In IWT, these translate to the availability of the waterway, terminal facilities like jetties and ports, barges and other vessels capable of navigation, and finally the management component. All these factors were kept in mind while estimating potential divertible traffic to IWT.

Owing to tremendous cost benefit advantages IWT has over the other modes of transports, economic activities not only of Sahibganj but also of adjoining area were studied to determine the potential divertible traffic to proposed IWT services.

For estimation of potential divertible traffic from existing road traffic flows, primary survey approach was employed. Goods O-D surveys were conducted at major road intersections and major traffic generating areas; industries like stone crushers, agricultural hubs etc. The surveys were conducted round the clock by employing suitable number of enumerators. For this, a detailed questionnaire was formulated. In addition to the goods O-D survey, traffic count survey was also carried out to reconfirm the quantum of traffic. The data gathered were punched, cleaned and analyzed to arrive at the base year traffic. In Railways, the commodity movement data are well recorded and were used to estimate the current commodity flow between various O-D pairs. As per the TOR of the study, traffic projection should be done with the specific reference to anchor commodities of domestic coal and stone chips apart from other relevant commodities.

Consultants assessed various commodities moving on various corridors either originating or terminating in the PIZ regions. This includes bulk and non-bulk items. However, it was found that bulk commodities are more likely to get diverted to the IWT services. In this regards, it is expected that coal is expected to be the major commodity likely to be transported though the waterways. It is worth mentioning that the Nation Waterways-1 is marked by the huge coal mines in its close vicinity. In addition, due the presence of coal and ample water, many thermal power plants have come up adjoining to the River Ganges with many other in the pipeline.

Hence it is assumed that the major portion of the potential traffic demand shall come from the thermal power plants, both existing as well as proposed, situated in the districts directly falling on NW-1. As already mentioned that the focus of the study is to determine the traffic potential of coal and stones transport in particular.

3.3.11 Methodology Adopted to Estimate Coal Transport Potential

To estimate the potential coal diversion to IWT, the consultants studied the present and projected coal demand of the existing and planned thermal plants. This data was corroborated with the Information on past rail flows collected from concerned railway offices for the current year. There are close to 11 running thermal plants which are situated on the districts falling directly on NW-1. All these thermal plants have their own captive coal mines and have already well laid down infrastructure facilities.

However, to estimate the coal which can be transported though IWT mode, the first step is to identify the thermal plants to which the Rajmahal and adjoining coal mines are linked to. Moreover, only those thermal plants which are situated along the NW-1 are selected as the

possible demand centres. Nevertheless, the annual coal demand is worked out and on the basis of respective coal linkages, potential divertible traffic to Sahibganj IWT terminal shall be worked out.

Existing thermal power plants and planned thermal plants that are running on coal originated from Rajmahal collieries and other adjoining coal mines are targeted as potential demand centres for IWT services from Sahibhanj. After establishing the coal linkages from the collieries, exact distance between thermal power plant and Rajmahal collieries were calculated. This is done to establish the potential traffic that can be handled at proposed IWT terminal at Sahibganj.

3.3.12 Methodology Adopted to Estimate Stone and Other Commodity Transport Potential

3.3.12.1 Primary Survey Approach- For Road Sector

To estimate the stone chips and other commodity movement data, past commodity movement by Indian Railway (IR), information was collected from concerned railway offices. Since on road transport sector, no authentic data to generate commodity wise flows are available, primary survey approach were adopted. Consequently, various types of primary surveys were carried out to determine the potential stone chips and other commodities traffic.

The surveys were carried out at various important road transactions and corridors to know the current traffic flow pattern on different corridors. The surveys were conducted round the clock for 2 days at all the survey locations. Sufficient numbers of enumerators were employed to record the data on specially designed questionnaires. At each checkpost, some enumerators were kept as backup to give sufficient rest to enumerators. In addition, provision of survey supervisors was made to maintain the quality of the survey work. The enumerators were given sufficient training by the consultants to conduct the survey work smoothly. Survey locations were carefully selected so that road traffic flows could not be disturbed.

- Road Goods Origin-destination Survey: - The survey was carried out at road transactions and major stone quarries gates and areas like Mahadev Pahar area and Karamtola area to identified major O-D corridors on which the commodity is moving. In this survey, truck operators were asked about the origin and destination of the current trip, what commodity they are carrying and how much they are carrying. The replies received from them were duly recorded in the questionnaires.
- User Cost & Opinion Surveys:- The survey was carried out with transport agents, stone query operators and truck operators to know the transportation cost by road.

To conclude the level of diversion from the existing goods vehicular traffic between selected pairs of points, opinions of the stone query operators were gathered through personal interview method by introducing a specially designed questionnaire.

Results arrived from the analysis of O-D surveys were used to arrive at the potential divertible traffic on the major corridors. Corridors on which small quantity of cargo are ignored for the potential divertible traffic estimation.

In addition, for other commodities fruits & vegetables, food grains etc moving in large quantities and on longer distances, data arrived from Goods O-d survey conducted on major road intersections were used. POL products are kept beyond the purview of traffic estimates.

3.4 Traffic Potential for Proposed IWT Terminal at Sahibganj

3.4.1 Estimated Base Year Potential Traffic

As explained earlier, the focus of the study is to determine the bulk commodity movement that can be diverted to the proposed IWT services from Sahibganj. However, the consultant made an attempt to estimate the other commodities as well which has the potential to get diverted to IWT mode. The IWT services are expected to provide secured, time bound services and cheap alternate mode of transport to bulk commodity movers/users. Moreover, the targeted commodity in this exercise is coal and stone chips which are abundantly available in the Sahibhanj and adjoining area. At present, the commodity is either moved by road sectors or by railway. Road sector is not suitable for bulk movement of commodity like coal and is well known fact that railway is marred by capacity constraints on various corridors, thus, hampering the flow of traffic. More importantly, due to the non availability of wagons/rakes commodity flow also gets hampered. Development of inland water transport with adequate intermodal connectivity can help to reduce the congestion on roads and rail and reduce environment pollution.

3.4.2 Estimation of Coal Potential

The volume of cargo moved through inland water transport remains very low, confined largely to the movement of iron ore in Goa and fertilizer raw material in the West Coast region in the past. However, in the recent years, IWT is being used to transport coal in very big way. NTPC started transporting imported coal through the Ganges to its Farakka plant in Bengal, leading to a huge saving in cost. Additionally, National Waterways-1 has huge potential for transporting bulk commodity especially coal due to the presence of huge coal deposits as well as presence of many thermal power plants along the river Ganges. In addition, many new thermal power plants are also being planned and many other existing

thermal power plants planning to increase their generation capacity and thus shall require huge quantity of coal to be transported to the plants.

3.4.3 Coal Production

India has one of the largest coal reserves in the world. As on 2011, India ranked 3rd in world coal production. After nationalisation of coal mines, few companies are extracting coal in various parts of the country. Among them, Coal India is the largest coal producing company in the country. Over the years, coal production had gone through an impressing growth to feed the ever increasing appetite for power for overall growth of economy. Following Table 3.6 shows the coal production in year 2013-14 and targeted coal production for the year 2014-15.

Table 3.6: Production of Coal (Million Tonnes)

Company	2013-14		2014-15
	Target	Actual	Target
CIL	482	462.41	507
SCCL	54.3	50.47	55
Captive	50	39.91	50
Others	18.25	12.97	18.25
Total	604.55	565.76	630.25
Others include other public sectors, TSL, Meghalaya			

State-owned Coal India Limited (CIL) has recorded close to a 7% rise in production at 494 million tonnes (mt) in 2014-15. The company had produced 462 mt coal in the 2013-14 and set the output target at 507 mt for the financial year ended March 31, 2015.

Through systematic investment program and greater emphasis on application of modern technologies, the country is able to raise the production of coal from a level of about 70 million tonnes at the time of nationalization of coal mines in early 1970's to 565 million tonnes in 2013-2014.

Following Table 3.7 shows the State wise Coal Reserves in India.

Table 3.7: State wise Coal Reserves in India (In MT)

State	Proved	Indicated	Inferred	Total
Jharkhand	41377	32780	6559	80716
Odisha	27791	37873	9408	75073
Chhattisgarh	16052	33253	3228	52533
West Bengal	13403	13022	4893	31318
Madhya Pradesh	10411	12382	2879	25673
Andhra Pradesh	9729	9670	3068	22468
Maharashtra	5667	3186	2110	10964
Others	1478	340	1003	2819
Total	**125909**	**142506**	**33149**	**301564**
(Source: Geological Survey of India)				

The State of Jharkhand is endowed with close to 80 Billion Tons of coal of all categories. This is distributed in 12 Major Coalfields. The maturity of coal varies from Meta lignitous coal of low rank to Semi anthracitic coal. Jharkhand is the only State which is having prime coking coal. The State supplies about 70 MT of coal for Thermal Power Stations located in various parts of the country.

3.4.4 Eastern Coalfield Ltd

The existing coal mines in the region are under Eastern Coalfields Limited (ECL). These mines are expected to generate coal traffic for proposed IWT terminal in Sahibganj. Therefore it is pertinent to study the past coal production and future coal projections, mode used to transport coal currently etc. The company came into existence in 1975 after nationalization of coal mines in India. It is one of the eight fully owned subsidiaries of Coal India Limited. At present, ECL owns approx. 103 numbers of operating mines out of which 75 are underground mines, 19 are opencast mines and 9 mixed mine. The majority of its mines are in West Bengal and some in Jharkhand State.

ECL has total geological reserve of 31.32 Billion Tonne of Coal in the state of West Bengal in ECL command area out of which 13.40 Billion Tonne is in the proven category. The company has premium grade of coal with average ash content less than 20% at Raniganj Coalfields. This coal can be blended with high ash coal from other subsidiaries to satisfy the Ministry of Environment & Forests (MoEF) stipulations. It is estimated that reserves of 18.61 Billion Tonne of Coal are present down to a depth of 600 metre (as per GSI) in Jharkhand.

As per the company annual report, in the year 2014-15, ECL has achieved growth of 10.99% over the year 2013-14 in coal production. Following Table 3.8 shows the coal production in the year 2014-15 and comparison with the last financial year:

Table 3.8: Coal Production in ECL Mines for 2014-15

Particulars	Unit	2014-15			2013-14	Growth Over Last Year	
		Target	Actual	Achieved	Actual	Absolute	%
Raw Coal-UG	MT	7.25	7.292	100.57	6.871	0.421	6.13
Raw Coal-OC		30.75	32.714	106.39	29.175	3.539	12.13
Total		38	40.006	105.28	36.046	3.96	10.99
**UG= Under Ground, OC= Open Cast*							

Following Table 3.9 shows the Sectorwise Consumption of Coal Produced in ECL Mines for 2013-14 & 2014-15.

Table 3.9: Sectorwise Consumption of Coal Produced in ECL Mines for 2013-14 & 2014-15

Sector	Off-take (2014-15)			Off-take (2013-14)		
	Demand	Actual	% Satisfaction	Demand	Actual	% Satisfaction
Power	33.727	35.102	104	29.95	31.052	104
Cement	0.128	0.08	62	0.2	0.064	32
Cpp (Ors)	0.279	0.09	32	0.403	0.123	31
Cpp (Steel)	0.303	0.364	120	0.3	0.313	104
Steel (Blend)	0.014	0.007	47	0.008	0.007	88
Sponge Iron	0.227	0.134	59	0.807	0.146	18
Export	--	0.004	--	--	--	--
Loco	--	0.001	--	--	--	--
Def	--	0.001	--	0.03	0.004	13
Colly. Cons.	0.38	0.249	66	0.34	0.277	81
Others	2.942	2.438	83	3.162	4.269	135
Source: ECL annual Report 2014-15						

ECL is targeting to produce 42.13 million tonnes of coal in the current financial year (2015-16). The coal produces at the mines owned and operated by ECL are supplying coal for many sectors in the country. However, on close scrutiny of the coal dispatch data of ECL, it was found that majority of the coal produced at the ECL mines are used by various thermal power plants operating in the region. As per the ECL annual report 2014-15, Actual off-take of coal in 2014-15 was 38.469 million tonne against the demand of 38.00 million tonne i.e. demand satisfaction of 101%. Sector-wise demand and off-take during the year 2014-15 compared to 2013-14 is as follows:

3.4.5 Sector-wise demand and off-take during the year 2014-15 (Figures in Million Tones)

The coal produced at the ECL coal mines are predominantly dispatched by IR to various sector present in various parts of the country. Mode-wise dispatch of coal in 2014-15 compared to previous year are shown in Table 3.10 below:

Table 3.10: Mode Wise Coal Dispatch

Mode of Dispatch	**2014-15**	**2013-14**
Rail	25.538	24.598
Road	1.639	1.936
Merry-Go-Round(MGR)	11.043	9.444
Total	**38.22**	**35.978**
Source: ECL annual Report 2014-15		

It can be seen that, as expected most of the coal is being transported by IR. However, sizable quantity of coal is also being transported by MGR system. NTPC thermal power station operating in Farakka and Bhagalpur is getting coal by MGR system from nearby Rajmahal coalmines area. Whereas IR is used as the mode of transportation to transport coal to thermal power plants present in the nearby areas like in Murshidabad, Bardhhaman, Hoogly, Kolkata among many others.

Field-wise average loading of wagons for the year 2014-15 compared to previous year are shown in Table 3.11 below:

Table 3.11: Field Wise Loading of Wagons/Day

Field	Loading of Wagons			
	2014-15		2013-14	
	Target	Actual	Target	Actual
Raniganj	656	696	701	663
Mugma/Salanpur	180	190	150	164
Adra	20	19	24	16
Pirpainti	122	28	201	76
Rajmahal (Wharf wall)	142	143	0	130
Total	**1120**	**1076**	**1076**	**1049**
Source: ECL annual Report 2014-15				

With the various factors like capacity constraint in case of rail transport, ever increasing coal demand and increasing production level by ECL, IWT is expected to present a lucrative and viable proposition for coal transportation.

3.4.6 Coal Deposits- Rajmahal Coal Mines Area

Sahibhanj and adjoining areas like Godda and Pakur are blessed with abundance of coal deposits. Lalmatia Colliery which is located in Rajmahal coal mines area is one of the largest collieries in the region. It is an open cast operational mine located in Godda district and about 60km from the district headquarters on the Sahibhanj. Previously it was privately owned and was an underground coal mine but after nationalization of non-coking coal mines in India during 1973, this mine was taken over by the Indian government and came under Eastern Coalfields Limited (ECL, a subsidiary of Coal India Limited). This suburban area are ECL's one of the largest opencast project. This colliery is the main supplier of coal to Farrakka NTPC and Kahalgaon NTPC.

Sahibganj has got excellent potential for transportation of domestic coal of Rajmahal and adjoining coal mines due to abundance of coal and relatively good connectivity and nearby railway line. Distance of coal mines from Proposed IWT Terminal at Sahibganj is presented in Table 3.12. There are 11 thermal power plants of varying capacity along the NW-1 with many additional are in pipeline for future development. All these thermal plants need tremendous quantity of coal which can be either mined locally or can be imported from other countries. It is a well known fact that imported coal is very expensive as compared to domestic coal and since thermal power plants are still using domestic coal for 80% of their requirement, NW-1 particularly a IWT terminal at Sahibganj can play an important in transportation of domestic coal from the local mines to intended thermal plants owing to its good railway connectivity.

Distance of coal mines from Proposed IWT Terminal at Sahibganj

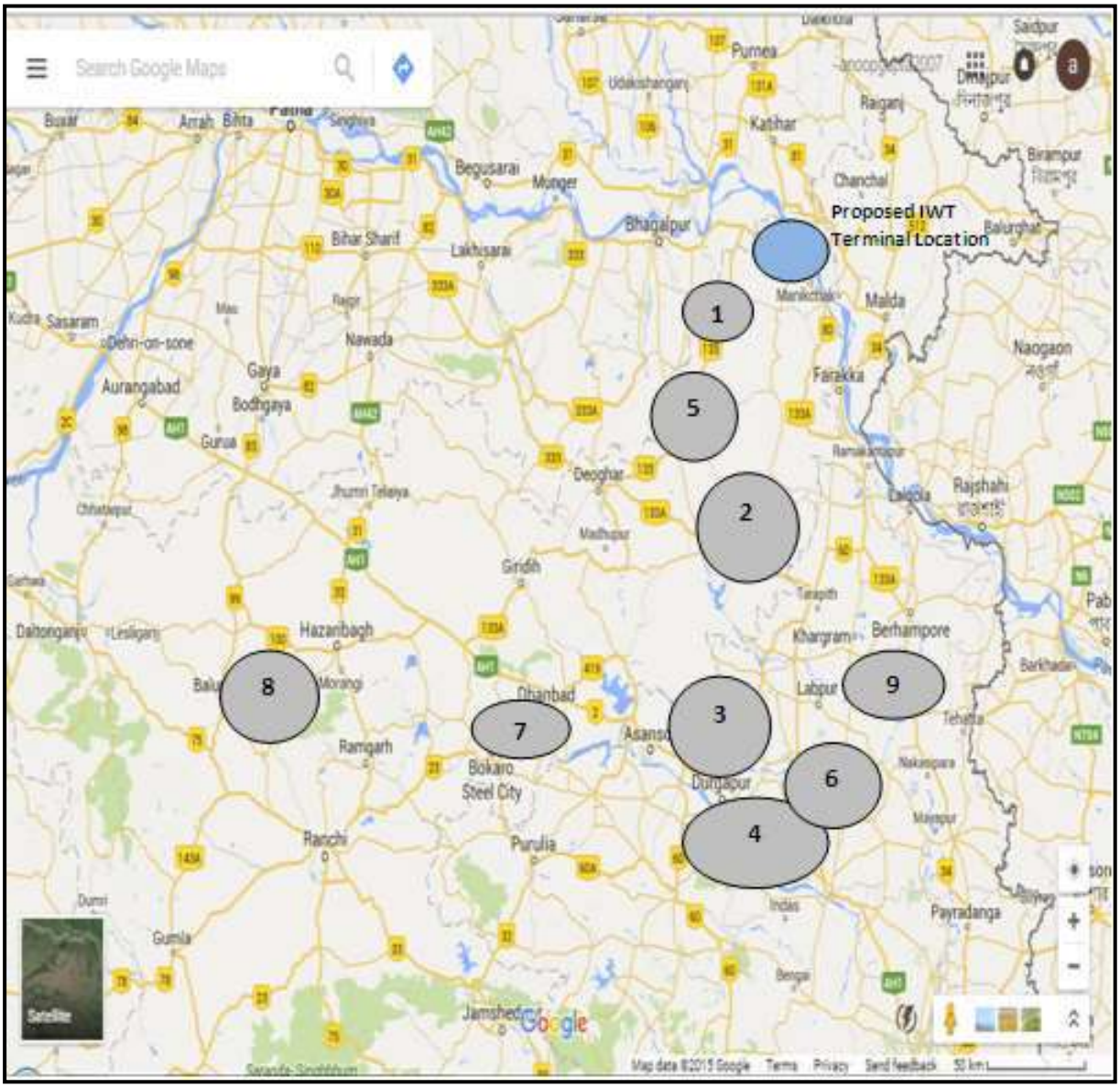


Table 3.12: Distance of Coal mines from Proposed IWT Terminal at Sahibganj

S. No.	Coal Mines Name	Distance from Proposed IWT Terminal (KM)	
		Road	Rail
1	Lalmatia Colleries	63	85 No Direct Linkage. Rail linkage via Kahalgaon NTPC.
2	Urma Paharitola Coal Block	104	107
3	ECL, BCCL, MCL (Durgapur and Asansol)	280	243
4	Bankura & Birbhum coal Mines	280	155
5	Pachawar North & East of Damagaria	110	72
6	Emta Coal Mines, Burdwan	252	237
7	Jitpur Coal Block (Rajmahal fields)	290	330
8	Amrapali Block / North Karanpura Coalfields	375	474

3.4.7 Thermal Power Scenario around NW-1 and its Coal Requirement

All the existing and proposed thermal power plants along the National Waterways-1 were studied to estimate the coal traffic flows. Extensive literature surveys were carried out to ascertain the coal blocks allocated to various thermal power plants by the government are shown in Table 3.13 below:

Table 3.13: Existing Thermal Plants along National Waterways-1

S. No.	Name	Operator	District	Capacity (MW)	Coal Mine allocated	Estimated* Annual Coal demand (MMTA)	District	Distance from Plant (KM)	Distance between Sahebganj Terminal & Mines (KM)		Mode of Transport	Remarks, if any
									Road distance	Rail Sakrigali SLJ		
1	Kahalgaon Super Thermal Power Station	NTPC	Bhagalpur	2,340	Rajmahal Coal Fields, Raniganj coal Fields, Imported Coal	12.13	Godda/ Sahibganj	30	63	85	MGR (Pvt)	No Direct Linkage. Rail linkage via Kahalgaon NTPC.
2	Barauni Thermal Power Station	NTPC	Begusarai	810	Urma Pahari Tola.	4.20	Amrapara, Pakur	210	104	107	IR	No direct connection, Railway till Pakur only. The coal mines is approx 30 Km from Pakur city
3	Farakka Super Thermal Power Station	NTPC	Murshidabad	2,100	Rajmahal Coal Fields, Raniganj coal Fields, Imported Coal	10.89	Godda/ Sahibganj	90	45	85	MGR (Pvt)	No Direct Linkage. Rail linkage via Kahalgaon NTPC.
4	Kolaghat Thermal Power Station	WBPDCL	East Midnapore	1,260	ECL, BCCL, MCL	5.78	Durgapur and Asansol	290	280	243	IR	
5	Durgapur Steel Thermal Power Station	DVC	Bardhaman	1,000	Bankura & Birbhum coal Mines	5.18	Birbhum and Bankura	85	280	155	IR	
6	Sagardighi Thermal Power Station	WBPDCL	Murshidabad	1600	Pachawar North & East of Damagaria, bardhaman Coal Mines	3.11	Pakur, bardhaman	400	100, 252	72, 237	IR	Railway distance till Pakur and Bardhaman Railway station
7	Bandel Thermal Power Station	WBPDCL	Hooghly	450	Pachwara North coal blocks , Pakur	2.33	Pakur, bardhaman	240	110, 252	72, 237	IR	Railway distance till Pakur and Bardhaman Railway station. Pachwara North coal blocks is approx 32 Km from Pakur City and coalmines in Bardhaman are approx 80-90 Km from city
8	Durgapur Thermal Power Station	DVC	Bardhaman	350	Bankura & Birbhum coal Mines	1.82	Birbhum and Bankura	85	280	155	IR	
9	CESC Southern Generating Station	CESC	Kolkata	135	Emta Coal Mines, Asansol	0.70	Burdwan, ECL Mines	200	252	237	IR	Distance till Bardhaman railway

S. No.	Name	Operator	District	Capacity (MW)	Coal Mine allocated	Estimated* Annual Coal demand (MMTA)	District	Distance from Plant (KM)	Distance between Sahebganj Terminal & Mines (KM)		Mode of Transport	Remarks, if any
									Road distance	Rail Sakrigali SLJ		
												station. Coal mines in Bardhaman are approx 80-90 Km from city.
10	New Cossipore Generating Station	CESC	Kolkata	100	Emta Coal Mines, Asansol	0.52	Burdwan, ECL Mines	200	252	237	IR	Distance till Bardhaman railway station, coalmines in Bardhaman are approx 80-90 Km from city
11	Haldia Energy Power Station	CESC	Haldia	600	Mahanadi Coalfields	3.5	Mines in Orissa	500	700	619	IR	

	**53.8T/hr for 100 MW(Indian coal)+ with reserve, IR= Indian Railway*
	Railway distance: http://rbs.indianrail.gov.in/ShortPath
	Other information from respective thermal power plants official website, other relevant websites

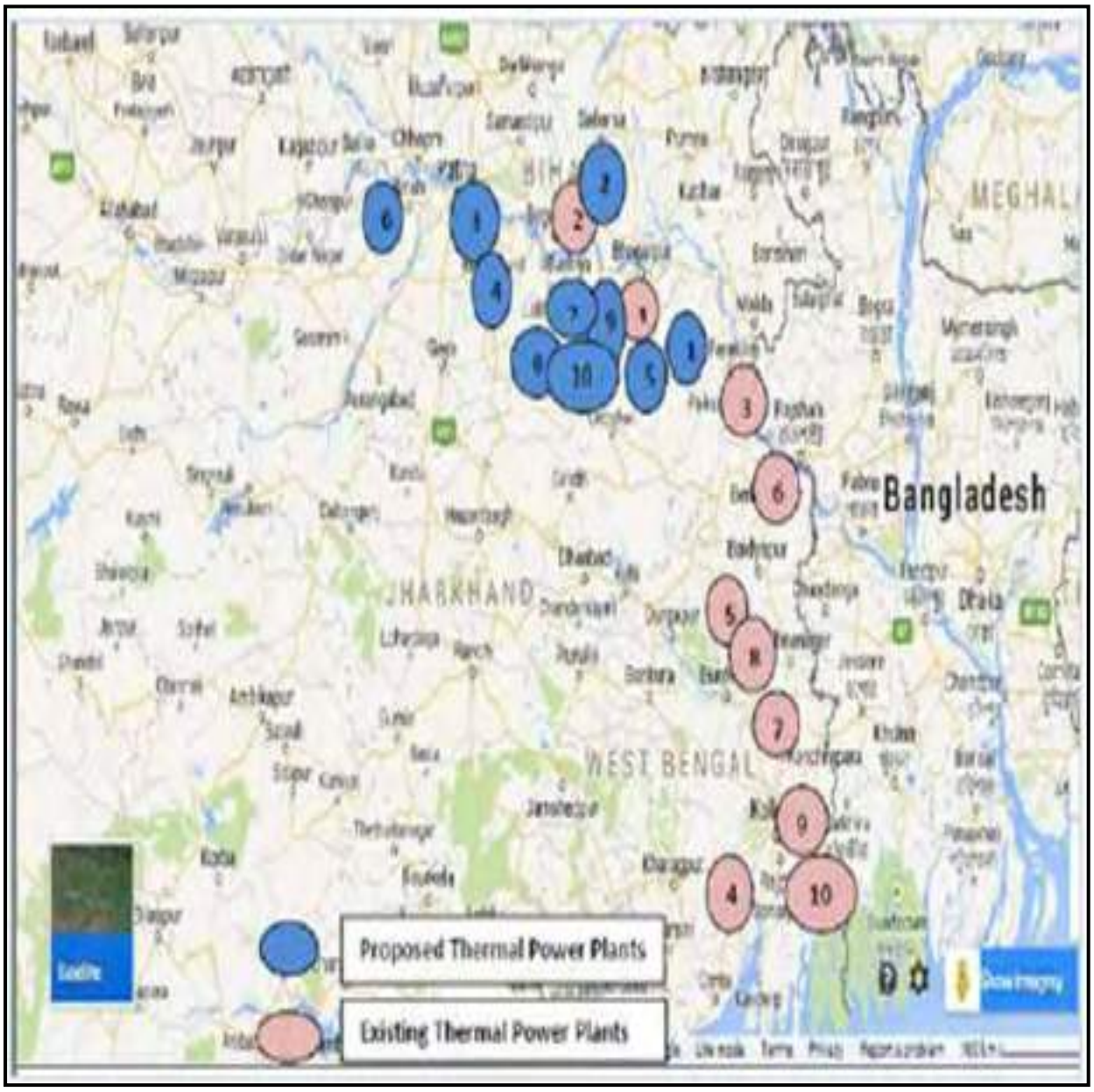
Where ever, secondary data was not available, field visits to power plant were organized and relevant data were gathered. This was done to identify those thermal plants which are linked to coal mines of Rajmahal collieries or its adjoining areas. After carefully analysing the coal linkages to existing thermal power plants, the next step was to identify the mode of transport used to transport coal from mines to respective thermal power plant. It is found that nearly all thermal power plants have their own railway siding which is generally very close to the plant or inside the plant complex. It is found that majority of thermal power plants are getting coal from nearby coal fields with very small distance involved by Railway or road.

While studying the current power scenario of the region, it was known that various new thermal power plants are in the planning and implementation stage in the adjoining districts to the NW-1. In addition, various existing thermal power plants are planning to increase capacity by establishing new power generation units in the existing plants. In this direction, consultants have identified following proposed thermal power plants which are situated in the districts bordering NW-1 are shown in Table 3.14 below:

Table 3.14: Proposed Thermal Power Plant Along NW-1

S. No.	Unit	Parent	Capacity (MW)	Status	District	Coal Block Allocated	MTPA	Coal Blocks District	Distance from Plant (KM)	Distance between Sahebganj Terminal & Mines (KMs)	
										Road Distance	Rail Sakrigali SLJ
1	Godda Project Unit 1	Jindal Steel Power	1320	Permitted	Godda	Jitpur Coal Block (rajmahal fields)	6.5	Godda	40	290	330
2	Barauni power station Unit 8	Bihar State Electricity Board	500	Pre-permit development	Begusarai/ Barauni	Urma Paharitola Coal Block,	2.31	Amrapara block, Pakur	210	104	107
3	Barh I power station Unit 1-3	NTPC	1980	Construction	Patna/ Barh	Amrapali Block / Norht Karanpura Coalfields	12.8	CHatra, Ranchi	250	375	474
4	Barh II power station Unit 2	NTPC	1320	Construction	Patna/ Barh	Amrapali Coal Mining Blocks.	8.57	CHatra, Ranchi	250	375	474
5	Bhagalpur Power Project Unit 1	Adhunik Group	1320	Pre-permit development	Bhagalpur Kehalgaon	Coal Mines not allocated	NA	NA	NA	NA	NA
6	Buxar Thermal Power Station (Chausa) Unit 1	BSEB and ILFS	1320	Pre-permit development	Buxar	Deocha Pachami-Dewanganj Horisingha Coal Block-Birbhum district	6.25	Birbhum	575	280	155
7	Lakhisarai TP Station(kajara) Unit 1	BSPGL, NTPC	1320	Pre-permit development	Lakhisarai	Deocha Pachmi Coal Block(WB)	6.25	Birbhum	337	280	155
8	Moma power station	HPP	1980	Announced	Lakhisarai	NA	NA	NA	NA	NA	NA
9	Pirpainti power station (CESC) Phase- I	CESC	2000	Announced	Bhagalpur	Deocha Pachmi Coal Block(WB)	5.24	Birbhum	166	280	155
10	Pirpainti Thermal Power Station	Pirpainti Bijlee Company	1320	Permitted	Bhagalpur	Deocha Pachmi Coal Block(WB)	6.25	Birbhum	166	280	155
11	Haldia Power Plant	IPCL	450	Under Construction	Haldia	Bankhui Coal Mines,	2.3	Burdwan, Berhampur	200	252	237

Map showing locations of existing as well as planned thermal power plant along National waterways-1 are shown below:



The list of existing as well as proposed thermal power plant along National Waterways-1 is given in Table 3.15 below:

Table 3.15 : List of Existing as well as Proposed Thermal Power Plant along National Waterways-1

S. No.	Existing Thermal Power Station	Proposed Thermal Power Station
1	Kahalgaon Super TPS	Godda Project Unit 1
2	Barauni TPS	Barauni power station Unit 8
3	Farakka Super TPS	Barh I power station Unit 1-3
4	Kolaghat TPS	Barh II power station Unit 2
5	Durgapur Steel TPS	Bhagalpur Power Project Unit 1
6	Sagardighi TPS	Buxar TPS (Chausa) Unit 1
7	Bandel TPS	Lakhisarai TP Station(kajara) Unit 1
8	Durgapur TPS	Moma power station
9	CESC Southern Generating Station	Pirpainti power station (CESC) Phase- I
10	New Cossipore Generating Station	Pirpainti Thermal Power Station
11	Haldia Energy PS	Haldia Power Plant

Based on the coal linkages to the thermal power plants along NW-1, following thermal power plants were selected as shown in Table 3.16 below for further analysis. Rest of the thermal power plants are not likely to be benefited from the proposed NW-1 as the coal mines to which they are linked are very far off from proposed terminal at Sahibganj.

Table 3.16: Potential Divertible Coal Traffic on IWT- Terminal – Sahibganj

S. No.	Name	District	Capacity (MW)	Coal Mine allocated	Estimated* Annual Coal demand (MMTA)	Distance		Potential Traffic (Yes/No)	Reasons/ Remarks
						IR	IWT (IR+IWT)		
1	Kahalgaon Super TPS	Bhagalpur	2,340	Rajmahal Coal Fields, Raniganj	12.13	30	110	No	NTPC own MGR
2	Barauni TPS	Begusarai	810	Rajmahal coal field/ Urma Pahari Tola.	4.2	210	385	No	No distance advantage
3	Farakka Super TPS	Murshida-bad	2,100	Rajmahal Coal Fields, Raniganj, Imported Coal	10.89	90	115	No	NTPC own MGR
4	Barauni power station Unit 8	Begusarai/ Barauni	500	Rajmahal Coal Fields	2.31	210	385	No	No distance advantage
5	Godda Project Unit 1	Godda	1320	Jitpur Coal Block (rajmahal fields)	6.5	40	NA	No	Thermal plant and Mines are in Same District
6	Sagardighi TPS	Murshida-bad	1600	Pachawar North & East of Damagaria(Pakur), Bardhman CoalMines	8.11	400	223	Yes	Partially
7	Bandel TPS	Hooghly	450	Pachawar North & East of Damagaria (Pakur), Bardhman Coal Mines	2.33	250	430	Yes	Partially

It can be seen that out of the proposed thermal power plants along the NW-1, only Godda Project Unit-1 (annual coal demand 6.5 MMTA) and Barauni power station Unit-8 (annual coal demand 2.31 MMTA) are the potential demand area for proposed IWT services from Sahibganj terminal to transportation of coal from nearby mines. However, the distance of Godda Project Unit 1 thermal plant is to the Sahibganj IWT terminal is very less which will make transportation of coal via IWT mode economically not viable. Moreover, Godda does not directly falls on NW-1 and thus lacks any IWT facility.

In the case of Barauni Thermal Power Station, coal block allocated falls in Dumka/Pakur districts and is at the distance of approx 90 Km from Sahibganj IWT terminal. The IWT terminal is another approx 295 KM from thermal power plant. Whereas the mine is approx 210 KM from Barauni (Begusarai district) Thermal plants by rail/road. Hence, it is not likely to divert on proposed IWT terminal. Moreover, the thermal power plant is on upstream of river resulting in higher operational costs for vessels. In case of Bandel, though the distance advantage is in favour of IR, however, considering the lower transportation cost in case of IWT transportation and most importantly, being on the downstream(resulting in lower operational cost for Vessels), sizable quantity of coal can be handled by IWT transport.

Additionally, to determine the coal potential likely to be handled by IWT for existing thermal power plants, consultants visited Lalmatia collieries (Rajmahal Mines area) and met officials of the company and gathered useful information regarding company's current coal dispatches, mode used, any expansion plans etc. It was found that to transport coal to Farrakka thermal plant and Kahalgaon Thermal plant, NTPC has its own dedicated Mary-Go-Round (MGR) system along with its own rolling stocks and locomotives. Majority of coal are transported through this dedicated MGR system only as shown in Table 3.17 below:

Table 3.17: Coal Dispatches from Lalmatia Colliery (in MT)

Year	NTPC Farrakka Thermal Power Plant	NTPC Kahalgaon Thermal Power Plant	Others
2013-14	4.22	9.87	0.29
2014-15	4.31	10.67	0.15

Lalmatia colliery which is an important coal block in Rajmahal area, is currently supplying coal to Kahalgaon Thermal power plant and Farrakka Thermal power plant. Nearly all its annual production is consumed at these thermal plants only. Moreover with the annual production of around 14-15 MT, Lalmatia Collieries are unable to meet the demand of these thermal plants, as a result, as per the officials of Kahalgaon Thermal power plant, they are forced to look out for other sources like Raniganj coal mines and imported coal for their requirement. Currently, Rajmahal collieries are undergoing expansion plan to raise its production capacity to 17 MT annually. However, increase in production is expected to meet the coal demand of these power plants only. Moreover, as already explained that coal is being transported to these thermal power plants mainly through dedicated MGR system maintained and owned by NTPC and very small quantity of coal is transported through IR, requisite data was collected from concerned railway authorities.

The other two thermal power plants i.e Bandel Thermal Power Station and Sagardighi Thermal Power Station are currently getting coal supplies from the defined PIZ for proposed IWT terminal. West Bengal Power Development Corporation Ltd (WBPDCL) which recently won crucial coal blocks for its thermal power plants in West Bengal. Pachwara North block which is located in the Pakur region is one of the biggest coal blocks and expected to provide maximum coal to these power plants. However, these thermal power plants are also linked to other coal blocks. Nevertheless, the region is expected to provide half of the coal requirement for Bandel thermal ppwer Plant. Similarly, Sagadighi Thermal Power plant, which recently undergone an expansion plan is also expected to get higher share of coal from the region (presently, around 5% of coal are originated from Pakur coal blocks). The estimated quantity is very substantial and is more likely to be handled by IWT services from Sahibganj.

In addition to above, consultants also studied coal transported by IR from the regions in PIZ to other districts along the NW-1. Where ever, traffic flow data was not available for the year 2014-15, actual coal flow data pertaining to year 2013-14 was raised by employing appropriate raising factor (based on the GDP growth rate). Based on the distance (wherever large distance is involved), following IR corridors are identified for estimation of potential coal traffic for proposed IWT terminal at Sahibganj as shown in

Table 3.18.

Table 3.18: Actual Coal Traffic Flow- Railway (2014-15)

S.No.	Destination	Annual Quantity (T)
1	Kolkata (Chunchura)	12747
2	Mirzapur	667824
3	Varanasi	59169
4	Barddhaman	28012

Base on the actual coal moving on various corridors by IR, potential coal for IWT is estimated (wherever, distance involved is very large). Consequently, based on the study of thermal power station, their linked coal blocks and actual railway flows for coal in past years, following coal traffic are likely to be potential for proposed IWT services from Sahibganj as shown in Table 3.19 below:

Table 3.19: Coal Traffic Potential for IWT Terminal at Sahibganj

S.No.	Destination	Annual Quantity (T)
1	Murshidabad	1216500
2	Hoogly	1165000
3	Mirzapur	667824.2
4	Kolkata	12747
5	Varanasi	59169
6	Barddhaman	28012
Total (in MT)		**3.15**

3.4.8 Stone Chips and Other Commodities Traffic Potential

The Rajmahal Hills are the source of building and road stones. Most of the quarrying is done by the side of the loop line of the Eastern Railway. The stone chips of Pakur are very famous and are used extensively all over Jharkhand, Bihar and parts of West Bengal. Kaolin is found near Mangal Hat in Rajmahal subdivision. According to estimates roughly 5 million of Black stones and 12 million of Kaolin were produced and transported to other parts of the state and country in 2010. Besides this, other types of stones and minerals are also produced in Sahibganj and other adjoining areas.

3.4.9 Base Year Traffic Estimation- Road

The entire belt comprising Sahibganj, Pakur and adjoining area have numerous stone crushers. Sahibganj itself has more than 500 stone crushers in areas like Mahadev mountain, Karamtola area etc. The crushers are of varying capacity. Stone chips of various sizes are being transported to various cities of Bihar, Jharkhand, West Bengal and eastern Uttar Pradesh. Both road and rail transport are used to transport stone chips.

As explained earlier, in case of railway, all commodity flow data are duly recorded but in the case of road sector, so agency maintains such type of data. Therefore consultants conducted goods O-D survey at selected locations.

As, its adjoining district, Pakur, is also famous for its stone chips, goods O-D survey was also organized at key road intersections as well. However, due to large distance involved between Pakur and sahibganj IWT location, the stone movement from Pakur to rest of the regions falling in the districts adjoining to NW-1 are not likely to shift. Hence, traffic from Pakur or any other neighbouring district is not included in potential traffic. In total approx 617 trucks of various carrying capacity were intercepted in the surveys.

The data so received were punched, cleaned and analysed to arrive at annual stone chips movement on various locations. However, as already explained, only those districts which fall on the either side of the National Waterway-1 considered for the traffic estimation. After analysis, it was found that majority of traffic originating from Sahibganj belongs to the Stone chips. Following table shows top 15 O-D flows (both ends falls on NW-1) as came out in the survey.

3.4.10 Stone Chip Traffice

Table 3.20 shows top-15 Origin-Destination (O-D's) pair for Stone Chips Transportation.

Table 3.20: Top-15 O-D's for Stone Chips Transportation

S.No.	Origin	Destination	Daily Traffic (T)	Annual Traffic (T)
1	Sahibganj	Patna	835	275470
2	Sahibganj	Kathiar	655	216216
3	Sahibganj	Luckeesarai	514	169488
4	Sahibganj	Begusarai	489	161469
5	Sahibganj	Ingraj Bazar/Maldah	485	160083
6	Sahibganj	Munger	441	145464
7	Sahibganj	Khagaria	374	123476
8	Sahibganj	Samstipur	358	118028

S.No.	Origin	Destination	Daily Traffic (T)	Annual Traffic (T)
9	Sahibganj	Vaishali	330	108847
10	Sahibganj	Haora	328	108247
11	Sahibganj	Bardhaman	316	104247
12	Sahibganj	Bahrampur/Murshidabad	313	103211
13	Sahibganj	Nalanda	261	86229
14	Sahibganj	Bhojpur	253	83604
15	Sahibganj	Buxar	226	74448
16	Sahibganj	Saran	196	64796
17	Sahibganj	Barasat	173	57024
18	Sahibganj	Birbhum	169	55902
19	Sahibganj	Krishnanagar	149	49104
20	Sahibganj	Others	196	64631
Total (in MT)				**2.33**

In addition to coal and stone chips, consultants tried to identify and estimate other commodities which can be diverted to proposed IWT on NW-1. Here it is worth mentioning that those commodities which are moving in very small quantity are not considered as potential traffic. Consequently, other commodities, moving on different corridors which are likely to shift on the proposed IWT services are shown in Table 3.21 below:

Table 3.21: Potential Major Commodities (Apart from Stone)- Originating from Sahibganj (Road)

S. No.	Origin	Destination	Commodity	Quantity (T)
1	Sahibganj	Khagaria	Food Grains	10439
2	Sahibganj	Munger	Building Material	68012
3	Sahibganj	Vaishali	Food Grains	12672
Total				**91123**

Similarly, terminating traffic which is likely to be the potential for the proposed IWT terminal at Sahibganj are tabulated in Table 3.22 below:

Table 3.22: Base Year Major Commodities Potential – Terminating at Sahibganj (Road)

S.No.	Origin Place	Destination	Commodity	Quantity (T)
1	Bankura	Sahibganj	Cement	27704
2	Birbhum	Sahibganj	Sugar	26704
3	Burdhmaan	Sahibganj	Cement	52560
4	Buxar	Sahibganj	Fertilizer	13992
5	Durgapur	Sahibganj	Fertilizer	38280
6	Hajipur	Sahibganj	Building Material	8126
7	Hoogly	Sahibganj	Cement	34848
8	kolkata	Sahibganj	Fertilizer	52998
9	kolkata	Sahibganj	Food Grains	15317
10	Krishnagiri	Sahibganj	Food Grains	48204
11	Nadia	Sahibganj	Sugar	13992
12	Paschim Medinipur	Sahibganj	Cement	7738
13	Patna	Sahibganj	Fertilizer	23466
14	Patna	Sahibganj	Food Grains	46004
15	Patna	Sahibganj	Sugar	30519
16	PurbaMidinapur	Sahibganj	Cement	16936
17	Samastipur	Sahibganj	Sugar	13860
18	Varanasi	Sahibganj	Sugar	26400
Total (in MT)				**0.50**

3.4.11 Railway Traffic

As it already explained, consultant shall use the rail as well as road traffic for estimation of base year potential traffic. To update traffic flows, in the case of Railways, actual commodity wise flow data for the year 2013-14 have been collected from the Ministry of Railways. It is further raised by employing appropriate raising factor (average GDP growth rate over the years) to arrive at 2014-15 figures. In this regard, base year (2014-15) commodity wise rail based traffic flows (originating) are shown in Table 3.23.

