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.

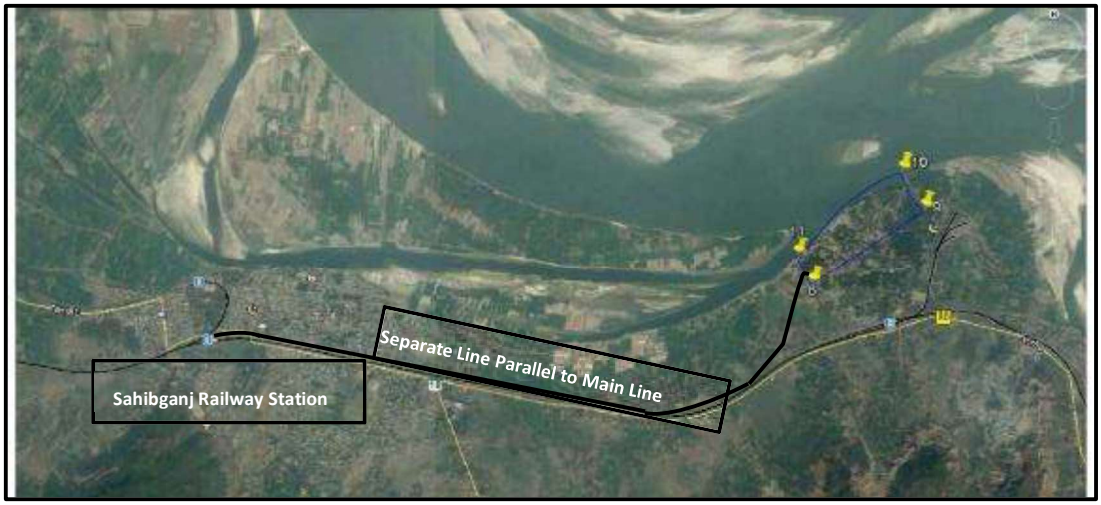


Figure 8.1: Option-1: Near Sahibganj Station

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.**

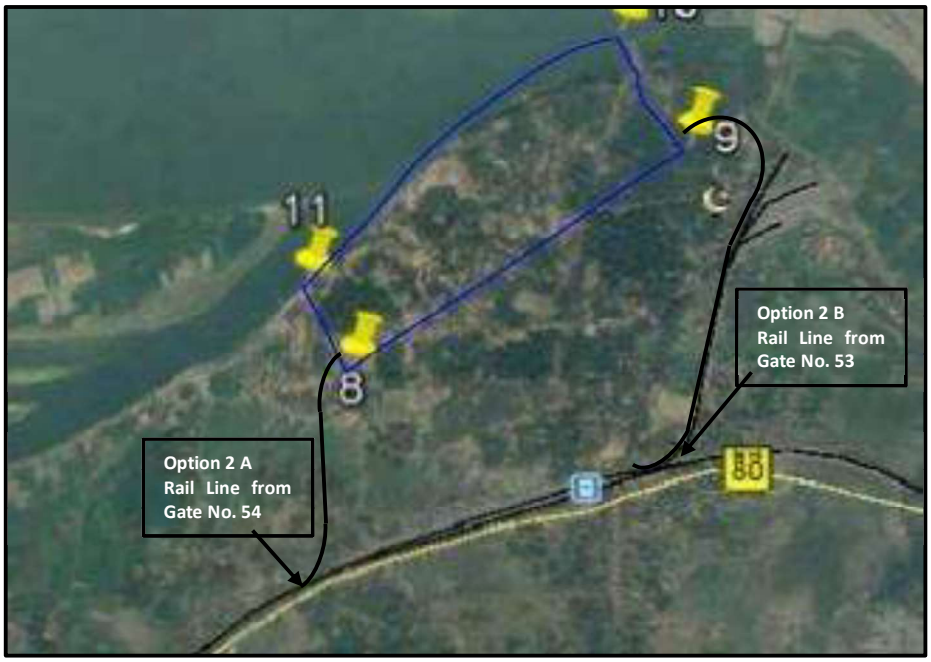


Figure 8.2: Option-2: From Level Crossing Gate No.53 or 54 at Sakrigali station

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.

