Haryana Orbital Rail Corridor Project

Detailed Project Report

(Volume 1 of 3)

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Haryana Rail Infrastructure Development Corporation Limited

(Joint Venture of Government of Haryana & Ministry of Railways)

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1 EXECUTIVE SUMMARY

1.1 Introduction

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) was incorporated on 22nd August 2017 as a Joint Venture with Government of Haryana and Ministry of Railways with equity participation of 51% and 49% respectively. The Company has a mandate of selecting bankable railway projects for development, study, arranging finance, execution of Projects and to boost the Rail infrastructure projects in the state of Haryana on the principle of cooperative federalism.

HRIDC has developed Haryana Orbital Rail Corridor (HORC) from Palwal to Sonipat in the State of Haryana, bypassing Delhi. It is envisaged that the Haryana Orbital Rail Corridor (HORC) will facilitate the diversion of goods traffic not meant for Delhi region and will help in developing multimodal hubs in National Capital Region (NCR) region of Haryana. The project will serve open unserved areas of the state of Haryana, thereby enhancing economic and social activity of the Haryana sub-region of NCR. The project will also serve passenger trains on this route, which will directly connect region of Gurugram with capital of state i.e. Chandigarh, bypassing Delhi, leading to reduced journey travel time.

During preliminary study, there was a proposal to connect Palwal- Manesar- Patli-Farukhnagar- Jhajjar to make a Western Peripheral Rail Corridor to connect Palwal to Panipat bypassing Delhi.

After Implementation of Kundli-Manesar-Palwal (KMP) Expressway and the planning of Panchgram Urban centres, the Haryana Orbital Rail Corridor (HORC) project alignment from Palwal to Sonipat has been conceived on Techno-Economic consideration.

The alignment of this project is mostly along the KMP Expressway along the inner side (towards Delhi). A 50 meter strip adjacent to the Right of Way (ROW) of KMP expressway is earmarked for the HORC alignment in the approved Master Plan for NCR area. In addition, a Green belt of width 100 meters has also been earmarked on outer side of KMP Expressway and the inner side of HORC.

After completion of Feasibility study of this project, Ministry of Railways has already given its In-principle approval for this project vide letter no. 2019/JV/Cell/Haryana/Project/06 dated 05.03.2019.

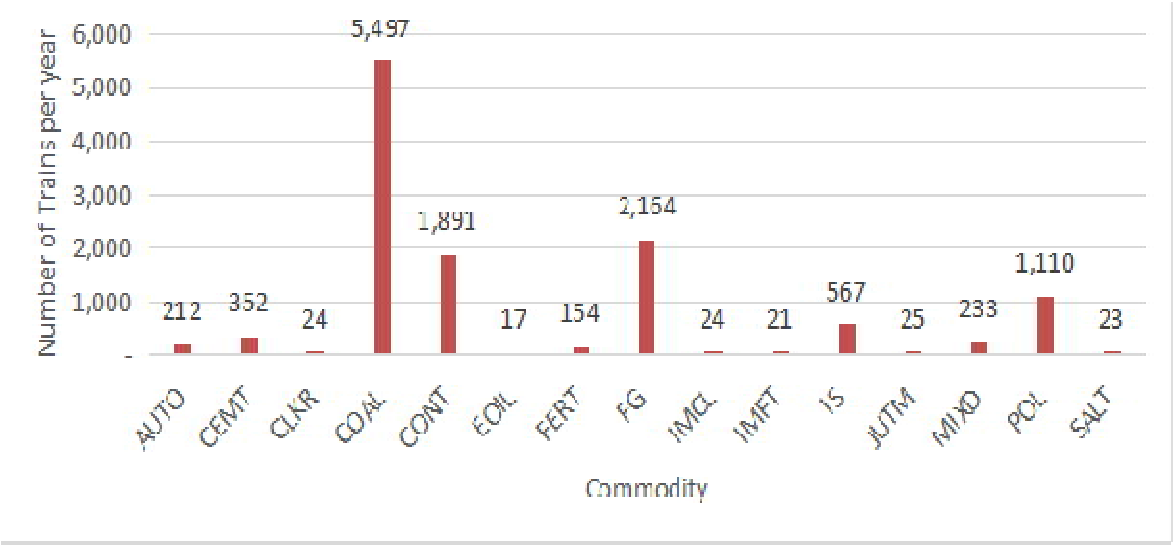
The proposed Rail corridor will facilitate the diversion of Freight traffic not meant for Delhi and will help in developing Multi Modal Hubs in NCR region of Haryana.

This study and the Detailed Project Report (DPR) pertain to new electrified Double BG rail line from Palwal to Sonipat bypassing Delhi region. It will take off from New Pirthala station with suitable connectivity to existing Palwal Station of Indian Railway and proposed Pirthala Yard of DFCCIL. This project will also have connectivity with

existing Indian Railway stations at Patli on Delhi-Rewari section, Sultanpur on Farukhnagar-Garhi Harsaru section, Asaudah on Delhi-Rohtak section and Harsana Kalan on Delhi-Panipat Section.

1.2 Traffic Demand Forecast

- The forecast includes the diversion of freight from existing railway routes passing in and around Delhi, traffic expected due to future expansion of industries & logistics centers and by diversion from existing road-based modes to railways on proposed HORC.
- The potential Assessed traffic that can be diverted through the proposed corridor is as shown in the graph below. Based on the total tonnage of the divertible traffic, in 2018, Coal (55.08%), Food Grains (15.08%) and Containers (12.43%) form more than 70% of all divertible traffic.



- Traffic from Maruti Suzuki is 2.55 & 4.08 Rakes per day for the years 2022 and 2027 respectively.
- Anticipated passenger traffic is 22000 persons per day for starting year.
- The train requirement for handling traffic shifted from road to rail is 2 trains/day.

1.3 Total Freight Traffic in the Horizon years

The freight trains have been forecasted for 30 years, considering 2022 as the first year of operation, for the horizon years 2027, 2032, 2037, 2042, 2047 and 2052.

The total tonnage and number of trains for the horizon years on proposed HORC is presented in the table below.

Financial Year	Tonnage in Million Tonnes (MMTPA)	Trains per Day
2025	54	48
2027	67	59
2032	81	72
2037	89	81
2042	100	93
2047	115	108
2052	134	128

1.4 Total passenger traffic along the project corridor

The rail passenger demand for horizon year is calculated by considering 15% of total potential trips as rail-based trips along the project corridor. Passenger trains on the proposed rail corridor for horizon years are shown in the table below.

Trains/day

S.No	Year	Passenger trains		
		UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)	Total
1	2025	9	9	18
2	2027	10	10	20
3	2032	11	11	22
4	2037	12	12	24
5	2042	13	13	26
6	2047	14	14	28
7	2052	15	15	30

1.5 Site Investigation

Detailed Topographical Survey of the entire corridor from Palwal to Sonipat has been carried out using DGPS, RTK, Total Station, Auto level and Drone (UAV), to assess the topography of the project area, type of terrain, profile of alignment, ground features etc. to enable planning, engineering and construction work. The survey details and drawings have been used as basis for all designs of alignment, track, bridges, structures and ancillary works.

1.6 Civil Engineering

- New Palwal to Harsana Kalan – 121.742 Km
- Connectivity to existing Asaoti Station (through Pirthala station of DFC).
- Connectivity to Palwal Station of IR from New Palwal Station of HORC. This connectivity shall be provided by the DFCCIL as per the decision of RB conveyed by RB inspection note no 2011/Infra/6/20 dated 11.04.2019.
- Connectivity to Pirtahla station of DFCCIL.
- Connectivity to Patli station (Delhi-Rewari line) from Manesar Station - 6.02 Km
- Connectivity to Patli station (Delhi-Rewari line) from New-Patli Station– 3.45 Km

- Connectivity to Sultanpur Station (Garhi Harsaru-Farukhnagar line) from Badsa Station -4.72 Km
- Connectivity to Asaudah station (Delhi-Rohtak line) from Mandothi station - 8 Km
- The minimum and maximum inter distance between the proposed crossing stations are 5.063 Km and 16.869 Km
- Total 89 curves are proposed in the enroute. The maximum degree of curvature considered as 5 degree.
- Land required for construction is 655.92 Hectares, of which 70 Hectares of land is under HSIIDC, 8 Hectares under Railway and 19.67 Hectares is under DFCCIL.
- All the bridges on the proposed new BG line will be of 25 T Axle loading and provided with ballasted deck as per extant guidelines of Railway Board.
- Track structure is proposed with 60 Kg. 90 UTS Rails on PSC sleepers 1660 Nos. per KM and 350 mm ballast cushion.
- 4.88 km tunnel length is proposed enroute.

1.7 Salient Features

- Route Length- 121.742 KM
- Total Length - 143.932 KM (including connectivities)
- Ruling Gradient -1 in 150 compensated or 1 in 200 non compensated.
- Bridges:

Description	Nos.
Minor Bridges	
Waterway	195
RUB	137
Major Bridges	
Water way	23
RUB	16
ROB	2
RFO	3

- Proposed Stations:
  - There are 15 new Crossing Stations namely New Palwal, Silani, Sohna, Dhulawat, Chandla Dungerwas, Manesar, New Patli, Badsa, Deverkhana, Badli, Mandothi, Jasur Kheri, Kharkhoda, Tarakpur and New Harsana Kalan proposed on the HORC Line based on the site feasibility.
  - Out of 15 stations, 4 (Four) are Junction Stations namely Manesar, New Patli, Badsa and Mandothi proposed with proper connectivity with IR stations.

- The proposed HORC line will be ending with connectivity to UP line at New Harsana Kalan station. Since the existing Station is halt Station, New Harsana Kalan crossing station is proposed to facilitate the Traffic flow towards North direction.
- The average inter distance between stations is 8.696 Kms. The station locations are identified with a prime importance of village centric.
- All the crossing stations have been proposed with minimum two common loops.

1.8 Power Supply and System of Traction

- The proposed corridor between New Palwal-Harsana Kalan having a total of about 143.932 Track KM & Over Head Conductor Track Km of 305 TKM. The section is proposed to be electrified section.
- The corridor is proposed to be electrified with 25 KV, single phase, 50 Hz High Rise OHE.
- **TSS** - Traction Substations with 2x21.6 MVA transformers have been proposed at the following locations for power supply to the sections.

S.No.	Station	Rating	Capacity
1	Dhulawat	220/132/27.5 kV	2x21.6 MVA
2	Mandothi	220/132/27.5 kV	2x21.6 MVA

- Over Head Equipment's (OHE) and Supervisory Control and Data Acquisition System (SCADA) have been proposed.
- Necessary modifications to the power line crossings of 11/33Kv line have been considered.
- Electric power supply system including 220, 132 KV D/C transmission line from SEB Grid substation to TSS & modification in Grid Substation also considered.

1.9 Signalling and Telecommunication

- All stations shall be class-B type with Standard-III interlocking having Electronic Interlocking, multi aspect LED based color light signaling, electrically operated point machine and DC track circuiting for detection of track section.
- For Block working, it is proposed to provide UFSBI token less Block instrument along with bell equipment as per latest RDSO specification. The block instrument will be connected to the interlocking system.
- In order to improve system reliability, the provision of integrated power supply system has been considered. This will have an added advantage of ensuring uninterrupted power supply round the clock, preventing signal going blank.
- Provision of optical fibre based communication system has been planned for complete section.

1.10 Rolling Stock

Existing Rolling Stock of Indian Railways shall be used on the proposed project line.

1.11 Cost Estimate

- The Cost Estimate of all components of works envisaged to be taken up for implementation has been prepared.
- The overall capital cost for Haryana Orbital Rail Corridor including land cost is as follows:

SUMMARY OF COST ESTIMATES		
S.No	**Description**	**Cost (in Crores)**
1	Civil Engineering	3357.77
2	Signaling and Telecommunication	161.46
3	Over Head Electrification and General Electrical	348.79
	Total Construction cost	**3868.02**
4	Land* Cost including Rehabilitation and resettlement	1358.67
5	Interest During Construction (IDC)	391.00
	Total Cost (In Crores)	**5617.69**
6	Revenue from PD/TOD upfront	795.00
	Net Cost	**4822.69**

*In addition, Land belonging to Indian Railway, DFCCIL and Government of Haryana shall be taken free of Cost.

- Any increase in the cost of the project (including land) shall be shared proportionately by all the stakeholders.

1.12 Project Financial Results

The summarized financial results are as below:

MEASURE	RESULTS
Project IRR	10.22%
Equity IRR	14.35%
Min. DSCR	1.31
Average DSCR	3.19
Min. ISCR	1.91

On overall basis of above capital structure and project financials, the equity IRR is 14.35%. Considering the fact that the project is recipient of only 50% of the revenue, excluding terminal handling costs, this is a good return.

As Indian Railways shall be a major beneficiary of this project, in terms of decongestion of Delhi, as well as increase in rail-share from new traffic, there is a strong case for HRIDC to seek better revenue share in the form of "inflated kilometres" and "terminal handling fees", which shall improve the project financially. Moreover, since the anticipated number of passenger trains is more than 2 pairs, suitable compensation shall be sought from Indian Railway in the concessionaire agreement.

1.13 Stakeholders Consultation

The project is envisaged to be executed as per JV model with participation of various stakeholders. In this regard, HRIDC has taken following action to identify the potential stakeholders:

1.13.1 Stakeholders Meet at Gurugram

A "Stakeholders meet" in connection with 'Haryana Orbital Rail Corridor' project was held at Gurugram on 13.02.2019. The meeting was attended by officers from Railway Board, Northern Railway, Government of Haryana, concerned PSUs of Central & State Government and representatives of Industries, Banks & Financial Institutions etc. Hon'ble Chief Minister Haryana has also attended this Stakeholders meet and appreciated the project & the enthusiasm shown by the participants in the meet. During the Stakeholders meet, Maruti Suzuki India Ltd has confirmed to participate in the Project SPV as one of the equity partners. Also, keen interest was shown by Allcargo Logistics, Reliance MET and J.M. Baxi Group for participation in the Project SPV.

1.13.2 Expression of Interest

To seek participation of all concerned stakeholders in the process of development of this project and to ensure full transparency, Expression of Interest (EOI) for Equity Participation in Project SPV (Special Purpose Vehicle) for "Haryana Orbital Rail Corridor" Project was invited by publishing EOI notice in leading newspapers and by uploading on HRIDC website. Though keen interest was shown by a few parties, no party participated in the EOI.

Further, the HRIDC conducted meetings and held discussions with various public and private entities that are in the logistics business along the project alignment to solicit their participation in the project as stakeholders.

Govt./ Public entities like HSIIDC and GMDA have consented to participate in the project. Private entities like MSIL, JM Baxi Group and All Cargo Logistics have also consented to participate in the project. The private entities that have shown their willingness to participate as equity partners in the project fulfil the required eligibility criteria as per EOI.

MSIL has already given its firm consent for participation in the project SPV to the tune of Rs. 182 Cr. M/s All Cargo Logistics has conveyed their In-Principle

approval for participation in the project SPV vide their letter dated 04.04.2019. M/s. JM Baxi Group has conveyed their In-Principle approval for participation in the project SPV vide their letter dated 30.04.2019.

1.14 Proposed Financial Structuring

- As per the JV model, Ministry of Railways (Railway Board), Government of India Letter No. 2011/Infra/12/32 dated 10.12.2018, "Participative models for rail-connectivity and capacity augmentation projects.
- From the project structure, it can be seen that the HORC project shall be developed as Special Purpose vehicle of HRIDC. Accordingly, it is proposed that the HORC project is financed in the form of debt and equity.
- In light of buoyant traffic, we reckon, it shall be possible to finance the project in the debt: equity ratio of 70: 30 with the availability of long tenure structured debt. In the current debt market scenario, 18-year to 25-year instrument can be raised from financial institutions at an average annual debt cost of 7.85% to 8.5%.
- Further, since the project development period is five years, the debt and equity finance shall be spread over this period. This inter-alia means that project shall have to incur additional burden of interest during construction (IDC).
- The proposed alignment passes through the HSIIDC land near IMT Sohna, Manesar and Kharkhoda and this land shall be taken on sub-ordinate Debt from HSIIDC.
- The total project cost including private land that needs to be acquired and IDC is Rs. 5617.69 Cr. Considering upfront Revenue of Rs. 795 Cr from Transit Oriented Development (TOD) during construction, the Net Cost is Rs. 4822.69 Cr. Out of this, 70% debt i.e. Rs. 3322.69 Cr and 30% overall equity i.e. Rs. 1500 Cr is considered.
- Out of the total equity, proposed Equity share of various stakeholders is mentioned below:

Overall Equity	Rs. 1500 Cr
Equity share of Various Stakeholders	
Stakeholder	**% Equity Share(in Rs)**
HRIDC	45% (644 Cr)
HSIIDC	15% (285 Cr)
GMDA	4.77% (71.5 Cr)
Private Sectors (MSIL, AllCargo, JM Baxi)	33.30% (499.5 Cr, out of which share of MSIL is 182 Cr i.e. 13%)

1.15 Conclusion & Recommendations

- Since the project alignment is mostly along the Dedicated Freight Corridor (DFC) or Kundli-Manesar-Palwal (KMP) Expressway and most of the land is within the command Zone of either DFCCIL or transport corridor declared by GoH which includes KMP Expressway alongwith railway transportation network, there shall not be any problem in acquiring the land. Also, there shall be no further segmentation of Agricultural/ Forest land, minimizing the environmental or social impact in this area due to this project.
- The total project cost including private land that needs to be acquired and IDC is Rs. 5617.69 Cr. Considering upfront Revenue of Rs. 795 Cr from Transit Oriented Development (TOD) during construction, the Net Cost is Rs. 4822.69 Cr. Out of this, 70% debt i.e. Rs. 3322.69 Cr and 30% overall equity i.e. Rs. 1500 Cr is considered.
- Further EIRR of 15.71% makes the project viable on Socio-Economic consideration also.

2 INTRODUCTION

2.1 Background

State of Haryana is strategically located bordering the National capital of Delhi. NCT, Delhi shares three fourth of its border with Haryana alone and remaining with Uttar Pradesh. The development of Haryana region, bordering Delhi is very important for balanced growth of NCR as it acts as buffer zone against rampant migration and other support infrastructure. At present on account of growth of Metro network in Delhi & NCR, there is radial movement of commuters to and fro, Delhi being in center. This "Hub and Spoke" traffic planning has resulted in rapid growth of Noida, Greater Noida, Faridabad and Gurugram. However, for hub and spoke concept to sustain it is necessary to link the ends of spoke by ring connectivity. There will be natural demand for commuter movement within these towns like Gurugram, Faridabad, Ballabhgarh, Palwal, Sohna, Manesar etc. Peripheral roads have been commissioned recently, linking these towns around Delhi but Rail link provides economical, sustainable, eco-friendly and bulk freight transport option. The peripheral Rail link will also help in growth of other cities within the same distance from Delhi like Sonipat, Panipat, and Rohtak. Western DFCCIL originating from Dadri Station is passing through Asaoti Station on Delhi- Mathura route, providing peripheral connectivity of Dadri-Palwal-Manesar-Rohtak-Panipat for freight traffic. This will also help in easing the pressure on the transport network of Delhi as some of the commuter traffic moving on the radials will get shifted to peripheral corridor.

Apart from passenger traffic, substantial amount of freight traffic, which is entering the Delhi area of rail network but is not meant to be consumed in Delhi, will also get diverted via this corridor. Apart from this, there are major goods sheds in the heart of Delhi causing endless avoidable traffic jams. The goods sheds in west Delhi are Azadpur, Shakurbasti, Dayabasti, Sabzi Mandi which are located on prime commercial land and are black spots of the urban planning. Previously moving out commercial activity to other states had interstate taxation issues but now with GST in place, there is no reason of not shifting these activities to the peripheral region. In any case, if freight traffic movement through Delhi is restricted, then these goods sheds or alternatives will be serviced via the proposed peripheral network only.

NCRPB has been proposing the regional Rail Network or circular Railway around Delhi for the organized growth of NCR for last two decades. However, Railways did not accept the demand on account of resource constraints. But now, in view of policy changes, resources can be pooled by partnering with State Governments and other Stakeholders.

2.2 Haryana Rail Infrastructure Development & Corporation

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) was incorporated on 22nd August 2017 as a Joint Venture with Government of Haryana and Ministry of Railways with equity participation of 51% and 49% respectively. The

Company has a mandate of selecting bankable railway projects for development, study, arranging finance, execution of Projects and to boost the Rail infrastructure projects in the state of Haryana on the principle of cooperative federalism. For this purpose, the Company can create 'Special Purpose Vehicles' (Subsidiary companies for each identified project which has its own financial viability) in partnership with other stake holders. The aim of Haryana Rail Infrastructure Development Corporation Limited is to mobilize resources, planning and implementation of Rail Infrastructure Projects in the State of Haryana.

2.3 Aarvee Associates Architects Engineers & Consultant Pvt. Ltd. (AARVEE)

Aarvee Associates is a premier ISO 9001:2008 certified multi-disciplinary engineering consulting company, established in 1989 and based at Hyderabad in India. We have a pan-India presence, with branch offices and project offices in all the major states across the country. We also have a wholly-owned Australian subsidiary, Aarvee Associates Pty Ltd, based at Brisbane, Queensland, and a branch office at Dar es Salaam, Tanzania.

Having planned and designed over 4,000km of railway siding and overseen the development of another 1,500km of railway track from concept to commissioning, we are now one of the largest and most innovative consulting firms in this field in India. In addition, we provide engineering services for Metro Rail, Heavy Haul Freight Rail and High-Speed Rail projects in India and overseas.

2.4 Award of Work

HRIDC has appointed and authorized M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd., an approved Railway Consultant, to carry out the Feasibility Study and Preparation of Detailed Project Report for the development of the Haryana Orbital Rail corridor project i.e. connecting Palwal to Sonipat Rail corridor bypassing Delhi area by linking Asaoti/ Palwal, Patli, Sultanpur, Asaudha and Harsana Kalan by new electrified double line.

2.5 Overview of Rail Network of Delhi and Haryana

The NCR is an area of 33,578 sq. km covering the National Capital Territory (NCT) of Delhi, Haryana sub-region, Rajasthan sub-region and Uttar Pradesh sub-region. NCT-Delhi is a small part of the region, less than 5 per cent, while regions of Haryana comprise roughly 40 per cent, Rajasthan 23 per cent and Uttar Pradesh 32 per cent of the NCR area respectively.

2.5.1 Existing Rail Network in Delhi

The NCR rail network covers three Zonal Railways (Northern, North Western and North Central) and five divisions. The rail network consists of broad gauge (1676 mm). Five broad gauge railway lines converge at Delhi. The rail network has two specially identified lines known as Goods avoiding lines (GAL) and Delhi avoiding lines (DAL). Delhi area handles tremendous volumes of coaching and freight traffic.

The coaching traffic has grown at an exponential rate during the last two decades with addition of large number of mail, express, Shatabdi and Rajdhani trains catering to long distance. The existing network of NCR is shown in Fig. 2.1 below:

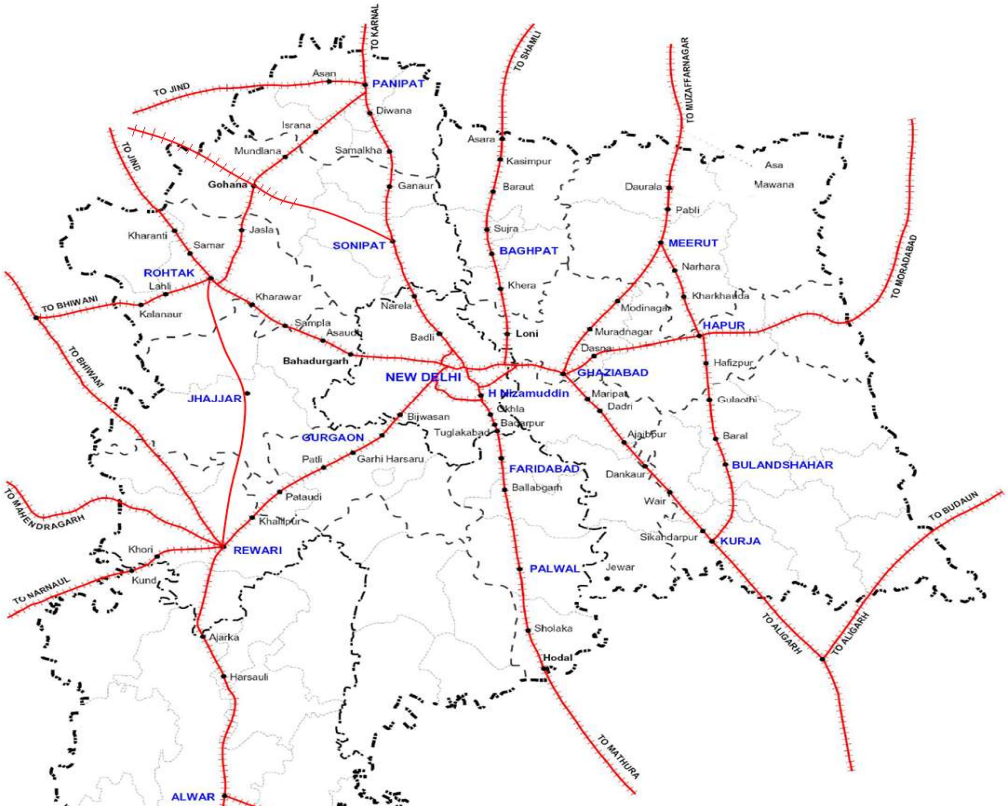


Figure2.1 Existing Rail Network of NCR

2.5.2 Existing Rail Network in Haryana

Rail network in Haryana, is covered by 5 Railway divisions under 3 Railway zones, namely, North Western Railway zone, Northern Railway zone and North Central Railway zone.

Total Route length of Haryana rail network is 1710.49 Km. Fig. 2.2 Shows the existing rail network of Haryana below:

Figure 2.2 Existing Rail Network in Haryana

Presently all rail-lines are used by both freight and passenger trains. The freight traffic from Haryana mainly includes food grains, oil seeds and sugar. Rail routes that serve Haryana sub-region and their capacity utilization are indicated in the table 1 below.

Table 1 Rail Route Serving Haryana Sub Region

S.No	Route Details	Administrative Rail Zone	Length in Haryana sub Region of NCR	Capacity Utilization %
1	Delhi-Gurugram-Rewari-Bawal-Alwar	N.R	100	80-150
2	Delhi-Rohtak-Jind-Bhatinda	N.R	60	100-130
3	Rohtak-Panipat	N.R	143	60-75
4	Delhi-Sonipat-Ambala	N.R	75	100-140
5	Panipat-Jind	N.R	25	60-75
6	Rohtak-Bhiwani	N.R	30	70-80
7	Garhi-Harsaru-Farukhnagar	N.R	11	40-60
8	Rewari-Dabla-Ringus-Phulera	N.R	25	75-90
9	Rewari-Bhiwani-Hisar	N.R	50	100
10	Rewari-Sadulpur-Bikaner	N.R	35	50-75
11	Delhi-Faridabad-Palwal-Mathura	N.R	70	130-160

Source: Indian Railways

More than 50% of rail route that serves the sub-region are already over saturated and capacity utilization is more than 100%.

2.5.3 Congestion Issue in Delhi

The railway network in NCR consists of complex rail radials and hubs which have got developed over the last hundred years. It serves the National capital - New Delhi and strives to meet transportation needs of India's population, people visiting it for business and social requirements. All railway lines carrying through (non-destined) traffic within Delhi with their saturation level are detailed below:

Table 2 Traffic in Delhi with Saturation level

S.No.	Area	Saturation level (in%)
1	Lajpat Nagar-Patel Nagar Delhi Avoiding Line (DAL)	133
2	Patel Nagar- Adarsh Nagar	98
3	Adarsh Nagar – Sonipat- Panipat	121
4	Patel Nagar – Delhi Cantt (North Line)	65
5	Tilak Bridge – Anand Vihar	174
6	Nizzamudin – Tughlakabad	163
7	Tughlakabad – Palwal	141

The Major incoming Commodities is Steel from West Bengal, Chhattisgarh, Jharkhand & Odisha and Outgoing is Automobiles to Bengaluru and Mundra.

2.6 Transport needs of Delhi NCR Area

The rail network connecting various important Districts of Haryana State involves passing through Delhi, particularly for Gurugram, Faridabad, Balabhgarh & Palwal area and thus becomes a major bottleneck in its industrial growth. Traffic pattern in the NCR region is of mixed type i.e. there is both passenger and freight traffic moving through this area. The metro rail can only be suitable for high density passenger traffic. Thus, the railway broad gauge network is the most suitable mode of transport for the mixed traffic particularly for the Special Economic Zones (SEZs) identified by the Govt. of Haryana in the NCR region.

At present goods traffic from East to West and vice-versa is moving through Railway network in Delhi, resulting into congestion on the existing rail network due to which the Railways is not able to run passenger trains as per requirement to handle the ever growing Passenger traffic. Hon'ble Minister of Railways in his budget speech for the year 2016-17 (Para 90) had also stressed on the need to revive the Ring Railway system for suburban commuter traffic. This proposed rail link will enable bypassing of the freight traffic from Delhi. Thus, it will generate extra capacity in Delhi rail network for passenger & suburban services and also opportunity for commercial exploitation of the urban real estate by Railway in Delhi area.

Thus, the proposed Delhi bypass rail corridor will play a major change to overcome the above hurdles in transportation needs and will go a longer way in development of the National Capital Region.

2.7 Feasibility Study

Aarvee Associates in connection with Haryana Orbital Rail Corridor connecting Palwal to Sonipat by Linking Asaoti - Patli- Sultanpur- Asaudah –Harsana Kalan Stations has been prepared and submitted the Feasibility report. In Principle approval from MoR for the Project has been obtained vide letter No. 2019/JVCell/Harayana/Project/06, Dated: 05.03.2019, placed as Annexure-I.

2.8 Project Objective – Haryana Orbital Rail Corridor

The objective of this study is to facilitate and develop an orbital rail corridor connecting Palwal and Sonipat with suitable Rail corridor by easing out the Delhi region from the freight traffic movement by allowing shifting from radial and inner ring rail network to the proposed corridor.

- Delhi NCR being centre acts as a Hub connecting the spokes in nearby states
- Direct connectivity for Gurugram, Faridabad, Balabhgarh, Palwal, Manesar & Farukhnagar etc. with all the districts of Haryana
- Peripheral rail link will help in industrial growth of cities around Delhi (Sohna, Manesar, Gurugram, Jhajjar, Rohtak)
- Connectivity to Dedicated Freight Corridor (DFCCIL) at Pirthala
- It will help in easing pressure from transport network of Delhi as traffic movements in radial will shift to peripheral
- Freight traffic not meant for Delhi will get diverted and will help in developing Multi Modal Hubs in NCR region of Haryana
- Connectivity to Maruti Suzuki, MET/Reliance, All Cargo and other Logistic Hubs in the region.

The aim of this study is to prepare Detailed Project Report along with estimates, drawings, of Civil works, GADs and drawings for Signalling arrangements, Electrification of yards, stations and other buildings in connection with construction of a new electrified BG rail line corridor between Palwal and Sonipat.

2.8.1 Major Development near project location

Panchgram Yojana

The Haryana government will develop five new cities on either side of the Kundli-Manesar-Palwal expressway and the area will be named as Panchagram. The Haryana Govt. approved the concept of the Panchagram Region and developing five cities on the Kundli-Manesar-Palwal (KMP) expressway on 50,000 hectares each side of the expressway which would cover eight districts of the State namely Sonipat,

Rohtak, Jhajjar, Gurugram, Rewari, Mewat, Faridabad and Palwal. The Industrial and Commercial Townships were being set up on 3,300 acres area in Kharkhoda, Sonipat. Similarly, Industrial Model Township has been developed on 1,400 acres in Sohna of Gururgram. The Proposed Alignment is going parallel to Kundli-Manesar-Palwal expressway of about 95 Km which will give boost to industrial Sector in the State.

Dedicated Freight Corridor

The Indian Railways quadrilateral linking the four metropolitan cities of Delhi, Mumbai, Chennai and Howrah, commonly known as the Golden Quadrilateral; and its two diagonals (Delhi-Chennai and Mumbai-Howrah), adding up to a total route length of 10,122 km carries more than 55% of revenue earning freight traffic of IR. Western dedicated freight Corridor comprising of 1483 km of a double line track from JNPT to Dadri via Vadodara-Ahmedabad-Palanpur-Phulera-Rewari. In addition, a single line connection of 32km long from proposed Pirthala Junction Station (near Asaoti) to Tughlakabad is also proposed to be provided. The Proposed rail corridor is going parallel to the Western DFCCIL alignment for all stretch of 15.6 Kms and crosses the Western DFCCIL at Proposed New Palwal Station which is shown in Figure 2.3 below.

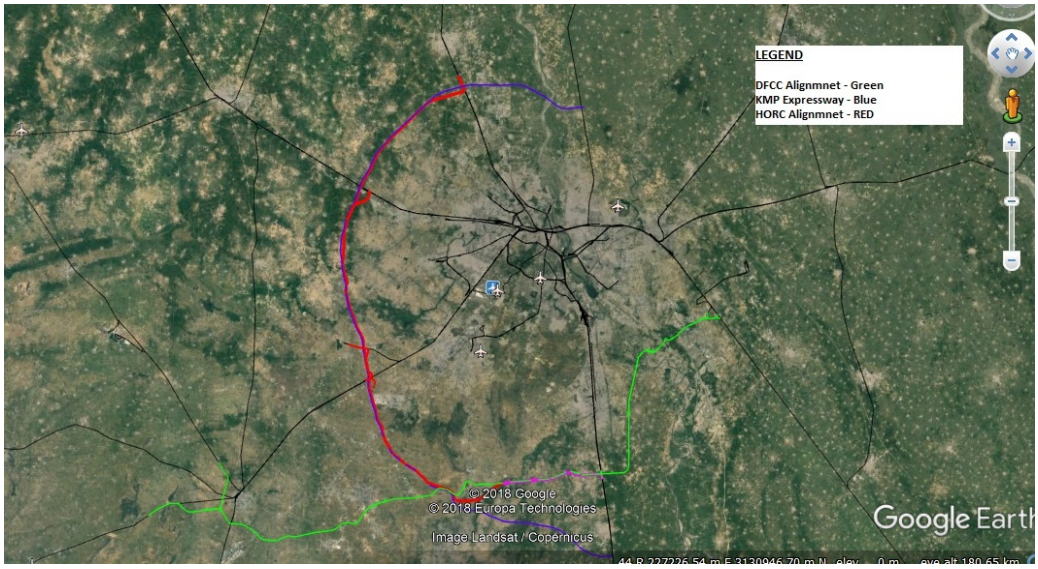


Figure 2.3 Proposed Alignment crosses DFCCIL

2.9 Project Location

2.9.1 Key Map of Project location

Proposed Haryana Orbital Rail Corridor is from Palwal to Sonipat by linking Asaoti-Patli-Asaudha & Harsana Kalan by new BG line. Total length of project is 143.932 Km (including Connectivities). The Proposed rail corridor is bypassing Delhi which is shown in Fig. 2.4 below:

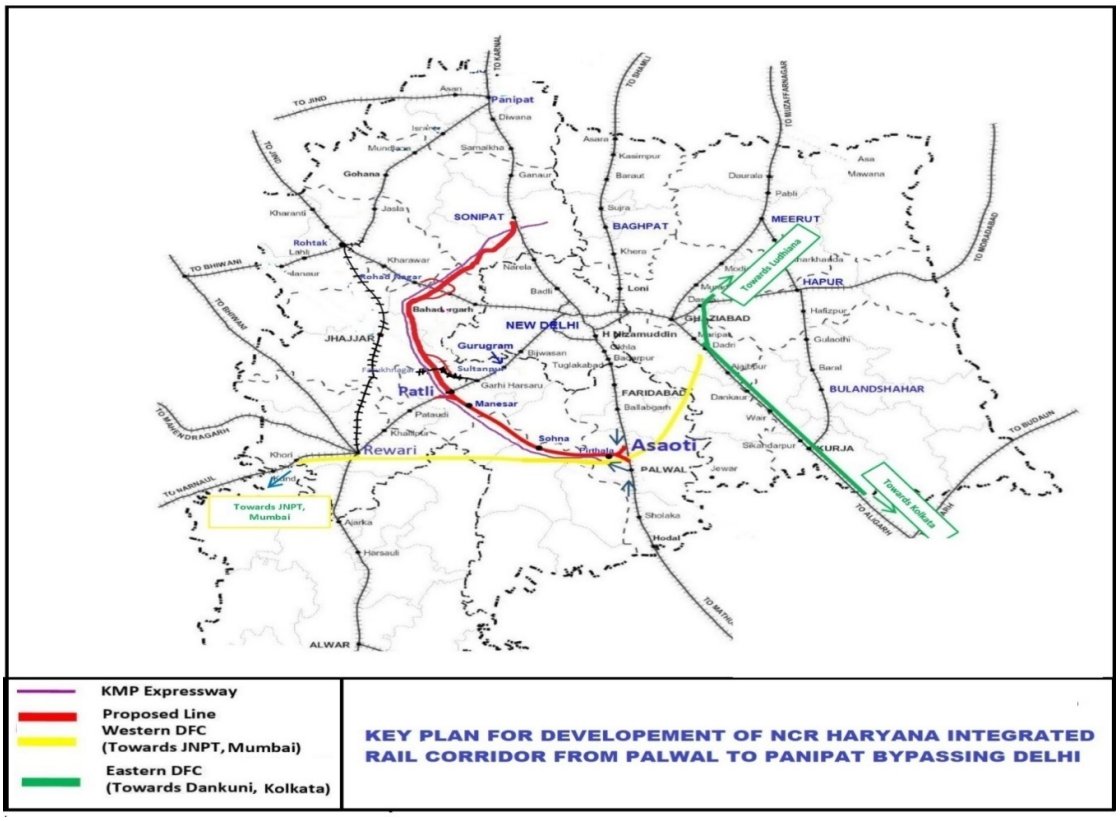


Figure 2.4 Key Plan of Proposed Rail Corridor

2.9.2 Serving Station and connectivities to Existing IR Network:

The serving stations for the connectivity shall be

- Pirthala station on the Rewari-Dadri section of Dedicated Freight Corridor having connectivity to both Asaoti and Palwal with Y-connectivity.

The connectivities to Existing IR Network.

- Patli Station on Delhi-Rewari section of Northern Railways
- Sultanpur Station on Garhi Harsaru- Farukhnagar section of Northern Railways
- Asaudah Station on Delhi -Rohtak section of Northern Railways
- Harsana Kalan on Delhi-Panipat Section of Northern Railways

2.9.3 Major Locations & Districts

The proposed alignment of 143.932 Track Km (including Connectivities to the existing Stations on IR) length passes through 14 no. of proposed station locations and connecting to 5 no. of existing station locations. The Proposed line runs parallel to Kundli-Manesar-Palwal (KMP) Expressway near Sohna-Manesar-Harsana Kalan Stretch and about 95 Km alignment runs parallel to KMP.

Apart from that proposed alignment passes through 5 Districts i.e. Palwal, Nuh, Gurugram, Jhajjar and Sonipat in the state of Haryana and that will help in growth of industrial development as alignment is directly connect to cities near Delhi.

2.10 Concept of Study

Our scope of work formulated as below:

2.10.1 Feasibility Study

a) Field Reconnaissance and assessment of existing yard facilities at serving station using hand held GPS.

b) Desk study on Google imagery and Topo sheets for assessment of alignment.

c) Foot by foot survey for identification of major constraints and features

d) Finalization of route based on Reconnaissance Survey.

e) Proposed rail connectivity route has been formulated with due consideration to the following aspects.

- Topographical and Geographical features of route.
- Existing National as well as State Highways and Indian Railway lines.
- Existing rivers, streams, canals and forest lands.
- Rail corridor by means of curves and gradients.
- Proximity of crossing stations to human settlements for future development as passenger corridor.
- Proximity to have connectivity to Industrial Model Townships along the corridor.
- Minimum Social and Environmental Impact.

2.10.2 Detailed Project Report

a) Detailed survey of the entire corridor was carried out with state of art DGPS, RTK, Total station, auto level and Drone (UAV). In the detailed survey, actual field data was collected duly covering the entire project area so as to prepare the scheme proposal in detail.

b) Methodology adopted for Topographic Survey and Hydrological Studies

c) Design Criteria and Design Standards adopted

d) Designs prepared for various elements of the Project such as Alignment, Station Yard Layouts, Earthwork, Bridges and other Structures, Track, Station Structures, Signalling and Telecommunications and other Ancillary Works based on the Design Criteria and Standards.

e) Calculations of Land Details including type of land and area of land falling under different agencies.

2.11 Stakeholder outreach on Haryana Orbital Rail Corridor Project

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) has hosted an outreach event to the stakeholders on 13-02-2019 at Gurugram to deliberate on the "Haryana Orbital rail Corridor Project from Palwal to Sonipat" with a key objective of providing boost to Rail Infrastructure projects in the Haryana state on the principle of cooperative federalism and emphasizing on opportunities for investors and stakeholders.

The event was a great success with large number of stakeholders and investors turned up and showed their interest to invest in the project. The list of all participant for the event is placed in the Annexure-II.

The Brief descriptions on the proceedings of the event are mentioned below:

- Sh. Alok Nigam, IAS, Addl. Chief Secretary, Govt. of Haryana Chief guest of the event inaugurated the Stakeholders Meet and presided over the function.
- 30 delegates from the Govt. of Haryana & Ministry of Railways, 10 from the Financial Institutions and 24 delegates from the Industry participated in the discussion.
- Sh Dinesh Chand Deshwal, MD/ HRIDC briefed the gathering about the activities of the company and about the Haryana Orbital Rail Corridor specifically.
- Sh. Alok Nigam, ACS (PW) addressed the gathering highlighting the need for the project. Running of Shatabdi from Gurugram to serve the unserved areas was emphasized.
- ED/ MTP/RB: Praised the efforts by HRIDC to develop this project. Explained the idea behind formation of JV companies with the participation of state Govt. & their working.
- Sh. Subodh Jain, Principal Advisor, HRIDC (Former Member Engineering, Railway Board) made detailed presentation on the proposed Haryana Orbital Rail corridor project and clarified the doubts of the participants.
- Representatives from Reliance, All-Cargo, Maruti participated enthusiastically in the question & answer session.