Table 3.23: Potential Base Year Railway Originating Commodity Flow for IWT-Other Than Coal (2014–15)

S. No.	From	To	Commodity	Quantity (T)
1	Sahibganj	Alipur	Building Material	2784.6
2	Sahibganj	Baharampur	Stone Chips	43441.65
3	Sahibganj	Barasat	Building Material	49031.85
4	Sahibganj	Barasat	Stone Chips	28933.8
5	Sahibganj	Begusarai	Stone Chips	23497.95
6	Sahibganj	Bihar Sharif	Stone Chips	2562
7	Sahibganj	Buxar	Stone Chips	6865.95
8	Sahibganj	Chandauli	Stone Chips	15655.5
9	Sahibganj	Chhapara	Stone Chips	19800.9
10	Sahibganj	Ghazipur	Stone Chips	16789.5
11	Sahibganj	Hajipur	Stone Chips	15592.5
12	Sahibganj	Haora	Stone Chips	102792.9
13	Sahibganj	Ingraj Bazar	Stone Chips	191537.85
14	Sahibganj	Krishnanagar	Stone Chips	13258.35
15	Sahibganj	Luckeesarai	Stone Chips	10220.7
16	Sahibganj	Munger	Cement	1065.75
17	Sahibganj	Munger	Stone Chips	44063.25
18	Sahibganj	Patna	Stone Chips	110154.45
19	Sahibganj	Samastipur	Stone Chips	388712.1
20	Sahibganj	Varanasi	Stone Chips	36528.45
Total (in MT)				**1.12**

Similarly, base year (2014-15) rail terminating traffic are shown in Table 3.24 below:

Table 3.24: Potential Base Year Railway Terminating Commodity Flow for IWT–(Other Than Coal) (2014–15)

S. No.	From	To	Commodity	Quantity (T)
1	Barddhaman	Sahibganj	Cement	6591
2	Ingraj Bazar	Sahibganj	Cement	3690
3	Ingraj Bazar	Sahibganj	Stone Chips	10298
4	Krishnanagar	Sahibganj	Food Grains	2693
5	Munger	Sahibganj	Cement	1257
Total				**24529**

On close scrutiny of data, short distance traffic was pruned-out. Similarly, O-Ds handling small quantum of traffic were also discarded.

Total Base Year Potential Traffic Estimation

Using commodity wise base year inter-regional flows both by road and railway, potential traffic that can divert to the proposed IWT service from Sahibganj are estimated. While estimating the potential traffic, consultants have kept in mind the distance of actual origin of cargo to the proposed IWT terminal at Sahibganj. Base year potential originating traffic commodity wise from Sahibganj is shown in Table 3.25 below:

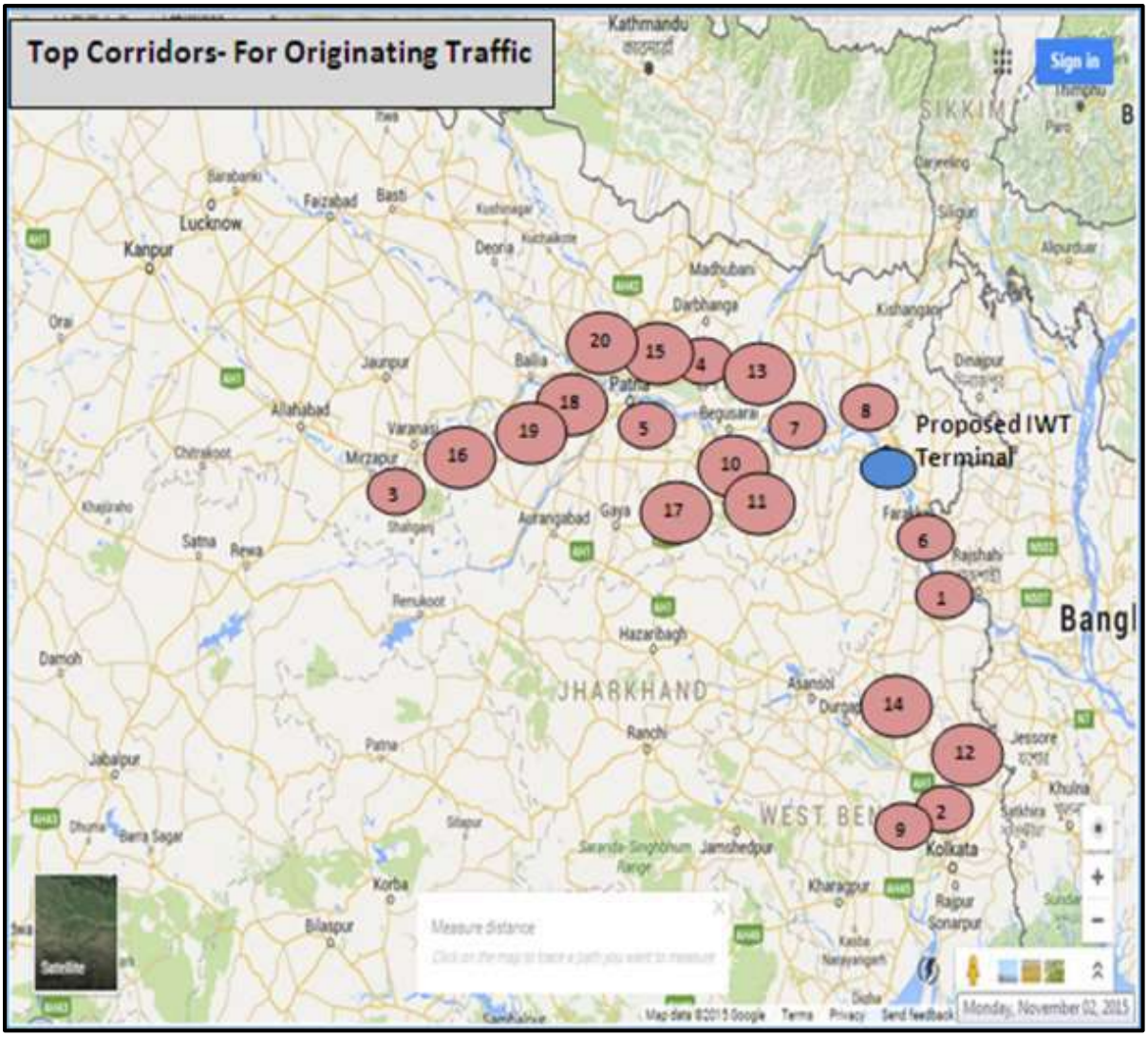
Table 3.25: Base Year Commodity Wise Potential Traffic for Sahibganj IWT Terminal-Originating

S. No.	Origin	Commodity	Quantity (T)
1	Sahibganj	Stone Chips	3400390
2	Sahibganj	Coal	3149252
3	Sahibganj	Building Material	119828
4	Sahibganj	Food Grains	23111
5	Sahibganj	Cement	1066
Total (in MT)			**6.69**

Similarly, base year potential commodity wise terminating traffic for Sahibganj are given in Table 3.26 below:

Table 3.26: Base Year Commodity Wise Potential Traffic from Sahibganj IWT Terminal-Terminating

S.No.	To	Commodity	Quantity (T)
1	Sahibganj	Cement	151323
2	Sahibganj	Fertilizer	128736
3	Sahibganj	Food Grains	112218
4	Sahibganj	Sugar	111474
5	Sahibganj	Stone Chips	10298
6	Sahibganj	Building Material	8126
Total (in MT)			**0.52**


Top Corridors- For Originating Traffic
Proposed IWT Terminal
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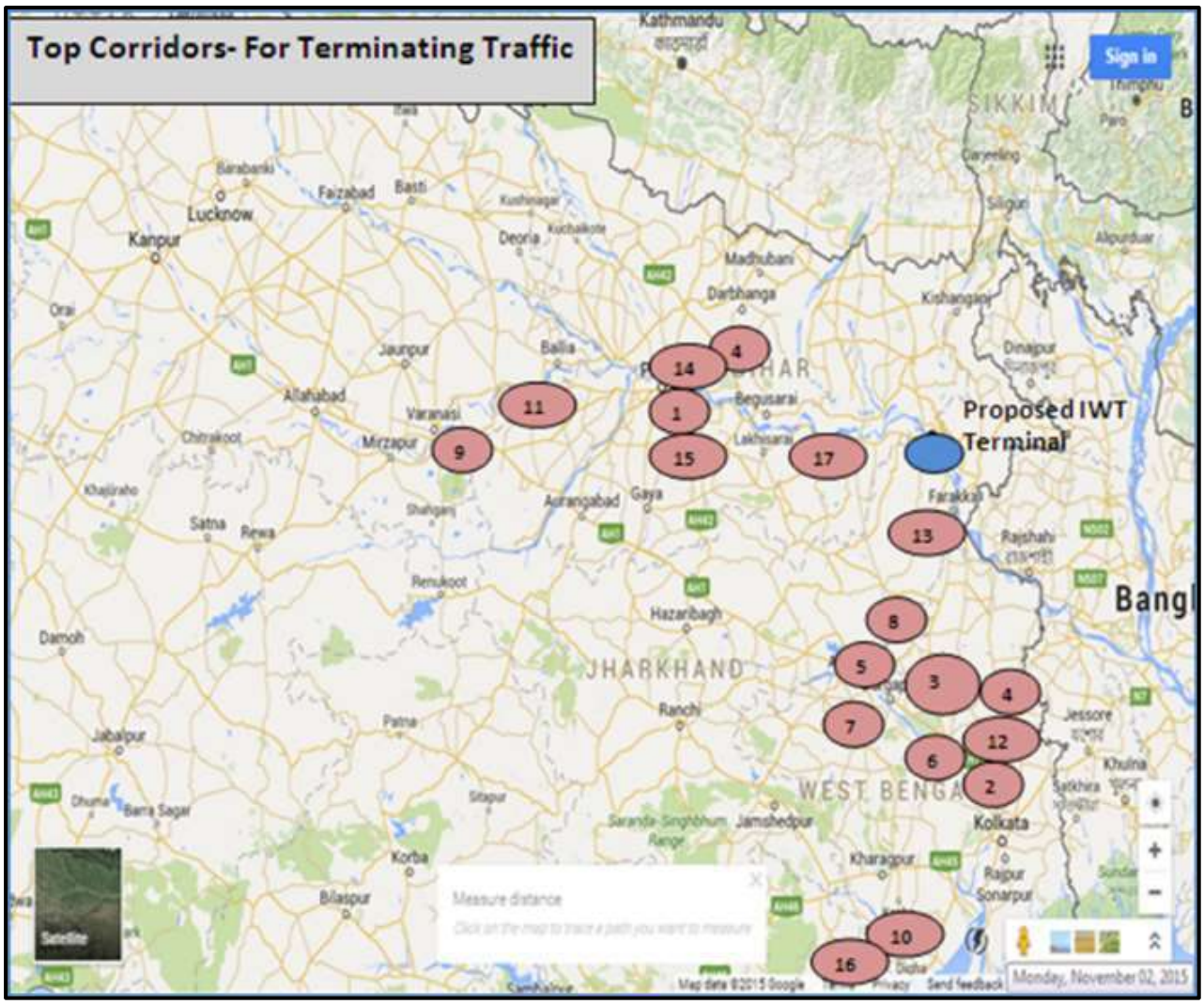
15
4
13
18
19
5
7
8
16
10
3
11
17
6
1
14
12
2
9
Kathmandu
Lucknow
Kanpur
Faizabad
Basti
Deoria
Darbhanga
Madhubani
Jaunpur
Ballia
Patna
Begusarai
Allahabad
Varanasi
Mirzapur
Chitrakoot
Khajuraho
Satna
Rewa
Shahganj
Aurangabad
Gaya
Hazaribagh
Damoh
JHARKHAND
Ranchi
Asansol
Durgapur
Jabalpur
Patna
Dhuma
Bara Sagar
Silapur
Korba
Bilaspur
Jamshedpur
Kharagpur
Kolkata
Raipur
Sonarpur
Jessore
Khulna
Rajshahi
Siliguri
Kishanganj
Dinajpur
Alipurduar
Darjeeling
Sikkim
Sign in
Satellite
Measure distance
Monday, November 02, 2015

Hence, the total base year potential traffic at proposed Sahibganj IWT terminal is worked out to be around **7.22 million tons** annually. The above analysis was done on commodity wise. Consequently, top corridors for originating traffic are presented in Table 3.27 below:

Table 3.27: Base Year Corridor Wise Traffic- Originating

S.No.	From	To	Annual Quantity (T)	Distance		
				IWT	IR	Road
1	Sahibganj	Bahrampur/ Murshidabad	1363152	169	472	177
2	Sahibganj	Hoogly	1165000	345	306	364
3	Sahibganj	Mirzapur	667824	660	575	697
4	Sahibganj	Samstipur	506740	250	270	284
5	Sahibganj	Patna	385624	300	303	332
6	Sahibganj	Ingraj Bazar/ Maldah	351621	72	62	83
7	Sahibganj	Munger	258605	155	135	141
8	Sahibganj	Kathiar	216216	90	202	166
9	Sahibganj	Haora	211040	415	332	373
10	Sahibganj	Begusarai	184967	196	234	217
11	Sahibganj	Luckeesarai	179709	190	181	198
12	Sahibganj	Barasat	134990	381	346	428
13	Sahibganj	Khagaria	133915	265	275	177
14	Sahibganj	Barddhaman	132259	280	237	279
15	Sahibganj	Vaishali	121519	275	288	351
16	Sahibganj	Varanasi	116715	580	529	631
17	Sahibganj	Nalanda	86229	260	310	302
18	Sahibganj	Bhojpur	83604	405	352	429
19	Sahibganj	Buxar	81314	471	421	470
20	Sahibganj	Saran	64796	367	366	395
21	Sahibganj	Others	247809	--	--	--
Total (in MT)			**6.69**			


Top Corridors- For Terminating Traffic
Proposed IWT Terminal
Kathmandu
Lucknow
Kanpur
Faizabad
Basti
Deoria
Madhubani
Darbhanga
Jaunpur
Ballia
Allahabad
Varanasi
Mirzapur
Chitrakoot
Khajuraho
Satna
Rewa
Shahganj
Aurangabad
Gaya
Begusarai
Lakhisarai
Farakka
Rajshahi
Renukoot
Hazaribagh
Damoh
JHARKHAND
Ranchi
Patna
Jabalpur
Sitapur
Jamshedpur
Kharagpur
Kolkata
Jessore
Khulna
Korba
Bilaspur
Raipur
Sonarpur
Siliguri
Darjeeling
Kishanganj
Dinajpur
Measure distance
Monday, November 02, 2015
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Similarly, base year consolidated corridor wise commodity flow (terminating) are tabulate in Table 3.28 below:

Table 3.28: Base Year Corridor Wise Commodity Traffic Flow- Terminating

S. No.	Origin	Destination	Base Year Potential Traffic (T) 2014-15	Distance		
				IWT	IR	Road
1	Patna	Sahibganj	99988	300	303	332
2	Kolkata	Sahibganj	68315	400	332	357
3	Barddhaman	Sahibganj	59151	280	237	279
4	Krishnanagar	Sahibganj	50897	310	375	273
5	Durgapur	Sahibganj	38280	280	237	279
6	Hoogly	Sahibganj	34848	345	306	364
7	Bankura	Sahibganj	27704	315	345	293
8	Birbhum	Sahibganj	26704	120	153	185
9	Varanasi	Sahibganj	26400	580	529	631
10	Purbamidinapur	Sahibganj	16936	455	460	475
11	Buxar	Sahibganj	13992	471	421	470
12	Nadia	Sahibganj	13992	220	250	313
13	Ingraj Bazar	Sahibganj	13988	72	62	83
14	Samastipur	Sahibganj	13860	250	270	284
15	Hajipur	Sahibganj	8126	300	303	332
16	Paschim Medinipur	Sahibganj	7738	420	439	418
17	Munger	Sahibganj	1257	155	135	141
Total (in MT)			**0.52**			

Even in few corridors, where the distance advantage are not in favour of IWT, the lower transportation cost for IWT transportation, very less distance gap between other modes of transportation makes the IWT more viable then other modes of transport. Based on the above, total base year potential traffic for IWT terminal at Sahibganj is estimated which come to 7.09 Million Tonnes annually as given in Table 3.29 below.

Table 3.29: Base Year Potential Traffic for Proposed Terminal at Sahibganj (in MT)

S.No.	Commodity	Quantity (T)
1	Stone Chips	3.41
2	Coal	3.15
3	Cement	0.15
4	Food Grains	0.14
5	Fertilizer	0.13
6	Sugar	0.11
Total (in MT)		**7.09**

Based on the primary surveys and research based on the secondary data collected from the various governmental and private agencies, consultants came to the conclusion that there are substantial amount of cargo moving on various corridors from/to Sahibganj that can be handled by IWT mode.

Taking into account the Sahibganj terminal being a new startup facility in the region, operating policy of carriers and associated agencies, handling last mile connectivity, development of navigation facility in entire stretch of National Waterway 1 in the coming years, continued thrust of government towards developing waterways in coming years and other factors, it is assumed 25% of potential traffic tabulated above for base year is likely to get handled at proposed IWT terminal at Sahibganj which is presented in Table 3.30 below.

Table 3.30: Base Year Traffic Likely to Handle at Proposed IWT Terminal at Sahibganj (in MT)

S.No.	Commodity	Quantity (T)
1	Stone Chips	0.85
2	Coal	0.79
3	Cement	0.04
4	Food Grains	0.03
5	Fertilizer	0.03
6	Sugar	0.03
Total (in MT)		**1.77**

There are a number of factors affecting diversion level of various goods between different pairs of regions. In the current exercise, following factors have been considered while assigning diversion of base year traffic to proposed IWT services. Factors Affecting Level of Diversion:

- Type and volume of commodity (Bulk/Break Bulk/Container/Perishable)
- Long Term & firm commitment of traffic
- Actual place of origin / destination within the region
- Distance from/upto the proposed / identified IWT terminal at either end
- Comparative inter modal distance
- IWT trip (O-D) distance (for deployment of IWT services)
- Backward / foreword Rail & Road connectivity

RO-RO Service

During field visits, it was found that the RO-RO services are already being operated from the place known as Dighighat (Sahibganj ghat) in Sahibganj near Samda village. The RO-RO services are used to reach the other side of the river at the place called as Manihari ghat in the Katihar district. Nearly all types of vehicles like trucks, cars, motorcycles etc are using this service to cross the river to reach Kathiar which otherwise is very far off due to the absence of any bridge nearby. It was found that the truck of 3 axles is charged around Rs 2500 per trip (one way) and car is charged Rs 200 per trip (one way). A large number of loaded trucks mostly with stone chips are ferrying from Sahibganj to Manihari ghat. While returing from Manihari ghat the trucks mostly returns empty. One vessel carries approx 7-8 truck in one trip. The ferry is conducting approx 6 trip per day. The majority of the commodity carried is stone chips by the trucks using the RO-RO services. However, other commodities are also being carried by the RO-RO services.

Considering the huge cost associated with the establishment and development of Greenfield RO-RO services and its related infrastructure at new place, it is decided that the existing RO-RO facility at Sahibganj ghat can be further developed instead of the creation of entirely new facility at the proposed IWT terminal at Sahibganj. Moreover, the district as well as the entire region is well served by the excellent web of roads which also involves roads running parallel to the NW-1, negating any distance advantages in the favor of IWT mode for RO-RO services. The existing ferry services/RO-RO services can be further developed on a large scale under PPP mode. Therefore, provision of RO-RO/passenger services at the proposed Sahibganj terminal may not be considered as of now.

3.4.12 Forecasting

Forecasting of the above estimated potential traffic for IWT terminal at Sahibganj (base year) has been done by employing the GDP forecasted by Organisation for Economic Co-operation and Development (OECD) for India for next 50 years. It is an international economic organisation of 34 countries. The organisation is promoting policies that shall improve the economic and social well-being of people around the world. It intends to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability and to contribute to sound economic expansion in member as well as non-member countries in the process of economic development. India is associated with the organisation as one of the Enhanced

engagement countries. Table 3.31 shows the GDP growth rate as forecasted by OECD for next 34 years for India which formed the basis for forecasting potential traffic at proposed terminal at Sahibganj:

Table 3.31: GDP Forecast for India- By OECD

Year	GDP Forecast	Year	GDP Forecast	Year	GDP Forecast
2015	5.87%	2026	5.85%	2037	4.97%
2016	6.07%	2027	5.82%	2038	4.87%
2017	5.96%	2028	5.77%	2039	4.77%
2018	5.89%	2029	5.71%	2040	4.67%
2019	5.87%	2030	5.64%	2041	4.58%
2020	5.87%	2031	5.56%	2042	4.49%
2021	5.88%	2032	5.48%	2043	4.41%
2022	5.90%	2033	5.38%	2044	4.33%
2023	5.90%	2034	5.29%	2045	4.25%
2024	5.89%	2035	5.18%	2046	4.18%
2025	5.88%	2036	5.08%	2047	4.11%
Source: OECD				2048	4.04%

Consequently, the potential traffic projection for proposed IWT terminal at Sahibganj is presented in Table 3.32 below:

Table 3.32: Potential Traffic Projections for proposed Terminal at Sahibganj (in MT)

S.No.	Commodity	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Stone Chips	3.41	4.55	6.06	8.03	10.48	13.36	16.64
2	Coal	3.15	4.20	5.59	7.42	9.68	12.34	15.37
3	Cement	0.15	0.20	0.27	0.35	0.46	0.59	0.73
4	Food Grains	0.14	0.19	0.25	0.33	0.43	0.55	0.68
5	Fertilizer	0.13	0.17	0.23	0.31	0.40	0.51	0.63
6	Sugar	0.11	0.15	0.20	0.26	0.34	0.43	0.54
Total (in MT)		**7.09**	**9.46**	**12.59**	**16.69**	**21.79**	**27.77**	**34.60**

With assumption of 25% of potential traffic for base year that is likely to get handled at proposed IWT terminal at Sahibganj as discussed above, it is further assumed that the traffic shall grow to 2.5 % for every ten years starting from base year i.e. 2014-2015 to 2044-45 as NW 1 gains recognition and grows as potential mode of transport in due course of time. Consequently, the traffic likely to be handled at proposed IWT terminal at Sahibganj is projected and presented in the Table 3.33 below:

Table 3.33: Traffic Projection Likely to be Handled at Sahibganj IWT Terminal (in MT)

S. No.	Commodity Name	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Stone Chips	0.85	1.19	1.67	2.29	3.14	4.12	5.41
2	Coal	0.79	1.10	1.54	2.11	2.90	3.81	5.00
3	Cement	0.04	0.05	0.07	0.10	0.14	0.18	0.24
4	Food Grains	0.03	0.05	0.07	0.09	0.13	0.17	0.22
5	Fertilizer	0.03	0.04	0.06	0.09	0.12	0.16	0.21
6	Sugar	0.03	0.04	0.05	0.07	0.10	0.13	0.17
Total (in MT)		**1.77**	**2.48**	**3.46**	**4.76**	**6.54**	**8.57**	**11.25**

While estimating the traffic for proposed services and subsequent forecasting for the same, consultants applied some of the assumptions which are needed to achieve the desired goal. Underlying Assumptions for the Study:

- IWAI would maintain fairways, navigation channel/depths and navigational aids for smooth and effective movement of goods.
- IWAI would maintain a constant water draft of 2.5 to 3 meters on the waterway stretch upto Varanasi to operate vessel size of 1200 to 2500 DWT.
- All IWT terminals are connected to the national road network and major terminal are connected by both road and rail.
- No procedural delays towards obtaining approvals and clearances from various government authorities have been considered.
- IWT would offer cost effective transport services, in comparison to other modes.
- If economical, potential agencies would utilize IWT corridors.

3.5 Conclusion and Recommendations

3.5.1 Conclusions

Owing to the inherent advantages IWT offers as a preferred mode of transport, the study was done on the entire stretch of NW-1 to estimate the cargo potential that can be handled at proposed terminal at Sahibganj. The focus of the study was to estimate the

likely potential of coal that can be handled at the proposed IWT terminal at Sahibganj to various existing and proposed thermal power plants along the NW-1. Another major commodity targeted in the study is stone chips as the entire area is known for its stone chips mining industries. Additionally, other commodities were also estimated that are likely to be handled at proposed IWT terminal at Sahibganj. The methodology adopted included detailed study of all thermal power plants (existing and proposed) for their coal requirement, respective coal linkages, distance analysis, primary survey approach (for stone chips and other commodities) etc. Based on the cargo potential for base year, the future potential traffic and the traffic that is likely to be handled at IWT Sahibganj for time frame of 2019-20, 2024-25, 2029-30 till 2044-45 are forecasted and is shown in following Table 3.34 below:

Table 3.34: Annual Traffic Forecasting for 30 Years for Sahibganj IWT Terminal (in MT)

S. No.	Commodity Name	Base Year 2014-15	2019-20	2024-25	2029-30	2034-35	2039-40	2044-45
1	Total Potential Traffic for IWT Sahibganj	7.09	9.46	12.59	16.69	21.79	27.77	34.60
2	Total Traffic Likely to be Handled at IWT Sahibganj	1.77	2.48	3.46	4.76	6.54	8.57	11.25

3.5.2 Recommendation

- Based on estimated traffic likely to get handled at the proposed terminal at Sahibganj, it is recommended to establish a comprehensive IWT terminal with all necessary cargo handling facilities.
- Suitable strategies should be formulated to attract perspective users to shift their cargo movement though IWT mode.
- To promote IWT services and to attract shippers & investors, incentives should be offered.
- Phase wise development plan should be initiated.
- Land acquisition process should be initiated immediately.
- Land acquisition should be done based on the cargo traffic projections likely to be handled in the horizon year (30th Year) of project analysis.
- Provisions should be made to connect the terminal with national highways and IR network.
- Process for mandatory clearances should be started.

If IWT terminal or vessels operations to be developed by Public Private Partnership (PPP) mode, search for operator should be initiated.

4.0 DESIGN VESSEL SIZES

The size of vessels that would call at any terminal will generally be governed by the following aspects:

- The trading route
- Availability of a suitable vessel in the market
- Available facilities mainly navigational channel and manoeuvring areas including the draft
- The available facilities for loading & unloading
- Volume of annual traffic to be handled and the likely parcel size as per the requirements of the user agency.

The following main cargo commodities for proposed terminal at Sahibganj have been identified:

- Coal
- Stone chips
- Other Cargo such as Food Grains, Cement, Fertilizer and Sugar.

The size of vessels calling at the proposed IWT terminal at Sahibganj is restricted by the availability of draft in the navigation channel of National Waterway-1. Due to backwater effect of Farakka barrage and relatively high discharge in the river, the Farakka–Sahibganj stretch has a natural least available depth (LAD) of 2.2 m to 2.5 m and it is assured that LAD of 3.0 m shall be maintained by IWAI for movement of vessels.

Based on the LAD of 3.0 m in the navigational channel, the vessels that can carry the above mentioned commodities through inland waterway route are presented in Table 4.1 below:

Table 4.1: Vessels that can ply through Inland Waterway Route with LAD of 3.0 m

Tonnage (T)	Length (m)	Beam (m)	Draft (m)
Self-Propelled Motor Vessels			
650-1000	60-80	8.20	2.20
1000-1500	80-85	9.50	2.20
1500-3000	85-95	15.00	2.50

The design vessel is maximum size of vessel that would be handled at the IWT terminal and principal dimension of the design vessel considered for the preparation of the terminal layouts and design of marine structures are presented in Table 4.2 below:

Table 4.2: Parameters of Design Vessel Size

Design Vessel Size (DWT)	Overall Length (m)	Beam (m)	Loaded Draft (m)
3,000	**95**	**15**	**2.50**

5.0 TERMINAL FACILITY REQUIREMENTS

5.1 Introduction

Based on the future traffic likely to be handled at IWT Sahibganj as projected in the Section-3, the terminal for Sahibganj is proposed to be developed in three phases, starting with Phase-1 , Phase-2 and extending to Phase-3. The terminal capacity in each phase shall be designed to cater the traffic of subsequent years till commencement of the next phase and provided in Table 5.1 below:

Table 5.1: Phasing and Capacity of Terminal based on Traffic Projection

S. No.	Cargo	Import (I)/ Export (E)	Phase-1	Phase-2	Phase-3
			Phase Commencement year		
			2019-20	2024-25	2032-33
1.	Coal	E	1.35	2.40	4.80
2.	Stone Chips	E	1.46	2.68	3.95
3.	Other Cargo	I/E	0.22	0.40	0.75
	Total Capacity (MTPA)		**3.03**	**5.48**	**9.50**

The layout of the terminal in different phases should be based on the facility requirements in terms of number and length of berths, navigational requirements, material handling equipment, storage area required for each type of cargo, road and rail access for the receipt and evacuation of cargo, and other utilities and service facilities. This section deals with assessment of the terminal facilities in all the phases for the projected traffic at Sahibganj.

5.2 Berth Requirements

5.2.1 General

The required number of berths depends mainly on the cargo volumes and the handling rates. While various general cargoes can be handled at the same (multi-purpose) berth, major quantities of bulk cargoes would require dedicated facilities. Other factors that influence the number of berths are:

- Number of operational days per year
- Allowable berth occupancy
- Number of working hours per day
- Vessel sizes and parcel sizes
- Time required for peripheral activities

The commodity wise traffic forecasts and the sizes of vessels have been discussed in the earlier sections. The cargo handling arrangements (and rates) and other factors are discussed below.

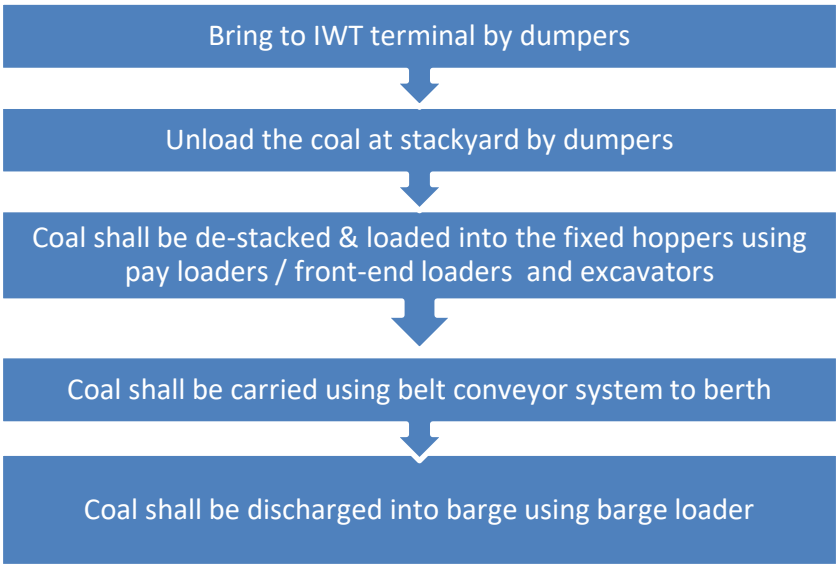
5.2.2 Cargo Handling Arrangements

For estimating the required number of berths, the handling arrangements assumed for various commodities in different phases of the terminal at Sahibganj are described below:

5.2.3 Coal

Phase-1

As the coal to be exported through the terminal is 1.35 million tonne, the coal would be handled using dumpers, pay loaders, excavators, belt conveyor with fixed hopper and barge loader to cater the said coal throughput. The flow chart for handling coal at the terminal is given below:

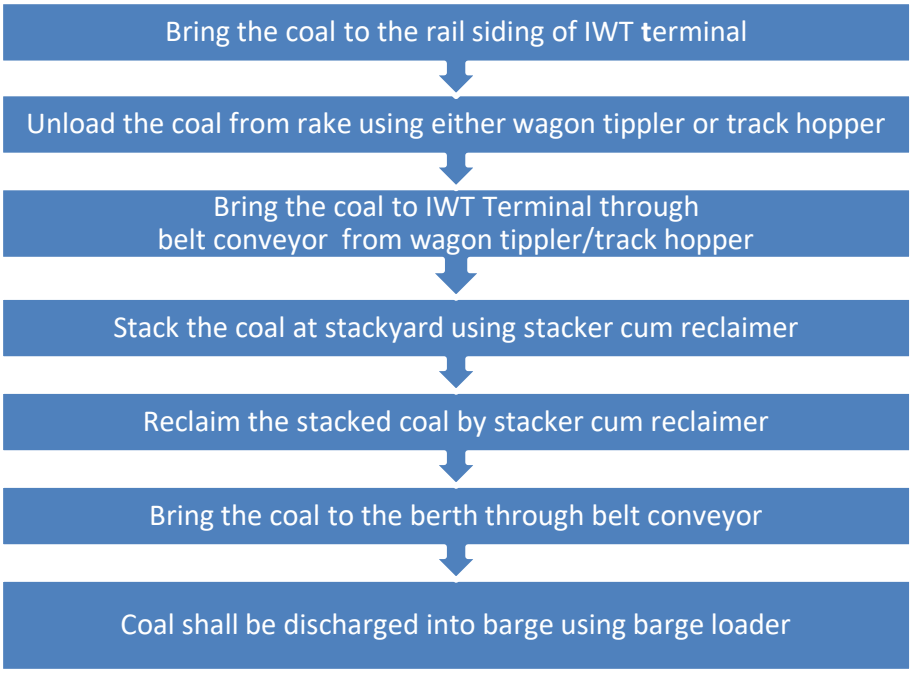


To achieve handling of the projected cargo as per Table-5.2, additional equipments as given below shall be considered by the operator.

- Pay loader : 2 No.
- Excavator (3.5 cum capacity) : 6 No.

Phase-2 and Phase-3

The coal to be exported through the terminal is of the order 2.4 to 4.8 million tonne in phase-2 and phase-3 and it is therefore proposed to provide mechanised coal handling system to cater the said coal throughput. The flow chart for handling coal at the terminal is given below:

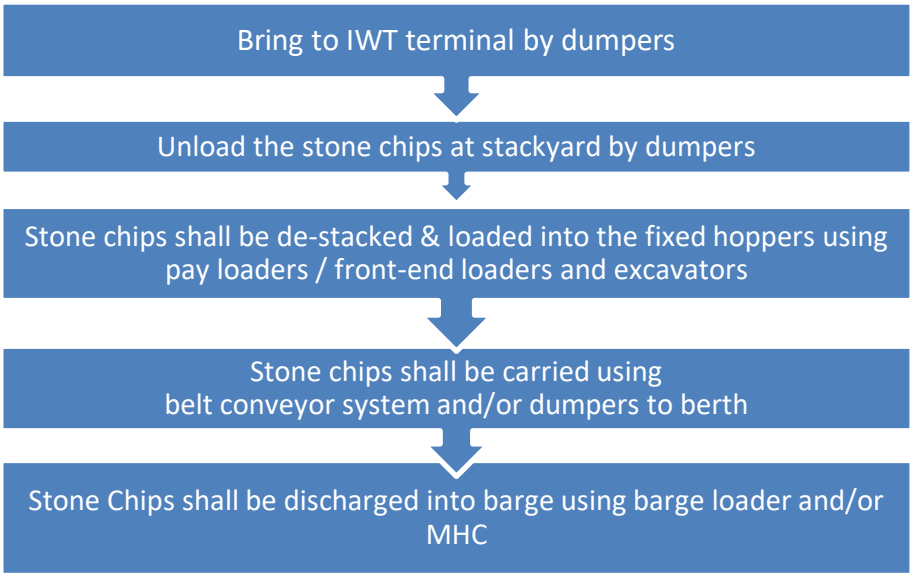


With the above proposed fully mechanised handling arrangement, coal can be handled with handling rate of 1000 TPH in phase-2 and phase-3.

5.2.4 Stone Chips

Phase-1

The stone chips would be handled at the terminal using dumpers, pay loaders, excavators, belt conveyor with fixed hopper and barge loader as the stone chips to be exported through the terminal is 1.46 million tonne. The flow chart for handling stone chips at terminal is given below:



To achieve handling of the projected cargo as per Table-5.2, additional equipments as given below shall be considered by the operator.

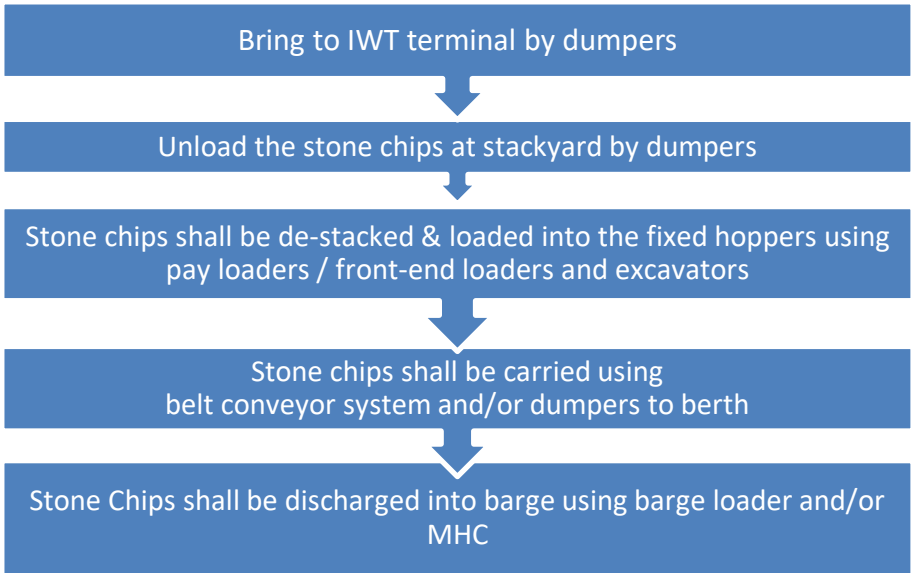
- Pay loader : 2 No.
- Excavator (3.5 cum capacity) : 6 No.

Phase 2

Due to substantial R&R and land acquisition issues,the Electrical substation and Control area containing switch yard and control room are already built for Phase-1 of the terminal, in the area where coal yard conveyors and coal stockpiles were envisaged for phase-2 in the earlier DPR. It is therefore proposed to provide fixed hoppers with belt conveyor in the area below stockyard area of Phase-1 of the terminal. The stone chips to be exported in Phase-2 shall be stacked in the stockyard area of Phase-1 of the terminal and in the newly proposed stockyard area below the stockyard area of Phase-1 of terminal.

The stone chips shall be handled using dumpers, pay loaders, excavators, belt conveyor with fixed hopper and barge loader in both stockyards as discussed above.

The flow chart for handling stone chips at terminal is given below:

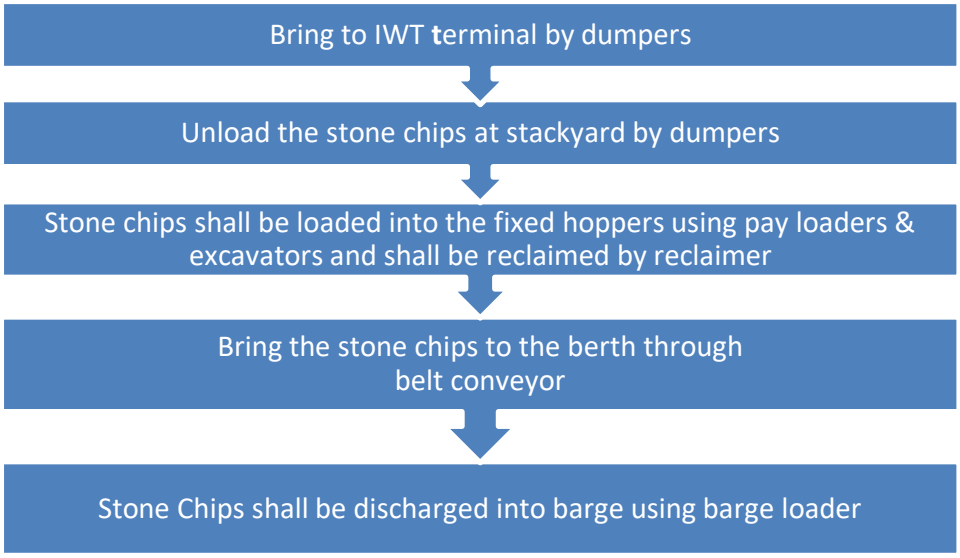


To achieve handling of the projected cargo as per Table-5.2, the equipments for newly proposed stockyard below stockyard area of Phase-1 of the terminal, are proposed as given below.

- Pay loader : 8 No.
- Excavator (3.5 cum capacity) : 4 No.

Phase-3

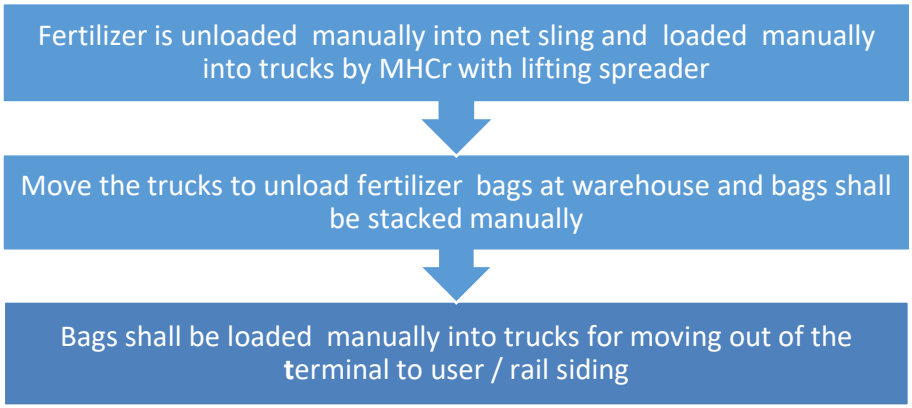
The stockyard area which has been provided with fixed hoppers along with belt conveyor in Phase-1 of the terminal shall be modified with mechanised conveyor system equipped with reclaimer. The stockyard area of Phase-2 below stockyard area of Phase-1 which has been provided with fixed hopper and belt conveyor system shall continue in Phase-3 . The flow chart for handling stone chips at the terminal is given below:



With the above proposed handling arrangement, stone chips can be handled with a handling rate as per Table-5.2.