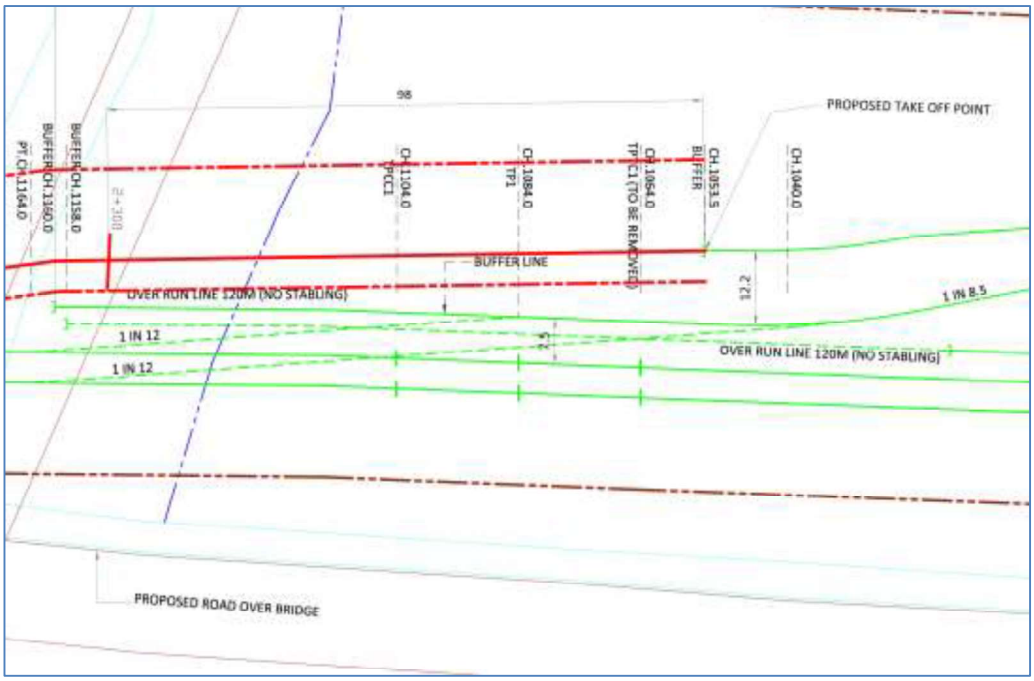


Figure 8.5: Junction Arrangement

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.

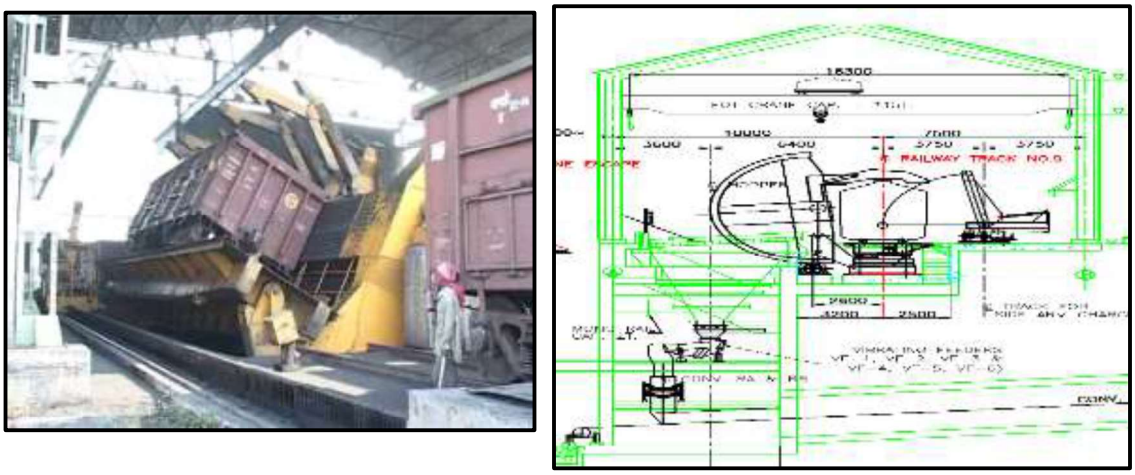


Figure 10.3: Typical Arrangement of Wagon Tippler

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.