Major highlights of the event

- M/s. Maruti Udhyog Ltd has confirmed participation in the project SPV as Equity partner.
- M/s. AllCargo has also shown keen interest to participate in this project and they will revert shortly after due deliberations in their BOD.
- This event has generated a lot of interest among various stakeholders and Investors.

- Railway Board & Northern Railway officials have also commended the idea of the proposed Haryana Orbital Rail Corridor.

2.12 Salient features of proposed rail infrastructure facilities are as follows:

1.	Serving Railway Station	:	Harsana Kalan on Delhi-Ambala Line and Palwal & Asaoti (through Pirthala yard of DFCCIL) on Delhi-Mathura line.
2.	Route length	:	121.742 Km 143.932 Km(including Connectivities)
3.	Gauge	:	Broad Gauge 1676mm
4.	Ruling Gradient	:	1 in 150 (compensated)
5.	No. of Curves	:	89
6.	Maximum Permissible Speed	:	160 kmph
7.	Bridges:- Major RUB Minor RUB ROB RFO Water Way:- Major Minor	 : : : : : 	 16 137 02 03 23 195
8.	Design Loading		IRS 25T Axle load
9.	Rails	:	60 Kg (T-12)/90 UTS - Prime quality
10.	Sleepers	:	60kg PSC sleepers with 1660Nos. Per Km
11.	Point and Crossings	:	1in 12 with CMS crossings, thick web switches on PSC Sleepers with fan-shaped layout in crossing stations connecting with main line and loop lines
12.	Rail Joints	:	Primarily LWR Track with SWR on sharp curves and at other obligatory locations.
13.	Ballast	:	65mmsize Ballast with350mmcushion
14.	OHE and Traction	:	Electrified(High Rise)
15.	Net Estimated Cost	:	Rs. 4822.69 Crores
16.	Number of crossing/Junction stations	:	14 New namely New Palwal, Silani, Sohna, Dhulawat, Chandla Dungerwas, Manesar, New Patli, Badsa, Deverkhana, Badli, Mandothi, Jasaurkheri, Kharkhoda Kirholi and Tarakpur
17.	Safety Provisions	:	The stations and the locations where infringement from outside

			is envisaged shall be barricaded.

2.13 Report Format

The Report Constitute the other details in next chapters which are as following:

- Site Conditions and Terrain Assessment
- Traffic Projections
- Basis of Design and Methodology
- Recommended Rail Infra Structure
- Civil Engineering
- Electrical Engineering
- Signaling & Telecommunication System
- Land Acquisition, Resettlement and Rehabilitation
- Operations and Maintenance Arrangements
- Cost Estimate
- Financial and Economic Analysis
- Proposed Financial structuring
- Annexures and Drawings

3 SITE CONDITION AND TERRAIN ASSESSMENT

The proposed alignment passes through 5 Districts i.e. Palwal, Nuh, Gurugram, Jhajjar and Sonipat in the state of Haryana.

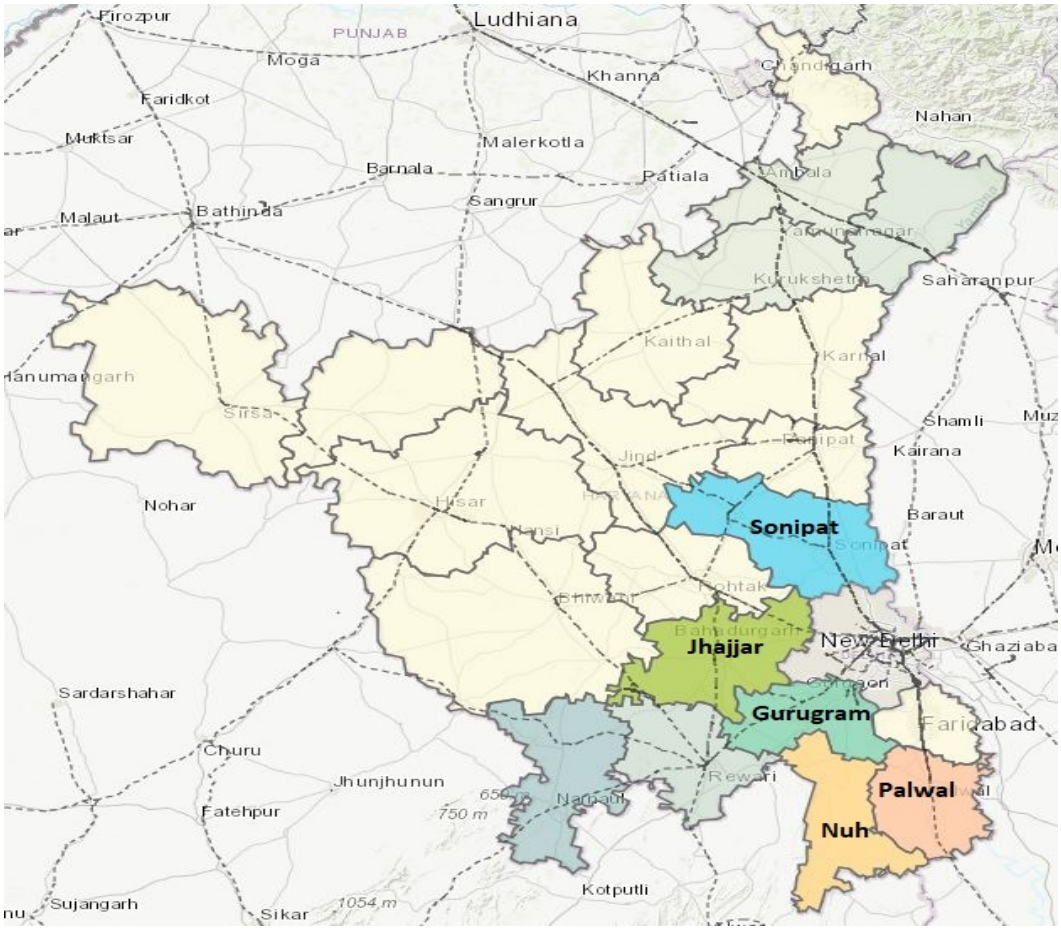


Figure 3.5Districts passes through Alignment

3.1 Palwal District

Palwal is a city and a municipal council. It is the headquarters of Palwal district, the 21st district of Haryana state in northern India. It is a center for the cotton trade in the area. Palwal district being part of National Capital Region (N.C.R.) and Haryana sub-region is proposed as a regional centre in 2021. It serves as a potential region for economic development in Palwal as well as adjoining districts.

3.1.1 Geography

Palwal is 60 Kms from Delhi, 29 Kms from Faridabad, 313 Kms from Chandigarh and 143 Kms from Agra. The latitude of the town is 28° 40' N and longitude is 76° 59' E. The area of town is 22.10 sq. Kms. The City has an average elevation of 195 meters.

3.1.2 Transportation

Palwal District is strategically located with respect to the whole NCR and is well connected by both Road and rail network. A broad gauge railway line connects it to the Indian Railways network of the Delhi Agra Branch line. Palwal block is connected to Prithla (14 Kms) and Faridabad (30 Kms) by NH2. Sohna is located (30 Kms) away on NH71B. Palwal block is linked to other blocks of the district through a network of Major district and other district roads. The block headquarters connected by M.D.R. are Hathin (18 Kms), Hassanpur (34kms). Palwal is located at a distance of 30 km from Yamuna expressway.

3.1.3 Demographics

In 2011, Palwal had population of 1,042,708 of which male and female were 554,497 and 488,211 respectively. Out of the total Palwal population for 2011 census, 22.69 percent lives in urban regions of district. In total 236,544 people lives in urban areas of which males are 125,590 and females are 110,954. Sex Ratio in urban region of Palwal district is 883 as per 2011 census data. Child population (0-6) in urban region was 33,728 of which males and females were 18,427 and 15,301. As per 2011 census, 77.31 % population of Palwal districts lives in rural areas of villages. There was change of 25.76 percent in the population compared to population as per 2001. In the previous census of India 2001, Palwal District recorded increase of 34.21 percent to its population compared to 1991. Average literacy rate of Palwal in 2011 were 69.32 compared to 59.20 of 2001.

3.1.4 Rainfall and Climate

The climate of Palwal district can be classified as tropical steppe, semiarid and hot which is mainly characterized by the extreme dryness of the Air except during monsoon months. During three months of south west monsoon from last week of June to September, the moist air of oceanic penetrate the district and causes high humidity, cloudiness and monsoon rainfall. The period from October to December constitutes post monsoon season. The cold weather season prevails from January to the beginning of March and followed by the hot weather or summer season which prevails up to the last week of June. The normal annual rainfall in Palwal district is about 542 mm.

3.1.5 Economy

Palwal consists of agricultural and commercial areas, and has many temples, schools, colleges and banks. It also contains developed areas like Housing board colony, New colony, Main market, Shivapuri, Krishna colony, shiv colony, camp colony and Huda sector 2. There is a main chowk called the Heart of Palwal. The government plans to develop the economy of Palwal in line with nearby cities like Delhi, Gurugram, Noida, Faridabad, Khair, Mathura. The dominant sector in Palwal is primary sector. The terrain is flat the agricultural production is higher in Khadar (new alluvium) belt as compared to Bhangar (old alluvium) belt and lowest in some of the villages along

SH13 due to high salinity of soil. Due to upcoming infrastructural projects like DFCCIL, KMP and KGP, Palwal is likely to have stimulated economic development.

3.2 Nuh District

Mewat District officially known as Nuh District. The Mewat district was carved out from erstwhile Gurugram and Faridabad districts, which came into existence on 4th April 2005 as the 20th district of the Haryana State. It has an area of 1,507 square kilometres (582sq mi) and 10.9 million population. It is bounded by Gurugram district on the north, Rewari district on the west and Faridabad and Palwal districts on the east. It is predominantly populated by the Meos, who are agriculturalists, and Muslims. Mewat district's some area also touches with Mathura District of Uttar Pradesh Near Bichhor Village and Nai Village of Punahana Tehsil. It is predominantly populated by the Meo farmers.

3.2.1 Geography

Mewat region geographically coordinates on Latitude 27°54'05" North and Longitude 77°10'50"East, is a hilly region, comprising the portions of ancient Matsya-desh and Surasena or modern southern part of Haryana and north-eastern Rajasthan. It was for many centuries famous for the predatory character of its inhabitants, who at all times gave great trouble to the Turk, Pathan, Mughal and British rulers at Delhi. In Mughal times, Mewat formed a part of the Subah of Delhi and Agra. Mewat district is largely comprises of planes. Inconsistency in Mewat topography is evident from its patches of land with hills and hillock of the Aravali Mountain on the one hand and plains on the other. Thus, physio-graphically the area is divided into two tracts- upland and low land.

3.2.2 Transportation

The district headquarter Nuh town is on Gurugram-Sohna-Alwar road which is now National Highway 248 (NH 248) connecting it to Gurugram and Alwar. Kundli Manesar Palwal Expressway provides high speed access to district from Palwal and Manesar. Major District Roads 131 and 135 passing through district connects major town to Delhi-Agra Highway. There is no railway line and railway station in this district. Nearest Railway Station from district boundaries is Hodal which is around 21 Kms away from Punahana town.

3.2.3 Demographic

According to the 2011 census, Nuh district had a population of 1,089,406, roughly equal to the nation of Cyprus or the US state of Rhode Island. This gives it a ranking of 420th in India (out of a total of 640). The district had a population density of 729 inhabitants per square Kms (1507/sq km). Its population growth rate over the decade 2001-2011 was 37.94% It has a sex ratio of 906 females for every 1000 males, and a literacy rate of 56.1%. According to the Census of India 2001, the total population of the district was 993,617 (including Hathin Block of district Palwal) of

which 46,122 (4.64%) lived in urban areas and the major chunk 947,495 (95.36%) of the population lived in rural areas. Out of the total population of 993,617, there are 524,872 males and 468,745 females. The SC population is around 78,802. The total numbers of households are 142,822 out of which 135,253 (95%) are in rural areas and remaining 7,569 (5%) are in urban areas. The total number of BPL households are 53,125 including Hathin Block.

3.2.4 Rainfall and Climate

The district falls under the Sub-Tropical, Semi-arid climatic zone with extremely hot temperature in summer. Dryness of air is a standard feature in Nuh district except during the monsoon season. May and June are the hottest months of the year with the temperature ranging from 30C to 48C. January, on the other hand, is the coldest month with temperature ranging between 2 °C to 25 °C. Strong dusty winds are conspicuous during summer. The principal precipitation occurs during monsoon period from June to September when about 80% of the rainfall is received. The average rainfall varies from 336 mm to 440 mm in the district. The maximum rainfall is experienced during the monsoon season, which reaches its peak in the month of July.

3.2.5 Economy

The main occupation in the district is agriculture along with allied and agro-based activities. The Meos are the predominant population group and are all agriculturists. Agriculture is mostly rain-fed except in small pockets where canal irrigation is available. Agriculture production measured in terms of crop yield per hectare is low in comparison to the other districts of the State. Animal husbandry, particularly dairy, is the secondary source of income for the people and those who live closer to the hilly ranges of Aravali also keep sheep and goats. Milk yields are not so low, however, due to heavy indebtedness, most of the farmers are forced to sell the milk to the lenders at lower than normal price, which drastically reduces their income from the milk. Towns like Punhana, Pinangwan, Ferozepur Jhirka, Taoru and Nuh are major hub of retail shops and acts as the backbone of day to day life in area. The district also has an MMTC-PAMP factory located in the Rojka-Meo industrial estate.

3.3 Gurugram District

It is the southern-most district of Haryana. The district lies between 27°39' and 28°32'25" latitude, and 76°39'30"and 77°20' 45" longitude. Gurugram district is one of the 22 Districts of Haryana in northern India. Gurugram city is the administrative headquarters of the district.

Gurugram, officially named Gurugram, is a city located in the northern Indian state of Haryana. It is situated just near the Delhi-Haryana border, It is one of the major satellite cities of Delhi and is part of the National Capital Region of India. As of 2011, Gurugram had a population of 876,900. Gurugram has become a leading financial and industrial hub with the third-highest per capita income in India. District

Gurugram is located 30 Km south of National Capital New Delhi, about 10 Kilometers from Dwarka sub-city and 268 Km south of Chandigarh, the State Capital. Over the past 25 years the city has undergone rapid development and construction. The District is one of Delhi's major satellite cities and is part of the National Capital Region. It is within commuting distance of Delhi via an expressway and Delhi Metro. The District is the second largest city in the Indian State of Haryana and is the industrial and financial centre of Haryana. It has the 3rd highest per capita income in India after Chandigarh and Mumbai. It is also the only Indian city to have successfully distributed electricity connections to all its households. It is also the IT hub & centre of various BPO companies.

3.3.1 Geography

Gurugram is located in Gurugram district in the Indian state of Haryana and is situated in the south eastern part of the state, and northern part of the country. The city is located on the border with Delhi with New Delhi to its northeast. The city has a total geographical area of 1254sq.Km. The average land elevation is 217 metres above sea level. The area is conspicuously flat topography, however, in the north-eastern part small isolated hillocks of Precambrian rocks are exposed. The alluvial plain is formed by the sahibi river which is tributary of River Yamuna. Administratively, the district is divided in to four Blocks, namely, Gurugram, Pataudi, Farukhanagar, Sohna, and one sub – divisions, Gurugram. Gurugram town is the headquarter of the district.

3.3.2 Transportation

The area is well connected by roads and railways. National Highway No. 8 connecting Delhi with Jaipur passes through the district. Major state highways are - No. 13, No 28, No 26 and No. 15A connecting Gurugram - Alwar, Palwal - Sohna, Gurugram - Rewari -Narnaul-Singhana road and Jhajjar -Farrukhnagar- Gurugram respectively. Almost all the villages are connected by metalled roads. Northern Railway Broad gauge main line Delhi – Gurugram - Rewari and branch line Garhi-Harsaru-Farrukhanagar meter gauge branch line was constructed as far back as in 1883 for the salt traffic of that area.

Gurugram railway station is operated by Northern Railway of Indian Railways. The rail station forms a part of the larger Indian Railways network. Along with that, Gurugram has Tajnagar railway station, Dhankot railway station, Ghari Harsaru Railway Junction and Farrukhnagar Railway Station, Patli Railway Station. Manesar is an industrial town in Gurugram district of the State of Haryana in India and is a part of the National Capital Region (NCR) of Delhi.

3.3.3 Demographic

In 2011, Gurugram had population of 1,514,432 of which male and female were 816,690 and 697,742 respectively. Gurugram District population constituted 5.97 percent of total Maharashtra population. There was change of 73.96 percent in the

population compared to population as per 2001. In the previous census of India 2001, Gurugram District recorded increase of 44.15 percent to its population compared to 1991. As per 2011 census, 31.18 % population of Gurugram districts lives in rural areas of villages. The total Gurugram district population living in rural areas is 472,179 of which males and females are 251,462 and 220,717 respectively. In rural areas of Gurugram district, sex ratio is 878 females per 1000 males. Average literacy rate of Gurugram in 2011 were 84.70 compared to 78.50 of 2001.

3.3.4 Rainfall and Climate

The normal annual rainfall in Gurugram district is about 596 mm spread over 28 days. The south west monsoon sets in the last week of June and withdraws towards the end of September and contributes about 85% of the annual rainfall. July and August are the wettest months. 15% of the annual rainfall occurs during the non-monsoon months in the wake of thunder storms and western disturbances. Gurugram experiences a monsoon-influenced Composite climate. The city experiences four distinct seasons - spring (February - March), summer (April - August), fall/autumn (September - October) and winter (November - January), along with the monsoon season setting in towards the latter half of the summer. Summers, from early April to mid-October, are typically hot and humid, with an average daily June high temperature of 40 °C. The season experiences heat indices easily breaking 43 °C. Winters are cold and foggy with few sunny days, and with a December daytime average of 3 °C.

3.3.5 Economy

Gurugram has the third-highest per-capita income in India and is the site of Indian offices for half of Fortune 500 companies. The first major American brand to set up a unit in Gurugram was General Electric in 1997. GE's setup in Gurugram prompted other companies, both international as well as domestic, to follow suit. Providing outsourcing solutions in software, IT, service and sales through delivery facilities and call centres. However, due to the lack of proper public transport and the inability of most of the employees to afford a personal vehicle, most of the call centres provide pooled-in cars to and from their offices. Apart from Business process outsourcing and IT sectors, the city is home to several other companies that specialise in domain expertise. Siemens Industry Software, in Gurugram Business Park, made a portfolio of design software that was used by NASA to digitally design, simulate and assemble the vehicle before any physical prototypes were built. Various international companies, including Coca-Cola, Pepsi, BMW, Agilent Technologies, Hyundai have chosen Gurugram to be their Indian corporate headquarters.

The city's economic growth story started when the leading Indian automobile manufacturer Maruti Suzuki India Limited established a manufacturing plant in Gurugram in the 1970s.Today, Gurugram has local offices for more than 250 Fortune 500 companies.

3.4 Jhajjar District

Jhajjar is one of the 21 districts of Haryana state. Jhajjar district was carved out of Rohtak district on July 15, 1997. The district headquarter is situated in Jhajjar town at a distance of about 65 km from Delhi. Other towns in the district are Bahadurgarh and Beri. Bahadurgarh was founded by Rathi Jats and formerly known as Sharafabad. It is situated 29 km from Delhi and had developed into an important of industrial center. district lies between 28°22′ and 28°49′ N latitude and 76°18′ and 76° 59′ E longitude.

3.4.1 Geography

The Jhajjar district forms a part of Indo-Gangatic alluvial plain, with undulating dunes in some parts and small isolated hill in south-western part. Altitude of the district is ranges from 212 m to 276 m above mean sea level (MSL). The district falls within the classified arid and semi-arid zones. Broadly four types of soil are available in the District viz. clay, loamy clay, and loamy sandy. It is alluvial in nature and fertile. However, the soil is deficient in Nitrogen. Hot summer, cold winter and meager rain fall are the main climatic characteristics of Jhajjar District. The district is having an area of 1834 square Kms which is 3.77 % of total area of the state. The average plain elevation of the Distt is about 222 meters above mean sea level.

3.4.2 Transportation

Jhajjar Railway station consists of eight platforms. The station lies on Rewari-Rohtak line. A new 75 km long railway line was constructed between Asthal Bohar station that lies on Rohtal-Delhi railway line and Rewari via Jhajjar.

3.4.3 Demographic

Jhajjar district occupies 17th position in population size during 2011.Total population of Jhajjar district was 880,072. in Census 2001, representing 4.16% of Haryana State. More than seventy five percent of total population lives in rural areas (77.83%) and 22.17% in urban areas (Urbanization of the state28.9%). Sex-ratio of the district stood at 847 (rural-854, urban-823), when it was 860 for the State. Scheduled castes population is 17.79% (rural-18.32%; urban15.90%); while no Scheduled Tribe has been notified. Population below 6 years of age in Jhajjar district is 14.97% (rural-15.11%; urban-14.48%), having sex-ratio of 801 (rural-800; urban-804). Total literacy rate (TLR) of the district was 72.37% as against 67.90% of Haryana, in rural areas it was 70.36% (State-63.19%) and in urban 79.42% (State-79.16%). Female literacy rate (FLR) in the district was 59.64% (rural-56.72%; urban-70.10%).

3.4.4 Rainfall and Climate

Annual average rainfall is 444 mm, with 23 normal rainy days in a year. Average rainfall of 379 mm in monsoon accounts for 85% of the total rainfall. The climate of the district is sub-tropical, semiarid, continental and monsoon type. Average temperature ranges from 7°C in January to 40.5° C in May and June. January is the coldest month, bringing down the temperature to 3° C; while in summer season it

goes up to 47° C. Four seasons of the district are winter from end of November to middle of March, dry summer from April to June, south-west monsoon from July to September and post monsoon season in October and November. Air is generally dry in the district; while hot desiccating winds (loo), dust storms are common in summer. Relative humidity ranges from 95% in monsoon to 15% in summer.

3.4.5 Economy

Agriculture is the major activity in the district. Livestock rearing is also an important activity. Bahadurgarh, Najafgarh, Jhajjar, Beri towns of the district has seen faster growth of industries, due to proximity of these areas to the cities of Delhi and Gurugram and infrastructure development. Many of the industries in this district are engaged in production of materials used in building and construction sector. Thermal power plants are generating electricity. Infrastructure development fosters growth of tertiary sector industry. Special Economic Zone has been proposed along the National Highway passing through this district for industrial development. Bahadurgarh is the major industrial estate of the district. Bahadurgarh alone covers 3,000 industries out of 3,300 total industries in district. Basic industries are ceramics, glass, chemicals, engineering, electrical and electronics.

3.5 Sonipat District

Sonipat is located at 28.98°N 77.02°E. It comes under the National Capital Region and is around 43 Kms(27 mi) from Delhi. It is also around 214 km (128 miles) southwest of Chandigarh, the state capital. The Yamuna River runs along the eastern boundary. On 22 December 1972, Sonipat was carved out of Rohtak and made a full-fledged district. By taking 69 villages from Sonipat tahsil, Ganaur as a sub-tahsil was created in February 1980. Kharkhauda with 38 villages was created as a sub-tahsil on March 30, 1982. The sub-tahsil of Ganaur was upgraded to the level of tahsil on April 19, 1982. Gohana sub-division of Sonipat district was included in Rohtak district1. The position as on December 31, 1990 is as under 2 sub-divisions (Sonipat and Ganaur); 2 tahsils (Sonipat and Ganaur) and Kharkhauda as a sub- tehsil.

3.5.1 Geography

The total area of Sonipat district is 2,260 sq km. It has an average elevation of 224.15 meter above the sea level (735.4 ft). Topographically Sonipat district is divided into three regions - Khadar, Upland Plain and Sandy Region. Sonipat city is lying on upland plains, which is covered with old alluvium, which if properly irrigated, is highly productive. Extensive farming of crops, oilseeds, horticultural plants, vegetables and flowers, is undertaken in this region. Broadly speaking, the district is a continuous part of the Haryana-Punjab plain, but the area is not leveled in some parts. Sonipat District has fine loamy soil with rich color. However, some areas have sandy soil.

3.5.2 Transportation

Sonipat Junction Railway Station is located on the Northern Railways' Ambala-Panipat-Delhi rail route. It lies on one of the busiest railway lines in North India that is Delhi - Chandigarh. A number of passengers and express trains daily passes through it like Shatabadi Express, Shaan-e-Punjab, Malwa Express, Muri Express, Saryu Yamuna Express, Himalayan Queen, Sachkhand Express, Paschim Express, Kalka Mail, Jammu Mail, Unchahar Express, Amritsar Express, Jhelum Express, Tata Jat Express, Jan Shatabi, Shahid Express etc. In total, 64+ trains available from Sonipat daily. National Highway 1 and National Highway 71A pass through this district.

3.5.3 Demographic

An official Census 2011 detail of Sonipat (Sonipat), a district of Haryana has been released by Directorate of Census Operations in Haryana. Enumeration of key persons was also done by census officials in Sonipat District of Haryana. In 2011, Sonipat had population of 1,450,001 of which male and female were 781,299 and 668,702 respectively. In 2001 census, this figure for Sonipat District was at 6.05 percent of Maharashtra population. There was change of 13.35 percent in the population compared to population as per 2001. In the previous census of India 2001, Sonipat District recorded increase of 22.39 percent to its population compared to 1991.

3.5.4 Rainfall and Climate

The climate of Sonipat is composite, dry with a hot summer and a cold winter. The weather becomes milder during the Monsoon period (July to September). The post-monsoon months of October and November constitute a transition period prior to the onset of winter. The winter starts in December when day and night temperatures fall rapidly. January is the coldest month when the mean daily minimum temperature is 6–7 °C. During cold waves, the minimum temperature may go down to the freezing point of water, and frosts can occur. During the summer months of May and June, the maximum temperature sometimes reaches 47 °C. On average there are 24 days in a year with rainfall of at least 2.5 mm. Humidity is low during the greater part of the year.

3.5.5 Economy

There are two (Haryana State Industrial and Infrastructure Development Corporation) HSIIDC industrial estates, one each at Sonipat city and Kundli. The development of Sonipat industrial area in the city started in the 1950s with Atlas Cycle. Since then, many small and big industries have been established here. Sonipat has four industrial areas (Sonipat, Kundli, Rai, Bari) which contain numerous small- and medium-scale industries. Atlas, E.C.E. or the Birla Factory, OSRAM India (formerly part of E.C.E., but in October 1998 it was acquired by OSRAM were few large-scale industries name which were in city (now they have been re-located to Rai/Kundli/bari industrial areas).

4 TRAFFIC STUDY

4.1 Project Objective

The objective of this study is to facilitate and develop an orbital rail corridor connecting Palwal and Sonipat for easing the Delhi area of the freight traffic movement. The freight traffic presently moving through the congested Delhi area rail network is expected to shift to the proposed rail corridor.

Assessment of freight & passenger transport demand for 25 years from the year of starting of operation in 5 years intervals has been made.

4.2 Concept of Study

- Review of Existing Traffic Survey/ studies including study on passenger/goods traffic forecast.
- Delineation of Project influence area (PIA) and review of existing transport facilities available in PIA.
- Primary surveys to fill the gap in the data where ever applicable and required.
- Passenger and Goods traffic potential and forecasting for period of 25 years at 5-year interval.

4.3 Project Influence Area (PIA)

Delineation of project influence area (PIA) is done considering 50km of area along the proposed route.

However, as a 50 km influence area boundary is cutting across administrative boundaries, the PIA has been extended a bit further to encompass the taluka level administrative boundaries, as all the socio-economic data for planning and forecasting purposes is available at District and Taluka Level.

Table 4-1 Districts and Tehsils of Project Influence Area

District	Tahsil	District	Tehsil
Palwal	Palwal	Sonipat	Ganaur
	Hathin		Gohana
Gurgaon	Maneasr		Sonipat
	Pataudi		Kharkhoda
	Farrukhnagar	Panipat	Panipat
	Gurgaon	Faridabad	Ballabhgarh
	Sohna		Hassanpur
Jhajjar	Bahadurgarh		Hodal
	Beri		Faridabad
	Matenhail	Alwar	Kishangarh Bas
	Sahalawas		Tijara
	Jhajjar	Delhi	Delhi

District	Tahsil	District	Tehsil
Mewat	Nagina	Rewari	Bawal
	Taoru		Rewari
	Punhana	Rohtak	Rohtak
	Firozpur Jhirka		
	Nuh		

4.4 Immediate influence area (IIA)

The immediate influence area is considered within 15-20 km radius along the proposed railway corridor. The IIA is comparatively smaller than the PIA as each station's influence or catchment is much smaller when it comes to passenger traffic. Therefore, the block/tehsil level zones have been considered for determining the zone of influence for each station. The following tehsils were considered for co-relating trip making with population within the IIA.

Table 4-2 Districts and Tehsils of Immediate Influence Area

District	Tehsil / Block
Faridabad	Ballabhgarh
Gurgaon	Sohna
	Manesar
	Farrukhnagar
	Gurgaon
Jhajjar	Bahadurgarh
Mewat	Nuh
	Taoru
Palwal	Palwal
	Hathin
Sonipat	Kharkhoda
	Sonipat

4.5 Population

District-wise rural-urban population in the Immediate Influence Area Districts, during 2001 and 2011 is as shown below in the table.

Table 4-3 Population Statistics of IIA, 2001 and 2011

S.N.	District	Population (2001)			Population (2011)		
		Rural	Urban	Total	Rural	Urban	Total
1	Faridabad	303,158	1,062,307	1,365,465	370,878	1,438,855	1,809,733
2	Jhajjar	684,975	195,097	880,072	1,232,015	332,693	1,564,708
3	Mewat	730,449	59,301	789,750	965,157	124,106	1,089,263
4	Palwal	670,084	159,037	829,121	806,164	236,544	1,042,708
5	Sonipat	957,800	321,375	1,279,175	996,637	453,364	1,450,001
6	Gurgaon	1,291,285	369,004	1,660,289	472,179	1,042,253	1,514,432
Total		4,637,751	2,166,121	6,803,872	4,843,030	3,627,815	8,470,845

Source:http://censusindia.gov.in/pca/cdb_pca_census/Houselisting-housing-HARYANA.html&http://www.censusindia.gov.in/DigitalLibrary/MFTableSeries.aspx

4.6 Work Participation Rate

Nature of one's activity and extent of participation in economically productive works are the decisive factor for such a classification. Level of economic development of different regions within the District, availability of opportunities besides willingness to work especially among women, initiative and entrepreneurship evinced by men folk in general activities are the important factors that influence the distribution of population under these three categories i.e., main workers, marginal workers and non-workers.

Main worker

A person who has worked for major part of the reference period (i.e. six months or more during the last one year preceding the date of enumeration) in any economically productive activity is termed as "Main worker".

Marginal worker

A person who worked for less than six months of the reference period (i.e. in the last one year preceding the date of enumeration) in any economic activity is termed as "Marginal worker".

Non-worker

A person who has not worked at all in any economically productive activity during the reference period (i.e. last one year preceding the date of enumeration) is termed as "Non-worker".

Table below presents number and percentage of main workers, marginal workers and non-workers in the Sub-Districts of the District according to Census, 2011

Table 4-4 Number and percentage of main workers, marginal workers and non-workers in IIA, 2011

S.N	District	Block	Population	Main Worker	Marginal Worker	Total Worker		Non-Worker	
			Number	Number	Number	Number	Percentage	Number	Percentage
1	Palwal	Palwal	291,145	58,524	26,581	85,105	29.20%	206,040	70.80%
		Hathin	254,594	50,118	28,441	78,559	30.90%	176,035	69.10%
2	Gurgaon	Gurgaon	134,089	42,108	5,402	47,510	35.40%	86,579	64.60%
		Farukhnagar	113,493	30,421	9,078	39,499	34.80%	73,994	65.20%
		Sohna	157,688	39,682	10,152	49,834	31.60%	107,854	68.40%
		Taoru	5,004	989	407	1,396	27.90%	3,608	72.10%
		Manesar	23,448	9,563	357	9,920	42.30%	13,528	57.70%
3	Faridabad	Ballabgarh	206,901	46,296	12,640	58,936	28.50%	147,965	71.50%
4	Mewat	Taoru	144,179	29,827	10,491	40,318	28.00%	103,861	72.00%
		Nuh	270,841	48,180	21,676	69,856	25.80%	200,985	74.20%
5	Sonipat	Sonipat	212,622	60,750	21,301	82,051	38.60%	130,571	61.40%
		Kharkhoda	137,807	37,380	15,504	52,884	38.40%	84,923	61.60%
6	Jhajjar	Bahadurgarh	232,979	63,124	20,398	83,522	35.80%	149,457	64.20%

Source: http://censusindia.gov.in/pca/cdb_pca_census/Houselisting-housing-HARYANA.html

4.7 Vehicle Registration Data

The total number of registered motor vehicles in the Project Influence Area (PIA) which includes districts of Sonipat, Rohtak, Jhajjar, Faridabad, Palwal, Gurugram, Nuh and Rewari, for the past years is as given below.

Table 4-5 Total Registered Motor Vehicles in Project Influence Area (PIA)

Type of vehicle	Year			
	2014-2015	2015-2016	2016-2017	2017-2018
Cars	82,863	74,142	81,486	83,724
Jeeps	6,034	8,258	3,528	5,423
Trucks	7,748	13,010	15,168	15,087
Taxies	2,749	4,400	4,624	5,854
Tractors	8,941	9,870	8,724	8,595
Buses	1,914	1,223	2,638	5,084
Two-wheeler	161,766	165,848	168,683	212,190
Autorickshaws	3,984	5,363	6,524	7,653
Miscellaneous	9,569	10,128	13,158	21,785
Total	**285,568**	**292,242**	**304,533**	**365,395**
CAGR (%)	**6.36%**			
YOY growth (%)		**2.34%**	**4.21%**	**19.99%**

Source: http://esaharyana.gov.in

The total number of vehicles registered in PIA has increased from 2,85,568 to 3,65,395 from 2014 to 2018. The Compound Annual Growth Rate (CAGR) of total number of vehicles registered is 6.36 %. It may be noted that there is a steep increase in number of two-wheelers and miscellaneous vehicles in the year 2017-18.

The total no. of registered motor vehicles in Haryana for past years is as given below.

Table 4-6 Total Registered Motor Vehicles in Haryana

Type of Vehicles	Year			
	2014-2015	2015-2016	2016-2017	2017-2018
Cars	138,437	147,393	137,756	141,633
Jeeps	9,301	11,395	6,551	12,533
Trucks	11,428	17,989	18,029	19,914
Taxies	4,153	6,036	6,462	7,467
Tractors	28,534	31,400	27,071	25,410
Buses	3,647	2,965	4,314	5,039
Two-Wheelers	391,557	350,514	446,586	485,406
Autorickshaws	12,614	14,558	15,832	16,653
Miscellaneous	15,553	51,174	21,608	32,853
Total	**615,224**	**633,424**	**684,209**	**746,908**
YOY growth (%)		**2.96%**	**8.02%**	**9.16%**
CAGR (%)	**4.97%**			

Source: http://esaharyana.gov.in

The total number of vehicles registered in Haryana has increased from 6,15,224 to 7,46,908 from 2014 to 2018. The Compound Annual Growth Rate (CAGR) of total number of vehicles registered is 4.97 %.

4.8 Economy

Industry

In terms of industrial activity, Haryana has been providing constant impetus to manufacturing activity across the past few years, with the objective of developing the state as major manufacturing/export hub of Northern India. Regarding the above, the state government has been promoting industry specific infrastructure developments such as Export Promotion Parks, Food Parks, Apparel Parks, Auto Clusters, Engineering Clusters, etc. to provide manufacturers a level platform to successfully compete with both domestic and international counterparts. These initiatives have led to enhanced investments across sectors such as automobile and auto components, food processing, wearing apparel, basic metals, light engineering, textiles, machinery, construction material and scientific instruments. In addition to the above, the state government has also introduced specific policies such as the "Total Industrial Support" policy to augment investment across specific sectors. The objective of this policy is to provide a gamut of services such as industry specific Infrastructural Development, Project Promotion and Financial Services, thereby facilitating ease of establishment of industrial units. Further, Haryana's key strength of abundance of agricultural products coupled with proactive development of industry specific infrastructure is also expected to raise the potential of Agro-processing sector in the state.

Implementation of DMIC (Delhi Mumbai Industrial Corridor) and DFCCIL (Dedicated Freight Corridor) in Haryana is a major infrastructure development with both the projects expected to act as catalysts to enhance industrial/manufacturing activity. Inherent strengths such as large agricultural resources (which provide upstream raw materials for the food and agro-processing sector), synergies of strategic location with respect to major markets, superior transport linkages, state of the art industrial infrastructure, established industrial investments and proactive government initiatives are expected to develop the state as a major industrial hub in the DMIC region.

Over the years, Haryana Sub-Region has also emerged as an established IT/ITeS hub. Gurgaon today, is one of the prominent IT/ITeS centers in India. Further, availability of a large talent pool, established industry clusters, well developed physical infrastructure, development of dedicated industrial clusters and investor focused approach in administration processes etc. continue to attract investments across the secondary & tertiary sectors.

The primary industries of the Sub-Region are Automobiles and Auto Components, Textiles and Apparel, Light & Heavy Engineering: Basic Metals, Fabricated Metal

Products, Machinery & Equipment, Electrical Machinery & Apparatus, Petrochemicals, Plastic, Pharmaceuticals, Biotechnology, Food Products and Beverages, IT/ITeS (including Knowledge Services).

Gross State Domestic Product (GSDP)

Gross State Domestic Product (GSDP) for Agriculture and Industrial sector in Haryana State is shown in the table below.

Table 4-7 Gross State Domestic Product (GSDP) for Agriculture and Industrial sector in Haryana State

In Crore

Year	Agriculture and Allied sector	Industrial Sector
2014-15	63,577	105,735
2015-16	66,022	117,479
2016-17	72,909	129,440
2017-18	76,908	136,435
2018-19	81,114	148,200
CAGR (%)	**6.28%**	**8.81%**

Source: Economic Survey of Haryana, Department of Economic and Statistical Analysis, Haryana

Major Development near project location

Panchgram Yojana

The Haryana government will develop five new cities on either side of the Kundli-Manesar-Palwal expressway and the area will be named as Panchgram. The Haryana Govt. approved the concept of the Panchgram Region and developing five cities on the Kundli-Manesar-Palwal (KMP) expressway on 50,000 hectares each side of the expressway which would cover eight districts of the State namely Sonipat, Rohtak, Jhajjar, Gurugram, Rewari, Mewat, Faridabad and Palwal.

The Industrial and Commercial Townships were being set up on 3,300 acres area in Kharkhoda, Sonipat. Similarly, Industrial Model Township has been developed on 1,400 acres in Sohna of Gurugram.

The Proposed Alignment is going parallel to Kundli-Manesar-Palwal expressway of about 95 Km so that will give boost to industrial Sector in the State.

Dedicated Freight Corridor

The Indian Railways quadrilateral linking the four metropolitan cities of Delhi, Mumbai, Chennai and Howrah, commonly known as the Golden Quadrilateral; and its two diagonals (Delhi-Chennai and Mumbai-Howrah), adding up to a total route length of 10,122 km carries more than 55% of revenue earning freight traffic of IR.

Western Dedicated Freight Corridor comprising of 1483 km of a double line from JNPT to Dadri via Vadodara-Ahmedabad-Palanpur-Phulera-Rewari. In addition, a single line connection of 32km long from proposed Pirthala Junction Station (near Asaoti) to Tughlakabad is also proposed to be provided.

4.9 Primary Traffic Surveys

Estimation of traffic in the study area is an essential step towards establishing the better understanding for base year traffic scenario. The aforesaid traffic surveys are planned, as indicated below for obtaining necessary information and data necessary for assessing the base line passenger traffic.

4.10 Classified Traffic Volume Counts (CTVC)

Count of traffic is the basic traffic study required in connection with many types of projects. Three-days traffic counts were taken on selected locations. The count stations were selected such that the results represent the traffic flow in homogeneous sections of the highway. The CTVC count will give the Average Daily Traffic (ADT).

The collected traffic data mode-wise has been converted into Passenger Car Units (PCU) by adopting equivalent PCU factor as per IRC: 64-1990 as below.

Table 4-8 PCU value adopted as per IRC:64-1990

Mode of Transport		PCU
Passenger Traffic	Two-wheeler	0.5
	Three-wheeler	1
	Car/SUV/Van	1
	Mini Bus	1.5
	School Bus	3
	Govt. Bus	3
	Private Bus	3
Goods Traffic	Mini LCV	1
	LCV Four-wheeler	1.5
	LCV Six-wheeler	3
	Two Axle Truck	3
	Three Axle Truck	3
	4-6 Axle Truck	4.5
	MAV Over six Axle	4.5
	Container	3
	Tanker	3
	Tractor Trailer	4.5

4.11 Origin-Destination (O-D) Surveys

Origin and Destination surveys were carried out to appreciate the travel pattern of passenger and Goods vehicles. These surveys were carried out on a sample basis by stopping vehicles at highways on road side in the study area. The surveys have been conducted by interviewing occupants of vehicles appropriately spread across the time of the day and type of vehicle.

The information collected from survey includes Origin and Destination of the trip, Trip Frequency, Trip Purpose, Occupancy, Trip Length etc. Trained enumerators were engaged to conduct these surveys.