5.2.5 Fertilizer- Import

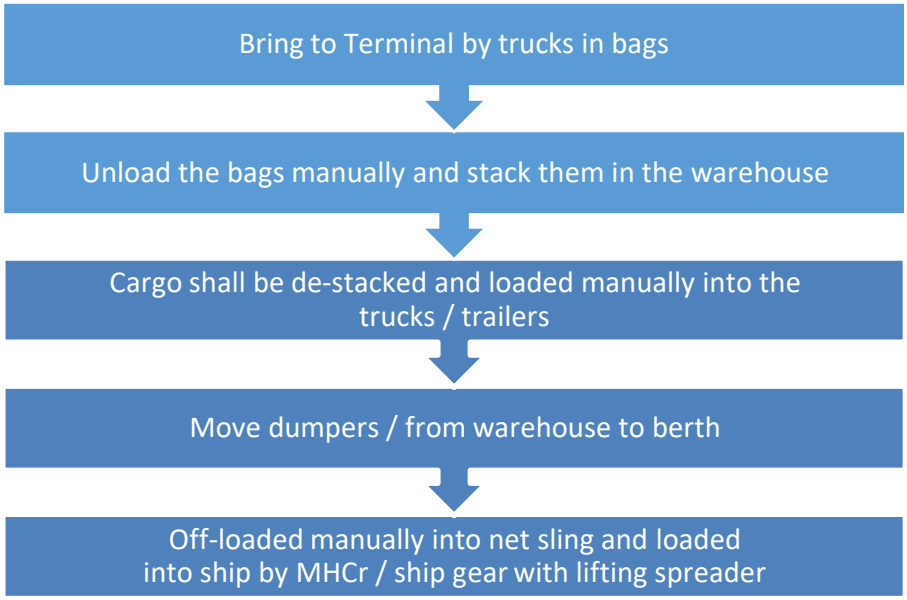
Fertilizers are required to be stored in covered storage because of being highly hygroscopic i.e. it absorbs moisture from the surrounding air. The proposed flow diagram for handling Fertilizer and FRM at the terminal is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.6 Food Grains Cargo (Wheat, Maize) – Export

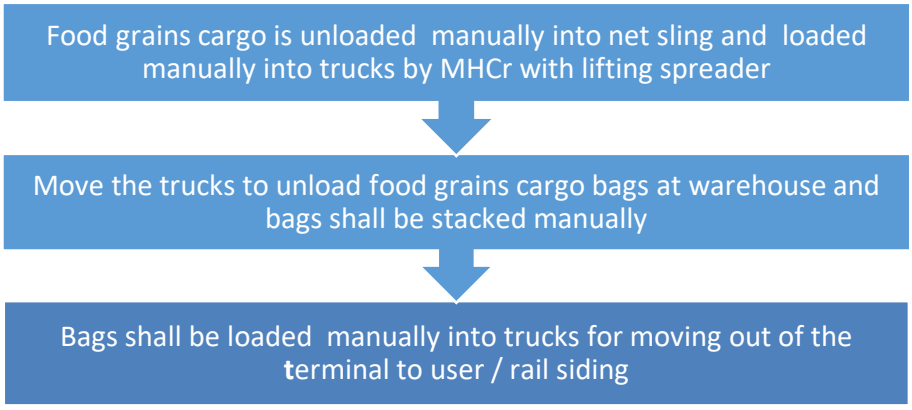
These cargos shall be exported through the terminal. Being edible in nature and to protect from rain and dust, these cargoes require covered storage. The flow chart for handling bagged cargo at terminal in all the phases, is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.7 Food Grains Cargo (Wheat, Maize) – Import

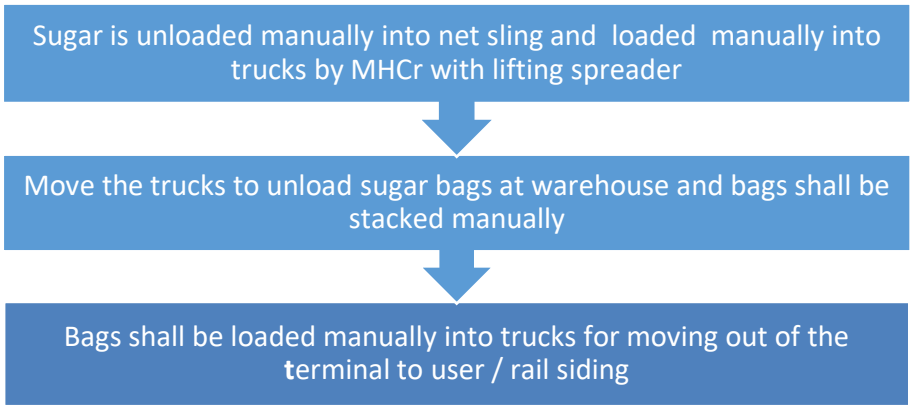
These cargos shall be imported through the terminal. Being edible in nature and to protect from rain and dust, these cargoes require covered storage. The flow chart for handling bagged cargo at terminal in all the Phases, is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.8 Sugar- Import

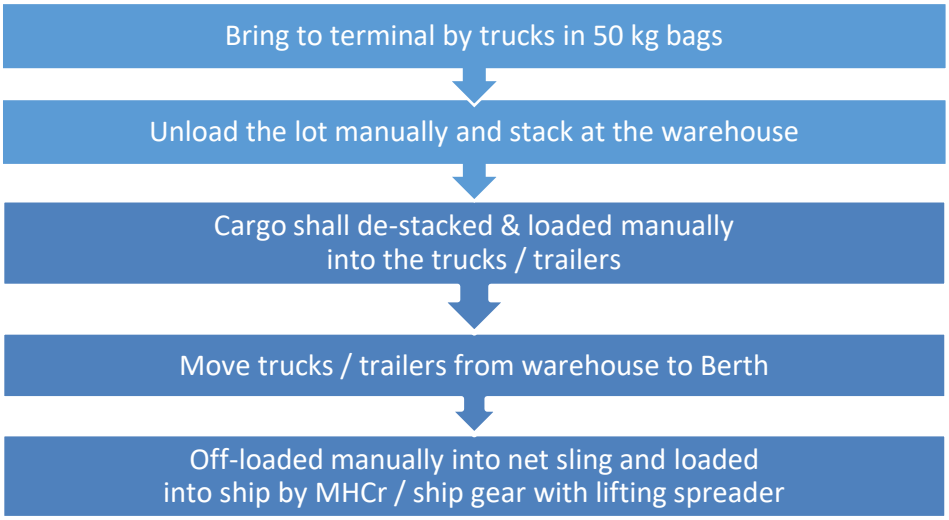
Raw Sugar shall also be imported through the terminal. The flow chart for the same is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.9 Cement - Export

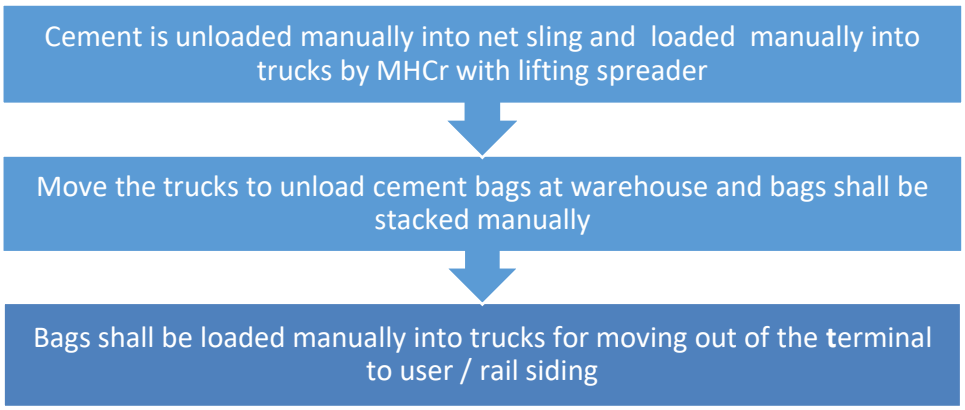
Cement is exported through the terminal. The flow chart for handling cement at terminal is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.10 Cement - Import

Cement is imported through the terminal. The flow chart for handling cement at terminal is given below:



It is expected that with the above handling arrangement, a handling rate as per table-5.2 can be achieved.

5.2.11 Cargo Handling Rates

Based on the above cargo handling arrangements for various commodities, the cargo handling rates assumed in different phases are presented in Table 5.2 below:

Table 5.2: Cargo Handling Rates in different Phases of Terminal

S. No.	Cargo	Handling Rate (TPH)		
		Phase-1	Phase-2	Phase-3
1.	Coal	1000	1,000	1,000
2.	Stone Chips	1000	500	1,000/500
3.	Food Grains	225	225	225
4.	Cement	225	225	225
5.	Fertilizer	225	225	225
6.	Sugar	225	225	225

5.2.12 Operational Time

It is assumed that Sahibganj Terminal will work seven days a week, which brings the effective number of working days to 315 days per year, allowing for 50 non-operational days during flood season and dry season and other reasons.

Further, it is assumed that the terminal will operate round the clock i.e. three shifts of eight hours each. This results in an effective working of 20 hours a day.

5.2.13 Time Required for Peripheral Activities

Apart from the time involved in loading / unloading of cargo, additional time is required for peripheral activities such as berthing and de-berthing of the vessels, positioning and hook up of equipment, etc. For such small vessels, these activities are assumed to take, on an average, 1.5 hours per vessel call.

5.2.14 Allowable Levels of Berth Occupancy

Berth occupancy is expressed as the ratio of the total number of days per year that a berth is occupied by a vessel (including the time spent in peripheral activities) to the number of terminal operational days in a year. High levels of berth occupancy will result in bunching of vessels resulting in undesirable pre-berthing detention. For limited number of berths and with random arrival of vessels, the berth occupancy levels have to be kept optimized to reduce this detention.

The recommended berth occupancy for Sahibganj terminal is considered as 70% for planning the optimal number of berths.

5.2.15 Berth Requirements

Based on the considerations discussed above, the requirements of cargo handling berths for Sahibganj Terminal in Phase-1, Phase-2 and Phase-3 have been calculated as shown in Table 5.3, Table 5.4 and Table 5.5 respectively, which also provides other parameters like cargo handling rates, parcel sizes, berth occupancy, vessel call etc.

Table 5.3: Details of Cargo Handling Berths in Phase-1

CARGO	UOM	VALUE		
Export/Import		Export		Export/Import
Coal	MMTPA	1.35		
Stone Chips	MMTPA	1.05	0.41	
Other/Bags				0.22
Total Cargo/category	MMTPA	**2.40**	**0.41**	**0.22**
Total Cargo/Annum	MMTPA	**3.03**		
Average Parcel Size	T	1500	1500	1000
Vessel Call per Annum	Nos.	1600	273	220
Loading Rate (Rated)	TPH	1000	150	225
Loading Time	Hrs./Vessel	1.50	10.00	4.44
Peripheral Time	Hrs./Vessel	1.50	1.50	1.50
Total Time per Vessel	Hrs/Vessel	3.00	11.50	5.94
Required Days	Days/Annum	220	153.8	62.6
Total Working Days Allowed	Days/Annum	315		
Berth Occupancy		69.8%	68.7%	
Allowed Berth Occupancy	%	70%	70%	
Days as per allowed Berth occupancy	Days/Annum	220.5	220.5	
Calculated Berths	Nos.	0.998	0.697	0.284
Berth Provided	Nos.	1	1	
Equipment Provided	Nos.	1	1	

Table 5.4: Details of Cargo Handling Berths in Phase-2

CARGO	UOM	VALUE			
Export/Import		**Export**			**Export/Import**
Coal	MMTPA	2.4			
Stone Chips	MMTPA		2.40	0.28	
Other/Bags					0.4
Total Cargo/category	MMTPA	**2.40**	**2.40**	**0.28**	**0.40**
Total Cargo/Annum	MMTPA	**5.48**			
Average Parcel Size	T	1500	1500	1500	1000
Vessel Call per Annum	Nos.	1600	1600	187	400
Loading Rate (Rated)	TPH	1000	1000	150	225
Loading Time	Hrs./Vessel	1.50	1.50	10.00	4.44
Peripheral Time	Hrs./Vessel	1.50	1.50	1.50	1.50
Total Time per Vessel	Hrs/Vessel	3.00	3.00	11.50	5.94
Required Days	Days/Annum	220	220	105	114
Total Working Days Allowed	Days/Annum	315	315	315	
Berth Occupancy	%	69.8%	69.8%	69.5%	
Allowed Berth Occupancy	%	70%	70%	70%	
Days as per allowed Berth occupancy	Days/Annum	220.5	220.5	220.5	
Calculated Berths	Nos.	1.00	1.00	0.48	0.52
Berth Provided	Nos.	1	1	1	
Equipment Provided	Nos.	1	1	1	

Table 5.5: Details of Cargo Handling Berths in Phase-3

CARGO	UOM	VALUE				
Export/Import		Export				Export/Import
Coal	MMTPA	2.4	2.4			
Stone Chips	MMTPA			1.55	2.40	
Other/Bags						0.75
Total Cargo/category	MMTPA	**2.40**	**2.40**	**1.55**	**2.40**	**0.75**
Total Cargo/Annum	MMTPA	**9.50**				
Average Parcel Size	T	1500	1500	1500	1500	1000
Vessel Call per Annum	Nos.	1600	1600	1033	1600	750
Loading Rate (Rated)	TPH	1000	1000	500	1000	225
Loading Time	Hrs./Vessel	1.50	1.50	3.00	1.50	4.44
Peripheral Time	Hrs./Vessel	1.50	1.50	1.50	1.50	1.50
Total Time per Vessel	Hrs/Vessel	3.00	3.00	4.50	3.00	5.94
Required Days	Days/Annum	220	220	220	220	214
Total Working Days Allowed	Days/Annum	315	315	315	315	315
Berth Occupancy	%	70%	70%	69.7%	69.8%	68%
Allowed Berth Occupancy	%	70%	70%	70%	70%	70%
Days as per allowed Berth occupancy	Days/Annum	220.5	220.5	220.5	220.5	220.5
Calculated Berths	Nos.	1.00	1.00	1.00	1.00	0.97
Berth Provided	Nos.	1	1	1	1	1
Equipment Provided	Nos.	1	1	1	1	1

5.2.16 Length of the Berths

Based on the design vessel size, the length of berths considered for the development of terminal layouts in different phases is presented in Table 5.6 below:

Table 5.6: Berth Length in Different Phases of Terminal

Berth Type	Berth Length (m)		
	Phase-1	Phase-2	Phase-3
Coal	270*	130	270
Stone Chips		140	270
Other Cargo		130**	130

* Phase-1 shall have common berth for Coal, Stone Chips and Other Cargo

** Phase-2: Other cargo & Stone chips shall be handled on existing berth of phase-1 using Mobile Harbor Crane (MHC).

5.3 Storage Requirements

As per the international practice, the storage capacity at terminal for a particular commodity should at least cater to the higher of the following:

- Upto 5% of the annual cargo throughput; or
- 1.5 times the maximum parcel size.

Other factors to be taken into account in determining the size of the terminal storage areas are stacked densities, angle of repose, average stacking height, etc.

The norms adopted for calculating the storage areas in Sahibganj terminal for various commodities are given in Table 5.7:

Table 5.7: Norms Adopted for Calculating Storage Area at IWT Sahibganj Terminal

S. No.	Commodity	Maximum Parcel Size (T)	Criteria for providing storage area		
			% of Annual Throughput considered	Material Stacking Density T/m3	Angle of repose (degrees)
1.	Coal	3000	Upto 5%	0.8	37
2.	Stone chips	3000	Upto 5%	1.4	37
3.	Food Grains	1500	Upto 5%	-	-
4.	Cement	1500	Upto 5%	-	-
5.	Fertilizer	1500	Upto 5%	-	-
6.	Sugar	1500	Upto 5%	-	-

Based on the above criteria, the storage area worked out in different phases for the Sahibganj terminal as given in Table 5.8 below:

Table 5.8: Storage Area Requirement in different Phases for Sahibganj Terminal

S. No.	Commodity	Storage Area (in m^2)		
		Phase-1	Phase-2	Phase-3
Open Storage Area				
1	Coal	11200	29000	58000
2	Stone Chips	8750	53000	38000
	Sub-total 1+2	**19950**	**38150**	**76300**
Covered Storage Area				
3	Other Cargo	4160	8320	16640
	Sub-total 3	**4160**	**8320**	**16640**

The above storage areas duly account for the circulation space within the storage area for effective stacking/removal of cargo.

5.4 Water and Power Requirements

5.4.1 Water Requirements

Total water demand is broadly classified in the following categories:

- Potable water for consumption of terminal personnel.
- Potable water for vessels calling at the terminal.
- Water for dust suppression.
- Water for fire-fighting.
- Other uses like greenery etc.

Based on the requirements of facilities the water demand shall be calculated in all the phases of terminal development. The major water demand is likely to be for the dust suppression system for the coal. Based on the exact water demand suitable size of underground and overhead storage tanks will be provided at appropriate places.

5.4.2 Power Requirements

The power is required at the terminal for the following activities:

- Mechanised cargo handling equipment and other equipment
- Lighting of the terminal area
- Offices and transit sheds
- Miscellaneous

Based on the above requirements the power demand shall be calculated. The power will be drawn at 11 KV brought upto the substation of the terminal and internal electrical distribution system shall be accordingly planned for the required HT and LT supply.

6.0 LAYOUT OF IWT TERMINAL

6.1 Planning Considerations

6.1.1 Seasonal Water Levels

The proposed IWT terminal at Sahibganj is subjected to variation in water level of the order of 10 m. The layout of facilities has to be prepared such that vessels can access the berth at all the water levels round the year.

6.1.2 Topographic Information

Based on the results of topographic survey carried out for the terminal and discussed in Section-2, it is identified that the area is undulating with hillocks and the level varies from 22.0 m to 64.0 m. The onshore facilities have to be planned such that the requirement for borrowed material for reclamation or the disposal of excess material as a result of site grading could be minimised.

6.1.3 Rail Connectivity

The layout shall allow the provision of rail line inside the terminal such that rail connectivity to the nearest rail head can be achieved suitably.

6.1.4 Storage Requirements

As the terminal is required to cater different commodities, the layout shall be planned such that required storage area including storage shed alongwith circulation area is provided for each commodity.

6.1.5 Hydrographic Details

The hydrographic survey carried out for the terminal indicates that shallow depths of the order of 1m to 2.5m are available near the shoreline and deeper depths of the order of 7m to 11m are available at a distance of 50 m away from shoreline. The layout has to be planned such that dredging quantity for achieving the required draft could be minimised.

6.1.6 Provision for Future Expansion

The layout shall be planned such that provision for future expansion can be achieved suitably without acquiring additional land/water front area for such facilities.

6.1.7 Optimal Cost of Overall Development especially the Initial Phase

The water front and onshore facilities while planning the layout should be decided so as to achieve the optimal solution and optimal cost for development of terminal in initial phase and subsequent phases.

6.2 Alternative Terminal Layouts

6.2.1 General

As already discussed in Section-5, the terminal for Sahibganj is proposed to be developed in three phases with capacity as given in Table 6.1 below:

Table 6.1: Phasing and Capacity of Terminal based on Traffic Potential

S. No.	Cargo	Import (I)/ Export (E)	Phase-1	Phase-2	Phase-3
			Phase Commencement year		
			2019-20	2024-25	2032-33
1.	Coal	E	1.35	2.40	4.80
2.	Stone Chips	E	1.46	2.68	3.95
3.	Other Cargo	I/E	0.22	0.40	0.75
	Total Capacity (MTPA)		**3.03**	**5.48**	**9.50**

Alternative terminal layouts for Phase-1 have been prepared for comparison purposes and the recommended layout for Phase-1 would be developed further for other phases in subsequent chapters.

6.2.2 Alternative Layout-1

The layout for this alternative is presented in **Drawing I-521/ST/207.** In this alternative, U type jetty is provided in the river, which is aligned parallel to river bank and connected to bank by approach trestle of length 50 m.

6.2.3 Alternative Layout-2

The layout for this alternative is presented in **Drawing I-521/ST/208.** This alternative is basically similar to alternative-1 but the jetty is proposed at the river bank itself and aligned parallel to the river bank. As the depths near berth-line are shallow, this alternative necessitates the requirement of dredging to achieve the draft of vessels calling at terminal.

6.3 Multi Criteria Analysis of Alternative Terminal Layouts

The above alternative layouts were evaluated using Multi Criteria Analysis. The following criteria are considered for analysis:

- Operational considerations
- Navigational aspects
- Ease of construction and maintenance

- Flexibility for expansion
- Construction cost.
- Mathematical model study

The comparison of these layouts is presented inTable 6.2**.**

Table 6.2: Multi-Criteria Analysis of Alternatives

S.No.	Criteria Description	Alternative-1	Alternative-2
1	Dredging at Jetty	As the berth is located in deep water and connected to shoreline by approach trestle, there is no requirement to carry out the dredging	As the berth is located on river bank itself where shallow water is available, there is requirement to carry out the dredging
2	Dredging in approach channel, turning circle and maneouvering area	As there are some pockets in approach channel, turning circle and manoeuvring area where water available is less than the required draft of design vessel, capital dredging is required to be carried out	Same as Alternative-1 but the capital dredging quantity is worked out to be more in this alternative
3	Scope for Expansion	As sufficient river water front is available, there is enough scope for expansion in Alternative-1	Same as Alternative-1
4	Degree of Operation	As the cargo is proposed to be handled by combination of dumpers, pay loaders, belt conveyors with fixed hopper and barge loaders in Phase-1, the degree of operation is good in this alternative	Same as Alternative-1
5	Ease of Construction	As Alternative-1 involves construction of jetty alongwith 50 m long approach trestle, the construction can be carried out easily by well established methods	As Alternative-2 involves construction of jetty at river bank only, the construction can be done easily in relatively short time as compared to Alternative-1
6	Cost of Construction	The cost of construction for Alternative-1 works out to be marginally higher in comparison to Alternative-2	The cost of construction for Alternative-2 is marginally lower than Alternative-1

The model study shall be carried out by the EPC contractor to check run-up and effect of proposed structure to be erected on stability of bank, if any, during and after construction is completed.

6.4 Recommended Terminal Layouts

Based on multi criteria matrix presented above, both the alternative layouts have certain advantages as well as disadvantages. It could be observed that in terms of available required depth round the year without need of dredging and marginal cost difference between two alternatives, Alternative-I is preferred alternative for development of IWT Terminal at Sahibganj in Jharkhand.

7.0 PHASED DEVELOPMENT PLAN OF IWT TERMINAL

7.1 Detailed Layout

The detailed layout of the terminal in Phase-1 showing berthing area, navigational access and onshore facilities catering to traffic for the year 2023-24 is shown in **Drawing I-521/ST/209.**

The layout of the terminal in Phase-1 is further developed for Phase-2 catering to traffic for the year 2031-32 and shown in **Drawing I-521/ST/210**. This layout includes additional berth, onshore facilities in terms of storage areas including LNG, equipment, rail sidings, etc. IWAI may take up any component of Phase-2 like rail sidings, LNG storage in advance, based on requirement.

For the Phase-3, the detailed layout is further developed to include additional onshore and berthing facilities so as to cater the traffic for the year 2048-49. The detailed layout for Phase-3 is presented in **Drawing I-521/ST/211.**

The extent of different phases of the terminal in a google map are shown in **Drawing I-521/ST/212**.

7.2 Marine Facilities

7.2.1 Water Area & Approach Channel

The water area for development of terminal in Phase-1 comprises of turning circle, approach channel, manoeuvring area and berthing area.

The layout of approach channel is dictated by river bed topography and other local conditions. The approach channel of width 45 m is located in areas of maximum natural depth to reduce cost of dredging.

The turning circle with diameter of 200 m is proposed at two locations, one each at start and end point of manoeuvring area so as to facilitate the safe entry and exit of vessels without hindrance.

For development of Phase-2 and Phase-3 of Terminal, the same considerations for Phase-1 development are followed for providing turning circle, approach channel and manoeuvring area.

7.2.2 Berths

For Phase-1 development of terminal, the number of berths is estimated as one for coal & stone chips and other one for stone chips & other cargo as discussed in Section-5. Two berths for coal, stone chips and other cargo are proposed to be provided in a length of 270 m and connected to shoreline / bankline by approach trestle of 50 m length at its berth ends. Considering the operational requirement & equipment to be accommodated on the berth, the width of the berth is considered as 25 m wide.

As the terminal initiates operation in Phase-1 and the traffic gets build-up, the requirement of berth for Phase-2 to cater traffic for the year 2031-32 is worked out as given in Table 7.1 below:

Table 7.1: Berths Required for Phase-2 of Terminal

S.No.	Commodity	Number of Berths
1.	Coal	1
2.	Stone chips	1
3.	Other cargo + Stone chips	1

The one berth provided for coal & stone chips in Phase-1 would be considered as berth for stone chips in Phase-2. The other berth provided in Phase-1 would be considered as berth for Other cargo & Stone chips in Phase-2. One additional berth for coal shall be provided in a length of 130 m. The width of berth for coal shall be kept as 25 m.

For Phase-3, the berths required to cater traffic for the year 2048-49 is worked out as given in Table 7.2 below:

Table 7.2: Berths Required for Phase-3 of Terminal

S.No.	Commodity	Number of Berths
1.	Coal	2
2.	Stone chips	2
3.	Other cargo	1

In this phase, one additional berth each for coal and stone chips shall be built adjacent to the berths provided in Phase-2. The length of berths for coal and stone chips shall be 140m & 130m respectively. The width of each additional berth shall be 25 m.

7.2.3 Shore Protection

The shore protection works are generally adopted on the river bank against erosive action of river. It is therefore, proposed to provide stone pitching on the slope of river bank for length of 800 m in Phase-1 and for another length of 800 m in Phase-2 of terminal. The typical details for shore protection work is shown in **Drawing I-521/ST/213**. However, the requirement of quantum of shore protection works shall be confirmed by EPC contractor after carrying out model study for the same.

7.3 On-shore Facilities

7.3.1 General

The main consideration in locating the onshore facilities has been to utilise the existing onshore area available to the maximum extent with keeping in view of the logistics of transport of material from berths to shore. The onshore layout of the cargo handling facilities in different phases as presented in **Drawing I-521/ST/214 to I-521/ST/216,**

respectively has been arrived keeping in view of the many engineering considerations discussed in subsequent chapters.

7.3.2 Roads

The external road to the terminal shall follow the road corridor from level crossing at Gate No.54. The entry is at western end of the terminal with a security office at the entrance. Thereafter the internal road shall lead towards the stockyard areas for coal, stone chips and storage shed for other cargoes. In Phase-1, the jetty shall be accessible from storage areas through ramps provided in a slope of 1 in 30. During Phase-2 and Phase-3, the internal road shall be further extended to cater the additional storage areas and the ramp shall be provided for making access to additional berthing facilities that are proposed in these phases. Road shall be extended upto the railway siding from storage area to cater the movement for other cargo.

7.3.3 Storage Areas

Coal Stockyard

In Phase-1, the full length stockyard can be planned along either side of the reclaim conveyor to cater the intended throughput using all the fixed hoppers at all the time. The stockyard is placed behind the jetty and the coal shall be handled using combination of dumpers, payloaders, excavators, belt conveyors with fixed hopper and barge loaders as discussed in Section-5.

In Phase-2, with increase in traffic, the coal stockyard is provided in a group of 8 stock piles, each pile shall cater to individual user as and when required. The coal shall be handled using mechanised coal handling system from rail siding to the berth as discussed in Section-5.

During Phase-3, there are 16 stock piles making coal stockyard to cater traffic generated in this phase. The stockyard is placed behind the jetty and the coal shall be handled using mechanised coal handling system from rail siding to the berth as discussed in Section-5.

Stone Chips

In Phase-1, the full length stockyard can be planned along either side of the reclaim conveyor to cater the intended throughput using all the fixed hoppers at all the time. The stockyard is placed behind the jetty and the stone chips shall be handled using combination of dumpers, payloaders, excavators, belt conveyors with fixed hoppers and barge loaders as discussed in Section-5.

In Phase-2, the stockyard provided for coal and stonechips in Phase-1 shall be used for stacking stonechips only and new stockyard below the stockyard provided in Phase-1 shall be provided for stone chips in a group of 10 stock piles, each pile shall cater to individual user as and when required. The stone chips shall be handled using dumpers, payloaders, excavators, belt conveyors with fixed hoppers and barge loaders as discussed in Section-5.

During Phase-3, the stockyard provided in phase-1 shall be mechanized for stone chips using recliamer and belt conveyor. The stockyard of Phase-2 below stockyard of Phase-1 which has been provided with fixed hopper and belt conveyor system shall continue in Phase-3. The stone chips shall be handled as discussed in Section-5.

7.3.4 Fuel Bunkering

It is proposed to provide an area of 1,000 m^2. for bunkering of fuel so as to meet the fuel requirement of barges calling at the terminal.

7.3.5 Buildings

The buildings catering to cargo operations, users, amenities etc. are placed close to the gate. The following buildings are envisaged in the onshore area of the terminal.

- Terminal Administration Building
- Workers' Amenity Building
- Electrical Sub-station Building
- Security Office
- Weigh Bridge Building

7.3.6 Onshore Utilities

The following utilities shall be provided in the terminal area as per requirements. The details are provided in Section-12:

- Roads
- Drainage
- Sewerage
- Water supply
- Power supply
- Communication system
- Fire fighting
- Dust suppression system

8.0 RAIL AND ROAD CONNECTIVITY FOR TERMINAL

8.1 Introduction

The economic development of the Sahibganj IWT terminal on NW–1 (River Ganges) will very much depend upon transport route connectivity and availability of means of communication. This transport connectivity helps in flow of both inbound and outbound goods.

Road and rail are the main modes of transport, besides the inland waterway. For efficient working of the terminal , it is important that the design of the facilities shall be such that cargo handling and dispersal by all means of transport is done in most cost effective manner without congestion on any front.

The linkage of the road as well as railways should take into account the volume of projected traffic and the nature of commodities with O-D analysis and integrate the same with the proposed cargo handling arrangement of the terminal.

8.2 Rail Connectivity

Sahibganj Railway Station is on the loopline connecting Howrah, which branches off from the main line at Khana junction and rejoins the main line at Kiul junction. It is a BG line and is connected by mail/express trains to Delhi, Howrah and Patna. It is part of Malda Division of Eastern Railway and prominently operates on freight loading of coal.

It is proposed to provide railway connectivity with rail siding inside the terminal in Phase-2 development of terminal. IWAI may take up development of rail sidings in advance, based on requirement.

Based on the topography of the region, presence of existing rail line near the terminal location and site visit, following three options have been analysed for providing rail connectivity to the terminal:

- Option-1: From Sahibganj Station
- Option-2: From Level Crossing Gate No.53 or 54 at Sakrigali Station
- Option-3: From Ch.1053.5 km between Gate No. 54 and Sakrigali Station

Option-1: From Sahibganj Station

In Option-1, the railway track is proposed to take-off near Sahibganj Station, runs adjacent to the existing line and then changes its alignment towards the entrance of the terminal as shown in **Figure 8.1**.

The said option is not found to be feasible as no railway land is available near Sahibganj Station to have extra track and length of track works out to be on higher side.

Figure 8.1: Option-1: Near Sahibganj Station

Option-2: From Level Crossing Gate No.53 or 54 at Sakrigali station

In Options 2, two sub-options as Options 2A & 2B are identified where the proposed railway line shall take-off from Level Crossing Gate No. 53 & 54 towards the entrance of the terminal as shown in **Figure 8.2.**

Figure 8.2: Option-2: From Level Crossing Gate No.53 or 54 at Sakrigali station

Both these sub-options have not been found feasible in view of the high level difference between the track and terminal area exceeding the per missible gradient and curve limits under the Railway rules.

Option-3: From Ch.1053.5 km between Gate No. 54 and Sakrigali Station

In Option-3, the railway track is proposed to take-off from the loop line no. 5 at Ch. 1053.5 km between Gate No. 54 and Sakrigali Railway Station, runs parallel to existing line towards Sahibganj station for about 690 m and then takes a U-turn towards the entrance of the terminal as shown in **Figure 8.3**.

Figure 8.3: Option-3: From Loop Line at Sakrigali Station

The Option-3 is found to be feasible considering the length of track, permissible gradient, degree of curve and cost involved.

Further, during discussions with Railway authorities, it is suggested to provide Y shape conneciton in between Sakrigali and Sahibganj railway station and connected to Sakrigali Railway station as shown in **Figure 8.4**.

Figure 8.4: Y shape Connection with IWT terminal at Sahibganj

The details of proposed rail connectivity are given in Table 8.1 below:

Table 8.1: Details of Proposed Rail Connectivity

Descriptions	Details
Length of Track	3.6 km
ROW	30
Tunnel Length	Nil
Radius of curve	440 m
Gradient	1 in 600

8.3 Junction Arrangement

The proposed rail connectivity shall take off from the existing loop line no. 5 at Chainage 1053.5 km between Gate no. 54 and Sakrigali Railway Station on Sahibganj- Sakrigali section of Malda Division of Eastern Railway as shown in **Figure 8.5**. This alignment further remains straight, without much of level difference.

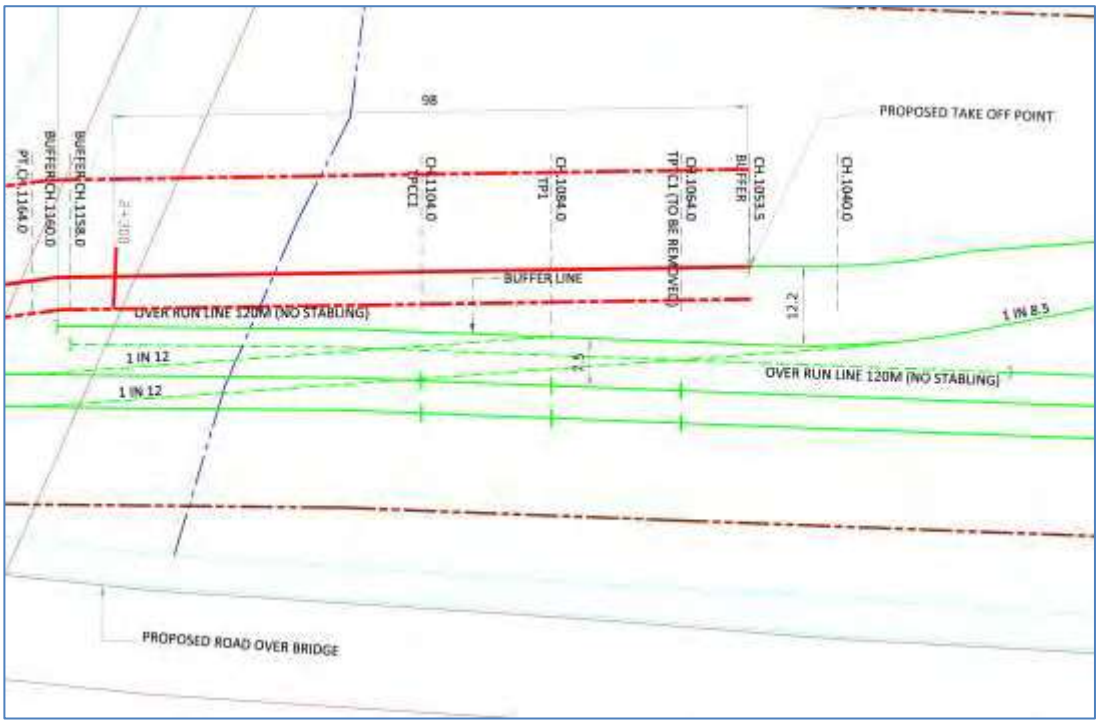


Figure 8.5: Junction Arrangement

8.4 Engineering of Rail Connectivity

Land

The width of the land required for Rail corridor is proposed as 30 meter. The land details including revenue map and ownership are furnished in Section-15.

Gauge

The proposed rail link will be constructed to 1676 mm gauge (BG) at 6.0m track centre from the existing main line.

Track Structure

The track is proposed to be laid on 52 kg rails with PSC sleepers @M+7 sleeper density i.e. 1540 nos. per Km. for main line and for loop line as per policy of Railway. The ballast cushion underneath the sleepers shall be varying from 150 mm to 250 mm.

Typical Cross-Section of Railway Track is shown in **Drawing I-521/ST/217.**

Gradient and Curve

The gradient has been adopted as 1:400 proceeded by level grade for the railway line. The proposed alignment shall have maximum 5 degree of curvature. Fixed structure clearance shall be as per schedule of dimensions for 1676 mm gauge (BG).

Formation

Formation top width in embankment is proposed as 6.85m and in cutting as 6.25m as per RDSO Guidelines.

Formation width in embankment is proposed to be widened to 15m and in cutting as 12m to accommodate 2nd line with side slope of 2:1 for earthwork in embankments and 1:1 for earthwork in cutting. The formation width is based on ballast section having 1.5: 1 side slope as per directives of Railway Board vide revised Schedule of Dimensions, 2004.

Ballast

Provision of 250mm ballast cushion made up of 65mm gauge stone ballast has been made conforming to RDSO Specification for track ballast IRS-GE-1 of 2004. The ballast has been calculated @2 cubic metres per metre of track.

Station

No new railway station is proposed on the project section and existing station shall cater for the rail connectivity to terminal.

Necessary facilities for S&T and Electrical departments shall be incorporated as per their requirements and approval of the railway.

Most of the CSRs of the proposed lines for the loading and unloading facilities in the railway siding at the terminal shall be propose to be 700m or more.

Signalling and Telecommunication

The existing main line is provided with Standard–III Interlocking with Multi Aspect Colour Light (MACL) Signalling. Accordingly same type of signalling and interlocking is proposed in conformity with guidelines issued by Railway Board.

Electrical Works

Electrification shall be as per actual requirement.

Cost of Railway Line

The summary of capital cost estimates for rail connectivity is given in Table 8.2 below:

Table 8.2: Cost Estimate for Rail Connectivity

SL No	Description	Capital Cost (Rupees in Crores)
External Rail Connectivity		
1	Ground Improvement work	26.00
2	Earthwork in Cutting & Embankment	23.50
3	Permanent way work	25.00
4	Workshop, Inspection pit, Foot Over Bridges, Service Building and S&T Buildings	13.00
5	Signalling & Telecommunication work (Supply)	16.50
6	Signalling & Telecommunication work (Execution)	3.00
7	Electrical Works	3.00
8	Miscellaneous works	4.00
	Sub-Total	**114**
Internal Rail Connectivity		
9	Internal Rail Network (for 5150 m length)	34.00
	Grand Total (Rupees in Crores)	**148**

8.5 Railway Layout in the Terminal

Four full length railway tracks are proposed inside the terminal area during Phase-2. The total length of the railway lines is about 5150 m. For mechanical unloading, tipplers have been provided. For shunting, double length track has been provided. The length and number of railway lines in Phase-3 would remain the same.

Extra line has been provided with platform and covered shed for handling perishable and bagged consignments. Engine escape line has also been provided.

The railway layout in the terminal shall be finalised based on DPR prepared by technical consultant for railways and approved by IWAI.

8.6 Road Connectivity

The adequacy of the proposed road linkages is important and connection with National Highway 80 (Mokamma to Farakka) is essential to facilitate smooth two way flow of goods through trucks and dumpers between terminal and hinterland.

National Highway 80 passes via Sahibganj and is parallel to the railway track. The terminal is on the north side, on the other side of the track.

Based on the topography, availability of existing National Highway and site visit, following two options have been analysed for providing road connectivity to the terminal:

- Option-1: Along existing road from Gate No. 54
- Option-2: New road from Gate No. 54

Option-1: Along existing road from Gate No. 54

In Option-1, the road alignment is proposed to take-off from Gate No. 54 along existing road leading to the entrance of the terminal as shown in **Figure 8.6**.

Figure 8.6: Option-1: Along existing road from Gate No. 54

The said option is found to be feasible using existing road and widening the same to four lane road.

The details of proposed road alignment is given Table 8.3 below:

Table 8.3: Details of proposed Road Connectivity

Descriptions	Details
Length of Road	902 m
Number of Lanes	4
ROW	40 m
Gradient	1 in 200

Typical Cross-Section of proposed four lane road is shown in **Drawing I-521/ST/218.**

Option–2: New road from Gate No. 54

In Option-2, the road alignment is proposed to take-off from Gate No. 54 along new road leading to the entrance of the terminal as shown in **Figure 8.7**.

Figure 8.7: Option-2: New Road from Gate No. 54

The length of the said option works out to be more as compared to Option-1 and therefore not recommended.

Cost Estimates for Road Work

The summary of capital cost estimates for widening of existing road is given in Table 8.4 below:

Table 8.4: Cost Estimates for Road Work

Sl. No.	Description	Amount (Rs. in Crores)
1	Earth Work	4.5
2	Granular Sub-base and Base Courses	2.0
3	Bituminous Courses (Flexible Pavement)	5.5
4	Culverts	1.5
5	Drainage and Protection Works	2.0
6	Traffic Signs, Marking and Appurtenances	0.50
	Total	**14.0 Crores**

8.7 Road Over Bridge

The IWT terminal at Sahibganj shall be connected to National Highway 80 through proposed road alignment along existing road, passing through Gate No. 54 where railway level crossing exists as of now.

There shall be substantial movement of dumpers and other vehicles to the terminal location, necessiating the requirement of road over bridge at Gate No. 54 so as to achieve uninterrupted flow of said traffic.

The layout of proposed terminal with rail, road connectivity and road over bridge is shown in **Drawing I-521/ST/219.** The topographic survey details of rail and road connectivity is shown in **Drawing I-521/ST/220.**

Based on the site conditions, Railways & National Highway Authority of India (NHAI) guidelines, the general arrangement and sections of road over bridge are prepared and shown in **Drawing I-521/ST/221 & I-521/ST/222** respectively. The traffic circulation plan for proposed ROB is shown in **Drawing I-521/ST/223.**

The summary of capital cost estimates for road over bridge is given in Table 8.5 below:

Table 8.5: Cost Estimates for Road Over Bridge

Sl. No.	Description	Amount (Rs. in Crores)
1.	Superstructure	15
2.	Substructure	10
3.	Foundation	3
4.	Approach with RE wall	9
5.	Miscellaneous Item	1
	Total	**38 Crores**

8.8 Approval Required for Rail Connectivity & Construction of Road Over Bridge

Firstly a profile sketch of the proposed ROB to be constructed, is to be prepared, and then submitted to the Bridge Branch of Head Quarter of Eastern Railway, Kolkata. This sketch will indicate all the details like width of road over bridge, its location, take off point, approaches, length & height of bridge, gradients, curves & key plan etc.

This profile sketch it to be sent to concerned Railway Division i.e. Malda for checking its feasibility by all the branches of the divisions which in turn shall send it back to H.Q. Office. The General Arrangement Drawing (GAD) is to be prepared after detailed engineering for the ROB and will be submitted to Bridge Branch H.Q. Office. The necessary charges for approval shall be required to be deposited to Railways.

One copy of the profile sketch & the GAD shall be also submitted to NHAI with essential like gradient, curve etc. of approaches of road. After NHAI gives acceptance, the GAD plan be examined by Railway & if all is in order & feasible, it shall accord its approval. State Govt. (PWD) is also involved for ROB connectivity to approach road across the tracks.

The plan for Rail connectivity consists of the location of take-off point from the running line (loop line or level crossing), detailed layout of the railway yard for loading/unloading of cargo, engine escape line, length of each line in the yard & location of signal etc. Proper Engineering Scale Plan (ESP) and Signal Interlocking Plan (SIP) are to be prepared and sent to the Railway Division for examining the scheme by all branches viz. Civil Engineering, Electrical, Mechanical, Signal & Telecommunication & Traffic, and Divisional/Additional Divisional Rail Manager, Malda. After the ESP and SIP are examined & signed by the divisional officers and thereafter submitted to Railway HQ for approval of Heads of all Departments indicate above. On approval of the plans, the work can be executed.

8.9 In-Principle Approval for Rail Connectivity & Construction of Road Over Bridge

Following the methodology discussed in section 8.8 and further communications with NHAI and Railway authorities, the in-principle approval for rail connectivity and road over bridge is obtained and enclosed below.

9.0 ENGINEERING OF CIVIL WORKS

9.1 Berthing Facilities

9.1.1 Deck Elevation

The deck of the jetty should be high enough so that during normal conditions it would be possible to inspect and repair the structural elements like deck and beams at all water levels.

It is therefore proposed to keep the deck elevation at +33.50 m. Considering the depth of main beam as 1.6 m, it still allows a clearance of about 1.0 m from the high flood level to allow inspection or structural repairs.

9.1.2 Design Criteria

Water Levels

The following water levels have been considered at the Site.

- High flood Level : 30.91 m
- Low water Level : 21.06 m

Design Dredged Level

The design vessel and the design dredged level for the structural design of the berths are given in Table 9.1 below:

Table 9.1: Design Vessel Parameters

S.No.	Design Vessel Size (DWT)	Design Vessel Dimensions (m)			Designed Dredged Level at Berth (in m wrt MSL)
		LOA	Beam	Loaded Draft	
1.	3,000	95	15	2.5	18.06

The jetty has been designed for the dredged level of 18.06 m wrt MSL.

9.1.3 Geotechnical Criteria for Design of Berths Piles

The brief description of the existing geotechnical information at site has been provided in Section-2 of this report. Preliminary design of the berths has been carried out based on the subsoil profiles discussed in Section-2.

The following safety factors are used to establish the safe geotechnical working load capacities of the piles given in Table 9.2 below:

Table 9.2: Safety Factors

End Bearing	SF = 2.5
Skin Friction on compression piles	SF = 2.5
Skin Friction on tension piles	SF = 3.0
Lateral Load	SF = 2.0

9.1.4 Loads Considered for Design of Jetty

The major loads considered for the design of the various components of the jetty are:

i. Dead Load
ii. Live Load
iii. Berthing Load
iv. Mooring Load
v. Current Load
vi. Wind Load
vii. Temperature Load
viii. Earthquake Load

Dead Load

The dead load comprising the self-weight of the structure plus superimposed loads of permanent nature are considered as per IS: 875 (Part-I) 1987.