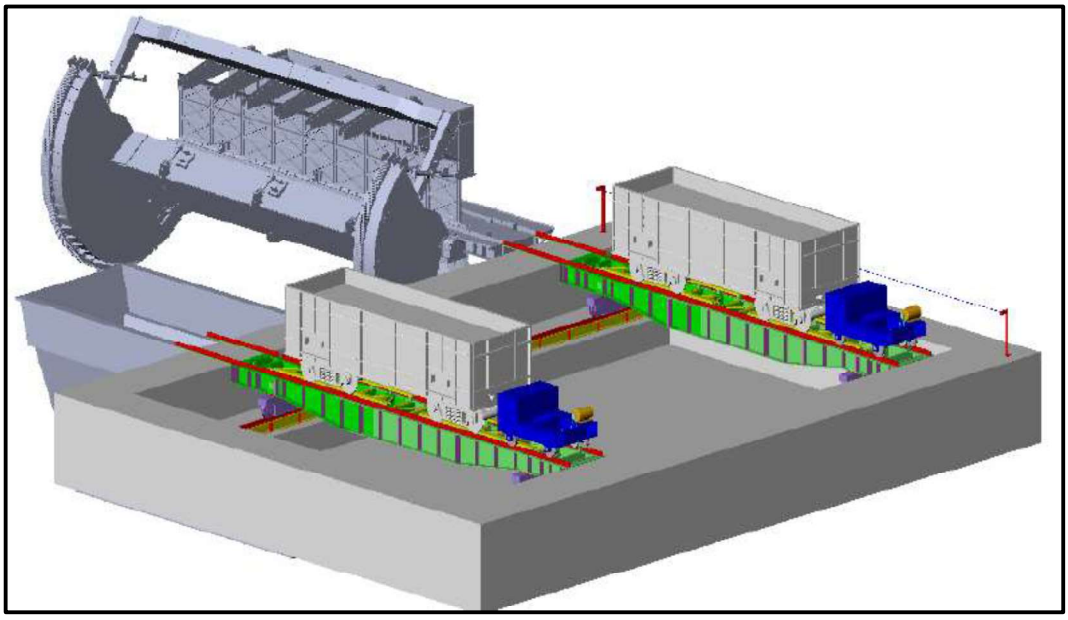


Figure 10.4: Typical Arrangement of Wagon Shifter-Pusher

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**.