Traffic survey locations CTVC and O-D surveys are given in the table below. Traffic Survey Formats and Photographs are given in Annexure-IV(A) & IV(B).

Traffic survey locations CTVC and O-D surveys are given in the table below:

Table 4-9Traffic Survey Locations (CTVC and O-D)

S.No.	Survey Location	Code	Road / Location
1	Palwal-Hodal Toll Plaza	T-1	Delhi-Agra Highway
2	Nimrana Toll Plaza	T-2	Delhi-Jaipur Highway
3	Bawal Toll Plaza	T-3	Rewari-Rohtak Highway
4	Dighal Toll Plaza	T-4	Rohtak-Jhajjar Highway
5	Rohad Toll Plaza	T-5	Delhi-Rohtak Highway
6	NHAI Toll Plaza, Sonipat	T-6	Delhi-Chandigarh Highway
7	Sohna Road	T-7	Gurgaon-Sohna Road
8	Bhiwadi Toll Plaza	T-8	Bhiwadi-Alwar Road

Location wise vehicular and PCU traffic is as below:

Table 4-10 Location wise vehicular and PCU Traffic

S.No.	Location Name	ADT (Vehicle)			ADT (PCU)		
		Passenger	Goods	Total	Passenger	Goods	Total
1	T-1	20,960	10,006	30,966	19,602	34,421	54,023
2	T-2	13,437	18,382	31,819	14,109	65,592	79,701
3	T-3	10,555	5,636	16,191	8,752	19,724	28,476
4	T-4	13,934	4,933	18,867	12,187	15,318	27,505
5	T-5	25,799	3,160	28,959	23,689	9,021	32,710
6	T-6	66,037	17,470	83,507	69,226	51,100	120,326
7	T-7	24,973	4,638	29,611	21,983	13,161	35,144
8	T-8	22,259	5,123	27,382	20,400	15,099	35,499

Location wise Modal split and classified traffic volume count data are presented as figures and tables in Annexure-IV(C).

4.12 Summary of Origin-Destination Surveys

The following zones have been considered for O-D survey and data analysis.

- Zone No 1-33 Taluka level (PIA)
- Zone No. 101-122 District Level
- Zone No. 201-204 state Level

Table 4-11 Delineation of Zones in PIA

Zone No.	Zone Name	Zone No.	Zone Name	Zone No.	Zone Name
1	Delhi	24	Faridabad	114	Aligarh

Zone No.	Zone Name	Zone No.	Zone Name	Zone No.	Zone Name
2	Ballabhgarh	25	Punhana	115	Muzaffarnagar
3	Hathin	26	Firozpur Jhirka	116	Baghpat
4	Hassanpur	27	Nuh	117	Saharanpur
5	Nagina	28	Farrukhnagar	118	Gautam Buddha Nagar
6	Maneasr	29	Gurgaon	119	Ghaziabad
7	Taoru	30	Sohna	120	Mathura
8	Pataudi	31	Sahalawas	121	Bulandshahr
9	Bahadurgarh	32	Jhajjar	122	Meerut
10	Beri	33	Kharkhoda	201	Andhra Pradesh, Kerala, Telangana, Tamil Nadu,Pudduchery, Karnataka & Goa
11	Matenhail	101	Ambala	202	Bihar
12	Panipat	102	Bhiwani	203	Chhattisgarh
13	Bawal	103	Fatehabad	204	Jharkhand
14	Rewari	104	Hisar	205	Madhya Pradesh
15	Rohtak	105	Jind	206	Orissa
16	Ganaur	106	Kaithal	207	Rajasthan
17	Gohana	107	Karnal	208	Uttar Pradesh
18	Sonipat	108	Kurukshetra	209	North East states and Westbengal
19	Kishangarh Bas	109	Mahendragarh	210	Gujarat, Dadar & Nagar and Daman & Diu, Maharashtra
20	Tijara	110	Panchkula	211	Uttaranchal
21	Sonipat	111	Rohtak	212	Punjab
22	Palwal	112	Sirsa	213	Himachal Pradesh
23	Hodal	113	Yamuna Nagar	214	Jammu and Kashmir

4.13 Type of commodity observed and distribution of traffic

The type of commodity observed in the OD surveys are as below.

Table 4-12 Commodities observed in the OD surveys

S.No.	Commodity
1	Container
2	Construction Material
3	Cement
4	Fuel & Gas
5	Automotive Parts and vehicles
6	Vegetables
7	Food item
8	Food Grains

S.No.	Commodity
9	Iron & Steel
10	Empty
11	Household Items & Electronics
12	Clothes
13	Wood, Plastic & Carton
14	Medicine, Chemical & Fertilizer
15	Coal
16	Others

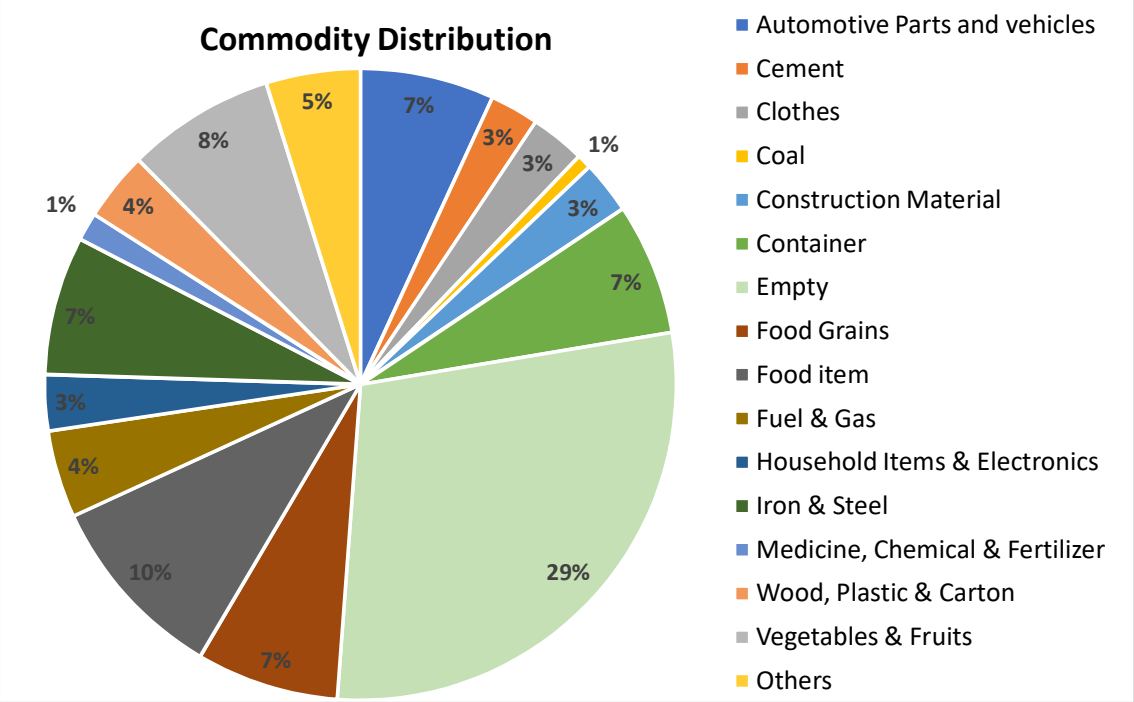


Figure 4-1 Commodity wise distribution of traffic observed in OD survey

It is observed that 10% of total traffic is Food item, 8% is processed vegetables and fruit, 7% is food grains, and 7% is Automotive parts and vehicles, Iron & steel and container each. About 29% of all goods vehicles were empty.

4.14 Existing Rail Network in Haryana

Rail network in Haryana, is covered by 5 railway divisions under 3 rail zones, namely, North Western Railway zone, Northern Railway zone and North Central Railway zone.

Total Route length of Haryana rail network is 1710.49 Km. and the existing rail network of Haryana is shown in the figure below:

Figure 4-2 Existing Rail Network in Haryana

Presently all rail-lines are used by both freight and passenger trains. The freight traffic from Haryana mainly includes food grains, oil seeds and sugar. Rail routes that serve Haryana sub-region and their capacity utilization are indicated in the table below.

Table 4-13 Rail Route Serving Haryana Sub Region

S.No	Route Details	Administrative Rail Zone	Length in Haryana sub Region of NCR	Capacity Utilization %
1	Delhi-Gurgaon-Rewari-Bawal-Alwar	N.R	100	80-150
2	Delhi-Rohtak-Jind-Bhatinda	N.R	60	100-130
3	Rohtak-Panipat	N.R	143	60-75
4	Delhi-Sonipat-Ambala	N.R	75	100-140

S.No	Route Details	Administrative Rail Zone	Length in Haryana sub Region of NCR	Capacity Utilization %
5	Panipat-Jind	N.R	25	60-75
6	Rohtak-Bhiwani	N.R	30	70-80
7	GarhiHarsaru-Farukhnagar	N.R	11	40-60
8	Rewai-Dabla-Ringus-Phulera	N.R	25	75-90
9	Rewari-Bhiwani-Hisar	N.R	50	100
10	Rewari-Sadulpur-Bikaner	N.R	35	50-75
11	Delhi-Faridabad-Palwal-Mathura	N.R	70	130-160

Source: Indian Railways

More than 50% of rail route that serves the sub-region are already over saturated and capacity utilization is more than 100%.

4.15 Existing Rail Network in Delhi NCR

The NCR rail network covers three zonal railways (northern, western and central) zones and five divisions. The rail network consists of broad gauge(1676mm). Five broad gauge railway lines converge at Delhi. The rail network has two specially identified lines known as goods avoiding lines (GAL) and Delhi avoiding lines (DAL). Delhi area handles tremendous volumes of coaching and freight traffic. The coaching traffic has grown at an exponential rate during the last two decades with addition of large number of mail, express, Shatabdi and Rajdhani trains catering to long distance. The existing network of NCR is shown in the figure below.

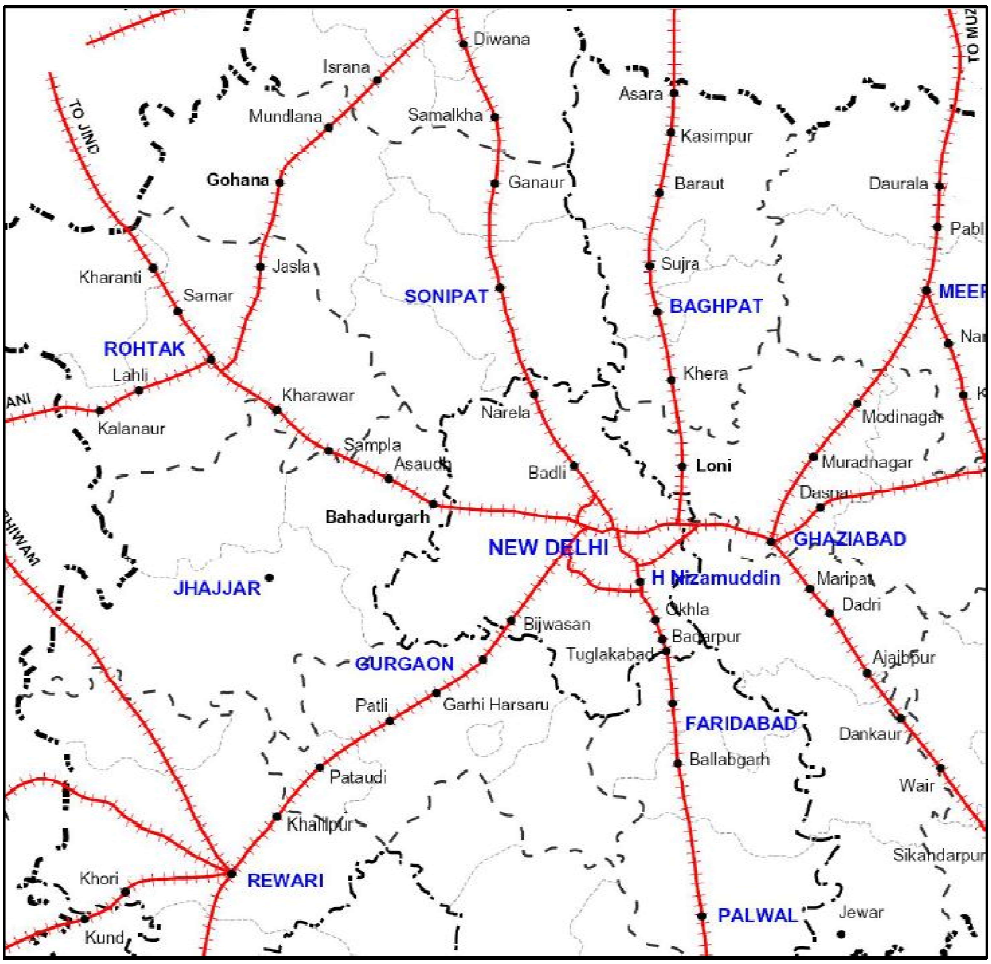


Figure 4-3 Existing Rail Network in Delhi

4.16 Line capacity and utilization

The railway network in NCR consists of complex rail radials and hubs which have got developed over the last hundred years. It serves the National capital – New Delhi and strives to meet transportation needs of India's populations, people visiting it for business and social requirements.

Charted line capacity and utilization of various sections of Delhi division as shown in the table below.

Table 4-14 Charted line capacity and utilization of various sections of Delhi division

S. No.	Section	Line Type	Electrification	Distance (km)	Charted capacity			Trains running each way			% of Utilization		
					W/o MB.	With 2 Hrs MB	With 4 hrs MB	Coaching	Goods	Total	W/o MB.	With 2 Hrs MB	With 4 Hrs MB
1	**Delhi-Ghaziabad (DLI-GZB)**			19.88									
	DLI-DSA	TWIN SINGLE LINE	ELECTRIFIED	6.02	85	78	72	80	23.4	103.4	122%	133%	144%
	DSA-SBB	TWIN SINGLE LINE	ELECTRIFIED	7.14	85	78	72	67	22.1	89.1	105%	114%	124%
	SBB-GZB	QUADRIPLATE	ELECTRIFIED	6.72	160	146	133	162	59.1	221.1	138%	151%	166%
2	**GZB-MTC**	DOUBLE LINE	ELECTRIFIED	47.29	60	55	50	23	12.2	35.2	59%	64%	70%
3	**Delhi-NDLS-Palwal**			60.34									
	DLI-NDLS	DOUBLE LINE	ELECTRIFIED	3.16	40	37	34	18	21	39	98%	105%	115%
	NDLS-TKJ	QUADRIPLATE	ELECTRIFIED	2.6	180	170	160	131	29.9	160.9	89%	95%	101%
	TKJ-HNZM (M/L)	QUADRIPLATE	ELECTRIFIED	4.63	80	74	68	64	31.7	95.7	120%	129%	141%
	HNZM-TKD ML	QUADRIPLATE	ELECTRIFIED	10.51	80	74	68	92	18.7	110.7	138%	150%	163%
	TKJ-B Panal	DOUBLE LINE	ELECTRIFIED	-	80	74	68	75	43.3	118.3	148%	160%	174%
	B Panel-SBB	DOUBLE LINE	ELECTRIFIED	-	80	74	68	76	38	114	143%	154%	168%
	TKD -HNZM (GAL)	QUADRIPLATE	ELECTRIFIED	10.51	50	46	42	12	28.1	40.1	80%	87%	95%
	TKJ-NZM (3rd Line)	QUADRIPLATE	ELECTRIFIED	4.63	25	23	21	7	9	16	64%	70%	76%
	HNZM - OKA (GAL)	QUADRIPLATE	ELECTRIFIED	3.66	50	46	42	8	18.2	26.2	52%	57%	62%
	TKD-PWL	QUADRIPLATE	ELECTRIFIED	39.44	125	115	105	96	52.4	148.4	119%	129%	141%
4	**HNZM-LPNR**	DOUBLE LINE	ELECTRIFIED	1.88	45	41	38	8	18.4	26.4	59%	64%	69%
5	**OKA-LPNR(DAL)**	DOUBLE LINE	ELECTRIFIED	2.45	42	38	35	5	22.4	27.4	65%	72%	78%
6	**OKA-TKD (GAL)**	QUADRIPLATE	ELECTRIFIED	6.85	60	55	50	3	44.4	47.4	79%	86%	95%

S. No.	Section	Line Type	Electrification	Distance (km)	Charted capacity			Trains running each way			% of Utilization		
					W/o MB.	With 2 Hrs MB	With 4 hrs MB	Coaching	Goods	Total	W/o MB.	With 2 Hrs MB	With 4 Hrs MB
7	**LPNR-DSJ-PTNR**	DOUBLE LINE	ELECTRIFIED	17.57	50	46	42	13	42.8	55.8	112%	121%	133%
8	**Delhi-Rewari (DLI-RE)**	DOUBLE LINE	ELECTRIFIED	82.16									
	DLI-NDLS-DEE	DOUBLE LINE	ELECTRIFIED	4.28	60	55	50	33	6	39	65%	71%	78%
	DEE- DEC-GHH	DOUBLE LINE	ELECTRIFIED	36.29	65	60	55	41	19.9	60.9	94%	102%	111%
	GHH-RE	DOUBLE LINE	ELECTRIFIED	41.63	65	60	55	38	17.7	55.7	86%	93%	101%
	PTNR-DEC North line	DOUBLE LINE	ELECTRIFIED	6.44	24	22	20	4	9	13	54%	59%	65%
9	**GHH-FN**	SINGLE LINE	NON-ELECTRIFIED	11.2	10	8	6	6	0.2	6.2	62%	78%	103%
10	**ABO-RE**	SINGLE LINE	NON-ELECTRIFIED	75.27	22	20	18	4	1	5	23%	25%	28%
11	**Delhi - Panipat (DLI-PNP)**			88.29									
	DLI- SZM	DOUBLE LINE	ELECTRIFIED	2.77	25	20	21	22	9.8	31.8	127%	159%	151%
	SZM- ANDI	DOUBLE LINE	ELECTRIFIED	6.13	85	79	72	56	14.9	70.9	83%	90%	98%
	ANDI-SNP-PNP	DOUBLE LINE	ELECTRIFIED	79.39	85	79	72	58	28.9	86.9	102%	110%	121%
12	**Delhi - Rohtak (DLI-ROK)**			69.91									
	NDLS-DKZ	DOUBLE LINE	ELECTRIFIED	4.12	36	33	30	12	11.8	23.8	66%	72%	79%
	DKZ -DBSI	DOUBLE LINE	ELECTRIFIED	2.94	45	41	38	50	18.8	68.8	153%	168%	181%
	SSB-ROK	DOUBLE LINE	NON-ELECTRIFIED	59.72	65	60	54	31	18.8	49.8	77%	83%	92%
	ROK-PNP	SINGLE LINE	NON-ELECTRIFIED	71.4	15	13	10	6	0.1	6.1	41%	47%	61%
	NDLS-SZM	DOUBLE LINE	ELECTRIFIED	3.91	36	33	30	34	7.1	41.1	114%	125%	137%
13	**ROK-JHI**	DOUBLE LINE	ELECTRIFIED	57.15	65	60	54	19	16.3	35.3	54%	59%	65%
14	**JHI- GHNA-SNP**	SINGLE LINE	NON-ELECTRIFIED	89.1	22	20	18	2	1	3	14%	15%	17%
15	**SBB-ANVT**	DOUBLE LINE	ELECTRIFIED	5.68	60	55	50	29	2	31	52%	56%	62%

All railway lines carrying through (non-destined) traffic within Delhi with their saturation level are detailed below.

Table 4-15 Critical sections with Saturation level in Delhi area

S.No.	Sections	Saturation Level(in %)
1	Lajpat Nagar-Patel Nagar Delhi Avoiding Line (DAL)	133
2	Patel Nagar- Adarsh Nagar	98
3	Adarsh Nagar – Sonipat- Panipat	121
4	Patel Nagar – Delhi Cantt (North Line)	65
5	Tilak Bridge – Anand Vihar	174
6	Nizamuddin – Tuqlakabad	163
7	Tuqlakabad – Palwal	141
8	Shakurbasti - Rohtak	92

The following inferences are made from studying the above tables.

- Trains coming from Bhatinda, Ludhiana, Ferozepur etc. south bound via Palwal are presently routed via Rohtak- Patel Nagar- Lajpat Nagar-Tuglakabad or Panipat-Sonipat-Adarsh Nagar-Dayabasti – Patel Nagar – Lajpat Nagar – Tuglakabad. Presently, 16.3 goods trains run on Jind(JHI) – Rohtak (ROK) section, 18.8 goods trains run on Rohtak (ROK) – Dayabasti (DBSI) section,3.6 goods trains run on Shakurbasti -Patel Nagar (PTNR) section and 42.8 goods trains run on Patel Nagar (PTNR) – Lajpat Nagar (LPNR) section.
- Trains coming from Bhatinda, Ludhiana etc. moving via Panipat (PNP)-Sonipat (SNP)-Adarsh Nagar (ANDI)-Dayabasti (DBSI) – Patel Nagar (PTNR) – Lajpat Nagar (LPNR) – Tuglakabad can be diverted on to proposed line from Sonipat (SNP) to Asaoti (AST) and Palwal (PWL).
- The trains North bound originating in Manesar, Patli and GariHarsaru towards Bhatinda, Firozpur, Chandigarh, Ludhiana etc. are moving Via Delhi cantonment (DEC) – Patel Nagar (PTNR) – Adarsh Nagar (ANDI) & Rohtak (ROK) can be moved via proposed line. Presently 19.9 goods trains run on Delhi Cantonment (DEC) – GarhiHarsaru Junction (GHH).

At present goods traffic from East to West and vice-versa is moving through Railway network in Delhi, resulting into congestion on the existing rail network due to which the Railways is not able to run passenger trains as per requirement to handle the ever-growing Passenger traffic. The over saturation of the existing system is affecting the average speed of the goods trains due to heavy regulation due to crossings and precedences.

This proposed rail link will enable bypassing of the freight traffic from Delhi. Thus, it will generate extra capacity in Delhi rail network for passenger & suburban services and also opportunity for commercial exploitation of the urban real estate by Railway in Delhi area and generation of freight traffic with financial benefits to railways. The proposed Delhi bypass rail corridor will play a major change to overcome the above

hurdles in transportation needs and will go a long way in development of the National Capital Region.

4.17 Existing Rail Freight Traffic, Potential Traffic Generators and Stakeholders Outreach

Potential Traffic Generators

ICD, CFS and Goods sidings

The overall logistics and freight movement patterns in the catchment area is studied for the purpose of assessment of the existing quantum and concentration of logistic scenario in the region. An overall logistics ecosystem provides the multi-modal connectivity for inbound and outbound freight movement between the ports and hinterland and distribution to various parts and centers across the country. Such facilities include freight terminals, logistics parks, warehouses, container depots, goods sheds etc. which are developed, planned and implemented by various agencies under the support of ministry of railways, ministry of civil supplies, warehousing corporation and private incorporates.

List of ICDs and CFS located in Haryana and Delhi along the project corridor are as below.

Table 4-16 : ICDs and CFS in Haryana and Delhi area

S.N	Location	ICD/CFS	Operated by
1	Faridabad	CFS	Associated Container terminal
2	Rewari	CFS	Haryana warehousing Limited
3	Kundli	CFS	Central warehousing Limited
4	GarhiHarsaru	ICD	Gateway Distripark Limited
5	Tuglakabad	ICD	Container corporation of India
6	Patli	ICD	Adani Logistic Limited
7	Piyala, Asaoti	ICD	Gateway Distripark Limited
8	Ballabhgarh	ICD	Container corporation of India
9	Rai, sonipat	ICD	Container corporation of India
10	Panchi, Gujaran, Sonipat	ICD	BoxTrans Logistics
11	Bhagola, Palwal	ICD	Hind Terminal Pvt. Limited
12	Jattipur, panipat	ICD	Container warehousing corporation limited
13	Pali,Rewari	ICD	Kirbhco infrastructure Limited
14	Panipat	ICD	Continental warehousing corporation

Goods Station Sidings

The Station Sidings are Illustrated in below table.

Table 4-17 List of Station Sidings

S.No	Station
1	Palwal Station Siding
2	Asaoti Station Siding
3	Rai, Sonipat Station Siding

The details of inward outward movement of rakes from above goods sidings by mean of primary interactions is as below.

a) Palwal Station Siding

Major Inward rakes are from JNPT, MDCC and outward is same, Incoming rakes per year is around 93, Outgoing rakes per year is 82.5, Major commodities are Milk, Iron, Containers.

b) Asaoti Station Siding

Asaoti Station Siding is located at Asaoti station itself. The Major Commodity handled by this siding is Oil. It handles on an average of one rake per month, rakes are coming fromSanehwal and Kalamboli. The traffic handled by this siding is listed below:

Table 4-18 Traffic handled by rail at Asaoti Station Siding

Station	No. of rakes (2017-18)		No. of rakes (2018-19)	
	Inward	Outward	Inward	Outward
Asaoti Station	14	14	12	12

c) Bharat Petroleum Ltd. (BPAG) siding, Asaoti

Oil & LPG ICD is Located at 6.1 kms from Asaoti Railway station towards Hazrat Nizamuddin. Major Inward rakes are coming from MGG (Manliyagaon Station) and Gandhi Dham (GIMB) and Outward rakes are towards Jammu, Panipat, Eastern Delhi. The traffic handled by this ICD is listed below:

Table 4-19Traffic handled by rail at Bharat petroleum Siding

ICD, CFS (Asaoti)	No. of Rakes (2017-18)		No. of Rakes (2018-19)	
	Inward	Outward	Inward	Outward
POL	16	638	48	431
LPG	11	0	12	0

d) Rai, Sonipat Station Siding

Rai, Sonipat Station Siding is located at Rai, the major commodity handled by this siding is Food Grains, Fertilizers, Containers. This siding handled approximately 55 rakes per year, Rakes are coming from Batela, BON (Bonra), KDL (Kankroli), MDCC. The traffic handled by this siding is listed below:

Table 4-20 Traffic handled by rail at Asaoti Station Siding

Station	No. of rakes (2017-18)		No. of rakes (2018-19)	
	Inward	Outward	Inward	Outward
Rai, Sonipat Siding	66	66	48	48

Details of ICDs, CFS in Project Influence Area

The ICDs, CFS, Container Depots are Illustrated in below table:

Table 4-21 List of ICDs, CFS, Container Depots

S. No	ICDS/CFS
1	Hind Terminal Pvt. Limited
2	Associated Container Siding
3	Tughlakabad ICD
4	Okhla ICD
5	Boxtrans Logistics Pvt Ltd
6	Adani Logistics Pvt Ltd
7	Gateway Rail Freight Limited

The details of inward outward movement of traffic from above goods sidings by mean of primary interactions is as below.

a) Hind Terminal Pvt. Limited ICD

Hind terminal is located at 6 kms from Palwal railway station towards Hazrat Nizamuddin. Major Inward Rakes are from JVSL, Jamshedpur and outward rakes are towards MDCC (Mundra Port Cargo Complex), JNPT (Jawaharlal Nehru Port Trust). Major Commodities are Iron, Milk and Containers.

The traffic handled by rail is listed below:

Table 4-22 Total rail traffic handled by Hind terminal ICD

Commodity	No. of rakes(2017-2018)		No. of rakes(2018-2019)	
	Inward	Outward	Inward	Outward
Container	574	273	557	231

b) Associated Container ICD siding (Asaoti)

Associated Container Siding is located at 6.4 kms from Asaoti Railway Station towards Hazrat Nizamuddin. Major inward rakes are coming from MDCC, JNPT.

The traffic handled by this ICD is listed below:

Table 4-23 Total rail traffic handled by Associated Container ICD

Commodity	No. of Rakes (2017-18)		No. of Rakes (2018-19)	
	Inward	Outward	Inward	Outward
Containers	350	350	245	273

c) Boxtrans Logistics Pvt Ltd. ICD, Sonipat

M/S Boxtrans Logistics Pvt Ltd Container Depot is Located at 4.5kms from Ganaur Railway Station. Traffic handled by this depot is around 60 rakes per month Inward

and Outward. About 60% of rakes are coming from MDCC and 40% are coming from Pipavav.

The traffic handled by this ICD is listed below:

Table 4-24 Total rail traffic handled by Box Trans Logistics ICD

Commodity	No. of Rakes (2018-19)	
	Inward	Outward
Container	573	573

d) Adani Logistics Pvt Ltd. ICD, Patli

M/S Adani Logistics Pvt Ltd Depot is located at Patli Railway Station. About 72% of rakes are coming from MDCC and 19% from Pipavav and outgoing rakes is same. It handles approximately 45 rakes per month Inward and Outward.

The traffic handled by this ICD is listed below:

Table 4-25 total rail Traffic handled by Adani Logistics ICD, Patli

Commodity	No. of Rakes (2018-19)	
	Inward	Outward
Container	493	352

e) Gateway Rail Freight Limited, Garhiharsaru

M/s. Gateway Rail Freight Limited Depot is Located at 1.85 km from Garhi Harsaru junction, around 45% of inward rakes are coming from JNPT and 24% are from MDCC, PPSP (Pipavav Siding). Traffic handled at the Depot is around 220 rakes per year Inward and Outward.

The traffic handled by this ICD is listed below:

Table 4-26 Total rail traffic handled by Gateway Rail Freight Limited ICD, Garhiharsaru

Commodity	No. Of rakes (2017-18)		No. Of rakes(2018-19)	
	Inward	Outward	Inward	Outward
Container	221	231	218	234

f) Tughlakabad ICD

Tughlakabad ICD (Inland Container Depot) is located at 1 km from Tughlakabad station towards Hazrat Nizamuddin. This ICD serves for International Exports and Imports. About 50% of inward containers are from JNPT and 50% are from Mundra Port (MDCC). The traffic dealt by this ICD is listed below:

Table 4-27 Total rail traffic handled by Tughlakabad ICD

Commodity	2017-2018		2018-2019	
	Inward	Outward	Inward	Outward
Containers	2701	2788	2277	2289

g) Okhla ICD

Okhla ICD is located at 1.5 km from Okhla station towards Hazrat Nizamuddin. The inward container traffic is majorly from JNPT. Approximately 1500 rakes per year is handled by Okhla ICD.

The month wise details of traffic dealt by ICDs, CFS and Goods station sidings are given in Annexure-IV(D).

Thermal Power Plants

There are 12 Thermal power plants in Haryana, Punjab and Rajasthan. All Power plants are having sidings and are using coal as raw material and coming to the plant through rail.

Thermal power plant located in Haryana, Punjab and Rajasthan states are as below.

Table 4-28 Thermal Power Plant in Haryana, Punjab and Rajasthan

S.N	State	Plant	Place	Capacity (MW)	Operated By
1	Haryana	Deenbandhu Chhotu Ram TPP	Yamunanagar	600	HPGCl
2		Panipat Thermal Power Station I	Panipat	1370	HPGCl
		Panipat Thermal Power Station II	Panipat	920	HPGCl
3		Faridabad Thermal Power Plant	Faridabad	430	HPGCl
4		Rajiv Gandhi Thermal Power Station	Hisar	1200	HPGCl
5		Indira Gandhi Super Thermal Power plant	Jhajjhar	1500	APCPL/NTPC
6	Punjab	Guru Hargobind Thermal Plant (GHTP)	LehraMohabbat,Bhatinda	920	PSPCL
7		Guru Nanak Dev Thermal Plant (GNDTP)	Bhatinda	460	PSPCL
8		Guru Gobind Singh Super Thermal Power Plant (GGSSTP)	Ropar	1260	PSPCL
9		Goindwal Thermal Power Station	Goindwal	540	GVK
10		Talwandi-Sabo Thermal Power Plant	Talwandi-Sabo	1980	Vedanta
11		Rajpura Thermal Power Plant	Rajpura	1400	L&T Power
12	Rajasthan	Suratgarh Super Thermal Power Plant	Suratgarh	1500	RRVUNL

The coal for power plants is sourced from Bihar, West Bengal, Chhattisgarh, Jharkhand and Madhya Pradesh, etc.

Existing Rail freight traffic through Delhi area

The existing loaded freight trains running on various sections of Delhi Division i.e. Shakurbasti- Rohtak (SSB-ROK), Adarsh Nagar - Panipat (ANDI-PNP), Palwal - Tuglakabad (PWL-TKD) etc. sections were analyzed from FOIS train data. For calendar year 2018, total freight traffic moving on SSB - ROK and ANDI – PNP is shown in the table below.

Table 4-29 Existing Freight traffic moving on SSB-ROK and ANDI-PNP sections

S.No.	Section	Direction	Trains /year	MMT/Year
			2018	2018
1	SSB-ROK	SSB-ROK	5447	20.12
		ROK-SSB	3303	9.38
2	ANDI-PNP	ANDI-PNP	4994	15.66
		PNP-ANDI	4014	10.74

Source: FOIS train data

Broad commodity wise details of traffic in terms of number of trains and tonnage on SSB-ROK and ANDI-PNP Sections are shown in the table below.

Shakurbasti – Rohtak (SSB-ROK) Section

UP Direction (SSB-ROK)

Table 4-30 Commodity wise details of existing freight traffic SSB-ROK direction

Commodity	No. of Trains(2018)	MMT/ Year(2018)
Coal	4209	16.77
Container	618	1.69
Fertilizer	310	0.87
Iron & steel	94	0.26
Oil & gas	71	0.18
Imported fertilizer	68	0.21
Jute manufactured	43	0.03
Others	34	0.01

Source: FOIS train data

Down Direction (ROK-SSB)

Table 4-31 Commodity wise details of existing freight traffic ROK-SSB direction

Commodity	No. of Trains (2018)	MMT/ Year
Food grain	2007	5.79
Container	1157	3.11
Stone	74	0.30
Oil & gas	23	0.05
Edible oil in tank wagon	17	0.04
Others	25	0.07

Source: FOIS train data

It can be observed that the major commodities transported by rail in SSB-ROK section are coal, container and food grain. 77% of trains running in the SSB-ROK direction are carrying coal and 11% trains are carrying container. Whereas in the ROK-SSB direction 61% of trains carry food grains and containers are carried by 35% of trains.

Adarsh Nagar - Panipat (ANDI-PNP) Section

UP Direction (ANDI-PNP)

Table 4-32 Commodity wise details of existing freight traffic ANDI-PNP direction

Commodity	No. of Trains (2018)	MMT/ Year
Coal	1922	7.69
Container	939	2.56
Oil & gas	755	1.63
Iron & steel	551	1.56
Fertilizer	374	1.07
Jute manufactured	125	0.10
Imported fertilizer	123	0.40
Imported coal	43	0.17
Chemicals salt	42	0.14
Food grain	36	0.10
Others	84	0.23

Source: FOIS train data

Down Direction (PNP-ANDI)

Table 4-33 Commodity wise details of existing freight traffic PNP-ANDI direction

Commodity	No. of Trains (2018)	MMT/ Year
Food grain	2046	5.87
Container	1004	2.67
Mixed	373	0.99
Oil & gas	251	0.59
Automobiles	163	0.24
Cement	146	0.3
Others	31	0.09

Source: FOIS train data

It can be observed that the major commodities transported by rail on section ANDI-PNP are coal, container and food grain. Around 38% of trains running on the ANDI-PNP direction are carrying coal and 18% trains are carrying container. Whereas, on PNP-ANDI direction 51% of trains carry food grains and containers are carried by 25% of trains.

Major origin and destination points of different commodity captured in the FOIs data is illustrated in the table below.

Table 4-34 Major origin and destination points of different commodity

Commodity	Station From	Station To
Automobile	Manesar,Farukhnagar, Chandigarh etc.	Nidvanda, Guwahati, Bhubaneshwar etc.
Cement	M/s.Vikram Cement Siding - Nimbahera (VCSN), Wonder Cement Siding- Chittorgarh, Ultratech Cement Siding- Shambhupura& Chittorgarh, Ambuja cement siding - Roopnagar etc.	Gurgoan, Ghaziabad, etc.
Coal	Gevera Project Junadih Colliery (GPCK)-Korba, M/s. Sarguja Rail Corridor Pvt. Ltd. (PSRS)-Surajpur, Belpahar Open Cast Mines (BOMB) etc.	Suratgarh Thermal Power plant Siding, M/S Nabha Power Ltd.Siding (NPSB), M/S Talwandi Sabo Power Ltd. (MTSS), M/S Jhajjhar Power Plant,etc.
Container	Gateway Distrid Parks Ltd Siding (GDGH)-Garhiharsaru, Box Trans Logistics Pvt Ltd, Sonipat, Sanahwal (SNL), MDCC etc.	Ports on Western Coastal Area
Fertilizer	Roza Jn, CFCL-BON (Guwahati) etc.	Kurukshetra Jn, Bhagtanwala (BGTN), Jalandhar City Jn. (JUC), Kaithal (KLE)
Steel	Visakhapatnam Steel Plant Siding, Bokaro Steel Plant (BSCS), JSW Steel Plant etc.	Dhandari Kalan (DDL), Satrod (STD), Chandigarh (CDG)
POL	OIL REFINERY SIDING (ICB)-Panipat, HPC SIDING (HPCA)-Asaudah India Oil Refinery Siding (IORG), Bharat Petroleum Ltd., ASOTI, BPCL SDG. AT URAN (MBPP)	IOC SIDING, LKU (LIOC), HPCL SIDING (HPCM), IOC SIDING-MANGLIAGAON (IOCM) OIL REFINERY SIDING (ICB), LPG BOTTLING PLANT, LLU (LPBP), Jammu Tawi (JAT)

Source: FOIS train data

Stakeholder outreach on Haryana Orbital Rail Corridor Project

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) has hosted an outreach event to the stakeholders on 13-02-2019 at Gurgaon to deliberate on the "Haryana Orbital rail Corridor Project from Palwal to Sonipat" with a key objective of providing boost to Rail Infrastructure projects in the Haryana state on the principle of cooperative federalism and emphasizing on opportunities for investors and stakeholders

The event was a great success with great number of stakeholders and investors turned up and showed their interest to invest in the project. Major highlights of the event are as below.

- M/s Maruti Udhyog Ltd have confirmed participation in the project SPV as Equity partner.
- M/s AllCargo has also shown keen interest to participate in this project and they will revert shortly after due deliberations in their BOD.
- This event has generated a lot of interest among various stakeholders and Investors.
- Railway Board & Northern Railway officials have also commended the idea of the proposed Haryana Orbital Rail Corridor.

4.18 Future Freight Traffic Forecast

Project Alignment Traffic Facility

The following are the proposed stations for the proposed Haryana Orbital Rail Corridor (HORC).

Table 4-35 Proposed stations with chainages and inter block distance for HORC

S.No	Name of Station	Approx. Distance from Pirthala in m	Inter Station Distance in m	Remarks
1	NEW PALWAL	0	-	Crossing/ Junction Stations
2	SILANI	6506.0	6506.0	
3	SOHNA	11977.0	5471.0	
4	DHULAWAT (TAURU)	28846.0	16869.0	
5	CHANDLA DUNGERWAS	39450.0	10604.0	
6	MANESAR	48593.0	9143.0	
7	NEW PATLI	54700.0	6107.0	
8	BADSA	61957.0	7257.0	
9	DEVERKHANA	67806.0	5849.0	
10	BADLI	77027.0	9221.0	
11	MANDOTHI	83808.0	6781.0	
12	JASAUR KHERI	97103.0	13295.0	
13	KHARKORDA KIRHOLI	105885.0	8782.0	
14	TARAKPUR	110948.0	5063.0	
15	HARSANA KALAN	121742.0	10794.0	Existing

The serving stations for the connectivity shall be

- Pirthala station on the Rewari-Dadri section of Dedicated Freight Corridor having connectivity to both Asaoti and Palwal with Y-connectivity.

The Existing connectivity's on IR

- Patli Station on Delhi-Rewari section of Northern Railways
- Sultanpur Station on GarhiHarsaru- Farukhnagar section of Northern Railways
- Asaudah Station on Delhi -Rohtak section of Northern Railways
- Harsana Kalan on Delhi-Panipat Section of Northern Railways

Line capacity of the project line

Line capacity of a section represents the maximum number of trains that can be passed over the section from 00 hrs to 24 hrs without reducing the speed considerably.

For the calculation of Line capacity of the proposed HORC, following methodology was followed.

Scott's Formula

$$Line\ Capacity\ (No.of\ trains) = \frac{1440\ (minutes\ per\ day)}{T+t} * \frac{70}{100}$$

Where,

- T – Running time of the slowest moving train on lengthiest / ruling section of the Line.
- t – time in minutes normally required for block operation.
- The 70% factor is an efficiency factor which accounts for the impossibility of regular distribution of the trains over a day, as it is not possible to run trains strictly one after the other, which is assumed while arriving at the theoretical line capacity.

For the proposed HORC following details are applicable:

- Ruling section will be the section with longest distance between consecutive stations. For the proposed railway route this section is between the stations Sohna and Dhulawat.
- The Speed of slowest moving freight train is assumed to be 60.
- The value of "t" is assumed to be 2 minutes. This is taken as the trains on the proposed stations shall be worked on token-less system. The authority to enter section will be through advance starter signal provided at station locations.

Line capacity calculation parameters as per Scott formula for the proposed HORC is as below.

Table 4-36Line capacity calculation parameters for the proposed HORC

Crossing Station	Chainage (m)	Section Length (m)	Speed of slowest moving train (kmph)	Section Travel Time T(min)	t(min)
Sohna	11977.0		60	16.869	2
Dhulawat	28846.0	16869.0			2

The line capacity of the proposed HORC is shown below.

Table 4-37 Line capacity of the proposed HORC

Line	Withoutmaintenanceblock	With 2 hr.maintenanceblock

Double	54	49
Single	27	25

The estimated line capacity of double line is 54 trains per direction per day without maintenance block and 49 trains per direction per day with 2-hour maintenance block. Whereas, line capacity for single line is 27 trains per direction per day without maintenance block and 25 trains per direction per day with maintenance block of 2-hours.

The section wise capacity estimation of proposed HORC is shown in Annexure-IV(E).