Live Load

The live load to be considered on the deck of jetty includes the following loads

- Uniform distributed Live load of 3. 5 T/m2
- IRC class A/AA /70 R vehicle
- Loads due to mobile crane with a 50 T lifting capacity

Berthing Load

- Berthing Energy

The design vessels are assumed to approach the berths under moderate berthing condition at an angular approach of 10^{o}. Based on this criteria, the berthing velocity perpendicular to the berth has been evaluated to arrive at the design berthing energy for design vessel.

Berthing loads are considered as per IS: 4651 Part III-1989. The Berthing energy is calculated for 3,000 DWT vessel using IS: 4651 as per details in Table 9.3 below:

Table 9.3: Loads Considered for Design of Jetty

Dead Weight Tonnage (DWT)	3,000
Displacement Tonnage (DT)	3,990
Overall Length, LOA (m)	95
Beam Width, B (m)	15
Loaded Draft, d (m)	2.5
Berthing Velocity (m/s)	0.45

The design berthing energy works out to be 59 Tm considering required safety factors.

Fendering System

Considering the level variation of the order of 10m between high flood level and low water level at the site and also the variation in the sizes of vessels to be handled at the jetty, the fendering system is designed such that sufficient contact area between the hull of the vessel and the fender face is ensured at all water levels.

It is required to provide a suitable fender system, not only to absorb the design berthing energy of the vessel but also to keep the vessel's hull pressure below the limit of 20 T/m2. Based on these criteria, the fender AN 800, grade E3.0 of length 3m of Trellborg make or equivalent has been proposed at the berths.

Mooring Load

Mooring force of 30 T, as per Table-4 of IS: 4651-Part III, shall be applied at any of the bollard location.

Current Load

The current loads on the structure shall be applied on the submerged parts of the structure as per IS: 4651 - Part III. The current velocity considered are as given below:

- Operation condition : 1 m/s
- Extreme condition : 4 m/s

Wind Load

The wind load on structure is considered as per IS: 875-Part 3. The basic wind speed (Vb) for operational and extreme condition shall be 17 m/s and 47 m/s respectively.

Temperature Load

- Daily maximum and minimum temperature difference is +15°C
- Daily maximum temperature during winter season is 30°C and the daily minimum temperature is 15°C
- Coefficient of thermal expansion for RCC structure is taken as 11.7×10^{-6}/°C.
- In temperature analysis, long term elastic modulus of the concrete is taken as half the instantaneous elastic modulus of the concrete.

Earthquake Load

Earthquake load shall be considered in design as applicable for the site as per IS 1893-2002.

The design horizontal seismic coefficient αh is calculated based on the following parameters:

- αh = Z I (Sa/g) / (2R), where
- Z = Zone factor = 0.24
- I = Importance factor = 1.5
- R = Response reduction factor = 5

- Sa/g = Average response acceleration coefficient, which depends on Time Period of the Structure The Time Period, T of the structure will be evaluated by STAAD Analysis considering Dead Load and 50% Live Load.

9.1.5 Load Combinations

The above loads with appropriate load combinations, as per IS 4651 (Part 4): 2014 are considered for design of different components of the jetty.

9.1.6 Materials and Material Grades

Concrete of grade M 40 and High Yield Strength Deformed round bars such as Fe 500 grade conforming to IS:1786-1985" shall be used for jetty construction. The protection of reinforcement shall be provided by any of the following methods.

a. Anti-corrosion treatment as per IS:9077

b. Fusion bonded epoxy coating as per IS:13620

c. Corrosion resistant reinforcement as rolled in the factory and commercially available.

9.1.7 Proposed Structural Arrangement of Berth

In Phase-1, the proposed jetty having two berths, one for coal & stone chips and other one for stone chips & other cargo, is aligned parallel to the river bank and access to the bank for operations and maintenance is provided through an approach trestle connecting the jetty to the bank. **Drawing I-521/ST/224 & I-521/ST/225** present the general arrangement and cross section of jetty and approach trestle for Phase-1 development of the terminal.

The width of the jetty, keeping in view the operational requirement shall be about 25 m. The total length of jetty provided is 270 m. In view of the above arrangement of berth and their locations, piled foundation is considered for the structural system. The proposed structural scheme consists of four rows of vertical bored cast-in-situ piles of 1.2 m diameter and one row of fender piles of 1.0 m diameter, spaced at 6 m c/c in the longitudinal direction. The piles will be founded at a level of -17 m.

In the transverse direction, cross beams are provided supported over the piles, which in turn support main beams in the longitudinal direction. A 500 mm thick deck slab will be provided supported over the longitudinal and cross beams. It is proposed to provide steel ladders at the berthing face to access the berthed vessels. In Phase-2, one additional berth for handling coal is aligned parallel to the river bank and access to the bank for this berth is provided through an approach trestle connecting the berth to the bank. The same structural scheme as followed for jetty in Phase-1 is adopted for this berth in Phase-2.

In Phase-3, the two additional berths, one each for handling coal and stone chips are aligned parallel to the river bank and access to the bank for both these berths is provided through approach trestles already proposed in Phase-1 and Phase-2 development of the terminal. The same structural scheme as followed for jetty in Phase-1 is adopted for these berths in Phase-3.

9.1.8 Approach Trestle

The total length of the approach trestle is approximately 50 m, measured along the centerline from berth till shoreline/ bank line. The trestle comprises a total of 4 spans of 12.0 m. The approach trestle is at an elevation of 33.50 m CD.

The approach trestle superstructure at one end comprise of a deck slab spanning across main longitudinal beams. The approach trestle superstructure at other end comprise of a deck slab spanning across main longitudinal beams and supporting structure for carrying belt conveyor system. The total width of the trestle superstructure is 10 m at one end and is 12 m at other end including width for belt conveyor system. The deck slab shall be of reinforced concrete construction, either cast in place or precast. The longitudinal beams shall be reinforced concrete supported on the pile caps.

The longitudinal beams are supported by pile bent capping beams, which in turn are supported by two piles of 1.2 m diameter.

The same structural scheme as discussed above is followed for approach trestle provided to the jetties in all phases of terminal.

9.1.9 Navigational Aids

9.1.9.1 General

Navigational aids are required to be provided to ensure safe and efficient navigation of vessels to and from the terminal. These aids will assist in determining the position of vessel while transiting the navigational channel and manoeuvring inside the terminal.

The aids to navigation proposed to be provided are shown in **Drawing I-521/ST/226** and are detailed in paras below.

9.1.9.2 Channel Marker Buoys

There will be a pair of Channel Marker Buoys at the beginning of the channel on either side. Thereafter, pairs of Channel Marker Buoys shall be provided along the channel at a spacing of about 1800 m.

The channel marker buoys will have the following characteristics:

- Type - FRP (3 m dia)
- Day mark - Single Green, Cone type (Starboard buoy)
- Single Red, Can type (Terminal side buoy)
- Radar reflector - Fitted
- Light characteristics - Fl G 3s 2 m (star board buoys)
  Fl R 3s 2 m (portside buoys)
  LED 20 W Halogen Lamps
- Power - Solar plus backup battery for optimum autonomy.
- Anchoring arrangement - With 32 mm diameter chain and 3.0 T anchor weight

In addition, there will be 7 buoys marking the periphery of the Terminal. These will have following characteristics:

- Type - FRP
- Day mark - Single Green, Cone type (Starboard buoy)
  Single Red, Can type (Portside buoy)
- Radar reflector - Fitted
- Light characteristics - Fl G 1s, 2s, 4s 5 m (Three starboard buoys)
  Fl R 2s 5 m (1 portside buoy)
  LED 20 W Halogen Lamps
- Power - Solar plus backup battery for optimum autonomy
- Anchoring arrangement - With 22 mm diameter chain and 1.5 T anchor weight

9.1.9.3 Leading Lights / Lines

The provision of leading lights does not seem necessary as the channel shall be adequately marked with the buoys.

9.2 Site Grading & Dredging

As the terminal is proposed to be developed for Phase-1 initially, the main onshore facilities that would be located on the land comprise of coal & stone chips stockyard, covered sheds, access roads and operational buildings, covering an area of 59.30 acre. The existing ground levels at these proposed onshore facilities range from 28 m to 56 m. Therefore, significant amount of cutting and filling would be required to level these areas to 37 m, the proposed formation level, which would enable better planning of drainage system to avoid flooding. The open areas shall be achieved after carrying out site grading with the formation level of 37 m.

The area where site grading is proposed in Phase-1 and the cross sections showing details of finished land between terminal area and adjoining area is shown in **Drawing I-521/ST/227.**

With the increase in traffic over the years, the terminal shall be developed for phase-2 and further for phase-3. In these phases, the additional onshore facilities such as stockyards, covered sheds, internal roads and rail siding shall be provided covering the terminal area excluding area in Phase-1. The existing ground levels at these proposed additional onshore facilities range from 24 m to 54 m and site grading shall be carried out to achieve the formation level of 37 m.

The area where site grading is proposed in Phase-2 and Phase-3 is shown in **Drawing I-521/ST/228.**

The volume of cutting and filling required to achieve the site grading level of 37 m in different phases of terminal is worked out as given in Table 9.4.

Table 9.4: Quantity of Cutting & Filling in Different Phases of Terminal

S.No.	Item Description	Unit	Phases of Terminal	
			Phase-1	Phase-2
1.	Earthwork in Excavation/Cutting	Cum	14,25,000	21,50,000
2.	Earthwork in Filling	Cum	215,000	7,00,000

As there are some pockets in approach channel, turning circle and manoeuvring area where water available is less than the required draft of design vessel, dredging is required to be carried out. For Phase-1 of the Terminal, the volume of dredging is worked out to be 1,50,000 cum.

While carrying out site grading & dredging works, it is ensured that no existing natural drainage shall be blocked without providing required cross-drainage structures or alternative drainage arrangement.

The material arising from site grading and dredging activity which are surplus or unsuitable for use in the Works shall become the property of the EPC Contractor and shall be disposed of by him in an environmentally friendly manner up to a lead distance of 5 km as agreed by the Employer on the Site in an approved manner.

The Contractor shall propose two sites for disposal of unsuitable or surplus material, one of which shall be specified as having priority and which must be filled before the second is used, together with a separate location where hard debris, such as concrete, kerbing etc. shall be disposed of. The Contractor shall seek approval for all nominated sites from the concerned local authority before work commences.

9.3 Storage Areas

9.3.1 Stockyard for Coal & Stone Chips

In Phase-1 of terminal, the stockyard for coal and stone chips is proposed to be hard stand consisting of gravel / brick ballast / crushed stone spread uniformly over prepared subgrade and packed properly, with interstices filled with sand and typical details are shown in the **Drawing I-521/ST/229.**

In Phase-2 and Phase-3 of terminal, the stacker cum reclaimer tracks are proposed to be supported on precast concrete sleepers resting on a flexible foundation made of stone ballast and typical details are shown in the **Drawing I-521/ST/230.**

9.3.2 Storage Sheds

There are few cargos like fertilisers, food products etc. which cannot be stored in open atmosphere and need covered warehouses.

The Sheds shall be mainly built using structural steel for the frames and galvalume sheets for roofing and cladding. Details are shown in the **Drawing I-521/ST/231** which is only indicative and may undergo changes based on the design. Grade slab are provided for maintaining the finished floor level so as to give a plinth height of not less than 500 mm above Finished Ground level.

Foundations shall be of isolated footings with pedestals which will be connected with tie beams at Ground Level. Retaining wall for adequate height shall be provided around the shed for optimising the storage capacity.

9.4 Terminal Buildings

The following terminal buildings are proposed for the Sahibganj terminal:

9.4.1 Terminal Administration Building

It shall be 2-storey building housing the following:

- Administration wing of the terminal including documentation
- Terminal operations wing

Based on the estimated manpower requirements for terminal operations, it is assessed that the terminal building will have a total floor area of 520 sqm.

Typical Layout and Elevations of Terminal Administration Building are shown in **Drawings I-521/ST/232 and I-521/ST/233** respectively.

9.4.2 Security Office

This shall be a single storey building for security personnel with covered area of about 25 sqm, and shall be provided near the terminal entrance. Details of security office are shown in **Drawing I-521/ST/234.**

9.4.3 Weigh Bridge Building

This shall be a single storey weigh bridge building with a covered area of about 25 sqm, and shall be provided near the terminal entrance. Details of weigh bridge building are shown in **Drawing I-521/ST/235.**

9.4.4 Electrical Sub-station

The electrical sub-station floor area of 900 m^2 is already built near Storage Shed for other cargo provided in Phase-1 of terminal. The floor area of 360 m^2 is envisaged in Phase-1 of terminal and increasing upto 900 m^2 in Phase-3 of terminal. The details of electrical sub-station are shown in **Drawing I-521/ST/236**. The control area containing switchyard and control room adjacent to electrical sub-station in an area of 50mx20m is also built in Phase-1 of terminal.

9.4.5 Worker's Amenity Building

Worker's Amenity Building shall be located near terminal administration building. The total floor area of 108 sqm is envisaged and will include bath and lavatory facilities. Details of Worker's Amenity Building are shown in **Drawing I-521/ST/237**.

Based on the review of onshore geotechnical data it is assessed that for buildings that are not located on the filled up ground, spread footing or raft foundations would be adequate. The structures that are located on the filled up ground pile foundations shall be necessary.

10.0 ENGINEERING OF MATERIAL HANDLING SYSTEM / EQUIPMENTS

PHASE-1

As already discussed in Section-5, the commodities like coal and stone chips in Phase-1 would be handled at the terminal by using dumpers,pay loaders, excavators, belt conveyor with fixed hopper and barge loader. The other cargo & stone chips shall be handled at jetty with the help of Mobile Harbour Crane with lifting spreader and trucks/dumpers.

The summary of mechanical equipments proposed in Phase-1 of the terminal is given in Table 10.1 below:

Table 10.1: Summary of Phase-1 Mechanical Equipments

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	1
2.	Mobile Harbour Crane	1
3.	Pay Loader / Front End Loader	8
4.	Fixed Hopper	4
5.	Conveying System	Lot

The flow diagram of cargo handling system that would be followed in Phase-1 is presented in **Drawing I-521/ST/238.**

As presented in the flow diagram the details of mechanical equipments including broad specifications are discussed below:

10.1 Coal / Stone Chips Handling Equipment for Export

10.1.1 Mobile Barge Loader

Mobile Barge loader, as shown in **Figure 10.1**, consists of a conveyor which is carried on a tripod of twin motorized rubber tires. Each set of twin tires is mounted at a vertical kingpin and can rotate 360 degrees about that vertical axis. Thus, without repositioning, it can set up to travel in any direction. With the tail tires fixed, the front tires can be oriented and travelled for a slewing motion. The mobile barge loader shall have design capacity of 1200 TPH in all the phases.

Materials for export are trucked to the dock and dumped onto a special trap loader type feeder. The cargo is fed continuously and uniformly onto the conveyor's receiving chute. The equipment elevates the bulk cargo over the ship's deck to the hatch where it is discharged into the ship's hold. At the discharge, a special telescoping chute, with rotating, pivoting spoon, facilitates even and complete filling of the holds.

Figure 10.1: Typical Mobile Barge Loader

10.1.2 Mobile Harbour Cranes (MHCr)

MHCr as shown in **Figure 10.2**, shall be of proven design complete with on-board diesel engine and alternator, multi axle chassis, torsion resistant steel structure, hydraulic propping system, self-adjusting stabilizer, hydraulic travel drive with hydraulic steering, machinery house, hoist drive, slewing gear drive, operators cabin, control and instrumentation equipment, lighting communication and all safety devices. The MHCr shall have lifting capacity of 25T at 25 m radius.

The crane shall be provided with multi-axle travel drive. The drives shall be of hydraulic type and shall ensure that the torque is distributed equally between the driven axels. The axles shall be suspended in an equalizer suspender system, which shall ensure that the total load is distributed equally to all axles irrespective of ground conditions.

All steered axles shall be connected by tie rods so that simultaneous steering is guaranteed. Suitable brake shall be provided for travel drive and also for parking.

Suitable propping system with stabilizer pads shall be provided for propping the crane during normal operation. The system shall ensure uniform distribution of the total load between each propping pad.

The boom luffing device shall be either hydraulic or mechanical depending on manufacturers' standard. The luffing motion shall be smooth and infinitely variable. Suitable braking system shall be provided for the luffing drive.

The cranes shall be equipped with a 4-rope-grab hoist unit comprising of hoists in modular construction. Grab shall be suspended from the tower / boom system by two wire ropes. The rope connector at the end of hoist rope shall permit easy connection and removal of grab.

The grab shall be clamshell type with a frame fabricated from welded steel. Abrasion resistant steel shall be provided over the digging edges of the jaws. Different grabs shall be provided to suit different cargo.

A general cargo lifting beam of adequate capacity shall be provided with the crane which shall be connected with hook for lifting multiple bag bundles using net or pre-sling methodology to handle maximum cargo per cycle.

The operator's cab shall be of enclosed type with sheet metal panelling and thermal insulation. The operator's cab shall be provided with a window type air conditioner and heat resistant glass to give a good view over the area of operation

Figure 10.2: Typical Details of Mobile Harbour Crane

10.1.3 Belt Conveyor System

The belt conveyor system broadly consists of the following:

- Conveyors from stockyard to Barge loader i.e. BC-7A, BC-8A, BC-9A, BC-10A & BC-11A for transferring of coal / stone chips.
- One barge loader BL-1 for loading of coal / stone chips from the conveyors into the barge holds.
- Four numbers of fixed hoppers for transfering coal / stone chips from stockyard using front end loader / pay loader / excavator on the belt conveyor.

The cross section of conveyor profiles for Phase-1 is presented in **Drawing I-521/ST/239.**

10.1.4 Front End Loader / Pay Loader

The front end loader / pay loader is used heaping up the coal / stone chips within the stockyard. The general technical parameters governing the design of the pay loader shall be as follows:

- Capacity of bucket : 3 cum
- Bucket width : About 3 m
- Static tipping load : About 13 T
- Operating height : Not less than 5.4 m
- Turning radius : Not more than 6.5 m
- Dump angle : Not less than 50
- Dump reach : Not less than 2.4 m

The conveyor profile with cross sections in Phase-1 is presented in **Drawing I-521/ST/239.**

10.1.5 Excavator (Additional Equipment)

The excavators may be used for feeding the fixed hoppers on conveyor and for heaping up the coal / stone chips within the stockyard. Excavator with 3.5 cum bucket capacity and suitable reach may be selected by operator to cater the proposed throughput.

10.1.6 Road Weigh Bridge

The weigh bridge structure shall be robust in construction with ample safety margin above the rated capacity.

The lower structure of the platform shall comprise of wide flanged steel beams and high grade tested steel. The structure shall be sand blasted to SA 2½ grade and suitably painted with special anti-corrosion epoxy based paint.

The assembly shall be designed to compensate for expansion and contraction between the Weigh Bridge and foundation, caused by temperature variation.

The load cells shall be sealed and compression type suitable for pit less weigh bridge installation.The load cells (6 nos.) shall be of rated capacity 23T (approx) each having safe overload limit of 150% and breaking load of 300% of rated capacity.

Each load cell shall have safe temperature range 0-65 degree Celsius and shall be weather proof IP-68 protection.

Weigh bridge electronics shall be micro controller based with standard software capable of providing various kind of information on selectable basis.

The system shall be provided with communication facility with the main PIC in the control room and a real time clock to print date and time on the printouts.

The system shall be provided with suitable PC with software and dot matrix printer of latest technology is given in Table 10.2 below:

Table 10.2: Specification Data Sheet - Road Weigh Bridge

S. No.	Description	Data
1.	Type	Pit less, Static
2.	Capacity	60T
3.	Accuracy	± 0.05% of Full scale
4.	Platform size	15 m x 3 m
5.	Trucks to be weighed	Heavy duty Trucks /
6.	Operator interface	Menu driven
7.	PC & Printer	Required
8.	Auto zero & Auto Calibration	Required
9.	Anti-skid to plate	Required
10.	Stamping by W&M Inspector	Required

10.1.7 Storage Sheds

As annual throughput for other cargoes works out to be 0.22 MTPA in Phase-1, it is therefore proposed to provide only one storage shed giving about 4,160 sqm of covered storage for the said commodities.

PHASE-2

The summary of mechanical equipments proposed in Phase-2 of the terminal is given in Table 10.3 below:

Table 10.3: Summary of Phase-2 Mechanical Equipments

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	1
2.	Stacker cum Reclaimer for Coal	2
3.	Fixed hoppers for Stone chips	4
4.	Pay Loader / Front End Loader for Stone chips	8
5.	Excavator for Stone chips	4
6.	Trucks	5
7.	Conveying System	Lot
8.	Wagon Tippler with side arm charger	1
9.	Wagon shifter with pusher car	1
10.	Track Hopper	1

The flow diagram of cargo handling system that would be followed in Phase-2 is presented in **Drawing I-521/ST/240.**

As presented in the flow diagram the details of mechanical equipments including broad specifications are discussed below:

10.2 Mechanised Coal Handling System

The system broadly consists of the following:

- One Rotaside type wagon tipplers with Tippler # WT-1 designed to handle wagons at 25 Tips per hour. A set of wagon shifter with pusher car shall be installed to accommodate operational requirements of post tippling activities of railways.
- Conveyors from Wagon tippler complex to stockyard viz., BC-4A, BC-12A & BC-12B for conveying and unloading of coal for stock piling.
- One Stacker cum Reclaimer SR-1 mounted on Yard Conveyor BC-12A for stockpiling of coal unloaded from wagons and conveyed through conveyors, with the machines working in stacking mode. The same machine can work in reclaiming mode to reclaim the coal and transfer further towards Barge loader.
- One Stacker cum Reclaimer SR-2 mounted on the other Yard conveyors # BC-12B for stockpiling of coal unloaded from wagons and conveyed through conveyors, with the machines working in stacking mode. The same machine can work in reclaiming mode to reclaim the coal and transfer further towards Barge loader.

- Conveyors from stockyard to Barge loader i.e. BC-14A, BC-15A, BC-16A, & BC-17A for transferring of coal.
- One barge loader BL-2 for loading of coal from the conveyors into the barge holds.

10.2.1 Wagon Tippler

The system provides for one wagon tippler of Rotaside type WT- 1 designed for 25 tips/hr respectively.

The rotaside wagon tippler system is designed to handle BOXN wagons and its variants. The tippler with its table level at + 0.5 m consists of a table, two end rings, four top stop clamps and a drive for tippling for an angle of 150^{o}. The coal rakes brought by the locomotives of Indian railways upto the terminal will be taken over and brought to the incoming line of wagon tippler by the port's diesel shunting locomotives. Each such rake that is brought to the tippler proper within the operating range will be taken over by wagon indexer designed to haul a fully loaded rake. The indexer with hydraulic drive runs on a rail gauge of 1500 mm located on one side of the tippler main incoming track with drive imparted through three drive pinions on a spline bar and rack. It has a normal travel distance of about 17 m and can haul a loaded rake at a speed of about 0.3 m/s. The indexer will haul the entire rake and position it within the reach of side arm charger which is designed to haul a single loaded wagon and place it on the table. The side arm charger runs on another track with a gauge of about 1800 mm on the side opposite to indexer and can haul a single loaded wagon onto the table at a forward speed of 0.5 m/s. The hauling of wagon in the forward cycle is affected by the charger's arm having a length of about 3700 mm, lifts and positions itself on the wagon coupling for such pushing. After retracting of the side arm charger from the table, the tippling operation takes place and after completion of tippling by the tippler proper, the next loaded wagon charged by the side arm charger in the next cycle will eject out the empty wagon from the tippler table. The wagon indexer, the side arm charger and the wagon tippler are all synchronized to operate at the designed capacity.

10.2.1.1 Apron Feeders & Dribble Conveyors

The material unloaded by the tippler into the hopper is carried by a single apron feeder for transferring the same to the tunnel belt conveyor BC-3. The apron feeder located right below the hopper with its carrying side is designed to take the heavy impact of fall of coal from the wagons as also coal from the hopper. In view of the need for flexibility between the pans of the apron feeder, a small quantity of ore trickles out through them which are carried by the dribble conveyor which is a belt conveyor and is located right below the apron feeder. This put the coal that dribbles out from the feeder into BC-3 along with main ore transferred by apron feeder.

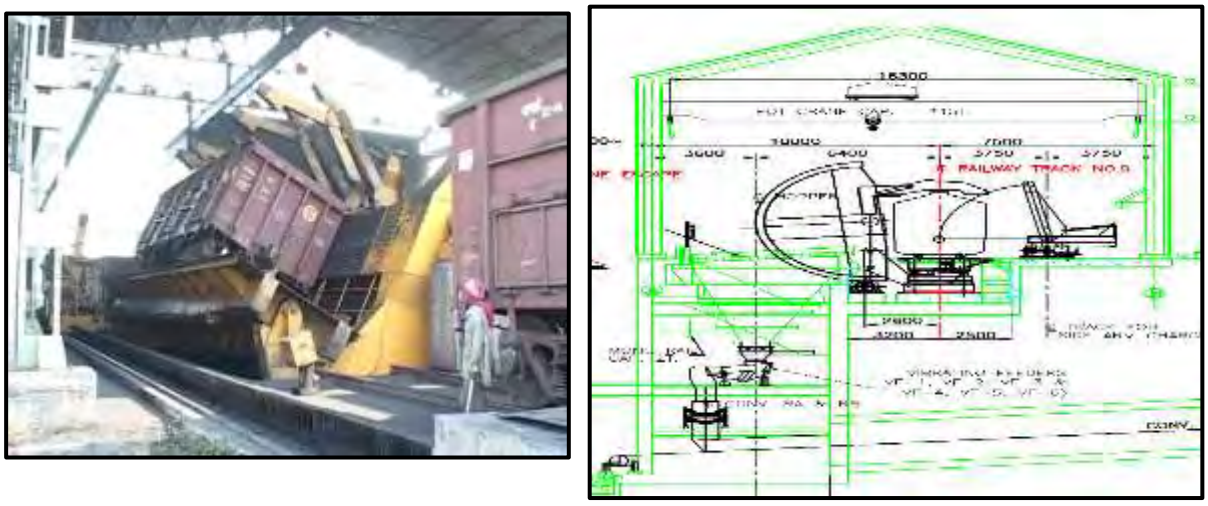


Figure 10.3: Typical Arrangement of Wagon Tippler

10.2.1.2 Wagon Shifter - Pusher

The wagon shifter-pusher is a rail mounted equipment, moving on a rail perpendicular to the tippler rail. After tippling of the loaded material into the hopper, the empty wagon is moved towards the out haul side to clear the tippler platform. The empty wagon is then shifted from the tippler line to out haul line by using the wagon shifter-pusher. Tippling of wagon and shifting of wagon are done simultaneously which also helps in improving the effeciency of the siding holder by reducing the cycle time.

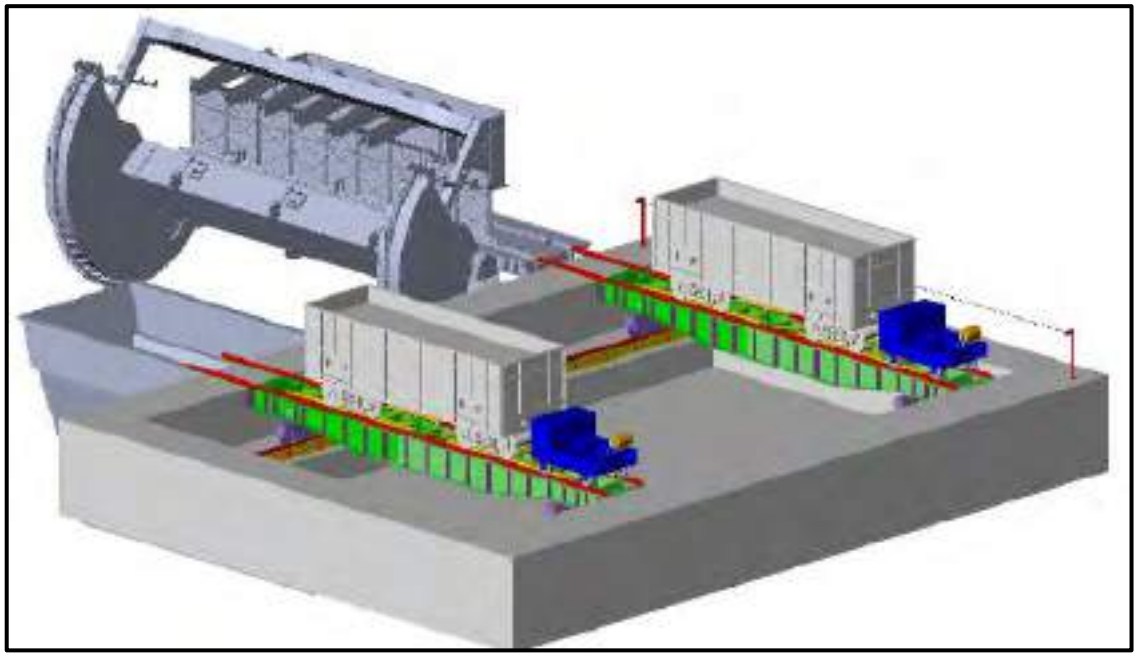


Figure 10.4: Typical Arrangement of Wagon Shifter-Pusher

10.2.2 Track Hopper with Paddle Feeder

This system is used when the cargo is received through a rake consisting of bottom discharge type wagons. The wagons are equipped with special hydraulically operated bottom doors.. The wagons alternately unload themselves in the underground R.C.C Track Hopper below rail siding. Cargo from the Track Hopper is discharged onto a conveyor belt through a paddle feeder for further conveying. The typical/optional details of this arrangement are shown in **Figure 10.5**.

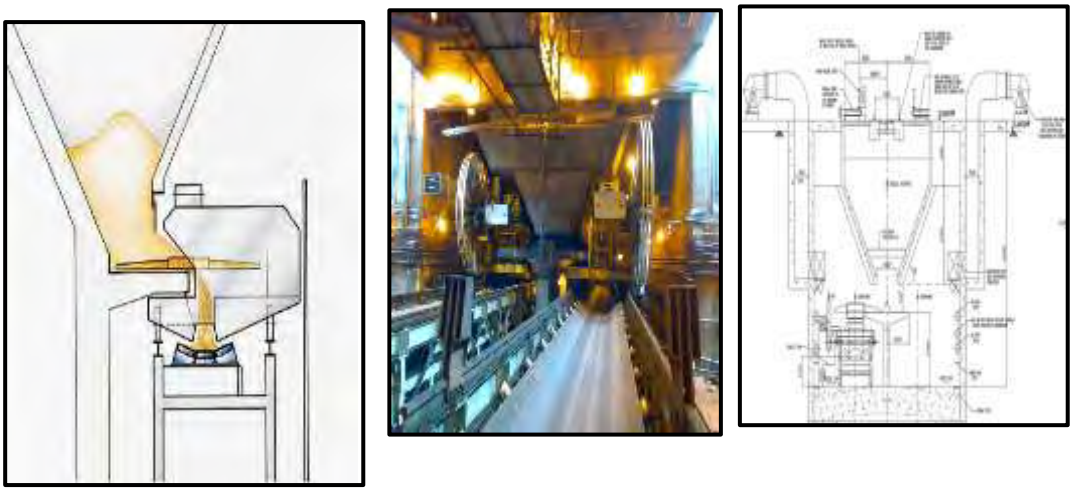


Figure 10.5: Typical Arrangement of Track hopper

10.2.3 Belt Conveyor System

10.2.3.1 General

Belt Conveyor System as specified herein is proposed to receive the coal from Wagon Tippler, transport to stockyard, reclaim the coal from the stockyard and transport to coal berth to load in barges. Similarly stone chips is proposed to receive by dumpers to stockyard and transport to stone chips berth to load in barges.

All conveyors shall be designed for 24 hours of operation under climatic and ambient conditions. The components of conveyors proposed in the facility shall be standardised to the extent possible.

Complete Belt Conveyor System shall be designed based on IS: 11592 “Code of Practice for Selection and Design of Belt Conveyors” / CEMA – Belt Conveyors for Bulk Materials, 5th / 6th Edition.

Belt Conveyors shall be complete in all respects and shall include but not limited to conveyor belting, idler rolls with supports, pulleys, drive units with base frames, head and tail frames, take-up units, skirt boards, scrapers, transfer chutes, stringer frames, short supports, deck plates, gates, etc. and all bolts including anchor bolts.

10.2.3.2 Conveyor Belting

Nylon-Nylon belting shall be used for all conveyors. Belt ratings are selected in such a way that normal working tension in the belt will not exceed 80 % of the maximum allowable working tension. The belt cover for conveyors shall be of rubber and grade of cover shall be Fire Resistant (FR) grade conforming to Canadian Standard Association CAN / CSA / M-222-M87 Grade-C.

10.2.3.3 Drive Arrangement

All conveyors shall be provided with single snub drive unit at head end.

Gear boxes shall be helical or bevel helical type. High speed (input) couplings shall be scoop controlled / delayed chamber type fluid couplings. Low speed (output) couplings shall be geared type.

Gear box, couplings etc. connecting the motor to the driven equipment shall be rated according to the motor rating with a service factor of 1.25.

Hold back units (integral with gear box) shall be provided, if required to arrest the reverse motion of the belt. Brakes, if required shall be provided to adjust the coasting time of conveyors such that there will not be any build-up of material in the chutes. Brakes shall be thrustor type and designed considering a deceleration of 0.3 m/s2.

The complete drive system has been rated for 120% of the actual requirement of driven equipment at specified design load.

10.2.3.4 Idlers

Carrying idlers shall be of fixed type and provided with three equal rolls with 35° troughing angle. Return idlers shall be of two equal rolls with 10° trough ('V' type). At loading zone impact idlers shall be provided.

Idlers shall be made from ERW steel tube. The rollers shall be mounted on EN 8 or equivalent material shaft by means of heavy-duty ball bearings. The bearings shall be adequately lubricated and sealed for life.

Idler rolls shall be water proof, dust proof and weather proof against a high velocity water jet. All idlers shall be provided with double labyrinth dust seal.

10.2.3.5 Pulleys

The pulleys shall be made from mild steel conforming to IS: 2062. All pulleys shall have ring feeder or tapered lock be keyed to forged steel shafts of EN8 or equivalent material. The bearings shall be heavy duty roller bearings. Suitable stiffening arrangement shall be provided in all pulleys.

All drive pulley surfaces shall be provided with vulcanised natural rubber lagging grooved in diamond / herringbone pattern. All non-drive pulleys shall be provided with plain lagging with natural rubber.

The rubber used for lagging shall be of RMA grade 1 with shore hardness of 60 ± 5 for drive pulleys and 40 ± 5 for other pulleys. Minimum lagging thickness shall be 8.0 mm.

10.2.3.6 Belt Cleaners

External belt cleaners shall be double bladed, spring loaded modular segmented and replaceable polyurethane scrapper. The modular units shall be easily replaceable. The scraper assembly shall be easily maintainable from outside without any interference with the chute arrangement and assembly.

Internal belt cleaners shall be V plough type made of mild steel flats and hard rubber strips with automatic wear adjustment.

10.2.3.7 Belt Take-up Arrangement

The conveyors shall be provided with automatic take-up of gravity type. Gravity take up arrangement shall comprise of a structural steel frame sliding up and down on two vertical steel pipe guides, a take up pulley unit mounted on antifriction bearing pillow blocks bolted on to the steel frame and threaded counter weight rods secured to the lower edge of the steel frame each provided with two nuts and washer at their lower end for attaching counter weights.

The take up movement shall not be less than the values specified in Table 1 of IS 4776 (Part I).

Take-up weight shall consist of multi-blocks to facilitate adjustment in weight if required during operation. Weight of single heaviest piece shall be suitable for easy handling.

10.2.3.8 Belt Protection Equipment

Pull chord type (manually reset type) emergency stop switches shall be located on both sides of belt conveyors along the walk ways for the entire length of conveyors for emergency stopping of conveyors.

Belt sway switches of resetting type shall be provided at periodic intervals on both sides of conveyor to limit belt sway to permissible extent.

Zero speed switches shall be non-contact (proximity) type electronic switch and shall be mounted on tail / bend pulleys.

Chute blockage switch: All chutes shall be provided with plugging switches connected to the conveyor interlocking system.

10.2.3.9 Conveyor Galleries

Conveyor galleries shall be provided with walkways of adequate width on either side to facilitate inspection and maintenance work. Minimum walkway width of 1000mm on each side shall be provided.

Generally conveyor galleries shall be of open type with conveyor hood, however, at grab unloader travel portion the gallery shall be open type.

Handrails of suitable size and construction shall be provided for safety reasons.

10.2.3.10 Transfer Towers

All transfer towers shall be provided with GI corrugated sheet cladding as necessary to have an enclosed structure for dust containment. Necessary louver arrangement shall be provided to have natural ventilation.

Sufficient headroom and a minimum space of 1500mm all-round the equipment installed shall be provided in all transfer towers for the purpose of maintenance and safe operation.

All transfer towers shall be provided with electric / manual hoists with monorails for maintenance purpose. The rails shall protrude out of the house by 1500mm or so for enabling lifting and lowering of heavy components / spares.

10.2.3.11 Chutes

Guided transfer chutes suitably designed with a minimum valley angle of 65° shall be provided at all transfer points for transfer of cargo from one conveyor to the next in the direction of belt travel.

Chutes shall be made of structural steel as per IS 2062 and shall have minimum thickness of 10mm.

Chutes shall be provided with replaceable type liner plates. Such liner plates shall be of abrasion resistant type or impact resistant type depending on whether the surface is subjected to friction or impact.

Hoods shall be provided over chutes having provision for fixing dust suppression system as per requirement.

10.2.3.12 Two Way Diverter

Required number of two way diverters (2 way flap gates) complete with all accessories like electrical actuators shall be provided as per system requirement.

Abrasion resistant or impact resistant liners shall be provided on the flap faces.

10.2.3.13 Belt Weigher

Belt weighers shall be provided in the system at appropriate locations for measurement of cargo handled.

The belt scale shall be load cell type and shall be continuous operating. Accuracy shall be ±0.25%.

Provisions for local and remote measurement of instantaneous throughput and to falling shall be made. Signals for remote indication and overload alarm shall be provided. Local control panel including rate indicator and totalizer shall be provided.

The load cells shall be completely sealed, water and dust proof, and maintenance free.

10.2.3.14 Metal Detectors and Magnets for coal

In-line magnetic separator shall be provided on conveyor as shown in the flow diagram to remove tramp metals being carried along with the material on the belt.

- Lifting capacity shall minimum
- MS cube of 20 mm size
- MS plate: 250 mm x 250 mm x 100 mm size.
- Shovel teeth & spikes: Carbon steel, typ. size.
- Max. 5, 50 Kg weight.

Metal detector shall be provided for each magnet to detect presence of any metallic object and subsequently send signal to the magnet to remove it. Sensitivity shall be detection of minimum 30 mm sphere for non-ferrous metal and 20 mm sphere for ferrous metal below the burden of coal.

10.2.3.15 Monorail Hoists / Cranes

Monorail Hoists with pendant control shall be provided in towers, transfer towers, drive houses, and other areas, as required, where equipment parts heavier than 200 Kg are to be handled for maintenance or lifting height is more than 10m. Elsewhere, monorails shall be provided to facilitate manual chain pulley block operations for lighter parts is given in Table 10.4 below:

Table 10.4: Data Sheet for Belt Conveyor System

1.	Belting	Nylon-Nylon type
2.	Grade of Cover	Fire Resistant (FR) grade conforming to Canadian Standard Association CAN / CSA / M-222-M87 Grade-C
3.	Motor	TEFC Squirrel cage Induction motors
4.	Gear boxes	Helical or bevel helical type without fans or cooling coils
5.	High speed couplings	Scoop controlled / delayed chamber type
6.	Low speed couplings	Geared type
7.	Brakes (as applicable)	Thrustor type
8.	Hold back units	Integral with gear box
9.	Carrying idlers	Fixed type with three equal rolls with 35° troughing angle
10.	Return idlers	Fixed type and provided with two equal rolls with 10° trough ('V' type)
11.	Pulleys	Mild steel construction keyed to forged steel shafts with vulcanized natural rubber lagging
12.	External belt cleaners	Double bladed, spring loaded modular segmented and replaceable polyurethane scrapper

13.	Internal belt cleaners	V plough type made of mild steel flats and hard rubber strips
14.	Take-up	Automatic take-up of gravity type
15.	Belt Protection	Pull chord switches, Belt sway switches, Zero speed switches, Chute blockage switches, etc.
16.	Chutes	Structural steel construction as per IS 2062, 10mm thick Mother Plate with replaceable type liner plates
17.	Flap gates	Linear actuator operated
18.	Belt scale	Load cell type
19.	Magnetic separator	In-line D.C. operated, Electromagnetic suspended type
20.	Metal detector	Electronic Solid State
21.	Maintenance	Monorail Hoists/Cranes

10.2.4 Stacker cum Reclaimer

Stacker cum reclaimer, as shown in **Figure 10.6**, is a large machine mounted on a travelling gantry with a boom conveyor with a rotating bucket wheel at the end. Its function is to stack bulk materials in an orderly and geometric stockpile optimising the area and to reclaim the bulk material from a stockpile.

A stacker cum reclaimer has three basic movements:

Luffing: This is vertical movement done by luffing (raising and lowering) of its boom by either a winch mechanism with a wire rope, or by hydraulic cylinders. This minimises the dust generation by reducing the discharge height. The boom is luffed upwards as the height of the stockpile increases.

Travelling: The stacker cum reclaimer moves on a rail track (gauge proportionate to the boom), enabling it to stack or reclaim the cargo along the length of the stockyard as required. For this purpose, traction motors powered with gear reducers and multi wheel bogies are provided. All controls are either in a control cabin located at the boom or in the Main Control Room. It can also be controlled remotely.

Slewing: This allows the machine to form stockpiles as well as reclaim the cargo on either side of the conveyor by rotation of the boom around its central axis to align where required. This works mostly by a slew pinion that rotates around a slew base with a sun and planet gear arrangement.

Figure 10.6: Typical Arrangement of Stacker cum Reclaimer

10.3 Stone Chips Handling System

The system broadly consists of the following:

- Stone Chips directly come by dumpers from stone chips mines and dumped in the stockpile area by dumpers. For stockpiling of stone chips Pay Loaders / Front End Loaders shall be used. If required, excavators shall be used for high heaping.
- 4 nos. of fixed hoppers would be mounted on the Yard conveyor BC-6 for loading of stone chips into the barges.
- Conveyors from stockyard to Barge loader i.e. BC-6, BC-8A (extension), BC-9A, BC-10A & BC-11A for transferring of stone chips from the stockyard to barge loader.
- One barge loader BL-1 for loading of stone chips from the conveyors into the barges holds.

10.4 Storage Sheds

As the traffic builds-up, the annual throughput for other cargoes increases upto 0.40 MTPA in Phase-2, two storage sheds are proposed; one shed for sugar & food grains and other shed for cement and fertilisers. Each shed provides about 4,160 sqm of covered storage area.

PHASE-3

It is proposed to provide coal stockyard with mechanised handling system for coal to cater the traffic in Phase-3. To cater the traffic for stonechips in Phase-3, the stockyard area which has been provided with belt conveyor and fixed hopper in Phase-1 of the terminal shall be modified with mechanised conveyor system equipped with reclaimer. The stockyard area of Phase-2 below stockyard area of Phase- 1 which has been provided with fixed hopper and belt conveyor system shall continue in Phase-3.

The mechanised coal stockyard in Phase-3 may be required to develop earlier to avoid obstruction to handling of stone chips in the stockyard area which has been provided with belt conveyor and fixed hopper in Phase-1 of the terminal during modification of this stockyard area to mechanised conveyor system with reclaimer in phase-3. In view of this, the stone chips may be handled through the proposed mechanised coal stockyard of Phase-3 during modification period. After having mechanised stockyard with reclaimer available for handling stone chips, the mechanised coal stockyard can be used for handling coal traffic in Phase-3.