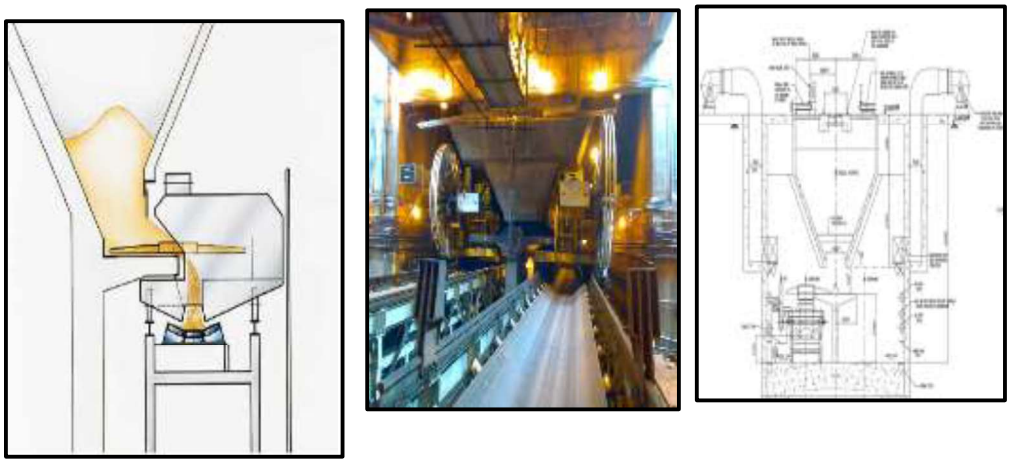


Figure 10.5: Typical Arrangement of Track hopper

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**

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

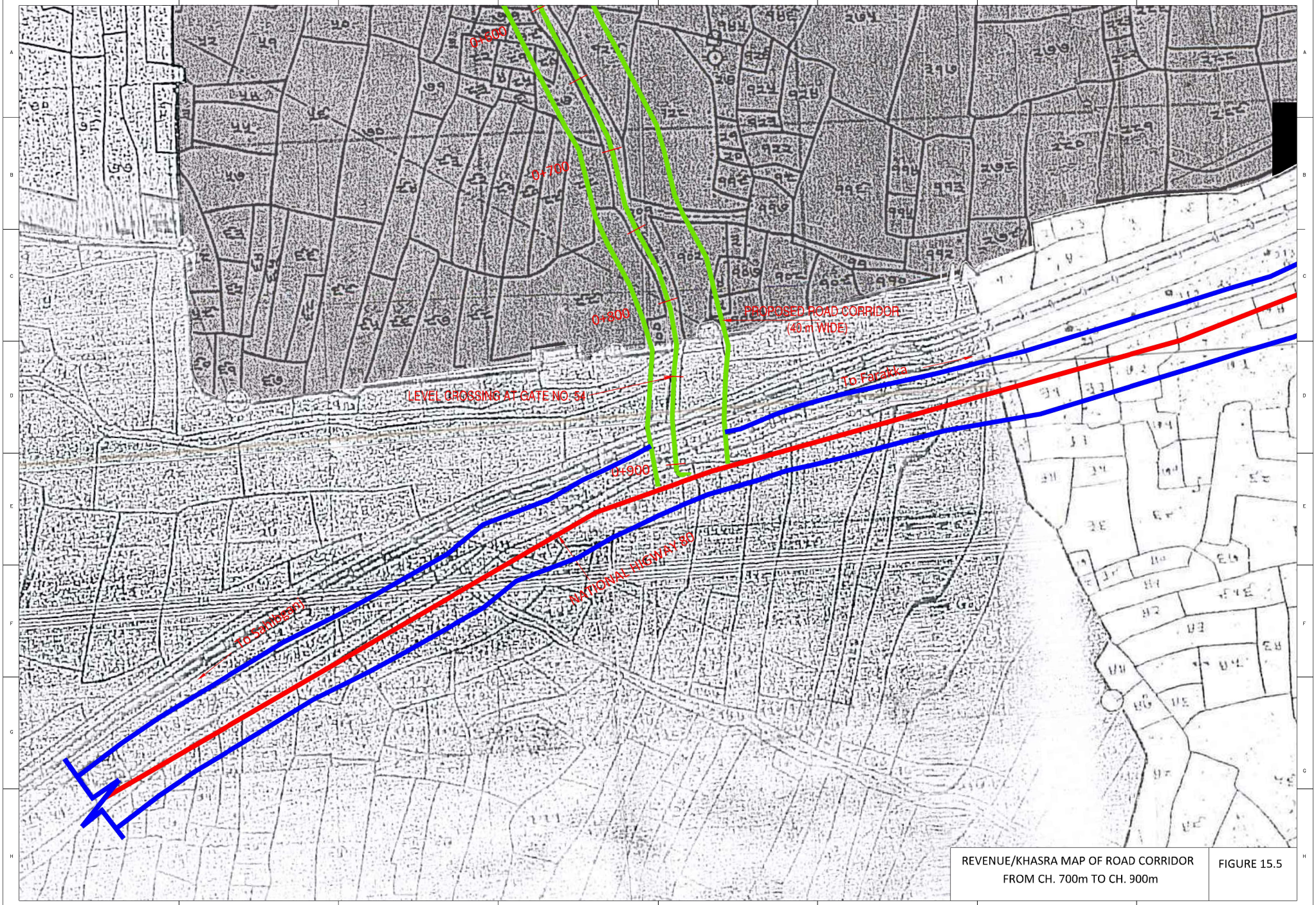
The road over bridge along NH-80 at Gate No. 54 includes elevated portion and approach on filling with total length of 1000 m. The width of corridor is proposed to be 45 m. Accordingly, area of land to be acquired for this portion is **13.61 acres** in view of the topography of area.