Industrial activities in project influence area and train requirement for future needs

Maruti Suzuki Limited (MSIL)

Maruti Suzuki has three manufacturing facilities in India. All manufacturing facilities have a combined installed production capacity of 17,00,000 vehicles annually. The Manesar manufacturing plant was inaugurated in February 2007 and is spread over 600 acres. Initially it had a production capacity of 1,00,000 vehicles annually, but this was increased to 3,00,000 vehicles annually in October 2008. The production capacity was further increased taking total production capacity to 8, 00,000 vehicles annually.

The forecast of MSIL traffic is considered from Final Report, Traffic Estimation & Financial analysis of New Palwal -Manesar line and is discussed in subsequent paragraphs as below.

The current production capacity for Gurugram and Manesar Plant combined is 16, 00,000 vehicles and by 2022-23, 30% of the total production capacity is planned to be dispatched through railways from the proposed private MSIL siding on the project corridor.

The Traffic planned to originate/destine from MSIL Plant in Manesar by rail is as follows.

Table 4-38 Traffic planned to originate/destine from MSIL Plant in Manesar by rail

S.No	Company	In/Out	2015-16	2016-17	2017-18	2018-19	2023-24
1	Maruti Suzuki Ltd	Out (Cars)	76,000	88,000	1,10,000	1,35,000	4,80,000
2	Maruti Suzuki Ltd	In (Cars)	n/a	n/a	n/a	n/a	1,00,000

Source: Final Report - Traffic Estimation & Financial analysis of New Palwal -Manesar Line.

Table 4-39 Projected Traffic from MSIL Plant in Manesar by rail (In Units)

Company	Commodity	Wagon	Units	Origin	Destination	In/ Out	FY21	FY25-FY 48 (Per Annum)
MSIL	CBUs	BCACBM	In Units	Manesar	Across India	Out	3,00,000	4,80,000
MSIL	CBUs	BCACBM	In Units	Ahmedabad	Manesar	In	1,00,000	1,00,000

Source: Final Report – Traffic Estimation & Financial analysis of New Palwal -Manesar Line.

Total Projected traffic for Maruti Suzuki for horizon years is as below.

Table 4-40 Projected Traffic of Maruti Suzuki by rail (MSIL)

	Unit	FY 21	FY26	FY31	FY36	FY41	FY46
Outbound Cars	Nos.	3,00,000	4,80,000	4,80,000	4,80,000	4,80,000	4,80,000
Inbound Cars	Nos.	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000	1,00,000
Raw Material- Steel	MT	30,000	30,000	30,000	30,000	30,000	30,000
Raw Material - Car Components	TEUs	13,500	13,500	13,500	13,500	13,500	13,500

Source: Final Report - Traffic Estimation & Financial analysis of New Palwal -Manesar Line.

The inward traffic (Raw material) to Manaser plant is from Mundra and Pipavav.

The outward traffic from Manesar plant will move to all regions of the country. Following table shows a distribution of traffic originating from MSIL for projection year 2022-23.

Table 4-41 Traffic movement distribution for MSIL Traffic

Direction	Station	Percentage	Lead (Km)	Cars
South	NDV	40%	2365	1,92,000
West	GIMB	10%	995	48,000
West	BCT	10%	1395	48,000
North East	GHY	15%	1864	72,000
West	DRJ	20%	1373	96,000
East	BBS	5%	1698	24,000
Weighted Average (Km)			1824 Km	

Source: Final Report – Traffic Estimation & Financial analysis of New Palwal -Manesar Line

Traffic towards South, East and North East will move through proposed railway line.

The Manesar-Patli and New Patli-Patli connection on the rail corridor would be used to carry west bound traffic including traffic from MSIL (Maruti Udyog).

Total train requirement (318 car units per rake BCACBM wagon) for MSIL considering for horizon years are as follows:

Table 4-42 Train requirement for MSIL

Trains/day

Financial Year	Outward traffic (Car Unit/year)	Total trains	No. of trains on project section			
			South Direction	North East Direction	East Direction	Total
2023	300,000	2.58	1.03	0.39	0.13	1.55
2027	480,000	4.14	1.65	0.62	0.21	2.48
2032	480,000	4.14	1.65	0.62	0.21	2.48
2037	480,000	4.14	1.65	0.62	0.21	2.48
2042	480,000	4.14	1.65	0.62	0.21	2.48
2047	480,000	4.14	1.65	0.62	0.21	2.48
2052	480,000	4.14	1.65	0.62	0.21	2.48

Total approx. requirement of BCACBM wagon(1 BCACBM wagon = 12 Car Units) for MSIL considering for horizon years are as follows:

Table 4-43 Wagon requirement for MSIL

FinancialYear	No. of BCACBMWagons requiredper Day
2023	42
2027	67
2032	67
2037	67
2042	67
2047	67
2052	67

All cargo Logistic Limited

M/s. Reliance Haryana SEZ Limited (RHSL), a joint venture between Reliance Ventures Limited and HSIIDC along with IL&FS proposed to jointly develop an integrated economic enclave namely Model Economic Township (MET) consisting of industrial Parks, SEZs and supporting infrastructure such as private freight terminal (PFT) and other amenities in the district of Jhajjar in Haryana.

In order to meet the logistics requirements for industries in the integrated economic enclave M/s. All cargo proposes to setup a Private Freight terminal (PFT) with rail connectivity taking off from Farukhnagar Railway Station on GarhiHarsaru – Farukhnagar branch line of Delhi division.

The forecast of All Cargo Logistics traffic is considered from Validation Report, Proposed PFT siding Taking off from Faruukhnagr station and is discussed in subsequent paragraphs as below.

The traffic forecast of export/import of containerized commodities likely to be handled at the PFT in term of TEUs from 2016 to 2024 are as below.

Table 4-44 Traffic forecast of export/import from All cargo siding

TEU/year

FinancialYear	EXIM		Domestic	
	Inward	Outward	Inward	Outward
2016	10,605	10,605	3,530	3,530
2017	22,763	22,763	4,456	4,456
2018	31,466	31,466	5,513	5,513
2019	38,024	38,024	7,024	7,024
2022	43,987	43,987	10,623	10,623
2024	67,840	67,840	25,021	25,021

Source: Validation Report, Proposed PFT siding taking off from Farukhnagar station

The 90% of the above traffic will move towards southwest direction and rest 10% traffic will move towards north direction.

Total train requirement for All Cargo logistics considering 90 TEUs per rake for horizon years is as follows:

Table 4-45 Train requirement for All cargo logistics

Trains/day

FinancialYear	Southwestdirection		Northern Direction	
	Inward	Outward	Inward	Outward
2023	1.50	1.50	0.17	0.17
2027	2.54	2.54	0.28	0.28
2032	2.54	2.54	0.28	0.28
2037	2.54	2.54	0.28	0.28
2042	2.54	2.54	0.28	0.28
2047	2.54	2.54	0.28	0.28
2052	2.54	2.54	0.28	0.28

The approx. Wagon requirement for All cargo logistics considering (1 rake = 45 BRN wagon) for horizon years is as follows:

Table 4-46 Wagon requirement for All cargo logistics

Financial Year	No. of Rakesper Day	No. of BRN Wagonsper Day
2023	3.32	150
2027	5.65	255
2032	5.65	255
2037	5.65	255
2042	5.65	255
2047	5.65	255
2052	5.65	255

Traffic from Road to Rail Diversion

Traffic observed based on Origin Destination Surveys

Origin Destination surveys were conducted at various strategic locations as described in the previous sections. Based on the analysis from the O-D survey major commodities observed in PIA transported by road are Automotive, cement, container, Food grain, Fuel & Gas and Iron &Steel.

The following traffic has been observed along the proposed railway line.

Table 4-47 Commodity wise traffic moving via road likely to shift on rail

MMT/Year

S.No.	Commodity	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)
1	Automotive	0.58	0.53
2	Cement	0.38	0.37
3	Container	0.59	0.87
4	Food Grain	0.94	0.87
5	Fuel & Gas	0.43	0.36
6	Iron & Steel	0.62	0.44
Total		3.53	3.44

Growth Rate

Growth rates observed for the two entities i.e. Industrial sector and Agricultural and allied sector is calculated from the past data is as below.

Table 4-48 Growth rate observed for two entities i.e. Industrial sector and Agricultural and allied sector

S.No.	Sector	Growth (%)
1	Industrial sector	6.28%
2	Agricultureand Allied	8.81%

Criterion for Road to Rail diversion

A comparison of freight transport rates by road and by rail has been done for the present-day traffic (all of which moves by road) and the results are given below. For these calculations, Haulage Charge per TEU has been taken from Rates Circular No. 20 of 2018 (dated 31.10.2018) and for other commodities from Rates Master Circular/PCC/2015/0, GOI, MOR of Indian Railways and IRC SP: 30-2009 code for calculation of haulage rate by road. Net weight of a standard TEU is taken to be in the 20-26 tonnes slab as per Rates Circular No. 20 of 2018 (dated 31.10.2018).

Table 4-49 Comparison of haulage charges by rail and road

Item	Distance (km)	Freight Rates (Rs.)				
		Container	Iron or Steel	FG	POL	Cement
		Per TEU	Per Tonne			
Rail	300	7,845	540	426	589	458
Road		19,512	735	735	735	735

% Difference		59.79%	26.53%	42.11%	19.85%	37.66%
Rail	500	11,937	875	689	954	742
Road		32,520	1,225	1,225	1,225	1,225
% Difference		63.29%	28.60%	43.75%	22.11%	39.42%
Rail	1000	22,168	1,682	1,326	1,835	1,427
Road		65,040	2,450	2,450	2,450	2,450
% Difference		65.92%	31.33%	45.90%	25.09%	41.74%

It is observed that the difference in haulage charges by road as compared to rail increases as the lead (km) increases as shown in the above table. However, the tendency to carry containers by rail for short distances seems unlikely although the cost is less. Therefore, the criteria for diversion of Freight traffic from road to rail is assumed based on the lead (km) for the trip. If the lead of the trip is more than 300 Km, it is considered that 20% of road traffic is likely to shift to rail.

Table 4-50 Traffic shift from road to rail

MMT/year

S.No.	Commodity	UP (Palwal toHarsanakalan)	DN (Harsanakalan to Palwal)
1	Automotive (Container)	0.12	0.11
2	Cement	0.08	0.07
3	Container	0.12	0.17
4	Food Grain	0.19	0.17
5	Fuel & Gas	0.09	0.07
6	Iron & Steel	0.12	0.09
Total		**0.71**	**0.69**

Train Requirement for handling traffic shifted from Road to Rail

Growth rate considered for the forecasting of road to rail diverted traffic is 6.28% and 8.81% for agricultural and Industrial sector respectively as shown in the previous section.

The train requirement for handling traffic shifted from road to rail is as below.

Table 4-51 Train requirement for handling traffic shifted from road to rail

Financial Year	MMT/Year		Trains/day	
	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)
2023	0.97	0.94	0.99	0.95
2027	1.43	1.40	1.48	1.42
2032	2.13	2.08	2.21	2.13
2037	3.17	3.11	3.32	3.20
2042	4.74	4.64	4.99	4.81

Financial Year	MMT/Year		Trains/day	
	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)
2047	7.09	6.96	7.50	7.24
2052	10.63	10.44	11.30	10.91

The approx. wagon requirement for handling traffic shifted from road to rail is as below.

Table 4-52 Commodity wise Wagon type and rake sizes

S.No.	Commodity	Wagon Type	Wagon per rake
1	Cement	BCN	41
2	Container	BRN	45
3	Food Grain	BCNHL	58
4	Fuel & Gas	BTPN	48
5	Iron & Steel	BOXN	59

Table 4-53 Wagon requirement for handling traffic shifted from road to Rail

Year	No. of Wagons per Day				
	BRN	BCN	BCNHL	BTPN	BOXN
2023	34	10	21	13	23
2027	51	14	28	19	35
2032	77	22	38	29	54
2037	118	33	51	43	82
2042	179	50	69	66	125
2047	272	76	94	100	190
2052	414	115	127	152	289

Traffic by means of diversion from existing Indian railway routes in and around Delhi

Divertible traffic from Existing Indian Railway

Divertible traffic has been calculated based on the Origin-Destination of the traffic moving through the following sections:

Section	Name
AND-PNP	Adarsh Nagar-Panipat
DEC-REW	Delhi Cantt – Rewari
GZB-SBB	Ghaziabad- Sahibabad
PWL-TKD	Palwal-Tughlakabad
REW-SNP	Rewari-Sonipat
ROK-SSB	Rohtak-Shakur Basti

Majority of the divertible freight traffic consists of trains on from Delhi-Rohtak section and Delhi-Panipat sections which are presently using the Lajpat Nagar- Patel Nagar

section (Delhi-Avoiding Line), Tuglakhabad- Hazrat Nizamuddin (Goods Avoiding Line) and the Delhi-Cantt. -Patel Nagar (North Line). The proposed Haryana Orbital Rail Corridor (HORC) will connect existing Delhi-Palwal, Delhi-Rewari, GhariHarsaru-Farukh Nagar, Delhi-Rohtak and Delhi-Panipat Railway lines. Proposed HORC will reduce the dependence of freight trains on DAL, GAL and NL which will allow these lines to be used for the much-awaited Ring Railway of Delhi which will cater to the growing passenger travel needs of Delhi.

Data from FOIS, for the year 2018, was analyzed in detail and traffic moving through Delhi entering and exiting from one of the sections mentioned in the table above. Total number of trains which could be diverted onto proposed HORC in 2018 is shown in figure below. Coal (5,497), Food Grains (2,164), Container (1,891) and Petroleum & Oil (1,110) carrying trains form the majority in the divertible traffic.

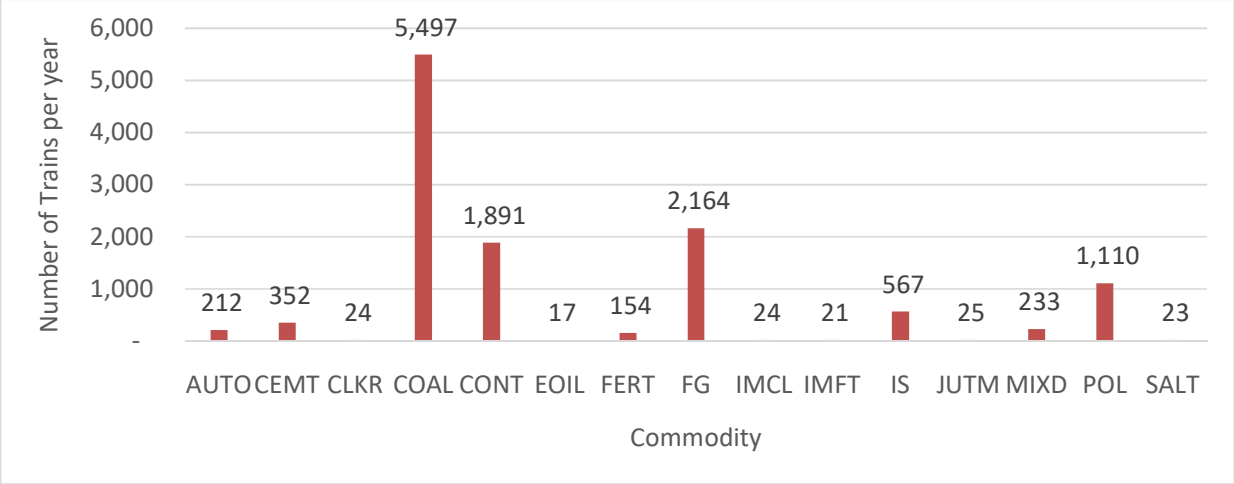


Figure 4-4 Commodity wise number of divertible trains during the year 2018

Based on the total tonnage of the divertible traffic, in 2018, Coal (55.08%), Food Grains (15.08%) and Containers (12.43%) form more than 70% of all divertible traffic. This is presented in the figure below.

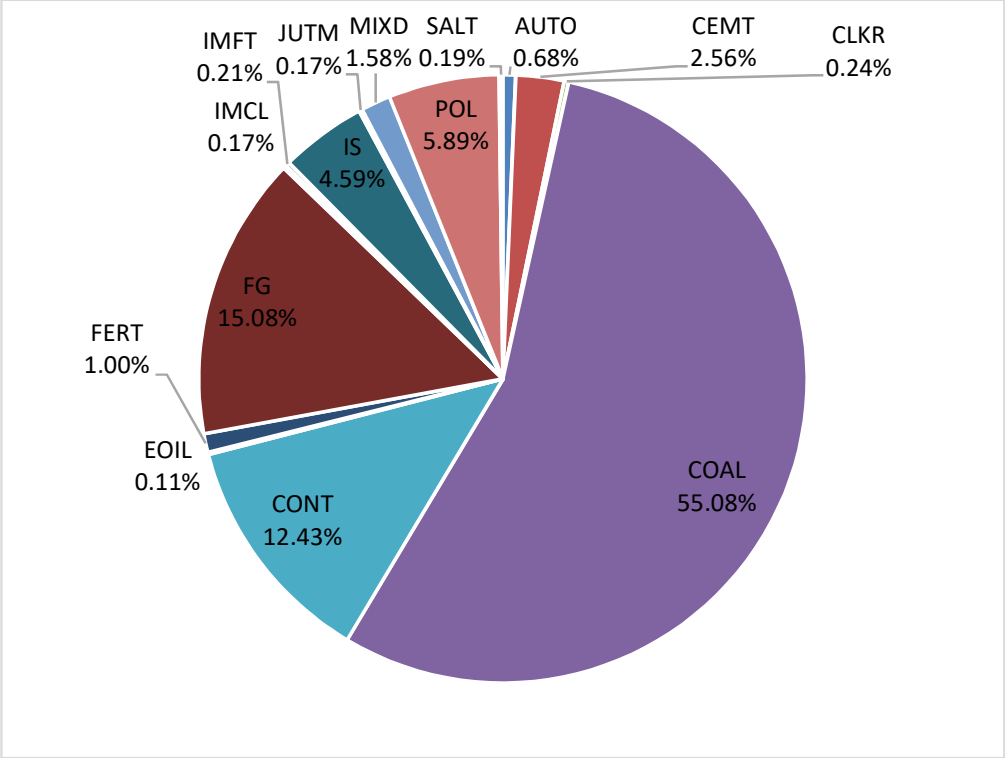


Figure 4-5 Distribution of Commodities from the divertible traffic based on Tonnage

Impact of traffic diversion

The length of the route from Palwal to Harsanakalan and Palwal to Asaudah via existing rail network through Delhi and via proposed HORC is shown in the table below.

Table 4-54 Route length comparison via Delhi and HORC

Section	Line	Distance (Km)
Palwal to Harsana Kalan	Existing Network	104
	HORC	122
	Difference	18
Palwal to Asaudah	Existing Network	100
	HORC	110
	Difference	10

There is a difference of 18 km in route length from Palwal to Harsanakalan and 10 km of route length from Palwal to Asaudahrespectively from existing rail network via Delhi and Via HORC.

A comparison of haulage rates for 1,000 to 1,300 Km of lead for different commodities is shown in the table below.

Table 4-55 Haulage charges of container traffic by rail

Commodity	Distance (Km)	1001-1050	1051-1100	1151-1200
Container	Haulage Rate per TEU (Rs.)	22,168	23,191	25,237
	Difference (Rs.)		1,023	1,023
	Haulage Rate per Train (lakh Rs.)	19.95	20.87	22.71
	Difference (Lakh Rs.)		0.92	0.92
	% Difference		4.61%	4.22%

Table 4-56 Haulage charges for Bulk traffic by rail

Commodity	Distance (Km)	1001-1100	1101-1200	1201-1300
Coal	Rate per Tonnage (Rs.)	1,478.40	1,607.60	1,736.20
	Difference (Rs.)		129.20	128.60
	Rate per Train (Lakh Rs.)	57.57	62.60	67.61
	Difference (Lakh Rs.)		5.03	5.01
	% Difference in Rate		8.74%	8.00%
Iron or Steel	Rate per Tonnage (Rs.)	1,682.30	1,829.40	1,975.70
	Difference (Rs.)		147.10	146.30
	Rate per Train (Lakh Rs.)	47.02	51.13	55.22
	Difference (Lakh Rs.)		4.11	4.09
	% Difference in Rate		8.74%	8.00%
Food Grain	Rate per Tonnage (Rs.)	1,325.50	1,441.30	1,556.60
	Difference (Rs.)		115.80	115.30
	Rate per Train (Lakh Rs.)	35.6	38.7	41.8
	Difference (Lakh Rs.)		3.11	3.10
	% Difference in Rate		8.74%	8.00%
POL	Rate per Tonnage (Rs.)	1,835.30	1,995.70	2,155.30
	Difference (Rs.)		160.40	159.60
	Rate per Train (Lakh Rs.)	47.82	52.00	56.16
	Difference (Lakh Rs.)		4.18	4.16
	% Difference in Rate		8.74%	8.00%
Cement	Rate per Tonnage (Rs.)	1427.4	1552.2	1676.4
	Difference (Rs.)		124.80	124.20
	Rate per Train (Lakh Rs.)	36.87	40.09	43.30
	Difference (Lakh Rs.)		3.22	3.21
	% Difference in Rate		8.74%	8.00%

As most of the bulk commodities are moving presently via Delhi have a lead of more than 1000 Km, the impact on the haulage charges for diverted traffic via HORC will not be significant as the rate slab is changing at every 50 km lead difference as shown in the above table and the maximum difference in route km is 18 km only.

A bulk of all freight traffic moving through Delhi getting diverted to HORC thus allow existing rail network to be used to cater to passenger traffic demand of Delhi NCR for running more commuter services.

Growth Rates

Based on analysis of the FOIS data, the average growth rate (CAGR) of the all traffic was calculated for each commodity separately. Growth Rates for the Commodities were calculated based on the FOIS data 2014-2018 are as below. Although some commodities have a high growth rate (CAGR), their growth has been capped to the average growth all divertible traffic which is 4.32%. Growth of Cement, Container and Food Grain is lower than the average CAGR of 4.32%. However, to give a conservative forecast, as these are the major commodities from the divertible traffic, actual CAGR for these commodities have been considered for future forecasts in order to avoid over-estimation of traffic. Growth of Domestic Coal and Imported Coal has been considered as 4.32% for the forecast and has been considered only till the horizon year 2032 as there may be no new requirement of coal for the power houses in Haryana and Punjab beyond 2032 unless new power plants are setup. However, for the existing power plants the requirement of coal is taken constant after the year 2032.

Table 4-57 CAGR considered for forecast of future divertible traffic

Commodity	Code	Actual CAGR	CAGR taken for forecasting
Cement	CEMT	0.99%	0.99%
Container	CONT	3.43	3.43%
Food Grain	FG	3.38%	3.38%
Coal	COAL	9.78%	4.32%
Automobile	AUTO	16.32%	4.32%
Cement Clinker	CLKR	20.36%	4.32%
Edible Oil	EOIL	39.33%	4.32%
Fertilizer	FERT	6.08%	4.32%
Imported Coal	IMCL	17.61%	4.32%
Imported Fertilizer	IMFT	30.76%	4.32%
Iron and Steel	IS	11.60%	4.32%
Jute Manufactured	JUTM	14.42%	4.32%
Mixed	MIXD	-9.08%	4.32%
Petroleum Oil and Lubricants	POL	-3.45%	4.32%
Salt	SALT	26.97%	4.32%

Total Freight Traffic in the Horizon years

The freight traffic has been forecasted based on the growth rates and assumptions mentioned in the previous paragraphs. The HORC has been divided into four major sections for the purpose of estimating future traffic. These sections are New Palwal-

Manesar, Manesar-Badsa, Badsa-Asaudah and Asaudah-Harsana Kalan considering the connectivity with existing railway lines. The freight trains have been forecasted for 30 years, considering 2023 as the first year of operation, for the horizon years 2027, 2032, 2037, 2042, 2047 and 2052. The forecast includes the diversion of freight from existing railway routes passing in and around Delhi, traffic expected due to future expansion of industries & logistics centers and by diversion from existing road-based modes to railways on proposed HORC.

The total tonnage and number of trains for the horizon years on proposed HORC is presented in the table below.

Table 4-58 Forecasted Tonnage and number of trains

Year	Trains per day				MMTPA
	Rail to Rail Diversion	Traffic from Industries	Road to Rail Diversion	Total	Total
2023	41.2	4.9	1.9	48.1	54
2027	48.4	8.1	2.9	59.5	67
2032	59.3	8.1	4.3	71.8	81
2037	66.2	8.1	6.5	80.9	89
2042	74.7	8.1	9.8	92.6	100
2047	85.0	8.1	14.7	107.9	115
2052	97.7	8.1	22.2	128.0	134

Rolling Stock requirements:

The traffic forecasted is mostly the diverted traffic Palwal-Delhi, LPNR-PTNR & touching local Delhi network. Hence the proposed section does not require any extra rolling stock for movement in the section. The new freight traffic generated in the proposed section like MSIL, All Cargo requires allotment of wagons for loading. The general type of wagons such as BCN, BOXN, BLC, BCNHL etc. will be supplied for loading based on the old date of registration. Special type of wagons like BCACBM for loading cars have to be procured by M/s MSIL with 4% spares depending upon the daily requirement of wagons along with BV.

Table below shows the forecasted freight trains for each commodity separately.

Table 4-59 Summary of Freight Trains for the horizon years

	Year	AUTO	CEMT	CLKR	COAL	CONT	EOIL	FERT	FG	IMCL	IMFT	IS	JUTM	MIXD	POL	SALT	TOTAL
Tonnage Per Year (Million Tonne)	2023	1.2	1.3	0.1	27.1	9.4	0.1	0.5	7.8	0.1	0.1	2.7	0.1	0.8	3.1	0.1	54
	2027	1.8	1.5	0.1	32.1	12.7	0.1	0.6	9.3	0.1	0.1	3.4	0.1	0.9	3.7	0.1	67
	2032	2.0	1.7	0.2	39.7	14.3	0.1	0.7	11.5	0.1	0.1	4.4	0.1	1.1	4.7	0.1	81
	2037	2.3	2.1	0.2	39.7	16.2	0.1	0.9	14.3	0.2	0.2	5.7	0.2	1.4	5.9	0.2	89
	2042	2.7	2.6	0.3	39.7	18.7	0.1	1.1	17.8	0.2	0.2	7.5	0.2	1.7	7.5	0.2	100
	2047	3.3	3.3	0.3	39.7	21.9	0.2	1.4	22.1	0.2	0.3	10.0	0.2	2.1	9.6	0.3	115
	2052	4.1	4.4	0.4	39.7	26.0	0.2	1.7	27.5	0.3	0.3	13.5	0.3	2.6	12.3	0.3	134
Trains Per Year	2023	943	451	30	6,791	3,604	21	190	2,801	30	26	842	31	288	1,463	28	17,539
	2027	1,391	508	35	8,042	4,857	25	225	3,340	35	31	1,046	37	341	1,764	34	21,710
	2032	1,556	593	43	9,935	5,449	31	278	4,147	43	38	1,355	45	421	2,219	42	26,196
	2037	1,787	713	54	9,935	6,192	38	344	5,151	54	47	1,769	56	520	2,803	51	29,514
	2042	2,112	885	66	9,935	7,134	47	425	6,402	66	58	2,331	69	643	3,558	63	33,796
	2047	2,576	1,138	82	9,935	8,346	58	525	7,962	82	72	3,103	85	794	4,539	78	39,374
	2052	3,244	1,514	101	9,935	9,928	72	648	9,906	101	88	4,172	105	981	5,826	97	46,719
Trains Per Day	2023	2.6	1.2	0.1	18.6	9.9	0.1	0.5	7.7	0.1	0.1	2.3	0.1	0.8	4.0	0.1	48
	2027	3.8	1.4	0.1	22.0	13.3	0.1	0.6	9.1	0.1	0.1	2.9	0.1	0.9	4.8	0.1	59
	2032	4.3	1.6	0.1	27.2	14.9	0.1	0.8	11.4	0.1	0.1	3.7	0.1	1.2	6.1	0.1	72
	2037	4.9	2.0	0.1	27.2	17.0	0.1	0.9	14.1	0.1	0.1	4.8	0.2	1.4	7.7	0.1	81
	2042	5.8	2.4	0.2	27.2	19.5	0.1	1.2	17.5	0.2	0.2	6.4	0.2	1.8	9.7	0.2	93
	2047	7.1	3.1	0.2	27.2	22.9	0.2	1.4	21.8	0.2	0.2	8.5	0.2	2.2	12.4	0.2	108
	2052	8.9	4.1	0.3	27.2	27.2	0.2	1.8	27.1	0.3	0.2	11.4	0.3	2.7	16.0	0.3	128

The section-wise number of trains has been forecasted based on the Origin-Destination pairs of the freight traffic on Proposed HORC and is presented in the table below.

Table 4-60 Section wise forecast of Freight Trains

Financial Year	Direction	Pirthala-Manesar	Manesar-Badsa	Badsa-Asaudah	Asaudah-Harsana Kalan
2023	Up	26.5	24.7	24.8	14.5
	Down	14.2	13.5	12.1	8.5
2027	Up	32.4	30.3	29.7	17.4
	Down	18.3	16.9	14.5	10.3
2032	Up	39.8	37.1	36.8	21.7
	Down	21.6	20.5	18.1	12.9
2037	Up	42.7	40.9	40.9	25.3
	Down	25.9	25.2	22.7	16.2
2042	Up	46.5	45.8	46.3	30.0
	Down	31.4	31.1	28.5	20.6
2047	Up	51.8	52.4	53.3	36.2
	Down	38.6	38.9	36.2	26.4
2052	Up	58.9	61.1	62.6	44.5
	Down	48.2	49.1	46.3	34.1

4.19 Traffic Diversion to and from DFCCIL

Traffic Diversion to DFCCIL from HORC

a) Total rail traffic handled by Hind terminal ICD, Palwal

Hind terminal is located at 6 kms from Palwal railway station towards Hazrat Nizamuddin. Major Inward Rakes are from JVSL, Jamshedpur and outward rakes are towards MDCC (Mundra Port Cargo Complex), JNPT (Jawaharlal Nehru Port Trust). Major Commodities are Iron, Milk and Containers.

The traffic handled by rail is listed below:

Table 4-61 Rail traffic handled by Hind terminal ICD, Palwal

Commodity	No. of rakes(2018-2019)		Source/Destination	
	Inward	Outward	Inward	Outward
Iron	222	-	Jamshedpur	
Milk	104	-	Palanpur	
Containers	231	231	MDCC, JNPT	MDCC, JNPT
Total	557	231		

Total rail traffic handled by Hind terminal towards Ports is listed below:

Table 4-62 Rail traffic handled by Hind terminal towards Ports from Palwal side

Commodity	No. of rakes (2018-2019)		Source/Destination	
	Inward	Outward	Inward	Outward
Milk	104	-	Palanpur	
Containers	231	231	MDCC, JNPT	MDCC, JNPT
Total	335	231		

b) Total rail traffic handled by Box Trans Logistics ICD, Sonipat

M/s.Boxtrans Logistics Pvt Ltd Container Depot is Located at 4.5kms. from Ganaur Railway Station. Traffic handled by this depot is around 60 rakes per month Inward and Outward. About 60% of rakes are coming from MDCC and 40% are coming from Pipavav.

The traffic handled by this ICD is listed below:

Table 4-63 Rail traffic handled by M/S Boxtrans Logistics Pvt Ltd

Commodity	No. of Rakes (2018-19)		Source/Destination
	Inward	Outward	
Container	573	573	Mundra (60%), Pipvav (40%)

c) Traffic from Manesar (MSIL)

Traffic from Manesar Plant is towards Guwahati (GHY) and Bhubaneshwar (BBS) will be 0.5 rakes per day in the year 2023 and 0.83 rakes per day after 2023.

d) Total Traffic to DFC from HORC

Total traffic diversion to DFCCIL from HORC is as below.

Table 4-64 Total Traffic diversion to DFCCIL from HORC

FinancialYear	Port Traffic		MSIL Traffic	Total
	FromPorts	TowardsPorts	EastDirection	
2023	2.85	2.52	0.52	6
2027	3.37	2.98	0.83	7
2032	3.99	3.53	0.83	8
2037	4.72	4.18	0.83	10
2042	5.59	4.95	0.83	11
2047	6.62	5.86	0.83	13
2052	7.83	6.93	0.83	16

Traffic Diversion from DFC

a) Traffic from DFC to HORC via Dadri at Pirthala

The Traffic diversion from DFC to HORC is of coal traffic which will be coming via eastern DFC to Pirthala via Dadri to Power Plants located in Northern India. Major Origins and Destinations of Coal trains are as below.

Major Origins	Major Destinations
In-Plant Yard of M/s. Sarguja Rail Corridor Pvt,Belpahar Open Cast Mines No. 6, Gevera Project Junadih Colliery, Deepika Siding of SECL,DudhichuaWharfwallSdg, Hind Energy&Coal Benefication (I) Ltd, Birds Sonda Colliery Siding, Gatora,Belpahar Open Cast Maines 1 and 2, ChuriSdg, RAY, KKC Link, Belpahar Open Cast Mine III, M/s.ACB (India) Ltd. siding, Anaanta Colliery Siding, Bina Wharfwall Siding, K D Heslong Siding etc.	SURATGARH THERMAL PWR SDG, M/s Nabha Power Siding, M/s.Jhajjhar Power Plant, M/s. Talwandi Sabo Power Ltd., PTPP SIDING, Rajiv Gandhi Thermal, Power Plant, Khedar, etc.

Total traffic diversion from DFC to HORC is below.

Table 4-65 Total traffic diversion from DFCCIL to HORC

Financial Year	Trains/Day
2023	17
2027	22
2032	27.2
2037	27.2
2042	27.2
2047	27.2
2052	27.2

4.20 Future Passenger Traffic Forecast

The Passenger traffic demand forecast is based on conventional method of actual census of particulars of passengers in the project influence area. It is assumed that proposed line will be operational by financial year 2023.

4.21 Growth Rate

Population projection for the districts of Haryana Sub-Region for the year 2011 and 2021 as given in the Sub Regional Plan for Haryana Sub-Region of NCR-2021 is shown in the table below.

Table 4-66 Population projection of the Haryana Sub-Region for 2021

District	Population	
	2011	2021
Panipat	1,189,692	1,411,935
Sonipat	1,507,780	1,736,385
Rohtak	1,084,502	1,228,876
Jhajjar	1,045,008	1,209,944
Rewari	904,658	1,043,965

District	Population	
	2011	2021
Gurgaon + Mewat	2,058,469	2,456,648
Faridabad + Palwal	2,793,482	3,392,377
Total	**10,585,602**	**12,482,151**
CAGR	**1.66%**	

The growth rates considered for the projection of population for Haryana Sub-Region in the Sub Regional plan for Haryana Sub-Region of NCR-2021 is 1.66%. The same growth rate i.e. 1.66% is taken to project the population of immediate Influence area (IIA) for 2023 and horizon years.

Projected population of Immediate Influence area for horizon years is shown in the table below.

Table 4-67 Projected population of Immediate Influence area

S.No	Year	Population
1	2011	2,184,790
2	2023	2,618,550
3	2027	2,843,226
4	2032	3,087,180
5	2037	3,352,065
6	2042	3,639,678
7	2047	3,951,969
8	2052	4,291,054

4.22 Passenger Traffic Forecast

Passenger trips for the base year 2021 is calculated considering a per capita trip rate of 0.5 trips (assuming a household of two adults and two children where the earning member makes 2 trips in a day). It is further assumed that 30% of the trips will be travelling along the project corridor and 15% of these trips are considered as Rail based trips likely to use the proposed Railway corridor. It is to be noted that there is no road that runs parallel to the project corridor within 5 km of influence. Western Peripheral Expressway (KMP) is operational and is fully access controlled and is a toll road where two wheelers and Public Transport stops are prohibited, thereby deterring passengers to use it for daily commute. It is envisioned that even after KMP expressway will be used mainly for bypassing Delhi. However, the service roads on either side of KMP will be used for local travel near the project corridor.

Potential trips along the project corridor

The forecasted total potential passenger trips along the corridor in immediate Influence area for horizon year by considering the growth rate of 1.66% is as below.

Table 4-68 Total Potential passenger trips along the corridor in immediate Influence area

Passenger trips / day

S.No	Year	Potential trips
1	2011	146,281
2	2023	175,323
3	2027	190,366
4	2032	206,700
5	2037	224,435
6	2042	243,692
7	2047	264,602
8	2052	287,305

Total passenger traffic along the project corridor

The rail passenger demand for horizon year is calculated by considering 15 % of total potential trips as rail-based trips along the project corridor. Passenger traveling by rail on the proposed rail corridor for horizon years is shown in the table below.

Table 4-69 Total passenger travelling by rail on proposed rail corridor for horizon year

Passenger trips/day

S.No	Year	UP (Palwal to Harsanakalan)	DN (Harsanakalan to Palwal)	Total
1	2023	10,974	10,974	21,948
2	2027	11,916	11,916	23,832
3	2032	12,938	12,938	25,876
4	2037	14,048	14,048	28,096
5	2042	15,253	15,253	30,506
6	2047	16,562	16,562	33,124
7	2052	17,983	17,983	35,966

The passenger trains have been forecasted assuming a train capacity of 1200 passengers and presented in the table below.

Table 4-70 Total Passenger trains for the horizon years

Trains/day

S.No	Year	Passenger trains		
		UP (Palwal toHarsanakalan)	DN (Harsanakalan toPalwal)	Total
1	2023	9	9	18
2	2027	10	10	20
3	2032	11	11	22
4	2037	12	12	24
5	2042	13	13	26
6	2047	14	14	28
7	2052	15	15	30

It is estimated that there is a demand of 9 train per direction every day on the proposed Haryana Orbital Rail Corridor (HORC) from first year of operation i.e. 2023. This has been forecasted to 15 trains in the year 2051.

The capacity utilization and methods to improve the line capacity of proposed routes is illustrated in the Annexure-IV(E).

4.23 Conclusion

- The line capacity of proposed HORC for double line is estimated to be 54 trains both ways/per day without maintenance block and 49 trains per day with 2-hour maintenance block. Whereas, line capacity is 27 trains/each way per day without maintenance block and 25 trains/ each way per day with maintenance block of 2-hours for single line.
- Passenger trains forecasted for or first year of operation i.e. 2023 (base year) is 9 trains per day per direction and 15 trains per day per direction in 2052.
- Freight trains forecasted for the section between Badsa and Asaudah is 24 trains and 11 trains in UP and Down direction respectively for first year of operation i.e. 2023 (base year) and 51 trains and 37 trains in UP and Down direction respectively for year 2052.
- The freight traffic from MSIL plant Manesar to Western India, which would be around 20% of the total dispatch by rail, amounting to 0.52 rakes per day for year 2023 & 0.82 rakes per day for year 2027 onwards have not been included in the Traffic calculations. This traffic would move on the Manesar-Patli rail line to Rewari & beyond.
- There is a future demand of 34 trains and 21 trains in UP and Down direction respectively for first year of operation i.e. 2023 (base year) and 77 trains and 61 trains in UP and Down direction respectively for year 2052., Whereas, line capacity of single line will be 27 trains per day per direction without maintenance block and for double line it will be 54 trains per day per direction without maintenance block.
- It is observed that most of the divertible freight traffic consists of trains from Delhi-Rohtak section and Delhi-Panipat sections which are presently using the Lajpat Nagar- Patel Nagar section (Delhi-Avoiding Line), Tuglakhabad- Hazrat Nizamuddin Section (Goods Avoiding Line) and the Delhi-Cantt. -Patel Nagar (North Line). Proposed HORC will reduce the dependency of freight trains passing through Delhi from DAL, GAL and North Line which will allow these lines to be used to augment the capacity of the Ring Railway of Delhi which will cater to the growing passenger travel needs of Delhi.

5 BASIS OF DESIGN AND METHODOLOGY

5.1 Fixed Points

5.2 Take off at New Pirthala Station

Alignment for Haryana Orbital Rail Corridor is proposed by taking-off from Common Loop Line No.1A at Ch. 91861.351 m F/CSB of PirthalaDFC yard for proposed loop line on New Pirthala Yard. A New Pirthala yard has been proposed for this section. For computing the route length of proposed alignment, the CSB of New Pirthala Yard is assumed as 0.00m. Subsequently the Chainage towards Sonipat has been considered as positive.
Connectivity to Palwal Station of IR fromPirthala station of DFC shall be provided by the DFCCIL as per the decision of RB conveyed by RB inspection note no 2011/Infra/6/20 dated 11.04.2019.(Copy Placed at Annexure-1(D)

5.3 Connectivity to Patli Station (Delhi-Rewari section)

Connectivity to Patli Station has been planned on Down Loop Line from the proposed Manesar Junction station & on Down Loop Line from New Patli Junction Station, in order to cater for the traffic flow to & from the proposed Haryana Orbital rail Corridor alignment with Delhi–Rewari route. For computing the route length of the connectivity, the CSB of proposed Manesar & New Patli Junction stations assumed as 0.00m. Subsequently the chainage towards Patli has been considered as positive.

5.3.1 Connectivity to Sultanpur Station (GarhiHarsaru-Farukhnagar section)

Connectivity to Sultanpur Station has also been planned from Common DN Loop Line of Badsa Junction Station of the proposed Haryana Orbital rail Corridor alignment to cater for the Traffic flow. For computing the route length of the connectivity, the CSB of proposed Badsa Junction stations are assumed as 0.00m. Subsequently the Chainage towardsSultanpur Station has been considered as positive.

5.3.2 Connectivity to Asaudah Station (Delhi-Rohtak section)

Connectivity to Asaudah Station has been planned from Down Loop Line of the proposed Mandothi Junction station in order to cater for the traffic flow from the proposed Haryana Orbital rail Corridor alignment with Delhi – Rohtak route. For computing the route length of connectivity, the CSB of proposed Mandothi Junction station is assumed as 0.00m. Subsequently the chainage towards Asaudah has been considered as positive.