The summary of mechanical equipments proposed in Phase-3 of the terminal is given in Table 10.5 below:

Table 10.5: Summary of Phase-3 Mechanical Equipments

S. No.	Equipment Type	Number of Equipment
1.	Mobile Barge Loader	2
2.	Trucks	5
3.	Conveying System	Lot
4.	Stacker cum Reclaimer for Coal	2
5.	Reclaimer for Stone chips	1

The flow diagram of cargo handling system that would be followed in Phase-3 is presented in **Drawing I-521/ST/241.**

As presented in the flow diagram the details of mechanical equipments including broad specifications are discussed below:

10.5 Mechanised Coal Handling System

The system broadly consists of the following:

- One Track Hopper # TH-1 designed to handle bottom discharge wagons. However, Coal shall be unloaded to conveyors either through track hopper or wagon tippler at a time.
- Conveyors from Track Hopper to stockyard viz., BC-1, BC-2, BC-3, BC-4B, BC-5A & 5B, BC-13A and BC-13B for conveying and unloading of coal for stock piling.
- One Stacker cum Reclaimer SR-3 mounted on Yard Conveyor # 13A for stockpiling of coal unloaded from wagons and conveyed through conveyors, with the machines working in stacking mode. The same machine can work in reclaiming mode to reclaim the coal and transfer further towards Barge loader.

- One Stacker cum Reclaimer SR-4 mounted on Yard Conveyor # 13B for stockpiling of coal unloaded from wagons and conveyed through conveyors, with the machines working in stacking mode. The same machine can work in reclaiming mode to reclaim the coal and transfer further towards Barge loader.
- Conveyors from stockyard to Barge loader i.e. BC-14B, BC-15B, BC-16B & BC-17B for transferring of coal from the stockyard to barge loader.
- The barge loader BL-4 shall be utilized for loading of coal from the conveyors into the barges holds.

10.5.1 Stone Chips Handling System

The system broadly consists of the following:

- Stone Chips directly comes by dumpers from stone chips mines and dumped in the stockpile area by dumpers. For stockpiling of stone chips Pay Loaders / Front End Loaders shall be used as in phase-2. If required, excavators shall be used for high heaping.
- During the early phase of commencement of phase-3, stone chips can be handled through S/R-3 of coal in reclaim mode from Conveyor BC-14A. Subsequently stone chips can be transferred to barges using BL-4 through conveyors BC-14B, BC-15B, BC-16B & BC-17B.
- Subsequently, after availability of mechanised yard with reclaimer for stone chips, one Reclaimer RE-1 mounted on the Yard conveyor # BC-7 shall be used for loading of stone chips into the barges.
- Conveyors from stockyard to Barge loader i.e. BC-7, BC-8B, BC-9B, BC-10B & BC-11B for transferring of stone chips from the stockyard to barge loader.
- One barge loader BL-3 for loading of stone chips from the conveyors into the barges holds.

10.5.2 Bucket Wheel Reclaimer

A reclaimer, as shown in **Figure 10.7**, is also a large machine mounted on a travelling gantry with boom conveyor at the end of which a rotating bucket is used to reclaim bulk materials from a stockpile. A bucket wheel reclaimer can typically have three types of movements (similar to stacker); horizontally along the rail, vertically by "luffing" its boom and rotationally by slewing its boom. All three movements of reclaimers are generally electrically powered and centrally controlled.

Reclaimers are typically operated from a control cabin strategically located on the boom and have many functions which are automated with their parameters remotely set.

Figure 10.7: Typical Bucket Wheel Reclaimer

10.6 Storage Sheds

To cater the annual throughput of 0.75 MTPA for other cargo in Phase-3, it is proposed to provide four storage sheds, each shed for each commodity of other cargo. The storage area of each shed shall be about 4,160 sqm.

11.0 ELECTRICAL AND CONTROL SYSTEM

11.1 Electrical Power Requirement

The main power requirement for electrical load in the Construction of IWT Terminal at Sahibganj on National Waterway-1 project shall be on account of Barge Loader, Belt Conveyors, Wagon Tippler, Stacker, Reclaimer, etc. Other infrastructure such as general lighting, power for auxiliary services like dust suppression system, etc. will also need their share of electric power.

Total project shall be executed in three phases. In Phase-1, major loads shall be due to Barge Loader, Belt Conveyors, Metal detector, Electric hoist, Lighting, Fire Fighting, Dust Suppression System etc. In Phase-2, major loads connected shall be on account of Belt conveyors, Wagon Tippler, Wagon shifter, Stacker cum reclaimer, Barge Loader, Metal detector, Electric hoist, Lighting etc. In Phase-3, major loads shall be on account of Belt Conveyors, Stacker cum reclaimer, Reclaimer, Electric Hoist, Lighting etc.

In case of operational power, all the installed loads shall not be required simultaneously. For instance, in case of stacker, reclaimer, barge loader etc., all the loads shall not be operating simultaneously. Similarly all the running conveyors shall also not draw maximum power at the same time.

All Electrical and controls equipment shall be designed for an ambient of $45^{O}C$.

Taking all such aspects and applying suitable diversity factors, the connected power and demand load is estimated in Table 11.1 below:

Table 11.1: Electrical Power Requirement

Phase Description	Connected Load	Demand Load
Phase-1	1391 kW	797 kW
Phase-2	3201 kW	1760 kW
Phase-3	3758 kW	2067 kW

11.1.1 Source of Power Supply

Power at 11kV shall be made available upto a DP (Double Pole) Structure adjacent or within the Project boundary by JUVNL (Jharkhand Urja Vikas Nigam Limited). Beyond this DP structure, power shall be fed to the Metering cubicle of JUVNL through buried 11kV cable by either JUVNL or IWAI. DP structure shall also be provided by either JUVNL or IWAI. 11kV cable from metring cubicle of JUVNL to 11kV switchgear Incomer shall be in the scope of the EPC contractor. Further Power distribution shall be as per the attached **Power Single Line Diagrams I-521/ST/242 to 244**.

11.1.2 System Description

Power at 11kV received at the incomer of HT Switchgear shall be fed at the same voltage to High Power Consuming Equipment (> 110 kW) like Belt Conveyors, Barge Loaders, Pump House Load, Transformers and HT Capacitor Bank etc.

11.1.3 Utilization Voltages

The particulars of Power Supply shall be as in Table 11.2 follows:

Table 11.2: Power Supply

Voltage	• 11kV +/- 10% & 415V +/- 10%
Phase	• 11kV (3 Phase 3 Wires) • 415V (3 Phase 4 Wires)
Frequency	50 Hz +/- 3%
Combined Voltage & Frequency Variation	10%
Fault Level	• 40kA for 1 second at 11kV • 50kA for 1 second at 415V
System Earthing - 415 V	Solidly Earthed
Control Circuits	
Circuit Breaker Protection & Tripping	110 V DC, 2 Wire grounded
Control System	
Server, PLC, FI (Intelligent) I/O VDU, Keyboard, Printer	240 V +/- 10%, AC, 50 HZ +/- 3%, 1 Ph, 2 Wire All equipment shall have internal close loop regulation & spike arrestors
UPS System, Field Hooters	240 V +/- 10%, AC, 50 HZ +/- 3%, 1 Ph, 2 Wire

11.1.4 Electrical Sub-station (ESS)

One number ESS with equipment layout is proposed to be located and constructed progressively with each phase as shown in the **Drawing I-521/ST/245.** Switchgear room shall be housing JUVNL metering panel, transformers, Power control Center (PCC), Diesel Generator sets, 11 kV HT switchgear panel, various distribution Boards, sitting space with table & chairs for 2-3 persons, toilet etc.

A part of the Pump House shall be prepared for receiving power supply at 11 kV and house 11 kV switchgear, Transformer and LT Panel for power distribution to the Fire Fighting and Dust Suppression panel as shown in the attached **Power Single Line Diagram**.

11.1.5 Control Room

Control room is located on the First Floor of Terminal Administration Building shall be housing Operating cum Programming Station, Server Station, CCTV Control Station, Server Station, PLC Panel, UPS & 64" LED Screen as shown in the **Drawing I-521/ST/246.**

11.1.6 Power Factor Correction

11 kV capacitor banks with Automatic Power Correction Panels shall be provided at SS for each phase as shown in the attached **Power Single Line Diagram** to achieve power factor of 0.95 lag on 11 kV bus.

11.1.7 Distribution Transformer

11kV voltage is further stepped down to 415V through two numbers of distribution transformers for each phase has been considered, each capable of handling 100% load at a time. Transformers of rating 11kV/433V, 750KVA (Phase-1), 1500kVA (Phase-2) & 2000kVA (Phase 3), indoor Dry type, having off circuit tapping of +/-10%, in steps of 2.5%, winding temperature detectors with scanner for temperature alarm and trip, door safety limit switch and accessories are proposed for this project. One number 250kVA transformer has also been considered at Pump house.

11.1.8 Motors

All Motors including and below 132 kW shall be 415V and all motors above 132 kW shall be 11 kV, energy efficient (IE3), squirrel cage induction motors.

11.1.9 HT Power Distribution System

11kV HT Switchgear Panels are proposed at ESS for **Phase-1, Phase-2 & Phase-3.** All relays in these HT Switchgear Panels shall have intelligent type Multifunction relays(Numerical relays) and meters shall be of digital type with RS 485 communication port facility both for relays & meters. Lamps shall be LED type. . Busbars shall be high conductivity Aluminium alloy @ 1.0 Amps/mm^2 current density for HT Switchgear panels. One of each type of feeder, shall be provided as spare. The enclosure protection shall be IP54 minimum for indoor installation and IP55 minimum for outdoor installation.

11kV HT Switchgear Panel shall be provided with Vacuum Circuit Breaker (VCB) and Vacuum Contactor(VC) with HT Fuse of suitable breaking capacities but not less than 40KA for 1 second.

All of the above panels are shown in the attached **Power Single Line Diagrams for each phase.**

11.1.10 LT Power Distribution System

One number of 415V Power Control Centre (PCC) is proposed at ESS Phase-1, Phase-2 & Phase-3. All relays in this LT Switchgear Panel shall have intelligent type Multifunction relays (Numerical relays) and meters shall be of digital type with RS 485 communication port facility both for relays and meters. Lamps shall be LED type. Busbars shall be high conductivity Aluminium alloy @ 1.0 Amps/mm2 current density for PCC, ACDB & MLDB. Bus bar shall be of high conductivity electrolytic grade Copper @1.25 Amps/mm2 current density for other distribution boards (like LDB, PDB, CDB etc.). PCC shall feed power at 415V to the various LT Loads such as Belt conveyor motors, ACDBs, MLDB/LDBs, Distribution Boards (DBs) etc. The enclosure protection shall be IP54 minimum for indoor installation and IP55 minimum for outdoor installation.

PCC shall be provided with Air Circuit Breaker (ACB) and moulded case circuit breaker (MCCB) of suitable breaking capacities but not less than 50KA for 1 second. The rupturing capacity of miniature circuit breaker (MCB) used in DB's/SB's/FP's for further distribution shall not be less than 10 KA.

Industrial power sockets 240V 15A, minimum 2 Nos. at each floor or at a distance of every 30m in Electrical Substation, Pump House, Terminal Admin. Building, Worker's Amenity Building, Security Office, Weigh Bridge Building, Sewage Treatment Plant, Waste Collection Center, Covered shed, Transfer towers & Conveyors etc.

Welding socket 415V TPN and earth 63A, minimum 2 Nos. at each floor or at a distance of every 30m in Electrical Substation, Pump House, Terminal Admin. Building, Worker's Amenity Building, Security Office, Weigh Bridge Building, Sewage Treatment Plant, Waste Collection Center, Covered shed ,Transfer towers & Conveyors etc.

All of the above panels are shown in the attached Power Single Line Diagrams for each phase.

11.1.11 Standby Power Supply

Diesel generator (DG) set has been envisaged for the proposed project for feeding 20% of the High Mast and balance 100% Lighting requirements. As per Annexure-1 attached, one number 140 kVA DG set is proposed for Phase-1 and one number 140 kVA is proposed for both Phase-2 & Phase-3.

11.1.12 Illumination

The illumination level in various areas to be maintained at the working plane are mentioned below and for other areas not mentioned below it shall be based on National Electric Code.

Location	Average Lux Level	Type of Luminaire
Stockpile and Jetty Area	30	1x400W LED Flood Light, weather proof, Heavy duty High Mast(30 m) light in die cast Aluminium alloy housing
Electrical Substation, Transformer, DG Room, Worker's Amenity Building, Sewage Treatment Plant, Pump Room, Waste Collection Center, Weigh Bridge Building & Security Office	200	General Purpose Industrial compact batten suitable for 40 W LED Tube Light fitted with Aluminium heat sink
Terminal Admin. Building & Control Room	300	34Watt LED Panel with ultramodern recess mounting luminaire suitable for armstrong/grid/POP ceiling complete with separate electronic driver & high brightness Surface Mounted Device (SMD) LEDs
Storage shed	100	Open type vertical Medium Bay LED luminaire with high power COB 50W LED as light source
Belt Conveyors walkways, Transfer Towers	50	Vertical/Horizontal surface mounting pressure die-cast aluminium well glass luminaires with high power 40W LED as light source

Location	Average Lux Level	Type of Luminaire
Electrical Substation, Pump Room, Terminal Admin Building, Worker's Amenity Building, Security Office, Weigh Bridge, STP, Covered Shed, Transfer Towers, conveyor galleries, all exit / entry points etc.	10	Battery operated emergency lighting unit consist of aesthetically designed rechargeable 5 Watt LED lantern with dimming and SOS feature. Battery shall be rechargeable Li-ion type & 5V DC Li-ion charger with 1 hour battery backup

Wherever required poles of suitable height with fittings shall also be installed for outdoor lighting of the buildings.

Three numbers of MLDBs are proposed, one for each Phase. Phase-3 MDB shall be fed from Phase-2 MLDB. MLDBs shall receive dual power from respective MCC and DG supply, which in turn shall feed various LDBs. 1:1 Lighting transformers shall be placed at MLDB to maintain voltage drop within the permissible limits.

11.1.13 Cables

Power distribution at 11 kV shall be done through 11 kV (E), XLPE, stranded aluminium conductor, armoured, overall FRLS PVC sheathed cable laid on cable trays, ducts, directly buried in ground and in trenches, etc. as per site requirement.

LT power distribution to various LT motors and services such as illumination, firefighting, air conditioning, water supply etc. shall be done through 1.1 kV grade XLPE insulated, stranded aluminium conductor, armoured, overall FRLS PVC sheathed power cables. Laying of cables shall be done as per site requirement.

Internal wiring shall be done in recessed PVC conduit or on surface with GI conduit and single core PVC insulated FRLS copper wire.

FRP type cable trays shall be considered for the project. Thickness of the various components shall be as per the calculations and these calculations shall be submitted for client approval before starting the manufacture.

11.1.14 Earthing & Lightning Protection

An efficient earthing and lightning protection system shall be designed to ensure protection of men & material in worst of the weather conditions. Suitable Lightning protection system shall be installed as per the guide lines of the IS: 2309.

All equipment of substation and various other services / equipment shall be earthed at two points. There shall be one earth grid formation using 75 x 8 mm GI strip and all equipment earthing shall be connected to this earth grid through Aluminium wire with PVC coating or GI strip as per the requirement. This grid shall be connected with number of pipe electrodes. However, the neutrals of transformers and DG sets shall be earthed separately. Each neutral shall be connected to 2 numbers separate pipe earth electrodes. Earthing system shall be designed in principle as per IS: 3043, however for chemical earthing IEEE: 80-2000 shall also be followed.

For lightning protection separate earth pits shall be provided. Exact number of earth pits shall be worked out after earthing and lightning protection calculation has been carried out measuring the soil resistively at site.

Earth (chemical) pits shall be based on High Conductivity Technology. In this technology of chemical earthing, a compound of high electrical conductivity shall be filled up in the space around the ground electrode, so that the earth resistance value would decrease appreciably. Minimum Electrode size shall be as per the latest amendments of IS: 3043.

The high Conductive Compound shall be able to perform in any weather and soil Conditions and shall have following properties;

1) It shall have high electrical conductivity, which should remain constant and unaffected by changes in temperature & moisture.
2) It shall permanently remain embedded and should neither dissolve in and swept away by water.
3) It shall have an ability to absorb large amount of water and retain the same over a long periods of time.
4) It shall decreases earth pit resistance with passage of time.
5) Solubility: Shall be partly miscible; so that it does not dissolve fully like common salt and thus increasing the Earth Pit Life.
6) The pH value shall be near neutral so that it does not pollute soil or water and also does not corrode earth electrode.
7) It shall be maintenance free Compound so that there shall be no need of extra water pouring at regular interval as in conventional earthing material, because it should retain the moisture.
8) Chemical Compound shall be thermally conductive, in order to maintain a constant Earth resistance in temperature range of -50 to +60 degree Celsius.
9) The Compound shall have relatively High conductivity so that it can create very low resistance even in rocky areas.
10) It shall have low earth resistance, carries high peak current repeatedly.
11) It shall have a Long and reliable life.
12) It shall be easily installed in any soil conditions.

11.1.15 Ventilation and Air Conditioning (AC) System

Switchgear, DG, Transformer, JUVNL metering room, Electrical part of the Pump house etc. shall be provided with exhaust fans for ventilation to ensure proper maintenance of temperature inside the panel room and removal of additional heat produced due to various switchgears.

Control Room and Offices in the Administrative Building shall be Air-conditioned through centralized AC so as to maintain an inside temperature of 27^{O}C.

Tentative layout of the various rooms is shown in the drawings mentioned below:

a) Typical Layout of Terminal Administration Building, I-521/ST/232
b) Typical Details of Worker's Amenities Building, I-521/ST/237
c) Substation Equipment Layout, I-521/ST/245
d) Typical Layout & Elevations of Security Office, I-521/ST/234

e) On-shore Layout of Terminal Facilities in Phase-1, I-521/ST/214

f) On-shore Layout of Terminal Facilities in Phase-2, I-521/ST/215

g) On-shore Layout of Terminal Facilities in Phase -3, I-521/ST/216

11.1.16 Battery and Battery Charger

One number dual Battery and Battery Charger with DC Distribution Board for all the panels of all the Phases-1, 2 & Phase 3 shall be provided for the control, protection, interlocks and indication of switchgears.

11.1.17 Closed Circuit TeleVision (CCTV) System

To ensure surveillance of required locations as well as create secured record for post event analysis, CCTV system is proposed to be installed during Phase-2. The system shall provide an online display of video images on LED monitors located in Control Room and PTZ (360^{O}) cameras at various locations like Jetty, Stockyard, Covered Shed, etc. The core of the surveillance system shall be Network Video recorder (NVR) server. System shall also have operating systems, appropriate software, networking equipment and other essential components.

11.1.18 Control System

Centralized Control system for Phase-1, Phase-2 & Phase-3 shall be installed in control room as per attached control architecture drawings **Drawing I-521/ST/247 to 249**. To cater the requirement of Phase-2 & Phase-3 and extended panel housing input / output modules, LIUs, converters and other necessary items shall be provided and the same shall be hooked with central control room for Phase-1.

Centralized Control system shall be installed to ensure safe and reliable operation of conveyors, dust suppression system and others facilities. PLC system shall read the inputs, perform all system logic, conduct online diagnostics, sequencing control and control the outputs. The processor based central control system is envisaged to control and monitor the material handling operations so as to carry out the operation in an integrated mode from “Control Room”.

The core of the system shall consist of an Operating station and Programming cum Server Station (both the computers shall be latest version of the Industrial PCs - IPC as on the date of bidding) with printer and along with centralized real –time redundant PLC system (One online and the other in hot standby excluding I/O modules), sharing a RAID 6 (redundant array of independent disk) data storage system and a data network, with shared high-capacity data backup and off-site data archiving**.**

The control system would incorporate all safety interlocks to ensure complete safety to operating personnel and to avoid any damage to equipment due to mal-functioning.

The control system shall generally be based on the following principles:

i) To start equipment in either of the two modes i.e. ‘Local’ or ‘Remote’

ii) To trip off minimum equipment in the desired sequence during abnormal operating conditions, leaving all the other equipment running, which may safely be permitted to continue the operations

iii) To annunciate the fault which has tripped equipment along-with the cause for tripping

iv) To prevent restarting of the equipment until safe conditions have been restored

v) To retain maximum flexibility of operation consistent with safety

vi) To prevent mal-operation of equipment on interruptions

vii) To stop all the running equipment simultaneously by pressing Emergency Stop Push Button

viii) To stop running equipment in the reverse order with time lag during normal stop.

Processor would perform all operational and control functions. Processor would collect all the field related data from local field devices like local push button station, pull chord switch, belt sway switch, zero speed switch, local control panels etc. via junction boxes by means of data bus cable. The control network shall be real-time network, requiring long time continuous operation. During normal operations, the system cannot be shut off and it shall be possible to replace the components without shutting off the power. It shall be feasible to program the system online.

Proper care shall be taken in data transfer so as to achieve quick response while transmitting control and management information. The response time should not be more than one millisecond. The network system shall have fault clearance functions, secure transmission of data through error checking routines on all data transmitted. The networks shall use open systems (universal protocol) technology, support multiple industrial standards, allow a combination of multiple communication agreements, and shall have the capability to join wider networks in future through the server.

The analogue module system shall have provision to accept signals from other subsystems generating 4-20mA analogue signals. Proper conversion to standard units shall be done by control software. Redundancy (100% hot standby) is provided in the PLC's so that in case of failure of any of the processors, the hot stand by processor shall take over automatically. The changeover shall be smooth. Redundancy shall be provided for complete processor subsystem including CPU, memory, power supply.

Input/output units shall be capable of accepting discrete, analogue and digital input and output devices. If the number of slots for input and output modules in the controller rack is not sufficient, expansion units shall be connectable to the CPU by means of interface modules. Each Input and Output module shall be electrically isolated from the controllers through opto-couplers or isolation transformers and shall withstand severe voltage transients without damage or adverse effect on the controller. Output modules shall incorporate self-contained damping networks and voltage limiting devices to prevent false triggering of outputs and to suppress line voltage spikes.

PLC power supply units must have self-test facilities for detecting under voltage and also must be able to give alarm and switch over to UPS mode in case the output voltage is + 20% above the normal value. SCADA system shall be provided to control and monitor operation of the proposed facility.

11.1.19 Safety Switches

Safety switches for conveyors shall mainly consist of the Zero Speed Switches (ZSS), Belt Sway Switches (BSS), Pull Chord Switches (PCS) and Belt Take-up Switches (BTS).

PCS shall be installed @ 30m on both sides of each belt conveyor. BSS shall be installed @ 50m to stop drive unit for protecting belt from rubbing against the structural parts on both sides of each belt conveyor. One number ZSS shall be provided to stop the motor when the speed of the equipment drops below a specified value or if normal speed is not reached within a specified time, and to signal starting and stopping of preceding conveyor/ equipment. PCS and BSS shall be microprocessor based addressable type and shall be connected to the Master Unit for monitoring, which in turn shall communicate with the PLC. This Master unit shall be placed in the Field / Remote I/O panel as shown in the attached Control Architecture.

BTS switches shall be provided and installed so as to be actuated by an extreme movement of the conveyor belt take ups, should the belt tension not be adequate for any reason.

11.1.20 Communication System

Communication system comprises of Telephone and Public Address (PA) System.

11.1.21 Telephone System

EPABX system of 200 lines is proposed for this project covering the requirements of all the three Phases-1, 2 & 3. It is proposed to install the EPABX system in Phase-1 only, however the Telephone instruments as required in each phase can be procured during the commissioning of respective phases.

11.1.22 Public Address (PA) System

No PA system is proposed for this project.

Table 11.3: 11kV Load Calculation (Phase-1)

S.NO.	Equipment	Connected load (KW)	Utilization Factor (%)	Maximum Demand (KW)	TOTAL CAPACITANCE LOAD	
1	Barge Loader	200	0.70	140	140	
2	Pump House LT Load	380.0		80	80	
3	LT LOAD	811.1		577	577	
	Total HT Load in KW	**1391**		**797**	**Capacitance load**	797
					Multiplying Factor	0.553
					(0.75 to 0.95)	
					Required Capacitance	**440.80**
					CAPACITOR BANK	
					SELECTED	**450 kVAR**

Table 11.4 : LT Load Calculation (Phase-1)

S.NO.	Equipment	Connected load (KW)	Utilization factor (%)	Maximum Demand (KW)	DG Rating (kVA)
1	BC-7	75	0.8	60	
2	BC-8A	75	0.8	60	
3	BC-9A	65	0.8	52	
4	BC-10A	55	0.8	44	
5	BC-11A	75	0.8	60	
6	Tripper	7.5	0.8	6	
7	Flap Gate-1	3.7	0	0	
8	Flap Gate-2	3.7	0	0	
9	Flap Gate-3	3.7	0	0	
10	Magnet With Metal Detector	15	0.8	12	
11	Belt Weigher	0.5	0.8	0.4	
12	Electric Hoist-1	5.9	0	0	
13	Electric Hoist-2	5.9	0	0	
14	Electric Hoist-3	5.9	0	0	
15	Electric Hoist-4	5.9	0	0	
16	Electric Hoist-5	5.9	0	0	
17	Sewage Treatment Plant	7.5	1	7.5	
18	Water Supply Pump	30	1	30	
19	Weigh Bridge (including control room) (2x2kW)	4	0.8	3.2	0
20	High Mast Load (10x12kW)	120.0	0.8	96	0
21	MLDB (For 20% High Mast Load & Building Lighting Load)	106.0	1	106.0	106.0
22	ACDB (For Welding Socket Load)	85.0	0	0	0
23	Air conditioning Load	45.0	0.8	36	0
24	Battery Charger	5.0	0.8	4.0	0
	Total LT Load in kW	811.1		**577.1**	**106.0**
	Load in kW			**519.4**	**95.4**
	at 90% Diversity factor				
	Load in kVA at .95 pf			546.7	119.3
	Load at 120% Overload			656.1	143.1
	TRANSFORMER RATING SELECTED			**750 kVA**	**140 kVA**

Table 11.5: Pump House LT Load Calculation (Phase-1)

S.NO.	Equipment	Connected load (KW)	Utilization factor (%)	Maximum Demand (KW)
1	Fire Fighting- Phase -1	140.0	1	140
2	DSS - Phase-1	50.0	0.8	40.0
3	Fire Fighting - Phase -2	140.0	0	0
4	DSS - Phase -2	50.0	0.8	40.0
5	Fire Fighting - Master Plan Phase	0.0	0	0
6	DSS - Master Plan Phase	0.0	0.8	0.0
	Total LT Load in kW	380.0		**220.0**
	Load in kW			**198.0**
	at 90% Diversity factor			
	Load in kVA at .95 pf			208.4
	Load at 120% Overload			250.1
	TRANSFORMER RATING SELECTED			**250kVA**

Table 11.6: 11kV Load Calculation (Phase-2)

S. No.	Description	Installed KW	Utilization Factor (%)	Maximum Demand KW	Total Capacitance Load
1	Barger Loader (1 Nos.)	200	0.7	140	140
2	Wagon Tippler (1 Nos.)	600	0.7	420	420
3	Wagon Shifter (1 Nos.)	150	0.7	105	105
4	Stacker cum Reclaimer (2 Nos.)	800	0.7	560	560
5	LT Load	1470		958.32	958.32
	Total HT Load in KW	**3220**		**2183.32**	**2183.32**
			Capacitance Load		2183.32
			Multiplying Factor (0.75 to 0.95)		0.553
			Required Capacitance		1207.37596
			Capacitor Bank Selected		**1200 KVAR**

Table 11.7: LT Load Calculation (Phase-2)

S. No.	Description	Installed KW	Utilization Factor (%)	Maximum Demand KW	DG Rating (KVA)
1	Weigh Bridge (1 No.)	2	0.8	1.6	
2	BC-4A	90	0.8	72	
3	BC-12A	132	0.8	105.6	
4	BC-12B	132	0.8	105.6	
5	BC-14A	90	0.8	72	
6	BC-15A	75	0.8	60	
7	BC-16A	75	0.8	60	
8	BC-17A	55	0.8	44	
9	BC-6	110	0.8	88	
10	BC-6A	45	0.8	36	
11	BC-6B	75	0.8	60	
12	BC-8 (Extension)	75	0.8	60	
13	Travelling Tripper (1 Nos.)	22	0.8	17.6	
14	Flap / Diverter Gate (7 Nos.)	25.9	0	0	
15	Belt weigher (4 Nos.)	6	0.8	4.8	
16	Metal Detector (8 Nos.)	12	0.8	9.6	
17	Suspended Magnet / ILMS (4 Nos.)	60	0.8	48	
18	Electric Hoist (9 Nos.)	53.1	0	0	
19	High Mast	120	0.8	96	24
20	Battery Charger	5	0.8	4	
21	MLDB	120	1	120	120
22	ACBD (for welding socket load)	90	0	0	
	TOTAL LT Load in KW	1470		1064.8	144
	Load in KW at 90% Diversity Factor			**958.32**	**129.6**
	Load in kVA at 0.95 pf			1008.76	136.42
	Load at 120% Overload			1210.51	163.71
	Transformer & DG rating selected			**1500 kVA**	**170 kVA**

Table 11.8: 11kV Load Calculation (Phase-3)

S. No.	Description	Installed KW	Utilization Factor (%)	Maximum Demand KW	Total Capacitance Load
1	Barge Loader (2 No.)	400	0.7	280	280
2	Stacker cum Reclaimer (2 Nos.)	800	0.7	560	560
3	Reclaimer (1 No.)	500	0.7	350	350
4	LT Load	1914.8		1236.24	1236.24
	Total HT Load in KW	**3614.8**		**2426.24**	**2426.24**
			Capacitance Load		2426.24
			Multiplying Factor (0.75 to 0.95)		0.553
			Required Capacitance		1341.71072
			Capacitor Bank Selected		**1400 KVAR**

Table 11.9: LT Load Calculation (Phase-3)

S. No.	Description	Installed KW	Utilization Factor (%)	Maximum Demand KW	
1	Paddle Feedeer (2 No.)	90	0.8	72	
2	BC-1	110	0.8	88	
3	BC-2	75	0.8	60	
4	BC-3	132	0.8	105.6	
5	BC-4B	75	0.8	60	
6	BC-5A	75	0.8	60	
7	BC-5B	75	0.8	60	
8	BC-13B	132	0.8	105.6	
9	BC-7	132	0.8	105.6	
10	BC-8B	90	0.8	72	
11	BC-9B	55	0.8	44	
12	BC-10B	45	0.8	36	
13	BC-11B	75	0.8	60	
14	BC-13A	132	0.8	105.6	
15	BC-14B	90	0.8	72	
16	BC-15B	75	0.8	60	
17	BC-16B	75	0.8	60	
18	BC-17B	55	0.8	44	
19	Travelling Tripper (2 Nos.)	44	0.8	35.2	
20	Diverter / Flap Gate (10 Nos.)	37	0	0	
21	Belt weigher (3 Nos.)	4.5	0.8	3.6	
22	Metal Detector (7 Nos.)	10.5	0.8	8.4	
23	Suspended Magnet / ILMS (3 Nos.)	45	0.8	36	
24	Electric Hoist (12 Nos.)	70.8	0	0	
25	High Mast	20	0.8	16	
26	Battery Charger	5	0.8	4	
27	ACBD (for welding socket load)	90	0	0	
	TOTAL LT Load in KW	1914.8		1373.6	
	Load in KW at 90% Diversity Factor			**1236.24**	
	Load in kVA at 0.95 pf			1301.31	
	Load at 120% Overload			1561.57	
	Transformer & DG rating selected			**2000 kVA**	

12.0 ONSHORE TERMINAL INFRASTRUCTURE

12.1 Boundary Wall / Fencing

It is proposed to provide boundary wall of 2.4 m height using brick masonry with barbed wire fencing of 1 m high. The boundary wall shall be provided all-round the boundary of the project facilities founded on strip footing.

12.2 Internal Roads

In Phase-1 of the terminal, internal road shall be provided from security office and run all round the terminal and connecting to buildings, stockyard areas for coal and stone chips and storage shed for other cargo.

In addition to internal roads, the two ramps are also proposed connecting the onshore terminal area to the approach trestles of coal berth and stone chips/other cargo berth in Phase-1 of the terminal.

In Phase-2 and Phase-3, the internal road shall be extended covering the entire terminal area and additional stockyard areas for coal and stone chips and storage sheds for general cargo. Moreover, the additional ramps are also proposed connecting the onshore terminal area to the approach trestles of additional berths for coal, stone chips and other cargo.

The details of internal roads to be developed in all the phases are as given in Table 12.1, Table 12.2 & Table 12.3 respectively:

Table 12.1: Details of Internal Roads in Phase-1 of Terminal

Carriageway Width	Length
12 m	1396 m
10 m	520 m

Table 12.2: Details of Internal Roads in Phase-2 of Terminal

Carriageway Width	Length	Incremental length
12 m	6896 m	5500 m
10 m	1020 m	1200m
8 m	920 m	550 m

Table 12.3: Details of Internal Roads in Phase-3 of Terminal

Carriageway Width	Length	Incremental length
12 m	7676 m	850m
10 m	1020 m	-
8 m	1250 m	550 m

Typical cross sections of Internal Roads and Parking Area for terminal in all the Phases are shown in **Drawing I-521/ST/250** to **I-521/ST/252** respectively.

12.3 Water Supply

The water requirements for the terminal in different Phases are furnished in Table 12.4 below:

Table 12.4: Water Demand in different phases for Terminal (Litre/per day)

S. No.	Facilities	Water Demand (Litre/per day)		
		Phase-1	Phase-2	Phase-3
1.	**Raw Water**			
	• Greenery and Landscape	22,000	40,000	40,000
	• Dust Suppression	140,000	170,000	310,000
	Total Raw Water Requirement (Litre/per day)	**162,000**	**210,000**	**350,000**
2.	**Potable Water**			
	• Terminal Personnel & Users	38,000	42,000	59,000
	• Vessel Supply	8,500	20,000	40,000
	Total Potable Water Requirement (Litre/per day)	**46,500**	**62,000**	**99,000**

The scheme for providing raw water and potable water in Phase-1 development of terminal is described below.

The potable water required for personnel and vessel supply shall be drawn by the water supply source of state government through a pipeline laid upto the boundary of the project facilities or shall be tapped from borewell. Water shall be tapped from that source and transferred to an underground reservoir of 100 cum capacity located within the project boundary.

The potable water from the sump will again be pumped into an overhead tank of 100 cum capacity provided, from where the potable water shall be supplied to the tanks located on the top of buildings by gravity. The potable water from overhead tank shall be supplied to the vessels calling at the terminal by gravity.

The raw water required for dust suppression, firefighting and plantation shall be tapped from bore-well and transferred to an underground reservoir 500 cum capacity located adjacent to potable water reservoir.

The raw water shall be pumped to another underground reservoir of 500 cum capacity located at coal stockyard, which includes a separate chamber of 350 cum for static storage of fire water and another chamber of 150 cum for dust suppression system.

To cater the demand of raw and potable water in Phase-2 and Phase-3, the only addition shall be the underground reservoir of 350 cum capacity for static storage of fire water and located adjacent to reservoir planned for firefighting in Phase-1.

The schematic layout of water supply system in all the Phases are shown in **Drawing I-521/ST/253 to I-521/ST/255** respectively.

12.4 Sewerage System

The amount of sewage/waste water generated in the terminal are worked out in all the Phases and furnished in Table 12.5 below:

Table 12.5: Details of Sewerage in different Phases of Terminal

S. No.	Phases of the Terminal	Sewerage/Waste water generation in L/day
1.	Phase-1	30,000
2.	Phase-2	34,000
3.	Phase -3	48,000

It is therefore proposed to provide a small sewage treatment plant of 30 kLD capacity in Phase-1 itself and further extended to 60 kLD capacity in Phase-3, located near the terminal building. It shall receive sewerage from the terminal building and Worker's Amenities Building. The treated sewage shall be used for greenery and in case of any surplus that will be discharged to the drainage network along the access road outside the terminal boundary. The sludge from the treatment plant will be processed and converted into Biomass used as manure.

There will be very little sewage water generated at the berths and hence separate treatment proposals are not contemplated.

12.5 Storm Water Drainage

The drainage system for carrying the storm water run-off shall be designed for rainfall intensity of 55 mm/hr at project site location based on iso-pluvial maps of india.

In Phase-1, the drainage system at the coal stockyard and stone chips stockyard mainly comprises of the open drain which carry the storm water runoff to dumping pond from where the clear water shall be used for plantation.

The drainage network for the storage shed will comprise mainly of two longitudinal drains at front and rear end of shed. From the central part, shed pavements will slope at 1:1000 on either side to the drains. These longitudinal drains will discharge the water to the transverse drains, which disposes the water into the rain water harvesting pond for harvesting purpose. The storm water from the buildings will also be connected to the respective storm water drain through small drains and then carried to rain water harvesting pond for harvesting purpose.

The drainage system for coal & stone chips stockyard and storage shed as followed in Phase-1 shall be provided for additional stockyards for coal & stone chips and storage sheds in Phase-2 and Phase 3.

The proposed drainage network in Phase-1, Phase-2 and Phase-3 are as shown in **Drawing I-521/ST/256** to **I-521/ST/258** respectively.

12.6 Computer System

A system whereby the central computer is connected with computers through local area network (LAN) has been considered. The computers would be able to work independently as well as 'in linked' mode with the terminal's central computer.

12.6.1 Information Technology Systems

12.6.1.1 Overall Objectives

- Establish one common IT infrastructure that is based on large scale operations in order to deliver services of high quality.
- Enable centralized control of the Infrastructure to ensure effective management and security.
- Ensure mobility of users located at different office premises by providing the necessary services to ensure connectivity from anywhere.
- Utilize best practices for technology selection and implementation.

12.6.1.2 IT Architecture

Service Oriented Architecture is proposed wherein underlying systems offer their functionality in the form of services to a central services platform catering to the following:

- Processing the services and presenting them to the user through a portal interface
- Managing the business processes to combine multiple services based on user request or information
- Internal and external integration
- Provide generic services such as security, authorization/authentication, load balancing etc.

For Project Facilities the IT architecture will have the following components

- Business systems for Terminal
- TAS- Terminal Administrative System/ERP System
- System Software – Operating Systems, Database
- IT Infrastructure & Facility Management.
- Business Intelligence/ Data Warehousing
- Networking –Wired & Wireless
- Hardware Systems (Servers, Storage, Desktops/Laptops)
- ISP Connectivity
- Backup & Recovery systems
- BCP/DR.

12.7 Fire Fighting Facilities

The firefighting system should be capable of both controlling and extinguishing fires. In Phase-1 of the terminal, it is proposed to install single headed Fire Hydrant System at the berths and coal stockyard and the spacing of hydrants shall not be more than 45m.

12.7.1 Water Sources for the Fire Protection Systems

It is envisaged to use raw water for fire hydrant system. The raw water shall be drawn from the dedicated underground firefighting reservoir. There shall be two pumps (1W+1S). The main pump shall be electric motor driven and the standby pump shall be diesel driven. The jockey pump shall also be provided to keep the firewater main under required pressure.

12.7.2 Fire Detection and Alarm System

Fire detection and alarm system shall be provided to indicate incident of fire in any part of the terminal complex. The fire detection and alarm system shall mainly comprise of manual call points and glass bulbs in the automatic sprinkler system, notifiers (hooters, sirens and exit signs) and local fire alarm panels.

The Fire detection and alarm system shall be microprocessor based, intelligent, addressable Main Fire Alarm Panel, located in the Fire Station, interfaced with a number of, fire detectors, MCP, glass bulb and Notifiers placed strategically throughout the complex. A Repeater panel shall be located in the Central Control Room to give and receive status signals.

Drawing I-521/ST/259 presents the General Arrangement of firefighting system in Phase-1 development of the terminal.

Portable fire extinguishers shall be provided at all fire hose box inside the terminal buildings in addition to the key locations such as parking area and storage shed. The extinguishing medium selected shall be based on hazards encountered in the immediate area. Fire Extinguishers with suitable capacity, rating and medium such as CO2, Dry Chemical Powder (DCP) and with standard accessories and in adequate numbers as per TAC shall be provided.

In Phase-2 and Phase-3, the fire hydrant system, fire detection & alarm system, fire extinguishers in buildings as followed during Phase 1 of the terminal shall continue in these phases also. In addition to this, Medium Velocity Water Supply (MVWS) system for coal conveyor system shall be laid from Transfer Tower at the stockyard and up to the beginning of the berth.

The water required for the medium velocity water spray system on the conveyor galleries shall be raw water collected into an underground reservoir planned for firefighting use. The spray water pumps (1W+1S+1J) shall be installed at the underground reservoir. The main water pump shall be electric motor driven and stand-by shall be diesel driven. The jockey pump shall also be electric motor driven.

Drawing I-521/ST/260 and I-521/ST/261 presents the General Arrangement of firefighting system in Phase-2 and Phase-3 of the terminal.

12.8 Dust Suppression System

Dust control equipment is proposed for efficient control of dust pollution to the environment during storage and handling of coal/stone chips at the terminal. An efficient dust suppression system will contain dust particles before it becomes airborne.

The following Dust Suppression System has been planned for the coal & stone chips handling facilities in all the phases of terminal:

Table 12.6: Dust Suppression System

S.No.	Facilities	Dust Suppression System
1.	Barge Loaders	Plain water fine spray with medium pressure standard hydraulic system using raw water.
2.	Stacker cum Reclaimers	Plain water fine spray with medium pressure standard hydraulic system using raw water.
3.	Coal Stockyard	Swiveling plain water sprinklers for abatement of coal dust generation along the length of the stockpile.
4.	Reclaimers	Plain water fine spray with medium pressure standard hydraulic system using raw water.
5.	Stone chips Stockyard	Swiveling plain water sprinklers for abatement of stone chips dust generation along the length of the stockpile.
6.	Transfer Towers	Plain water fine spray nozzles for dust suppression of airborne dust at the conveyer discharge and receipt points

- An underground reservoir dedicated for dust suppression System shall be provided in the stockyard.
- Two (2) DSS pump (1 working + 1 standby) shall be provided for water and air supply to Barge Loaders and conveyor Transfer points of DS system. The pipe routing shall be taken through the conveyor structures.
- Each water spray header in DS system shall be provided with a solenoid valve to stop the water spray when the concerned plant and equipment of coal/stone chips handling system do not operate.
- Each DS system shall be operated from the local control panels and shall be interlocked with the respective conveyor / equipment.
- Local Control Panel / Cabinets as per requirement of DSS shall be provided, in the central control room, including cabling, fiber optic cables, from the respective equipment. Provision shall be made in the local control panel to receive all input signals through potential free interfaces from the Central Control Room of the main coal handling facility for the operation of the DSS. Similarly all out put signals giving status of the operation of DSS shall be given through the potential free interfaces of the LCP to the Central Control Room.

The layout of Dust Suppression System (DSS) in all the phases are shown in **Drawings I-521/ST/262** to **I-521/ST/264** respectively**.**

12.9 Security System

Keeping in view the importance of various areas of the terminal development, the following proposals are made as part of the security system:

- A brick masonry wall 2.4m high with barbed wire fencing of 1m high will be provided covering the boundary of the IWT terminal.
- A security office and check post each at the entrance to the IWT terminal.
- Provision of CCTV at strategic locations.

13.0 INSTITUTION MECHANISM FOR EXECUTION

13.1 Introduction

Time and cost overruns are common in Indian infrastructure projects in particular public sector investments. Delays and cost overruns in massive infrastructure projects like development of inland water terminals may bring down the effectiveness of the investment made.

In this chapter, the various reasons that may cause time and cost overrun has been captured and the institutional mechanism to avoid the time and cost overrun has been elaborated. In addition, the advantages of Project Management Method (PMC) is also detailed.