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

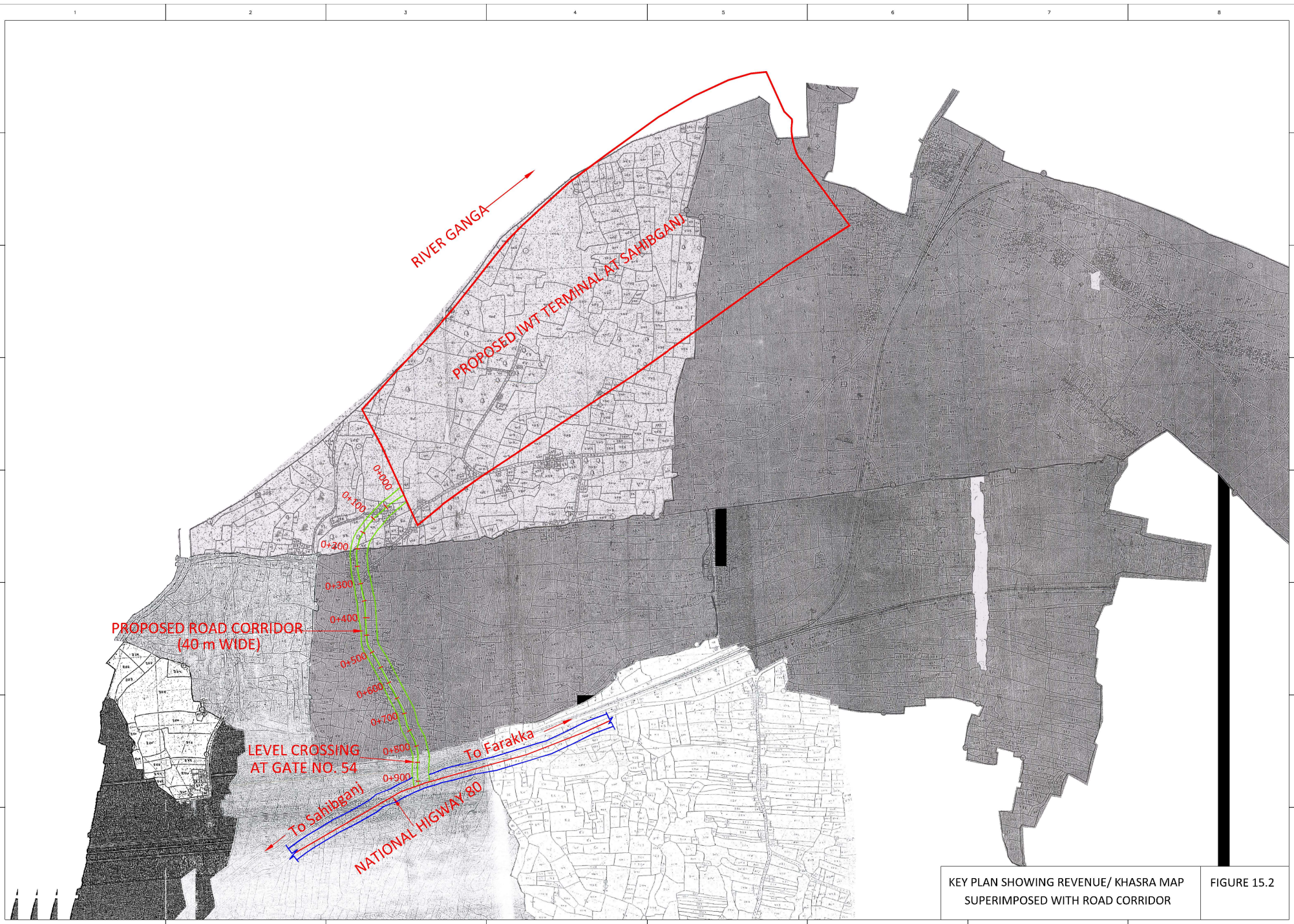
Sl.No.	Name of Mauza	Type of Land	Area of Land (in Acres)
1	Chhota Bhagiamari	Private Land	3.17
		Government Land	0.49
		Sub-total-1	**3.66**
2.	Jamuni	Private Land	7.975
		Government Land	1.975
		Sub-total-2	**9.95**
		Total-1+2	**13.61**

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**.



REVENUE/KHASRA MAP OF ROAD CORRIDOR FROM CH. 700m TO CH. 900m

FIGURE 15.5



KEY PLAN SHOWING REVENUE/ KHASRA MAP SUPERIMPOSED WITH ROAD CORRIDOR

FIGURE 15.2