5.3.3 Connectivity to Harsana Kalan Station (Delhi-Panipat section)

New Harsana Kalan crossing station has been proposed at a distance of 2.1 km (approximately) away from Existing Harsana Kalan Halt station towards Delhi end parallel to Delhi-Panipat line for respective movements of the proposed Traffic.

5.4 Standard of Construction

Minimum Standards of construction for new railway lines under JV model participative policy of Indian railway vide Railway Board circular no. 2016/Infra/12/1, dt. 06.04.2018 shall be followed for the proposed railway infrastructure of Haryana Orbital Rail Corridor.

5.4.1 Category of Line

The proposed passenger line between Palwal to Sonipat 143.932 km (including Connectivities to the existing IR Stations) will be constructed to Group 'A' standard with maximum speed potential of 160 kmph.

5.4.2 Gradient

Ruling Gradient

1 in 150 compensated grade is considered as ruling gradient of the section.

5.4.3 Station Yards

A gradient of 1 in 1200 & 1 in 400 is generally adopted in all station yards. High level Passenger platforms have been proposed at stations with necessary loop lines and provisions kept for future sidings development based on the requirement.

5.4.4 Grade Compensation

1 in 150 compensated grade is considered as ruling gradient of the section.

5.4.5 Gauge

The gauge adopted for the proposed alignment is 1676 mm to suit the existing gauge of Indian Railways.

5.4.6 Rails

60 Kg (T-12) - Prime quality 90UTS is envisaged for connectivity and 60/52 Kg second hand rails to be used on loop lines and as guard rails for major bridges.

5.4.7 Ballast

Track Ballast as per IRS: GE-1 with 350 mm minimum cushion for mainline and 250mm for loop line have been envisaged for the project.

5.4.8 Sleepers

60 Kg PSC sleepers with 1660 nos. per Km for entire stretch/ alignment shall be used.

5.4.9 Track Structure

Normal ballasted LWR track all along the alignment with the provision of blanket material (granular fill as per RDSO Specs) has been proposed.

5.4.10 Welding

Flash butt welding has been proposed except for the locations where FBW is not feasible,Alumino Thermic welding/SKV welding will be done.

5.4.11 Points & Crossings

All the crossovers in the proposed crossing stations connecting the main lines and loop lines shall have P&C of 1 in 12 with 60 Kg rails, CMS crossing on PSC fan shaped PSC sleeper layouts. Turnouts provided for over shoot lines are proposed with 1 in

12 with 60 kg rails, CMS crossing and Fan shaped PSC sleeper layouts conforming to RDSO standards.

5.4.12 Switches & SEJ

For running lines, Thick web switches shall be used. Improved SEJ will be used in LWR track section.

5.4.13 Track Tolerances

Track tolerances specified under IRPWM by the Railway Board for new lines shall be maintained.

5.4.14 Catch Water Drains and Longitudinal side Drains

Catch Water Drain or Longitudinal Side Drains are proposed wherever the depth of cutting is more than 3 m.

5.4.15 Speed potential

Maximum permissible speed on proposed corridor shall be 160 kmph. On turnouts speed shall not cross 30 kmph.

5.4.16 Length of Infrastructure

The total route length of the proposed alignment from New Pirthala to Harsana Kalan is 121.742 km & 143.932 km total track length (including Connectivities).

5.4.17 Traction

Proposed HORC line will be fully electrified from Take-off at New Plawal to Harsana Kalan.

5.4.18 Horizontal and Vertical Alignment

Design parameters for Railway Infrastructure are detailed below:

S.No.	Description	Specification
Horizontal Alignment Design Criteria		
1	Main line Curve Radius in m	
a	Preferred	1750
b	Absolute Minimum	350
Vertical Alignment Design Criteria		
1	Ruling Gradient	1 in 150 (compensated)

5.4.19 Formation

The top width of the formation in bank is proposed as 7.85m for Single line and 13.85m for double line. The bottom width proposed in cutting shall be 10.85m for single line and 16.85m for double line including side drains. The formation in the embankment is proposed with side slopes of 2H to 1V in banking and 1H to 1V in

cutting. Granular blanketing layer as per GE G: 14 is proposed over the earth fill for the formation in embankment. An extra width of 150mm is considered for formation width on curved track. The drawing showing Typical Cross sections of Embankment and cutting are annexed as Annexure-V.

5.4.20 Bridges

All the bridges are proposed for 25T loading as per IRS bridge rules-2008. The super structure of all major bridges is proposed either as Steel open web girders/plate girders or PSC slabs. RDSO type Composite Girders are proposed for ROBs. However, a different design of superstructure during detailed design stage is not ruled out.

5.4.21 Fixed Structure Clearance

Clearance of fixed structures is proposed to be adopted as per Indian Railway standard schedule of dimension (with latest updation) for BG line.

5.4.22 Road Crossing

All proposed road crossings are provided with either RUB or ROB as per the importance of road. Level crossings are avoided as per Railway Board's letter No. 2013/W-I/Genl./0/30 pt.-II, for not proposing any Level crossings on new lines.

5.4.23 Protective Works

Side slopes of banks shall be protected by providing turfing to prevent rain water flowing down and eroding the side-slopes. It is proposed to provide pitching to the slopes of the bank at platform locations to avoid erosion of slopes. The bridge quadrants will be provided with pitching to avoid erosion. Toe wall / Retaining wall with pitching of slopes may be provided at locations where the available width of land is less.

5.4.24 Land requirement

Proposed alignment runs through Western DFCCIL ROW between Pirthala – Sohna, Reserved land corridor of 50mtr along the KMP expressway, Government land, private land, forest land etc. Necessary arrangement will be made by HRIDC to acquire the required land for development of Rail corridor. Entire land has been proposed to be acquired for double line.

5.5 Miscellaneous works

Features like sign boards, Fouling marks, surface drains, embankment side slope protection, river training works etc shall be provided as per existing railway specifications and RDSO guidelines. Road diversions have been proposed for minor/earthen roads at certain locations based on importance to reduce the number of bridge openings.

6 RECOMMENDED RAIL INFRASTRUCTURE

6.1 Junction Arrangements

The proposed HORC line between Palwal to Sonipat takes off from proposed New Pirthala Station parallel to DFCCIL line which in turn connects to IR on Delhi-Mathura line at Asaoti Station and connectivity on Palwal end with suitable junction arrangements. The above IR connections from Pirthala Station yard shall be developed by DFCCIL. Necessary connectivities to the existing Stations Patli, Sultanpur, Asaudah and Harsana Kalan from the proposed HORC line have been planned to facilitate mixed traffic from Palwal to Sonipat. For computing the route length of proposed alignment, the Centre Line of proposed New Pirthala Railway station is assumed as 0.00 m and subsequently the chainage towards Sonipat has been considered as positive.

6.2 Stations along the Proposed HORC line and its connectivity to the Existing IR

Table 71Existing & Proposed Stations with connectivity details

S.N	Name of Station	Existing / New	Type	Chainage	Section	Remarks
1	Asaoti	Existing	Crossing Station	(-)4.20 Km	Palwal - Tugalakabad section	Connectivity from Pirthala Yard by DFCCIL
2	New Pirthala	New	Crossing Station	0.00		Connectivity to 3rd& 4th lines on Palwal end to be developed by DFCCIL
3	Silani	New	Crossing Station	6.506 Km		
4	Sohna	New	Crossing Station	11.977 Km		
5	Dhulawat(Tauru)	New	Crossing Station	28.846 Km		
6	ChandlaDungerwas	New	Crossing Station	39.450 Km		
7	Manesar	New	Junction station	48.593 Km		• Connectivity to existing Patli Station on UP line from HORC line-6.02 Km
8	New Patli	New	Junction station	54.700 Km		• Connectivity to existing PatliStation(Delhi-Rewari Section) on DN line from HORC line -3.45 Km
9	Badsa	New	Junction station	61.957 Km		• Connectivity to existing Sultanpur Station (Garhiharsaru-Farukhnagar Section) from HORC line-4.72 Km • Badsa to Farukhnagar connectivity yet to be assessed based on the MET & ALL CARGO Traffic

S.N	Name of Station	Existing / New	Type	Chainage	Section	Remarks
10	Deverkhana	New	Crossing Station	67.806 Km		
11	Badli	New	Crossing Station	77.027Km		
12	Mandothi	New	Junction Station	83.808 Km		Connectivity to existing Asaudah Station (Delhi-Rohtak section) from HORC line on UP line – 8.00 Km
13	Jasaurkheri	New	Crossing Station	97.103 Km		
14	Kharkhorda Kirholi	New	Crossing Station	105.885 Km		
15	Tarakpur	New	Crossing Station	110.948 Km		
16	New Harsana Kalan	New	Junction Station	121.742Km	Adarsh nagar-Sonipat - Panipat section	Connectivity with HORC line to UP & Down lines at station.

6.2.1 **Take off**

The proposed HORC line takes off from the New proposed Pirthala station Yard on west end. For computing the route length of proposed alignment, the CSB of New Pirthala Yard is assumed as 0.00m. Subsequently the Chainage towards Sonipat has been considered as positive.

Pirthala station yard has been proposed by DFCCIL to serve freight traffic of Dadri-Rewari rail corridor. Pirthala yard is located at a distance of 92 kms from Rewari Junction and 49 kms from Dadri. A proposal has been made by DFCCIL to connect Pirthalayardfrom east end to existing Asoati Railway station which is situated on Delhi - Mathura electrified line section of Northern railways.

Connectivity to 3rd & 4th lines on Palwal end of the IR need to be developed by DFCCIL to deal the Traffic to & from South direction.

Alignment for Haryana Orbital Rail Corridor is proposed by taking-off from Common Loop Line No.1A at Ch. 91861.351 m F/CSB of PirthalaDFCCIL yard for loop line on proposed New Pirthala yard and meeting with existing railway track at proposed NewHarsana Kalan station which is in between Sonipat - Delhi route of Northern Railways.

Existing and Proposed facilities at Pirthala Station

Pirthala station has been proposed by Western DFCCIL with two main lines for up and down directions. For computing the route length of proposed alignment, the CSB of New Pirthala Yard is assumed as 0.00m. The following lines constitute the Pirthala station yard.

L-1A (Common Loop Line)	CSR: 855.175 m (FM to FM)
L-2A (Common Loop Line)	CSR: 765.000 m (FM to FM)
L-3A (UP Main)	CSR: 893.648 m (FM to FM)
L-4A (DN Main)	CSR: 1246.846 m (FM to FM)
L-5A (Common Loop Line)	CSR: 1273.094 m (FM to FM)
L-6A (Common Loop Line)	CSR: 1306.167 m (FM to FM)
L-7A (Common Loop Line)	CSR: 1356.665 m (FM to FM)
L-1B (Common Loop Line)	CSR: 762.000 m (FM to FM)
L-2B (Common Loop Line)	CSR: 865.144 m (FM to FM)
L-3B (UP Main)	CSR: 1087.792 m (FM to FM)
L-4B (DN Main)	CSR: 1013.865 m (FM to FM)
L-5B (Common Loop Line)	CSR: 885.217 m (FM to FM)

L-6B (Common Loop Line)	CSR: 852.144 m (FM to FM)
L-7B (Common Loop Line)	CSR: 843.000 m (FM to FM)
L-3 (UP Main)	CSR: 1438.873 m (FM to FM)
L-4 (DN Main)	CSR: 1315.625 m (FM to FM)
L-5 (Common Loop Line)	CSR: 1110.996 m (FM to FM)
L-6 (Common Loop Line)	CSR: 864.500 m (FM to FM)
L-7 (Common Loop Line)	CSR: 762.000 m (FM to FM)
Machine Siding	CSR: 126.000 m (DS to BS)
Machine Siding	CSR: 126.000 m (DS to BS)
Hot Axle Siding	CSR: 126.000 m (DS to BS)
L-7 (DN Loop/ UP Rec. & Des. Line - 2)	CSR: 855.175 m (FM to FM)

6.2.2 **Proposed Stations**

There are 15 (Fifteen) new proposed Stations namely New Pirthala, Silani, Sohna, Dhulawat, ChandlaDungerwas, Manesar, New Patli, Badsa, Deverkhana, Badli, Mandothi, Jasaurkheri, Kharkhoda,Tarakpur and New Harsana Kalan station proposed on the HORC Line based on the site feasibility.

New Pirthala (CSB Ch: 0.00 m)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 825.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR:889.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 gradient.

Silani (at Ch: 6506.082m F/CSB of New Pirthala Station)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)

e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 and 1 in 1500 gradient.

Sohana (at Ch: 11977.455m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 981.563 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations. A private siding will be provided from Sohana station to IMT Sohana.

The station is proposed on 1 in 400 gradient.

Dhulawat (Tauru) (at Ch: 28845.776m F/CSB of New Pirthala Station)

The proposed crossing station constitutes the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each
f) Track Machine Siding	100 m

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 gradient.

ChandlaDungerwas (at Ch: 39449.813m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)

e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 gradient.

Manesar (at Ch: 48593.276m m F/CSB of New Pirthala Station)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations. Necessary connectivity for developing a private siding has been catered at IMT Manesar for Maruti Suzuki Ltd to their specified location.

The station is proposed on 1 in 400 gradient.

New Patli (at Ch: 54700.123m F/CSB of New PirthalaStation)

Connectivity has been proposed to existing Patli Station (Delhi-Rewari Section) on DN line from HORC line. Length of the connectivity with IR is 3.45 Km.

The proposed station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 gradient.

Badsa (at Ch: 61957.174 m F/CSB of New PirthalaStation)

Connectivity has been proposed to existing Sultanpur Station (Garhiharsaru-Farukhnagar Section) from HORC line. Length of the connectivity with IR is 4.72 Km.

One more connectivity to Farukhnagar yet to be assessed based on the MET & ALLCARGO Traffic.

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each
f) Track Machine Siding	100 M

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 1200 gradient.

Deverkhana (at Ch: 67806.359 m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 1200 gradient.

Badli (at Ch: 77027.386 m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 864.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) T\W Siding	CSR: 70 m (DS to DE)
f) Hot Axle Siding	CSR: 60m (DS to DE)
g) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 1200 gradient.

Mandothi (at Ch: 83807.994 m F/CSB of New PirthalaStation)

Connectivity has been proposed to existing Asaudah Station (Delhi-Rohtak section) on UP line from HORC line. Length of the connectivity with IR is 8.00Km.

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 1200 gradient.

Jasaurkheri (at Ch: 97102.763 m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 M each
f) Track Machine Siding	100 M

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 400 gradient.

Kharkhoda (at Ch: 105884.685 m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 491 gradient.

Tarakpur (at Ch: 110948.326 m F/CSB of New PirthalaStation)

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

The station is proposed on 1 in 800 gradient.

6.2.3 Junction Stations (New)

There are 4 (Four) new Junction Stations namely Manesar, New Patli, Badsa&Mandothi proposed with proper connectivity with IR stations.

Manesar (at 48593.276m F/CSB of New Pirthala Station)

Connectivity has been proposed to existing Patli Station (Delhi-Rewari Section) on UP line from HORC line. Length of the connectivity with IR is 6.02 Km.

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations. Necessary connectivity for developing a private siding has been catered at IMT Manesar for Maruti Suzuki Ltd to their specified location.

New Patli - (at Ch: 54700.123m F/CSB of New Pirthala Station)

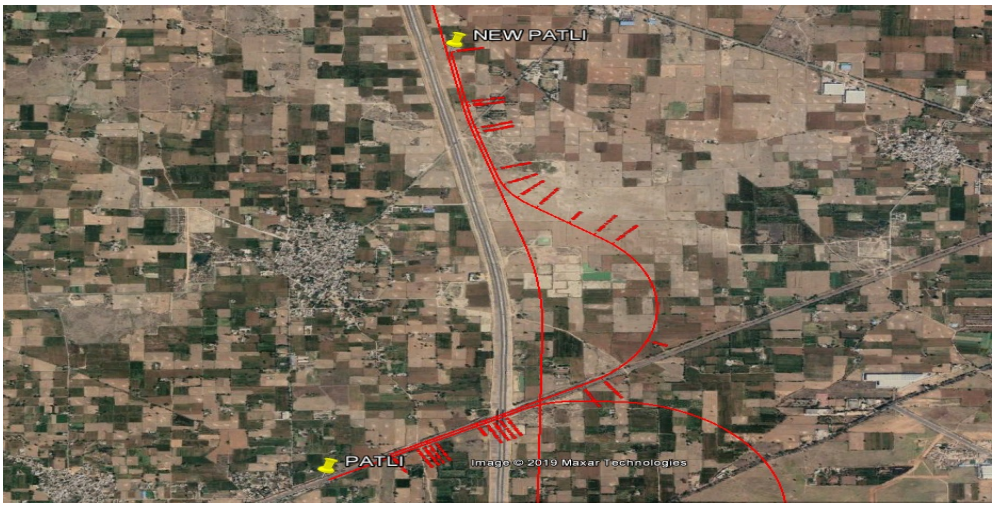
Connectivity has been proposed to existing Patli Station (Delhi-Rewari Section) on DN line from HORC line. Length of the connectivity with IR is 3.45 Km.

One more connectivity from this station has been proposed to the existing Farukhnagar Station (Garhiharsaru-Farukhnagar Section) from HORC line. Length of the connectivity with IR is 7.45 Km.

The proposed station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.



Badsa(at Ch: 61957.174 m F/CSB of New Pirthala Station)

Connectivity has been proposed to existing Sultanpur Station (Garhiharsaru-Farukhnagar Section) from HORC line. Length of the connectivity with IR is 4.72 Km.

One more connectivity to Farukhnagar yet to be assessed based on the MET & ALLCARGO Traffic.

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 770.00 m (FM to FM)
b) Up Main line	CSR: 770.00 m (FM to FM)
c) Down Main Line	CSR: 770.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

Mandothi(at Ch: 83807.994 m F/CSB of Palwal Station)

Connectivity has been proposed to existing Asaudah Station (Delhi-Rohtak section) on UP line from HORC line. Length of the connectivity with IR is 8.00Km.

The proposed crossing station constitute the following:

a) Common Up Loop Line	CSR: 889.00 m (FM to FM)
b) Up Main line	CSR: 889.00 m (FM to FM)
c) Down Main Line	CSR: 1008.00 m (FM to FM)
d) Common Down Loop line	CSR: 770.00 m (FM to FM)
e) Down Loop line	CSR: 770.00 m (FM to FM)
f) Overrun lines	120 m each

All the lines are inter connected with crossovers at appropriate locations.

6.2.4 Junction Station

New Harsana Kalan (Adarsh Nagar – Sonipat – Panipat section)

The proposed HORC line will be ending with connectivity to UP line at New Harsana Kalan station. Connectivity to DN line will be provided later at the time of executing Eastern Peripheral Project from Sonipat to Meerut. Since the existing Station is halt Station, New Harsana Kalan crossing station is proposed to facilitate the Traffic flow towards North direction.

Length of the connectivity from Tarakpur Station with IR at New Harsana Kalan is 11.547 Km.

- Conceptual plan of proposed Crossing stations is place at Annexure-VI(A1 to A18)
- Key Plan is placed at Annexure-VI(B)
- Typical 'B' Class crossing station plan and GAD for Type III & II Quarters is placed at Annexure-VI(C1 to C3)

7 CIVIL ENGINEERING

7.1 New Pirthala Station to New Harsana Kalan

Alignment for Haryana Orbital Rail Corridor is proposed by taking-off from Common Loop Line No.1A at Ch. 91861.351 m F/CSB of PirthalaDFCCIL yard for UP Main line and merges with existing railway track at NewHarsana Kalan station which is in between Sonipat – Delhi route of Northern Railway.

For computing the route length of proposed alignment, the CSB of New Pirthala Railway station is assumed as 0.00m. Subsequently the chainage towards Harsana Kalan has been considered as positive.

7.2 Route Description

The alignment runs almost parallel to KMP expressway (Kundli-Manesar-Palwal) and the alignment runs straight for most of the part except at the locations where obstructions viz., topography, water bodies, habitation and electrical crossings. To avoid such infringements, various curves have been introduced in alignment. The alignment details, regarding curves, their radius and the intermediate proposed structures with their respective dimensions have been tabulated below:

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
-1500.000	-979.727	Curve (LH)	1600	1	-1492.897	Road Bridge
				2	-1476.983	Waterway Bridge
				3	-1464.388	Road Bridge
				4	-1307.181	Road Bridge
				5	-1280.000	Waterway Bridge
-979.727	1803.976	Straight	-	6	-936.125	Road Bridge
				7	-521.528	Road Bridge
				8	-420.000	Waterway Bridge
				9	-320.542	Road Bridge
				10	-313.158	Waterway Bridge
				11	-94.000	Waterway Bridge
				12	252.641	Road Bridge
				13	1006.611	Road Bridge
				14	1225.934	Road Bridge
				15	1752.231	Waterway Bridge
				16	1762.730	Road Bridge
1803.976	2453.769	Curve (RH)	1506			
2453.769	4446.139	Straight	-	17	2470.000	Waterway Bridge
				18	2791.333	Road Bridge
				19	3698.009	Road Bridge
				20	4176.783	Road Bridge
				21	4210.000	Waterway Bridge
4446.139	4763.358	Curve (LH)	5000	22	4658.299	Road Bridge
4763.358	5766.609	Straight	-	23	5120.436	Road Bridge
5766.609	5995.082	Curve (RH)	5000			

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
5995.082	9799.463	Straight	-	24	6005.000	Waterway Bridge
				25	6200.113	Road Bridge
				26	6879.781	Road Bridge
				27	7078.679	Road Bridge
				28	7305.000	Waterway Bridge
				29	7325.956	Road Bridge
				30	7342.865	Waterway Bridge
				31	7356.263	Road Bridge
				32	7600.000	Waterway Bridge
				33	7620.539	Road Bridge
				34	7643.164	Waterway Bridge
				35	7912.000	Waterway Bridge
				36	8240.000	Waterway Bridge
				37	8671.851	Road Bridge
				38	8844.027	IOCL Pipeline
				39	9055.000	Waterway Bridge
				40	9175.000	Waterway Bridge
				41	9220.681	Road Bridge
				42	9410.700	Waterway Bridge
				43	9696.184	Road Bridge
9799.463	10082.964	Curve (LH)	1800	44	10024.343	Road Bridge
10082.964	11506.018	Straight	-	45	10222.000	Waterway Bridge
				46	10521.633	Road Bridge
				47	10700.000	Waterway Bridge
				48	10849.391	Road Bridge
				49	11120.000	Waterway Bridge
11506.018	12448.892	Curve (LH)	1600	50	11619.391	Road Bridge
				51	11620.300	Waterway Bridge
				52	12125.000	Waterway Bridge
				53	12431.740	Waterway Bridge
12448.892	16400.067	Straight	-	54	13220.000	Waterway Bridge
				55	13345.293	Waterway Bridge
				56	13493.000	Waterway Bridge
				57	13955.000	Waterway Bridge
				58	14066.514	Road Bridge
				59	14215.000	Waterway Bridge
				60	15460.000	Waterway Bridge
				61	15468.867	Road Bridge
				62	15477.570	Waterway Bridge
				63	16016.775	Road Bridge
				64	16312.205	Waterway Bridge
16400.067	17766.389	Curve (RH)	2000	65	16820.000	Waterway Bridge
				66	17378.000	Waterway Bridge
17766.389	20759.900	Straight	-	67	18320.000	Waterway Bridge
				68	18592.617	Road Bridge
				69	19070.000	Waterway Bridge

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
				70	19604.000	Waterway Bridge
				71	20196.000	Waterway Bridge
				72	20365.634	Road Bridge
20759.900	22422.147	Curve (RH)	1000	73	20803.000	Road Bridge
				74	20813.233	Waterway Bridge
				75	20823.233	Road Bridge
				76	20850.000	Waterway Bridge
				77	21112.000	Waterway Bridge
				78	21123.681	Road Bridge
				79	21200.000	Waterway Bridge
				80	21530.000	Waterway Bridge
				81	21790.000	Waterway Bridge
				82	22075.000	Waterway Bridge
				83	22270.000	Waterway Bridge
					22380.000	Start of Tunnel
22422.147	22542.904	Straight	-			Tunnel Location
22542.904	23851.348	Curve (LH)	1000			Tunnel Location
23851.348	27657.875	Straight	-		27260.000	End of Tunnel
27657.875	28803.719	Curve (RH)	1800	84	27658.288	Waterway Bridge
				85	28827.274	Road Bridge
28803.719	29676.674	Straight	-			
29676.674	30262.286	Curve (LH)	1500			
30262.286	30384.725	Straight	-			
30384.725	30860.226	Curve (RH)	1500			
30860.226	31195.921	Straight	-	86	31020.000	Waterway Bridge
31195.921	31785.537	Curve (LH)	1500			
31785.537	33712.614	Straight	-	87	32202.924	Road Bridge
				88	33400.000	Waterway Bridge
				89	33710.757	Road Bridge
33712.614	34227.032	Curve (RH)	1500	90	34010.000	Waterway Bridge
34227.032	35024.182	Straight	-	91	34920.000	Waterway Bridge
				92	34966.011	Road Bridge
35024.182	35379.480	Curve (LH)	2000			
35379.480	36635.596	Straight	-	93	35560.000	Waterway Bridge
				94	36402.578	Road Bridge
36635.596	37371.573	Curve (RH)	1500	95	36860.000	Waterway Bridge
				96	36870.342	Road Bridge
				97	37090.000	Waterway Bridge
37371.573	37667.157	Straight	-			
37667.157	38058.837	Curve (RH)	1500			
38058.837	38179.568	Straight	-			
38179.568	38645.933	Curve (LH)	2000			
38645.933	39746.724	Straight	-	100	38760.000	Waterway Bridge
39746.724	40473.794	Curve (RH)	1800	101	38834.320	Road Bridge
				102	40281.547	Road Bridge
40473.794	40784.323	Straight	-			

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
40784.323	41061.672	Curve (LH)	2100	103	40970.000	Waterway Bridge
				104	41051.682	Waterway Bridge
41061.672	41656.852	Straight	-	105	41458.488	Waterway Bridge
41656.852	42045.817	Curve (RH)	500			
42045.817	42149.059	Straight	-			
42149.059	42584.357	Curve (LH)	500	106	42386.150	Road Bridge
42584.357	42643.908	Straight	-			
42643.908	43126.032	Curve (LH)	1500			
43126.032	43720.560	Straight	-	107	43570.000	Waterway Bridge
				108	43687.551	Road Bridge
43720.560	44821.240	Curve (RH)	2000	109	44157.572	Road Bridge
				110	44690.000	Waterway Bridge
44821.240	45056.312	Straight	-			
45056.312	45458.683	Curve (LH)	1500	111	45234.759	Road Bridge
45458.683	50451.457	Straight	-	112	45662.105	Road Bridge
				113	45690.000	Waterway Bridge
				114	47305.231	Waterway Bridge
				115	47342.960	Road Bridge
				116	47682.319	Road Bridge
				117	48381.381	Road Bridge
				118	48510.000	Waterway Bridge
				119	49280.000	Waterway Bridge
				120	49607.188	Road Bridge
				121	49920.000	Waterway Bridge
50451.457	51079.163	Curve (RH)	1500	122	50820.000	Waterway Bridge
51079.163	53008.135	Straight	-	123	51260.000	Waterway Bridge
				124	51320.301	Road Bridge
				125	51870.000	Waterway Bridge
				126	52513.000	Waterway Bridge
				127	52553.668	RFO
				128	52894.000	Waterway Bridge
53008.135	53750.252	Curve (LH)	2000	129	53104.988	Road Bridge
				130	53434.000	Waterway Bridge
				131	53680.000	Waterway Bridge
53750.252	54432.794	Straight	-	132	54320.000	Waterway Bridge
54432.794	54758.273	Curve (RH)	2000	133	54548.028	Road Bridge
54758.273	55868.449	Straight	-	134	55330.000	Waterway Bridge
55868.449	56144.746	Curve (RH)	3000	135	55921.822	Road Bridge
56144.746	57185.614	Straight	-	136	56260.000	Waterway Bridge
				137	56726.625	Road Bridge
				138	57005.000	Waterway Bridge
57185.614	57521.478	Curve (LH)	5000			
57521.478	58633.174	Straight	-	139	57707.000	Waterway Bridge
				140	58040.000	Waterway Bridge
				141	58509.297	RFO
				142	58540.000	Waterway Bridge

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
				143	58561.390	Road Bridge
58633.174	59041.718	Curve (RH)	1600			
59041.718	59526.417	Straight	-	144	59150.000	Waterway Bridge
				145	59169.755	Road Bridge
59526.417	60998.453	Curve (LH)	3000	146	59820.000	Waterway Bridge
				147	60374.398	Road Bridge
60998.453	62785.778	Straight	-	148	61060.000	Waterway Bridge
				149	61320.834	Road Bridge
				150	61735.764	Road Bridge
				151	62650.000	Waterway Bridge
				152	62761.311	Road Bridge
62785.778	63199.887	Curve (RH)	1600	153	63020.000	Waterway Bridge
63199.887	65642.658	Straight	-	154	63890.000	Waterway Bridge
				155	64003.000	Waterway Bridge
				156	64065.000	Road Bridge
				157	64140.000	Waterway Bridge
				158	64860.000	Waterway Bridge
				159	65058.202	Road Bridge
65642.658	66045.619	Curve (LH)	1600	160	65793.000	Waterway Bridge
				161	65898.564	Road Bridge
				162	66030.000	Waterway Bridge
66045.619	66199.337	Straight	-			
66199.337	66920.149	Curve (RH)	2500	163	66530.000	Waterway Bridge
				164	66579.008	Road Bridge
				165	66704.473	Waterway Bridge
66920.149	68635.179	Straight	-	166	67170.000	Waterway Bridge
				167	67183.670	Road Bridge
				168	67330.000	Waterway Bridge
				169	68320.000	Waterway Bridge
				170	68550.651	Road Bridge
68635.179	68898.371	Curve (RH)	4000			
68898.371	69651.736	Straight	-	171	69340.000	Waterway Bridge
69651.736	70300.443	Curve (RH)	2000	172	69920.000	Waterway Bridge
				173	70098.000	Waterway Bridge
				174	70260.315	Road Bridge
70300.443	70914.049	Straight	-	175	70340.000	Waterway Bridge
				176	70647.000	Waterway Bridge
70914.049	71246.791	Curve (RH)	800	177	70919.000	Waterway Bridge
				178	71012.000	Waterway Bridge
				179	71185.148	Road Bridge
71246.791	71402.600	Straight	-	180	71270.000	Waterway Bridge
				181	71318.324	Waterway Bridge
				182	71385.738	Waterway Bridge
71402.600	72065.237	Curve (LH)	800	183	71420.000	Waterway Bridge
				184	71764.365	Road Bridge
72065.237	72473.542	Straight	-	185	72210.000	Waterway Bridge

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
72473.542	73143.908	Curve (RH)	5000	186	72730.000	Waterway Bridge
				187	72928.774	Waterway Bridge
				188	72952.688	Road Bridge
				189	73110.000	Waterway Bridge
73143.908	74864.116	Straight	-	190	73650.000	Waterway Bridge
				191	73860.000	Waterway Bridge
				192	74380.000	Waterway Bridge
				193	74410.260	Waterway Bridge
				194	74490.000	Waterway Bridge
				195	74565.938	Waterway Bridge
				196	74727.935	Waterway Bridge
74864.116	75514.869	Curve (RH)	1600	197	74890.000	Waterway Bridge
				198	75365.171	Road Bridge
75514.869	78877.805	Straight	-	199	75515.000	Waterway Bridge
				200	75870.000	Waterway Bridge
				201	75884.699	Road Bridge
				202	76500.000	Waterway Bridge
				203	76904.761	Road Bridge
				204	77224.000	Waterway Bridge
				205	78020.000	Waterway Bridge
				206	78304.061	Road Bridge
				207	78420.000	Waterway Bridge
78877.805	79127.705	Curve (LH)	5000	208	78882.139	Road Bridge
79127.705	81511.286	Straight	-	209	79290.000	Waterway Bridge
				210	79598.141	Road Bridge
				211	79921.892	Waterway Bridge
				212	80380.000	Waterway Bridge
				213	80827.204	Waterway Bridge
				214	80970.000	Waterway Bridge
				215	81506.891	Road Bridge
81511.286	82057.136	Curve (RH)	1600	216	81860.528	Waterway Bridge
				217	82030.000	Waterway Bridge
82057.136	84029.803	Straight	-	218	82073.179	Road Bridge
				219	82410.000	Waterway Bridge
				220	82660.000	Waterway Bridge
				221	82864.696	Waterway Bridge
				222	82907.046	Road Bridge
				223	83170.000	Waterway Bridge
				224	83611.799	Road Bridge
				225	83806.492	Waterway Bridge
84029.803	84745.155	Curve (RH)	1800	226	84390.000	Waterway Bridge
84745.155	84801.457	Straight	-			
84801.457	85369.532	Curve (LH)	1600	227	85050.000	Waterway Bridge
85369.532	85918.481	Straight	-	228	85730.000	Waterway Bridge
				229	85758.000	Waterway Bridge
				230	85872.783	Road Bridge

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
85918.481	86317.375	Curve (RH)	1600	231	86250.000	Waterway Bridge
86317.375	87765.291	Straight	-	232	86890.000	Waterway Bridge
				233	87138.390	Road Bridge
				234	87583.000	Waterway Bridge
87765.291	88227.642	Curve (LH)	1600	235	87814.000	Waterway Bridge
				236	87824.648	Road Bridge
88227.642	88904.568	Straight	-	237	88365.000	Waterway Bridge
				238	88631.826	Road Bridge
				239	88740.000	Waterway Bridge
88904.568	89485.748	Curve (LH)	5000			
89485.748	89964.742	Straight	-	240	89823.000	Waterway Bridge
				241	89960.000	Waterway Bridge
89964.742	90622.242	Curve (RH)	1600	242	90590.000	Waterway Bridge
90622.242	91684.640	Straight	-	243	90942.000	Waterway Bridge
				244	91063.999	RFO
				245	91580.817	Road Bridge
91684.640	92180.449	Curve (LH)	1600			
92180.449	92311.679	Straight	-	246	92212.410	Road Bridge
92311.679	92911.781	Curve (RH)	1600	247	92837.381	Road Bridge
92911.781	94224.260	Straight	-	248	93187.000	Waterway Bridge
				249	93385.109	Road Bridge
				250	93625.140	Waterway Bridge
				251	94180.000	Waterway Bridge
94224.260	94597.000	Curve (LH)	1600	252	94506.531	Road Bridge
94597.000	97956.092	Straight	-	253	94900.000	Waterway Bridge
				254	95430.000	Waterway Bridge
				255	95958.320	Road Bridge
				256	96250.593	Waterway Bridge
				257	96560.000	Waterway Bridge
				258	97500.000	Waterway Bridge
				259	97591.081	Road Bridge
97956.092	98564.762	Curve (RH)	1800	260	98245.369	Road Bridge
98564.762	100817.909	Straight	-	261	98900.000	Waterway Bridge
				262	99366.418	Road Bridge
				263	99372.000	Waterway Bridge
				264	99380.863	Road Bridge
				265	100004.350	Waterway Bridge
				266	100430.000	Waterway Bridge
100817.909	101217.817	Curve (RH)	5000	267	101015.294	Road Bridge
101217.817	102307.513	Straight	-	268	101340.000	Waterway Bridge
				269	101376.314	Road Bridge
				270	102040.000	Waterway Bridge
102307.513	102683.738	Curve (RH)	5000			
102683.738	105774.822	Straight	-	271	103060.000	Waterway Bridge
				272	103380.997	Road Bridge
				273	104230.000	Waterway Bridge

From	To	Alignment Description	Radius(m)	Intermediate Structures	Chainage	Remarks
				274	104306.977	Road Bridge
				275	105054.348	Road Bridge
				276	105160.000	Waterway Bridge
				277	105680.000	Waterway Bridge
105774.822	106103.703	Curve (LH)	5000	278	105902.579	Road Bridge
106103.703	108280.309	Straight	-	279	106200.000	Waterway Bridge
				280	106877.293	Road Bridge
				281	107328.600	Waterway Bridge
108280.309	108518.825	Curve (RH)	5000	282	108393.796	Road Bridge
108518.825	111845.708	Straight	-	283	108870.247	Road Bridge
				284	108894.760	Waterway Bridge
				285	109675.262	Road Bridge
				286	109720.000	Waterway Bridge
				287	110150.000	Waterway Bridge
				288	110201.000	Waterway Bridge
				289	110637.700	Waterway Bridge
				290	111532.720	Waterway Bridge
				291	111588.793	Road Bridge
111845.708	112940.126	Curve (RH)	2000	292	112230.000	Waterway Bridge
				293	112377.862	Road Bridge
112940.126	118944.475	Straight	-	294	112947.000	Waterway Bridge
				295	113100.535	Road Bridge
				296	113580.000	Waterway Bridge
				297	113605.676	Road Bridge
				298	113840.000	Waterway Bridge
				299	114670.843	Road Bridge
				300	114820.000	Waterway Bridge
				301	115174.000	Waterway Bridge
				302	115192.211	Road Bridge
				303	115210.000	Waterway Bridge
				304	115904.000	Waterway Bridge
				305	116212.251	Road Bridge
				306	116320.000	Waterway Bridge
				307	116742.000	Waterway Bridge
				308	117397.060	Road Bridge
				309	117910.000	Waterway Bridge
				310	118594.000	Waterway Bridge
				311	118722.612	Road Bridge
118944.475	119819.059	Curve (LH)	450	312	119428.825	Road Bridge
				313	119560.000	Waterway Bridge
119819.059	119997.005	Straight	-	314	119827.757	Road Bridge
				315	119865.980	Road Bridge
				316	119955.000	Waterway Bridge
119997.005	120277.166	Curve (RH)	3006			
120277.166	120524.299	Straight	-			
120524.299	120808.614	Curve (LH)	3200			

7.3 Horizontal curves

A list of the horizontal curves has been attached at Annexure-VII(A)

7.4 Bridges and Road Crossings

The list of the proposed bridges (water ways) and Road crossings has been attached as Annexure-VII(B1)

Typical Bridge GADs (Box/Twin cell) has been placed at Annexure-VII(B2 & B3)

Typical Bridge GADs (Major bridges) has been placed at Annexure-VII(B4 to B6)

7.5 Gradient

The proposed rail corridor consists of grade posts. The list of the proposed gradients has been attached as Annexure-VII(C)

7.6 Engineering Scale Plan

The Engineering Scale Plan of the proposed stations are placed as Annexure-VII(D1).

7.7 Plan and Section

Detailed Plan and Section of the proposed alignment are placed as Annexure-VII(D2).

7.8 Cost Estimate

The cost of works including Bridges, Earth work, Track work is estimated as Rs.3357.77 Crores and detailed estimate is placed at Annexure-VII(E).

8 DESIGN CRITERIA AND METHODOLOGY

8.1 Hydrology & Hydraulics

8.1.1 Introduction

Hydrology & Hydraulics Analysis is performed to estimate flood discharge for the required design return period and for assuring safe discharge of flood through the proposed waterway opening without causing any damage to the embankment of railway track, surrounding structures and the neighbouring properties.

Hydrological investigations are carried out with the topographical survey to understand the flood scenario at the proposed alignment. The high flood levels and cross section data are estimated through local enquiry and survey. Span arrangements for crossings are to be proposed so as to cater the flood discharge at highest flood events.

8.1.2 Objective

In this study, all the parameters related to the hydrology and hydraulics of waterway crossings are determined. The primary objective is to determine the size of opening required to discharge the design flood across the embankment safely. To arrive at the sizes, the areas contributing to the flow across the embankment at each location are separately delineated and the flow through each stream/river is identified. The parameters evaluated include

- Bridge length (span configuration)
- Design discharge
- Design velocity
- Design High Flood Level (HFL)
- Design Low Water Level (LWL) - not for all cases
- Standard High Water Level (SHWL) and
- Scour Depths at Pier and Abutments of Bridges.

The High Flood Levels at the bridges and culverts are used to arrive at the Formation level at the alignment so that the infrastructure is safe against all floods up to the design flood.

a) **Scope**

To achieve the above objectives the scope of the study evaluated is defined below:

i. Carrying out inventory of Bridges or Culverts in the Upstream or Downstream of the proposed railway alignment.

ii. Google data, survey data and toposheets are used for detailed study of the area

iii. Hydrology and hydraulic design which include;

   a) Catchment delineation

   b) Peak flood discharge estimation

c) Determination of span configurations required

Bridge configurations are proposed for safe passage of design discharge without any adverse impact on the river regime, upstream and downstream properties in vicinity of the Bridge on both banks.

8.1.3 Design methodology

The waterway crossings across the embankment is classified into three types

a) Important Bridges

b) Major Bridges

c) Minor Bridges

This classification is based on methodology adopted to estimate discharge. Crossings with catchment area less than 25 sqkm, rational method is used and these are classifed as minor crossings. Discharge for crossings with catchment area more than 25 sqkm is estimated using observed data at gauge discharge stations, in the absence of which, Synthetic Unit Hydrograph method is used. The limit for applicability of SUH method is 5000sqkm and these are referred to as major crossings. Crossings having catchment area more than 5000 sqkm have to be evaluated by Flood Frequency analysis and these are termed as Important crossings.

a) **Basis of Design**

The general guidelines for design is taken from the following codes of practice and guidelines.

RETURN PERIOD FOR BRIDGES	
Important bridges	100 years
Major bridges	100 years
Minor bridges	50 years

b) **Methodology**

Catchment Delineation: The process of delineating the catchment for a given point is an important part of a hydrological analysis. Normally, the delineation is done on toposheets.