13.2 Reason for Time and Cost Overrun

13.2.1 Reason for Schedule overrun during Pre-execution Stage

Following are the major reasons for project schedule delay during pre-execution stage.

- Poor project formulation due to inadequate field investigation, lack of adequate data, inadequate analysis of environmental and rehabilitation implications, changes in prices and exchange rate regimes, etc.
- Delay in Land/site handover
- Delays in obtaining clearance from various regulatory agencies in land acquisition and in procurement of materials. Such delays are primarily due to poor coordination and project planning, as these problems are not explicitly considered or taken into account at the planning stage
- Problems with Rehabilitation and Resettlement
- Relationship with other projects (Forward and Backward linkages).

13.2.2 Reason for Schedule overruns during Execution and Closing Stage

Following are the notable reasons for project schedule delay during execution and closing stage:

- Changes in design or scope of projects midway through execution
- Inability of the project management to take prompt decisions on various aspects of these projects even when the objective circumstances warrant such decisions
- Management problems such as personnel, labour and contractor disputes, mis-match of equipment, etc.
- Inadequate and untimely release of funds
- Unforeseeable factors such as adverse geotechnical conditions and natural calamities
- Contractual disputes
- Ineffective project monitoring
- Unavailable of funds.

13.2.3 Reason for Cost Overruns in Pre-execution Phase

- Scope creep
- Inadequate DPR, original estimate and budgeting of project
- Poor selection of consultant.

13.2.4 Reason for Cost Overruns during Execution Phase

- Material price escalations beyond projections
- Design changes/iterations
- Weak contract administration
- Weak procurement planning
- Contractual disputes due to poor framing of contract document.

13.3 Mechanism to Avoid Time and Cost Overrun during Project Preparation Stage

- Risk identification and Planning

Planning is the most effective component to avoid time and cost overruns. It is essential to do a detailed planning for all potential risks, so that the project could be completed effectively with minimum deviations.

- Appointment of qualified contractor

The time overrun of the project can be minimized to a greater extend, when a qualified contractor is deployed to carry out the construction work of Sahibganj terminal.

- Freezing the scope of the project stay

In general, scope creep is one of the keep element which may delay the project schedule. This can be avoided only when the scope of the project is frozen during the project preparation stage.

- Sound Implementation Planning

Sound implementation planning is a pre-requisite for effective implementation. Realistic, implementable plans can be formulated by using techniques such as PERT/CPM and estimating activity times, linkages and resource requirements realistically through an inter-disciplinary group-process where experiences of many persons is pooled together.

13.4 Mechanism to Avoid Time and Cost Overrun during Approval Stage

13.4.1 Planning of Approval Procedure

The approval procedure should be linked with early completion of projects and sustainability of project output. The unrealistic approval procedure may delay the project. At the other extreme, less stringent approval procedures encourage a tendency to get too many projects cleared without the requisite financial resources in sight. There is, thus, a need for striking a balance between these extremes.

13.4.2 Time-Bound Approvals

Apart from rigour in planning and project management, certain procedural and institutional reforms would be required to reduce avoidable delays and thus cost overruns. Time -bound clearances at different stages and effective inter-agency coordination would cut down time and cost overruns considerably.

13.5 Mechanism to Avoid Time and Cost overrun during Execution Stage

13.5.1 Using automated project management tools

Proper scheduling is a must in complex projects. The complexity of the scheduling and monitoring process can be simplified by adopting automated project management tools like MS Project, Primavera etc.

13.5.2 Effective Stakeholder Communication

Effective communication can help reduce the delays by avoiding working on wrong things and making the scheduling work better. The effective communication can be implemented by having periodic meeting with the stakeholders.

13.5.3 Periodic Review and Oversight

Periodic review and oversight is one of the most commonly adopted strategy to control project schedule delay.

13.5.4 Effective Risk Management Procedure

For the infrastructure projects like development of inland water terminals, the span of the project implementation will be long and therefore nature of risk involved in such projects also keeping evolving constantly. Therefore, it is essential to have an effective risk management procedure to avoid and overcome such type of risks.

13.5.5 Inclusion of Cost Escalation Clause in Contract Agreement

Inclusion of cost escalation clause in the contract agreement is an effective way of safeguarding against the project cost overruns.

13.6 Advantage of Project Management Consultancy

It is worthwhile to mention that our Indian Government is also emphasising the importance of the project management. In the Twelfth Five Year Plan, the government has plans to focus on improving the project management skills across country to get better returns from public investment in infrastructure. Even the Ministry of Statistics and Programme Implementation (MOSPI) confirms that many projects are suffering from delays and cost overruns.

The various time and cost overruns listed above can be effectively minimized by appointing a qualified Project Management Consultancy (PMC). The Project Management Consultancy (PMC) with a team of experienced professionals, will be able to identify the issues related to cost & schedule overrun. Also, the PMC could able to effectively implement the above said mechanisms to avoid the time and cost overruns.

Following are the notable advantages that can be obtained by appointing qualified PMC for the huge infrastructure projects like development of inland water terminals:

- Better Efficiency in Delivering Services
- Reduced cycle time and delivery Costs
- Improved quality of project deliverables
- Early identification of issues and risks
- Improved accuracy of project estimates
- Improved people and resource management.

14.0 TENDER DOCUMENTS

The Engineering, Procurement and Construction (EPC) mode contract documents for development of Phase-1 of the terminal are prepared and comprises of following:

a) Request for Qualification (RFQ)

The RFQ document is prepared so as to pre-qualify suitable applicants who will be eligible for participation in the bid stage.

b) Request for Proposal (RFP)

The RFP document is prepared to invite all the pre-qualified and short listed applicants so as to select the bidder for award of the contract.

The RFP document comprises of three volumes as given below:

Volume 1 : Bidding Document

Volume 2 : Technical Specification and Drawings

Volume 3 : Bill of Quantities (BOQ)

All the above mentioned documents are enclosed separately.

15.0 LAND DETAILS FOR TERMINAL AND RAIL & ROAD CONNECTIVITY

15.1 Main Terminal

The proposed IWT Terminal at Sahibganj shall require an area of 1500 m x 350 m in Phase 3and accordingly an area of 183.13 acres shall be acquired in view of the topography of area. Out of 183.13 acres area, 159.21 acres area falls on land upto low water line and the remaining area of 23.92 acres falls in river Ganga and exposed during lean season. The land details for main terminal is given in Table 15.1 below:

Table 15.1: Land Details for Main Terminal

Sl.No.	Name of Mauza	Type of Land	Area of Land (in Acres)
1.	Rampur	Private Land	31.27
		Government Land	1.11
		Sub-total	32.38
		Unsurveyed Land	4.42
		Sub-total-1	**36.80**
2.	Samda Nala	Private Land	120.79
		Government Land	6.04
		Sub-total	126.83
		Unsurveyed Land	19.50
		Sub-total-2	**146.33**
		Total-1+2	**183.13**

The Revenue/Khasra map and ownership details for **159.21 acres** excluding area of unsurveyed land are collected from State Revenue Department, Government of Jharkhand. The Revenue/Khasra map superimposed with layout of IWT Terminal is shown in **Figure 15.1**. The ownership details for main terminal are enclosed in **Appendix-B**.

15.2 Road Corridor

The road corridor from Gate No. 54 to the entrance of terminal is proposed to be 40 m wide & the length along the proposed road alignment is 902 m. The area of land to be acquired for road corridor works out to be 8.70 acres.

The land details for road corridor is given in Table 15.2 below:

Table 15.2: Land Details for Road Corridor

Sl.No.	Name of Mauza	Type of Land	Area of Land (in Acres)
1	Jamuni	Private Land	0.320
		Railway Land	0.175
		Sub-total-1	**0.495**
2.	Samda Nala	Private Land	2.020
		Government Land	0.045
		Sub-total-2	**2.065**
3.	Hathigarh	Private Land	4.755
		Government Land	1.385
		Sub-total-3	**6.14**
		Total-1+2+3	**8.70**

The key plan showing Revenue/Khasra map superimposed with road corridor is shown in **Figure 15.2**. The chainagewise details of road corridor showing Khasra numbers is shown in **Figure 15.3 to 15.5**. The ownership details of road corridor are enclosed in **Appendix-C**.

15.3 Rail Corridor

The rail corridor forming Y connection is proposed to be 30 m wide and the length along the proposed rail alignment is 3.6 km. The area of land to be acquired for rail corridor works out to be 20.307 acres; comprising of 19.284 acres for private land and 1.023 acres for government land. The land details for rail corridor is given in Table 15.3 below:

Table 15.3 : Land Details for Rail Corridor

Sl.No.	Name of Mauza	Type of Land	Area of Land (in Acres)
1	Jamuni	Private Land	2.489
		Government Land	0.150
		Sub-total-1	**2.639**
2.	Bohan	Private Land	8.441
		Government Land	0.426
		Sub-total-2	**8.867**
3.	Partabari	Private Land	1.673
		Government Land	0.118
		Sub-total-3	**1.791**
4.	Satichauki Khutahari	Private Land	1.437
		Government Land	0.326
		Sub-total-4	**1.763**
5.	Hathigarh	Private Land	0.016
		Government Land	0
		Sub-total-5	**0.016**
6.	Paltanganj	Private Land	1.835
		Government Land	0.003
		Sub-total-6	**1.838**
7.	Samda Nala	Private Land	**3.393**
		Government Land	**0**
		Sub-total-7	**3.393**
		Total-1+2+3+4+5+6+7	**20.307**

The key plan showing Revenue/Khasra map superimposed with rail corridor is shown in **Figure 15.6**. The ownership details of rail corridor are enclosed in **Appendix-D**.

15.4 Road Over Bridge

The road over bridge is proposed to be provided at Gate No. 54 and integrated with National Highway 80. The road over bridge comprises of two parts:

15.4.1 Road Over Bridge from Gate No. 54 to NH-80

The road over bridge from Gate No. 54 to NH-80 includes elevated portion of length 52 m and area of land to be acquired for this portion is already covered up in the area of road corridor.

15.4.2 Road Over Bridge along NH-80 at Gate No. 54

The road over bridge along NH-80 at Gate No. 54 includes elevated portion and approach on filling with total length of 1000 m. The width of corridor is proposed to be 45 m. Accordingly, area of land to be acquired for this portion is **13.61 acres** in view of the topography of area.

The land details for road over bridge along NH-80 is given in Table 15.4 below:

Table 15.4 : Land Details for ROB along NH-80

Sl.No.	Name of Mauza	Type of Land	Area of Land (in Acres)
1	Chhota Bhagiamari	Private Land	3.17
		Government Land	0.49
		Sub-total-1	**3.66**
2.	Jamuni	Private Land	7.975
		Government Land	1.975
		Sub-total-2	**9.95**
		Total-1+2	**13.61**

The Revenue/Khasra map superimposed with road over bridge corridor is shown in **Figure 15.7**. The ownership details of road over bridge corridor are enclosed in **Appendix-E**.

SANTHAL PARGANAS

MOUZA-SAMUDANALH No-1 AND RAM PUR No-3

BANGLA - SAHIBGANJ

ANCHAL + SUB. + DIST- SAHIBGANJ

SCALE - 1 INCH = 1 MILE.

YEA - 1924-25.

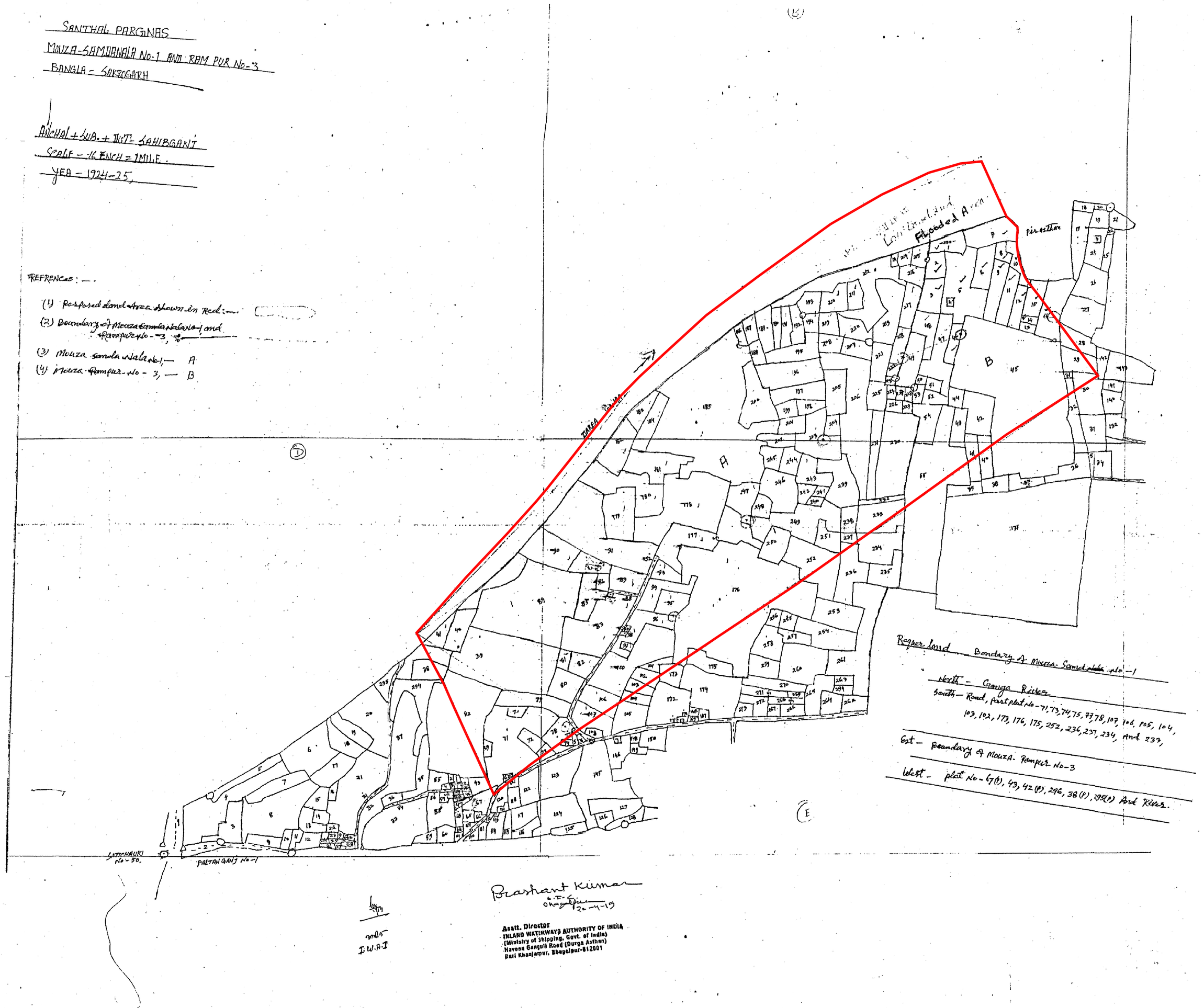
REFRENCES :—

(1) Reposed land area shown in Red :—

(2) Boundary of Mouza Samula Wala No-1 and Rampur No-3, ———

(3) Mouza Samula Wala No-1, — A

(4) Mouza Rampur No - 3, — B



Regd. land Boundary of Mouza Samula Wala No-1

North - Ganga River.

South - Road, Part plot no - 71, 73, 74, 75, 77, 78, 107, 104, 105, 104, 103, 102, 173, 176, 175, 252, 236, 237, 234, And 233,

East - Boundary of Mouza Rampur No-3

West - plot No - 67(P), 43, 42(P), 296, 38(P), 39(P) And River.

Prashant Kumar
A.E.
20-4-19

Asstt. Director
INLAND WATERWAYS AUTHORITY OF INDIA
(Ministry of Shipping, Govt. of India)
Navana Ganguli Road (Durga Asthan)
Pati Khanjanpur, Bhagalpur-812001

IWAI

Regd. land detail of Mouza Samula Wala No-1,

S.No	Plot No	Required Area in A- D-	S.No	Plot No	Required Area in A- D-	S.No	Plot No	Required Area in A- D-
1	29	5·40	56	190	0·26	113	232	0·25
2	69 (P)	0·40	57	191	0·49	114	233 (P)	0·96
3	41	0·73	58	192	0·43	115	234 (P)	0·02
4	42 (P)	2·36	59	193	0·56	116	236 (P)	0·09
5	395 (P)	0·44	60	194	0·25	117	237 (P)	0·16
6	70	0·19	61	195	0·06	118	238	0·05
7	71 (P)	0·35	62	196	0·45	119	250	0·10
8	72	0·39	63	197	0·81	120	241	0·12
9	73 (P)	0·13	64	198	0·33	121	250	0·78
10	74 (P)	0·01	65	199	0·32	122	251 (P)	0·58
11	75 (P)	0·01	66	200	1·87	123	252 (P)	1·07
12	77 (P)	0·01	67	201	0·75	124	173 (P)	0·13
13	78 (P)	0·57	68	202	0·96	125	175 (P)	0·05
14	79	1·09	69	203	1·53	126	293	0·62
15	80	0·88	70	204	0·27		Total	0·35
16	81	0·20	71	205	1·06			
17	82	0·59	72	206 (P)	1·52			
18	83	2·75	73	292	0·39			
19	84	6·51	74	207	0·29			
20	85	0·91	75	208	0·52			
21	86	0·23	76	209	0·42			
22	87	0·02	77	210	0·45			
23	88	0·08	78	211	0·83			
24	89	0·82	79	212	0·87			
25	90	1·06	80	213	0·87			
26	91	4·48	81	214	0·29			
27	92	0·72	82	215	0·78			
28	93	0·41	83	216	0·83			
29	94	0·81	84	217	0·78			
30	95	0·67	85	218	0·78			
31	96	1·05	86	219	1·88			
32	97	0·02	87	220	0·12			
33	98	0·01	88	221	0·89			
34	99	0·03	89	222	0·78			
35	100 (P)	2·47	90	223	0·92			
36	103 (P)	0·22	91	224	0·22			
37	102 (P)	0·25	92	225	0·58			
38	101 (P)	0·19	93	226	0·22			
39	100 (P)	0·08	94	227	0·78			
40	105 (P)	0·70	95	228	0·78			
41	104 (P)	0·36	96	229	0·22			
42	174 (P)	9·22	97	230 (P)	2·87			
43	177 (P)	2·90	98	231 (P)	0·87			
44	178	4·44	99	239 (P)	1·32			
45	179	1·58	100	38 (P)	0·78			
46	180	2·17	101	68	0·07			
47	181	1·50	102	242 (P)	0·58			
48	182	1·18	103	243 (P)	0·78			
49	183	0·49	104	249	0·58			
50	184	0·81	105	245	0·58			
51	185	12·80	106	246 (P)	1·36			
52	186	0·25	107	247	1·16			
53	187	0·35	108	248	0·58			
54	188	0·25	109	249 (P)	2·03			
55	189	0·67	110	69	0·03			
			111	67 (P)	0·88			
			112	68 (P)	0·09			
				Total	126·83			

Regd. land detail of Mouza Rampur No-3

S.No	Plot No	Required Area in A- D-
1	1	0·54
2	2	8·50
3	3	0·74
4	4	0·06
5	5	2·27
6	6	0·75
7	8	1·06
8	9	0·22
9	9	0·86
10	10	0·38
11	11	0·74
12	12	0·47
13	13	0·17
14	14	0·13
15	15 (P)	0·45
16	16 (P)	0·56
17	28 (P)	0·22
18	29 (P)	0·53
19	30 (P)	0·18
20	31	0·09
21	42	1·12
22	43	0·54
23	44	0·20
24	45 (P)	0·62
25	46	0·40
26	47	1·42
27	48	0·76
28	49	1·11
29	50	0·09
30	51	1·12
31	52	0·22
32	53	0·31
33	54	0·18
34	55 (P)	0·84
35	32 (P)	2·92
36	40 (P)	0·06
37	41 (P)	0·24
		0·35
	Total	32·38

Boundary

North - Ganga River.

South - Part plot no - 39, 32, 45, 40, 41 and 55,

East - Pir Asthan, part plot no - 15, 16, 28, 29.

West - Boundary of Mouza Samula Wala No-1

FIG.-15.1
REVENUE / KHASRA MAP SUPERIMPOSED WITH LAYOUT OF IWT TERMINAL

RIVER GANGA

PROPOSED IWT TERMINAL AT SAHIBGANJ

0+000

0+100

0+200

0+300

0+400

0+500

0+600

0+700

0+800

0+900

PROPOSED ROAD CORRIDOR
(40 m WIDE)

LEVEL CROSSING
AT GATE NO. 54

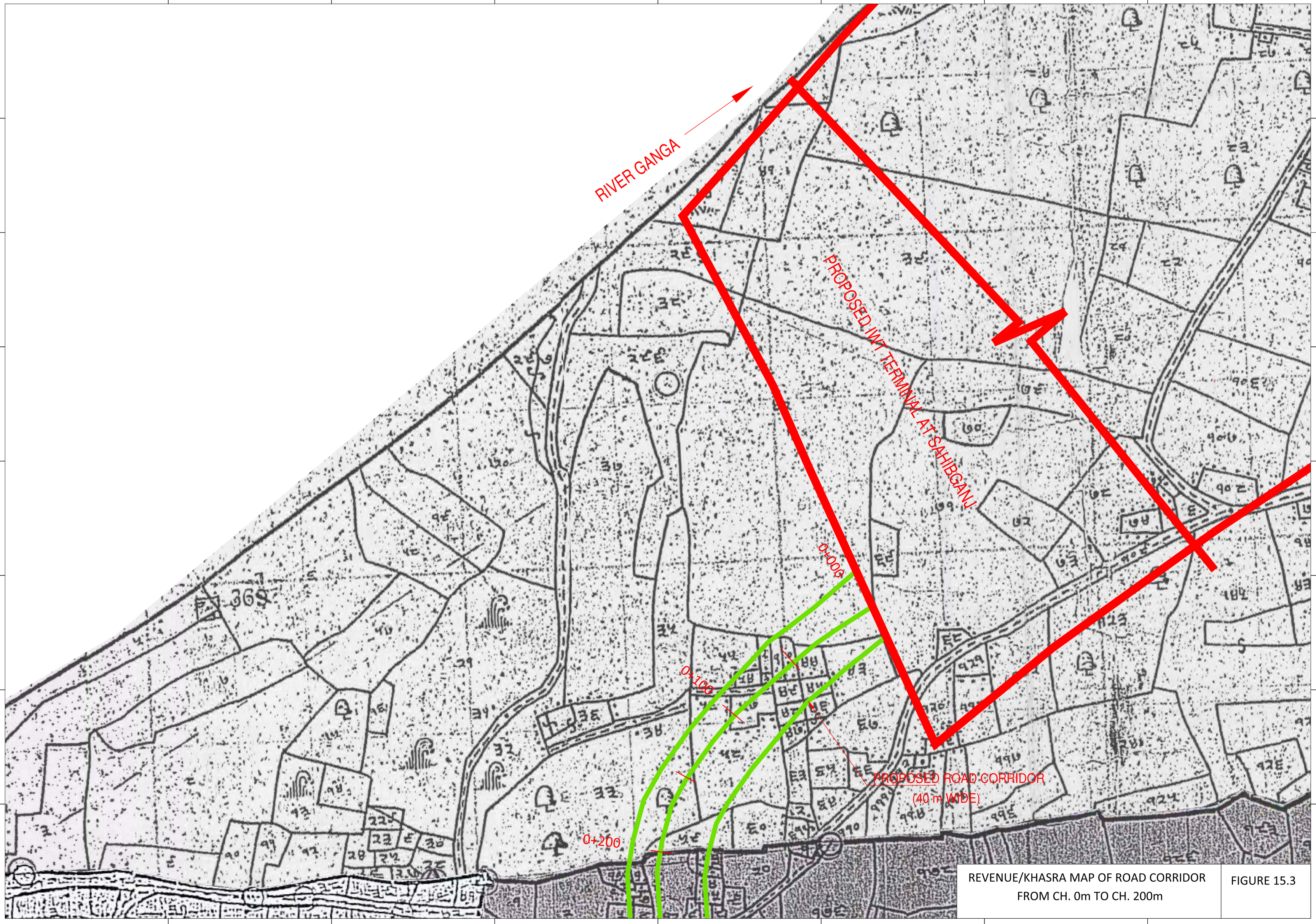
To Farakka

To Sahibganj

NATIONAL HIGWAY 80

KEY PLAN SHOWING REVENUE/ KHASRA MAP SUPERIMPOSED WITH ROAD CORRIDOR

FIGURE 15.2

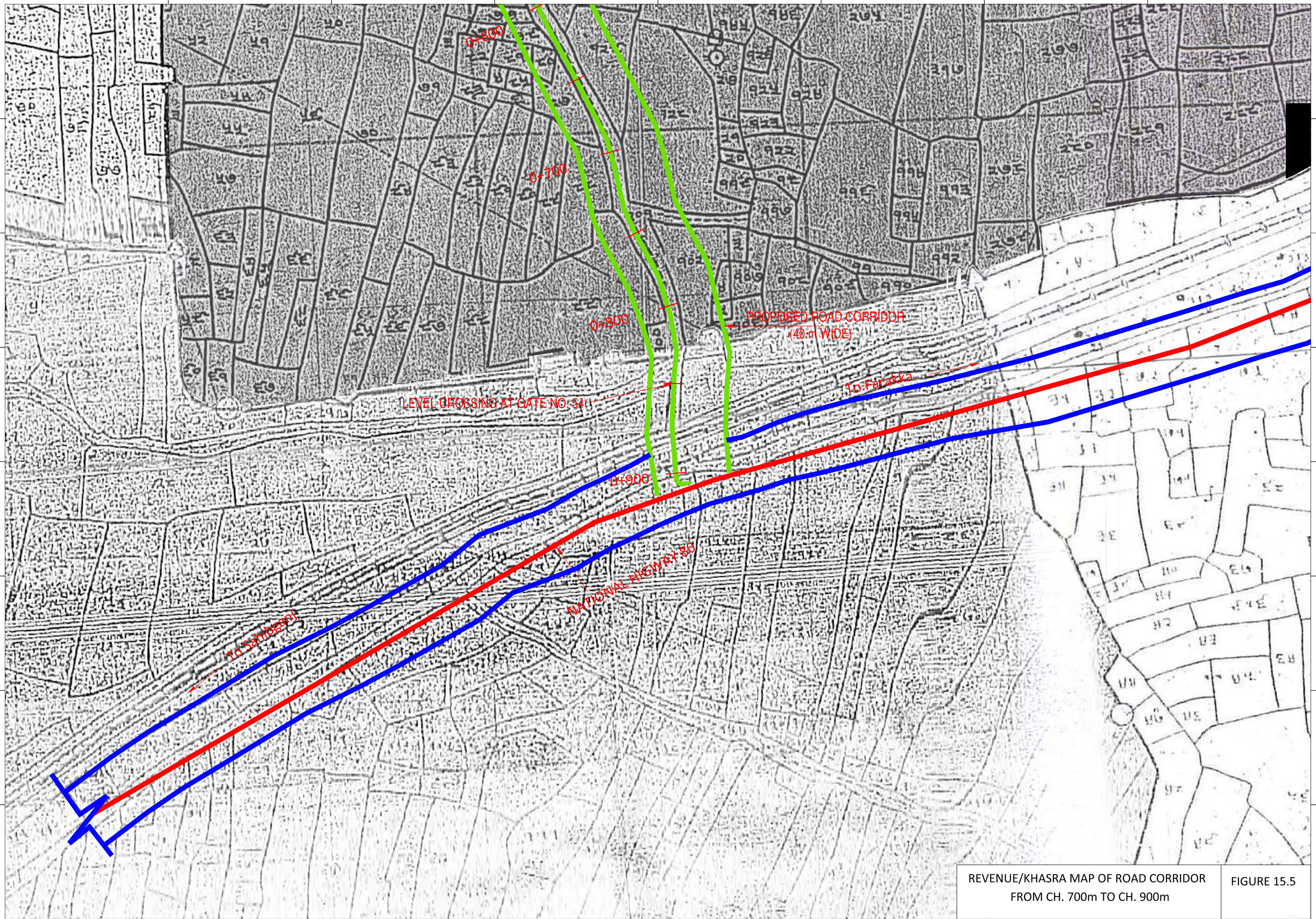


REVENUE/KHASRA MAP OF ROAD CORRIDOR
FROM CH. 0m TO CH. 200m

FIGURE 15.3

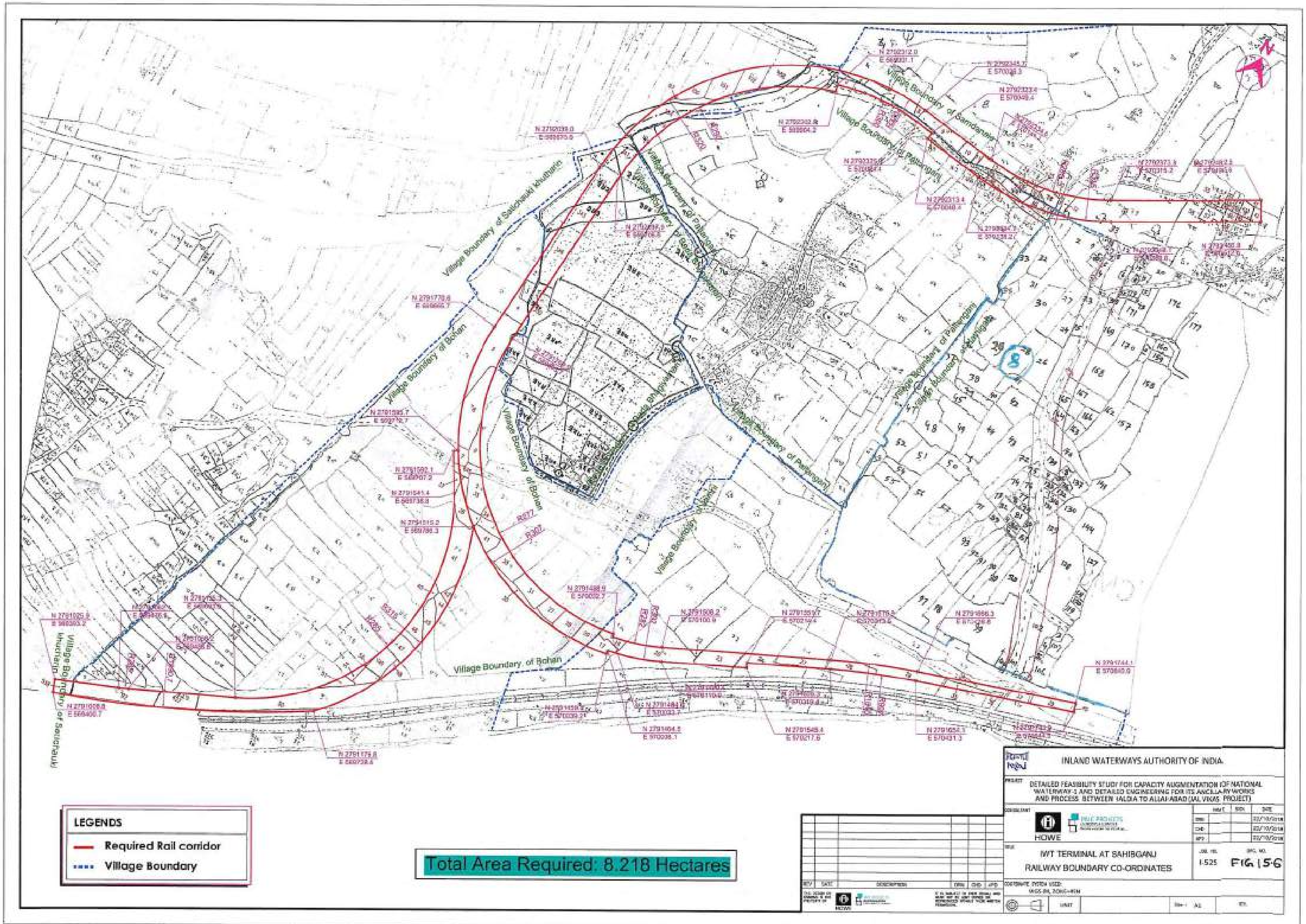
REVENUE/KHASRA MAP OF ROAD CORRIDOR FROM CH. 200m TO CH. 700m

FIGURE 15.4

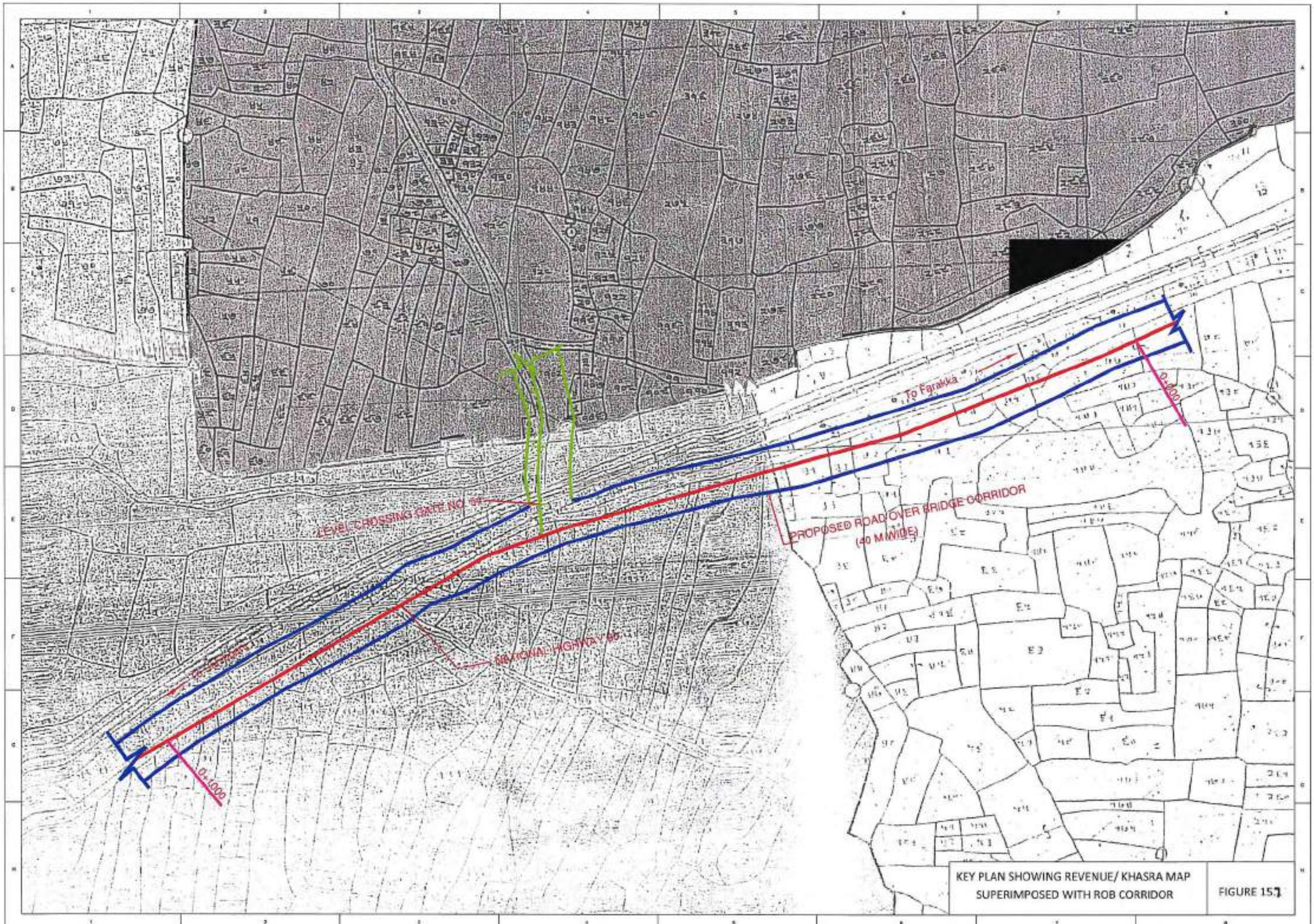


REVENUE/KHASRA MAP OF ROAD CORRIDOR
FROM CH. 700m TO CH. 900m

FIGURE 15.5



Village Boundary of Salchauki khurbari
Village Boundary of Bohan
Village Boundary of Patlanganj
Village Boundary of Samdanala
Village Boundary of Salchauki khurbari
LEGENDS
Required Rail corridor
Village Boundary
Total Area Required: 8.218 Hectares
INLAND WATERWAYS AUTHORITY OF INDIA
DETAILED FEASIBILITY STUDY FOR CAPACITY AUGMENTATION OF NATIONAL WATERWAY-1 AND DETAILED ENGINEERING FOR ITS ANCILLARY WORKS AND PROCESS BETWEEN HALDIA TO ALLAHABAD (JAL VIKAS PROJECT)
HOWE
IWT TERMINAL AT SAHIBGANJ
RAILWAY BOUNDARY CO-ORDINATES
I-525
FIG 15.6


To Farakka
0+000
PROPOSED ROAD OVER BRIDGE CORRIDOR
(40 M WIDE)
LEVEL CROSSING GATE NO. 97
To Siliguri
NATIONAL HIGHWAY 65
0+1000
KEY PLAN SHOWING REVENUE/ KHASRA MAP
SUPERIMPOSED WITH ROB CORRIDOR
FIGURE 15.1

16.0 ENVIRONMENTAL CLEARANCE REQUIREMENT

16.1 Introduction

The terminal at Sahibganj is proposed to be developed for Phase-1 initially catering to the traffic potential of 2.24 MTPA. The development of Phase-1 terminal includes construction of jetty in river, shore protection works, dredging, site grading, storage areas, roads, ramps, buildings, sewerage, water supply, and other utilities.

As per Ministry of Environment and Forests (MoEF) notification dated 14th September, 2006, the required construction of new projects or activities listed in the Schedule to this notification shall be undertaken in any part of India only after the prior environmental clearance from the Central Government or as the case may be, by the State Level Environment Impact Assessment Authority, duly constituted by the Central Government under sub-section (3) of section 3 of the said Act, in accordance with the procedure specified in the notification.

The said notification is attached in **Appendix-F**.

16.2 Requirement of Prior Environmental Clearance

The Schedule of the said notification does not specify the category for development of inland waterways projects and therefore there may not be requirement of prior environmental clearance for the development of terminal for Phase-1 at Sahibganj. Further vide MoEF&CC's Notification dated 15.01.2016, dredging and de-silting of dams, reservoirs, weirs, barrages, river and canals for the purpose of their maintenance, upkeep and disaster management has been exempted from prior environmental clearance.

IWAI may take a final view on requirement of prior environmental clearance. However, if the requirement of prior environmental clearance arises, the following process shall be followed for obtaining the same.

16.3 Application for Prior Environmental Clearance

For seeking prior environmental clearance, an application shall be made in prescribed Form-1 along with a copy of Detailed Project Report. The Form-1 is enclosed in **Appendix-F**.

16.4 Stages in Pre-Environmental Clearance

The process of environmental clearance for development of Phase-1 of terminal shall comprise of following four stages as given below:

- Screening (only for Category B Project)
- Scoping
- Public Consultation
- Appraisal

Stage-1: Screening

The application made in Form 1 shall be scrutinized by State level Expert Appraisal Committee (SEAC) for determining whether or not the project or activity requires further environmental studies for preparation of an Environmental Impact Assessment (EIA) for its appraisal prior to the grant of environmental clearance depending on the nature and

location specificity of the project. The projects requiring an Environmental Impact Assessment report shall be termed Category 'B1' and remaining projects shall be termed Category 'B2' and will not require an Environment Impact Assessment report. For categorization of projects into B1 or B2 except item 8 (b), the Ministry of Environment and Forests issues appropriate guidelines from time to time.

Stage-2: Scoping

i. In scoping stage, State level Expert Appraisal Committee in the case of Category 'B1' projects, determine detailed and comprehensive Terms Of Reference (TOR) addressing all relevant environmental concerns for the preparation of an Environment Impact Assessment (EIA) Report in respect of the project or activity for which prior environmental clearance is sought. The State level Expert Appraisal Committee shall determine the Terms of Reference on the basis of the information furnished in the prescribed application Form 1 including Terns of Reference proposed by the applicant, a site visit by a sub- group of State level Expert Appraisal Committee only if considered necessary by the State Level Expert Appraisal Committee, Terms of Reference suggested by the applicant if furnished and other information that may be available with the State Level Expert Appraisal Committee.

ii. The Terms of Reference (TOR) shall be conveyed to the applicant by the State Level Expert Appraisal Committee within sixty days of the receipt of Form 1. If the Terms of Reference are not finalized and conveyed to the applicant within sixty days of the receipt of Form 1, the Terms of Reference suggested by the applicant shall be deemed as the final Terms of Reference approved for the EIA studies. The approved Terms of Reference shall be displayed on the website of the Ministry of Environment and Forests and the concerned State Level Environment Impact Assessment Authority.

iii. Applications for prior environmental clearance may be rejected by the regulatory authority concerned on the recommendation of the SEAC at this stage itself. In case of such rejection, the decision together with reasons for the same shall be communicated to the applicant in writing within sixty days of the receipt of the application.

Stage-3: Public Consultation

After EIA Report is prepared, the public consultation shall be carried out which comprises of following:

i. A public hearing at the site or in its close proximity- district wise, to be carried out for ascertaining concerns of local affected persons;

ii. Obtain responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity.

The public hearing at, or in close proximity to, the site(s) in all cases shall be conducted by the State Pollution Control Board (SPCB) and forward the proceedings to the regulatory authority concerned within 45 (forty five) of a request to the effect from the applicant.

In case the State Pollution Control does not undertake and complete the public hearing within the specified period, and/or does not convey the proceedings of the public hearing within the prescribed period directly to the regulatory authority concerned as above, the regulatory authority shall engage another public agency or authority which is not subordinate to the regulatory authority, to complete the process within a further period of forty five days.

If the public agency or authority nominated reports to the regulatory authority concerned that owing to the local situation, it is not possible to conduct the public hearing in a

manner which will enable the views of the concerned local persons to be freely expressed, it shall report the facts in detail to the concerned regulatory authority, which may, after due consideration of the report and other reliable information that it may have, decide that the public consultation in the case need not include the public hearing.

For obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity, the concerned regulatory authority and the State Pollution Control Board (SPCB) shall invite responses from such concerned persons by placing on their website the Summary EIA report prepared by the applicant along with a copy of the application in the prescribed form , within seven days of the receipt of a written request for arranging the public hearing. Confidential information including non-disclosable or legally privileged information involving Intellectual Property Right, source specified in the application shall not be placed on the web site. The regulatory authority shall, however, make available on a written request from any concerned person the Draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing.

After completion of the public consultation, the applicant shall address all the material environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the applicant to the concerned regulatory authority for appraisal.

Stage-4: Appraisal

The process of appraisal involves the detailed scrutiny by the State Level Expert Appraisal Committee of the application and other documents like the Final EIA report, outcome of the public consultations including public hearing proceedings, submitted by the applicant to the regulatory authority concerned for grant of environmental clearance. This appraisal shall be made by State Level Expert Appraisal Committee concerned in a transparent manner in a proceeding to which the applicant shall be invited for furnishing necessary clarifications in person or through an authorized representative. On conclusion of this proceeding, the State Level Expert Appraisal Committee concerned shall make categorical recommendations to the regulatory authority concerned either for grant of prior environmental clearance on stipulated terms and conditions, or rejection of the application for prior environmental clearance, together with reasons for the same.

The appraisal of an application shall be completed by the State Level Expert Appraisal Committee concerned within sixty days of the receipt of the final Environment Impact Assessment report and other documents and the recommendations of the State Level Expert Appraisal Committee shall be placed before the competent authority for a final decision within the next fifteen days.

Grant or Rejection of Prior Environmental Clearance (EC)

The regulatory authority shall consider the recommendations of the EAC or SEAC concerned and convey its decision to the applicant within forty five days of the receipt of the recommendations of the State Level Expert Appraisal Committee concerned or in other words within one hundred and five days of the receipt of the final Environment Impact Assessment Report, except as provided below.

The regulatory authority shall normally accept the recommendations of the State Level Expert Appraisal Committee concerned. In cases where it disagrees with the recommendations of the State Level Expert Appraisal Committee concerned, the regulatory authority shall request reconsideration by the State Level Expert Appraisal

Committee concerned within forty five days of the receipt of the recommendations of the State Level Expert Appraisal Committee concerned while stating the reasons for the disagreement. An intimation of this decision shall be simultaneously conveyed to the applicant. The State Level Expert Appraisal Committee concerned, in turn, shall consider the observations of the regulatory authority and furnish its views on the same within a further period of sixty days. The decision of the regulatory authority after considering the views of the State Level Expert Appraisal Committee concerned shall be final and conveyed to the applicant by the regulatory authority concerned within the next thirty days.

In the event that the decision of the regulatory authority is not communicated to the applicant within the period specified above, as applicable, the applicant may proceed as if the environment clearance sought for has been granted or denied by the regulatory authority in terms of the final recommendations of the State Level Expert Appraisal Committee concerned.

On expiry of the period specified for decision by the regulatory authority above, as applicable, the decision of the regulatory authority, and the final recommendations of the State Level Expert Appraisal Committee concerned shall be public documents.

Clearances from other regulatory bodies or authorities shall not be required prior to receipt of applications for prior environmental clearance of projects or activities, or screening, or scoping, or appraisal, or decision by the regulatory authority concerned, unless any of these is sequentially dependent on such clearance either due to a requirement of law, or for necessary technical reasons.

Deliberate concealment and/or submission of false or misleading information or data which is material to screening or scoping or appraisal or decision on the application shall make the application liable for rejection, and cancellation of prior environmental clearance granted on that basis. Rejection of an application or cancellation of a prior environmental clearance already granted, on such ground, shall be decided by the regulatory authority, after giving a personal hearing to the applicant, and following the principles of natural justice.

16.5 Social Impact Assessment

Social Impact Assessment (SIA) is carried out to ascertain the impacts, which would occur due to implementation of the project. The exercise facilitates identifying types and extent of impacts and also identifying impacts that can be minimized by good engineering practices. Efforts are made to mitigate impacts, which cannot be minimized during the planning stage.

Accordingly, the Social Impact Assessment for development of proposed terminal in phase-1 at Sahibganj shall be carried out.

17.0 TERMINAL ADMINISTRATION AND MANAGEMENT

17.1 General

The IWT terminal at Sahibganj is proposed to be developed in phases catering to traffic till phase-3. Accordingly, the terminal is planned to handle various types of cargo for which suitable handling equipment and storage facilities are planned for initial phase and for subsequent phases. The terminal in all the phases, shall be controlled and managed by IWAI with organisation structure and manpower as discussed below.

17.2 Terminal Operations and Organisation Structure

The terminal operations shall be carried out by IWAI by employing personnel with necessary expertise and experience. The Director will be the overall in-charge of various functional departments like Engineering, Finance, Marketing, Operation & Maintenance and Human Resources. The proposed organization structure is given below in **Figure 17.1.**

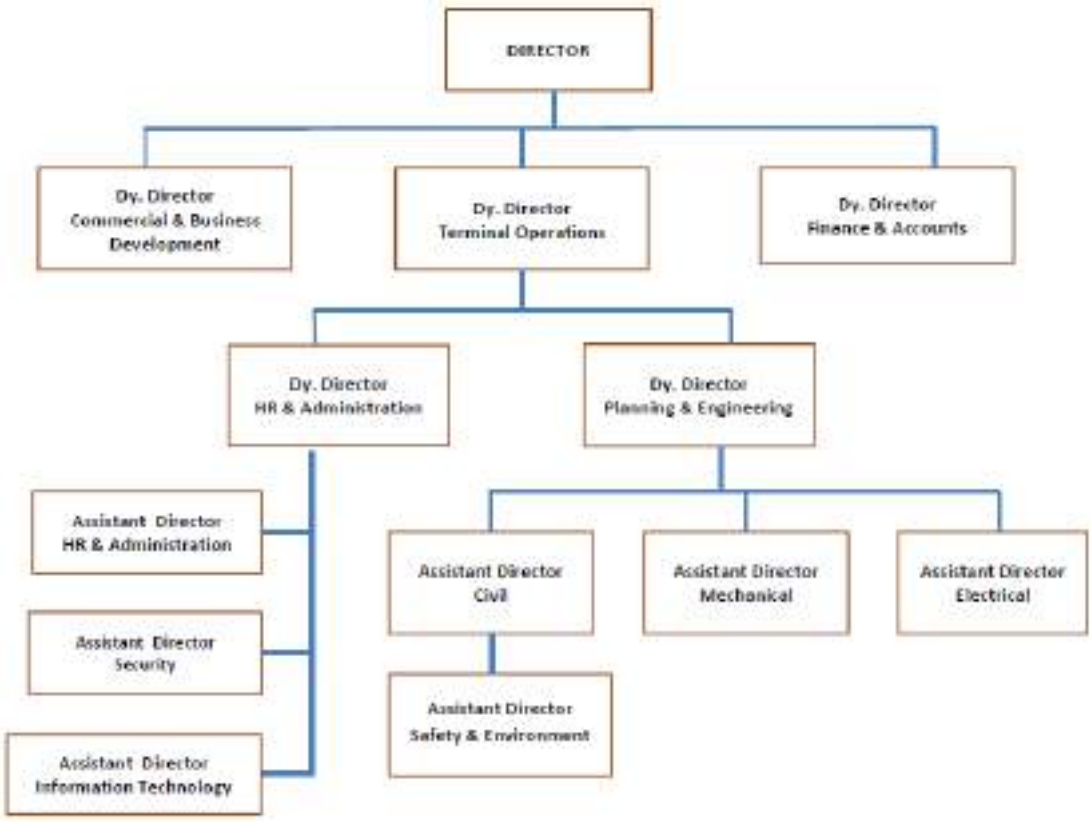


Figure 17.1: Proposed Organization Chart of the Terminal

17.3 Manpower Estimates

The operations at the terminal shall be organized in shifts to support 24-hour productivity. The manpower required for the proposed terminal in all the phases is assessed in Table 17.1 below:

Table 17.1: Manning for IWT Terminal at Sahibganj

S.No.	Name of Personnel	Total Staff		
		Phase-1	Phase-2	Phase-3
A. Manning for Terminal Administration				
1.	Director	1	1	1
2.	Dy. Director-Terminal Operations	1	1	1
3.	Dy. Director-Commercial & Business Development	1	1	1
4.	Dy. Director- Finance & Accounts	1	1	1
5.	Dy. Director- Planning & Engineering	1	1	1
6.	Dy. Director-HR & Administration	1	1	1
7.	Assistant Director-Civil	1	1	1
8.	Assistant Director-Mechanical	0	1	1
9.	Assistant Director-Electrical	0	1	1
10.	Assistant Director-Safety & Environment	1	1	1
11.	Assistant Director-HR & Administration	0	1	1
12.	Assistant Director-Security	1	1	1
13.	Assistant Director-IT	0	1	1
	Total Management and Administrative staff	**9**	**13**	**13**
B. Manning for Operation of Terminal				
S.No.	**Name of Equipment**	**Phase-1**	**Phase-2**	**Phase-3**
1	Barge Loader	10	20	40
2	Mobile Harbour Crane	3	3	3
3	Pay Loaders / Front End Loaders	24	24	24
4	Conveyor system with Transfer Towers	15	36	48
5	Stacker cum Reclaimer	0	6	12
6	Reclaimer	0	3	6
7	Dumpers	32	0	0
8	Trucks	0	32	32
9	Wagon Tippler	0	17	20
10	Wagon Shifter	0		
11	Track Hopper	0	0	

B. Manning for Operation of Terminal				
S.No.	**Category**	**Phase-1**	**Phase-2**	**Phase-3**
12	Mainteanance Crew for Mobile Harbour Crane & Others	4	4	4
13	Shift supervisors	4	4	4
	Total Manning for Terminal	**92**	**149**	**193**
C. Manning for Common Utilities				
S.No.	**Category**	**Phase-1**	**Phase-2**	**Phase-3**
1	Staff for Central Control Room	8	8	8
2	Security Staff	14	27	27
3	Manning of substations	7	7	7
4	Fire service station	10	14	14
5	Medical Assistance	8	12	12
6	Water supply	4	4	4
7	Support Staff	10	20	20
	Total Manning for Common Utilities	**61**	**92**	**92**

Total O&M Personnel at Terminal			
Descriptions	**Phase-1**	**Phase-2**	**Phase-3**
A. Manning for Terminal Administration	9	13	13
B. Manning for Operation of Terminal	92	88	111
C. Manning for Common Utilities	61	92	92
Total	**162**	**254**	**298**

18.0 IMPLEMENTATION SCHEDULE

18.1 General

It is proposed to develop IWT terminal at Sahibganj for Phase 1 initially. As the traffic gets build up and IWT sector gets momentum over the coming years, the terminal shall be developed for Phase II and further for Phase 3with all the required infrastructure and support system as discussed in the previous sections.

The main components for the terminal development in Phase 1 comprise of 270 m long jetty construction with approach trestle, road connectivity, Procurement of Mobile harbour cranes, Barge loaders, Levelling of the backup area for open storage, storage sheds, buildings and other onshore infrastructure and marine support systems. The schedule of the critical project items is discussed below.

18.2 Road Connectivity

Before start of construction activity at the terminal, it is necessary to make and construct the road providing connectivity to the terminal from Gate no 54 so that the material, machinery and manpower can reach to the terminal to facilitate the construction of terminal facilities.

18.3 Site Grading

The onshore terminal area to be developed in Phase 1 is undulating with levels varying from 28 m to 56 m and significant amount of cutting and filling would be required for site grading to 37 m. Therefore, it is necessary to carry out site grading work immediately after construction of road work as the onshore terminal area shall be used for storage of building material brought for construction of berth and approach trestle.

18.4 Berth Construction

The approach to the coal berth as well as stone chips/ other cargo berth would be taken up and the berth piling would be commenced using piling gantries.

The construction of berth including approaches is expected to take about 24 months from the commencement of their construction.

18.5 Equipment and Onshore Development

It is envisaged that the delivery and installation of cargo handling equipment as well as the onshore development will not have any impact on the implementation schedule of the project. Only important thing will be to ensure synchronization of the handling equipment with that of the various components of the berth construction.

18.6 Implementation Schedule

Based on the above it could be seen that the terminal construction could be completed within a time frame of 30 months. The project implementation schedule is shown in **Error! Not a valid bookmark self-reference.**.

Table 18.1: Implementation Schedule for Phase-1 of Terminal

S.No.	Item	Year 1												Year 2												Year 3					
	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Zero Date	⓪																													
1	Detailed Design																														
2	Site Development Works including Site Grading																														
3	Dredging & Aids to Navigation																														
4	Jetty Construction																														
5	Buildings and Sheds																														
6	Internal Roads, Ramps and Paved Areas																														
7	Mechanical Eqquipments																														
8	Water Supply, Electrical Works, Drainage and Other Utilities																														

19.0 COST ESTIMATES

19.1 Capital Cost Estimates

The capital cost estimates have been prepared for the Phase-1 development of IWT Terminal at Sahibganj as per Layout provided in **Drawing I-521/ST/209**. These are based on the project descriptions and drawings given under the relevant sections of the present report. The drawings were prepared after carrying out preliminary design of various components of the project. The quantities have been calculated from the drawings for cost estimation purpose. These will need to be developed, revised, and refined during the design phase.

The following is to be noted with respect to the cost estimates:

- The cost estimates of civil works have been prepared on the basis of CPWD Schedule of Rates 2014 and Market Rates for various items of work prevailing in the region.
- The costs of equipment is based on the quotations received from manufacturers, wherever applicable and also in-house data, and include manufacture, supply, installation and commissioning.
- All costs towards overheads, labour, tools, materials etc. are covered in the rates for individual items.
- The price level used for the estimates is as of the second quarter of 2019.

The estimates given here do not include the following items:

- Financing costs including IDC and other reserves

The capital cost estimates for Phase-1 of the Terminal is worked out to be **Rs.345 crores** and summary is presented in Table 19.1 below: The break-up of major components of the capital cost estimates for Phase-1 of the Terminal are furnished in Table 19.2 to 19.6 respectively:

Table 19.1: Summary of Capital Cost Estimates for Phase-1 of Terminal

S. No.	Item	Capital Cost (Rs. In Crores)
1	Site Grading and Dredging	56.38
2	Shore Protection Works	9.65
3	Berths including Approach Trestles	101.43
4	Buildings	2.56
5	Storage Areas	8.69
6	Internal Roads including Ramp	24.54
7	External / Approach Roads	14.00
8	Road Over Bridge	38.00
9	Equipments	33.40
10	Belt Conveyor System	28.00
11	Utilities and Others, Navigational Aids	18.27
Sub-total		**334.92**
Contingency @ 3% as per CPWD norms		**10.05**
Total		**344.97**
Say		**345 Crores**

Table 19.2 : Detailed Capital Cost Estimate for Phase-1 of Terminal

S. No.	Item		Quantity	Unit	Rate (Rs.)	Capital Cost (Rs. in Crores)	Reference
1.	**LAND & SITE DEVELOPMENT**					**51.88**	
	1.1	Studies and Investigations		LS		1.50	
	1.2	Site Grading		LS		50.38	**Refer Table 19.3**
2.	**DREDGING**		1,50,000	cum	300	**4.50**	
3.	**SHORE PROTECTION WORKS**					**9.65**	**Refer Table 19.4**
4.	**JETTY INCLUDING APPROACH TRESTLES**					**101.43**	
	4.1	Berths				88.11	**Refer Table 19.5**
	4.2	Approach Trestle				13.32	**Refer Table 19.6**
5.	**BUILDINGS**					**2.56**	
	5.1	Terminal Administration Building	520	sqm	25,000	1.30	
	5.2	Worker's Amenity Building	108	sqm	25,000	0.27	
	5.3	Electrical Substation Building	360	sqm	25,000	0.90	
	5.4	Weigh Bridge Building	25	sqm	18,000	0.05	
	5.5	Security Office	25	sqm	18,000	0.05	
6.	**STORAGE AREAS**					**8.69**	
	6.1	Coal Stockyard	11,200	sqm	1,200	1.34	
	6.2	Stone-chips Stockyard	8,750	sqm	1,200	1.05	
	6.3	Storage Shed	4,200	sqm	15,000	6.30	
7.	**INTERNAL ROADS INCLUDING RAMPS**					**24.54**	
	7.1	Roads to Operational Areas	21,952	sqm	3,000	6.59	
	7.2	Parking Area	10,000	sqm	700	0.70	
	7.3	Retaining Wall					
	i	For 7.5m high wall	902	m	1,40,000	12.63	
	ii	For 8.5m high wall	179	m	1,80,000	3.22	
	iii	For 10.5m high wall	50	m	2,80,000	1.40	
8.	**EXTERNAL / APPROACH ROAD**					**14.00**	
9.	**RAIL OVER BRIDGE**					**38.00**	
10.	**EQUIPMENTS**					**33.40**	
	10.1	Mobile Barge Loader	1	No.	400,00,000	4.00	
	10.2	Mobile Harbour Crane	1	No.	1550,00,000	15.50	
	10.3	Front End Loader	8	No.	80,00,000	6.40	
	10.4	Road Weigh Bridge	2	No.	25,00,000	0.50	
	10.5	Dumpers	10	No.	70,00,000	7.00	
11.	**BELT CONVEYOR SYSTEM**					**28.00**	
12.	**UTILITIES AND OTHERS**					**17.50**	
	12.1	Electrical Distribution System		LS		10.00	
	12.2	Fire Fighting System		LS		1.50	
	12.3	Dust Suppression System		LS		2.00	
	12.4	Water Supply and Distribution		LS		1.00	
	12.5	Drainage		LS		1.00	
	12.6	Sewerage		LS		1.00	
	12.7	Communication and IT		LS		1.00	
13.	**AIDS TO NAVIGATION**		17	No.	4,50,000	**0.77**	
Total (1+2+3+4+5+6+7+8+9+10+11+12+13)						**334.91**	

Table 19.3 : Capital Cost Estimate for Site Grading in Phase-1 of Terminal

Description	Quantity (cum)	Rate (in Rs)	Amount (Rs. In Crores)
Earthwork in Excavation by mechanical means (Hydraulics Excavator over areas including disposal of excavated earth lead upto 1 km and lift upto 1.5 m, disposed earth to be levelled and neatly dressed.	215000	280	6.02
Earthwork in Excavation by mechanical means (Hydraulics Excavator over areas including disposal of excavated earth lead upto 5 km and lift upto 1.5 m, disposed earth to be levelled and neatly dressed.	1210000	340	41.14
Earthwork in Filling	215000	150	3.23
Total			**50.39**

Table 19.4 : Cost Estimate for Shore Protection Works in Phase-1 of Terminal

S.No.	Item of Work	Unit	Quantity	Rate (In Rs.)	Amount (Rs. In Crore)
1	Loading and unloading of stone boulder / stone aggreagates weighing not less than 40 kg	Cum	53,760	162.00	0.87
2	Cost of haulage excluding loading & unloading to the terminal location	t-km	2,040,000	9.50	1.94
3	Providing and laying Pitching on slopes laid over prepared filter media & laid in wire crates made with 4mm dia GI wire conforming to IS: 280 & IS:4826 in 100mm x 100mm mesh (weaved diagonally) including 10% extra for laps and joints laid with stone boulders weighing not less than 40 kg each.)	Cum	16,800	1,260.36	2.12
4	Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification	Cum	3,360	1,446.12	0.49
5	Providing and laying boulders apron on river bed for protection against scour with stone boulders laid in wire crates made with 4mm dia GI wire conforming to IS: 280 & IS:4826 in 100mm x 100mm mesh (weaved diagonally) including 10% extra for laps and joints laid with stone boulders weighing not less than 40 kg each.)each complete as per drawing and Technical specification.	Cum	33,600	1,260.36	4.23
				TOTAL COST	**9.65 Crores**

Table 19.5 : Capital Cost Estimate for Berth in Phase-1 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		6.29
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforcement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	180	No.	50,000	0.90
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	1,840	T	55,000	10.12
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	4,500	m	2,500	1.13
iv	Boring through all types of soil strata	4,500	m	3,500	1.58
v	Boring through all types of Hard strata	900	m	6,500	0.59
vi	Cut & dress pile head to required lines & levels	180	No	5,500	0.10
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method including cost of all labour and materials but excluding the cost of steel reinforcement.	9,751	cum	8,000	7.80
4.	Supplying High Yield Strength deformed bars such as grade Fe 500, cutting, bending, tying with annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	1,463	T	72,000	10.53
5.	Construction of 1000 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforcement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	45	No.	50,000	0.23
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	290	T	55,000	1.60
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	1,125	m	2,500	0.28
iv	Boring through all types of soil strata	1,125	m	3,500	0.39
v	Boring through all types of Hard strata	225	m	6,500	0.15
vi	Cut & dress pile head to required lines & levels	45	No	5,500	0.02
6.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method including cost of all labour and materials but excluding the cost of steel reinforcement.	1,322	cum	8,000	1.06
7.	Supplying High Yield Strength deformed bars such as grade Fe 500, cutting, bending, tying with annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	198	T	72,000	1.43
8.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	11,317	cum	9,000	10.18
9.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	675	cum	6,000	0.41
10.	Supplying High Yield Strength deformed bars such as grade Fe 500, cutting, bending, tying with annealed binding wire & placing in position reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	1,811	T	72,000	13.04
11.	Providing and fixing cast steel bollards of 30 T capacity complete with base plate & H.T. anchor bolts of appropriate length, nuts washers, etc. including grouting with cement concrete M40 under base plate, filling the cavity with concrete grade M15, painting etc. complete.	45	No.	150,000	0.68
12.	Design, supply, assemble and fix in position in the required lines and levels arch type AN 800 E 3.0 grade rubber fenders of Trellborg or equivalent make of length 3m with stainless steel fixtures manufactured as per manufacturer's specifications as directed by the Engineer.	135	No.	1,350,000	18.23
13.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.				
i	Initial test	2	No.	1,000,000	0.20
ii	Routine test	2	No.	1,000,000	0.20
14.	Supplying, fabricating, painting, welding, drilling, grouting with 1:2 (1 Cement: 2 Sand) mortar & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, coping fender, ladders, handlhold, expansion joints, mooring rings, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		1.00
				Total	**88.11**

Table 19.6 : Capital Cost Estimate for Approach Trestle in Phase-1 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		1.21
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforcement as per design/drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	46	No.	50,000	0.23
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	470	T	55,000	2.59
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	1150	m	2,500	0.29
iv	Boring through all types of soil strata	1150	m	3,500	0.40
v	Boring through all types of Hard strata	138	m	6,500	0.09
vi	Cut & dress pile head to required lines & levels	46	No	5,500	0.03
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method including cost of all labour and materials but excluding the cost of steel reinforcement.	2,388	cum	8,000	1.91
4.	Supplying High Yield Strength deformed bars such as grade Fe 500, cutting, bending, tying with annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	358	T	72,000	2.58
5.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	1577	cum	9,000	1.42
6.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	100	cum	6,000	0.06
7.	Supplying High Yield Strength deformed bars such as grade Fe 500, cutting, bending, tying with annealed binding wire & placing in position, reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	252	T	72,000	1.82
8.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.,				
i	Initial test	1	No.	1,000,000	0.10
ii	Routine test	1	No.	1,000,000	0.10
9.	Supplying, fabricating, painting, welding, drilling, grouting with 1:2 (1 Cement: 2 Sand) mortar & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, ladders, handlhold, expansion joints, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		0.50
				Total	**13.32**

The capital cost estimate for Phase-2 and Phase-3 is worked out to be **Rs. 633 crores and Rs. 325 crores** respectively. The cost does not incude the creation of LNG storage, which will be developed at the LNG operators cost.

The capital cost estimate for Phase-2 includes development of rail connectivity & rail siding in the terminal with railway equipments. Accordingly, the summary of the capital cost for Phase-2 of the Terminal with railway component and without railway component are presented in Table 19.7 and Table 19.8 respectively below:

Table 19.7 : Summary of Capital Cost Estimates for Phase-2 of Terminal (with railway)

S. No.	Item	Capital Cost (Rs. In Crores)
1	Site Grading and Dredging	83.50
2	Shore Protection Works	9.65
3	Berths Including Approach Trestles and foundation for conveyor gallery	53.50
4	Storage Areas	16.14
5	Internal Roads Including Ramp	50.09
6	Rail Connectivity and Rail Siding in the Terminal	148.0
7	Equipments	164.40
8	Belt Conveyor System	57.37
9	Utilities and Others	32.00
	Sub-total	**614.63**
	Contingency @ 3% as per CPWD norms	**18.44**
	Total	**633.07**
Say		**633 Crores**

Table 19.8 : Summary of Capital Cost Estimates for Phase-2 of Terminal (without railway)

S. No.	Item	Capital Cost (Rs. In Crores)
1	Site Grading and Dredging	83.50
2	Shore Protection Works	9.65
3	Berths Including Approach Trestles and foundation for conveyor gallery	53.50
4	Storage Areas	16.14
5	Internal Roads Including Ramp	50.09
7	Equipments	62.40
8	Belt Conveyor System	57.37
9	Utilities and Others	32.00
	Sub-total	**364.65**
	Contingency @ 3% as per CPWD norms	**10.94**
	Total	**375.59**
Say		**376 Crores**

The break-up of major components of the capital cost estimates for Phase-2 of the Terminal (with railway) are furnished in Table 19.9 to Table 19. respectively.

Table 19.9 : Detailed Capital Cost Estimates for Phase-2 of Terminal (with railway)

S. No.	Item		Quantity	Unit	Rate (Rs.)	Capital Cost (Rs. in Crores)	Reference
1.	**LAND & SITE DEVELOPMENT**					**82.00**	
	1.1	Studies and Investigations		LS		2.00	
	1.2	Site Grading		LS		80.00	**Refer Table 19.10**
2.	**DREDGING**		50,000	cum	300	**1.50**	
3.	**SHORE PROTECTION WORKS**					**9.65**	**Refer Table 19.11**
4.	**JETTY INCLUDING APPROACH TRESTLES**					**53.5**	
	4.1	Berths				44.68	**Refer Table 19.12**
	4.2	Approach Trestle				5.50	**Refer Table 19.13**
	4.3	Foundation for Conveyor Gallery				3.31	**Refer Table 19.14**
5.	**STORAGE AREAS**					**16.14**	
	5.1	Coal Stockyard	50,000	sqm	1,200	6.00	
	5.2	Stone-chips Stockyard	32,000	sqm	1,200	3.84	
	5.3	Storage Shed	4,200	sqm	15,000	6.30	
6.	**INTERNAL ROADS INCLUDING RAMPS**					**50.09**	
	6.1	Roads to Operational Areas	83,000	sqm	3,000	24.90	
	6.2	Parking Area	8,000	sqm	700	0.56	
	6.3	Retaining Wall					
	i	For 4.0m high wall	330	m	45,000	1.49	
	ii	For 8.5m high wall	430	m	180,000	7.74	
	iii	For 10.5m high wall	550	m	280,000	15.40	
7.	**Rail Connectivity & Rail Siding in the Terminal**					**148.0**	
	7.1	External rail connectivity	1	LS	1,140,000,000	114.00	
	7.2	Internal rail connectivity	5.15	km	66,000,000	34.0	
8.	**EQUIPMENTS**					**164.40**	
	8.1	Stacker cum Reclaimer	2	No.	200,000,000	40.00	
	8.2	Fixed hopper	4	No.	2,500,000	1.00	
	8.3	Front end loader	8	No.	8,000,000	6.40	
	8.4	Excavator	4	No.	15,000,000	6.00	
	8.5	Rotaside Wagon Tippler	1	No.	130,000,000	13.00	
	8.6	Mobile Barge Loader	1	No.	40,000,000	4.00	
	8.7	Wagon Shifter with pusher	1	No.	60,000,000	6.00	
	8.8	Track Hopper	1	No.	700,000,000	70.00	
	8.9	Civil works for equipments	1	LS	180,000,000	18.00	
9.	**BELT CONVEYOR SYSTEM**					**57.37**	
10.	**UTILITIES AND OTHERS**					**32.00**	
	10.1	Electrical Distribution System		LS		12.00	
	10.2	Fire Fighting System		LS		8.00	
	10.3	Dust Suppression System		LS		6.50	
	10.4	Water Supply and Distribution		LS		1.50	
	10.5	Drainage		LS		3.00	
	10.6	Communication and IT		LS		1.00	
Total (1+2+3+4+5+6+7+8+9+10)						**614.63**	

Table 19.10 : Capital Cost Estimate for Site Grading in Phase-2 of Terminal

Description	Quantity (cum)	Rate (in Rs)	Amount (Rs. In Crores)
Earthwork in Excavation by mechanical means (Hydraulics Excavator over areas including disposal of excavated earth lead upto 1 km and lift upto 1.5 m, disposed earth to be levelled and neatly dressed.	673605.7	280.0	19
Earthwork in Excavation by mechanical means (Hydraulics Excavator over areas including disposal of excavated earth lead upto 5 km and lift upto 1.5 m, disposed earth to be levelled and neatly dressed.	1496420.1	340.0	51
Earthwork in Filling	673605.7	150.0	10
Total			**80**

Table 19.11 : Cost Estimate for Shore Protection Works in Phase-2 of Terminal

S.No.	Item of Work	Unit	Quantity	Rate (In Rs.)	Amount (Rs. In Crore)
1	Loading and unloading of stone boulder / stone aggreagates weighing not less than 40 kg	Cum	53,760	162.00	0.87
2	Cost of haulage excluding loading & unloading to the terminal location	t-km	2,040,000	9.50	1.94
3	Providing and laying Pitching on slopes laid over prepared filter media & laid in wire crates made with 4mm dia GI wire conforming to IS: 280 & IS:4826 in 100mm x 100mm mesh (weaved diagonally) including 10% extra for laps and joints laid with stone boulders weighing not less than 40 kg each.)	Cum	16,800	1,260.36	2.12
4	Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification	Cum	3,360	1,446.12	0.49
5	Providing and laying boulders apron on river bed for protection against scour with stone boulders laid in wire crates made with 4mm dia GI wire conforming to IS: 280 & IS:4826 in 100mm x 100mm mesh (weaved diagonally) including 10% extra for laps and joints laid with stone boulders weighing not less than 40 kg each.)each complete as per drawing and Technical specification.	Cum	33,600	1,260.36	4.23
				TOTAL COST	**9.65 Crores**

Table 19.12 : Capital Cost Estimate for Berth in Phase-2 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		4.06
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	88	No.	50,000	0.44
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	900	T	55,000	4.95
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	2,200	m	2,500	0.55
iv	Boring through all types of soil strata	2,200	m	3,500	0.77
v	Boring through all types of Hard strata	440	m	6,500	0.29
vi	Cut & dress pile head to required lines & levels	88	No	5,500	0.05
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	4,767	cum	8,000	3.81
4.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	715	T	72,000	5.15
5.	Construction of 1000 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	22	No.	50,000	0.11
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	188	T	55,000	1.03
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	550	m	2,500	0.14
iv	Boring through all types of soil strata	550	m	3,500	0.19
v	Boring through all types of Hard strata	110	m	6,500	0.07
vi	Cut & dress pile head to required lines & levels	22	No	5,500	0.01

6.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	646	cum	8,000	0.52
7.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	97	T	72,000	0.70
8.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	5,463	cum	9,000	4.92
9.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	325	cum	6,000	0.20
10.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	874	T	72,000	6.29
11.	Providing and fixing cast steel bollards of 30 T capacity complete with base plate & H.T. anchor bolts of appropriate length, nuts washers, etc. including grouting with cement concrete M40 under base plate, filling the cavity with concrete grade M15, painting etc. complete.	22	No.	150,000	0.33
12.	Design, supply, assemble and fix in position in the required lines and levels arch type AN 800 E 3.0 grade rubber fenders of Trellborg or equivalent make of length 3m with steel plates manufactured as per manufacturer's specifications as directed by the Engineer.	66	No.	1,350,000	8.91
13.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.	2	No.	1,000,000	0.20
14.	Supplying, fabricating, painting, welding, drilling, grouting & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, coping fender, ladders, handlhold, expansion joints, mooring rings, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		1.00
				Total	**44.68**

Table 19.13 : Capital Cost Estimate for Approach Trestle in Phase-2 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		0.50
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	18	No.	50,000	0.09
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	107	T	55,000	0.59
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	450	m	2,500	0.11
iv	Boring through all types of soil strata	450	m	3,500	0.16
v	Boring through all types of Hard strata	54	m	6,500	0.04
vi	Cut & dress pile head to required lines & levels	18	No	5,500	0.01
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	934	cum	8,000	0.75
4.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	140	T	72,000	1.01
5.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	785	cum	9,000	0.71
6.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	50	cum	6,000	0.03
7.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position, reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	126	T	72,000	0.90
8.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.,	1	No.	1,000,000	0.10
9.	Supplying, fabricating, painting, welding, drilling, grouting & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, ladders, handlhold, expansion joints, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		0.50
				Total	**5.49**

Table 19.14 : Capital Cost Estimate for Conveyor Gallery Foundation in Phase-2 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		0.30
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	10	No.	50,000	0.05
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	60	T	55,000	0.33
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	429	m	2,500	0.11
iv	Boring through all types of soil strata	429	m	3,500	0.15
v	Boring through all types of Hard strata	30	m	6,500	0.02
vi	Cut & dress pile head to required lines & levels	10	No	5,500	0.01
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	519	cum	8,000	0.42
4.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	78	T	72,000	0.56
5.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	375	cum	9,000	0.34
6.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	0	cum	6,000	0.00
7.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position, reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	60	T	72,000	0.43
8.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.,	1	No.	1,000,000	0.10
9.	Supplying, fabricating, painting, welding, drilling, grouting & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, ladders, handlhold, expansion joints, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		0.50
				Total	**3.31**

The summary of the capital cost for Phase-3 of the Terminal is presented in Table 19.15 below:

Table 19.15 : Summary of Capital Cost Estimates for Phase-3 of Terminal

S. No.	Item	Capital Cost (Rs. In Crores)
1.	Site Grading	1.00
2.	Berths	87.50
3.	Storage Areas	22.92
4.	Internal Roads Including Parking Area	5.33
5.	Equipments	73.00
6.	Belt Conveyor System	96.00
7.	Utilities and Others	30.00
	Sub-total	**315.74**
	Contingency @ 3% as per CPWD norms	**9.47**
Total		**325.21**
Say		**325 Crores**

The break-up of major components of the capital cost estimates for Phase-3 of the Terminal are furnished in Table 19.16 to 19.17 respectively.

Table 19.16 : Detailed Capital Cost Estimates for Phase-3 of Terminal

S. No.	Item		Quantity	Unit	Rate (Rs.)	Capital Cost (Rs. in Crores)	Reference
1.	**LAND & SITE DEVELOPMENT**					**1.00**	
	1.1	Studies and Investigations		LS		1.00	
	1.2	Site Grading		LS		-	
2.	**JETTY**					**87.5**	
	2.1	Berths				87.5	**Refer Table 19.17**
3.	**STORAGE AREAS**					**22.92**	
	3.1	Coal Stockyard	50,000	sqm	1,200	6.00	
	3.2	Stone-chips Stockyard	36,000	sqm	1,200	4.32	
	3.3	Storage Shed	8,400	sqm	15,000	12.60	
4.	**INTERNAL ROADS INCLUDING PARKING AREA**					**5.33**	
	4.1	Roads to Operational Areas	15,000	sqm	3,000	4.50	
	4.2	Parking Area	11,800	sqm	700	0.83	
5.	**EQUIPMENTS**					**73.00**	
	5.1	Stacker cum Reclaimer	2	No.	200,000,000	40.00	
	5.2	Reclaimer	1	No.	150,000,000	15.00	
	5.3	Mobile Barge Loader	2	No.	40,000,000	8.00	
	5.4	Civil works for equipments	1	LS	100,000,000	10.00	
6.	**BELT CONVEYOR SYSTEM**					**96.00**	
7.	**UTILITIES AND OTHERS**					**30.00**	
	7.1	Electrical Distribution System		LS		15.00	
	7.2	Fire Fighting System		LS		6.00	
	7.3	Dust Suppression System		LS		5.00	
	7.4	Water Supply and Distribution		LS		1.00	
	7.5	Drainage		LS		2.00	
	7.6	Communication and IT		LS		1.00	
Total (1+2+3+4+5+6+7)						**315.74**	

Table 19.17 : Capital Cost Estimate for Berths in Phase-3 of Terminal

Item No.	Description of Item	Quantity	Unit	Rate (Rs.)	Amount (Rs. in Crores)
1.	Mobilisation of all plant and equipment for the jetty construction and demobilisation of the same after completion of the works.	1	LS		7.95
2.	Construction of 1200 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	176	No.	50,000	0.88
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	1,799	T	55,000	9.90
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	4,400	m	2,500	1.10
iv	Boring through all types of soil strata	4,400	m	3,500	1.54
v	Boring through all types of Hard strata	880	m	6,500	0.57
vi	Cut & dress pile head to required lines & levels	176	No	5,500	0.10
3.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	9,535	cum	8,000	7.63
4.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	1,430	T	72,000	10.30
5.	Construction of 1000 mm dia bored cast-in-situ piles for berth with m.s. liner, boring in all types of soil /Hard strata stablising unlined soil using any other approved method during excavation, providing reinforecement as per design/ drawing providing and placing M40 grade concrete by means of tremie or any other approved method, providing all necessary labour, materials, plant tools etc.				
i	Shift & set up piling plant & equipment at each pile location	44	No.	50,000	0.22
ii	Supply, fabricate and driving mild steel liner (8 mm thick) including transport, alignment, pitching in position as required	284	T	55,000	1.56
iii	Driving the steel liners (8 mm thick) upto the required depth below bed level	1,100	m	2,500	0.28
iv	Boring through all types of soil strata	1,100	m	3,500	0.39
v	Boring through all types of Hard strata	220	m	6,500	0.14
vi	Cut & dress pile head to required lines & levels	44	No	5,500	0.02

6.	Supply & placing in position design mix cement concrete grade M40 in pile shaft by means of tremie or any other approved method using 20 mm MSA including cost of all labour and materials but excluding the cost of steel reinforcement.	1,293	cum	8,000	1.03
7.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, straightening, tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for piles.	194	T	72,000	1.40
8.	Supply & place in position to lines & levels cast in-situ design & precast units mix cement concrete of grade M40 for deck slab and beams including providing formwork shuttering, machine mixing, compacting, curing of concrete, centering, including providing pockets, openings, recesses, champhering where required and rendering if required to give a smooth and even surface in any shape etc. complete as directed with all labour and materials but excluding the cost of steel reinforcement.	10,925	cum	9,000	9.83
9.	Supply & place in position to lines & levels cast in-situ design mix cement concrete for wearing coat of average thickness 100 mm including provision of formwork, machine mixing, placing in panels, compacting, curing, etc. complete with all labour and materials.	650	cum	6,000	0.39
10.	Supplying corrosion resistant deformed bars grade Fe 500, cutting, bending, tying with 1.5 mm dia annealed binding wire & placing in position reinforcement cage including cleaning, strengthening tack/ lap/ butt welding with approved electrodes, etc. with all labour and materials complete for deck slab and beams.	1,748	T	72,000	12.59
11.	Providing and fixing cast steel bollards of 30 T capacity complete with base plate & H.T. anchor bolts of appropriate length, nuts washers, etc. including grouting with cement concrete M40 under base plate, filling the cavity with concrete grade M15, painting etc. complete.	44	No.	150,000	0.66
12.	Design, supply, assemble and fix in position in the required lines and levels arch type AN 800 E 3.0 grade rubber fenders of Trellborg or equivalent make of length 3m with steel plates manufactured as per manufacturer's specifications as directed by the Engineer.	132	No.	1,350,000	17.82
13.	Carrying out load test of pile including construction of test caps, accessories and dismantling same after test etc.	2	No.	1,000,000	0.20
14.	Supplying, fabricating, painting, welding, drilling, grouting & fixing in position etc. complete various miscellaneous items such as steel inserts, hand railing, coping fender, ladders, handlhold, expansion joints, mooring rings, nut, bolts, washers, bituminous filler etc in precast & in-situ concrete components in accordance with the drawings & as directed by the Engineer.		LS		1.00
				Total	**87.5**

The cost for developing the Sahibganj terminal in Phase-1 shall be borne by IWAI. The Sahibganj terminal is proposed to be developed under PPP mode for Phase-2 and Phase-3, if feasible, at that time.

19.2 Operation and Maintenance Costs

Operation and Maintenance costs have been calculated under various heads, as described in the subsequent paras:

- 1% of Civil Works
- 3% of Utilities
- 3% of Mechanical and Electrical Works

The summary of the annual operation and maintenance costs of the facilities for Phase-1 of terminal is presented in Table 19.18 below:

Table 19.18 : O&M Cost Estimates for Phase-1 of Terminal

S. No.	Item		Quantity	Unit	Rate	Unit	Annual Costs (Rs. in Crores)
A.	**REPAIR AND MAINTENANCE COSTS**						
	1.	Civil Works	251	Rs. in crores	1%	% of Cost	2.51
	2.	Mechanical, Electrical Works and other Utilities	79	Rs. in crores	3%	% of Cost	2.37
B.	**OPERATION COSTS**						
	1.	Maintenance Dredging	150,000	cum per annum	300	Rs. Per cum	4.50
	2.	Manpower Costs			LS		3.50
	3.	Electricity					
	a.	Electricity Consumption	3,472,000	kWH	6.50	Rs. Per kWH	2.26
	b.	Fixed Charges on Demand Load	900	kVA	400	Rs. Per kVA Per month	0.43
	4.	Fuel	380,000	litres	65	Rs./litre	2.47
C.	**SUB TOTAL**						**18.03**
	Insurance, Administrative Expenses and Miscellaneous				LS		**1.50**
D.	**TOTAL ANNUAL OPERATION AND MAINTENANCE COSTS**						**19.53**
						Say (Rs. in Crores)	**20.00**

20.0 FINANCIAL AND ECONOMIC ANALYSIS

20.1 Introduction

Financial feasibility is a key determinant in a business oriented investment decision. In case of the projects of public/national interest like development of Inland Water Terminal, the viability of the project depends on the economic feasibility which act as the deciding factor. The financial and economic viability is carried out for development of all phases of proposed terminal at Sahibganj.

20.2 Financial Analysis

The primary objective of the financial analysis is to evaluate the financial viability and to ascertain whether the project is attractive from the investor's point.

20.2.1 General Assumptions

Following are the key assumptions considered in the financial model

- The inputs are taken from the technical studies and traffic study carried out for the project.
- The financial analysis is carried out for Phase 1, Phase 2, Phase 3 individually, Phase 2 + Phase 3 consolidated & Phase 1 + Phase 2 + Phase 3 consolidated respectively.
- The base year for capital costs is 2014-15.
- The inflation rate of 5% per annum is considered in the model
- Depreciation rates and tax rates applicable to infrastructure projects have been taken as per the guidelines of Companies Act and Income Tax Act.

20.2.2 Construction Period and Project Life

As per the proposed schedule of implementation, the construction for the first phase is assumed to begin from 01st January 2017. The construction period, including post construction activities like commissioning, is assumed to be requiring 30 months. Therefore, for the Phase-1 development, the operation may be assumed as 01st October 2019.

Table 20.1: Phase–1 : Project Development Schedule

Construction Start Date for Phase 1	1-January-2017
Construction period for Phase 1 (months)	30
Operation Start (Phase 1)	1-October-2019
Project Life considered (Years)	30
End Date	31-March-2049

20.2.3 Means of Finance

The financial analysis is carried out assuming debt-equity ratio as 70:30 for the entire capital expenditure that will be invested by the Client.

20.2.4 Income Tax Calculations

IWAI is registered with the Income Tax Department, Ghaziabad under section 12 A (a) and has got exemption of income tax under section 10(23) (c) (iv) of Income Tax Act. Therefore, income tax is not considered in the Financial Analysis.

20.2.5 Project Cost

The estimated cost of the project for Phase- 1 is given below.

Table 20.2: Landing Cost for Phase-1 Development

S. No.	Item	Capital Cost (Rs. In Crores)
1	Site Grading and Dredging	56.38
2	Shore Protection Works	9.65
3	Berths including Approach Trestles	101.43
4	Buildings	2.56
5	Storage Areas	8.69
6	Internal Roads including Ramp	24.54
7	External / Approach Roads	14.00
8	Road Over Bridge	38.00
9	Equipments	33.40
10	Belt Conveyor System	28.00
11	Utilities and Others, Navigational Aids	18.27
Total		**334.92**

20.2.6 Revenue Estimation

Prevailing IWAI charges

The following Tariff charges published by Inland Waterways Authority of India (IWAI) has been considered for Sahibganj Terminal.

Table 20.3: Storage Charges

Storage Charges	Unit	Open Storage	Closed Storage
First 3 days	INR/Ton/day	0	0
From 4th - 15th day	INR/Ton/day	12	15
From 16th - 30th day	INR/Ton/day	22	27
From 31st day onwards	INR/Ton/day	44	54

Table 20.4 : Cargo Handling Charges

Type of Cargo	Unit	Handling Charges
Construction Materials (Bulk)	Rs/MT	170
Construction Materials (Bagged)	Rs/MT	210
Consumer good	Rs/MT	170
Containers	Rs/TEU	4500
Food and Food Stuff	Rs/MT	170
Project Cargo	Rs/MT	170

Table 20.5: Berthing Charges

Vessel related charges		
Berthing Charges	Rs/ 24hrs	1000

20.2.7 Expenses

Expenses would be incurred on day to day basis which includes Operating expenses, Administration expenses, Repairs & Routine Maintenance expenses, Expenses on electricity, Insurance premium, Salaries etc. The operation & maintenance cost is considered as mentioned in Chapter 19.

20.2.8 Key Results - Financial Analysis

Based on the financial analysis carried out taking into consideration of the above mentioned factors, the financial IRR has be worked out to be **14.77%** for Phase-1 development.