The major roads, lined canals etc., which will form an obstacle for flow of water due to the presence of embankment are taken as boundary for catchments. Stream is traced back from the bridge location to its upstream reaches. Locations on major roads, railway lines or canals, where culverts (or aqueducts) are present are considered and flowpath is traced through these. Lined/unlined canals or such dedicated waterway path carrying measured discharges are not taken as flowpaths as these are not designed to accommodate the flood discharge.

Thus each catchment area, bounded by natural or man made boundaries, will have a stream which is expected to cater the entire stormwater falling on any part of the catchment, across the embankment. The discharge in each of these streams will in turn be dependent on the area and topography of the delineated catchment.

To supplement the toposheets, Google Earth is also used as a base for delineation of Catchments. Catchment boundaries are traced along the ridges by identifying the highest elevations from Google data. Culverts and aqueducts across the catchment boundaries are identified through careful examination of the flow paths that will be visible near such cross drainage structures. Past data is also used for this exercise. The boundaries thus estimated are further analysed by tracing the stream path and ensuring its continuity inside the catchment. Though this exercise is tedious for catchment delineation, the outcome is more accurate than using toposheets alone.

Methods of design

After delineation, the discharge from each catchment is evaluated. Depending on the size of the catchment area, there are 3 main methods used for this are:

i. **Rational Method**

This method is adopted when the catchment has an area less than or equal to 25km2.

Discharge is evaluated from the area of catchment, intensity of critical rainfall and the topography of the region. Rational formula gives discharge as

$$Q = 0.278\ C\ i\ A$$

Where, 'Q' - Discharge in m^3/s

'C '- Runoff coefficient

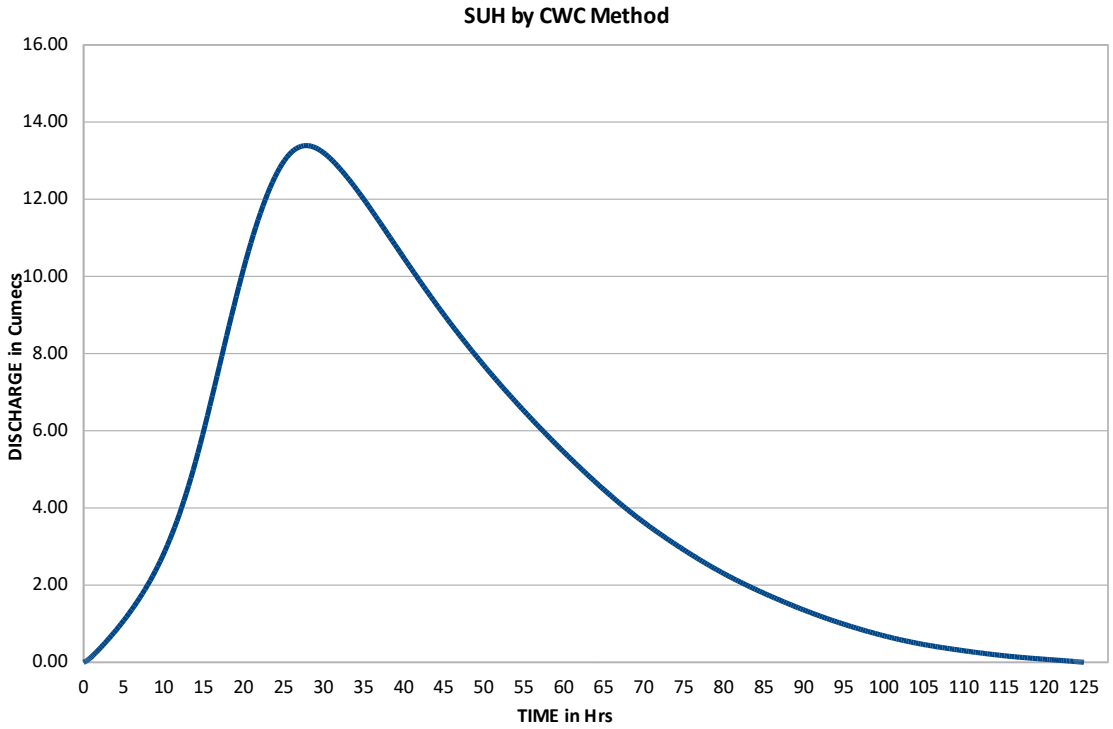
'A' - Area of catchment in km^2

- Runoff coefficient C and Rainfall intensity 'i' are calculated using the guide lines given in RBF 16

ii. **Synthetic Unit Hydrograph method**

This method is used when the catchment area is between 25-5000km2. The method is primarily used for ungauged catchments. Hydrograph for a rainfall excess of 1 cm falling over the entire catchment area is called unit hydrograph. Five points of the unit hydrograph are obtained from equations given in the Flood Estimation Report for the corresponding area.

The other ordinates are adjusted based on the area of the catchment for which the hydrograph is made.



The discharge from the catchment will depend on the coordinates of the storm hydrograph which is derived from the synthetic unit hydrograph based on

1. Time of concentration
2. Loss rates for the particular zone
3. 100-year 24-hour point rainfall
4. Catchment area and areal reduction factor

The flow so obtained is fit in the cross section observed in the survey data to compute the high flood levels in the undisturbed cross section.

iii. Flood Frequency Analysis

The method is used when the gauge discharge data is available for the river/stream at any nearby location. The data must be available for a period of 30 years or more. Yearly maximum of daily flow data is used. The data is fitted with a number of frequency distributions including Gumbel's extreme value distribution, log normal distribution, Gumbel's type 3 distribution etc. The analysis and curve fitting is done using a software, easyfit. Upon analyzing the data, the maximum value of flood for the design period is taken as the maximum value obtained from all the distributions considered. The obtained flow is then adjusted with the ratio of catchment area at the bridge location to the area of catchment area at the GD station.

After the discharge is obtained from one of the three methods, the size of opening required is calculated using area velocity method. Velocity is obtained from manning's equation and depth of flow for any given section is estimated. Span configuration which is agreeable with alignment levels is attempted, failing which alignment need to be raised according to the height of the necessary span arrangement.

8.2 Structural Design

8.2.1 Material Parameters

Concrete

Minimum grade of concrete is taken as per Table 4(b) of IRS Concrete Bridge Code based on durability consideration and environment to which structure is likely to be exposed during its service life.

Structural Member	Moderate exposure	Severe exposure	Extreme exposure
PCC Member	M-25	M-30	M-35
RCC Member	M-30	M-35	M-40
PSC Member	M-35	M-40	M-45

Properties such as modulus of elasticity, tensile strength, shrinkage, creep, coefficient of thermal expansion etc. is taken as per Clause 5.2 of IRS Concrete Bridge Code.

Reinforcement steel

Reinforcement bars of high strength deformed/ TMT bars of grade Fe500/ Fe500D or Fe415, having elongation more than 14.5% and conforming to other requirements of IS 1786:2008 are adopted as per Cause B-1.2 of IRS Seismic Code.

Surface reinforcement is provided with minimum of 8mm bars @ 200mm for plain cement concrete structures.

8.2.2 Classification of Structures

The bridges are designed to be durable and to serve satisfactorily for full minimum design life i.e., 100 years, as per in Clause 15.1.3 of IRS Concrete Bridge Code. Bridges are classified as follows:

- Important bridges: linear waterway of 300m or total waterway of 1000sqm or more
- Major bridges: linear waterway of 18m or more, or clear span of 12m or more
- All other bridges are considered as minor bridges

Box culvert

- Box culverts are proposed to be constructed after excavating to required depth and replacing it with soil improvement (if necessary) and 150mm thick PCC layer after the bed is levelled and well consolidated by ramming or rolling

- Standard RDSO drawings corresponding to 25T loading, where available, are used for structural details of box culverts:
  - RDSO/B-10155 to RDSO/B-10155-10 – for single cell box culvert with double track
  - RDSO/B-10158/1 to RDSO/B-10158/2A – for double cell box culvert with double track
- Wearing course is provided on top of bottom and top slab of box culverts
- In case of constructing boxes on erodible soil, 300mm thick stone flooring is proposed to be enclosed by suitable designed curtain and drop wall (tied to wing wall / toe wall)
- Bed slope is adjusted as per site conditions by competent authority

Superstructure

a) Road over bridge (ROB)

Road over bridges of span 18m, 24m, 30m and 36m Composite Girder are proposed. List of standard RDSO drawings used for superstructure details is as follows:

S.No.	Span (m)	Type of Girder	Reference Drawing
1	18	Composite Girder	RDSO/B-11772/1 to 11772/12
2	24	Composite Girder	RDSO/B-11773/1 to 11773/12
3	30	Composite Girder	RDSO/B-11774/1 to 11774/12
4	36	Composite Girder	RDSO/B-11775/1 to 11775/12

b) Waterway Bridge/ Road Under Bridge (RUB)

Superstructures of all waterway bridges/ RUB's are generally proposed to be simply supported spans of 6.1m, 9.15m, 12.2m, 18.3m, 24.4m, 30.5m and 45.7m. List of standard RDSO drawings corresponding to 25T loading used for superstructure details is as follows:

S No.	Span (m)	Type of Girder	Reference Drawing
1	6.1	PSC Slab	RDSO/B-10274
2	9.15	PSC Slab	RDSO/B-10272
3	12.2	PSC Slab	RDSO/B-10271 to 10271/1
		PSC I Girder	RDSO/B-10258 to 10258/3
		Restricted PSC I Girder	RDSO/B-10256 to 10256/3
		Composite Girder	RDSO/B-11752 to 11752/6
4	18.3	PSC I Girder	RDSO/B-10273/1 to 11751/4
		Composite Girder	RDSO/B-11753 to 11753/7
5	24.4	Composite Girder	RDSO/B-11751 to 11751/8
6	30.5	Composite Girder	RDSO/B-11754 to 11752/7
		Open Web Girder	RDSO/B-17161 to 17178
7	45.7	Open Web Girder	RDSO/B-17181-1 to 17181-19

c) Bearings

Bearings for all major bridges/ RUBs are proposed to be Elastomeric or Fixed-Expansion type. Bearing details and specifications are referred from standard drawings.

Substructure

d) Abutment

Solid RCC abutments retaining earth on back side, either cantilever or counterfort type, resting on pile or open foundation are proposed, depending upon height and soil conditions. RCC abutment cap with dirt wall and straight return walls with fly-wings or wing walls are proposed, as per site conditions. Weep holes are provided to dissipate water pressure on the wall, as per IRS Substructure Code. Approach embankments are restricted with reinforced retaining walls or reinforced earth walls at required locations, as per site conditions. Length of the abutment at the top is equal to formation width, sufficient to accommodate bearings, superstructure, OHE mast, as applicable.

e) Pier

Piers designed comprise of circular/ oblong RCC column, supporting superstructure of each track, and have pier caps to accommodate bearings. The length of pier cap is sufficient to provide adequate seating for superstructure, OHE mast and trolley refuge, as applicable.

f) Foundations

Foundations shall be generally of open foundation or bored-cast-in-situ piles for major bridges/ ROR/ major RUB/ ROB. The founding level and safe bearing capacity of soil shall be based on soil strength criteria and scour condition at particular bridge location.

Minimum depth of open foundation shall be as per Clause 6.1(iv) of IRS Substructure & Foundation Code.

Safe bearing capacity of the soil at the founding level shall not be less than the maximum foundation pressure at bottom of the foundation, to be ensured by the engineer in-charge at site.

Open foundation shall be constructed after excavating to required depth and preparation of 150mm thick PCC layer after the bed is levelled and well consolidated by ramming or rolling.

As per IRC 78-Cl.709.1.7, the minimum diameter of pile shall be 1.0m for river/marine bridges. For bridges beyond the water zone and for bridges on land, the diameter may be reduced to 750mm.

8.2.3 Backfill Material and Approach Transition

Behind abutments, return walls, wing wall boulder filling and backfill materials are provided as per Clauses 7.5.1 and 7.5.2 of IRS Substructure & Foundation Code and other relevant RDSO guidelines.

Approach slab is provided for non-ballasted deck bridges having spans 12.2m or more, as per Clause 7.5.3 of IRS Substructure & Foundation Code.

8.2.4 Durability, Inspectability and Maintenance

Structural design methodology adopted and composition of construction materials proposed ensure sufficient durability, considering the structural details of which they form part, as well as the effects of the environment to which they may be exposed. Bridge components such as bearing, expansion joints and items of equipment are designed such that they are easily replaceable. Provisions are made to ensure easy and adequate level of safety during inspection and maintenance operations.

Design is such that required inspection and maintenance of the structure is kept to minimum and that the effect of maintenance on the operation of the bridge is minimized.

Painting of structural steel elements is proposed to be carried out as per Clause 39 and Appendix-VII of IRS B1 (2001)[1]

8.2.5 General Aspects of Bridge Components/ Construction

- New bridges are located with respect to the centre line of the existing track and shall be verified before construction
- Location, formation level, rail level, number of tracks is based on L-section. These shall be verified at site before execution
- Clean or expansion joints shall be filled with bituminous boards/poly sulphide sealant filling
- All RCC surfaces in contact with soil shall be painted with bitumen/coal tar
- Clear cover to reinforcement, lap length, temperature reinforcement shall be according to relevant codal provisions
- Stone pitching resting on toe wall shall be provided to prevent erosion. Stone pitching of 300mm thick over 300mm graded stone chips/spalls over 300mm thick sand mixed gravel shall be provided

1 Indian Railway Standard, Specification for Fabrication and Erection of Steel Girder Bridges and Locomotive Turn-Tables, Serial No. B1-2001

8.3 Signaling, Operation & Maintenance and Miscellaneous

Table 72: Design Criteria for S&T, O&M

DESIGN ASPECT	DESIGN CRITERIA
Signal and Telecommunication	
Signal	Multi Aspect colour Light Signaling system (MACLS)
	Double distant in case the breaking distance is more than 1 km
	Point Operation - Electrical
	Point Locking - Running Lines - Clamp-lock type high thrust 220 mm Stroke Point Machine - Yard Lines – 143 mm stroke Normal Point Machine
	Point detection - Electrical
	Lock Detection – Yes
	Interlocking - Electronic
	Track Circuiting - DC Track circuits/ MSDAC depending upon site conditions
	Block Working - UFSBI Token less with BPAC/ Block Panel
	Note: The signaling shall be made suitable for 25 KV AC Traction.
Telecom	Optical Fiber Cable (OFC) with HDPE pipe Protection
	Control Communications to be provided at all stations and other Locations as per requirement
	Data communication infrastructure as per requirements
	Means of Emergency Control Communication (EC Sockets) signal to be provided
Electrification - To be provided as if the adjoining lines/ sections are being electrified	
	SP - One per 50 km of Route Length
	SSP - Two per 50 km of Route Length
	TSS with Associated Transmission Line - One at every 50 km of Route Length
	Tower wagon/ car & shed - One per 50 Route Km or 100 Track km. If new line is of less than 50 Route km or 100 Track km then, existing Tower car/ wagon may be utilized for maintenance etc.
	SCADA - if the number of Remote Terminal Units in existing SCADA is less than 50 & total number including that of new line does not exceed 50 then existing SCADA system shall be augmented otherwise new SCADA to be provided.
	Power Line crossings shall be as per the provisions of ACTM
	OHE shall be as per standard design of ACTM

DESIGN ASPECT	DESIGN CRITERIA
Mechanical	
	In case of POL/ Liquid consignments to be loaded, XR supervisor with the assistance of staff of NGR/ JV company, would be required for post loading check & assistance in loading. For them one room and store may be provided.
	In case of Steel loading, TR examination line with both side pathways to be provided along with one room and store for TXR staff.
	For loading of special consignments such as Ammonia, facility to be created in consultation with Zonal Railway.
	For detachment of sick wagons etc. one stabling spur of suitable length may be provided.
	-
	Watering arrangement sufficient for the longest coaching train to be operated in the section to be provided at any of the station if either the running time the last watering station is morethan 4 hrs. or the distance from last watering station is more than 125 km.

9 ELECTRICAL ENGINEERING

9.1 Broad Scope of work

- The objective of this study is to facilitate and develop an orbital rail corridor connecting Palwal and Sonipat with suitable Rail corridor by easing out the Delhi region from the freight traffic movement by allowing shifting from radial and inner ring rail network to the proposed corridor. Boost Industrial growth of cities around Delhi region namely Sohna, Manesar, Gurugram, Jhajjar, Rohtak etc also helping in developing Multi Modal Hubs in NCR region of Haryana.
- In this connection Orbital Rail Corridor from Palwal to Sonipat by linkingPirthala-Harsana Kalan by new BG line is proposed and it is to be electrified with 25 KV, single phase, 50 Hz, High raised OHE by anticipating DFCCIL traffic in near future.
- The proposed section is having broad gauge (1676 mm) and total length is near 143.932 Route KM & Over Head Conductor Track Km length is 305 TKM. The proposed Railway Electrification project mainly consists of the following works:
    i. To construct electric power supply system including 220, 132 KV D/C transmission line from SEB Grid substation to TSS & modification in Grid Substation.
    ii. To construct Traction Substation and Switching posts.
    iii. To construct Over Head Equipments (High raised OHE) and Supervisory Control and Data Acquisition System (SCADA).
    iv. To modify power line crossings of 11/33/66/132/220/400/765 kV.
    v. To electrify Railway stations and associated service buildings
- *The Salient features of the project are as under:*
    i. Total section length Route Km – 143.932 RKM
    ii. Over Head Conductor Track Km length - 305TKM
    iii. TSS proposed- 2 Nos.
    iv. SP/SSP proposed- 12 nos.
    v. Stations Electrification -15 nos& Platform Lighting- 30 nos.
    vi. OHE/PSI Depot - 2 nos
    vii. Tower Wagon Shed - 2 Nos.

9.2 Introduction

- There are 15 stations proposed at following locations for electrification

1) New Pirthala, 2) Silani, 3) Sohna 4) Dhulawat, 5) ChanndlaDungerwas , 6) Manesar, 7) New Patli 8)Badsa, 9) Deberkhana Kheri 10)Badli, 11) Mandothi, 12) JasaurKheri, 13) Kharkorda, 14) Tarakpur, 15) New Harsana Kalan,

- **TSS** - Traction Substations with 2x21.6 MVA transformers have been proposed at the following locations for power supply to the sections.

S.No.	Station	Rating	Capacity
1	Dhulawat	220/27.5 kV	2x21.6 MVA
2	Mandothi	220/27.5 kV	2x21.6 MVA

- Sub-Sectioning and Paralleling Post (SSP) and Sectioning and Paralleling Posts(SP) have been proposed at the following stations for sectioning and sub-sectioning in view of maintenance and fault isolation.

Sub-Sectioning and Paralleling Post (SSP)

S.No	Name of Station
1	New Pirthala
2	Sohna
3	ChanndlaDungerwas
4	Manesar
5	DeberkhanaKheri
6	Badli
7	JasaurKheri
8	Kharukoda
9	Harsanakalan

Sectioning and Paralleling Post (SP)

S.No	Name of Station
1	Silani
2	Badsa
3	Tarakpur

9.3 Design Specifications of Overhead Catenary System:

- A simple polygonal type of overhead equipment is comprising of a single 65 sq.mm, size Catenary wire of Cadmium Copper and a copper Contact wire of 107 sq. mm size suspended from the Catenary by 5 mm dia copper dropper wire spaced 9 meters apart. The OHE is supported by swiveling type Cantilever bracket assembly. A tension of 1000 kgf is given in each conductor i.e. Catenary and Contact wire. This tension is kept constant, automatically compensating the variations in conductor length due to change in temperature through the regulating equipment erected at the conductors, also known as Automatic Tensioning Device.
- The OHE span varies between 54 Meters and 27 Meters with a step of 4.5 m. The maximum span of 54 m is adopted on section having wind pressure of 155

kgs/sq m. The span is reduced on curvature depending upon the degree of curvature.

- The electrical clearance between live part, and earthed part i.e. fixed structures or moving load shall be maintained normally as large as possible. The minimum clearance under worst condition of temperature, wind etc. are given below:

  Minimum Vertical & Horizontal clearance

  a) Long duration - 250 mm
  b) Short duration - 200 mm

- The OHE conductors are terminated at maximum intervals of 1.5 kilometers and suitably anchored. The changeover is made by overlapping the conductors, normally on 3 spans or 4 spans. The Conductors height at support is so adjusted that the conductors are physically clear from any obstruction under all conditions as well as the pantograph glides over from one conductor to another smoothly without any spark. There are two types of overlap:

9.4 Un-insulated Overlap

In this type of overlap the distance between two conductors is kept 200 mm and the conductors are permanently connected by jumpers to have electrical continuity.

9.5 Insulated Overlap

- In this case, the two OHE conductors are kept apart at a distance of 500 mm. The electrical continuity at the insulated overlap in bridged by Interrupter or Isolating Switches except at Neutral Section (SP).
- In regulated OHE, to ensure uniform distribution of the mechanical tension in the OHE conductors, an anti-creep point is installed at the midpoint of the tension length of OHE conductor.
- Section Insulators are provided to insulate the OHE of one track and another track, such as at turn outs & cross over, and to separate secondary tracks and sidings from the main line or other sidings.
- When the pantograph of a locomotive passes from one track to another along a cross over, current collection changes from one OHE to another. The runners do have the overlap so that there may not be any sparking during change over.
- Solid Core Porcelain / Composite Insulators are used to support the OHE at Bracket and Stay arm Insulators. For termination 9 ton insulators are used.

- *OHE Parameters:*

1	Height of Double Stack Container	7100 mm
2	Height of Contact Wire at support from Rail Level	7570 mm
3	Height of Contact Wire at mid span from Rail Level	7520 mm

4	Height of Catenary Wire at support from Rail Level	8970 mm
5	Pre sag at mid span	50 mm
6	Max stagger at Tangent Track	+ or – 150 mm
7	Max stagger at Curves	+ or – 250 mm
8	Standard Encumbrance	1.40 mtr
9	Speed	140 KMPH
10	Type of Mast	B-150/B-175/B-200/B-225/B-250
11	Mast Length	11.4 Mtr
12	Min Implantation	2.8 Mtr
13	Max Tension Length	1.5 KM
14	Catenary Wire	65 Sq mm
15	Contact Wire	107 Sq mm

9.6 Traction Sub Stations (TSS):

- The function of Traction Sub-station is to transfer the power provided by the power system into the power that is suitable for electric traction and power supply method.
- Every TSS has 2 Nos. traction transformers out of which one is working at a time and the second transformer is stand by. The capacity of each traction transformer is sufficient is feed its own feed zone and half of the adjoining feed zone
- The power at each of the above Traction Sub-Stations will be received through 132kV/220 kV Transmission line/underground cable to be constructed by HRIDC through State Electricity Company and the Gantry towers/ cable bushing insulators for connection to the Traction Sub-Stations will be installed by HRIDC. The power as received from State Electricity Board (SEB) will be 132kV/220 kV and stepped down to 25kV by means of 132kV/27.5 kV, Traction Transformers. 132kV/27.5 kV Traction Transformer will supply power to the 25kV indoor Feeding Post, which will feed traction power to the OHE by outgoing feeders.
- Numerical Relays shall be provided in the Control and Relay Panels for protection of the equipments, feeding sections and power factor correction devices.
- *Feed Length*

  The distance for which a traction transformer will feed power in emergent conditions i.e. the distance between two adjoining FPs.
- *Elementary Section (ES):*

  This is the shortest section of the OHE which can be isolated manually for carrying out OHE maintenance work.

- *Major Equipments for OHE:*

  Following are the main activities for completion of the Overhead Catenary System:

- *Foundations:*

The foundation bending moment codes (FBM) for each location are obtained from the mast employment schedule or by actual calculations. Bearing capacity of soil is determined at the outer toe of the bottom of foundation at a representative number of locations. Type of foundations for mast and portals are as follows:

a) Side Bearing
b) Side Gravity
c) Pure Gravity
d) Black Cotton Soil (NBC/WBC)
e) Foundations in soft Rock
f) Foundations in Hard Rock

- *Selection of Foundations:*

a) Side Bearing Foundations are used for Masts where soil bearing capacity is 11,000 or 21,000 kg/sqm and 300 mm wide shoulder is available on the bank.
b) New pure gravity foundations may be used for masts where soil bearing capacity is 5500, 8000 & 11,000 kg/sqm or where adequate shoulder is not available.
c) Side gravity foundations may be used for masts where soil bearing capacity is 8000 & 11,000 kg/sqm or where adequate shoulder is not available. No portion of the foundation shall be exposed.
d) Pure gravity foundations may be used for masts where soil surrounding the foundation is loose and cannot exert passive pressure on the foundations.
e) The foundation of the Black Cotton Soil shall be done preferably in dry season.
f) The foundation of the soft and hard Rock soil shall be used for Rock zone.

- *Contact Wire & Catenary Wire:*

The Catenary wire comprises of Cu Mg, 65 sq.mm cross-sectional area. The contact wire is a solid hard drawn grooved electrolytic copper 107 mm 2 cross - sectional area. Total current carrying capacity of both wires is 600 Amps Contact Wire Height:

Normally the height of the Contact wire above the track plane shall not be less than 7.52 m at any point in the span under the worst temperature conditions. To ensure this, the normal height of contact wire at the suspension point shall be as under:

a) Regulated OHE : 7.57 m

Cantilever Assembly:

It is an insulated swiveling type structural member, comprising of different sizes of steel tubes, to support and to keep the overhead Catenary system in position so as to facilitate current collection by the pantograph at all speed without infringing the structural members. It consists of the following structural members.

i. Stay arm - It comprises of dia. 28.4/ 33.7 mm (Small) size tube and an adjuster at the end to keep the bracket tube in position. It is insulated form mast by stay arm insulator.

ii. Bracket tube - It comprises of dia 40/ 49 mm (large) or dia 30/38 mm (standard) bracket tube and insulated by bracket insulator. Catenary is supported form this member by Catenary suspension bracket and Catenary suspension clamp.

iii. Register Arm - It comprises of dia 28.4 x 33.7 mm tube to register the contact wire in the desired position with the help of steady arm.

iv. Steady arm assembly: It is 32 x 31 mm BFB section made of aluminium alloy to register the contact wire to the required stagger and to take the push up of contact wire. It is always in tension.

Mast / Steel Structures:

As a standard practice, an independent mast is used to support the OHE for each track to obtain mechanical independence Steel Galvanized masts are of Four types i.e., B.F.B (Broad Flanged Beam), RSJ (Rolled Steel Joist) and fabricated rectangular section mast of K and B type. Special care shall be taken in pollution areas.

Portals are also used to serve multiple track section where space between two tracks to locate an independent mast is not adequate. There are three types of Portals in use i.e. N, O & R type. P.G. and double BFB type uprights are used where track separation is less. All Masts & Portals are galvanized before installation

A single vertical post embedded in the foundation or otherwise rigidly fixed in vertical position to support the overhead equipment with cantilever assembly. It may be rolled section or fabricated. The uprights of portals and TTCs are also called masts.

Traction Mast/Portals are embedded in the concrete foundation. There are different type of foundations which are used according to soil pressure and location.

Neutral Section:

A short section of insulated dead overhead equipment which separates the sectors fed by two adjacent substations which are normally connected to different phases.

Section Insulator:

A device installed in the contact wire for insulating two elementary electrical sections from each other while providing a continuous path for the pantograph without break of current.

Supply Control Post:

It is general term which refers to an outdoor assembly of control gear, such as interrupters, isolators, potential transformers, auxiliary transformers, etc. including remote control equipment installed in a cubicle, for controlling power supply to overhead equipment.

a) Feeding Post (FP) - It is a supply post where the incoming 25 kV feeder lines from substation are terminated and connected to the overhead equipment through interrupters.

b) Sectioning and Paralleling Post (SP) - It is the supply control post situated mid-way between two feeding posts at the neutral section and provided with bridging and paralleling interrupters.

c) Sub-sectioning and Paralleling Post (SSP) - It is a supply control post where sectioning and paralleling interrupters are provided.

d) Sub-sectioning Post (SSP) - (for single line section): It is a supply control post where a sectioning interrupter is provided.

9.7 Sector

A Sector is defined as a section of Overhead equipment of a track which can be energized by closing a feeder circuit breaker at the substation.

a) Sub-sector - The smallest section of overhead equipment which can be isolated remotely by opening of interrupters.

b) Elementary Section - The smallest section of overhead equipment which can be isolated from the rest of the system by manual operations.

9.8 Neutral Sections

PTFE type short neutral section shall be erected on tangent track only. The stagger shall be zero at support.

If adoption of short neutral section on main line is unavoidable, short neutral section of ceramic beaded resin bonded glass fibre rod insulators be provided.

This is lighter and is considered fit for speeds upto 130 km/h.

Note: Ceramic beaded rod insulator type neutral section equipment have not yet been developed indigenously and are still under trial.

9.9 Regulated equipment

With regulated overhead equipment every tension length is equipped with an automatic tensioning device at each end and an anti-creep located approximately midway between the tensioning devices. The distance between the anti-creep and the anchor mast/ structures on either side should not exceed 750 m or 15 supporting masts.

9.10 Fittings

For the conductor connection and termination anchor clamp, they directly bear the operation tension of the conductor and exert the largest force in OHE parts, so the requirement of the material strength and ductility is very high. Normally alloy or aluminum bronze alloy is used.

The OHE estimate shall be prepared duly considering OHE components to latest RDSO and CORE approved makes and the OHE work shall be executed as per railways standards and specifications.

OHE layout plan, sectioning diagram, general power supply arrangements along with associated drawings shall be submitted for approval of Railway after approval of DPR and Engineering scale plan, prior to starting of OHE works. All types of foundation, steel structures, and conductors, power supply equipment; all fittings (ferrous and non-ferrous) insulators and execution processes and practices are covered by relevant specifications issued by RDSO and CORE

9.11 Isolation Arrangements

The lines in yards and sidings are proposed to be isolated using section insulator assembly and single or double pole isolators. Lines having loading/unloading facilities shall be provided with double pole isolator with section insulators, earthing heel at one end and double section insulator with single pole isolator and earthing heel at the other end.

Necessary Aluminium along track feeder line will be provided up to IOLs, PTFE sections.

Due to dust pollution in the loading & unloading area the OHE shall be erected with provision of long creep-age path porcelain insulators to avoid insulator failures.

9.12 SCADA Facilities

SCADA (Supervisory Control and Data Acquisition) system to be installed for remote sensing and control of traction power at the requisite remote control centre. Seamless integration of the new SCADA equipments and software for new work shall be of utmost priority. The new SCADA equipments shall be in conformity to RDSO standard specifications

9.13 General Electrical Works

There is requirement of electrification and illumination of all the station buildings, staff quarters, platforms and other service buildings which are essential part of the smooth operation of the railway system. All the service buildings are proposed to be electrified. Adequate illumination levels are to be maintained at station yards, platforms, buildings, staff colonies etc.

11kV /440 v sub-stations are proposed at stations for power supply to station buildings, platform lighting, staff quarter and colony, water pumping stations etc. Power for these substations shall be tapped from local power distribution network.

9.14 Staff Quarters and Service Buildings:

All staff quarters and service buildings shall be electrified. Fitting and fixtures conforming to latest building code and railway scale of fittings shall be provided at all buildings. Required local power supply arrangement for all stations, OHE/PSI depot has been considered in the estimate.

9.15 Modification of Power Line Crossings

Power lines crossing, if any, in the proposed alignment shall be suitably diverted so as not to infringe the handling operations. As per 1987 regulation for Power Lines crossing of Railway Tracks act (latest) Crossings of Voltage level up to and including 33 kv shall be made under ground.

The details of power line crossings occurring across the alignment & associated cost of their modification has been tabulated with theirs voltage levels mentioned below:

EHV Power Line Crossings

Voltage KV	Ground level	Proposed rail level	Clearance = (GL-RL)	Conductor Height from GL	Conductor Height from RL	Traction conductor height (cantenary height)	Minimum clearance required from highest traction conductor and lowest transmission conductor	Present Clearance	Remarks
220	197.529	205.675	8.146	30.12	21.974	8.92	4.58	13.054	
400	200.155	206.139	5.984	19.06	13.076	8.92	5.49	4.156	Modification Required
400	193.701	202.201	8.5	13.58	5.08	8.92	5.49	-3.84	Modification Required
220	192.136	201.520	9.384	12.92	3.536	8.92	4.58	-5.384	Modification Required
132	191.776	208.018	16.242	14.65	-1.592	8.92	3.05	-10.512	Modification Required
400	200.992	221.895	20.903	15.05	-5.853	8.92	5.49	-14.773	Modification Required
66	267.361	236.365	-30.996	14.06	45.056	8.92	2.44	36.136	
220	263.944	249.844	-14.1	19.76	33.86	8.92	4.58	24.94	
66	262.227	254.569	-7.658	28.54	36.198	8.92	2.44	27.278	
66	260.461	259.069	-1.392	29.94	31.332	8.92	2.44	22.412	

Voltage KV	Ground level	Proposed rail level	Clearance = (GL-RL)	Conductor Height from GL	Conductor Height from RL	Traction conductor height (cantenary height)	Minimum clearance required from highest traction conductor and lowest transmission conductor	Present Clearance	Remarks
765	254.067	261.108	7.041	19.00	11.959	8.92	7.94	3.039	Modification Required
220	258.365	269.956	11.591	13.41	1.819	8.92	4.58	-7.101	Modification Required
110	253.254	256.319	3.065	17.48	14.415	8.92	3.05	5.495	
765	228.789	239.608	10.819	13.41	2.591	8.92	7.94	-6.329	Modification Required
220	226.270	237.508	11.238	23.30	12.062	8.92	4.58	3.142	Modification Required
400	219.276	226.467	7.191	11.11	3.919	8.92	5.49	-5.001	Modification Required
220	219.279	226.277	6.998	24.50	17.502	8.92	4.58	8.582	
400	210.551	222.115	11.564	24.98	13.416	8.92	5.49	4.496	Modification Required
765	213.399	221.115	7.716	36.06	28.344	8.92	7.94	19.424	
765	212.132	218.778	6.646	19.81	13.164	8.92	7.94	4.244	Modification Required
765	212.479	217.108	4.629	25.49	20.861	8.92	7.94	11.941	
132	212.408	218.442	6.034	19.81	13.776	8.92	3.05	4.856	
765	212.706	219.228	6.522	25.49	18.968	8.92	7.94	10.048	
132	212.706	219.228	6.522	16.96	10.438	8.92	3.05	1.518	Modification Required
400	212.111	219.220	7.109	22.55	15.441	8.92	5.49	6.521	
220	211.424	218.161	6.737	13.88	7.143	8.92	4.58	-1.777	Modification Required
765	211.801	219.708	7.907	29.08	21.173	8.92	5.49	12.253	
765	212.802	221.577	8.775	21.67	12.895	8.92	7.94	3.975	Modification Required
765	212.948	226.969	14.021	17.63	3.609	8.92	7.94	-5.311	Modification Required
765	216.776	224.541	7.765	20.56	12.795	8.92	7.94	3.875	Modification Required

9.16 Abstract Cost Estimate

General Electrification cost for proposed Orbital Rail Corridor from Palwal to Sonipat by linking Asaoti – Patli – Harsana Kalan by new BG line

S.N.	Description	Qty.	Unit	Rate	Amount
1	Modification of SEB's 11KV HT electrical track crossing	5	Nos	860000	4300000
2	Modification of SEB's 132/220 KV EHT electrical track crossing	6	Nos	21800000	130800000
3	Modification of SEB's 400 KV EHT electrical track crossing	5	Nos	32800000	164000000
4	Modification of SEB's 765 KV EHT	6	Nos	80000000	480000000

S.N.	Description	Qty.	Unit	Rate	Amount
	electrical track crossing				
5	Modification to LT track crossing by using U/G cables	15	Nos	262071	3931065
6	Electrification of station building with S&T Structure	15	Nos	1198029	17970435
7	Electrification of Platform	30	Nos	1064847	31945410
8	Electrification of Cover shed (96 Sq.M each)	30	Nos	173884	5216520
9	Electrification of following Type-III staff qtrs	40	Nos.	146080	5843200
10	Electrification of following Type-II staff qtrs	200	Nos.	118832	23766400
11	Providing Submersible Pump Sets for Bore	15	Nos.	395568	5933520
12	Providing Submersible Pump Sets for Sump	15	Nos.	253453	3801795
13	Electrification of FOB as per	15	Nos.	206619	3099285
14	Electrification of AEN & PWI, ADEE office etc	4	Nos	1001189	4004756
15	Electrification IOW Store , Camp office and goods booking office and shed	4	Nos	4799444	19197776
16	DG Set	15	Nos	339895	5098425
17	High MAST 20MTR	15	Nos	500000	7500000
18	Tunnel	5.2	KM	3099917	16119568
19	TSS Control room Building & Yard lighting	2	Nos	802700	1605400
20	Tower Wagon shed Electrification	2	Nos	420557	841114
21	OHE/PSI Depot Electrification	2	Nos	104468	208936
	Sub- Total for General Electrical Works				935183605
	Add contigency including PMC Charges @ 3%				28055508
	Grand Total				**963239113**

25KV single Phase High Raised Overhead Electrification Cost

S.No	Description	Amount
1	OHE -GENERAL	29275839
2	SWITCHING POST BUILDING	7900685
3	OHE-FERROUS OTHER THAN STEEL STRUCTURES AND SPS	269917499
4	OHE NON-FERROUS 'A'	527980148
5	OHE NON-FERROUS 'B'	39957443
6	TSS	174276116
7	TSS SPARE	4132940
8	TOOLS AND PLANT(OHE & PSI)	7719872
9	SCADA	34043166
10	COMMON SCHEDULE OF OHE/TSS	
a	GALVANISED STEEL STRUCTURES	676494491
b	CONCRETE FOR FOUNDATION	213576326
c	MISCELLINEOUS	55053314
	Sub Total for RE Works	**2040327838**
	PAYMENT TO POWERSUPPLY AUTHORITY	401215178
	VEHICLE FOR MAINTENANCE ORGANIZATION	9342330
	FURNITURE FOR ADEE OFFICE AND OHE DEPOT	434494
	TOTAL ESTIMATED COST	2451319839
	CONTINGENCY INCLUDING PMC CHARGES	73539595
	GRAND TOTAL	**2524859435**

The detailed estimate is placed at Annexure-IX(A).

10 SIGNALLING & TELECOMMUNICATION SYSTEM

10.1 Introduction

Aiming at De-Congestion of Delhi network and divert the Freight traffic peripherally by-passing Delhi region for smooth movement of passenger trains, New electrified BG rail Double line from Palwal to Sonipat and Connectivities towards Rewari and Rohtak has been proposed by HRIDC.

10.2 Scope of Work

It is proposed to have New BG, electrified double line railway track From Pirthala yard of Western DFC to Harsana Kalan station

a. Pirthala yard on Dadri-Rewari Western DFC route to Harsana Kalan Station on Delhi-Sonipat route on Northern Railway and
b. Connectivities have been planned near Proposed Manesar, Badsa and Mandothi Station to connect to Patli, Sultanpur and Asaudah Station for facilitating the traffic movements towards Delhi -Rewari, Farukhnagar- Garhiharsaru and Delhi Rohtak section

10.3 Signaling System

The main purpose of signaling is to secure the safety of train operation in all the lines and to realize the efficient traffic in order to provide an undisturbed transportation. The proposed Signaling arrangements shall have to be carefully analyzed and rigorous value engineering exercise shall have to be undertaken for best utilization of the new equipment by way of addition, alteration and modification to the existing signaling system and new proposed station signaling system considering the speed potentials.

Modern Electronic Interlocking (EI) System will be proposed to cater for the envisaged speeds, ensuring safety and reliability of the upgraded signaling system will be the top priority. Signaling system will be designed fully compatible with proposed new tracks configuration and shall ensure safety of train operation. The signaling system to be designed shall comply with the requirements regarding user interface as per extant Indian Railway practice.

10.3.1 Signalling System shall mainly consist of:

a. Interlocking systems
b. Data Logger
c. Point Machines
d. Multiple Aspect Color Light Signaling System (MACLS)
e. Train Detection System
f. Absolute Block Working
g. Power Supply System
h. Signalling Cables

i. Earthing
j. Lightening & Surge Protection

10.3.2 Interlocking System

Interlocking is a mechanism to check the route the train is going to traverse before clearing the signal and to prevent the clearing of signal when it is unsafe for the movement. It is proposed to provide Standard-IV (R), Electronic Interlocking System at all stations with modificationsin existing stations such as Patli station andAsaudah station. The system will not only be tampered proof but will also have the facility to detect failures quickly.

As per RDSO specifications one of the following architectures shall be employed in the system

a. Two out of three hardware architecture with identical hardware and identical or diverse software.
b. Two sets of two out of two hardware architecture with identical hardware and identical or diverse software in hot standby mode. Failure of hardware will facilitate automatic change over in a fail-safe manner without affecting train operation.
c. Two sets of single hardware architecture with diverse software in hot standby mode.

Electronic Interlocking system shall ensure following functions (but not limited to):

a. Route Locking after Route setting;
b. Route holding while train passes through the route set;
c. Approach Locking after Route cancellation when train approaches the set route (including Gate Signals) and
d. Detector locking while the train is passing through turnouts.
e. Facility to Block/Unblock any signal route or track section.

10.4 Data Logger

Data loggers are microprocessor-based system for logging the progression of important signalling and interlocking events taking place at stations. The main function is to store change in status of the various field functions and relay functions along with exact time in battery backed memory. The stored data can be printed out at any time. At each stationone data logger system shall be provided. The status of each data logger provided at every station shall be monitored from control office using central monitoring unit to be provided in control office through omnibus channels available on OFC system.

10.5 Point Machines

It is proposed to use Electric Point Machines as per RDSO specification no. IRS: 524/2002 Amendment no.1. The machines controlling the points shall be 110 V DC,

220-mm throw with internal locking and non-trailable suitable for 25 KV RE areas. Where the points form a crossover, independent detection shall be provided for the points at each end of the crossover and separate detection shall be provided rather than super-imposed detection. Crank handle shall be provided for manual operation of point.

10.6 Signals

Signals are provided to guide the rail engine driver for safe onward journey. Therefore, it is necessary that signals display correct aspect. It is proposed to provide multi aspect LED based colour light signals at all stations. Calling-ON signal shall be provided below Home signals. Position light type Shunt signals shall be provided below all Starter signals. Independent position light type shunt signals shall be provided for exit from sidings and shunt back from Advanced Starter signals

10.7 Train Detection System

It is proposed to provide MSDAC. It is a counting device that energies the axle detectors for detecting the passing wheels determining the direction of movement and keeping the counting of wheels. It transmits the count and health information to the central evaluator at regular intervals. Based on the information detected, central evaluator determines status of track section whether clear or occupied.

It comprises of

a. Detection Point
b. Central Evaluator Unit
c. Reset Unit
d. Relay Unit
e. Event logger and diagnostic terminal

10.8 Block Working

Block section means that portion of the running lines between two block stations on to which no running train may enter until line clear has been received from the block station at the other end of the block section. Block working is an arrangement to control the entry and exit of train in a section called block section. For block working, it is proposed to provide a pair of UFSBI Double line block instrument along with HASSDAC as per latest RDSO specification. The block instrument & Axle counter will be connected with 6 quad copper cable laid all along the section. High Availability single section digital axle counter shall be provided to check last vehicle position.

10.9 Power Supply

In order to improve system reliability, the provision of integrated power supply (IPS) system with 300AH LM Battery has been considered. This will have an added advantage of ensuring uninterrupted power supply round the clock, preventing signal going blank.

10.10 Signaling Cables

All indoor and outdoor signaling cables shall be as per Indian Railway practice and as per latest RDSO specifications. Following cable shall be used:

a. Signaling outdoor cables: 1.5 sq mm copper cable of 30 core, 24 core, 19 core, 12 core, 6 core.
b. Quad cable: 0.9 mm dia, 6 quad, copper cable
c. Power cable: 70 sq mm Aluminum cable.
d. Indoor cables: 40 core, 60 core, and single core copper cables of size 0.6 sq mm & 1 sq mm.

These cables shall be sourced from RDSO approved manufactures.

Earthing

It is proposed to provide ring earth for EI system at all stations. It is proposed to provide maintenance free earthing system for IPS system, Block Instruments and telecom equipment's & normal earthing system for all outdoor signaling & telecom equipment's to achieve the following objectives:

a. To provide the safety to the operating & maintenance personnel against the electric shock on account of any potential appearing on exposed parts with respect to earth or due to electromagnetic or electrostatic induction
b. To ensure safe & reliable operation of the equipment by limiting or eliminating the induced voltages and transients in the signaling equipment
c. To protect the equipment against buildup of unduly high voltages, which can cause dielectric (Insulation) breakdown or damage to the equipment or their parts

Lightening & Surge Protection Devices

Surge protective devices shall be provided at the inputs and outputs of the power supply system to protect the power supply system and the load equipment against any power surge due to lightning, switching, etc.

Surge arrestors shall be provided at both the incoming signaling cable termination and the incoming power supply switches inside the SER to suppress any incoming voltage surge or spike.

10.11 Telecommunication System

Scope of Work

a. Provision of optical fiber-based communication system for complete section from Palwal to Harsana Kalan along with existing station Connectivities.
b. Provision of Public address system at all stations.
c. 25W VHF Communication System at all stations.
d. 5W Walkie-Talkie for operational and maintenance staff at all stations.

e. Provision of GPS based digital clocks at all stations.
f. Provision of emergency socket at every kilometer in the entire section.
g. Provision of one ISDN/IP based 300-line Exchange at one major station.

The communication would take place via three modes:

a. OFC communication
b. Quad Cable Communication &
c. Radio communication

OFC Communication

a. It provides omnibus communication circuits on cable for operation of train and other supporting activities of train control. The omnibus circuits provide telephone communication between the station-masters and the control center.
b. Optical fiber system will be the back bone of Telecommunication Network. 24 fiber Optical fiber cable will be laid on which the communication system provide would strive.
c. Two networks would be provided with interconnection of STM1 at every station and STM 4 at three locations i.e. two end stations and one mid station. If there is disconnection on STM 1 then the network would automatically switch over on STM 4 network.
d. One pair of fiber shall work with STM1 and other pair shall be ready spare duly terminate on pigtail with FC/PC connector. The third pair shall be for backup streamworking on STM4 and fourth pair shall be backup spare. The remaining 16 fibers shall be spliced in the fiber distribution management system.

Quad Cable Communication

a. 6 quads, 0.9 mm diameter telecom copper quad cable shall be provided at a constant and continuous separation all along the route with Optical fiber cable.
b. Block working and station to station communication shall be achieved using this cable.
c. Emergency telephone sockets shall be provided at every 1000 meter and also at obligatory points like level crossing gates, depot etc. By this arrangement communication between train driver after reaching the nearest emergencysocket side by track and station master, between train driver and controller, between station master and technical staff can be achieved.

Radio Communication

It is proposed to go for low cost simple VHF communication. 25-watt radio set shall be provided at every station and 5-watt radio set shall be provided to driver, guard and other maintenance and operating staff. The 25-watt radio set shall have a range of at least up to next station on both sides. The driver from receiving train can reach

to the nearest station master in case of emergency on this radio. The station master in turn can convey message to controller.

Telephone Exchange

300 lines IP based exchange expandable up to 1000 lines shall be provided at one major station. The exchange will work over Optical fiber-based network. Its server shall be connected to an IP cloud which shall be centrally managed through a Network Management System. IP phones/Analog phone will be provided at different locations which shall be connected through this exchange.

Train Controller Interface

As per Indian Railway Practice, DTMF technology-based system consisting head quarter equipment and station equipment shall be provided. The train controller interface would fulfill the following requirements:

a) A display to log the incoming calls.

b) Group call facility to call different group of users

To record the conversations between section controller and station masters, a server-based voice recorder shall be provided in control office.

Public Address System

A public address (PA) System is an electronic amplification system with a mixer, amplifier and loudspeaker. A full Zonal Public-Address System shall consist of Booster amplifiers,

Microphones, Various type of Loud speakers along with associated power supply arrangements & cables for making announcements. PA system shall be provided at all the stations.

10.12 S&T Cost Estimation

The Total Cost of S&T Estimate (Including charges) is about Rs. 161.46 Crores and the detailed estimate is placed at Annexure-X(A).

11 OPERATION AND MAINTENANCE

11.1 Objective

In terms of extant policy of Railway Board, train operations shall be managed by Northern Railway. Further, manpower required for stations, commercial operations, fuel / energy cost and operation, maintenance & replacement of all rolling stock shall be on Railway's account. The Concessionaire is expected to take care of maintenance of fixed assets, security, renewals and replacements, insurance, accident repairs etc. at its own cost. The Concessionaire shall have an O&M Agreement with Northern Railway to take care of these issues.

11.2 Maintenance Philosophy

The maintenance expenses are broken into four major heads:

i) Periodic maintenance including machines, and through renewals of all types.
ii) Scheduled inspections and maintenance of gear
iii) Casual renewals and break downs
iv) Accidents, insurance and security

The necessary facilities provided at stations for operation & maintenance staff are provided in Detailed Estimate. Broadly, the following assets are proposed to be created for maintenance infrastructure:

i) Depots and offices every 50 km.
ii) Emergency response gangs for each department to be stationed at every alternate station.
iii) Team of officers to be stationed at a major station at Manesar

Since, O&M of all fixed assets is an important cost element, it necessary to estimate it in detail, accounting for all heads of maintenance.

There is a fixed cost component of maintenance irrespective of quantum of traffic, such as:

a. Statutory inspection schedules, daily, weekly, monthly or quarterly.
b. Routine/periodic overhauling (POH) of station gear such as points and crossings, signals, OHE etc.
c. Watch and ward of Railway property.
d. Accident preparedness through maintenance gangs, inspection vehicles, accident reserve of spares.
e. Oiling, greasing, painting of curves, SEJs, bridge, rails, fittings etc.
f. Casual and periodic replacement of fittings
g. Variable cost components pertain to wear, and tear of different components based on the traffic intensity, such as:

- Weld and rail fractures and replacement of rails.

- Breakdowns & Signal failures.
- OHE breakage and replacements.
- Communication failure
- Accidents, derailments

Cost component of different activities has been assessed for FY 2024-2025 onwards and the same has been incorporated in the Financial Model.

Break up Fixed Component of Maintenance (lakh Rs. per annum)						
Activity	Qty.	Unit	Man per unit	Net man power	Cost per man/ item	Total Cost in Rs. Lakhs
Keyman's daily patrol	143	RKm	0.1	12.6	8	100.8
Gang for directed maintenance	143	Rkm	0.3	37.8	6	226.8
Regular Insp. Of SSE	143	Rkm	0.02	2.52	15	37.8
Casual Maint. Buildings/	10	Stations	3	30	6	180
Water supply/Sanitary						
Oiling and greasing of curves	89	Numbers	0.1	12.4	6	30
Painting of bridges	44	Numbers	0.1	4	7	28
O&G of bridge bearings	44	Numbers	0.1	4	7	28
Bridge Inspection	44	Numbers	0.03	1.2	15	18
USFD Testing	143	RKm	0.02	2.52	10	25.2
S&T Staff	10	Stations	2	20	8	160
Inspection SSE (S&T)	2	each	1	2	15	30
Road vehicles for Maintenance	6	each	4	24	7	168
Electrical	10	Stations	2	20	8	160
Inspection SSE (electric)	2	each	1	2	15	30
OHE Car Driver etc. plus repair gang	4	each	12	48	10	480
Total					**INR Lakhs pa**	**1702.6**

Break Up of Variable Components of O&M (lakh Rs. per annum)					
Particular	Total asset base	Units	Incidence per Annum	Rate in Rs.lakhs	Amount in Rs. Lakhs
Casual replacement of GJ--material	500	Nos	50	0.7	35.00
Casual replacement of rails/sleepers - Material	305	Tkm	30	1	30.00
Material Costoils/lubes/casual fittings	305	Tkm	305	0.1	30.50
Casual welding/fracture	305	Tkm	75	1	75.00
Casual replacement of fittings	305	Tkm	305	0.1	30.50
Casual replacement of points and crossings	290	Nos	80	5	400.00
Replacement of OHE/broken wires	305	Tkm	305	1	305.00
Replacement of communication cables/ S&T equipment	24	Stn	10	5	50.00
Trucks for gangs/Elect/S&T for carriage of material	12	each	12	12	144.00
Total					**1100**

Cost of Insurance, Accidents, Watch and Ward (Security) = 3% of revenue as the same is linked to scale of operations. The same has been accounted for in FM. The same will be treated as an Accident/contingency reserve if the amount remains unutilized in a particular year.

11.2.1 **Periodic Maintenance**

Periodic maintenance of assets is proposed at following frequency:

S.No.	Particulars	Frequency (Loaded/Unloaded)
1	Tamping	2 yrs/4yrs
2	Through Fitting Renewal (TFR)	8 yrs/12 yrs
3	Deep Screening/TBR	10 yrs/15yrs
4	Through Rail Renewal (TRR)	20 yrs/40yrs

12 LAND ACQUISITION, RESETTLEMENT AND REHABILITATION

12.1 Methodology

In order to optimize the cost of construction (including cost of land), bare minimum land is proposed to be acquired for laying track, yards, passenger platforms, circulating area and staff amenities.

12.2 Land Requirement

Total Land required for the proposed Connectivity is as follows:

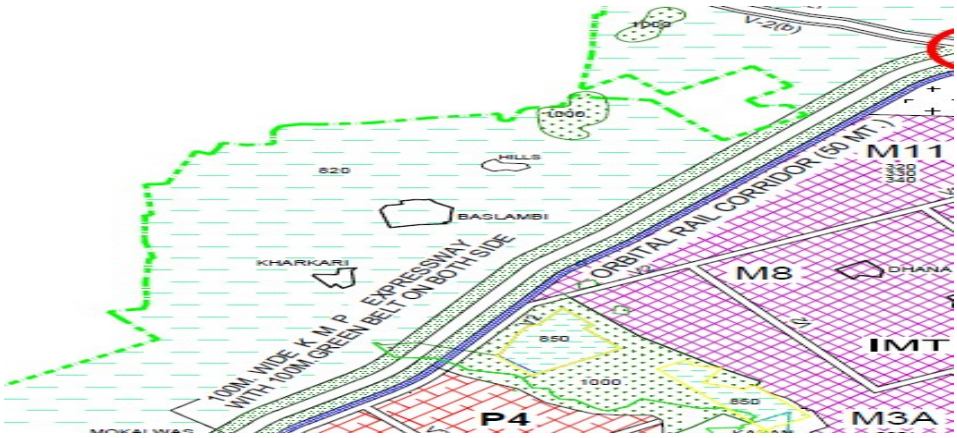
Description	Area	Units
Total Land requirement (details are placed at para 12.3)	**655.92**	**Ha**
IMT Sohna (Already acquired by HSIIDC)	10	Ha
IMT Manesar (Already acquired by HSIIDC)	38	Ha
IMT Kharkhoda (Already acquired by HSIIDC)	22	Ha
Available DFCCIL Land	19.67	Ha
Available Railway Land Requirement at Connection to Exg.Station	8	Ha
Net Land requirement	**558.25**	**Ha**

Total Private Land requirement = 558.25Hect which is mainly parallel to KMP Expressway and DFCCIL.

The proposed corridor alignment is already earmarked in the Master Plan of Haryana State as Orbital Rail.

The development of this rail corridor along the already developed road project paves way for integrated land use planning and it is also more environment friendly.

Fig showing GMDA Master Plan- 2031 Showing Orbital Rail Corridor



In the above fig. it can been that a blue line is shown as a Orbital Rail Corridor of 50m wide.

Considering the above corridor in the Master plan, the acquisition shall be more easier and hindrance free for the Project implementation.

Note:

The proposed alignment passes through the HSIIDC land near IMT Sohna, Manesar and Kharkhoda of about 70 Hectares is required to acquire, costing approximately 234.44 crores, which is proposed to take under sub-ordinate debt.

- The cost of DFCCIL and Indian Railway land not considered in the estimate

12.3 List of Village with land Areas

LIST OF VILLAGES						
S.N.	VILLAGE	CH FROM IN KM	CH TO IN KM	DIFF IN KM	AREA IN SQ M	AREA IN HEC
1	CHAPRAULA 1	0.00	0.71	0.71	44457.55	4.446
2	MANDPURA	0.72	1.90	1.18	58473.60	5.847
3	DAHLAKA 1	1.90	2.42	0.53	28456.65	2.846
4	PARAULI 2	2.42	2.73	0.31	14075.65	1.408
5	DAHLAKA 1	2.73	2.79	0.06	3134.11	0.313
6	PARAULI 2	2.79	4.72	1.93	83468.82	8.347
7	RATIKANAUBAD	4.72	5.97	1.25	41415.55	4.142
8	KHUTPURI	5.97	7.57	1.60	74063.15	7.406
9	SILANI 1	7.57	8.73	1.16	56616.00	5.662
10	SILANI 1	8.73	9.82	1.09	45899.29	4.590
11	BHIRAWATI	9.72	11.57	1.85	84868.33	8.487
12	SANCHOLI 1 & 2	11.16	12.91	1.76	55268.40	5.527
13	HILALPUR	12.92	13.34	0.42	15460.56	1.546
14	LAKHUWAS-2	13.34	16.52	3.18	166035.42	16.604
15	RAYSIKA	16.52	16.77	0.25	15861.03	1.586
16	KHANPUR	16.77	17.66	0.90	57301.71	5.730
17	BADELAKI	17.66	18.52	0.86	55089.06	5.509
18	KANWARSIKA	18.52	19.84	1.32	82577.43	8.258
19	MAHROLA	19.84	20.71	0.87	35930.64	3.593
20	KHOR	20.71	22.32	1.61	84064.04	8.406
21	MENDLA - 1	22.32	25.09	2.77	555003.71	55.500
22	MENDLA - 2	25.09	26.09	1.00	166775.74	16.678
23	DHULAWAT	26.09	28.03	1.94	274527.86	27.453
24	BIDHUWAS	28.03	28.60	0.56	66803.83	6.680
25	PADHENI	28.60	30.33	1.74	167576.81	16.758
26	GOGJAKA	30.33	30.83	0.50	36212.60	3.621
27	KALIYAKA	30.83	30.99	0.16	11280.76	1.128
28	GOELA	31.00	32.68	1.68	94745.21	9.475
29	GORAKHPUR	32.68	34.15	1.47	45280.28	4.528
30	SABRAS	34.15	36.23	2.07	71302.49	7.130
31	KALWADI	36.22	38.73	2.51	92974.18	9.297
32	PADHA	38.73	39.22	0.49	18188.03	1.819
33	RAJAVALLI TANI	39.22	41.91	2.69	129079.63	12.908

LIST OF VILLAGES						
S.N.	VILLAGE	CH FROM IN KM	CH TO IN KM	DIFF IN KM	AREA IN SQ M	AREA IN HEC
34	FAZALWAS	41.91	43.49	1.59	107337.41	10.734
35	FAZAKAR PUR	43.49	44.33	0.84	58188.82	5.819
36	MOKALWAS	44.33	46.17	1.84	101695.99	10.170
37	KHARKARI	46.17	47.72	1.55	46281.67	4.628
38	BASLAMBI	47.72	48.68	0.96	59665.30	5.967
39	ALIYAR	48.68	52.10	3.42	294938.96	29.494
40	PATLI	52.10	55.80	3.70	288033.78	28.803
41	SAIDPUR	55.80	57.57	1.77	91935.49	9.194
42	SULTANPUR	57.57	60.62	3.05	136983.38	13.698
43	JHANJRAULA	60.62	64.32	3.70	126172.53	12.617
44	MUNDA KHERA	64.32	66.85	2.54	91802.00	9.180
45	ISMIELPUR	66.85	67.48	0.63	33091.00	3.309
46	DEWERKHANA	67.48	67.64	0.16	8186.50	0.819
47	LAGARPUR-1	67.84	69.91	2.07	102301.00	10.230
48	DARIYA PUR	69.91	72.28	2.37	129488.00	12.949
49	BADLI	72.28	76.75	4.46	213784.60	21.378
50	GUBHANA	76.75	77.38	0.63	21406.00	2.141
51	BUPANIA	77.38	81.84	4.46	212718.50	21.272
52	DABODHA KHURD	81.84	84.09	2.25	91120.00	9.112
53	MEHNDIPUUR	84.09	85.59	1.50	61118.00	6.112
54	MANDOTI	85.59	90.54	4.95	234924.00	23.492
55	ASHODA TODRA	90.54	95.66	5.11	213159.00	21.316
56	KHERI JASOR	95.66	98.42	2.76	114012.00	11.401
57	NILOTHI	98.42	100.32	1.91	62869.38	6.287
58	PAHLADPUR	100.32	103.49	3.17	107583.20	10.758
59	GOPALPUR	103.49	106.26	2.77	92368.81	9.237
60	PIPLI	106.26	109.65	3.39	125997.45	12.600
61	MANDAUR&TURKPUR	109.65	115.13	5.48	213555.64	21.356
62	MALHA MAZRA&NAHRA	115.13	117.70	2.57	101830.69	10.183
63	CHATYARA BHADURPUR	117.70	119.23	1.53	74864.58	7.486
64	MALHA MAZR	118.68	118.72	0.04	13978.18	1.398
65	AKBARPUR BAROTA-2	119.52	121.15	1.63	76954.03	7.695
66	CHATYARA BHADURPUR	121.15	121.36	0.22	12804.41	1.280
67	JAGDISHPUR	121.36	121.46	0.10	5797.50	0.580
	TOTAL				**6559215.93**	**655.92**

12.4 Rehabilitation and Resettlement

National Resettlement and Rehabilitation Policy 2007 is applicable to the Project and the Project Authorities are committed to application of the same sincerely so as to

mitigate the hardship of land losers to the minimum. A detailed R&R Policy of the Project is under discussion separately. R&R to the affected persons can be provided under various forms such as,

- Provision and allotment of shops in the station area
- Assistance in purchase of farm equipment
- Setting up of cattle sheds or dairy business for the community.
- Unskilled jobs during construction phase
- Training assistance for improving employability during operation stage
- Monthly stipend to unemployable personnel
- Setting up of any other business-like tea stalls, cycle repair, small restaurants etc in the habitations on land arranged by State Govt. etc.

The fixed and recurring costs of R&R have been assessed tentatively.

12.5 Estimate

S.No	Description	Percentage	Qty.	Unit	Rate	Cost	
	Land Requirement						
1	Built up Area	2	11.72	Hect	24580000	288038272	
2	Wet Land	70	410.14	Hect	6720000	2756167680	
3	Dry Land	18	105.47	Hect	4704000	496110182.4	
4	Forest Land, Revenue Forest and govt. Land	10	58.59	Hect	2688000	157495296	
	Total		585.92			3697811430	In RS
						369.781	In Crores
5	Compensation for standing crop @ 4% of item 2 & 3 on Rs.	4	0				147912457.2
6	Solatium 100% on item 1, 2, 3	100	0				3697811430
7	R&R @100% on item 1,2&3	100	0				3697811430
8	Clearing of land acquisition			LS			1000000
							11242346748
						Total (In Crores)	**1124.235**
						Add cost of 70 Hectare of HSIIDC Land(In Crores)	**234.44**
						Total for Land (In Crores)	**1358.67**

13 COST ESTIMATION

13.1 Abstract Estimates

The total capital cost of the proposed Haryana Orbital Rail Corridor has been computed based on the Latest Awarded rates of the Northern Railways and summary of estimate is placed below:

SUMMARY OF COST ESTIMATES		
S.No	**Description**	**Cost (in Crores)**
1	Civil Engineering	3357.77
2	Signalling and Telecommunication	161.46
3	Over Head Electrification and General Electrical	348.79
	Total Construction cost	**3868.02**
4	Land Cost including Rehabilitation and resettlement	1358.67
5	Interest During Construction (IDC)	391.00
	Total Cost (In Crores)	**5617.69**
6	Revenue from PD/TOD upfront	795.00
	Net Cost (In Crores)	**4822.69**

Note: Any increase in the cost of the project (including land) shall be shared proportionately by all the stakeholders.

13.2 Transit Oriented Development

Efficient, safe, reliable and comfortable public transportation system emphasizing on a Transit Oriented Development (TOD), contributes significantly in improving the livability index of a City.

Transit Oriented System is an inspiring trend in creating vibrant urban spaces integrated with a high-quality transit system that enhance the quality of life.

TOD Can be given as a lease for the following and can get revenue from these sources

Office Space - IT/ITES and others

Retail - Malls, High Street Retail, etc.,

Hospitality - Hotels, Service Apartments, etc.,

Healthcare - Hospitals, Poly Clinics, etc.,

Others - Convention Centers, Entertainment zones, Theme parks, Warehousing, etc.

TOD Value Proposition:

For companies it will reduce transportation costs significantly apart from enhancing the quality of life of the workforce.

For the retail segment, higher footfalls due to customer travel convenience will be an added advantage.

For the current project it has been considered a lump sum amount of Rs.795 Cr as an initial income towards the proposed TOD facilities. The above said amount has been proportionately adjusted to the Project cost

TOD facilities have been considered at the following Stations:

1. New Palwal Station
2. New Patli Station
3. Manesar Station

13.3 Methodology

The project is divided into the following components for preparation of civil engineering cost estimate.

1. Formation in Filling/Cutting.
2. P. Way
3. Tunnels
4. Bridges
5. Station Buildings
6. Staff Quarters
7. Supervisory/Administrative Offices

Formation in Filling/Cutting

Vertical and horizontal alignment of the track was ascertained based on the land availability and gradient considerations. From the alignment parameters, earthwork in cutting and embankment were calculated based on the Proposed Formation Levels and Existing ground levels and in accordance with the standard cross section for double line track in the P.Way manual. These quantities have been used for preparation of cost estimate. Standard items of work and rates given in Northern Railway USSOR 2010 and the last accepted rates from the Contract agreements mentioned in references have been used to arrive at the rate of items. The above accepted rates have been escalated @ 3% per annum accordingly in order to get the rates for the year 2018-19.

P. Way

Quantities of rails, Points and crossings, fastenings, welds, guard rails, steel channel sleepers and ballast were ascertained for the standard BG track with 60 Kg 90 UTS rails for main line and loops with sleeper density of 1660 in main line & 1540 in loop lines. The rates for supply and installation works were taken from NRlyP-way Item list for 2018. For few items, the rates were taken from the contract agreement

mentioned in the references and have been escalated accordingly to ascertain the cost of Track works.

Tunnels:

Alignment encountered a tunnel of 4.88 km length. Based on the terrain it was assumed that the alignment passes through fairly weathered rock and 55% of the passage requires special protection. Suitable section as per SOD 2014 is selected for calculating the cost of construction based on NATM. Since, tunnels are not covered in USSOR 2010, rates published by RVNL for a recent tunneling tender were taken as basis.

Bridges:

All major and minor bridges have been estimated as per the proposed Formation levels & Bed levels. Typical RDSO drawings for various bridges like, PSC box girder bridges, Open web girder bridges, RCC slabs and Box culverts were used for quantity estimation. The rates given in Northern Railway USSOR 2010 and the last accepted rates from the Contract agreements mentioned in references have been used to arrive at the rate of items. The above accepted rates have been escalated @ 3% perannum accordingly in order to get the rates for the year 2018-19.

Stations, Staff quarters, Supervisory &Administrative Offices:

Drawings issued by RDSO were used for quantity estimations. rates given in Northern Railway USSOR 2010 and the last accepted rates from the Contract agreements mentioned in references have been used to arrive at the rate of items. The above accepted rates have been escalated @ 3% per annum accordingly in order to get the rates for the year 2018-19.

References:

1. Northern Railways USSOR 2010.
2. Northern Railway P.Way Rates 2018
3. Contract Agreement No. W-241/ROB-Kukrana dated 24.01.2018
4. Contract Agreement No. W-209/Linking/SNB/CSB dated- 30.05.2014
5. Contract Agreement No. 74-W-1-2-336-WA-NDWCS dated- 09.05.2017
6. RVNL Tender No. RVNL/RKSH-KNPG/TENDER/TUNNELS/PK5 dated-13.10.18
7. NMDC Contract Agreement No-HO(Contracts)/NISP/RSP/357/26 dated 26.11.2015

14 FINANCIAL & IMPLEMENTATION ASPECTS OF THE PROPOSAL

14.1 Estimation of Traffic Revenues

The Commissioning of the Project is assumed to be at the end of year 2024. Accordingly, revenue calculations have been done based on traffic projections from the year 2025.

14.2 Passenger Earnings

According to the Railway Board letter No. 2011/Infra/12/32 on Participative models for rail-connectivity and capacity augmentation projects, dated 10.12.2018, no apportionment of Passenger revenues will be made in the revenue model for the Project development JV. JV shall provide free Access to IR Passenger Trains. Hence, Passenger revenue calculations are not presented in this report.

14.3 Freight Earnings

Freight revenues have been calculated separately for all commodities of freight anticipated, based on traffic projects made for incoming and outgoing traffic.

- Shortest Route as per http://rbs.indianrail.gov.in/ShortPath/ShortPathServlet have been taken for finding shortest route.
- Revenue calculations and apportioning for project route has been made by using following formula

$$Revenue = (Freight\ Rate - Terminal\ Charges) * (Traffic) * (\frac{Project\ Route\ Length}{Total\ Route\ Length})$$

- The freight rate per tonne as given in the Indian Railway Conference Association's "Goods Tariff No. 48 Part I (Vol. II) & Part II", applicable from 1st April 2015 has been taken for calculating freight revenues.
- Additional surcharges are collected on the Base freight rate Vide Railway Board Letter No.TCR/1078/2015/14 DATED 20.07.2015. They are Busy season charge 15% from 1st April to 30th June & 1st Oct to 31st March on all commodities except Container traffic and Automobile traffic. In addition, Development surcharge is charged on all Goods Traffic through-out year.
- Terminal Charges have been taken as Rs. 20 as per Ministry of Railway – Railway Board Letter No. TCR1078/2018/17 Dated 27.12.2018. Terminal charges have been applied for both stations. Therefore, total terminal charges applied is Rs. 40 per ton.
- Revenue to SPV is taken as 50% of revenue of the project route length as per model JV agreement and Participative models for rail-connectivity and capacity augmentation projects- JV model.

The estimated total revenues (in Rs.Crore) from freight traffic as applicable to the Project line (Palwal to Sonipat), and SPV are shown in the table below. The revenue model assumes annual average tariff increase of 5% per annum.

Table 73 : Revenue Projections till Horizon Year 2069

	2020	2025	2030	2035	2040	2045	2049
Revenues/Year	1	6	11	16	21	26	30
Operating Revenues to SPV (Crore)	0.0	449.88	574.17	732.80	935.26	1193.65	1450.89
Including 10% Increased Revenue with non-fare box cost	0.00	494.86	631.58	806.08	1028.78	1313.02	1595.98

	2050	2055	2060	2065	2069
Revenues/ Year	31	36	41	46	50
Operating Revenues to SPV (Crore)	1,523.44	1,944.33	2,481.52	3,167.11	3,849.65
Including 10% Increased Revenue with non-fare box cost	1,675.78	2,138.77	2,729.67	3,483.83	4,234.61

14.4 O&M Costs

In terms of extant policy of Railway Board, train operations shall be managed by Northern Railway. Further, manpower required for stations, commercial operations, fuel / energy cost and operation, maintenance & replacement of all rolling stock shall be on Railway's account. The Concessionaire is expected to take care of maintenance of fixed assets, security, renewals and replacements, insurance, accident repairs etc. at its own cost. The Concessionaire shall have an O&M Agreement with Northern Railway to take care of these issues.

Year	2020	2025	2030	2035	2040	2045	2049
Maintenance Cost - For SPV (In Crores)	0.00	37.06	47.30	60.37	77.05	98.34	119.53

Year	2050	2055	2060	2065	2069
Maintenance Cost - For SPV (In Crores)	125.50	160.18	204.43	260.91	317.14

14.5 Financial Appraisal

Financial Appraisal is a method used to evaluate the viability of a project by assessing the value of net cash flows that result from its implementation. Financial Analysis looks at the impact of the project on the finances of the Sponsoring Agency.

A financial appraisal is concerned with the financial impact of the project on the finances of the Sponsoring Agency. Financial analysis focuses on cash flows as opposed to economic flows and, in particular, considers sustainability and profitability. Some of the general objectives associated with this type of analysis are:

- Identifying and estimating financial cash flows;
- Assessing financial suitability - sustainability occurs if the net flow of cumulated generated cash flow is positive for all years considered;
- Calculating performance indicators (e.g. Net Present Value, Internal Rate of Return); and
- Assessing funding sources for the project

14.5.1 Net Present Value Method (NPV)

The Net Present Value (NPV) is the sum of the discounted cash flows over the period. This criterion is simply based on whether the sum of discounted benefits exceeds the sum of discounted costs.

14.5.2 Internal Rate of Return (IRR)

The internal rate of return is the maximum rate of interest that a project can afford to pay for the resources used which allows the project to cover the initial capital outlay and on-going costs and still break even. It can also be described as the discount rate that equates the present value of benefits and costs. The IRR is generally compared to a hurdle rate of return (normally the test discount rate for public investment appraisal) which corresponds to the opportunity cost of funds. Discounted cash flow (DCF) appraisal or valuation views the intrinsic value of an asset or a project as the present value of its expected future cash flows. When applied to dividends, the DCF model is the discounted dividend approach or dividend discount model (DDM). This reading extends DCF analysis to value a company and its equity securities by valuing free cash flow to the firm (FCFF) and free cash flow to equity (FCFE). Whereas dividends are the cash flows actually paid to stockholders, free cash flows are the cash flows available for distribution to shareholders. In corporate finance or project appraisal, free cash flow to firm (FCFF) is a way of looking at a project's cash flow to see what is available for distribution among all the securities holders of the project entity. This may be useful to parties such as equity holders, debt holders, preferred stockholders, and convertible security holders when they want to see how much cash can be extracted from a company without causing issues to its operations. Unlike dividends, FCFF and FCFE are not readily available data. Analysts need to compute these quantities from available financial information,

which requires a clear understanding of free cash flows and the ability to interpret and use the information correctly. Forecasting future free cash flows is also a rich and demanding exercise.

Free cash flow can be calculated in various ways, depending on audience and available data. A common measure is to take the earnings before interest and taxes multiplied by (1 – tax rate), add depreciation and amortization, and then subtract changes in working capital and capital expenditure. Depending on the audience, a number of refinements and adjustments may also be made to try to eliminate distortions.

14.5.3 Discount Rate

The WACC is probably the single most important factor beside the return on invested capital (ROIC), when estimating a project's financial feasibility – the basis for most strategy and performance evaluation methods. It is also the discount rate (time value of money) used to convert expected future cash flow into present value for all investors. To be consistent with the Free Cash Flow or Economic Profit approach, the estimated cost of capital must comprise a weighted average of the marginal cost of all sources of capital -debt, equity etc. that involves cash payment, now or in the future - excluding non-interest-bearing liabilities (in simple form):

$$WACC = \frac{C_d \times (1-t) \times D}{V} + \frac{C_e \times E}{V}$$

Where,

C_d = Pre-tax debt nominal interest rate,

C_e = Opportunity cost of equity capital,

T = Corporate marginal tax rate,

D = Market Value of interest-bearing debt,

E = Market Value of equity,

V = Market Value of entity (V=D+E)

Discount rate reflects the amount of risk associated with a particular investment. In another way, it is the rate of return an investor would require for choosing a particular investment and not any other alternative opportunities. Two broad approaches, namely the Ibbotson Build-Up Method and the Capital Asset Pricing Method are available to value an equity interest.

14.5.4 Capital Asset Pricing Model (CAPM)

As per Capital Asset Pricing Model,

$$Cost\ of\ Equity\ (Ks) = Rf + \beta\ (ERP) + SCR$$

Where,

Ks = Cost of Equity,

Rf = Risk Free Rate of Return

β = Beta

ERP = Risk Premium

SCR = Project Specific Risk Premium

As can be observed, the CAPM model requires beta for which the market and comparable companies are selected and analyzed for their performances with regard to the market. In our analysis, the lack of comparable public companies prevented us from relying on CAPM model.

14.6 Haryana Orbital Rail Corridor Proposal –Project Executed by JV

This scenario is based on the following assumptions:

- The Discounting rate has been 8.5%
- 30% Equity and 70% Debt model has been considered.
- Revenues are shared between SPV and MOR with 50% share of each as per model JV agreement.
- Costs to be incurred by SPV includes Project's capital cost, O&M cost (Fixed + Manpower)

Profit and Loss Statement for SPV as per JV model agreement (Rs Cr)

	2020	2025	2030	2035	2040	2045	2050
Year	1	6	11	16	21	26	**31**
Project Revenues	-	494.86	631.58	806.08	1,028.78	1,313.02	1,675.78
Project O&M costs	-	37.06	47.30	60.37	77.05	98.34	125.50
EBITDA	-	457.80	584.28	745.71	951.73	1,214.68	1,550.28
Depreciation	-	109.81	109.81	109.81	109.81	109.81	109.81
EBIT	-	347.99	474.47	635.90	841.92	1,104.87	1,440.46
Interest	-	182.60	136.95	91.30	45.65	-	-
PBT	-	165.39	337.52	544.60	796.27	1,104.87	1,440.46
Income Tax	-	-	84.38	136.15	199.07	276.22	360.12
PAT	-	165.39	253.14	408.45	597.20	828.65	1,080.35

	2050	2055	2060	2065	2069
Year	**31**	**36**	**41**	**46**	**50**
Project Revenues	1,675.78	2,138.77	2,729.67	3,483.83	4,234.61
Project O&M costs	125.50	160.18	204.43	260.91	317.14
EBITDA	1,550.28	1,978.59	2,525.24	3,222.91	3,917.47
Depreciation	109.81	109.81	109.81	109.81	109.81

EBIT	1,440.46	1,868.78	2,415.42	3,113.10	3,807.66
Interest	-	-	-	-	-
PBT	1,440.46	1,868.78	2,415.42	3,113.10	3,807.66
Income Tax	360.12	467.19	603.86	778.27	951.91
PAT	1,080.35	1,401.58	1,811.57	2,334.82	2,855.74

Project IRR and Equity IRR Calculation for SPV

(Rs. Cr)	2020	2021	2022	2023	2024	2025	2030	2035
Opening Cash	-	1.77	4.92	3.45	4.68	4.67	683.59	1,967.17
Equity Infusion	595.00	225.00	225.00	225.00	230.00	-	-	-
Loan raised	-	885.00	970.00	720.00	745.00	-	-	-
Capex	593.23	1,082.52	1,121.12	821.94	812.89	-	-	-
PAT	-	(24.34)	(75.35)	(121.83)	(162.11)	165.39	253.14	408.45
Add Depreciation	-	-	-	-	-	109.81	109.81	109.81
Loan Repaid	-	-	-	-	-	166.00	166.00	166.00
Closing Cash	1.77	4.92	3.45	4.68	4.67	113.88	880.55	2,319.43
Post Tax Project CF	(593.23)	(1,082.52)	(1,121.12)	(821.94)	(812.89)	275.20	362.95	518.26
Project IRR	**10.22%**							
FCFE	(595.00)	(225.00)	(225.00)	(225.00)	(230.00)	109.20	196.95	352.26
Equity IRR	**14.35%**							

(Rs Cr)	2040	2045	2050	2055	2060	2065	2069
Opening Cash	4,090.92	7,239.68	12,410.85	18,972.81	27,309.79	37,912.19	48,440.37
Equity Infusion	-	-	-	-	-	-	-
Loan raised	-	-	-	-	-	-	-
Capex	-	-	-	-	-	-	-
PAT	597.20	828.65	1,080.35	1,401.58	1,811.57	2,334.82	2,855.74
Add Depreciation	109.81	109.81	109.81	109.81	109.81	109.81	109.81
Loan Repaid	166.00	-	-	-	-	-	-
Closing Cash	4,631.94	8,178.14	13,601.01	20,484.20	29,231.17	40,356.83	51,405.93
Post Tax Project CF	707.02	938.46	1,190.16	1,511.39	1,921.38	2,444.64	2,965.56
FCFE	541.02	938.46	1,190.16	1,511.39	1,921.38	2,444.64	2,965.56

14.7 Economic Appraisal

Substantial investment has been made at national level in rail transport infrastructure over the past 50 years and is likely to continue in the future. The need to appraise transport projects in economic and social terms has developed alongside this in both scope and complexity. The state-of-the-art in the economic appraisal of transport projects is reviewed, progress is assessed, and future challenges are identified. The review addresses the general framework, treatment of major impacts, presentation of outputs and issues such as uncertainty. It draws on national practice in India, and other countries, which varies substantially reflecting a range of cultural and economic differences. Some points of commonality exist, and the principle of monetizing direct transport impacts is generally accepted. Progress has been made towards the measurement of environmental impacts, but the assessment of the wider impacts remains under-developed. Increased sophistication and complexity have brought increasing data and presentation requirements, where computerized decision support methods have potential. Many challenges exist for the future of appraisal and the review is concluded with a discussion of some key issues. At the heart of these is the continuing debate over the relative roles of national and European government in decision-making and resource allocation.

Economic appraisal is a type of decision method applied to a project, programme or policy that takes into account a wide range of costs and benefits, denominated in monetary terms or for which a monetary equivalent can be estimated. Economic appraisal is a key tool for achieving value for money and satisfying requirements for decision accountability. It is a systematic process for examining alternative uses of resources, focusing on assessment of needs, objectives, options, costs, benefits, risks, funding, affordability and other factors relevant to decisions.

Economic appraisal is most effective when it becomes a routine part of capital works planning, incorporated from the early stages of project development. An iterative process may then follow, as data are updated; for example, as a result of revised more detailed construction cost estimates, or changes to the project asa consequence of the environmental assessment process. The appraisal is reassessed to ensure that the preferred option provides the best value for money outcome to meet the service objective.

An economic appraisal's methodology is such that certain concepts contained in conventional financial analysis, such as depreciation, interest, and inflation and sunk or historical costs are accounted for by different means or are not relevant to the evaluation of project options. While economic appraisal is required for capital works proposals, it does not remove the need or desirability for financial analysis which will show cash flow demands on the State's finances, and the financial rate of return from the project for Sponsoring authorities. Sponsoring authorities may also wish to separately show economic appraisal results from the agency's viewpoint, as well as from the overall community perspective, for comparative purposes.

14.8 Assessment of Economic Cost

The cost components of the Project are:

- Capital Cost of the Project - which are computed on the basis of depreciation and amortization charges of the Project, which reflect the annual capital cost for the Project
- Operating Cost of the Project - which are the operations and maintenance costs derived from our analysis and survey.

14.9 Assessment of Economic Benefit

Reduction in Pollution - The setting up of the project will trigger a modal shift in transportation of goods from road to rail. This would reduce the number of trucks plying on road and consequently the pollution (in the form of vehicular emission) caused by the trucks would fall.

The benefits due to reduction in pollution have been calculated by considering the emissions caused by heavy commercial vehicles per km (0.0169 kg/km), and damage cost due to these emissions (lNR 38.4 per kg of emission).

Land Freement - As major freight traffic will by-pass Delhi area, some of the yards & goods sheds will get closed, releasing huge area of prime real estate. Also, station development along the HORC corridor will boost mobility and real estate activity in the area around station. At the same time, the TOD policy of Haryana Government will also provide additional FAR in the TOD radius. This will lead to additional capex investment, on account of HORC project and will lead employment generation, hence employment benefit and stamp duty be considered as economic benefit accruing to the project.

Benefits due to Increased Employment and Household spending - The investment will lead to employment creation (both direct and indirect) An employment multiplier of 0.21 Jobs/INR Crore of investment as well as other appropriate multipliers (e.g. indirect employment multiplier of 2.0) have been taken to quantify the benefits on account of employment generation. The quantified benefits using the above employment multipliers and using the average per capita income of Rs. 1,00,000 per annum has been computed.