Table 20.6: Financial IRR for Phase-1 of Terminal

Year			1	6	11	16	21	26	30
FY	**2018**	**2019**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2049**
Project Cost									
Cargo in Million Tonnes			2.48	3.03	3.03	3.03	3.03	3.03	3.03
Revenues									
Cargo Handling Revenue			422.96	599.61	695.11	805.82	934.17	1082.96	1218.88
Storage Revenue			93.51	132.61	153.73	178.21	206.60	239.50	269.56
Vessel Related Revenue			0.26	0.50	0.58	0.67	0.78	0.90	1.02
Total Income			**516.72**	**732.71**	**849.42**	**984.71**	**1141.55**	**1323.36**	**1489.46**
Expenses									
Operating Expense									
Electricity Cost			26.84	36.94	42.83	49.65	57.56	66.72	75.10
Fuel Cost			24.68	35.44	41.09	47.63	55.22	64.01	72.05
Other Labour Cost			12.38	19.32	24.66	31.47	40.16	51.26	62.30
Manpower Cost			35.00	44.67	57.01	72.76	92.87	118.52	144.06
Insurance @ 0.75% of Project cost			2.51	2.91	3.37	3.90	4.53	5.25	5.91
Maintenance Cost			48.74	56.51	65.51	75.94	88.04	102.06	114.87
Total Expense			**150.16**	**195.79**	**234.46**	**281.36**	**338.37**	**407.83**	**474.29**
EBITDA			**366.56**	**536.93**	**614.96**	**703.35**	**803.18**	**915.54**	**1015.17**
Depreciation			243.72	149.53	98.37	68.42	49.53	36.81	29.39
EBIT			**122.84**	**387.40**	**516.59**	**634.93**	**753.65**	**878.73**	**985.78**
Interest	**257.30**	**257.30**	**257.30**	**158.34**	**59.38**	**0.00**	**0.00**	**0.00**	**0.00**
PBT	**(257.30)**	**(257.30)**	**(134.46)**	**229.07**	**457.22**	**634.93**	**753.65**	**878.73**	**985.78**
CAPEX	**(1675.00)**	**(1675.00)**							
Salvage Value									544.23
Cash Flow before Tax	(1675.00)	(1675.00)	**366.56**	**536.93**	**614.96**	**703.35**	**803.18**	**915.54**	**1559.39**
IRR	**14.77%**								
NPV	**775.54**								

20.3 Economic Analysis

In this section, economic analysis has been carried out for Phase 1 of Sahibganj terminal based on various socio-economic factors as mentioned below.

20.3.1 Economic Factors considered

Following are the factors that are considered to carry out the economic analysis for Sahibganj project:

- Energy Consumption
- Air Pollution
- Noise Pollution
- Soil and Water Pollution
- Accidents

20.3.2 Key Assumptions

In addition to the key assumptions that has been considered for the financial analysis, the following are the specific assumptions considered for carrying out economic analysis.

a) Based on the traffic study, the average distance considered between Sahibganj terminal and the origin/destination terminals is about 300 km.

b) It is assumed that in the present scenario, 70% of the cargo is transported through roadways and 30% of the cargo is transported through railways.

20.3.3 Approach and Methodology

The economic analysis of the project has been evaluated based on the following scenarios.

- 'With Project' Scenario and
- 'Without Project' Scenario

Both 'with project' and 'without project' scenarios have been quantified over the full life of the project. Also the 'incremental situation' or 'Benefit from the project' have been arrived by comparing the 'with project' scenario and 'without project' scenario wherein in the former case, the cargoes will be transported through barges and in later case, cargoes will be transported through road & rail.

20.3.4 Energy Consumption

Transport infrastructure plays a key role in the economic development of a country and an efficient transport sector, particularly for transportation of bulk goods is vital for development of any country. As per the World Bank study, Indian logistics cost is one of the highest in the world. As per this study, the logistics cost is 6% to 8% of the total value of goods in developing countries, 10% of the total values of goods in China whereas the cost of logistics in India is 14% of the total value of goods. By using the energy efficient mode of transportation, the logistics cost can be drastically reduced which in turn will boost the economy of the country.

In this section, a comparative study on the energy performance of inland shipping versus that of other land transportation modes has been carried out.

The energy consumption pattern of waterways, roadways and railways is illustrated in the below table, which is based on the 'Eleventh Working Group Report on Shipping and IWT' and 'Working Group Report on Railways'.

Table 20.7: Energy Consumption - Waterways, Road and Rail

Energy Consumption	Waterways		Road		Rail	
	Mj/t km	litre/Tkm	Mj/t km	litre/Tkm	Mj/t km	litre/Tkm
11th Working Group Report on shipping and IWT (Based on EU: Progress Report on short sea shipping 1999)		0.0048		0.0313		0.0089
Report of Working Group on Railways-2012			1.3550	0.0350	0.2550	0.0066
'Energy Consumption' considered for the Study		**0.0048**		**0.0313**		**0.0089**

For the present study, the energy consumption pattern published by `11th Working Group Report on shipping and IWT' has been considered for further analysis.

The benefit from the project pertaining to the energy consumption of all the three modes of transportation viz. waterways, roadways and railways has been forecasted and presented in below table.

Table 20.8 Energy Consumption – Economical Benefit

Energy Consumption - Phase 1	FY	2020	2025	2030	2035	2040	2045	2049
Without Project Scenario								
Road Transportation	0.70							
Road - Energy Consumption	Rs/ Tkm	2.19	2.54	2.94	3.41	3.96	4.59	5.16
Road- Total Energy Consumption	in Rs. Mn	1,138.89	1,614.71	1,871.89	2,170.03	2,515.66	2,916.34	3,282.37
Rail Transportation								
Rail Transportation	0.30							
Rail - Energy Consumption	Rs/ Tkm	0.62	0.72	0.84	0.97	1.13	1.30	1.47
Rail- Total Energy Consumption	in Rs.	138.79	196.77	228.11	264.44	306.56	355.39	400.00
Total	in Rs. Mn	1,277.67	1,811.48	2,100.00	2,434.48	2,822.23	3,271.73	3,682.36
With Project Scenario								
Waterways Transportation								
Waterways - Energy Consumption Cost	Rs/ Tkm	0.34	0.39	0.45	0.52	0.61	0.70	0.79
Waterways- Total Energy Consumption Cost	in Rs. Mn	737.60	1,045.76	1,212.33	1,405.42	1,629.27	1,888.77	2,125.82
Incremental Benefit from the project	**in Rs. Mn**	**540.07**	**765.71**	**887.67**	**1,029.06**	**1,192.96**	**1,382.97**	**1,556.54**

20.3.5 External Costs

Transport contributes significantly to economic growth. Unfortunately, most forms of transport do not only affect society in a positive way but also give rise to side effects. In contrast to the benefits, the cost of these effects of transport are generally not borne by the transport users and hence not taken into account when they make a transport decision. Therefore these effects are generally labelled as external effects. The various cost associated with the external effects are described below.

20.3.5.1 Air Pollution

Transport related air pollution causes damages to humans, biosphere, soil, water, buildings and materials. The most important pollutants are the following:

- Particulate matters
- Nitrogen oxides
- Sulphur oxide
- Ozone
- Volatile organic compounds

Several studies have been carried out to estimate the level of impact caused due to the air pollution triggered by road, rail and inland shipping. Subsequently, the cost factor was arrived for the air pollution by critically valuating various cost elements like valuation of human life, market prices for crops, valuation of building damages, and valuation of long term risks in biosphere. The external cost of air pollution arrived by various studies are listed below:

Table 20.9: External Costs of Air Pollution - Waterways, Roadways and Railways

Inland Water Transportation	**Unit**	**Cost**	**Cost (in Rs/tkm)**
Total Transportation System Study - Planning Commission Report	Rs / t km	0.0300	0.0300
Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0040	0.0011
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm		
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0014	0.0004
Cost considered for the study			**0.0300**

Roadway	Unit	Cost	Cost (in Rs/tkm)
Total Transportation System Study - Planning Commission Report	Rs / t km	0.2020	0.2020
Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0122	0.0033
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	0.0329	0.0090
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0096	0.0026
Cost considered for the study			**0.2020**

Railway	Unit	Cost	Cost (in Rs/tkm)
Total Transportation System Study - Planning Commission Report	Rs / t km	0.0366	0.0366
Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0122	0.0033
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	0.0329	0.0090
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0096	0.0026
Cost considered for the Study			**0.0366**

Based on the traffic projection, the external cost of air pollution is estimated for the both the scenarios 'With Project' and 'Without project' which are captured below:

Table 20.10: Air Pollution - Economical Benefit

Air Pollution - Phase 1	FY	2020	2025	2030	2035	2040	2045	2049
Without Project' Scenario								
Road Transportation	0.70							
Unit Cost	Rs/Tkm	0.20	0.23	0.27	0.31	0.36	0.42	0.48
Total cost	in Rs. Mn	105.00	148.87	172.58	200.07	231.93	268.87	302.62
Rail Transportation	0.30							
Unit Cost	Rs/Tkm	0.04	0.04	0.05	0.06	0.07	0.08	0.09
Total cost	in Rs. Mn	8.15	11.56	13.40	15.54	18.01	20.88	23.50
Without Project' Scenario - Total cost	**in Rs. Mn**	113.15	160.43	185.98	215.60	249.94	289.75	326.12
With' Project Scenario								
Waterways Transportation								
Unit Cost	Rs/Tkm	0.03	0.03	0.04	0.05	0.05	0.06	0.07
Total cost	**in Rs. Mn**	67.28	95.39	110.58	128.19	148.61	172.28	193.90
Increamental Benefit from the project	**in Rs. Mn**	**45.88**	**65.04**	**75.40**	**87.41**	**101.34**	**117.48**	**132.22**

20.3.5.2 Noise Pollution

Noise costs consist of costs for annoyance and health. The external cost of noise pollution arrived by various studies are listed in the below table. The cost factors for noise pollution are available only based on European conditions and are mentioned in Euros. Same has been converted to Rupees based on the purchasing power parity as mentioned in the Key Assumptions.

Table 20.11: External Cost of Noise Pollution

Inland Water	**Unit**	**Cost**	**Cost (in Rs/tkm)**
Union Internationale des Chemins de fer (PIANC)	€/Tkm	-	-
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	-	-
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	-	-
Cost considered for the study			
Roadways	**Unit**	**Cost**	**Cost (in Rs/tkm)**
Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0119	0.0032
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	-	-
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0018	0.0005
Cost considered for the Study			**0.0012**
Railways			
	Unit	**Cost**	**Cost (in Rs/tkm)**
Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0044	0.0012
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	0.0010	0.0003
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0035	0.0009
Cost considered for the study			**0.0008**

The incremental cost benefit for the project due to the external cost of noise pollution is estimated as given below.

Table 20.12 Noise Pollution - Economical Benefit

Noise Pollution-Phase 1	FY	2020	2025	2030	2035	2040	2045	2049
Without Project' Scenario								
Road Transportation	0.70							
Unit Cost	Rs/Tkm	0.001200	0.001391	0.001613	0.001870	0.002167	0.002513	0.002828
Total cost	in Rs. Mn	0.62	0.88	1.03	1.19	1.38	1.60	1.80
Rail Transportation	0.30							
Unit Cost	Rs/Tkm	0.00080	0.00093	0.00108	0.00125	0.00144	0.00168	0.00189
Total cost	in Rs. Mn	0.18	0.25	0.29	0.34	0.39	0.46	0.51
Without Project' Scenario - Total cost	**in Rs. Mn**	0.80	1.14	1.32	1.53	1.77	2.05	2.31
With' Project Scenario								
Waterways Transportation								
Unit Cost	Rs/Tkm	0	0	0	0	0	0	0
Total cost	**in Rs. Mn**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increamental Benefit from the project	**in Rs. Mn**	**0.80**	**1.14**	**1.32**	**1.53**	**1.77**	**2.05**	**2.31**

20.3.5.3 Soil and Water Pollution

The external cost of soil & water pollution arrived by various studies and it is observed that only roadways tends to produce soil & water pollution as mentioned.

Table 20.13 External Cost of Soil and Water Pollution

Roadways	Unit Rs / t km	Cost	Cost in Rs.
Union Internationale des Chemins de fer (PIANC)	€/Tkm	-	-
le Groupe d'Economie des Transports de l'ULB (PIANC)	€/ Tkm	-	-
Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0020	0.0005
Cost considered for the Study			**0.0005**

The incremental cost benefit for the project due to the external cost of noise pollution is estimated as given below.

Table 20.14: Soil and Water Pollution - Economical Benefit

Soil and Water Pollution - Phase 1	FY	2020	2025	2030	2035	2040	2045	2049
Without Project' Scenario								
Road Transportation	0.70							
Unit Cost	Rs/ Tkm	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0012
Total cost	in Rs. Mn	0.26	0.37	0.43	0.50	0.57	0.67	0.75
Rail Transportation	0.30							
Unit Cost	Rs/ Tkm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost	in Rs. Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Without Project' Scenario - Total cost	**in Rs. Mn**	0.26	0.37	0.43	0.50	0.57	0.67	0.75
With' Project Scenario								
Waterways Transportation								
Unit Cost	Rs/ Tkm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost	**in Rs. Mn**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increamental Benefit from the project	**in Rs. Mn**	**0.26**	**0.37**	**0.43**	**0.50**	**0.57**	**0.67**	**0.75**

20.3.5.4 Reduction in Accidents

The external cost for accident considered for three modes of transportation is mentioned below.

Table 20.15: Accident Cost - Waterways, Roadways and Railways

Accidents		Unit	Cost	Cost (in Rs/tkm)
Waterways	Total Transportation System - Planning commission	Rs./Tkm	-	-
	Union Internationale des Chemins de fer (PIANC)	€/Tkm	-	-
	le Groupe d'Economie des Transports de l'ULB (PIANC)	€/Tkm	-	-
	Bundesamt fur Umweltschutz (PIANC)	€/Tkm	-	-
	Cost considered for the Study		-	-
Roadways	Total Transportation System - Planning commission	Rs./Tkm	0.0620	0.0620
	Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0208	0.0057
	le Groupe d'Economie des Transports de l'ULB (PIANC)	€/Tkm	0.0353	0.0096
	Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0091	0.0025
	Cost considered for the Study			**0.0620**
Railways	Total Transportation System - Planning commission	Rs./Tkm	0.0010	0.0010
	Union Internationale des Chemins de fer (PIANC)	€/Tkm	0.0008	0.0002
	le Groupe d'Economie des Transports de l'ULB (PIANC)	€/Tkm	0.0005	0.0001

Accidents		Unit	Cost	Cost (in Rs/tkm)
	Bundesamt fur Umweltschutz (PIANC)	€/Tkm	0.0006	0.0002
	Cost considered for the study			**0.0010**

The incremental cost benefit for the project due to the external cost of reduction in accidents is estimated as given below.

Table 20.16: Reduction in Accident Cost - Economical Benefit

Accidents - Phase 1	FY	2020	2025	2030	2035	2040	2045	2049
Without Project' Scenario								
Road Transportation	0.70							
Unit Cost	Rs/ Tkm	0.06	0.07	0.08	0.10	0.11	0.13	0.15
Total cost	in Rs. Mn	32.23	45.69	52.97	61.41	71.19	82.53	92.88
Rail Transportation	0.30							
Unit Cost	Rs/ Tkm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost	in Rs. Mn	0.22	0.32	0.37	0.42	0.49	0.57	0.64
Without Project' Scenario - Total cost	in Rs. Mn	32.45	46.01	53.34	61.83	71.68	83.10	93.53
With' Project Scenario								
Waterways Transportation								
Unit Cost	Rs/ Tkm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cost	in Rs. Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increamental Benefit from the project	in Rs. Mn	32.45	46.01	53.34	61.83	71.68	83.10	93.53

20.3.6 Economic IRR

Taking in the consideration of the economic benefits from the projects as worked out above, the economic IRR has been worked out to be **32.05% for Phase-1 development** which indicates that the project is economically viable.

Table 20.17: Economic IRR for Phase 1 of Terminal

S.No.	Description	FY	2018	2019	2020	2025	2030	2035	2040	2045	2049
		Unit			1	6	11	16	21	26	30
A	**Cargo in Million Tonnes**	**Million Tonnes**			**2.48**	**3.03**	**3.03**	**3.03**	**3.03**	**3.03**	**3.03**
B	Benefit from the project	Rs Million									
1	Revenue	Rs Million			516.7	732.7	849.4	984.7	1141.5	1323.4	1489.5
2	Salvage Value	Rs Million									544.2
3	Economic Benefit from the project	Rs Million			619	878	1018	1180	1368	1586	1785
4	**Total Benefit from the project**	**Rs Million**			**1136**	**1611**	**1868**	**2165**	**2510**	**2910**	**3819**
C	**Operation Expenses**				**150.2**	**195.8**	**234.5**	**281.4**	**338.4**	**407.8**	**474.3**
D	EBIDTA				986	1415	1633	1884	2171	2502	3345
E	CAPEX	Rs Million	-1,675	-1,675							
F	Cash Flow (Before Tax)	Rs Million	**-1,675**	**-1,675**	**986**	**1,415**	**1,633**	**1,884**	**2,171**	**2,502**	**3,345**
G	**Economic IRR**		**32.05%**								

20.3.7 Financial & economic IRR for all Phases

Following the same methodolgy for arrving at financial & economic IRR for Phase 1 of Sahibganj Terminal, the financial & economic IRR for different phases are worked out as given in Table 20.18.

Table 20.18: Financial & Economic IRR for different phases of Sahibganj Terminal

S.No.	Phase Description	Financial IRR	Economic IRR
1	Phase 2		
a	Without Railway	12.60%	21.34%
b	With Railway	15.35%	20.65%
2	Phase 3	16.52%	28.70%
3	Phase 2 + Phase 3	13.78%	22.66%
4	Phase 1 + Phase 2 + Phase 3	12.23%	29.08%

39. ANNEXURE XVII: Base Case Financial Model

[Note: The model BCFM would be developed with the appropriate inputs from the financial and technical consultants. However such Financing Plan would need to be customized based on each project and its requirements. Such model Financing Plan would essentially include;

(i) Estimated Project Cost,

(ii) License Fee and Royalty payable to the Concessioning Authority,

(iii) Annual estimated Project revenue,

(iv) Equity contribution,

(v) Cargo handling projections estimated by Concessionaire,

(vi) Discounted net present value of the cash flows,

(vii) Equity IRR,

(viii) Debt equity ratio, and

(ix) Debt service ratio.

Such Financing Plan would be submitted by the concessionaire and got approved by the Concessioning Authority at the time of Financial Close.]

Note: Such format of the Financing Plan shall also identify the respective threshold limit of the above parameters and the basis of further projections and the detailed requirements that would need to be stratified with respect to each line item.

40. ANNEXURE XVIII: Draft Tripartite Agreement

MODEL TRIPARTITE AGREEMENT

BETWEEN INLAND WATERWAYS AUTHORITY OF INDIA,

CONCESSIONAIRE AND INFRASTRUCTURE DEBT FUND

This Tripartite Agreement is made at ****** on the ***** day of *****, 20** by

and between

(i) **MEMBERS OF INLAND WATERWAYS AUTHORITY OF INDIA**, a body corporate constituted under the provisions of the Inland Waterways Authority of India Act 1985, and having its principal administrative office at A-13, Sector-1, Noida – 201301, Uttar Pradesh,

hereinafter referred to as the "**Concessioning Authority**" which expression shall, unless repugnant to the context or meaning thereof, include its administrators, successors and assigns;

(ii) The [***** Infrastructure Debt Fund], a company registered under the Companies Act, 1956, acting through *****, and having its registered office at ***** (hereinafter referred to as the "**Debt Fund**" which expression shall, unless repugnant to the context or meaning thereof, include its administrators, successors and assigns);

And

[***** Limited], a company registered under the Companies Act, 2013, acting through *****, duly authorised by the resolution passed at the meeting of its Board of Directors held on *****,

and having its registered office at ***** (hereinafter referred to as the "**Concessionaire**" which expression shall, unless repugnant to the context or meaning thereof, include its administrators, successors and assigns)

40.1.1. WHEREAS:

(A) The Concessioning Authority and the Concessionaire had entered into a Concession Agreement (as defined hereinafter), a true copy of which is annexed hereto and marked as Annex-I, for development of ***** (the "**Project**");

(B) The Project entered into commercial operation or any substitute thereof on ***** (the "**Date of Commercial Operation**") in accordance with the provisions of the Concession Agreement;

(C) Following the occurrence of the Date of Commercial Operation, the Concessionaire has been operating the Project in accordance with the terms and conditions of the Concession Agreement;

(D) The Concessionaire had raised debt from the Senior Lenders for financing the Project and had utilised the same for the purposes of the Project under the Concession Agreement;

(E) The Concessionaire has been discharging its debt service obligations, including the repayment of principal and interest, in accordance with the provisions of the Financing Documents;

(F) The debt service obligations have not been rescheduled, waived or postponed in any manner during the past one year from the date hereof, and the Concessionaire is not in default of its debt service obligations under the Financing Documents; and

(G) The Concessionaire has decided to refinance all or part of its outstanding debt and has requested the Debt Fund to invest in its bonds, the proceeds of which shall be paid to the Senior Lenders as specified in Schedule-I.

Now, therefore, the Parties hereby agree and this agreement witnessed - as follows:

1. DEFINITIONS AND INTERPRETATIONS

1.1 For the purposes of this Agreement, the following terms shall have the meaning hereinafter respectively assigned to them:

"**Agreement**" means this Tripartite Agreement, and amendments if any thereto;

"**Bonds**" means the securities issued by the Concessionaire in consideration of the amounts paid for the investment thereof;

"**Concession Agreement**" means the executed Concession Agreement dated [date on which the Concession Agreement has been signed] for the Project, entered into between the Concessioning Authority and the Concessionaire,

and shall include all Schedules thereof and any amendments thereto made in accordance with the provisions contained in this behalf therein;

"**Financing Documents"** means financing documents under the Concession Agreement and documents executed on the date [...date of signing of the financing documents] for the Project and shall include all Schedules thereof and any amendments thereto made in accordance with the provisions contained in this behalf therein.

"Senior Lenders" means any Persons based in India or abroad providing Financial Assistance under the Financing Documents and includes a trustee for the holders of debentures/ or other debt instruments issued by the Concessionaire to finance the Project.

"Senior Lenders' Representative" shall have the same meaning as ascribed to it in the Financing Document, provided that, this would include the Trustees for any bonds issued by the Concessionaire. In absence of one such person/ entity having the authority to sign, Senior Lenders Representative shall mean all the Senior Lenders, and/or the Trustees for any bonds issued by the Concessionaire.

"**Parties**" means the parties to this Agreement collectively and "Party" shall mean any of the parties to this Agreement individually;

1.2 The words and expressions beginning with or in capital letters used in this Agreement and not defined herein but defined in the Concession Agreement shall have, unless repugnant to the context, the meaning respectively assigned to them in the Concession Agreement**.**

1.3 **Interpretation**

1.3.1 In this Agreement, unless the context otherwise requires,

(a) references to any legislation or any provision thereof, or any rules, regulations, bylaws or notifications thereunder, shall include amendment or re-enactment or consolidation of such legislation or any provision thereof so far as such amendment or re-enactment or consolidation applies or is capable of applying to any transaction entered into hereunder;

(b) references to "**development**" include, unless the context otherwise requires, construction, renovation, refurbishing, augmentation, upgradation and other activities incidental thereto, and "**develop**" shall be construed accordingly;

(c) "**lakh**" means a hundred thousand (100,000) and "**crore**" means ten million (10,000,000);

(d) save and except as otherwise provided in this Agreement, any reference, at any time, to any agreement, deed, instrument, licence or document of any description shall be construed as reference to that agreement, deed, instrument, licence or other document as amended, varied, supplemented, modified or suspended at the time of such reference; provided that this Sub-clause shall not operate so as to increase liabilities or obligations of the Debt Fund hereunder or pursuant hereto in any manner whatsoever;

(e) any agreement, consent, approval, authorisation, notice, communication, information or report required under or pursuant to this Agreement from or by any Party shall be valid and effective only if it is in writing under the hand of a duly authorised representative of such Party in this behalf and not otherwise;

(f) the Recitals and Annexes to this Agreement form an integral part of this Agreement and will be in full force and effect as though they were expressly set out in the body of this Agreement; and

(g) time shall be of the essence in the performance of the Parties' respective obligations. If any time period specified herein is extended, such extended time shall also be of the essence.

1.3.2 Any word or expression used in this Agreement shall, be construed as per the definition given in the General Clauses Act, 1897 failing which it shall bear the ordinary English meaning.

2. ISSUE OF BONDS

2.1 The Parties agree that the Concessionaire may, in accordance with the provisions of this Agreement, issue Bonds for the amounts subscribed by the Debt Fund; provided that the total value of such Bonds shall not exceed 94% (ninety four percent) of compensation payment from the Concessioning Authority on day of signing this Tripartite Agreement**(as specified in Schedule II)**; [provided further that the Concessionaire may, with prior written approval of the Concessioning Authority, which approval the Concessioning Authority may in its sole discretion deny, issue additional Bonds for a total value not exceeding the balance of the said compensation payable][5].

2.2 Upon investment in Bonds pursuant to Paragraph 2.1, the Debt Fund shall be deemed to be a Senior Lender and shall thereupon be entitled to all the rights and privileges of a Senior Lender under the Concession Agreement.

2.3 The tenor of the Bonds, in accordance with the provisions of this Agreement shall be such that at least 50% (fifty per cent) and 75% (seventy five per cent) of the total nominal value thereof shall be fully redeemed by the Concessionaire no later than the expiry of 75% (seventy five per cent) and 85% (eighty five per cent) of the Concession Period respectively and the balance, if any, shall be redeemed no later than 2 (two) years prior to the expiry of the Concession Period.

2.4 Subject to the clause 2.3 of this Agreement, the tenure, rate of interest and other commercial terms of the Bonds shall be determined by mutual agreement between the Debt Fund and the Concessionaire.

2.5 The Bonds shall be in such denomination as the Debt Fund and the Concessionaire may determine, but not less than Rs [10,000 (Rupees ten thousand)] in any case.

2.6 Subject to the provisions of Paragraph 4.1, the Debt Fund and the Concessionaire may, with prior written approval of the Concessioning Authority, which approval the Concessioning Authority may in its sole discretion deny, allocate and bear the foreign exchange risks for and in respect of any foreign-exchange denominated Bonds, in such manner as they may mutually agree. For the avoidance of doubt, the Parties expressly agree that if the foreign exchange risk for any or all Bonds is borne by the Concessionaire. The compensation to be made by the Concessioning Authority for and in respect of such Bonds shall be adjusted to cover the variation between the nominal value of Bonds and the actual amount payable to the Debt Fund, such that the liability of the Concessionaire for redemption of the Bonds hereunder is fully discharged by the Concessioning Authority.

2.7 The Parties expressly agree and confirm that repayment of the principal and interest in respect of the Bonds shall have a prior charge over the Senior Lenders on appropriation of compensation under Articles 9, 16 and 17 of the Concession Agreement, and only the balance remaining shall be paid to the other Senior Lenders.

2.8 Any delay in the repayment of the principal or interest for and in respect of the Bonds shall attract interest at a rate of 3% (three per cent) above the rate of interest applicable for the Bonds.

2.9 The Parties agree and confirm that upon execution of this Agreement, the Debt Fund shall, acting through the Senior Lenders' Representatives, be deemed to be a party to the Escrow Agreement and the Substitution Agreement for the Project, and all rights, privileges and obligations of the Senior Lenders shall also vest in the Debt Fund. The Parties further agree and confirm that the provisions of the Concession Agreement and all other agreements, including the Escrow Agreement, Substitution Agreement and Financing Documents, shall be read and construed so as to give effect to the provisions of this Agreement, but without increasing any financial obligations and/ or liabilities of the Concessioning Authority under the Concession Agreement.

2.10 By counter-signing the Tripartite Agreement, the Senior Lenders' Representative, acting on behalf of the Senior Lenders agrees, confirms and undertakes that the *paripassu* rights, title or interest of the Lenders in compensation, to the extent such rights, title or interest are provided in the Concession Agreement, Substitution Agreement, Escrow Agreement, Financing Documents or any other agreement, shall be subordinate to the rights, title or interest created by the Bonds in favour of the Debt Fund, and accordingly, the

compensation shall be applied first for the redemption of Bonds and only the balance remaining, if any, shall be paid into the Escrow Account for meeting other obligations including the balance Debt Due. For the avoidance of doubt, the Parties expressly agree that the Debt Fund may, in its discretion, exercise all the rights and privileges of the Senior Lenders' Representative under the Concession Agreement, Substitution Agreement, Escrow Agreement and this Agreement. The Parties further agree that save and except the application of compensation for redemption of Bonds in pursuance of this Agreement and subject to the provisions of Paragraph 2.7, the Senior Lenders shall have *paripassu* charge on the revenues of the Concessionaire in accordance with the provisions of the Concession Agreement.

2.11 The Debt Fund may, by notice to the Parties, transfer all or any Bonds to any other person, and upon such transfer, the rights and obligations of the Debt Fund shall vest in such person. Provided that no such notice shall be required for transfer of Bonds if they have been listed in any recognized Stock Exchange and such transfer is in accordance with the regulations of the Stock Exchange.

2.12 Notwithstanding anything to the contrary contained in this Agreement, the Debt Fund may have the option to extend a term loan to the Concessionaire for an amount not exceeding 50% (fifty per cent) of its total exposure to the Concessionaire and the provisions of this Agreement shall apply *mutatis mutandis* to such term loan as if it were a Bond.

3. REDEMPTION OF BONDS

3.1 The Concessionaire agrees and undertakes that upon completion of the tenor of the Bonds, it shall redeem the same by making full and complete payment of the outstanding principle and the interest thereon.

3.2 Notwithstanding anything to the contrary in this Agreement, the Debt Fund may by notice require the Concessionaire to redeem upto 10% (ten per cent) of the value of the Bonds in any financial year and upon notice in this behalf, the Concessionaire shall redeem such Bonds no later than 120 (one hundred and twenty) days from the date of receipt of such notice.

3.3 The Parties expressly agree that the Debt Fund and the Concessionaire may at any time by mutual agreement undertake early redemption of the Bonds and upon full redemption thereof, this Agreement shall cease to be in force.

3.4 The Parties expressly agree and confirm that in terms of Article [15, 16 and 17] of the Concession Agreement, the Concessioning Authority has covenanted that in the event of termination of the Concession Agreement, the Concessioning Authority shall pay compensation in accordance with the provisions of the Concession Agreement, which shall be applied for redemption of the Bonds in accordance with the provisions of this Agreement. The Parties further agree and confirm that upon termination on account of a Concessionaire Event of Default or Concessioning Authority Event of Default, the Concessioning Authority shall pay compensation in accordance with the provisions of the Concession Agreement.

3.5 The Parties agree and confirm that in the event of default in Debt Service by the Concessionaire, the Senior Lenders shall have the right to enforce termination of the Concession Agreement in terms of Article 15.1.1 and 17.1.2 of the Concession Agreement, which *inter alia* requires the Concessioning Authority to pay compensation in accordance with the provisions of the Concession Agreement. The Parties further agree that in the event the Concessioning Authority approves the issuance of additional Bonds under the provisions of Paragraph 2.1 of this Agreement, the liability of the Concessioning Authority shall, notwithstanding the provisions of the Concession Agreement, extend to an amount equal to 100% of the compensation in Concessionaire Event of Default.

3.6 The Concessioning Authority agrees and undertakes that upon receipt of a notice under and in accordance with the provisions of Article 3.2 of the Substitution Agreement, it shall, no later than 15 (fifteen) days from the date of receipt of such notice, issue a notice to the Concessionaire requiring it to cure the Financial Default and in the event the default is not cured before the expiry of the Remedial Period specified in Article 15.4 of the Concession Agreement, a Concessionaire Default shall have occurred and the Concessioning Authority shall issue the Termination Notice forthwith, but no later than 15 (fifteen) days from the date of occurrence of Concessionaire Default, and shall make compensation no later than 15(fifteen) days from the date of Termination Notice. The Parties expressly agree that the timelines specified in the Paragraph 3.6 of this Agreement are not in modification of the Concession Agreement but only in elaboration thereof.

3.7 The Parties expressly agree and confirm that the rights of the Debt Fund and the Senior Lenders' Representative to enforce termination of the Concession Agreement in accordance with Paragraph 3.6 may be exercised individually or jointly, as the case may be, by the Debt Fund and/or the Senior Lenders' Representative.

3.8 The Parties expressly agree that the Concessioning Authority shall, instead of depositing the compensation in the Escrow Account of the Project, redeem the Bonds by making payments due and payable to the Debt Fund, and the balance, if any, shall be paid into the Escrow Account. The Parties further agree that the provisions hereof shall in no way be construed to increase the financial liability of the Concessioning Authority for and in respect of the compensation [save and except as provided in Paragraph 3.5 for and in respect of the additional bonds specified therein].

3.9 The Parties agree and confirm that the amounts, if any, paid by the Concessioning Authority for redemption of Bonds and the balance compensation, if any, paid as per the Concession Agreement into the Escrow Account shall be deemed to be a valid discharge of its obligations to make compensation under and in accordance with the Concession Agreement.

4. FEES

4.1 The Debt Fund shall pay to the Concessioning Authority, 0.05% (zero point zero five per cent) per annum of the outstanding debt financed by the IDF, by way of a guarantee fee in consideration of the obligations of the Concessioning Authority hereunder; [provided that the guarantee fee shall be 1% (one per cent) in respect of Bonds for which the foreign exchange risk is to be borne by the Concessionaire] [provided further that the guarantee fee for and in respect of the additional Bonds specified in Paragraph 2.1 shall be 3% (three per cent) per annum of the nominal value thereof].

4.2 The guarantee fee specified in Paragraph 4.1 shall be due and payable annually before commencement of the financial year to which it relates. In the event of delay in payment of the guarantee fee, the Debt Fund shall pay interest at the rate of 14% (fourteen per cent) per annum, to be computed on a daily basis and compounded every month for the period of delay; provided, however, that if such delay exceeds the period of 180 (one hundred and eighty) days this Agreement shall cease to be in force, and upon termination of the Concession Agreement at any time thereafter, the Concessioning Authority's obligation to pay the compensation to the Debt Fund shall be deemed to be reduced by 20% (twenty per cent) thereof.

5. REPRESENTATIONS AND WARRANTIES

5.1 Each of the Parties represent, warrant and confirm the following:

(a) This Agreement constitutes its legal, valid and binding obligation, enforceable against it in accordance with the terms hereof, and its obligations under this Agreement will be legally valid, binding and obligations enforceable against it in accordance with its terms;

(b) the execution, delivery and performance of this Agreement will not conflict with or result in a breach or constitute default under or accelerate performance required by any of the terms of Memorandum and Articles of Association of any Party or any applicable law or any covenant, contract, arrangement or understanding, or any decree or order of any court to which it is a party or by which it or any of its properties or assets is bound or affected;

(c) all information provided by the Party is true and accurate in all material respect;

(d) there are no actions, suits, proceedings or investigations pending or to its knowledge threatened against it at law or in equity before any court or any other judicial, quasi judicial or other authority or body, the outcome of which may result in a material breach of this Agreement;

(e) the Party has complied with all Applicable Laws and Applicable Permits in all material respects;

(f) the Concessionaire is not in a material breach of the Concession Agreement or of any Project Contracts or Financing Documents; and

(g) no representation or warranty contained herein or in the Concession Agreement or any other document furnished by the Party contains or will contain any untrue or misleading statement of material facts or omits or will omit to state a material fact necessary to make such representation or warranty not misleading.

5.2 In the event of any occurrence or circumstance coming to the knowledge of the Party making any representation hereunder which renders any of its aforesaid representations or warranties untrue or incorrect at any time during the subsistence of this Agreement, such Party shall immediately notify the other Parties hereto about the same. Such notification shall not have the effect of remedying any such representation or warranty that has been found to be incorrect or untrue.

6. ARBITRATION

6.1 Any Dispute which is not resolved amicably by conciliation shall be finally decided by reference to arbitration by a Board of Arbitrators appointed in accordance with Paragraph 6.2 of this Agreement. Such arbitration shall be held in accordance with the Rules of Arbitration of the International Centre for Alternative Dispute Resolution, New Delhi (the "**Rules**"), or such other rules as may be mutually agreed by the Parties, and shall be subject to the provisions of the Arbitration Act. The venue of such arbitration shall be Delhi, and the language of arbitration proceedings shall be English.

6.2 In the event of a dispute between two Parties, there shall be a Board of three arbitrators, of whom each Party shall select one, and the third arbitrator shall be appointed by the two arbitrators so selected, and in the event of disagreement between the two arbitrators, the appointment shall be made in accordance with the Rules. In the event of a dispute involving all the Parties, a single arbitrator shall be appointed in accordance with the Rules.

6.3 The arbitrators shall make a reasoned award (the "**Award**"). Any Award made in any arbitration held pursuant to this Paragraph 6 shall be final and binding on the Parties as from the date it is made, and the Parties agree and undertake to carry out such Award without delay.

6.4 The Parties agree that an Award may be enforced against the Concessionaire, the Concessioning Authority and/or the Debt Fund, as the case may be, and their respective assets wherever situated.

6.5 This Agreement and the rights and obligations of the Parties shall remain in full force and effect, pending the Award in any arbitration proceedings hereunder.

7. COMING INTO FORCE AND DURATION OF THE AGREEMENT

This Agreement shall come into force and effect on the date hereof and shall remain in force until the redemption of all Bonds.

IN WITNESS WHEREOF, this Agreement has been executed on the day and year first above written.

For and on behalf of the **Concessioning Authority**

Signature :

Name :

Designation :

For and on behalf of the **Debt Fund**

Signature :

Name :

Designation :

For and on behalf of the **Concessionaire**

Signature :

Name :

Designation :

Agreed, Accepted, Countersigned and Witnessed by the Senior Lenders' Representatives for and on behalf of **Senior Lenders** by

Signature :

Name :

Designation :

SCHEDULE-I

(Refer Recital G)

No.	Name of Senior Lenders/Bond holders' Trustee with Address	Amount to be refinanced IDF by way of Bonds/Loan (Rs. in crore)	Remarks, if any
1.			
2.			
3.			
4.			

5.			
6.			
7.			
8.			
9.			
10.			

SCHEDULE-II

(Quantum of compensation)

As per the definition in the Concession Agreement, the quantum of (i) Book Value, (ii) 90% of Debt Due and (iii) –Total Project Cost as on the date of execution of this Agreement, and at the end of each financial year until the end of the concession period is mentioned in the table below:

(Rs. In Crores)

Date	Book Value	% of Debt Due	–Total Project Cost	Amount of Compensation

41. ANNEXURE XIX: Negative list for non-operational activities

This annexure presents only an indicative and not exhaustive list of activities that shall be prohibited within the Terminal. For any construction at the Terminal however, a final approval of Concessioning Authority shall be sought by Concessionaire.

(i) manufacture or handling or storage or disposal of hazardous substances as specified in Notifications of the Government of India in the Ministry of Environment and Forests
(ii) setting up and expansion of units/mechanism for disposal of waste and effluents, except facilities required for discharging treated effluents into the water course with approval under the Water (Prevention and Control of Pollution) Act, 1974; and except for storm water drains
(iii) dumping of city or town waste for the purposes of landfilling or otherwise
(iv) night clubs
(v) casinos
(vi) bars
(vii) any commercial activity interrupting any existing social and cultural practice prevalent locally; this shall exclude any activity related to infrastructure to be developed mandatorily as per scope of work mentioned in Annexure III of this agreement
(viii) organizations facilitating gambling and similar recreational activities such as night-clubs and casinos
(ix) arranging for musical or any other concerts
(x) setting up of any educational institution or university
(xi) setting up of healthcare facilities for commercial purpose
(xii) setting up of any religious structure/ monument, neither permanent construction nor temporary constructions
(xiii) allocating the land for purpose of rehabilitation
(xiv) allocating the land for any residential construction

42. Annexure XX: Auditors

42.1. Appointment of Auditors

42.1.1. The Concessionaire shall appoint, and have during the subsistence of this Agreement as its Statutory Auditors, a firm chosen by it from the mutually agreed list of 5 (five) reputable firms of chartered accountants ("Panel of Chartered Accountants"), such list to be prepared substantially in accordance with the criteria set forth in Schedule P. All fees and expenses of the Statutory Auditors shall be borne by the Concessionaire.

42.1.2. The Concessionaire may terminate the appointment of its Statutory Auditors in accordance with the provisions of the Companies Act, 2013, subject to the replacement Statutory Auditors being appointed from the Panel of Chartered Accountants.

42.1.3. Notwithstanding anything to the contrary contained in this Agreement, the Authority has the right, but not the obligation, to appoint at its cost from time to time and at any time, another firm ("**Additional Auditors**") from the Panel of Chartered Accountants to audit and verify all those matters, expenses, costs, realisations and things which the Statutory Auditors are required to do, undertake or certify pursuant to this Agreement.

42.1.4. Further, the Concessionaire shall change the Statutory Auditor from time to time to comply with the provisions of the Companies Act, 2013 and any rules and regulations framed thereunder.

42.2. Panel of Chartered Accountants

Pursuant to the provisions of the Agreement, the Authority and the Concessionaire shall prepare a mutually agreed panel of 5 (five) reputable firms of Chartered Accountants having their registered offices in India ("**Panel of Chartered Accountants**"). The criteria for preparing such Panel and the procedure to be adopted in this behalf shall be as set forth in this Annexure XX.

42.2.1. Invitation for Empanelment

The Authority shall invite offers from all reputed firms of Chartered Accountants who fulfil the following eligibility criteria, namely:

(a) the firm should have conducted statutory audit of the annual accounts of at least one hundred companies registered under the Companies Act, 2013, including any re-enactment or amendment thereof, of which at least ten should have been public sector undertakings;

(b) the firm should have at least 5 (five) practising Chartered Accountants on its rolls, each with a minimum experience of 10 (ten) years in the profession;

(c) the firm or any of its partners should not have been disqualified or black-listed by the Comptroller and Auditor General of India or the Authority; and

(d) the firm should have an office in the State or in an adjacent State with at least 2 (two) practising Chartered Accountants on its rolls in such State.

Interested firms meeting the eligibility criteria shall be required to submit a statement of their

capability, including the bio-data of all the practising Chartered Accountants, on its rolls. In particular, each firm shall be required to furnish year-wise information relating to the names of all the companies with an annual turnover exceeding Rs. 25,00,00,000 (Rupees Twenty Five Crore) whose annual accounts were audited by such firm in any of the preceding 5 (five) Accounting Years.

42.2.2. Evaluation and Selection

The information furnished by each firm shall be scrutinised and evaluated by the Authority and 1 (one) point shall be awarded for each annual audit of the companies specified in Paragraph 0 above. (By way of illustration, a firm which has conducted audit of the annual accounts of any such company for 5 (five) years shall be awarded 5 (five) points).

The Authority shall prepare a list of all the eligible firms along with the points scored by each such firm and 5 (five) firms scoring the highest points shall be identified and included in the draft Panel of Chartered Accountants.

42.2.3. Consultation with the Concessionaire

The Authority shall convey the aforesaid panel of firms to the Concessionaire for scrutiny and comments, if any. The Concessionaire shall be entitled to scrutinise the relevant records of the Authority to ascertain whether the selection of firms has been undertaken in accordance with the prescribed procedure and it shall send its comments, if any, to the Authority within 15 (fifteen) days of receiving the aforesaid panel.

42.2.4. Mutually Agreed Panel

The Authority shall, after considering all relevant factors including the comments, if any, of the Concessionaire, finalise and constitute a panel of 5 (five) firms which shall be deemed to be the mutually agreed Panel of Chartered Accountants.

After completion of every 5 (five) years from the date of preparing the mutually agreed Panel of Chartered Accountants, or such earlier period as may be agreed between the Authority and the Concessionaire, a new panel shall be prepared in accordance with the provisions of this Annexure XX.