Economic Internal Rate of Return

Based on the above net economic cash flows are computed, which are then adjusted for the initial investment required for the project and then, the economic internal rate of return is computed using the principles of discounting.

The EIRR of the project is therefore the implied rate of return for the society and other stakeholders at large and reflects a holistic assessment of the project.

	2020	2025	2030	2035	2040	2045	2049
Economic Benefits/ Year	**1**	**6**	**11**	**16**	**21**	**26**	**30**
Employment benefit	373.73	434.33	439.45	445.98	454.32	464.97	59.76
Fuel Saving		5.99	7.64	9.75	12.44	15.88	19.31
Land Benefit		90.00	90.00	90.00	90.00	90.00	90.00
Carbon Saving		2.09	2.67	3.40	4.35	5.55	6.74
Tax Benefit	88.98	198.00	198.00	198.00	198.00	198.00	198.00
Asset value to Govt.							3,461.16
Net Economic benefit	(895.95)	583.53	580.64	576.96	572.25	566.25	2,246.96
Capex	(593.23)	-	-	-	-	-	-
Economic Cash Flows	(1,489.18)	583.53	580.64	576.96	572.25	566.25	2,246.96
EIRR	**16.65%**						

14.10 Implementation through SPV as per JV Model

The project may be implemented as a JV model as per Government of India Ministry of Railways (Railway Board) Letter No. 2011/Infra/12/32 dated 10.12.2018, "Participative models for rail-connectivity and capacity augmentation projects. Brief features of JV model as per Railway Board letter is detailed below-

Applicability

It is generally applicable for bankable new line and gauge conversion projects either sanctioned or proposed to be sanctioned having clearly identifiable stakeholder either as user of the line or utilities such as ports, mines, exporters, plants and state governments. Bankability of the projects, if required, can be enhanced through innovative financial structuring such as sub-ordinate debt, grants etc.

Project Development and Project Structuring, Land Acquisition

- Project development will be done by HRIDC through consulting Firms to establish project cost, land requirement, project design and other project component requirements, and project bankability.
- IR will do financial structuring of the project to make it bankable including identification of risk and mitigation measures.
- Land acquisition will be done either by Indian Railways at the JV's cost or by the JV itself as mutually decided. Ownership of the land will vest with Railways. Land will be given to the JV on annual token lease of 1 Rs. For the entire concession period.
- Cost of acquisition of land will be treated as long term non-interest-bearing advance and will be refunded to the JV on expiry/ termination of concession. For such cases the land acquisition cost will be certified by an independent agency.

Selection of Equity Partners, Funding, Revenue Model

- It envisages participation of the stakeholder and beneficiaries besides national level infrastructure funding institutions in the development and creation of rail infrastructure through appropriate concession.
- Financial participation will be through equity participation in the JV. The JV will be a joint venture with railways as a partner with IR or HRIDC holding a minimum of 26% equity shares. Other partners will be selected from the stakeholders such as users of the line like ports, mines, other Industries etc.
- Selection of partners will be done through transparent expression of interest process, with clearly laid down technical qualification based on parameters like net worth, minimum threshold of equity participation etc. However, participation by state governments and PSUs and other government entities will be through nomination basis.
- Projects will be assigned to JV by Ministry of Railways on nomination basis.
- Debt will be raised through project finance route without any guarantee by the government of India.
- Revenue from the operation of the project line will be collected by IR though its commercial staff. Revenue stream of the JV shall be established through revenue apportionment from freight operation for the project line as per inter-railway financial adjustment as stipulated in the IR code volume 1. No apportionment of the passenger revenues will be made. JV will provide free access to IR Passenger trains.
- Normal IR tariff/ freight rates will be applicable, inflated tariff to improve bankability could be approved by Railway Board in specific cases.
- Commercial utilization of railway land, commercial publicity rights as permissible under the law and public policy.

Construction

Project construction will be done by the JV. The JV must ensure transparency in project procurement in line with the extant guideline of government for public procurement. The JV may, however, choose to entrust construction to HRIDC. Certification will, however, be done by IR as per the extant rules/policy.

Maintenance

Maintenance of the project line could be done either by the JV or by IR through an O&M agreement. In case the maintenance is undertaken by the JV, supervision/ certification shall be done by IR on payment of supervision/certification charges by the JV.

Operations

Operations will be done by IR.

Recovery of O&M Cost

IR will recover O&M cost or cost of operations as applicable as per the agreement. The JV shall compensate IR for the fixed cost that is the cost of essential operational and maintenance staff and other maintenance expenditure (if maintenance is to be done by IR), or the cost of supervision/certification. The variable cost of operation i.e. the cost of rolling stock usage, fuel, crew etc. shall be recovered from the apportioned revenue. IR will pay to the JV apportioned revenue net of such cost as applicable, as per a predefined formula to be specified in the O&M or operations agreement.

Concession Period

Concession period is normally 30 years including the construction period. However, basis appraisal of the project in the Expanded Board for Railways (EBR), Concession period for the project has been increased to 50 years, The concession period shall be subject to both upward and downward revision depending on shortfall/excess of traffic materialization vis-à-vis the specified threshold traffic (80% of the total traffic to be carried during the concession period expressed in terms of million tonne Kms.) On the target date (25 years after signing of the agreement) threshold traffic shall be determined on the basis of the feasibility report. For every shortfall of 4%, the concession shall be extended by 1 year and a reverse principle shall apply if actual exceed the threshold traffic.

Cost of land acquisition paid by the JV shall not be factored in for the purpose of such equity return. No termination payment shall be admissible in case of natural expiry of concession period.

Risk Mitigation

Traffic guarantee and rolling stock availability agreement will be signed wherever such guarantees are considered necessary to mitigate demand risk. Traffic guarantee shall be in form of a "Take or Pay" agreement on the part of strategic partners (users) for the minimum volume of traffic to be moved. Strategic partners will be required to enter into an agreement with IR on minimum commitment of traffic volumes to be moved on the line. IR shall assure provision of rolling stock for loading and transportation in respect thereof. In case of failure by either the strategic partners (users) or IR, penalties stipulated in the agreement shall be payable to JV.

General Features

JV shall operate "common carrier" principle of public transportation of goods and passengers. For Rail users, IR would be the interface.

Implementation Schedule

- Immediate development of Manesar to Patli new railway line, where land is already available. Maruti Suzuki India Ltd (MSIL) siding will take off from

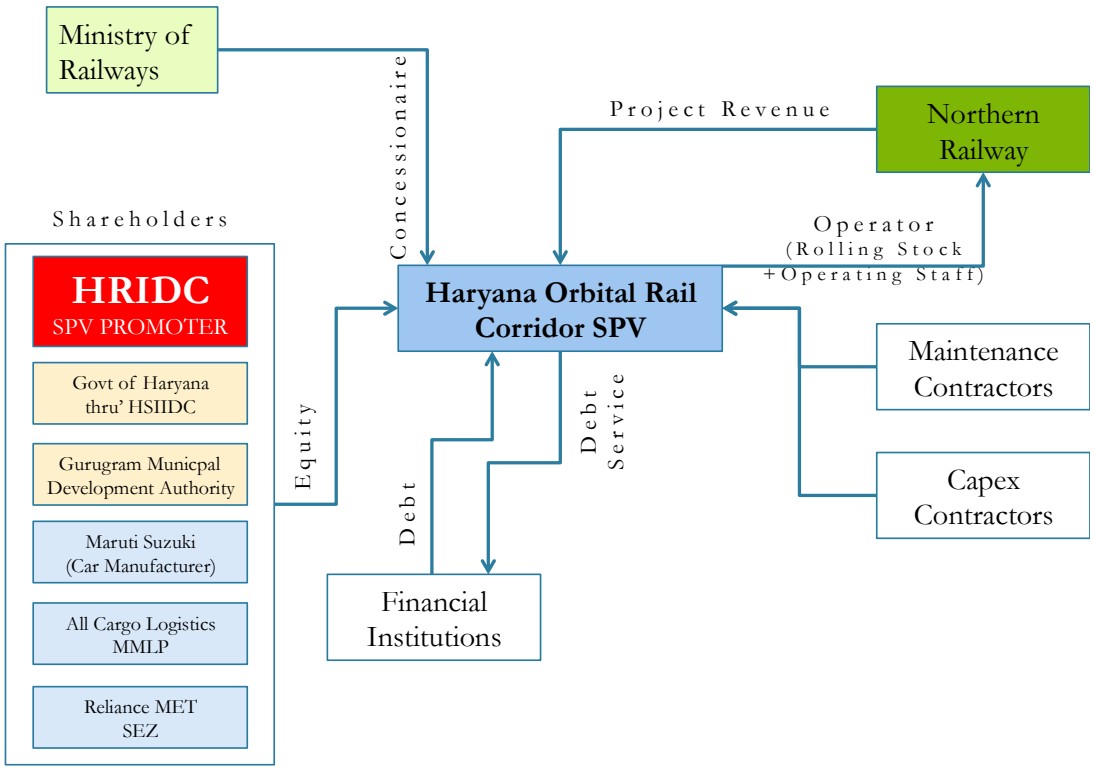
Manesar. The commissioning of this section and MSIL Siding will fetch revenue even during construction phase.

- Preparation of BID document for priority section can be taken up simultaneously while taking approval of CCEA.
- Land Acquisition process can be started immediately.
- Critical Activities like Tunneling, RFO/RUB/ROB, etc. shall be taken up simultaneously.
- Initially, the project is proposed to be financed through Equity only and Debt shall be required w.e.f. June,2020.
- The Detailed Implementation Plan is placed at Annexure-C1 & C2.

15 PROPOSED FINANCIAL STRUCTURING

15.1 Project Structure

Since the project has buoyant traffic, revenues and high operating margin, it is ideally suited for commercial financing models. The cost of project including land cost and net of TOD upfront revenue is Rs. 4822.69 Cr. The project has witnessed solid interest amongst key government stakeholders and major industries in the project influence zone. HSIIDC, the Industrial Development Corporation and GMDA, the local administrative body of Gurugram, have confirmed their interest to participate in the HORC Project as equity shareholders. Private parties like Maruti Suzuki, All Cargo Logistics and Reliance MET have expressed their interest to participate in the project with equity contribution. On the basis of JV model of Ministry of Railways Letter policy of "Participative models for rail-connectivity and capacity augmentation projects", the proposed project structure is as below.



15.2 Project Finance Structure

- As per the JV model, Government of India Ministry of Railways (Railway Board) Letter No. 2011/Infra/12/32 dated 10.12.2018, "Participative models for rail-connectivity and capacity augmentation projects.

- From the project structure, it can be seen that the HROC project shall be developed as Special Purpose vehicle of HRIDC. Accordingly, it is proposed that the HROC project is financed in the form of debt and equity.
- In light of buoyant traffic, we reckon, it shall be possible to finance the project in the debt: equity ratio of 70:30 with the availability of long tenor structured debt. For financial estimation, a loan tenure of 25 years (including construction period) has been considered at an interest rate of 5.5%. It has been considered that a soft loan shall be taken from Multilateral financial institutions such as Asian Infrastructure Investment Bank (AIIB). It is advisable that during negotiation, the Authority must propose a suitable moratorium period and longer loan repayment schedule as it will enhance the project sustainability.
- Further, since the project development period is five years, the debt and equity finance shall be spread over this period. This inter-alia means that project shall have to incur additional burden of interest during construction (IDC).
- The proposed alignment passes through the HSIIDC land near IMT Sohna, Manesar and Kharkhoda and 70 Hectares is required to acquire.

15.3 Project Operating Profit

The Operating profit for the project is difference between project revenues and O&M Cost. It can be seen in the table below:

	2020	2025	2030	2035	2040	2045	2049
Revenues/Year	1	6	11	16	21	26	30
Operating Revenues to SPV (Crore)	0.0	449.88	574.17	732.80	935.26	1193.65	1450.89
Including10% Increased Revenue with non-fare box cost	0.00	494.86	631.58	806.08	1028.78	1313.02	1595.98

	2050	2055	2060	2065	2069
Revenues/ Year	31	36	41	46	50
Operating Revenues to SPV (Crore)	1,523.44	1,944.33	2,481.52	3,167.11	3,849.65
Including10% Increased Revenue with non-fare box cost	1,675.78	2,138.77	2,729.67	3,483.83	4,234.61

It can be seen from the above table that the project has very high operating margins. It is expected to generate significant operating margins.

15.4 Capital Structure of the Project

The project is proposed to be financed through equity and debt in the ratio of 30:70.

Accordingly, the capital structure of the project is as follows:

- Project Cost = INR 5617.69Cr.
- Revenue from TOD upfront = INR 795 Cr.
- Net project Cost = INR 4822.69 Cr.
- Equity from Shareholders = INR 1500 Cr.
- Institutional Debt = INR 3322.69 Cr.

Assumptions for Debt

- Term loan tenor = 20 year(excluding construction period)
- Interest Rate = 5.5% per annum
- Moratorium = NIL
- Loan Amount = INR 3322.69 Cr
- Drawdown Scheme = Proportionate to Equity infusion

15.5 Projected Income Statement

Basis above assumptions, the projected Income Statement for HORC is as below:

(INR Crore)

	2020	2025	2030	2035	2040	2045	2050
Year	1	6	11	16	21	26	**31**
Project Revenues	-	494.86	631.58	806.08	1,028.78	1,313.02	1,675.78
Project O&M costs	-	37.06	47.30	60.37	77.05	98.34	125.50
EBITDA	-	457.80	584.28	745.71	951.73	1,214.68	1,550.28
Depreciation	-	109.81	109.81	109.81	109.81	109.81	109.81
EBIT	-	347.99	474.47	635.90	841.92	1,104.87	1,440.46
Interest	-	182.60	136.95	91.30	45.65	-	-
PBT	-	165.39	337.52	544.60	796.27	1,104.87	1,440.46
Income Tax	-	-	84.38	136.15	199.07	276.22	360.12
PAT	-	165.39	253.14	408.45	597.20	828.65	1,080.35

	2050	2055	2060	2065	2069
Year	**31**	**36**	**41**	**46**	**50**
Project Revenues	1,675.78	2,138.77	2,729.67	3,483.83	4,234.61
Project O&M costs	125.50	160.18	204.43	260.91	317.14
EBITDA	1,550.28	1,978.59	2,525.24	3,222.91	3,917.47

Depreciation	109.81	109.81	109.81	109.81	109.81
EBIT	1,440.46	1,868.78	2,415.42	3,113.10	3,807.66
Interest	-	-	-	-	-
PBT	1,440.46	1,868.78	2,415.42	3,113.10	3,807.66
Income Tax	360.12	467.19	603.86	778.27	951.91
PAT	1,080.35	1,401.58	1,811.57	2,334.82	2,855.74

15.6 Cash Flow Forecast

The table below shows the cash flow position of the project.

(Rs Cr)	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**
Opening Cash	-	1.77	4.92	3.45	4.68	4.67	683.59	1,967.17
Equity Infusion	595.00	225.00	225.00	225.00	230.00	-	-	-
Loan raised	-	885.00	970.00	720.00	745.00	-	-	-
Capex	593.23	1,082.52	1,121.12	821.94	812.89	-	-	-
PAT	-	(24.34)	(75.35)	(121.83)	(162.11)	165.39	253.14	408.45
Add Depreciation	-	-	-	-	-	109.81	109.81	109.81
Loan Repaid	-	-	-	-	-	166.00	166.00	166.00
Closing Cash	1.77	4.92	3.45	4.68	4.67	113.88	880.55	2,319.43

(Rs Cr)	**2040**	**2045**	**2050**	**2055**	**2060**	**2065**	**2069**
Opening Cash	4,090.92	7,239.68	12,410.85	18,972.81	27,309.79	37,912.19	48,440.37
Equity Infusion	-	-	-	-	-	-	-
Loan raised	-	-	-	-	-	-	-
Capex	-	-	-	-	-	-	-
PAT	597.20	828.65	1,080.35	1,401.58	1,811.57	2,334.82	2,855.74
Add Depreciation	109.81	109.81	109.81	109.81	109.81	109.81	109.81
Loan Repaid	166.00	-	-	-	-	-	-
Closing Cash	4,631.94	8,178.14	13,601.01	20,484.20	29,231.17	40,356.83	51,405.93

15.7 Project Financial Results

The detailed year on year cash flow forecast is in the Annexure. The summarized financial results are as below:

Measure	Results
Project IRR	10.22%
Equity IRR	14.35%
Min. DSCR	1.31
Average DSCR	3.19
Min. ISCR	1.91

On overall basis of above capital structure and project financials, the equity IRR is 14.35%. Considering the fact that the project is recipient of only 50% of the revenue, excluding terminal handling costs, this is a good return.

As Indian Railways shall be a major beneficiary of this project, in terms of decongestion of Delhi, as well has increase in rail-share from new traffic, there is a strong case for HRIDC to seek better revenue share in the form of "inflated kilometers" and "terminal handling fees", which shall better the project prospects for all.

15.8 Stakeholders Consultation

The project is envisaged to be executed as per JV model with participation of various stakeholders. In this regard, HRIDC has taken following action to identify the potential stakeholders:

15.8.1 Stakeholders Meet at Gurugram

A "Stakeholders meet" in connection with 'Haryana Orbital Rail Corridor' project was held at Gurugram on 13.02.2019. The meeting was attended by officers from Railway Board, Northern Railway, Government of Haryana, concerned PSUs of Central & State Government and representatives of Industries, Banks & Financial Institutions etc. Hon'ble Chief Minister Haryana has also attended this Stakeholders meet and appreciated the project & the enthusiasm shown by the participants in the meet. During the Stakeholders meet, Maruti Suzuki India Ltd has confirmed to participate in the Project SPV as one of the equity partners. Also, keen interest was shown by Allcargo Logistics, Reliance MET and J.M. Baxi Group for participation in the Project SPV.

15.8.2 Expression of Interest

To seek participation of all concerned stakeholders in the process of development of this project and to ensure full transparency, Expression of Interest (EOI) for Equity Participation in Project SPV (Special Purpose Vehicle) for "Haryana Orbital Rail Corridor" Project was invited by publishing EOI notice in leading newspapers and by uploading on HRIDC website. Though keen interest was shown by a few parties, no party participated in the EOI.

Further, the HRIDC conducted meetings and held discussions with various public and private entities that are in the logistics business along the project alignment to solicit their participation in the project as stakeholders.

Govt./ Public entities like HSIIDC and GMDA have consented to participate in the project. Private entities like MSIL, JM Baxi Group and All Cargo Logistics have also consented to participate in the project. The private entities that

have shown their willingness to participate as equity partners in the project fulfil the required eligibility criteria as per EOI.

MSIL has already given its firm consent for participation in the project SPV to the tune of Rs. 182 Cr. M/s All Cargo Logistics has conveyed their In-Principle approval for participation in the project SPV vide their letter dated 04.04.2019. M/s. JM Baxi Group has conveyed their In-Principle approval for participation in the project SPV vide their letter dated 30.04.2019.

15.9 Project Financial Structuring

- As per the JV model, Government of India Ministry of Railways (Railway Board) Letter No. 2011/Infra/12/32 dated 10.12.2018, "Participative models for rail-connectivity and capacity augmentation projects.
- From the project structure, it can be seen that the HORC project shall be developed as Special Purpose vehicle of HRIDC. Accordingly, it is proposed that the HORC project is financed in the form of debt and equity.
- In light of buoyant traffic, we reckon, it shall be possible to finance the project in the debt: equity ratio of 70: 30 with the availability of long tenure structured debt. For financial estimation, a loan tenure of 25 years (including construction period) has been considered at an interest rate of 5.5%. It has been considered that a soft loan shall be taken from Multilateral financial institutions such as Asian Infrastructure Investment Bank (AIIB). It is advisable that during negotiation, the Authority must propose a suitable moratorium period and longer loan repayment schedule as it will enhance the project sustainability.
- Further, since the project development period is five years, the debt and equity finance shall be spread over this period. This inter-alia means that project shall have to incur additional burden of interest during construction (IDC).
- The proposed alignment passes through the HSIIDC land near IMT Sohna, Manesar and Kharkhoda.
- The total project cost including private land that needs to be acquired with IDC is Rs. 5617.69 Cr (excluding TOD upfront revenue). Considering upfront Revenue of Rs. 795 Cr from Transit Oriented Development (TOD) during construction, the Net Cost is Rs. 4822.69 Cr. Out of this, 70% debt i.e. Rs. 3322.69 Cr and 30% overall equity i.e. Rs. 1500 Cr is considered.
- Out of the total equity, proposed Equity share of various stakeholders is mentioned below:

Overall Equity	Rs. 1500 Cr
Equity share of Various Stakeholders	
Stakeholder	**% Equity Share(in Rs)**
HRIDC*	42.93% (644 Cr)

HSIIDC	19.00% (285 Cr)
GMDA	4.77% (71.5 Cr)
Private Sectors (MSIL, AllCargo, JM Baxi)	33.30% (499.5 Cr)

*Contribution of HRIDC: Rs. 328.44 Cr from GoH and Rs. 315.56 Cr from MoR

16 PROJECT SENSITIVITY ANALYSIS

For a project of this nature with long duration and high gestation, sensitivity analysis is vital. The project returns shall change for increase/decrease in project cost and projected traffic. Therefore, we propose, following sensitivity analysis:

A. Decrease in Project Revenue by 10%

B. Increase in lending rate by 1.0%

C. Decrease in Project Revenue by 10% and Increase in lending rate by 1.0%

16.1 Project Financial Results for decrease in Project Revenue by 10%

In this event, the project financial parameters shall change as below:

Measure	Results
Project IRR	9.48%
Equity IRR	13.10%
Min. DSCR	1.17
Average DSCR	2.85
Min. ISCR	1.63

16.2 Project Financial Results for Increase in lending rate by 1.0%

In this event, the project financial parameters shall change as below:

Measure	Results
Project IRR	10.05%
Equity IRR	13.96%
Min. DSCR	1.20
Average DSCR	3.05
Min. ISCR	1.61

16.3 Financial Results for increase in lending rate by 1.0% and decrease in revenue by 10%

Measure	Results
Project IRR	9.34%
Equity IRR	12.80%
Min. DSCR	1.07
Average DSCR	2.72
Min. ISCR	1.38

It may be seen from the above sensitivity analysis scenarios that the project passes sensitivity analysis scenario and is able to serve debt obligations.

X-X-X-X-X

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2019/JVCell/Haryana/Project/06 New Delhi date. 05.03.2019

Managing Director,
HRIDC,
Bay no 13-14, Sector-2,
Panchkula, Haryana

Sub: Haryana Orbital Rail Corridor - New BG Electrified Double Line from Palwal to Sonipat, linking Asaoti-Patli-Rathdhana (141.5 Km) : IPA thereof.

Ref. (i) HRIDC's Letter No. HRIDC/PPJ-48/2019/251 dated 15.02.2019.
(ii)Railway Board's Letter No. 2018/JVCell/Genl./SPV/Policy/02 dated 05.04.2018.

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL) vide letter under reference (i) has submitted the feasibility study report for Haryana Orbital Rail Corridor - New BG Electrified Double Line from Palwal to Sonipat, linking Asaoti-Patli-Rathdhana Project (141.5 Km including connections) along with request to accord In-Principle approval for taking up further actions in terms of MoF letter No. 24(35)/PF-II/2012 dated 05.08.2016.

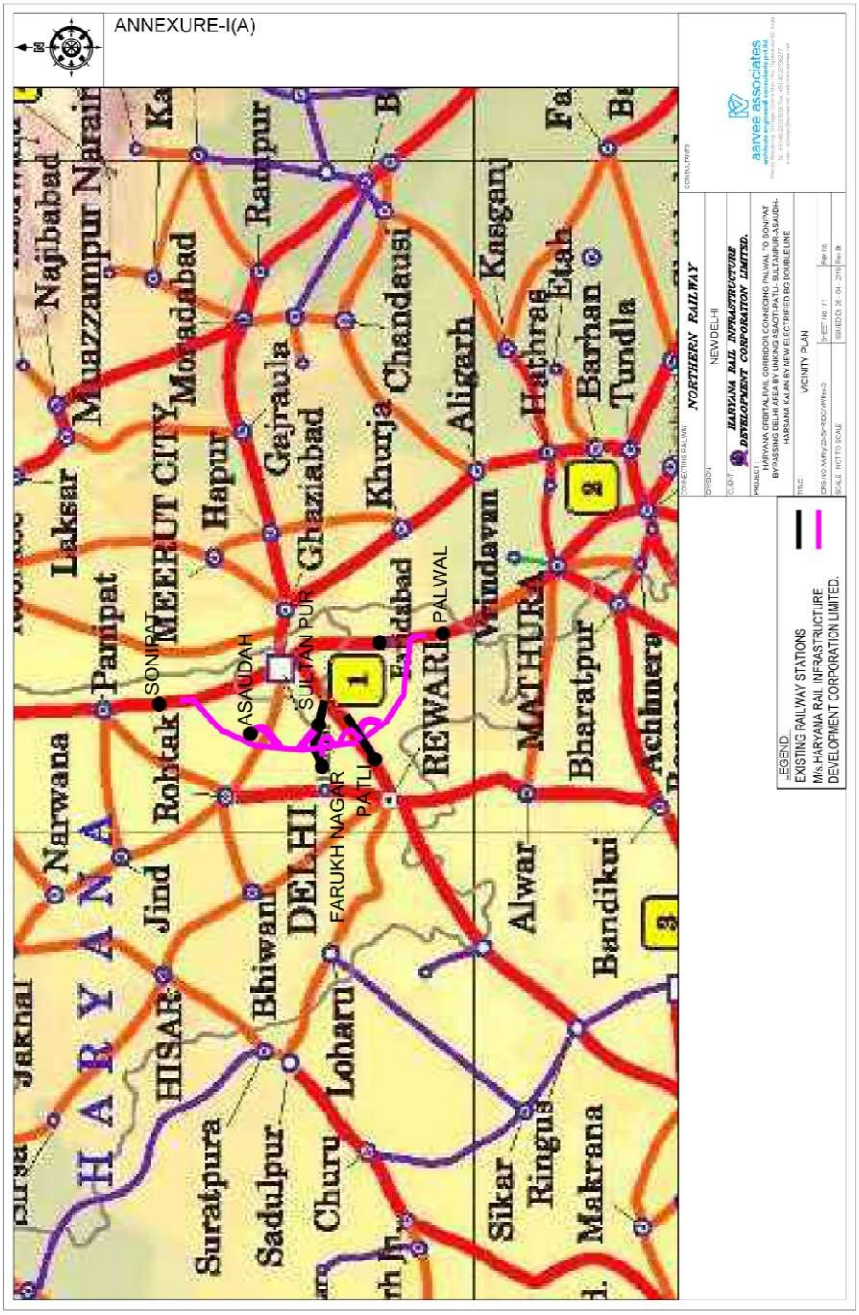
The project proposal has been examined in Ministry of Railways and Board (FC), the competent authority has accorded In-Principle Approval subject to the following:-

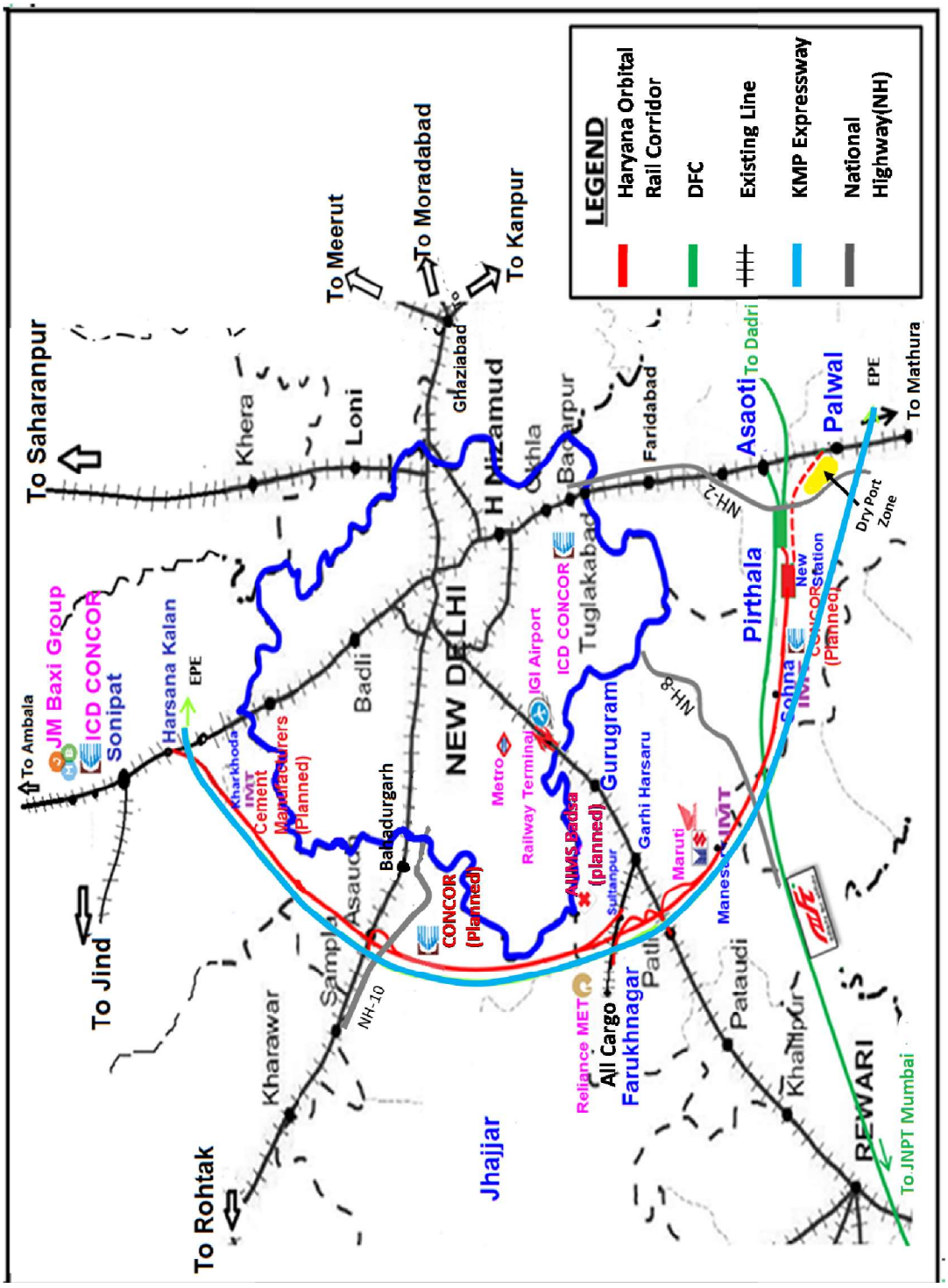
(i) The equity investment of MoR in the above project may be restricted to Rs. 200 crore or less, to the extent possible.
(ii) HRIDCL may incorporate Project SPV for the Project for the purpose of identifying partners, taking up pre-investment activity and achieving preliminary financial closure.
(iii) HRIDCL shall complete its due diligence, prepare DPR and obtain approval of the board of HRIDCL.
(iv) HRIDCL shall approach the concerned Zonal Railway(s) within 6 months, for evaluation of DPR as per Board's guidelines dated 05.04.2018 and also to Government of Haryana and other stakeholders for their consent/issue of Government Order.
(v) Thereafter, HRIDCL shall submit DPR with G.O. of Government of Haryana and consent of all stakeholders along with remarks on comments of the concerned Zonal Railway(s) to Railway Board, for obtaining sanction of the Project by the Competent Authority.

05.03.2019
(Ruth Changsan)
Director/MTP
Railway Board
011-47845480

Copy for kind information to:

1. Chief Secretary, Government of Haryana, 4th Floor, Haryana Civil Sectt., Chandigarh.
2. General Manager, Northern Railway, Baroda House, New Delhi.
3. Advisor (Transport), Advisor (PAMD), NITI Aayog, Yojana Bhawan, New Delhi.
4. AM (Works), AM (Planning), AM (Finance), AM (Traffic), Railway Board
5. PCE, COM, FA&CAO, CAO/C, Northern Railway, New Delhi.


ANNEXURE-I(A)
HARYANA
DELHI
Najibabad
Muzzampur Naraingarh
Laksar
Pampat
MEERUT CITY
Moradabad
Rampur
Hapur
Gajraula
Ghaziabad
Khurja
Chandausi
Aligarh
Kasganj
Hathras
Etah
Barhan
Tundla
Narwana
Jind
Rohtak
SONIPAT
ASAUDAH
SULTAN PUR
FARUKH NAGAR
PATLI
Faridabad
PALWAL
REWARI
Vrindavan
MATHURA
Bharatpur
Achhnera
Jakhal
HISAR
Bhiwani
Suratpura
Sadulpur
Churu
Loharu
Alwar
Bandikui
Sikar
Ringus
Makrana
1
2
3
LEGEND
EXISTING RAILWAY STATIONS
M/s HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.
NORTHERN RAILWAY
NEW DELHI
HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED.
VICINITY PLAN
aarvee associates


LEGEND
Haryana Orbital Rail Corridor
DFC
Existing Line
KMP Expressway
National Highway(NH)
To Saharanpur
To Meerut
To Moradabad
To Kanpur
Khera
Loni
Ghaziabad
H Nizamud
Ghla
Badarpur
Faridabad
Asaoti
To Dadri
Palwal
EPE
To Mathura
NH-2
Dry Port Zone
Pirthala
New CONCOR Station (Planned)
Sohna
IMT
NH-8
Tuglakabad
ICD CONCOR
IGI Airport
NEW DELHI
Metro
Railway Terminal
Gurugram
Garhi Harsaru
Maruti
Manesar IMT
Badli
Harsana Kalan
EPE
To Ambala
JM Baxi Group
ICD CONCOR Sonipat
Kharkhoda IMT
Cement Manufacturers (Planned)
Bahadurgarh
AIIMS Badsa (planned)
Sultanpur
CONCOR (Planned)
Sampla
Asaudah
NH-10
To Jind
Kharawar
To Rohtak
Jhajjar
Reliance MET
All Cargo
Farukhnagar
Patli
Pataudi
Khalilpur
REWARI
To JNPT Mumbai

S. No.	Schedule	Duration (Qtrs)	2020			2021				2022	
			2	3	4	1	2	3	4	1	2
PATLI to MANESAR - 8 Km											
1	Geo. Tech. Investigation & Designs	2									
2	Approval & Tendering	2									
3	Earthwork and Minor Br	4									
4	Major Bridge	3									
5	Track Work	3									
6	Station Buildings, etc.	2									
7	Traction & OHE Works	2									
8	Electrical Works	2									
9	S&T Works	2									
10	Testing and Commissioning	2									

aarvee associates
architects engineers & consultants pvt. ltd.

SN	Schedule	Duration (Qtrs)	2020			2021				2022				2023				2024				2025
			2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
Balance Section (114 Km)																						
1	Land Acquisition	6	■	■	■	■	■															
2	GT Investigation & Dsgn	3	■	■	■																	
3	Approval & Tendering	4		■	■	■	■															
4	Earthwork and Minor Br	9				■	■	■	■	■	■	■	■	■								
5	Major Br, ROB & RFOs	12				■	■	■	■	■	■	■	■	■	■	■	■					
6	Tunneling work	15			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
7	Track Work	6												■	■	■	■	■	■			
8	Station Buildings, etc	7										■	■	■	■	■	■	■				
9	Traction & OHE installation	4															■	■	■	■		
10	Electric Power Distribution	4															■	■	■	■		
11	S&T Installation	4																■	■	■	■	
12	Testing and Commissioning	2																				■

Stake Holders Out reach Event Guest List			Annexure – II
GOVERNMENT OF HARYANA			
S No.	**Name**	**Organisation**	**Designation**
1	Sh. Manohar Lal	State Government	Chief Minister, Haryana
2	Sh. Depinder Singh Dhesi, IAS	State Government	Chief Secretary, Haryana
3	Sh.Viney Partap Singh	State Government	DC Gurugram
4	Sh. Mani Ram Sharma, IAS	State Government	DC Palwal
5	Sh. Mohmad Sareen	State Government	Commissioner Of Police, Gurugram
6	Sh. V. Umashankar	State Government	Addl. PSCM
7	Sh. Alok Nigam, IAS	Public Works Department	Addl. Chief Secretary
8	Sh. Dilbaghh S. Dahhiya	HSIIDC	
9	Smt. Divya Kamal	HSIIDC	
10	Sh. Manoj Prashar	HSWC	AM (QC)
11	Sh. Narhari Singh Banger	HSIIDC	MD
12	Smt. Suman	HSWC	JTA-
13	Sh. Biplav Kumar	DFCCIL	GGM/BD
14	Sh. Narhari Singh Banger	HSIIDC	
15	Sh. O.P.Goyal	HSIIDC	
16	Sh. .S.K Verma	HSIIDC	
MINISTRY OF RAILWAY			
S No.	**Name**	**Organisation**	**Designation**
17	Mr. Rajesh Agarwal	Railway Board	ED/MTP/RB
18	Mr. Devender Singh	Northern Railway	CTPM/NR
19	Sh. Baljeet Singh Kundu	Northern Railway	Estate Officer
20	Sh. Harpal Singh	Ministry of Railways	
21	Sh. Rajeev Kumar	NCRTC	
22	Sh. Vikas Kumar	NCRTC	
23	Sh. Dhanesh Gupta	NCRTC	
24	Sh. R.D Gupta	NCRTC	
25	Sh. S.K. Lohia	IRSDC	MD & CEO
INDUSTRIES/LOGISTIC BUSINESS ENTITIES			
S No.	**Name**	**Organisation**	**Designation**
26	Sh. Prakash Tulsiani	Allcargo	
27	Sh. Sudesh Paul Vatsa	Allcargo	
28	Sh. Nihir Mishra	Maruti Suzuki India	
29	Sh. Shigeo Yanai	Mitsui & co. India Pvt. Ltd	GM
30	Sh. Himanshu Bisht	Mitsui & co. India Pvt. Ltd	Manager
31	Sh. Rohit Ahuja	Dp. World	GM Business Development
32	Sh. S.V. Goyal	Private Sector Omaxe	
33	Sh. Pawan Chaudhary	Invest India	
34	Sh. Ajay Nijhawan	Reliance Model Economic Township	
35	Sh. N. Ramakrishna	Kribhco Infrastructure Limited	
36	Sh. Gaurav Kumar	Infratech Pvt Ltd	
37	Sh. Surender Kumar Goyal	Private Sector Omaxe	
38	Sh. Deepak Jain	Federation of Indian Industry	
39	Sh. CA Naveen Jain	Industrial Financial Branch	
40	Sh. Saurabh Bhayana	L & T Financial Service	
41	Sh. Naveen Kumar	JSC Corp	
42	Sh. Venugopal Batchu	Maruti Suzuki India	
43	Sh. Capt. Viren Bawa	CMA-CGM	CEO
44	Sh. Parikshit Nagpal	Bothra Group	Sr. General Manager
45	Dr. L.R Thapar	Hind Terminals	
46	Sh. Nitin Behl	Allcargo	SGM
47	Sh. Tarun Garg	Maruti	
48	Sh. Jaspal Singh	M3M	
49	Sh. Harish Aher	Deesha Associates	
50	Sh. Manoj Kumar	Microtek	
51	Sh. Dipender Kaushik	MFH	
52	Sh. Akhilesh Kaushik	MFH	
53	Sh. Harpal Singh	ED/WD/Railway Board	

54	Sh. Shrivallabh Goyal	Reliance Met	Director-CEO
55	Sh. Alok Nigam	Public Works Department	IAS
56	Sh. Saurabh Suneja	NIIF	
57	Sh. K.S. Rao	Aarvee	
58	Sh. N. J Rao	Aarvee	
59	Sh. Dipesh Dipu	Aarvee	
60	Sh. Santosh Reddy	Aarvee	
		PWC	
S No.	**Name**	**Organisation**	**Designation**
61	Sh. Mayank Kumar	PWC	
62	Smt. Tanisha Kalra	PWC	
63	Sh. Pawan Nyayapati	PWC	
64	Sh. Sanchit Aggarwal	PWC	
65	Sh. Raghav Issar	PWC	
66	Sh. Satender Pratap Singh	PWC	
67	Sh. Kunal Aggarwal	PWC	
68	Sh. Navneet Kumar	PWC	
69	Sh. Ritwik	PWC	
		FUNDING AGENCIES : BANKS, FINANCIAL INSTITUTION	
S No.	**Name**	**Organisation**	**Designation**
70	Sh. A.K Azad	PNB	Executive Director
71	Smt. Rashmita	PNB	
72	Sh. N.D Bansal	PNB	
73	Sh. P.C. Sunoj	SBI	
74	Sh. S.K.Singh	Central Bank Of India	
		HRIDC	
S No.	**Name**	**Organisation**	**Designation**
75	Sh. Rajender Bhati	HRIDC	Co-ordinator

HRIDC

A JV Company of Ministry of Railways and Government of Haryana

EXPRESSION OF INTEREST

FOR INVESTMENT OPPORTUNITY IN "HARYANA ORBITAL RAIL CORRIDOR PROJECT FROM PALWAL TO SONIPAT" BYPASSING DELHI IN THE JURISDICTION OF NORTHERN RAILWAY

HRIDC invites interested parties to invest in the proposed project as Equity Partners in the Special Purpose Vehicle (SPV).

Salient Features of Project:

1. Approx. Cost	:	Rs. 4100 Cr
2. Length of Project	:	130 Km (Double Line)
3. Proposed Connectivity	:	All existing IR routes within the project reach and DFC network at Pirthala
4. Expected IRR	:	12-14 %

EOI can be submitted via email to hridc2017@gmail.com or via post at HRIDC Corporate Office address on or before 15:00 hrs, 29.03.2019.

For more details visit our website: http://hridc.co.in

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